

June 5, 1956

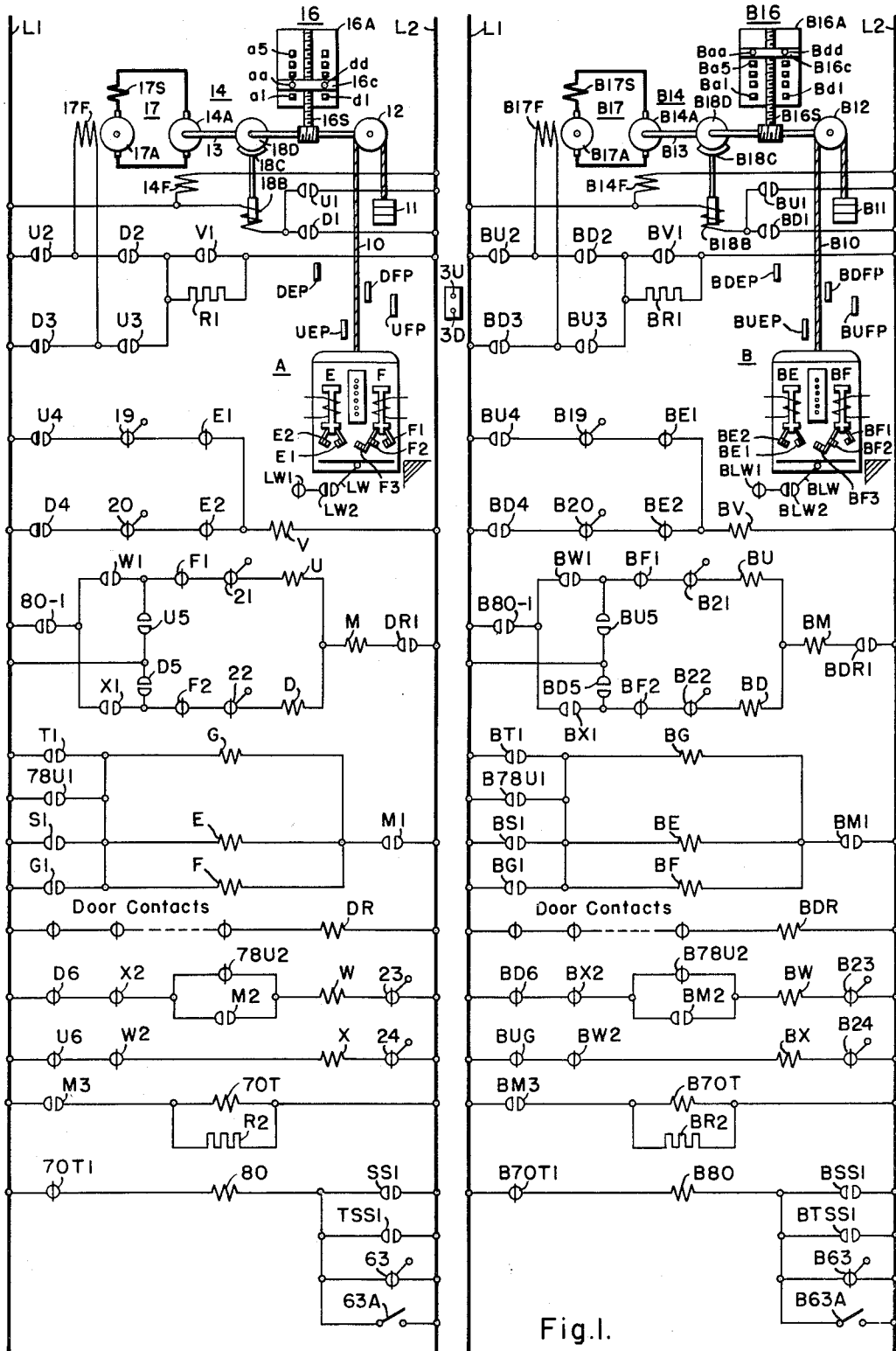
J. SUOZZO

2,748,894

ELEVATOR SYSTEMS

Filed March 29, 1955

8 Sheets-Sheet 1



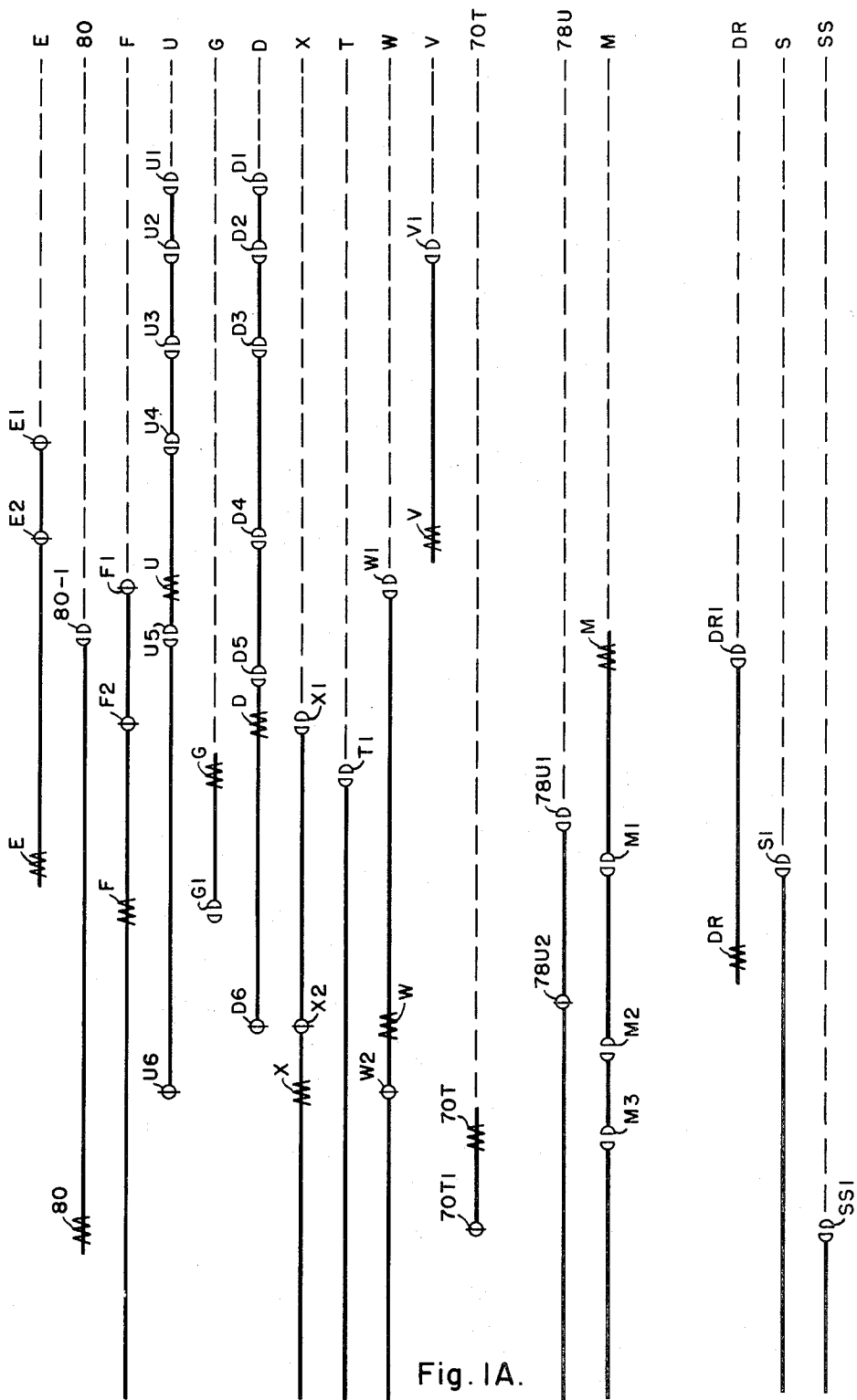
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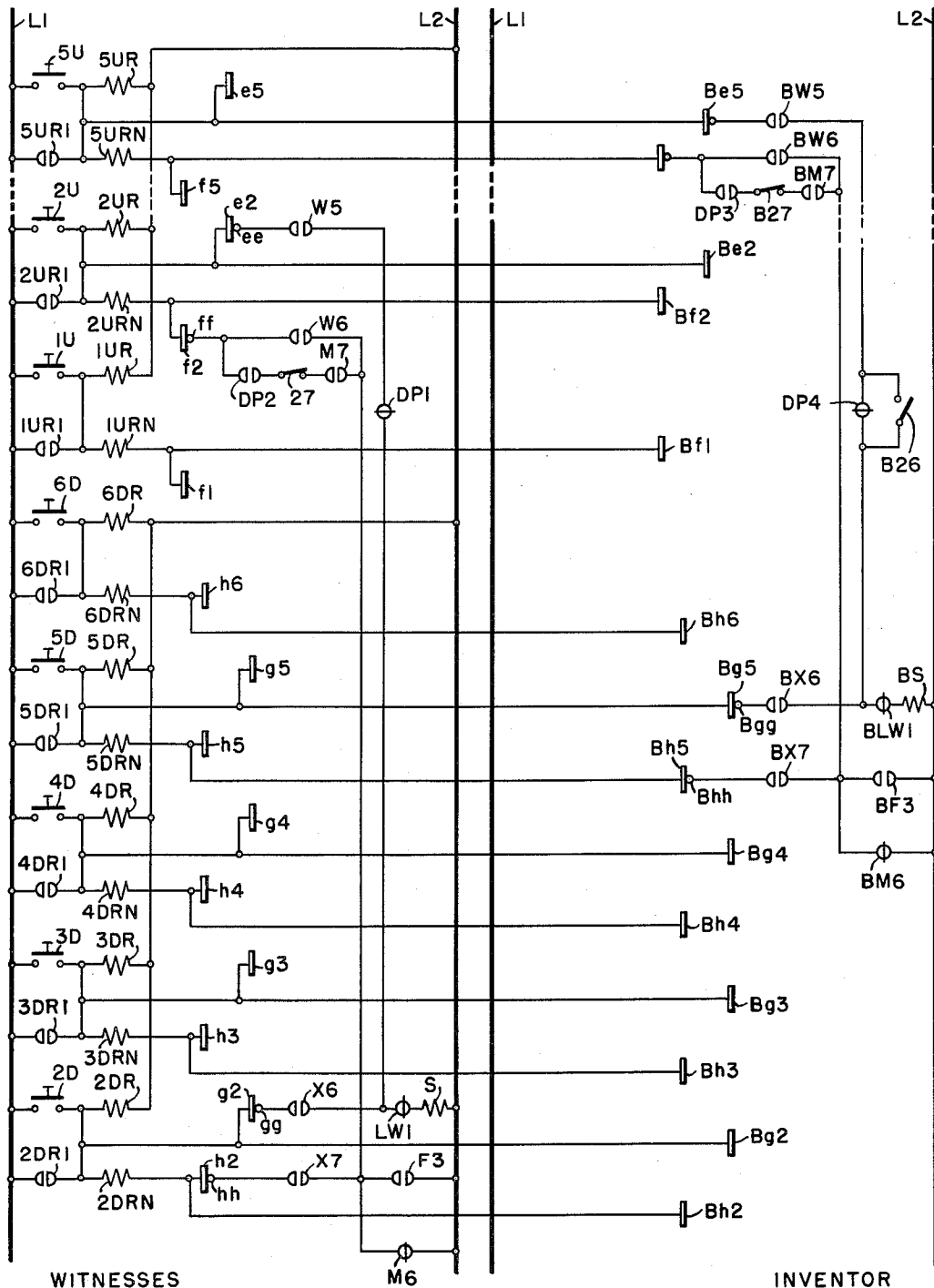
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WITNESSES

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Fig. 2.

