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Sept. 21, 1926.

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F. E. BOARDMAN

METHOD OF CONTROLLING ELEVATORS

Original Filed April 12, 1924 4 Sheets-Sheet 1

Fig. 2.

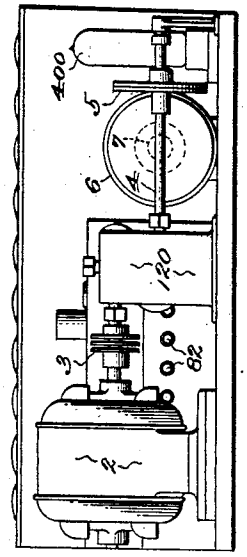


Fig. 3.

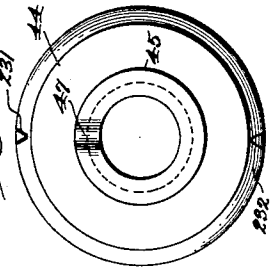


Fig. 4.

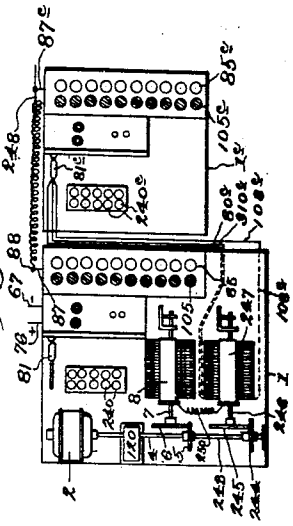
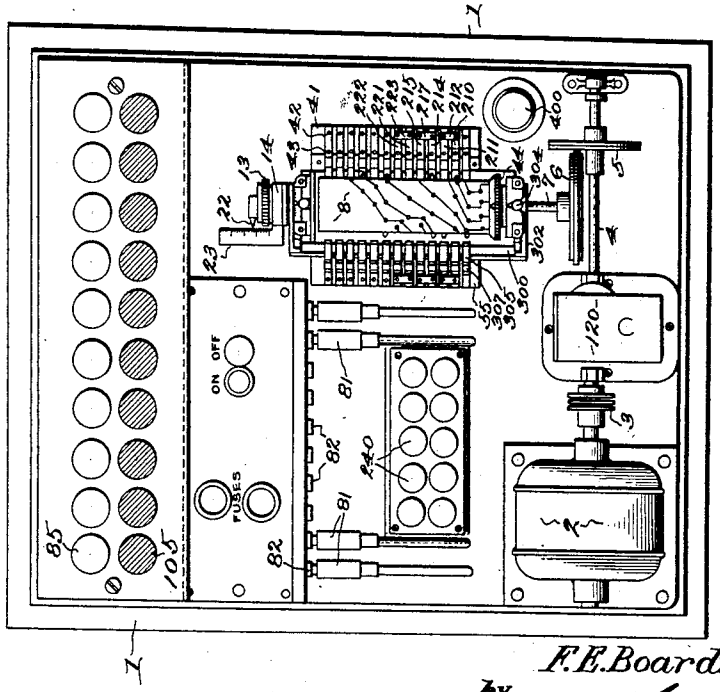


Fig. 1.



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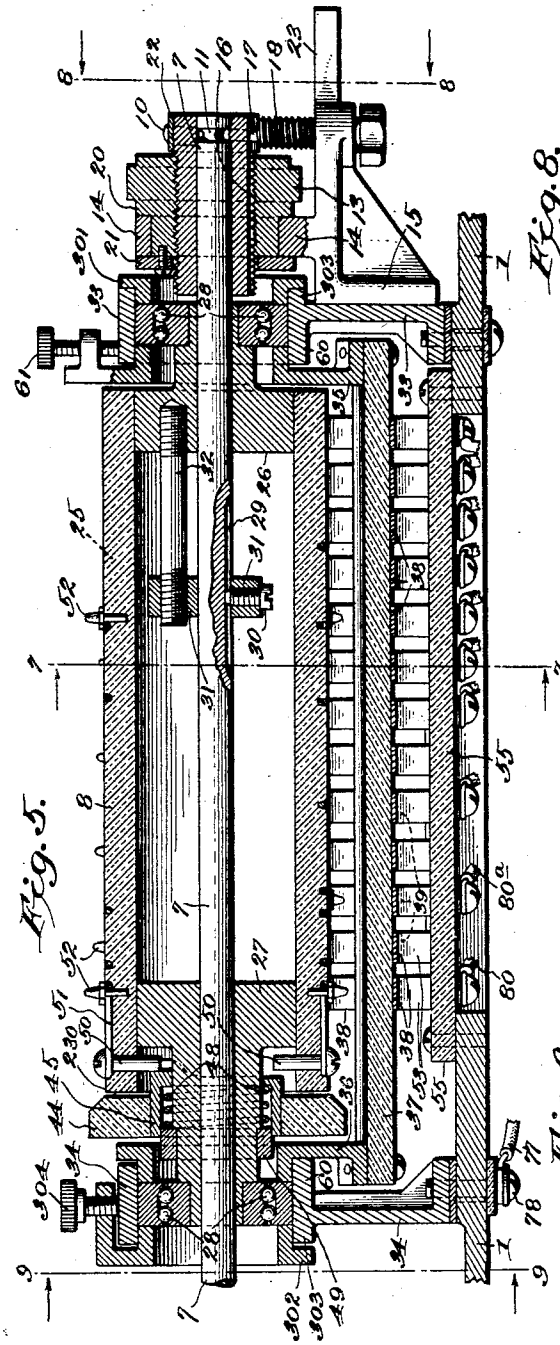


Fig. 5.