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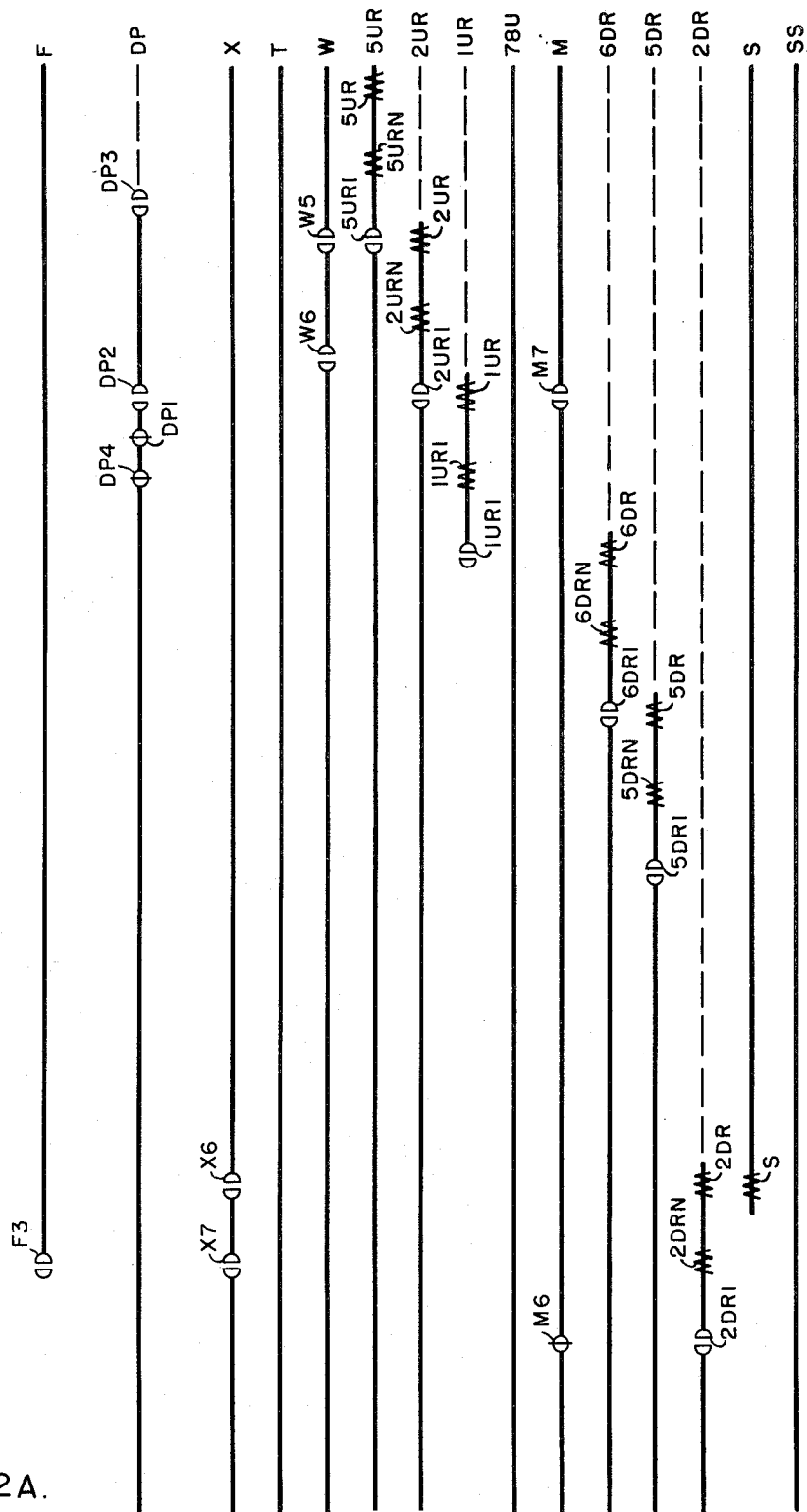


Fig. 2A.

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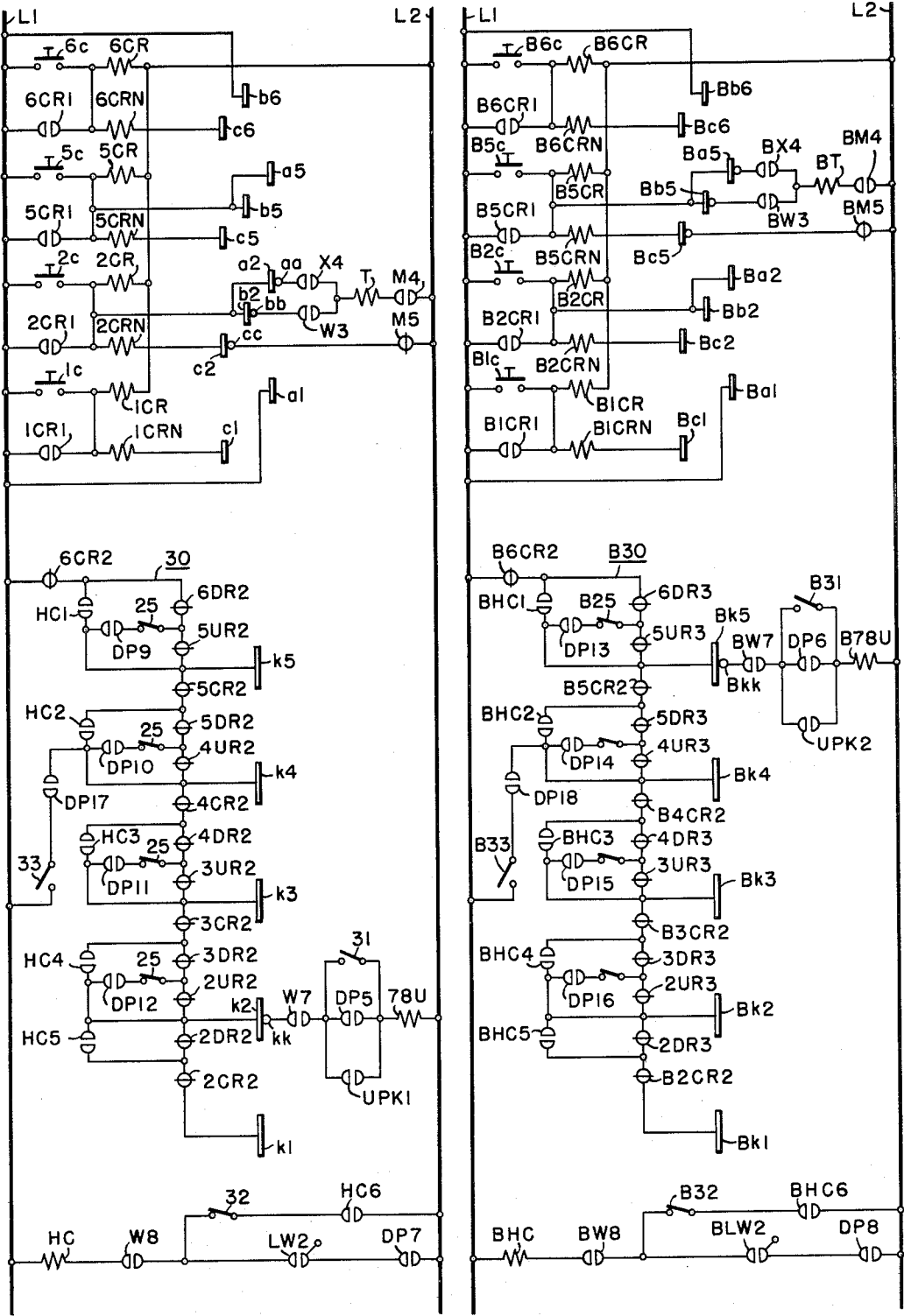


Fig. 3.

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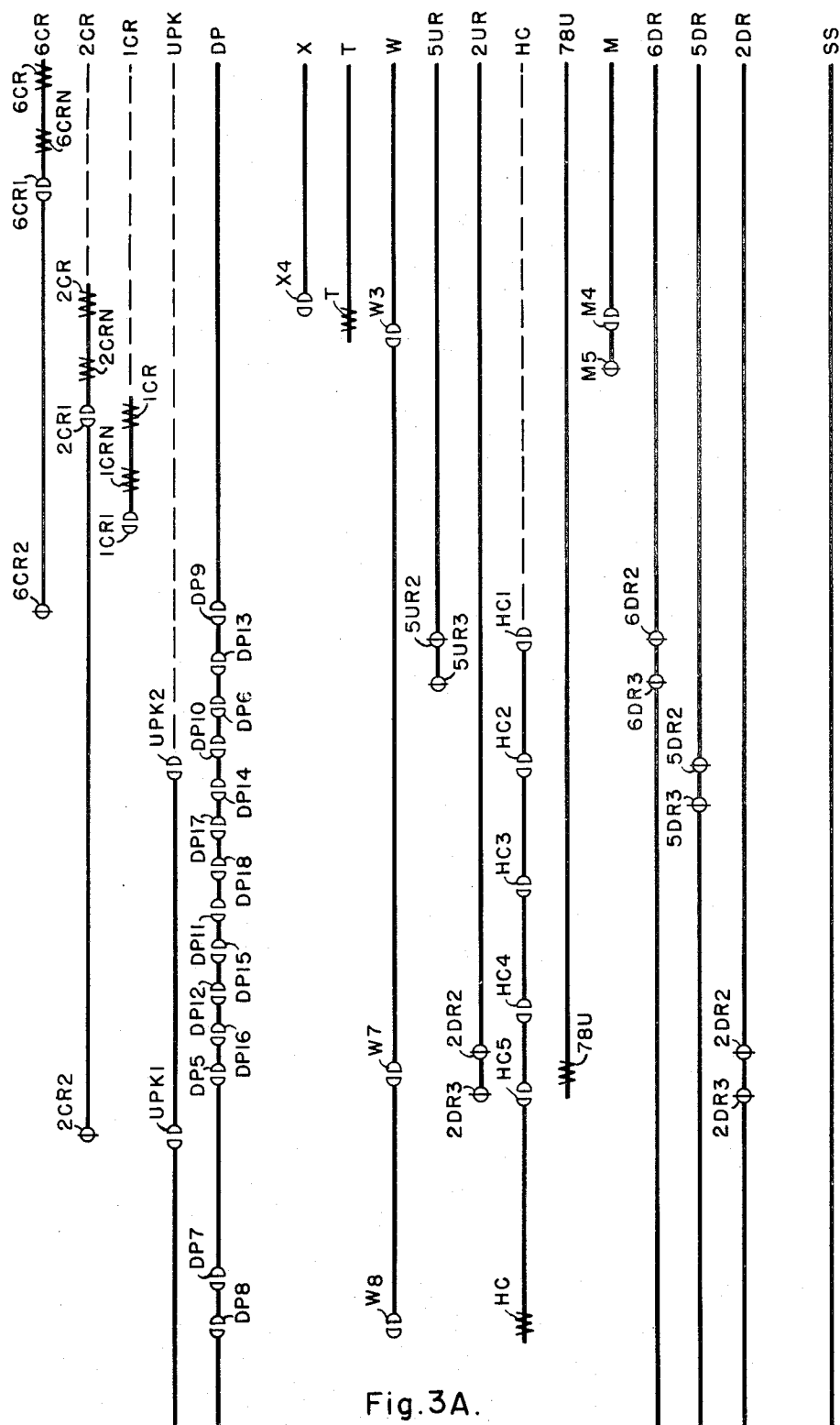
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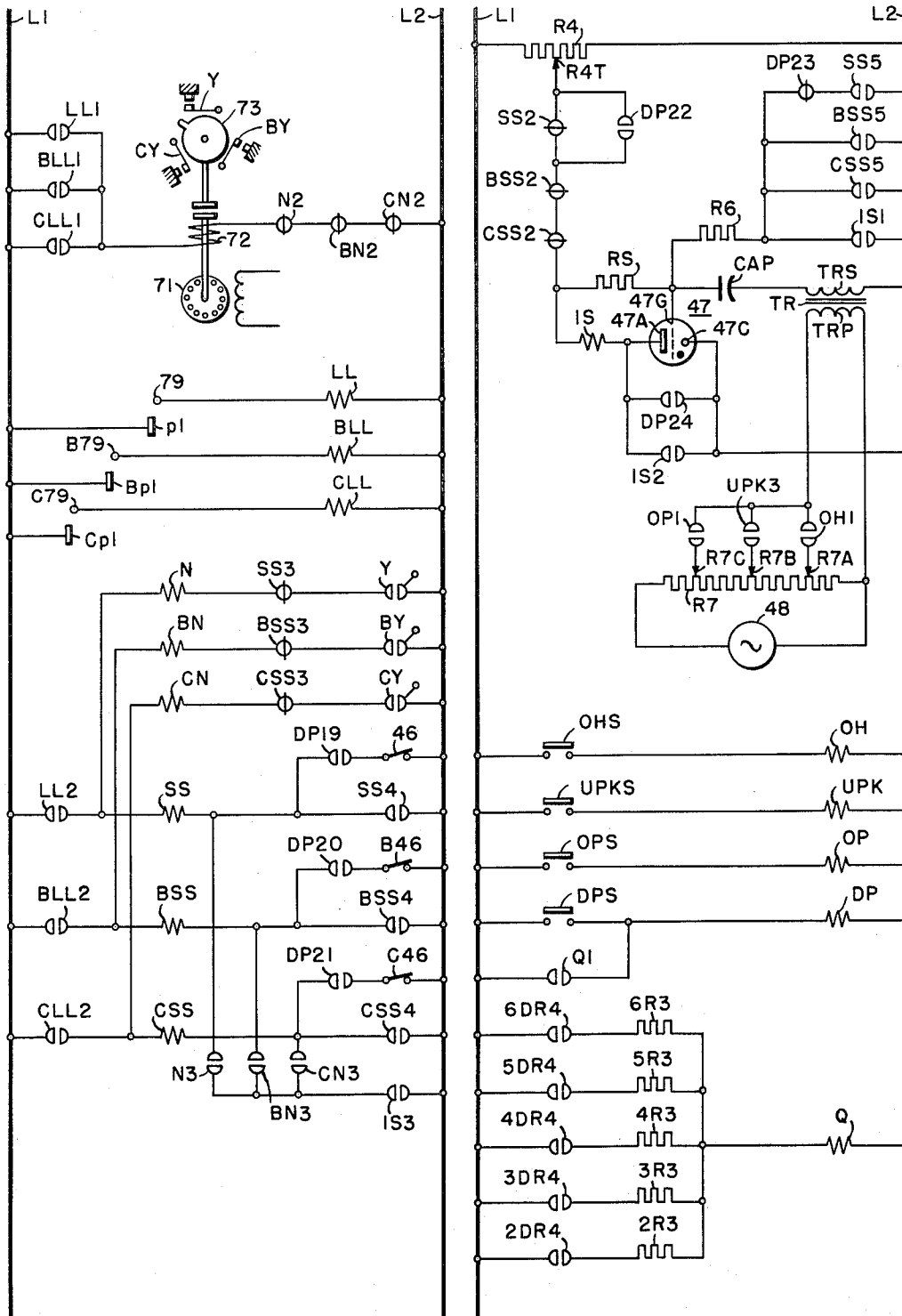