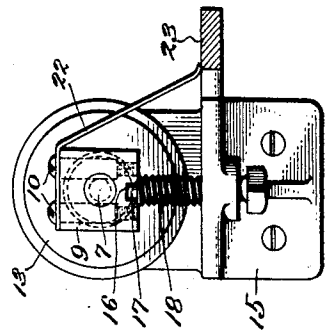


Fig. 8.

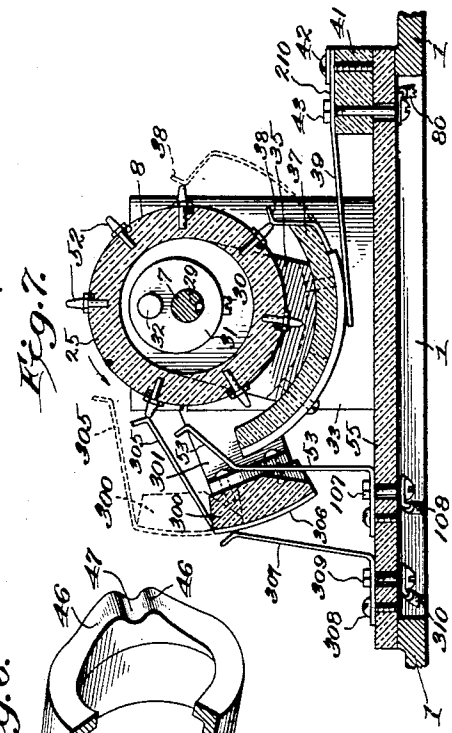


Fig. 7.

Fig. 6.

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Fig. 10.

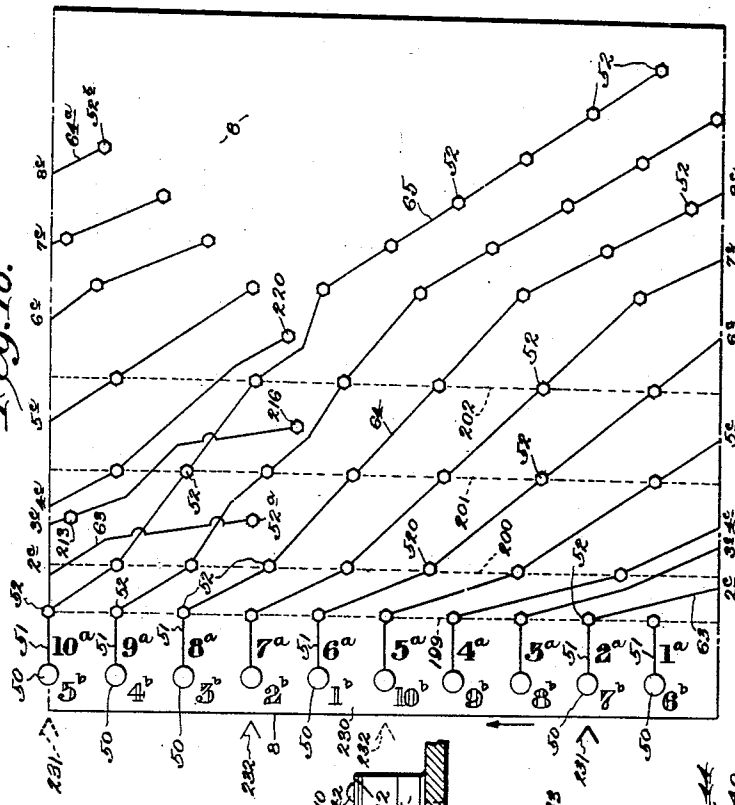


Fig. 9.

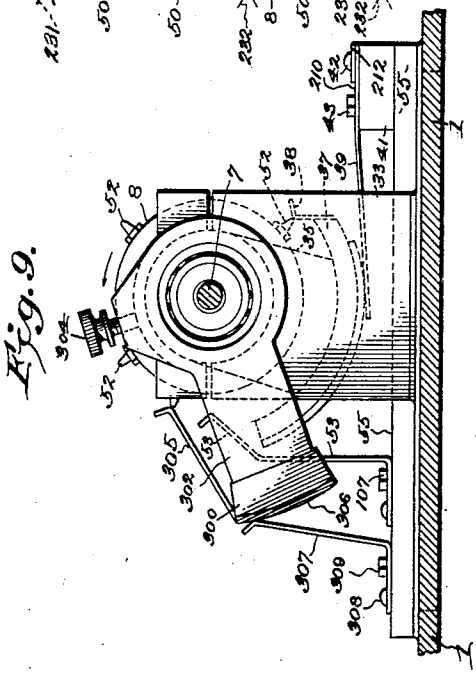
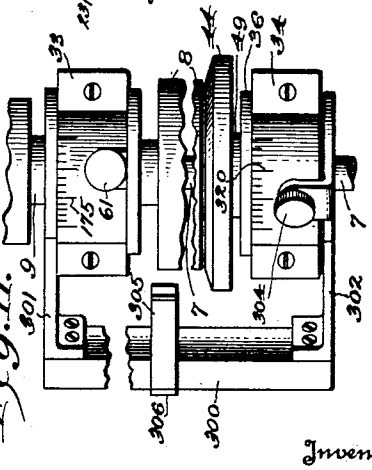


Fig. 11.