Fig. 4.

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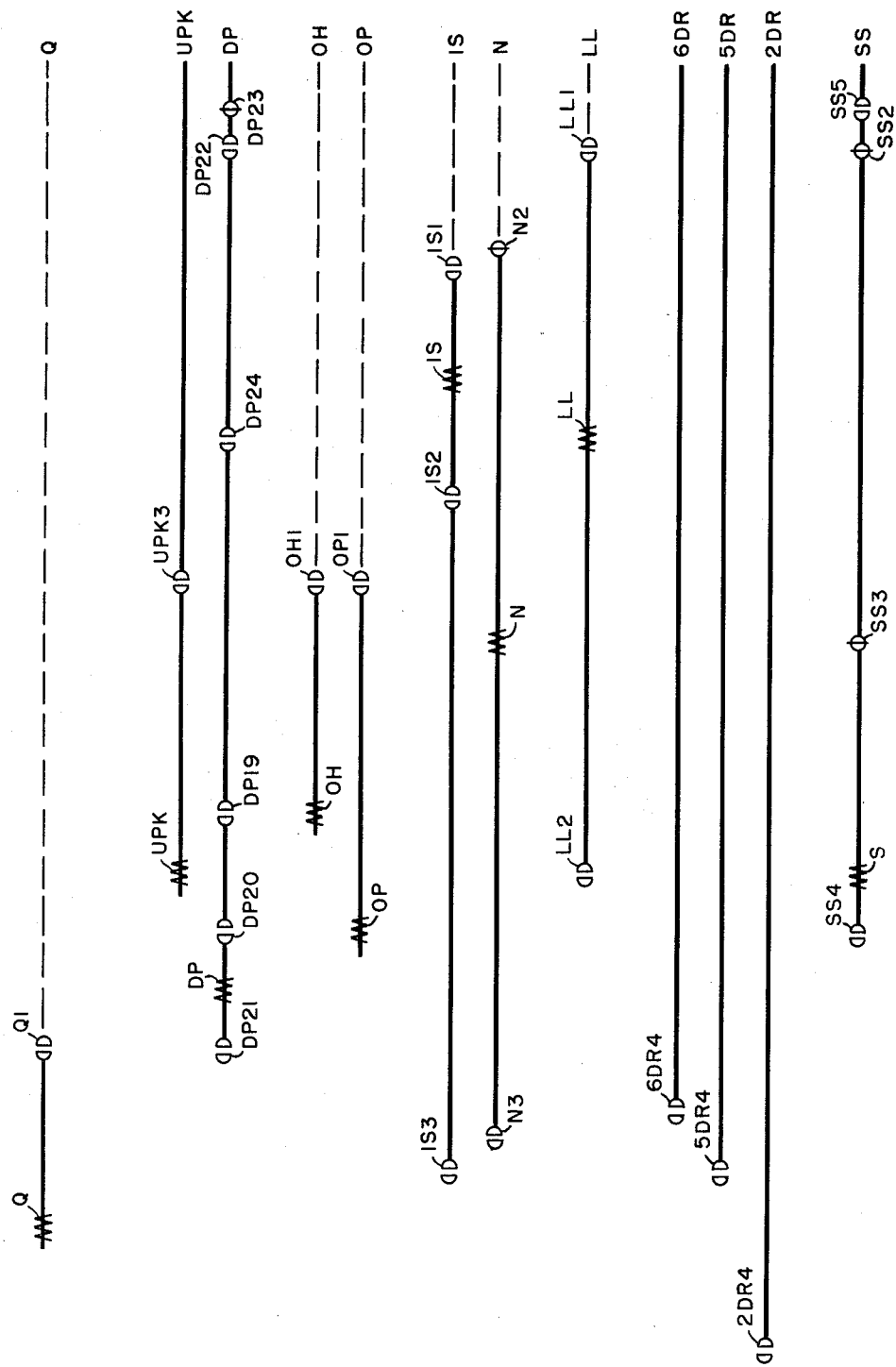


Fig. 4A.

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ELEVATOR SYSTEMS

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11 Claims. (Cl. 187—29)

This invention relates to elevator systems providing elevator service dependent on traffic demand and it has particular relation to elevator systems providing automatic control variations designed to assure continuous and efficient elevator service under various traffic demands and operating conditions.

The elevator system to which the invention is applied may be of the attendant or non-attendant type as desired. However, the invention is particularly suitable for a bank of elevator cars designed for operation without attendants and will be described with particular reference to such a system.

An elevator system designed to carry passengers should provide efficient service throughout a day wherein the nature of the demand for service may vary appreciably. Thus, the elevator system may be required to provide efficient service during periods which are known as off-hour periods, up-peak periods, off-peak periods and down-peak periods. An off-hour period is one wherein the demand for elevator service is infrequent or intermittent and may occur during the night in an office building. During an up-peak period the elevator car is required to carry passengers predominantly in the up direction. Traffic during an off-peak period is substantially balanced in the two directions of travel. In the down-peak period traffic is predominantly in the down direction.

When elevator cars are arranged in banks for operation between terminal floors, it is common practice to provide a dispatcher for controlling the departure of the elevator cars from each of the terminal floors. The dispatcher ordinarily controls the minimum lapse of time required between the startings of successive elevator cars from a terminal floor. This lapse of time is commonly referred to as a dispatching interval.

It has been found that different dispatching intervals are desirable for different modes of operation. Thus, for off-hour operation, a long dispatching interval may be desirable. For up-peak operation, a shorter dispatching interval may be desirable from the lower terminal floor. For off-peak operation, a still shorter dispatching interval may be satisfactory, while for down-peak operation a substantially zero dispatching interval may be satisfactory for the lower terminal floor. It is to be understood that the dispatching interval for the upper terminal floor need not be the same as that employed for the lower dispatching floor, particularly during peak-period operation.

In accordance with the invention, selective means is provided for controlling the mode of operation of the elevator system. A selective means preferably is effective for adjusting the response of the elevator cars to calls for service to provide the most efficient elevator car service for each of the modes of operation. In addition, the selective means adjust the dispatching interval at a dispatching floor to provide the most desirable interval for each of the modes of operation.

The invention further contemplates that the dispatching interval for any of the modes of operation may be

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adjusted independently of the intervals for the remaining modes of operation. In addition, a master adjustment may be provided which is effective for modifying the dispatching intervals for all of the modes of operation, preferably in a proportional manner.

It is, therefore, an object of the invention to provide an elevator system having plural modes of operation for a plurality of elevator cars wherein the conditioning of the elevator system for a specific mode of operation simultaneously selects a dispatching interval for a dispatching floor which is particularly suitable for the selected mode of operation.

It is another object of the invention to provide an elevator system having a plurality of elevator cars which may be arranged for various modes of operation and having different dispatching intervals for dispatching elevator cars from a dispatching floor for the various modes of operation wherein each of the intervals is adjustable independently of the remaining intervals.

It is also an object of the invention to provide an elevator system as described in the preceding paragraph wherein a master adjustment is provided effective for adjusting simultaneously the dispatching intervals available for all of the modes of operation.

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 schematic view with circuits shown in straight-line form of a portion of an elevator system embodying the invention;

Figs. 2, 3 and 4 are schematic views with circuits shown in straight-line form of further portions of the elevator system illustrated in Fig. 1; and

Figs. 1A, 2A, 3A and 4A, respectively, are key representations of relays and switches illustrated in Figs. 1, 2, 3 and 4. If Figs. 1A, 2A and 3A are horizontally aligned respectively with Figs. 1, 2, 3 and 4, it will be found that corresponding contacts and coils of relays and switches shown in the horizontally-aligned figures are substantially in horizontal alignment. In some instances wherein a group of similar relays are employed, only representative relays are shown in the key representations.

In order to facilitate the orderly presentation of the invention, a number of conventions have been adopted. Although the invention may be incorporated in an elevator system having any desired number of elevator cars serving a structure having any desired number of floors or landings, it will be assumed that the invention is incorporated in an elevator system having three elevator cars serving a structure having six floors or landings. The elevator cars are designated by the reference characters A, B and C.

Because of the similarity of the circuits and components associated with the elevator cars, components associated with the elevator cars B and C will be identified by the same reference characters employed for the components associated with the elevator car A preceded by the letter B or C. For example, the resistors R8 and BR8 are associated respectively with the elevator cars A and B. Inasmuch as circuits for the elevator cars are generally similar, circuits for the elevator cars A and B are shown in substantial detail, and components for the elevator car C are introduced as required for the discussion.

Relays and electromagnetic switches employed for the elevator system may have front or make contacts and back or break contacts. Front or make contacts of a relay are closed when the relay is energized and picked up. The contacts are open when the relay is deenergized and dropped out. Back or break contacts of a relay are closed when the relay is deenergized and dropped

out. The back or break contacts are open when the relay is energized and picked up. The relays and switches are illustrated in their deenergized and dropped out conditions.

Each set of contacts of a relay or switch is designated by the reference characters employed for the relay or switch followed by a suitable numeral specific to the set of contacts. For example, the reference characters U1 and U3 designate the first and third sets of contacts respectively associated with the up switch U of the elevator car A.

In order to further facilitate the presentation of the invention, certain apparatus specific to car A and certain apparatus common to all of the elevator cars are set forth as follows:

Apparatus for car A

E—Inductor slowdown relay
F—Inductor stopping relay
V—Speed relay
U—Up switch
M—Running relay
D—Down switch
G—Holding relay
W—Up preference relay
X—Down preference relay
70T—Non-interference relay
DR—Door relay
HC—High car call reversal relay
1CR to 6CR—Car call registering relays
T—Car call stopping relay
78U—Call-above relay
S—Floor call stopping relay
N—Loading relay
SS—Start relay
80—Auxiliary start relay
LL—Position relay

Apparatus common to all cars

1UR to 5UR—Up floor call registering relays
2DR to 6DR—Down floor call registering relays
1S—Timing relay
DP—Down-peak relay
UPK—Up-peak relay
Q—Quota relay
OH—Off-hours relay
UP—Up-peak relay
OP—Off-peak relay

Figure 1

Fig. 1 shows the elevator cars A and B and certain control circuits associated therewith. The elevator car A (illustrated in the left column) will be assumed to be stopped at the second floor of the structure whereas the elevator car B (illustrated in the right column) will be assumed to be stopped at the fifth floor of the structure. With these exceptions, the circuits and mechanisms associated with the two elevator cars are similar and will be understood by reference to those associated with the elevator car A.

The elevator car A is connected by a rope or cable 10 to a counterweight 11. The rope 10 passes over a sheave 12, which is secured to a shaft 13 for rotation therewith. The shaft 13 is rotated by a motor 14 which may be of any conventional type. For present purposes it will be assumed that the motor 14 is a direct current motor having its armature 14A secured to the shaft 13 and having a field winding 14F which is permanently connected across two direction current buses L1 and L2 which supply direct current energy for the control circuits.

The elevator car A has therein a plurality of normally-open car-call push buttons 1c to 6c which are actuated for the purpose of registering calls respectively for the first to sixth floors as desired by passengers entering the elevator car.

To permit registration of calls for service by prospective passengers located at the various floors served by the elevator cars, push button stations are located at such floors. Such a station is shown in Fig. 1 for the third floor. It includes a normally-open up floor call push button 3U which is pressed by a prospective passenger desiring elevator service in the up direction. A similar push button is located at each floor from which service in the up direction may be desired. The station also includes a normally-open push button 3D which is pressed by a prospective passenger desiring elevator service in the down direction. A similar push button is located at each floor from which elevator service in the down direction may be desired. The numeral of the reference characters (as 3D or 3U) indicates the floor at which the push button is located.

The elevator car A also has mounted thereon a slowdown inductor relay E and a stopping inductor F which may be of conventional construction. The slowdown relay E has two sets of break contacts E1 and E2 associated therewith. The relay has a normally incomplete magnetic circuit and energization of the winding of the relay alone does not affect the associated contacts. However, if the slowdown relay E reaches an inductor plate UEP located in the hoistway of the elevator car while the winding of the relay is energized, the contacts E1 open. In Fig. 1 the inductor plate UEP is assumed to be mounted in the hoistway to be reached by the slowdown relay E as the elevator car A nears the third floor. If the elevator car A is to stop at the third floor, the winding of the relay E is energized and when the relay reaches the inductor plate UEP for the third floor, the contacts E1 open to initiate a slowdown operation for the elevator car. It will be understood that a similar inductor plate is similarly associated with each of the floors at which the elevator car A may stop during up travel thereof.

During down travel of the elevator car A, the inductor relay E cooperates with down inductor plates DEP to initiate a slowdown of the elevator car as it approaches a floor at which the elevator car is intended to stop. For example, if the elevator car is to stop during down travel at the third floor, the winding of the inductor relay E is energized as the elevator car nears the third floor. When the inductor relay reaches the down inductor plate DEP for the third floor, the contacts E2 open to initiate a slowdown operation of the elevator car. It will be understood that a similar inductor plate DEP is provided for each of the floors at which the elevator car A is to stop during down travel thereof.

The stopping relay F similarly cooperates with inductor plates UFP and DFP for the purpose of bringing the elevator car to a stop as it reaches a floor at which it is to stop. Thus, if the elevator car A during up travel is to stop at the third floor, the winding of the stopping relay F is energized and as the inductor relay of stopping relay F reaches the stopping inductor plate UFP for the third floor, the contacts F1 open. These contacts in opening result in stopping of the elevator car at the third floor. A similar inductor plate is provided at each of the floors for which the elevator car A is to stop during up travel thereof.

If the elevator car A is to stop at the third floor during down travel thereof the winding of the stopping relay is energized and as the relay reaches the inductor plate DFP for the third floor, the contacts F2 open to produce a stopping operation of the elevator car at the third floor. At the same time, make contacts F3 close for a purpose pointed out below. It will be understood that a similar inductor plate is provided for each of the floors at which the elevator car A is to stop during down travel thereof.

When the elevator car is loaded to capacity a normally-open load switch LW is operated to open its break contacts LW1 and close its make contacts LW2.

Because of the large number of control circuits required, it is conventional practice to provide each elevator

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car with a floor selector 16. This selector includes a plurality of rows of contact segments mounted on the insulating panel 16A. Only two rows of contact segments *a1* to *a5*, *d1* to *d5* are illustrated in Fig. 1. These contact segments are successively engaged during travel of the elevator car respectively by brushes *aa* and *dd* for the purpose of controlling the energizations of certain circuits. For example, if the elevator car A during down travel is to stop at the third floor in response to a car call, the brush *aa* engages the contact *a3* shortly before the elevator car A reaches the third floor, to initiate a stopping operation thereof.

The brushes *aa* and *dd* are mounted on a brush carriage 16C which is mounted for movement in accordance with movement of the elevator car, but at a greatly reduced rate. In the embodiment of Fig. 1, it is assumed that the carriage 16C has threaded engagement with a screw 16S which is coupled to the shaft 13 through suitable gearing for rotation in accordance with movement of the elevator A. Consequently, as the elevator car A moves, the brushes mounted on the carriage 16C permit the energization of appropriate circuits at various points of travel of the elevator car.

Although the driving motor 14 may be energized in various ways, it will be assumed that the control of this motor is of the type commonly referred to as a variable voltage control. In such a control, a direct current generator 17 has its armature 17A connected in a loop with the armature 14A of the motor. A series field winding 17S for the generator also may be included in this loop. The generator has a main field winding 17F which is connected for energization from the buses L1 and L2 through a reversing switch. This reversing switch includes contacts U2 and U3 of an up switch. When these contacts are closed, the field winding is energized with proper polarity for up travel of the elevator car. On the other hand, when contacts D2 and D3 of a down switch are closed, the field winding is energized with proper polarity for down travel of the elevator car. The energization of the field windings is completed through a resistor R1 for slow speed operation of the elevator car or through make contacts V1 of a speed relay for full speed operation of the elevator car. If a direct-current exciter generator is mounted on the shaft 13, the terminals of the generator may be connected to the buses L1 and L2 for the purpose of supplying direct-current energy thereto.

The elevator car A is provided with a conventional spring-applied electromagnetically-released brake. This brake includes a brake drum 18D which is secured to the shaft 13 for rotation therewith. A brake shoe 18C normally is biased against the brake drum by means of a spring (not shown). The brake is released upon energization of a brake coil 18B which cooperates with a magnetic armature 18A secured to the shoe 18C. The coil 18B is connected to the buses L1 and L2 for energization either through make contacts U1 or through make contacts D1 of the up switch U or the down switch D.

The speed relay V is connected for energization from the buses L1 and L2 through either of two paths. One of these paths includes make contacts U4 of the up switch, a limit switch 19 and the break contacts E1 of the slowdown relay. The limit switch 19 is a cam-operated normally-closed switch which is opened as the elevator car nears its upper limit of travel.

The remaining path of energization comprises the make contacts D4 of the down switch, a limit switch 20 and the break contact E2 of the slowdown relay. The limit switch 20 may be cam operated. It is normally closed and is opened as the elevator car A near its lower limit of travel.

As long as the elevator car A is running, the running relay M is energized. This relay can be energized only as long as the make contacts DR1 of a door relay DR are closed. These contacts are closed only as long as all of the hoistway doors and car doors for the car A are

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closed. Such safety provisions are well known in the art.

The running relay M initially can be energized only if the make contacts 80-1 of the auxiliary start relay 80 are closed.

Assuming that the foregoing contacts 80-1 associated with the running relay M are closed, the relay may be energized initially through either of two paths. One of these paths is as follows:

L1, 80-1, W1, F1, 21, U, M, DR1, L2

Since the up switch U is energized through this path, it follows that the elevator car will be conditioned for up travel. The limit switch 21 is a normally-closed mechanically-operated switch which is opened as the elevator car A nears its upper limit of travel. When energized, the up switch U closes its make contacts U5 to establish a holding circuit around the contacts 80-1 and W1.

The second path for initially energizing the running relay M may be traced as follows:

L1, 80-1, X1, F2, 22, D, M, DR1, L2

Since the down switch D now is energized, it follows that the elevator car A is conditioned for down travel. The limit switch 22 is a mechanically-operated normally-closed switch which is opened as the elevator car A nears its lower limit of travel. When it picks up, the down switch D closes its make contacts D5 to establish a holding circuit around the contacts 80-1 and X1.

The slowdown relay E, the inductor relay F, and a holding relay G are energized in parallel from the buses L1 and L2 through make contacts M1 of the running relay M. To complete an initial energizing circuit for these relays E, F and G, one of three conditions must be present. First, the make contacts T1 are closed to indicate that a car call is registered for a floor which the elevator car A is approaching. Second, the contacts 78U1 are closed to indicate that the elevator car A is approaching a landing or floor at which it is to reverse. Third, the make contacts S1 are closed to indicate that the elevator car A is conditioned to stop at a floor in answer to a registered floor call for such floor.

When the holding relay G is energized, it closes its make contacts G1 to establish with the make contact M1 a holding circuit for the inductor relays E and F.

The direction of travel of the elevator car A is determined initially by an up preference relay W and a down preference relay X. For the up preference relay W to be energized, the break contacts D6 must be closed (i. e. the down switch D is deenergized). The break contacts X2 must be closed (i. e. the down preference relay X is deenergized). The limit switch 23 also must be closed. This switch is normally closed and is opened as the elevator car A reaches its upper limit of travel, in this case, the sixth floor.

Energization of the up preference relay W also requires closure of at least one of two sets of contacts. These include the break contacts 78U2 which are closed when the elevator car A is not conditioned to reverse at an intermediate floor or landing. Make contacts M2 are closed as long as the elevator car A is running.

The down preference relay X is energized if the break contacts U6 are closed (i. e. the up switch U is deenergized), the break contacts W2 are closed (i. e. the up preference relay is deenergized) and the limit switch 24 is closed. This limit switch is normally closed and is opened as the elevator car A reaches the lower terminal floor.

As long as the elevator car A is running, the make contacts M3 are closed to energize the non-interference relay 70T. When the elevator car A stops, the contacts M3 open to deenergize the relay. However, the relay 70T has a substantial delay in dropout. This relay may be provided in any suitable manner as by connecting a resistor R2 across the relay coil. The time delay in drop-

out is selected to be sufficient to permit discharge of passengers from the elevator car A or entry of passengers into the elevator car A after each stop.

It will be recalled that the door relay DR is connected across the buses L1 and L2 through contacts operated by each door associated with the elevator car A. If any of the doors is open, the contacts associated therewith are also open to prevent energization of the door relay DR.

Energization of the auxiliary start relay 80 requires closure of the break contacts 70T1 of the non-interference relay 70T. In addition, one of four parallel arms of a circuit must be completed. These arms respectively include make contacts SS1 of the lower terminal start relay SS, make contacts TSS1 of the upper terminal start relay, a mechanical switch 63 which is closed except when the elevator car A is at a terminal floor, and a manually-operable switch 63A.