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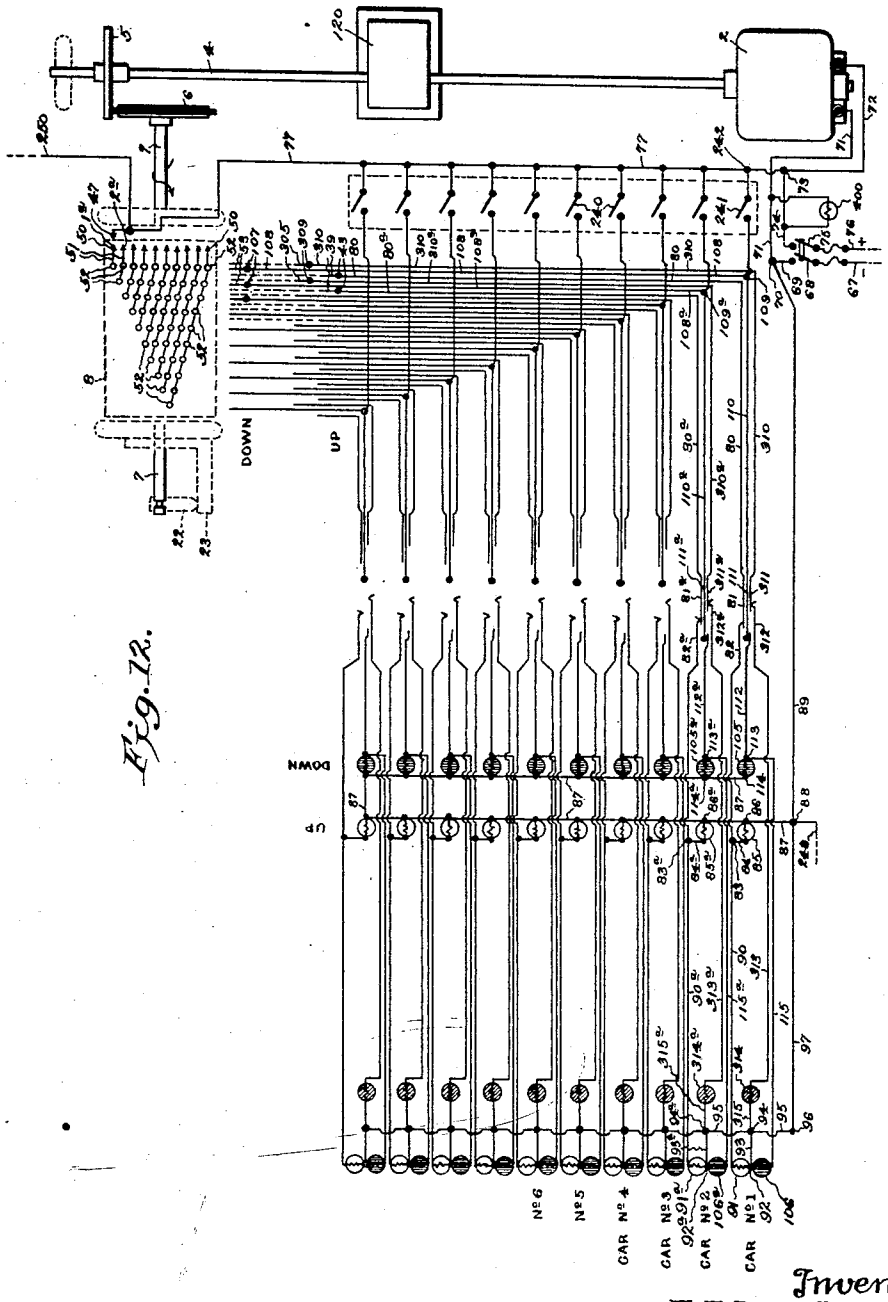


Fig. 12.

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Patented Sept. 21, 1926. 1,600,753

UNITED STATES PATENT OFFICE.

FRANK E. BOARDMAN, OF CHICAGO, ILLINOIS.

METHOD OF CONTROLLING ELEVATORS.

Continuation of application Serial No. 706,108, filed April 12, 1924. This application filed August 6, 1926. Serial No. 127,608.

This invention relates to a process or method for controlling elevators and has for its object to provide a procedure which will be more efficient in use than those which have been heretofore proposed.

With this and other objects in view, the invention consists in the novel steps and combinations of steps constituting the process, all as will be more fully hereinafter disclosed and particularly pointed out in the claims.

This invention differs from those disclosed in the sole and joint copending applications of Frank E. Boardman, and Frank E. Boardman, Jr., Serial No. 553,025 filed April 15, 1922, Serial No. 627,812 filed March 26, 1923, and Serial No. 711,371 filed May 6, 1924, all directed to elevator control apparatus, in that, it relates to a method which may or may not employ the apparatus of these said applications, all as will appear more fully hereinafter. Further, this application constitutes a continuation of the copending application of Frank E. Boardman, Serial No. 706,108 filed April 12, 1924, "Method of controlling elevators".

This method is directed to increasing the carrying capacity of a bank of elevator cars which are running below a normal or efficient carrying capacity, and to this end involves the operation, automatically, of said cars on what may be called the most economical time schedules. That is to say, as is well known, different banks or groups of elevators in different buildings require different periods of time to perform their various stops, startings, round trips, etc., and therefore what might be an economical interval of time between the startings of the cars of a group of elevators in one building might not be an economical interval of time for the startings of the cars of a group of elevators in another building. Therefore, this invention, when more specifically stated, may be said to involve a method of increasing the efficiency of a group of elevators which consists in automatically controlling the same by causing them to operate on schedules determined by such factors as the height of the building, speed of the elevator car, the acceleration of the elevator car, the minimum time required to open and close the shaft doors at all the floors, the time each elevator car consumes in stopping or parking at the top floor before its return trip, the time consumed by each car in stopping or parking at the lower termination or floor including the time for loading with passengers, the average number of stops made in either direction during various portions of a day, and the average number of passengers in either direction during various portions of a day. Of these factors the first six are fixed and determinable, and the remaining factors can be determined by the method of determining averages. Consideration should be given to the number of elevators in each bank in the building and when the above factors are taken into consideration, then the total time required for any one elevator car to make a complete round trip can be calculated, and this will be the efficient schedule time for each car.