Figure 2

Figure 2 shows the floor call registration circuits for the elevator cars. The upper part of the figure illustrates up floor call registering circuits. These circuits are operated by normally-open push buttons 1U to 5U which are located respectively at the first to fifth floors. The push buttons have associated therewith up floor call registering relays 1UR to 5UR and cancelling coils 1URN to 5URN in a manner which will be clear from the discussion of the call registering relays and cancelling coils associated with the car call push buttons.

The up floor call registering relays 1UR to 5UR and their cancelling coils are associated with contact segments for each of the elevator cars in the bank. For example, a row of contact segments e1 to e5 is provided for the elevator car A and cooperate with a brush ee. A brush ff cooperates with a row of contact segments f1 to f5, for the elevator car A.

Let it be assumed that while the elevator car A is traveling up a prospective passenger waiting on the fifth floor presses the up floor call push button 5U to energize the up floor call registering relay 5UR. This relay closes its make contact 5UR1 to establish a holding circuit around the push button.

Since the elevator car is assumed to be traveling up, the make contacts W5 of the up preference relay W are closed. It will be assumed further that the break contacts DP1 of the down-peak relay DP are closed. As the elevator car A nears the fifth floor, the brush ee engages the contact segment e5 to complete the following circuit:

L1, 5UR1, e5, ee, W5, DP1, LW1, S, L2

The buses L1 and L2 represent a source of direct current. The energization of the floor call stopping relay S initiates the stop at the fifth floor. In response to movement of the car towards the fifth floor, the brush ff engages its contact segment f5. As the elevator car stops, the make contacts F3 close to complete the following canceling circuit:

L1, 5UR1, 5URN, f5, ff, W6, F3, L2

This resets the up floor car registering relay 5UR. (If greater lead in cancelling is desired the contacts F3 could be replaced by make contacts of the relay E.) As the elevator car A comes to a stop, the brush ee preferably passes slightly above the contact segment e5. However, the brush ff remains in engagement with the contact segment f5 as long as the elevator car A remains at the fifth floor and closure of contacts M6 maintains the cancelling circuit. By inspection of Fig. 2, it will be observed that the contact segment e5 is connected to the corresponding contact segments for the other elevator cars in the bank (such as contact segment Be5 for the elevator car B). Similarly, the contact segment f5 is connected to corresponding contact segments (such as the contact segment Bf5) for the remaining cars of the bank. Consequently,

operation of the push button 5U is effective to stop the first up traveling elevator car which reaches the fifth floor and which is conditioned to accept the call at the fifth floor.

During a down-peak period, break contacts DP1 and DP4 are open to prevent the elevator cars from answering up-floor calls. Such calls are canceled by any down traveling elevator car which stops at the floors. For example, make contacts DP2 and M7 shunt the make contacts W6 to permit cancellation of an up floor call by any elevator car which stops at the appropriate floor regardless of the direction of travel of the elevator car. If one of the elevator cars, such as the elevator car B, is to answer up-floor calls during the down-peak period, the switch B26 may be closed and the switches 27 and B27 may be opened. It should be noted that if an up-floor call is canceled by an elevator car set for down travel, the call may be reregistered while the elevator car is at the floor of the canceled call. For example, contacts W6 and M7 for the elevator car A are open under such conditions to prevent cancellation of the reregistered calls. Break contacts M6 are designed to open slightly before make contacts M7 close.

The up-floor call registering circuits for all of the intermediate floors are similar. Consequently, such circuits are illustrated in Fig. 2 only for the second and fifth floors.

Since the elevator car A does not stop during up travel at the lower terminal or first floor, a contact segment in the e row is not required. With this exception, the call registering circuits for the first floor are similar to those described for the fifth floor.

The lower part of Fig. 2 illustrates the down floor call registering circuit for the elevator cars. Down floor calls are registered by operation of normally-open push buttons 2D to 6D which have associated therewith down-floor call registering relays 2DR to 6DR and cancelling coils 2DRN to 6DRN. Each push button cooperates with its call registering relay and its cancelling coil in the manner discussed with reference to the up-floor call push buttons.

For the elevator car A, a row of contact segments g2 and g5 cooperates with a brush gg and a row of contact segments h2 to h6 cooperates with a brush hh. Let it be assumed that the elevator car A while traveling down is approaching the fifth floor at which a down-floor call has been registered by operation of the push button 5D. Such operation results in energization of the down-floor call registering relay 5DR to close the make contacts 5DR1. Since the elevator car is traveling down, the make contacts X6 and X7 are closed.

As the elevator car A nears the fifth floor, the brush gg engages the contact segment g5 to complete the following circuit:

L1, 5DR1, g5, gg, X6, LW1, S, L2

The energization of the floor call stop relay S initiates a stopping operation of the elevator car A at the fifth floor. As the elevator car continues its approach, a brush hh engages the contact segment h5. The stopping of the elevator car A results in closure of the make contacts F3 to complete the following cancelling circuit:

L1, 5DR1, 5DRN, h5, hh, X7, F3, L2

The energization of the cancelling coil resets the call registering relay 5DR. Preferably, as the elevator car A comes to a stop, the brush gg passes slightly below the associated contact segment g5, but the brush hh remains in engagement with the associated contact segment h5. Inasmuch as break contacts M6 are closed while the elevator car is stopped, the down-floor call cannot be registered until the elevator car starts away from the floor.

The contact segment g5 is connected to corresponding contact segments (such as the contact segment Bg5)

of the remaining cars. Similarly, the contact segment *h5* is connected to the corresponding contact segments (such as the contact segment *Bh5*) for the remaining cars. Consequently, the first elevator car to approach the fifth floor while traveling down will answer a call registered by the call registering relay *SDR*.

The down-floor call registering circuits for all of the intermediate floors are similar and may be traced readily in Fig. 2. The down-floor call registering relays for the upper terminal or sixth floor also may be similar. However, since the elevator car *A* does not stop at the sixth floor during down travel, the contact segment in the *g* row may be omitted for the sixth floor.

Figure 3

Figure 3 shows the call registration circuits for the elevator cars. Car call registration circuits are illustrated for the elevator cars *A* and *B* in the upper part of Fig. 3. Fig. 3 also shows the call-above relay *78U* and the high car call reversal relay *HC*.

It will be recalled that the elevator car *A* is provided with a plurality of push buttons *1c* to *6c* for the purpose of registering car calls. Each of these push buttons has associated therewith a car call registering relay *1CR* to *6CR* respectively. Inasmuch as the relays and circuits for the intermediate floors are similar, they are not shown for the third and fourth floors. The push buttons and call registration relays cooperate with four rows of contact segments located on the floor selector for the elevator car *A*. The contact segments *a1* to *a5* cooperate with the brush *aa* for the purpose of initiating a stopping operation of the elevator car during down travel of the elevator car respectively at the first to fifth floors. The contact segments *b2* to *b6* cooperate with a brush *bb* for the purpose of initiating a stopping operation of the elevator car during up travel of the elevator car respectively at the second to sixth floors. A brush *cc* cooperates with a row of contact segments *c1* to *c6* for the purpose of canceling registered car calls as they are answered during down travel and up travel of the elevator car. It will be understood that for each contact segment, the numeral of the reference character designates the floor with which the contact segment is associated. Thus, the reference character *a1* designates the contact segment for the first floor in the *a* row.

By reference to Fig. 3, it will be observed that when the car call push button *5c* is pressed, the car call registering relay *5CR* is connected therethrough across the buses *L1* and *L2*. This relay closes its make contacts *5CR1* to establish a holding circuit around the push button. The contact segments *a5* and *b5* are connected through this set of contacts to the bus *L1*.

If the elevator car *A* is set for down travel, the make contacts *X4* are closed. And if the elevator car is approaching the fifth floor, the make contacts *M4* of the running relay also are closed. Consequently, as the elevator car nears the fifth floor, the brush *aa* engages the contact segment *a5* to complete the following circuit for the car call stopping relay *T*:

L1, 5CR1, a5, aa, X4, T, M4, L2

The energization of the relay *T* initiates a stopping operation of the elevator car *A* at the fifth floor.

As the elevator car *A* continues its approach toward the fifth floor, the contact segment *c5* is engaged by the brush *cc*. As the elevator car comes to a stop, the break contacts *M5* of the running relay close to complete the following canceling circuit:

L1, 5CR1, 5CRN, c5, cc, M5, L2

The operating coil of the registering relay *5CR* and the canceling coil *5CRN* are wound in opposition on a common core. Consequently, energization of the canceling coil *5CRN* cancels the effect of the operating coil and resets the registering relay *5CR*. Preferably, as the eleva-

tor car stops at the fifth floor, the brush *aa* passes slightly below the associated contact segment *a5*, however, the brush *cc* remains in engagement with the associated contact segment *c5* as long as the elevator car *A* remains at the floor.

Next it will be assumed that the same call is registered for the fifth floor as the elevator car *A* travels up towards the fifth floor. Under these circumstances, the make contact *W3* of the up preference relay is closed. As the elevator car *A* nears the fifth floor, the brush *bb* engages the contact segment *b5* to complete the following circuit:

L1, 5CR1, b5, bb, W3, T, M4, L2

The energization of the car call stopping relay *T* results in the initiation of a stopping operation for the fifth floor.

As the elevator car *A* continues to approach the fifth floor, the brush *cc* engages the contact segment *c5* to complete the following circuit:

L1, 5CR1, 5CRN, c5, cc, M5, L2

The energization of the canceling coil *5CRN* resets the call registering relay *5CR*. During the stopping operation, the brush *bb* preferably passes slightly above the associated contact segment *b5*, whereas the brush *cc* remains in engagement with the associated contact segment *c5* as long as the elevator car *A* is at the fifth floor.

The car call registering circuits for all of the intermediate floors are similar to those described for the fifth floor. For this reason and to conserve space, the intermediate floor circuits are illustrated in Fig. 3 only for the second and fifth floors.

The car call registering circuits for the upper terminal (sixth floor) may be similar to those employed for the intermediate floors. However, since the elevator car *A* stops at the sixth floor only during up travel, a contact segment for the sixth floor need not be provided in the *a* row. By reference to Fig. 3, it will be noted that only contact segments *b6* and *c6* are provided for the sixth floor. Contact *b6*, however, is connected directly to line *L1* as the car always stops at the sixth floor if it reaches such a floor.

The car call registering circuits for the lower terminal or first floor may be similar to those provided for the intermediate floors. Since the elevator car stops at the first floor only during down travel, a contact segment for the first floor need not be provided in the *b* row. For this reason, in the car call registering circuits only contact segment *a1* and *c1* are illustrated for the first floor. By reference to Fig. 3, it will be noted that contact segment *a1* is connected directly to line *L1*. This provides for a permanent stop at the first floor.

In Fig. 3, a call circuit 30 is provided which has two functions. This circuit energizes the call-above relay *78U* as the elevator car during up travel nears an intermediate floor at which the elevator car is to reverse.

The call-above circuit 30 includes break contacts for all of the floor call registering relays and for all of the elevator *A* car call registering relays except for the first floor arranged in the order of the floors. This circuit may be traced as follows:

L1, 6CR2, 6DR2, 5UR2, 5CR2, 5DR2, 4UR2, 4CR2, 4DR2, 3UR2, 3CR2, 3DR2, 2UR2, 2DR2, 2CR2

The call circuit 30 has associated therewith a row of contact segments *k1* to *k5* which are engaged successively by the brush *kk* as the elevator car *A* moves. The contact segments are so located relative to the call circuit 30 that each contact segment is placed below all break contacts of the call circuit which require travel of the elevator car *A* above such contact segment. Thus, the contact segment *k5* is connected to the call circuit between the contacts *5UR2* and *5CR2*. The contact segment *k4* is connected between the contacts *4UR2* and

4CR2. The location of the remaining contact segments similarly may be ascertained by reference to Fig. 3. It will be noted that the relay 78U is connected between the brush *kk* and the bus L2 through make contacts W7 of the up preference relay W, and through one of three paths. These three paths are represented by make contacts DP5, contacts UPK1 and a manual switch 31.