It is of course to be understood that at different portions of the day, the amount of traffic will vary in either direction. In other words, in the early morning hours, there will be a very heavy traffic in the up direction with practically no traffic in the down direction. At noon, and again in the late afternoon or at office closing time, the direction of traffic will be reversed in volume, or in other words, the traffic will be heaviest in the down direction with practically no traffic in the up direction. Therefore observations for betterment of traffic conditions will be made during various portions of the day in order to meet the needs of the service for said portions of the day.

In order to disclose a suitable apparatus for automatically carrying out this method of controlling elevators reference is made to the accompanying drawings forming a part of this specification, in which like numerals designate like parts in all the views:

Fig. 1 is a plan view of the assembled elevator controlling mechanisms;

Fig. 2 is an end elevational view of the parts shown in Fig. 1;

Fig. 3 is an end elevational view of the selective element associated with the contact cylinder shown in Fig. 5;

Fig. 4 is a diagrammatic view showing how a plurality of units may be joined or put together in order to enlarge the capacity of the system;

Fig. 5 is a sectional view of the rotary contact cylinder;

Fig. 6 is a perspective view partially broken away of the contact member illustrated in Fig. 5;

Fig. 7 is a sectional view taken on the line

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7—7 of Fig. 5 looking in the direction of the arrows;

Fig. 8 is a sectional view taken on the line 8—8 of Fig. 5 and looking in the direction of the arrows;

Fig. 9 is a sectional view taken on the line 9—9 of Fig. 5 and looking in the direction of the arrows.

Fig. 10 is a development of the rotary switch of the cylinder illustrated in Fig. 5, showing the disposition of the wires and contacts on said cylinder;

Fig. 11 is a fragmentary top plan view of the contact cylinder and its associated parts; and

Fig. 12 is a diagram of the wiring of the entire system.

1 indicates any suitable support or base which may be located at any convenient portion of the building, as for example, on the first floor. 2 indicates any suitable motor provided with a clutch 3, and a driven shaft 4. Secured to said shaft 4 is a suitable driving means such as the friction disk 5 with which contacts the adjustable friction disk 6 rigid with the longitudinally adjustable shaft 7 adapted to drive the cylinder 8. On one end of shaft 7, as best illustrated in Figure 5, is fixed a screw threaded sleeve 9, by means of the screw members 10 entering a groove 11 with which said shaft is provided. Surrounding the screw threaded sleeve 9 is a knurled nut-like member 13 supported in the ring member 14 rigid with the frame member 15. Said sleeve 9, see Figure 8, is provided with a slot 16 into which enters the end 17 of a screw member 18, in order to prevent the said sleeve from turning when the member 13 is turned. Said knurled nut 13 is provided with the shoulder 20 which fits on one side of the ring member 14, and a locking disk 21 secured to said nut 13, fits on the other side of said ring 14, so that while said nut 13 is free to turn, it cannot move longitudinally of the shaft 7, and therefore its motion compels said shaft 7 to move in a longitudinal direction. Also secured to the sleeve member 9 is an indicating member 22, adapted to coact with the scale 23, as best shown in Figure 1. The construction is such that, when the knurled nut member 13 is turned, the shaft 7 will be moved longitudinally to change the speed of rotation of cylinder 8, and the amount of movement will be indicated on the scale 23. That is, the different movements of the shaft 7 will determine the different speeds at which the cylinder 8 is rotated, as will be clear from the drawings.

The contact cylinder 8 is provided with the outer member 25, of insulating material, fitted over two drums 26 and 27, through which the shaft 7 passes, and these drums in turn are conveniently mounted on the ball bearing 28 as shown. The shaft 7 is splined as at 29, and the screw member 30 enters said spline so that power transmitted to shaft 7 will be transmitted to screw member 30, to the supporting member 31, to the screw threaded member 32, to the drum 26 and to the outer cylindrical member 25. The cylinder 8 is thus rotated at the same speed as is the shaft 7, while the shaft 7 may be longitudinally adjusted to change the speed of cylinder 8 without interfering with the rotation of the parts.

Secured to the base member 1 and insulated therefrom are the end members 33 and 34, in which are located the ball bearings 28 as shown; associated with the end member 33 is the bracket 35, while associated with the end member 34 is the bracket 36. Secured to the said brackets 35 and 36, is the contact carrying member 37 made of insulating material, and secured to the latter are a plurality of spring contact fingers 38 for each of which there is a corresponding spring contact finger 39, all as will be clear from Figures 5 and 7. Each of the contact fingers 39 is secured to the insulating block 41 as by means of the screws 42 and the contact terminal 43.

The cylinder 8 is further provided with the insulating disk-like ring 44 in which fits the thimble-like metallic member 45 provided with two cam projections 46 having the depression 47, therebetween. A spring 48 abutting against the collar 49 located on the inner portion of the member 45 and carried by the drum 27 constantly forces the member 45 toward the right as seen in Figure 5 and thus keeps the cams 46 in the path of movement of the series of contacts 50, with which the outer insulating cylinder 25 is provided.

There is a pin contact 50 for each car to be controlled, and each pin 50 is connected as by a wire 51 with a contact 52 located on the outer circumference of the cylinder 8, see Figures 5, 7 and 10. These said contacts 52 are preferably arranged in rows circumferentially around the cylinder 8, see dotted lines 200, 201, and 202, Figure 10, and for each row of contacts 52, there is a spring contact 53 secured to the base block 55 of insulated material, all as will be clear from the drawings.

With particular reference to Figures 5 and 7, the bracket 35 pivots in the inner flanges 60 of the members 33 and 34 around the axis of shaft 7 as a center, so that the sector shaped piece 37 may be rotated around said shaft to cause each contact member 38 to engage a contact member 52, in its particular row of contacts at different positions as will be clear from the dotted lines, Figure 7. The purpose of this rotation will be disclosed below. It will be observed that the bracket 36 is a substantial

duplicate of the bracket 35, so that when the sector 37 has been turned or rotated in the manner above disclosed, the bracket 35 will also be turned and the set screw 61 is employed to jam or lock the member 35 in its new position and thus lock the sector 37 in its adjusted position.

A second contact carrying member 300, likewise made of insulating material, is secured to the ends of a pair of brackets 301 and 302 pivoting respectively in the outer flanges 303 of the end members 33 and 34. This contact carrying block 300 may be revolved around shaft 7 to any desired position where it may be locked by means of the set screw 304. Secured to the block 300 are the spring contact fingers 305 adapted to make contact with the contact points 52 carried by the cylinder as it revolves, and for a purpose to be subsequently disclosed.

That is to say, there is provided a contact finger 305 for each circumferential row of contact points 52. Each contact finger 305 has an arcuate extension 306, fitting the block 300, by means of which said finger 305 is secured to said block. Each extension 306 also provides a contact surface against which presses a stationary spring contact member 307 secured to the base block 55 as by the screw 308 and contact terminal 309. From the foregoing and with particular reference to Figures 1, 5, 7 and 10, it will be understood that the contact points 52 are arranged about the cylinder 8 in circumferential rows; that each point 52 as it is carried around by the cylinder will make contact with the fingers 38, 53 and 305; that each movable finger 38 is in contact with a stationary contact member 39; that each movable finger 305 is in contact with a stationary contact member 307; and that the contact finger carrying members 37 and 306 may each be rotated about shaft 7.

Referring now to Figures 5, 6, 10 and 12, it will be observed that the contact 47 is adapted to turn entirely around the inside of the cylinder 8, and thus make contact with any one of the contact members 50. It will further be seen from Figure 10 that the circumferential row of contacts 50 are each joined by the wires 51 to a corresponding contact 52, and that a contact 52 in each instance is the beginning of a series of contacts disposed about the circumference of the cylinder, and that each series contains a different number of contacts 52 corresponding to the number of cars which are to be controlled by said series. Stated in other words, and referring to the numeral 1^a in Figure 10. it will be seen that its corresponding contact 50 is joined by the wire 51 to a single contact 52, and therefore 1^a indicates that a single car is controlled by the corresponding contact 50. The numeral 2^a, on the other hand, refers to a series of contacts consisting of two contacts and indicates that two cars are controlled by its corresponding contact 50. In Figure 10, the first contact 52 of the series 2^a is illustrated near the bottom of said figure, while the other contact 52^a is illustrated near the top of the figure, the two contacts 52 and 52^a being joined by the wire 63, (the numerals 2^c appearing at the bottom and top edges of Figure 10 identify the cut ends of the wire 63). In the same way, the numeral 8^a indicates that there are eight cars to be controlled in that series from its corresponding contact 50. Seven of the contacts 52 of this last mentioned series are shown as connected by the wire 64 and the eighth or last of said contacts 52^b is shown at the upper edge of Figure 10, and connected to the others as by the wire 64^a, (the numerals 8^c appearing at the top and bottom edges of Figure 10 identify the cut ends of the same wire). In the case of the series 10^a all of the contacts 52 are shown as joined by the wire 65, extending from the top to near the bottom of Figure 10.

Referring now to Figure 12, current enters the system over the wire 76, passes to and through the switch 75, and thence over the wire 74 to the point 73, where it divides. A portion of the current passes along the wire 72, to and through the motor 2, leaving the same over the wire 71 to the point 70. Said current now passes over the wire 69 through the switch member 68 and over the wire 67 back to the source of current. Another portion of said current passes from the point 73 along the wire 77 to the screw 78, Figure 5, thence to the bracket member 34 through the ball bearings 28, the drum member 27, the collar 49, and the contact member 47, to the contact pin 50. If said contact member 47 has been so turned, through the medium of the member 44 (see Figure 5), that said contact member 47 makes circuit with the contact pin 50, in the series of contacts 1^a, as is illustrated in Figure 12, then current will pass through the wire 51 to said contact 52 in series 1^a, and as the cylinder 8 revolves in the manner above disclosed said contact 52 will make circuit with the spring member 38 which is in contact with the spring member 39, see Figures 5 and 7, whereupon the current will pass out of the terminal 43 along the wire 80, Figures 7 and 12, to the spring plug 81, to its corresponding jack member 82 to the point 83 where it divides, a part of the current passing along the wire 84, through the white light 85 to the point 86, and thence along the wire 87 to the point 88. The current at the point 88 passes along the wire 89 back to the point 70, through the wire 69, switch 68, wire 67, and back to the source.

From the point 83, the current passes along the wire 90, through the white lamp 91

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which is carried on the car in shaft No. 1 and controlled by the series 1a, Figure 12. From said white lamp 91 the current passes to point 92, along wire 93 to point 94 on the common wire 95, along wire 95 to point 96, along wire 97 to point 88, and thence along the wire 89 and its connections back to the source of current.