In certain cases, it is desirable to prevent registered calls from affecting the call circuit 30. For example, it may be desirable under some conditions to prevent registered floor calls from affecting the operation of the relay 78U. To this end, make contacts DP9 to DP12 when their associated manual switches 25 are closed shunt the contacts of the up-floor call registering relays for floors above the second floor. As a further example, make contacts of the high car-call reversal relay HC are provided for the purpose of shunting the break contacts of the up- and down-floor call relays. When the relay HC is energized, the contacts HC1 to HC5 close to shunt respectively the contacts of the floor-call registering relays for floors above the first floor.

Make contacts DP17 may be connected between the bus L1 and a point on the circuit 30 through a manual switch 33 for the purpose of reversing the elevator car A at or below a predetermined floor.

The high car-call reversal relay HC is energized if the elevator car A is set for up travel (contacts W8 close), the elevator car is loaded (contacts LW2 are closed) and the system is on down-peak operation (contacts DP7 are closed). If the manual switch 32 is closed, pickup of the relay completes a self-holding circuit through the contacts W8 and HC6.

Figure 4

In Fig. 4, a dispatching device is illustrated which normally controls the dispatching of the elevator cars employed in the system.

The selection mechanism includes as one component a motor 71 which operates substantially at constant speed. This may be of any suitable type, but for the present purposes it will be assumed that the motor is a squirrel-cage alternating-current motor which is energized from a suitable source of alternating current. The motor 71 is connected through a spring-released electromagnetically-applied clutch 72 to a cam 73 having a protuberance for successively operating mechanical switches Y, BY and CY which are associated with the respective elevator cars. The electromagnetic clutch can be energized only if one or more elevator cars are located at the dispatching floor which is assumed to be the first floor (one or more of the contacts LL1, BLL1 and CLL1 are closed), and if no elevator car has been selected as the next car to leave the dispatching floor (break contacts N2, BN2 and CN2 all are closed).

The presence of an elevator car at the dispatching floor is determined by the energization of a car-position relay for each of the elevator cars. Thus, a car-position relay LL for the elevator car A is energized when a brush 79 engages a contact segment p1.

The brush 79 is operated by the floor selector for the elevator car A to engage the contact segment p1 when the elevator car is at the dispatching floor. If the elevator car A is at the dispatching floor (make contacts LL2 are closed), it has been selected as the next car to leave the dispatching floor (switch Y is closed), and if it is not being started (break contacts SS3 are closed), the loading relay N for the elevator car A is energized. The loading relay may be employed in a conventional way to permit loading of the elevator car A. For example, the loading relay when energized may operate a loading signal, such as a lamp, which indicates that passengers may enter the elevator car. If desired, the loading relay N when energized may open the normally-closed doors of the elevator car A to permit entry of passengers into the elevator car.

Energization of the start relays SS to CSS may be effected in either of two ways. For example, if the elevator car A is at the lower terminal floor, the position relay LL is energized and the make contacts LL2 are closed. If the system also is arranged for down-peak operation, the make contacts DP19 of the down-peak relay DP are closed. Consequently, if the switch 46 is closed and the system is on down-peak operation, the elevator car A is started promptly from the lower terminal floor and the minimum dispatching interval between successive cars may be negligible.

Assuming that the switch 46 is open, the start relay SS can be energized only if the elevator car A is at the lower terminal floor (make contacts LL2 are closed), and if the car has been selected as the next car to leave the lower terminal floor (make contacts N3 are closed). If these conditions are satisfied, closure of the make contacts 1S3 of the timing relay 1S completes an energizing circuit for the start relay. When once energized, the start relay closes its contacts SS4 to complete with the contacts LL2 a self-holding circuit.

The energization of the timing relay 1S is controlled through an electronic tube 47 which may be a high vacuum tube but preferably is of the gaseous discharge type, commonly referred to as a thyratron. This tube includes main electrodes in the form of an anode 47A and a cathode 47C. The tube may be of the hot cathode type, but for present purposes, it will be assumed that a cold cathode tube is employed. A control electrode or grid 47G is incorporated in the tube for the purpose of controlling the initiation of a discharge between the main electrodes.

An adjustable voltage for the main electrodes of the tube is provided by a voltage divider represented by a resistor R4 connected across the buses L1 and L2, the bus L1 being the positive bus of the source of direct voltage. An adjustable tap R4T is associated with the resistor. This tap is connected to the anode 47A through the break contacts SS2, BSS2, CSS2 of the start relays and through the timing relay 1S. Consequently, the timing relay 1S picks up in response to current flow between the main electrodes of the tube.

During down-peak operation if one of the elevator cars is assigned to the low zone of floors, it may be desirable to start the elevator car as soon as possible after it reaches the lower terminal floor. Under such circumstances, it may be desirable to shunt the break contacts of the start relay for said car by make contacts of the down-peak relay DP. Thus, in Fig. 4, the break contacts SS2 are shunted by make contacts DP22 of the down-peak relay.

A timing circuit containing a resistor R5 in series with a capacitor CAP, commonly referred to as an RC circuit, is connected in series with the secondary winding TRS of a transformer TR across the main electrodes of the tube 47 and the timing relay 1S. Consequently, the voltage appearing across this timing circuit is substantially the voltage between the main electrodes of the tube. The rate at which the capacitor CAP can charge is determined by the resistance value of the resistor R5 and the effective value of the resistor R4 which is in the charging circuit. By adjustment of the tap R4T, the charging rate of the capacitor can be adjusted.

It will be noted that the control electrode 47G is connected to the RC circuit at a point intermediate the resistor R5 and the capacitor CAP. Consequently, the voltage across the capacitor CAP and the secondary winding TRS in series appears between the control electrode 47G and the cathode electrode 47C and may be referred to as a biasing voltage.

Any charge appearing on the capacitor CA may be dissipated through a discharge resistor R6 which may be connected across the capacitor and the secondary winding TRS through any one of the parallel make contacts SS5, BSS5 and CSS5 of the start relays for the three cars or through the make contacts 1S1 of the timing relay.

An alternating biasing voltage also is applied between the control and cathode electrodes of the tube through the transformer TR which has a primary winding TRP connected for energization from a voltage divider represented by a resistor R7 connected across a suitable source 48 of alternating voltage. For example, the source of alternating voltage 48 may be a source having the customary power frequency of 60 cycles per second and a voltage such as 120 volts. The resistor R7 has three adjustable taps R7A, R7B and R7C associated therewith. These taps are connected to one terminal of the primary winding TRP respectively through make contacts OH1, UPK3 and OP1 of the off-hour, up-peak and off-peak relays. The remaining terminal of the primary winding is connected to one terminal of the resistor R7. Consequently, the voltage appearing across the transformer depends on the particular set of contacts which is closed.

The mode of operation of the elevator system is determined by the relays OH, UPK, OP and DP. Each of these relays is connected across the buses through a separate switch, respectively, the switches OHS, UPKS, OPS and DPS. These switches may be manually operated, but in a preferred embodiment of the invention, they are automatically operated to select the desired mode of operation of the system. For example, these switches may be operated by a time clock to close during certain periods of the day. This is acceptable if the traffic of the building in which the elevator system is located is sufficiently consistent from day to day. For example, the off-hour switch OHS may be closed between the hours 6:00 p. m. and 8:30 a. m. The up-peak switch UPKS may be closed from 8:30 a. m. to 9:00 a. m. and from 12:45 p. m. to 1:00 p. m. The off-peak switch OPS may be closed from 9:00 a. m. to 12:00 noon and from 1:00 p. m. to 5:00 p. m. The down-peak switch may be closed from 12:00 noon to 12:15 p. m. and from 5:00 p. m. to 5:15 p. m.

Preferably, however, the mode of operation is selected in accordance with the demand for elevator service. To illustrate such selection, make contacts Q1 of a quota relay are connected across the switch DPS. The quota relay Q is connected across the buses L1 and L2 through five parallel arms, each including a resistor and make contacts of one of the down floor call registering relays. For example, one of the arms includes in series a resistor 2R3 and the make contacts 2DR4. Consequently, the relay Q is energized in accordance with the number of registered down floor calls. The relay may be designed to pick up when the number of registered down floor calls exceeds a predetermined number, such as three.

Operation

In order to explain the overall operation of the elevator system, it will be assumed first that the elevator cars are at the first or dispatching floor when the system initially is energized. The cars will be assumed to be conditioned for operation in the up direction. For example, the elevator car A has its up preference relay W (Fig. 1) energized. Consequently, make contacts W1, W3, W5, W6, W7 and W8 of the relay are closed, whereas break contacts W2 of the relay are open.

The motor 71 (Fig. 4) is energized to rotate at a substantially constant rate.

Inasmuch as the elevator cars are assumed to be at the dispatching floor, the car-position relays are energized. For example, the car-position relay LL is energized through the circuit:

L1, p1, 79, LL, L2

As a result of its energization, the car-position relay LL closes its make contacts LL2 to prepare certain circuits for subsequent energization. In addition, the make con-

tacts LL1 close to complete the following circuit for the clutch 72.

L1, LL1, 72, N2, BN2, CN2, L2

The clutch now couples the motor 71 to the cam 73 for the purpose of successively closing and opening the associated mechanical switches. It will be assumed that the first switch reached by the cam is the switch Y for the elevator car A. Closure of this switch completes the following energizing circuit for the loading relay N of the elevator car A:

L1, LL2, N, SS3, Y, L2

It will be assumed that the loading relay N upon energization initiates opening of normally-closed doors of the elevator car A to permit intending passengers on the dispatching floor to enter the elevator car. Opening of the break contacts N2 (Fig. 4) deenergizes the clutch 72. Consequently, the cam 73 is uncoupled from the motor 71. The loading relay N also closes its make contacts N3 to prepare the start relay SS for energization.

When the system was initially energized, the break contacts SS2, DSS2 and CSS2 all were closed. Consequently, the energization of the system results in the application of charging current to the capacitor CAP, and the capacitor slowly starts to charge. It will be assumed further that the system is operating at a time of the day suitable for off-peak operation and the switch OPS is closed to energize the relay OP. The make contact OP1 consequently is closed, and an alternating voltage appears across the secondary winding of the transformer TR. However, at this stage, the voltage across the capacitor CAP and the secondary winding TRS in series is insufficient to initiate a discharge of the tube 47.

At this stage a passenger enters the elevator car and presses the button 5c (Fig. 3) to register a car call for the fifth floor. The operation of the button completes an energizing circuit for the car call registering relay 5CR which closes its self-holding contacts 5CR1. If the switch 31 is closed, opening of the break contacts 5CR2 deenergizes the call-above relay 78U which opens its make contacts 78U1 (Fig. 1) without immediate effect on the operation of the system.

After the expiration of a substantial time, such as 20 seconds, the capacitor CAP charges to a value sufficient to supply with the voltage across the secondary winding TRS a resultant voltage which causes the tube 47 to fire. The resultant flow of current between the main electrodes picks up the timing relay 1S which closes its make contacts 1S2 to establish in part a self-holding circuit and which closes its make contacts 1S1 for the purpose of completing a discharge circuit for the capacitor CAP. In addition, the make contacts 1S3 close to complete with the contacts LL2 and N3 an energizing circuit for the start relay SS.

The start relay SS closes its make contacts SS4 to establish with the make contacts LL2 a self-holding circuit. Break contacts SS2 open to interrupt the current through the tube 47, and the relay 1S consequently drops out. The resultant opening of the make contacts 1S1, 1S2 and 1S3 has no immediate effect on the operation of the system, assuming that the capacitor CAP has completely discharged.

Contacts SS3 open deenergizing relay N which permits another car to receive the next signal.

The start relay SS further closes its make contacts SS5 to permit any necessary discharge of the capacitor CAP. Finally, the start relay closes its make contacts SS1 (Fig. 1) to complete with the break contacts 70T1 an energizing circuit for the auxiliary start relay 80. Consequently, upon closure of the doors, the door relay DR closes its make contacts DR1 to complete the following circuit:

L1, 80-1, W1, F1, 21, U, M, DR1, L2

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Upon energization, the up switch U closes its make contacts U1 to release the elevator brake. Contacts U2 and U3 close to energize the generator field winding 17F with proper polarity for up travel of the elevator car. Contacts U4 close to complete the following energizing circuit for the speed relay V:

L1, U4, 19, E1, V, L2

The speed relay closes its make contact V1 to shunt the resistor R1 and conditions the elevator car for full speed operation.

Continuing with the operation of the up switch U, the energized up switch closes its make contacts U5 to establish a holding circuit around the contacts 30-1 and W1. Break contacts U6 open to prevent energization there-through of the down preference relay X.

The elevator car A now accelerates in the up direction for the purpose of carrying the passenger to the fifth floor.

It will be recalled that the running relay M also was energized. As a result of its energization, the running relay closes its make contacts to prepare the relays G, E and F for subsequent energization. The make contacts M2 close to maintain the energization of the up preference relay despite subsequent opening of the break contacts 78U2. Make contacts M3 close to energize the non-interference relay 70T. The non-interference relay opens its break contacts 70T1 but such opening has no immediate effect on the operation of the system.

Referring to Fig. 3, the running relay M closes its make contacts M4 and opens its break contacts M5 and M6. Such contact operations have no immediate effect on the operation of the system.

Assume first that the switch 31 (Fig. 3) is closed. As the elevator car nears the fifth floor, the brush *kk* engages the contact segment *k5* which is positioned above the break contacts 5DR2. Consequently, the call-above relay 78U is energized through the circuit:

L1, 6DR2, 6CR2, 5UR2, *k5*, *kk*, W7, 31, 78U, L2

The relay 78U closes its make contacts 78U1 (Fig. 1), and opens its break contacts 78U2. This would initiate a reversal of the elevator car at the fifth floor by a sequence to be discussed below. For present purposes, it will be assumed that the switch 31 is open at this time and that the relay 78U remains deenergized.

The approach of the elevator car A towards the fifth floor brings the brush *bb* (Fig. 3) into engagement with the contact segment *b5* to energize the car call stopping relay T through the circuit

L1, 5CR1, *b5*, *bb*, W3, T, M4, L2

The car call stopping relay closes its make contacts T (Fig. 1) to energize through the contact M1 the three relays G, E and F in parallel. The relay G closes its make contacts G1 to establish a holding circuit around the contacts T1.

The energization of the inductor slow down and stopping relays E and F prepares these relays for subsequent operation. As the elevator car A nears the fifth floor, the inductor slow down relay E reaches the inductor plate UEP for the fifth floor which completes a magnetic circuit resulting in the opening of the normally-closed contacts E1. Such opening deenergizes the speed relay V. As a result of the deenergization of the speed relay V, make contacts V1 open to introduce the resistor R1 in series with the generator field winding 17F. The resulting decrease in the output of the generator slows the elevator car A to a landing speed.

As the elevator car A slowly approaches the fifth floor, the stopping relay F reaches the inductor plate UFP for the fifth floor. This completes a magnetic circuit which results in opening of the normally-closed contacts F1. In opening, the contacts F1 deenergizes the up switch U and the running relay M.

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The up switch U now opens its make contacts U1 to apply the elevator brake. Contacts U2 and U3 open to deenergize the generator field winding and the elevator car now stops accurately at the fifth floor. Opening of the make contacts U4 and U5 and closure of the break contacts U6 have no immediate effect on the operation of the system.

The running relay M opens its make contacts M1 to deenergize the relays G, E and F. The relay G opens its make contacts G1. Opening of the make contacts M2 has no immediate effect on the system operation. Make contacts M3 open to deenergize the non-interference relay 70T. This relay now starts to time out and provides time for passengers to enter or leave the elevator car.

Referring to Fig. 3, it should be noted that as the elevator car A continued its approach toward the fifth floor, the brush *cc* engaged the contact segment *c5*. When the running relay drops out to close its break contacts M5, the following canceling circuit is completed:

L1, 5CR1, 5CRN, *c5*, *cc*, M5, L2

Consequently, the car call registering relay 5CR is reset. As the car comes to a stop, the brush *bb* passes slightly above the associated contact segment *b5*.

The resetting of the call registering relay 5CR opens the make contacts 5CR1. In addition, the break contacts 5CR2 (Fig. 3) reclose. These operations have no immediate effect on system operation.

Next it will be assumed that as the elevator car A was leaving the first floor in the preceding example, a prospective passenger at the second floor registered an up floor call by operation of the up floor call push button 2U (Fig. 2). Such operation energizes the up floor call registering relay 2UR which closes its contact 2UR1 to establish a holding circuit around the push button. In addition, the registering relay opens its break contacts 2UR2 in the call circuit 30 (Fig. 3) and similar contacts, such as the contact 2UR3, in the call circuits for the remaining elevator cars in the bank.

As the elevator car A nears the second floor, the brush *ee* engages the contact segment *e2* to establish the circuit

L1, 2UR1, *e2*, *ee*, W5, DP1, LW1, S, L2

The resultant energization of the floor call stopping relay S results in closure of the make contacts S1 (Fig. 1) to energize the relays G, E and F. These cooperate to stop the elevator car A at the second floor by a sequence which will be clear from the preceding discussion of the stopping of the elevator car at the fifth floor. As the elevator car stops, the engagement of the brush *ff* with the contact segment *f2* and the closure of the break contacts F3 completes the following canceling circuit:

L1, 2UR1, 2URN, *f2*, *ff*, W6, F3, L2

This resets the up floor call registering relay 2UR in the manner previously described. As a result of this resetting, the relay opens its contacts 2UR1 and recloses its break contacts 2UR2 (Fig. 3). Inasmuch as the contacts 5CR2 remain open, the reclosure of the contacts 2UR2 has no immediate effect on the system. The relay 2UR also recloses its break contacts 2UR3.

Next it will be assumed that a prospective passenger at the fourth floor registers a down floor call by operation of the push button 4D (Fig. 2) after the elevator car A reached the fifth floor. The resultant energization of the down floor registering relay 4DR closes the make contacts 4DR1 to establish a holding circuit around the push button. Closure of make contacts 4DR4 (Fig. 4) does not energize the quota relay sufficiently to cause it to pick up.

In addition, the registering relay 4DR opens its break contacts 4DR2 (Fig. 3) and similar contacts for the remaining cars, such as the contacts 4DR3 for the elevator car B. It will be assumed that the elevator car A has remained at the fifth floor for time sufficient to permit reclosure of the break contacts 70T1 of the non-interference

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relay. Consequently, the up switch U and the running relay M are energized in the manner previously described to move the car upwardly to the upper terminal floor. As the elevator car A nears the upper terminal floor, the brush *bb* (Fig. 3) engages the segment *b6* to complete the following energizing circuit:

L1, *b6*, *bb*, W3, T, M4, L2

The relay T closes its make contacts T1 (Fig. 1) to energize the relays G, E and F. These relays initiate a stopping operation of the elevator car A at the sixth floor in a manner which will be clear from the earlier discussion of the stopping of the elevator car at the fifth floor. As it reaches the sixth floor, the elevator car A opens its limit switch 23 (Fig. 1) to deenergize the up preference relay W. Since this relay closes its break contacts W2 and the break contacts U6 close as the car stops, an energizing circuit is completed for the down preference relay X through the limit switch 24. The deenergization of the up preference relay and the energization of the down preference relay condition the elevator car A for down travel.

After the expiration of time sufficient to permit the non-interference relay 70T to time out, the break contacts 70T1 close. It is assumed that a dispatcher for the upper terminal floor closes contacts TSS1 in the same manner by which the dispatcher for the lower terminal floor closed the contacts SS1. The closure of the contacts TSS1 and 70T1 energizes the relay 80 which in turn closes its contacts 80-1, to complete the following circuit:

L1, 80-1, X1, F2, 22, D, M, DR1, L2

The relay D upon energization closes its make contact D1 to release the elevator brake. Contacts D2 and D3 close to energize the generator field with proper polarity for down travel. Contacts D4 close to complete through the limit switch 20 and the contacts E2, an energizing circuit for the speed relay V. This relay closes its make contacts V1 to shunt the resistor R1. The elevator car A now accelerates to its full speed in the down direction.

Closure of the make contacts D5 establishes a holding circuit around the contacts 80-1 and X1. Opening of the break contacts D6 has no immediate effect on the operation of the system. The running relay M upon energization operates its contacts in the manner previously described.

As the elevator car A nears the fourth floor, the brush *gg* engages the contact segment *g4* (Fig. 2) to complete the following energizing circuit:

L11, 4DR1, *g4*, *gg*, X6, LW1, S, L21

As a result of its energization, the floor call stopping relay S closes its make contact to energize the relays G, E and F. The relay G closes its make contact to establish a holding circuit around the contacts S1. The continued movement of the elevator car A brings the inductor slow down relay adjacent the plate DEP for the fourth floor and completes a magnetic circuit resulting in opening of the contacts E2. Such opening results in deenergization of the speed relay V and this relay opens its make contact V1 to introduce the resistor R1 in series with the generator field winding. The decrease in energization of the field winding slows the elevator car to a landing speed. The continued movement of the elevator car A at a slow speed brings the inductor stopping relay F adjacent the inductor plate DFP to open the contacts F2 and close the make contacts F3 (Fig. 2b). Such opening of the contacts F2 deenergizes the down switch D and the running relay M. The down switch D opens its make contacts D1 to apply the elevator brake. Contacts D2 and D3 open to deenergize the generator field winding and the elevator car stops accurately at the fourth floor. Opening of make contacts D4 and D5 and closure of break contacts D6 have no immediate effect on the operation of the system.

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During the stopping operation the brush *hh* (Fig. 2) engages the contact segment *h4* to complete the following canceling circuit:

L1, 4DR1, 4DRN, *h4*, *hh*, X7, F3, L2

In resetting, the relay 4DR opens its holding contacts 4DR1. In addition, the relay recloses its break contact 4DR2 (Fig. 3) and corresponding contacts in the call circuits for the remaining elevator cars of the bank. Contacts 4DR4 (Fig. 4) open to deenergize completely the quota relay Q.

It will be assumed that the passenger at the fourth floor enters the elevator car and operates the push button 1c (Fig. 3) to initiate movement of the elevator car to the first floor. The resultant energization of the car call registering relay 1CR closes the holding contacts 1CR1. If sufficient time has elapsed for the non-interference relay 70T to drop out, the break contacts 70T1 close to complete with the switch 63 an energizing circuit for the relay 80. If the doors also are closed, an energizing circuit again is completed for the down switch D and the running relay M. These cooperate in the manner previously discussed to move the elevator towards the first floor.

As the elevator car A nears the first floor, the brush *aa* (Fig. 3) engages the contact segment *a1* to complete an energizing circuit for the car call stopping relay T. This relay closes its make contacts T1 to energize the relays G, E and F through the contacts M1. The energized relays E and F cooperate in the manner previously described to stop the elevator car A at the first floor. As the elevator car stops, the brush *cc* engages the contact segment *c1* to complete the following canceling circuit:

L1, 1CR1, 1CRN, *c1*, *cc*, M5, L2

In resetting, the relay 1CR opens its holding contacts 1CR1.

As it reaches the lower terminal floor, the elevator car A opens the limit switch 24 to deenergize the down preference relay. This relay closes its break contacts X2 to complete an energizing circuit for the up preference relay W as the elevator car stops at the lower terminal floor. The deenergization of the down preference relay X and the energization of the up preference relay W conditions the elevator car A for up travel.

Assume next that down floor calls are registered at the second, third and fourth floors. The sequence for registering such calls will be understood from the foregoing discussion. As the result of such call registrations, the quota relay Q (Fig. 4) is energized through the resistors 2R3, 3R3 and 4R3. Such energization is sufficient to pick up the quota relay which closes its make contacts Q1 to energize the down-peak relay DP.

As a result of its energization, the down-peak relay DP opens its break contacts DP1 to prevent the elevator car A from answering up floor calls.

In addition, the make contacts DP2 close. To illustrate the effect of the closure of the make contacts DP2, let it be assumed that at the time the down-peak relay operates, the elevator car A is approaching the fifth floor in the down direction to answer a car call for the fifth floor and that an up floor call is also registered for the fifth floor. The sequence for registering such calls has been discussed above. Inasmuch as an up call has been registered for the fifth floor, the car registering relay 5UR is energized.