From the mechanism so far disclosed, it will now be clear that as the motor 2 revolves, the shaft 4, disk 6, shaft 7, and cylinder 8 will be revolved at a speed corresponding to the adjustment of the disk 6, relatively to the disk 5. It will further be clear that as the cylinder 8 is thus turned in the direction indicated by the arrows in Figures 7, 10 and 12, the first contact 52 in each of the series of contacts numbered from 1a to 10a, will be brought into electrical connection with the contact member 38, Figure 7. When the contact series 1a is thus brought into electrical connection with the contact member 38 as described, current will pass through the white light 85 located on the stationary board 1, and simultaneously pass through a corresponding white light 91 located on the car, which belongs to the series 1a, and which is to be operated. The flashing of the white light 85 in the manner just disclosed will indicate to the elevator starter the fact that the car belonging to this particular series should start, and the flashing of the white light 91 will indicate to the operator of the car in shaft No. 1 that it is time for him to begin his upward trip. There are red lights to indicate to the car starter and to the operators of the various cars the beginnings of the downward trips, as will be presently disclosed.

It should be stated that conveniently located between the top and bottom of the elevator shaft, or say about midway thereof, is a contact plate provided with suitable terminals, etc., for making suitable and well known connections with the white and red lights. On each car, and of course, there would have to be as many sets of terminals as there are cars to be operated. As the connections are indicated in Figure 12, only a single car would be operated as the motor 2 revolves for the contact 47 only makes circuit with the single series 1a.

In case the elevator starter wished to control or to operate two cars instead of one, he would go to the indicator board 1, and turn the member 44, Figure 5, until the contact member 47 made circuit with the contact pin 50 pertaining to the series 2a which, as shown in Figure 12, is provided with the two contacts 52 on the cylinder 8. In such case the current having reached the point 47 in said figure, would now pass along the wire 51 corresponding to series 2a, and to both of the contacts 52 of said series 2a. As the cylinder 8 revolved, it would make electrical circuit successively with the corresponding two members 38 and their two coacting contacts 39, with which the apparatus is provided, see Figures 5 and 7, (it being understood that there is a member 38 for each member 39, see dotted lines in Figure 5). Current will now pass successively along both of said members 39, and along their corresponding connecting wires 80 and 80a where the current is divided, along the wires 84 and 84a, and through their corresponding white lights 85 and 85a, to the points 86 and 86a, along the wire 87 to the point 88. The current now returns along the wire 89 back to its source as above described, it being understood, of course, that the two cars now being operated do not leave the bottom floor simultaneously, and therefore the white lights 85 and 85a do not flash simultaneously but successively.

That is to say, the original car belonging to series 1a is now operating as car No. 1 of the series 2a, and therefore its white light 91 is flashed precisely as was the case just described when only one car was being used. In this series 2a, however, in addition to this said car No. 1 being operated, the second car carrying a white light 91a is also operated, and this said white light is flashed simultaneously with the stationary white light 85a above disclosed, by means of that portion of current passing from said point of division 83a over the wire 90a to the light 91a, carried by car No. 2, through the said light to the point 92a, along the wire 93a to the point 94a of the common return wire 95, along said wire 95 to point 96 over wire 97 back to the point 88, and thence to the source, as above disclosed, over the wire 89.

Whether one, two or more cars are used in this system, it is obvious that all of the said cars will never be started from the main or ground floor at the same time. That is to say, all the cars operating in this system will have successive times of departure from the main floor and this is taken care of through the medium of the said rotary contact cylinder 8. This is accomplished through the particular disposition or displacement of the several contact points 52 around the circumference of the said cylinder as shown in Figure 10. The spacing of these said contact points 52 is such as to cause each successive car to be automatically signalled by the rotation of cylinder 8, at uniform intervals. That is, considering for instance series 2a in which but two cars operate, it will be observed that the contact points 52 and 52a are 180° apart, or the distance from the first contact point 52 to the second contact point 52a, see Figure 10, is the same or equal to the distance from said contact point 52a, back to said first named contact point 52. Likewise, in any other se-

ries, such for example as series 8ª containing eight contacts, the locus of each of the successive contacts members 52 will be on the circumference of the cylinder 8 in an element thereof disposed one eighth of a circumference or 45° from another element which is the locus of the next adjacent contact members. In other words, the full circumference of the cylinder is divided into equal arcs by the number of cars to be operated in the series, and in the elements of the cylinder passing through these points of division are located the particular contact points 52 of that particular series. Thus it will be seen that each car in the series will receive its flash or signal for its upward or downward trip at equal intervals of time.

In a similar manner, signals for each car are flashed to start the downward trip through the medium of the red lights 105 and 106, located respectively on the board 1 and in the car. That is to say, after the white lights are flashed the cylinder 8 in its continued revolution will carry the contact points 52 of each series on around from the contact fingers 38 to the contact fingers 53, see Figures 7 and 12, and thus close the circuit momentarily which passes through the said red lights. The circuits for these red lights, or down signals are as follows:

The current passes from the source through the wire 76, through the switch member 75, wire 74, to division point 73, over wire 77 to the variable contact member 47, all as heretofore described, thence through the particular pin 50 with which the said variable contact member 47 engages over the wire 51 of that particular series connected with the variable contact member 47 to the contact member 52 carried by the cylinder 8. When the cylinder 8 has revolved sufficiently to carry the point 52 so as to make contact with the spring finger member 53, see Figures 7 and 12, the current passes from the said contact 52 to the member 53, through the terminal post 107 to the wire 108, along said wire to the point 109, thence over wire 110 to the other contact portion 111 of the plug 81, thence to the other contact member 112 of the jack 82, to the point 113 where the current divides, then through the red light 105 to the point 114, thence over wire 87 which from Figure 12, it will be observed, is common to one side of both white and red lamps, and so to the aforementioned point 88. From the said point 88 the current passes over the wire 89 to point 70, and back to the source all as will be clear from the foregoing. At the point 113 it will be observed that the current splits and a second circuit starting at this point, passes over wire 115 to the red light 106 carried by the car No. 1, through said light to point 92, over the wire 93 to the point 94, thence over wire 95 to point 96, over wire 97 to point 88, where it returns over the wire 89 as has been heretofore described, and as is illustrated in Figure 12.