As the elevator car A approaches the fifth floor, it stops in response to the registered car call by a sequence which will be clear from the preceding description. It will be recalled that during the stopping of the elevator car, the inductor relay F operates to close the make contacts F3. This now completes the following canceling circuit for the up floor call at the fifth floor:

L1, 5UR1, 5URN, *f5*, *ff*, DP2, 27, M7, F3, L2

Consequently, the stopping elevator car cancels the up floor call at the fifth floor even though it is not in condition to serve such call. As the elevator car A completes its stopping at the fifth floor, the break contacts M6 close. However, since the make contacts M7 and W6 are both open, the canceling circuit for the fifth floor registering relay 5UR is interrupted and an up floor call may be re-registered for the fifth floor despite the presence of the elevator car A at the fifth floor. Consequently, if an intending passenger really desires to proceed upwardly from the fifth floor, he may promptly reregister his call.

Returning to the operation of the down-peak relay, this relay further closes its make contacts DP3 and opens its break contacts DP4 for the purpose of conditioning the elevator car B to ignore up floor calls and to cancel an up floor call at any floor at which it stops while set for travel in the down direction. If it is desired to condition the elevator car B to respond to up floor calls during the down-peak period, the switches 27 and B27 may be opened and the switch B26 may be closed. This conditions the elevator car B to respond to up floor calls in the normal manner.

Alternatively, assume that the switches B26, B27 and 27 all are closed. Each car stopping at a floor while set for down travel cancels a registered up call for such floor. However, the elevator car B, when set for up travel, can answer an up floor call for any floor which it approaches.

Turning now to Fig. 3, it will be noted that the pick up of the down-peak relay also closes make contacts DP5 and DP6 to condition the elevator cars A and B to reverse at the farthest floor in the up direction for which a car call or a down-floor call is registered. If the elevator car is to ignore up-floor calls, make contacts DP9 to DP16 of the down-peak relay may be employed to shunt contacts of the up-floor call registering relays as indicated in Fig. 3.

If the elevator car A when traveling up is approaching the highest floor for which a car call or down floor call is registered (assuming that the car does not respond to up floor calls) the brush *kk* engages the *k*-segment for each floor to complete an energizing circuit for the relay 78U. This relay closes its contacts 78U1 (Fig. 1) to energize the windings of the relays E and F and these relays stop the elevator car at such floor by a sequence previously explained. In addition, contacts 78U2 open. As the elevator car stops, the make contacts 172 open to deenergize the up preference relay W. The deenergization of the relay W conditions the car for down travel by a sequence previously discussed.

Let it be assumed next that the elevator system is conditioned for down-peak operation, and that down-floor calls are registered for the third and sixth floors in the manner previously discussed. The car A is assumed to leave the first floor with a passenger who has registered a car call for the third floor. The car answers the car call in the manner previously set forth, and it will be assumed that passengers enter the car and fully load the car at the third floor. Inasmuch as the car is fully loaded, the switch LW1 (Fig. 2) is open to prevent the elevator car from responding to floor calls if it is otherwise conditioned to so respond. In addition, the switch contacts LW2 (Fig. 3) close to complete with the make contacts W8 and the down-peak relay contacts DP7 an energizing circuit for the high car call reversal relay HC. This relay closes its make contacts HC1 to HC5 for the purpose of shunting the contacts of the floor call registering relay in the circuit 30 for floors above the first floor. Inasmuch as the contacts W7 and DP5 are closed, the elevator car A now is conditioned to reverse at the third floor even though a floor call is registered for the sixth floor. If the switch 32 is closed, a holding circuit for the high car call reversal relay is also completed through the make contacts HC6.

If during down-peak operation the elevator car A is

assigned to serve the low zone of floors, the switch 33 is closed. Consequently, the closure of the make contacts DP17 conditions the elevator car A when traveling up to stop and reverse at the highest floor below the fifth floor for which a call is registered which the elevator car is conditioned to answer.

If the switch 46 in Fig. 4 is closed and the contacts DP19 are closed, the start relay SS picks up as soon as the elevator car A on a down trip reaches the lower terminal floor. Consequently, upon expiration of the non-interference time for such car, the elevator car A promptly leaves the lower terminal floor.

Inasmuch as the make contacts DP22 of the down-peak relay are closed and the break contacts DP23 are open, the operation of the elevator car A during the down peak period has no effect on the relay 1S.

Closure of the make contacts DP24 shunts the main electrodes of the tube 47. Consequently, if the elevator car B reaches the lower terminal floor prior to arrival of the elevator car C, the timing relay 1S is already picked up, and the selection of the elevator car B is accompanied by prompt energization of the start relay BSS.

Let it be assumed next that the up-peak relay UPK is energized. This relay closes its make contacts UPK1 (Fig. 3) to condition the elevator car A to reverse at the farthest floor when traveling in the up direction at which a down floor call or a car call is registered, provided that an up-floor call is not registered for such farthest floor and provided that an up-floor call is not registered for a floor above such farthest floor. Closure of make contacts UPK2 similarly conditions the elevator car B. The operation of the relays 78U and B78U previously has been discussed.

The up-peak relay also closes its make contacts UPK3 to connect the primary winding TRP across a distinct part of the resistor R7. The three taps of the resistor R7 may be positioned in accordance with the requirements of a specific elevator system. For illustrative purposes, it will be assumed that the tap R7A is positioned to provide a timing interval of the order of 35 seconds. The tap R7B is positioned to provide a timing interval of the order of 25 seconds, and the tap R7C is positioned to provide a timing interval of the order of 20 seconds. Consequently, during up peak operation, the minimum interval between departures of successive cars from the lower terminal floor is of the order of 25 seconds.

Finally, let it be assumed that the off-hours relay OH is energized and that this relay closes its make contacts OH1. Such closure conditions the dispatcher to provide a minimum interval between the departure of successive elevator cars from the lower terminal floor of the order of 35 seconds.

It should be noted that the adjustment of any of the taps associated with the resistor R7 adjusts the timing interval for the condition wherein the primary transformer is connected to such tap without affecting the intervals provided by the remaining taps. In addition, by adjustment of the tap R4T, the intervals provided by the taps R7A, R7B and R7C are all proportionately adjusted.

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. Consequently, the aforesaid embodiments are to be construed in an illustrative rather than a limiting sense.

I claim as my invention:

1. In an elevator system for a structure having a plurality of floors, a plurality of elevator cars, motive means for moving each of the elevator cars relative to the structure to provide elevator service for the floors, and control means for moving the elevator cars and stopping the elevator cars at desired floors of the structure, said control means being effective for stopping the elevator cars at a predetermined one of said floors and for start-

ing only one of the elevator cars from such predetermined floor, said control means including selective means operable into at least a first condition to control the elevator cars for a first mode of operation, said selective means being operable into a second condition to control the elevator cars for a second mode of operation, timing means requiring lapse of a first predetermined minimum time between the startings of successive elevator cars from the predetermined floor when the elevator cars are conditioned for said first mode of operation, said selective means being effective in said second condition to adjust the timing means to permit the startings of successive elevator cars from the predetermined floor upon lapse of a second time which is less than said predetermined minimum time.

2. A system as claimed in claim 1 wherein said timing means comprises adjusting means effective when operated for simultaneously adjusting the values of both of said times.

3. A system as claimed in claim 1 wherein the timing means comprises a manually-operable adjuster effective when operated for simultaneously and proportionately adjusting both of said times.

4. A system as claimed in claim 1 wherein the timing means comprises a main adjuster effective when operated for simultaneously adjusting the values of both of said times and independent adjusters effective when operated for independently adjusting the value of each of said times.

5. A system as claimed in claim 1 wherein the timing means includes a timing device having first and second sources of energy each effective when adjusted for independently controlling the time measured by the timing device, said selective means comprising an adjuster for adjusting the energization of the timing device from the first source to a first value for said first condition and to a second value for the second condition of the selective means, and an adjuster operable for adjusting the energization of the timing device from the second source.

6. A system as claimed in claim 1 wherein the timing means includes an electronic device having main electrodes between which electrical current can pass and an auxiliary electrode effective when electrically biased relative to one of the main electrodes for controlling the passage of said electrical current, a circuit including a first source of electrical energy for biasing said auxiliary electrode, a circuit including a second source of electrical energy for biasing said auxiliary electrode, and an adjuster responsive to transfer of the selective means between said conditions for altering the bias supplied by the first source to the auxiliary electrode, at least one of said circuits comprising a time delay for delaying application of a bias from the associated source to the auxiliary electrode.

7. A system as claimed in claim 6 in combination with an adjuster operable for altering the bias supplied by the second source to the auxiliary electrode.

8. A system as claimed in claim 6 in combination with means for adjusting independently the energization supplied by the first source to the auxiliary electrode for each condition of the selective means.

9. In an elevator system for a structure having a plurality of floors, a plurality of elevator cars, motive means for moving each of the elevator cars relative to the structure in each of two directions to provide elevator service for the floors, and control means for moving the elevator cars and stopping the elevator cars at desired floors of the structure, said control means being effective for stopping the elevator cars at a predetermined one of said floors and for starting only one of the elevator cars from such predetermined floor, said control means including selective means operable into at least a first condition to control the elevator cars for a first mode of operation, said selective means being operable into a second condi-

tion in response to a predetermined condition automatically occurring during load-carrying operation of the elevator system to control the elevator cars for a second mode of operation, timing means requiring lapse of a first predetermined minimum time between the startings of successive elevator cars from the predetermined floor when the elevator cars are conditioned for said first mode of operation, said selective means being effective in said second condition to adjust the timing means to permit the startings of successive elevator cars from the predetermined floor upon lapse of a second time which is less than said predetermined minimum time, said elevator cars in one of the modes of operation providing an off-peak operation which is substantially balanced in the two directions of travel and the elevator cars in the other of the modes of operation providing a peak-period operation which is substantially unbalanced in the two directions of travel.

10. In an elevator system for a structure having a plurality of floors, a plurality of elevator cars, motive means for moving each of the elevator cars relative to the structure in each of two directions to provide elevator service for the floors, and control means for moving the elevator cars and stopping the elevator cars at desired floors of the structure, said control means being effective for stopping the elevator cars at a predetermined one of said floors and for starting only one of the elevator cars from such predetermined floor, said control means including selective means automatically operated into at least a first condition in response to a predetermined condition occurring during load-carrying operation of the elevator system to control the elevator cars for a first mode of operation, said selective means being automatically operated into a second condition in response to a predetermined condition occurring during load-carrying operation of the elevator system to control the elevator cars for a second mode of operation and said selective means being automatically operated into a third condition in response to a predetermined condition occurring during load-carrying operation of the elevator cars to control the elevator cars for a third mode of operation, timing means requiring lapse of a minimum time between the startings of successive elevator cars from the predetermined floor, said elevator cars in the first mode of operation providing an off-peak service which is substantially balanced in the two directions of travel, the elevator cars in the second mode of operation providing an up-peak service which is unbalanced to expedite service in a first direction of travel, and the elevator cars in the third mode of operation providing a down-peak service which is unbalanced to expedite service in a second direction of travel, said selective means in each of said three conditions providing a different value of said minimum time.

11. In an elevator system for a structure having a plurality of floors, a plurality of elevator cars, motive means for moving each of the elevator cars relative to the structure to provide elevator service for the floors, and control means for moving the elevator cars and stopping the elevator cars at desired floors of the structure, said control means being effective for stopping the elevator cars at a predetermined one of said floors and for starting only one of the elevator cars from such predetermined floor, said control means including selective means operable into at least a first condition to control the elevator cars for a first mode of operation, said selective means being operable into a second condition to control the elevator cars for a second mode of operation, and timing means requiring lapse of a minimum time between the startings of successive elevator cars from the predetermined floor, said selective means in each of said conditions providing a different value of said minimum time, said modes of operation being selected from off-hours, off-peak, up-peak and down-peak modes of operation.