If two cars are utilized as was the case described previously, and the said contact member 47 engages the pin 50 of the series 2ª, then the circuit for the down signals will be as follows: As heretofore described, the circuit originating at the source will reach the contact 47, pass into the cylinder 8, enlivening both contact points 52 of the said series 2ª, so that when the said contacts have revolved through the turning of said cylinder they will successively contact with spring members 53 of which there are as many as spring contact members 38 and 39. The circuit now having reached contact member 52, passes through the spring member 53 to the terminals 107, thence over the wires 108 and 108ª, successively in the same manner as did current pass from the said contact members through the spring members 38, and thence over the wires 80 and 80ª as was disclosed previously, in the description of the white or up signals.

Referring to Figure 12, it will thus be seen that the current will pass through these said wires 108 and 108ª to the points 113 and 113ª where it divides, a portion passing to and through the red light 105 and 105ª to the points 114 and 114ª, thence over the common wire 87 to the point 88, and thence back to the source over the aforementioned return wire 89. The other portion of the said circuit passes from the points 113 and 113ª over the wires 115 and 115ª to the red or down signals 106 and 106ª, carried respectively by car No. 1, and car No. 2 of the series 2ª, through the said lamps to points 92 and 92ª, over the wires 93 and 93ª to the points 94 and 94ª, over the common wire 95 to the point 96, over the wire 97 to the point 88, and thence to the source over the common return wire 89.

A suitable pilot light 400, see Figures 1, 2 and 10, may be connected in circuit, as between the wires 71 and 74, to illuminate the control board 1 when necessary.

In a similar manner, as just described for series 2ª, the system may be utilized for any number of cars up to and including ten. For example, should there be ten cars in the building, all operated by this system, the white signals for the start of each car and located on the stationary board 1 as well as the white lamps of each car and carried thereon, will each be flashed successively, all in the same manner as has been heretofore described by the specific examples of one, or two cars, the only difference being that for each car there must necessarily be a plug and a jack and that said plug must be inserted in its corresponding jack to control the circuits of the cars in operation. Therefore, if ten cars are in use, all ten plugs must be inserted in their jacks to close the circuits,

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so that as each contact member 52 carried by the revolving cylinder 8 contacts with its respective spring member the circuit will be closed so as to momentarily flash the lamps corresponding to the cars. For the sake of brevity, only the circuits of one and two cars have been specifically traced and described, but it is obvious by referring to the drawings that in like manner the circuits will be made for any number of cars. That is to say, each circuit is really a duplicate of the other, the circuit being closed momentarily through the medium of the contact members 52 carried by the revolving cylinder.

It will now be seen that in order to control the starting of elevators such as in large office buildings, and so as to obtain the most efficient service, there should be a systematic control of the same, and this is accomplished through the employment of automatic means such as that explained herein. By the use of this system, each car is successively signalled, and therefore, with all cars in service, each car will have a uniform or equal number of trips during the day. Further, it will be obvious that in the early morning and after lunch hours the peak of up travel is reached, and therefore at this particular time all the cars in the building can be thrown into this system by plugging of the corresponding plugs into their jacks. However, say at about ten o'clock in the morning, and two o'clock in the afternoon, the volume of up traffic is considerably reduced and one or more cars may be temporarily thrown out of the system, the operators thereof laid off, and the volume of traffic handled in an efficient manner by the remaining cars at the will of the superintendent or starter. Likewise, at the noon rush hour, and the evening home-going peak, the down travel may be efficiently controlled by the employment of all the cars.

In this system, it is desirable to vary the time allowed for the upward and downward travel of the cars in accordance with the passage of traffic. That is to say, in the early morning hours when practically all of the traffic is upward it may become necessary to divide the round-trip time of each car so that the time consumed in the upward travel is longer than the time required for the descent of the car. This is obvious at this time of day from the fact that there will be little if no downward passage or travel, and consequently no stops. Therefore, little time is required for the car to reach the main or ground floor after leaving the top. To accomplish this the member 37, which is supported below the cylinder 8 by means of the depending brackets 35 and 36, see Figures 5 and 7, and which carries the series of spring contact members 38, is made capable of being swung, about the shaft 7 as a center, to such a position as is shown in dotted lines in Figure 7. With particular reference to this figure, it will be seen that the member 38 in dotted line position makes contact with the points 52 at a position practically diametrically opposite from that location at which the spring member 53 contacts with the said point 52. This indicates that both the up signal and the down signal are flashed at equal intervals of time with respect to each other. That is, if the volume of traffic were equal in both up and down directions, it would be obvious that the member 37 should be in such a position as is indicated by the dotted line representation in Figure 7. Suppose, however, that it is late afternoon, and consequently the down traffic has greatly increased over traffic in the opposite direction. Then it would be very advantageous to allow the car less time for its up trip than for the down trip and this is accomplished through the rotation of said bar 37, carrying the contact members 38, around to such a position as is indicated in full lines in Figure 7, whereupon, as the insulated cylinder 8 revolves in the direction of the arrow, the contact point 52 carried thereby will contact with the spring member 53 and thus give the signal for the car to start its upward travel. There being little or no passage of traffic in this direction, the car can make practically a non-stop trip, and therefore it needs but little time to reach the top floor. Upon reaching the top floor, it takes on its load of passengers and then receives its down or red signal by virtue of the point 52 having contacted with spring member 38 and by particularly referring to Figure 7, it will be quite obvious that the said car may start and continue its downward trip, making the necessary stops at intervening floors and reach the bottom or main floor after having consumed more time than was necessary for its up trip.

In like manner, if the volume of traffic is heaviest in an up direction, the said bar 37 carrying the spring member 38 may be swung in a counter-clockwise direction, as seen in Figure 7, to such a position as has been previously ascertained to be the most advantageous to correctly time the up and down trips of the cars. After the shifting of this member 37 it may be substantially held in a locked position through the medium of the milled set screw 61, see Figures 5 and 11, clamping against the upper portion of the supporting bracket 33, which may carry a scale 175, as shown.

It will be obvious from Figures 1, 8 and 12 that the means employed to rotate the cylinder 8 consists of the motor 2, which delivers power through suitable gear reduction not described but indicated at 120, to the shaft 4 upon which is mounted the insulated driven disk 6 carried by the cylinder shaft 7. It will thus be seen that the speed or

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revolution of the cylinder 8 may be varied to suit the different conditions existing in a system of this kind by the shifting of the shaft 7 toward or away from the shaft 4.

After the system has been in operation for a short time and numerous tests have been taken, the elevator starter or some one entrusted with the care and operation of the device will have discovered that certain speeds of the cylinder will be best suited for certain hours of the day. To facilitate the quick and easy adjustment of the speed of the cylinder, a scale 23, carried on one of the supporting brackets of the cylinder and a pointer 22 secured to the end of the shaft 7, are provided, so that as a result of the aforementioned tests certain divisional markings of the scale 25 will represent the speed best suited for that particular hour of the day and consequently the cylinder 8 can be quickly positioned.

By referring to Figure 10, it will be observed that whereas the contact 52 of series 2^a is on the row of contacts indicated by the dotted line 199, the other contact 52^a of said series 2^a is between the rows of contacts 52 which are on the dotted lines 200 and 201. That is to say, in order to place the contact 52 at say 180° from its corresponding contact 52 in the series 2^a it is necessary to displace said contact 52^a axially of the cylinder 8, for there is no room for the contact 52^a in the row of contacts found in the dotted line 200. On the other hand, it is essential that circuit should be made with the contact 52^a under the same conditions as if it were located on the dotted line 200 in the second row of contacts 52.

In order to accomplish this, the particular connections 210, see Figures 1 and 7 corresponding to the contact 39 which governs the row of contacts 52 placed on the dotted line 200, is connected with an auxiliary connection 211, Figure 1, which is in all respects similar to the connections 210, and which connection 211 leads to a corresponding contact such as 39, which would lie in the path of the particular contact 52^a. Further, the connections 210 and 211 are joined by the plate 212, so that when the circuit is made with the contact 52^a, it provides all the conditions that it would provide if such contact 52^a were located on the dotted line 200. The contact 213 pertaining to the series 3^a is likewise displaced from the dotted line 200 and located between said line 200 and the dotted line 201, as shown in Figure 9, so that it is taken care of by the connection 211 in the same manner as is the contact 52^a.

Coming now to the contact 216, it really belongs to the row of contacts 52 belonging to the row indicated on the dotted line 201. It is taken care of by joining the connection 214 with the connection 215 by means of the place 217, see Figure 1. Likewise, the contact 220, Figure 10, which has been displaced from the row of contacts 52 belonging on the dotted line 202, is taken care of by the connections 221 and 222, joined by the plate 223, all as will be understood from Figure 1. By adopting the construction just disclosed in Figures 1 and 10, it will be seen that the various contacts 52 may be placed in any given row of contacts, at such positions on the cylinder as will make the up and down trips of the cars at the desired intervals, and yet at the same time enable all of the contacts 52 to be crowded into a relatively very small space indeed, thus enabling the size of the cylinder 8 to be reduced to a minimum.

Referring again to Figure 10, it will be observed on the extreme end 230 of the cylinder 8 there is disposed a series of solid black numerals 1^a, 2^a, 3^a, up to 10^a, and near said first named numerals there is also a row of open or light numerals 1^b, 2^b, 3^b, etc., up to 10^b. It will further be observed that whereas the first mentioned solid numerals go consecutively from the bottom to the top of Figure 9, the second series of numerals begin at the middle and go to the top, and then begin at the bottom and go to the middle. In other words, the beginnings of the two sets of numerals are displaced 180° around the cylinder 8. The reason for this is as follows: These said cylinders 8 as they are manufactured are provided with these two rows of numerals disposed as indicated, and the disk like member 44 is provided with two V-shaped markings or indexes 231 and 232, readily distinguishable from each other by any suitable means not shown and displaced 180° from each other, as best illustrated in Figure 3. Further, the said disk 44 is so mounted upon the said variable contact member 45 that the notch 47 of the said member 45 is in the same diameter as that joining the two indexes 231 and 232, as will be clear from said Figure 3.

Assuming that the positions of these indexes 231 and 232 are those indicated on Figure 9, and that the cylinder 8 is revolving upwardly or in the direction of the arrow in Figure 9, the utility of these two sets of numerals 1^a and 2^a, etc., will be illustrated by the following.

Suppose the index 231 is opposite the solid numeral 2^a, meaning that there are two cars being operated and it is desired to suddenly place ten cars in service. Without the series of numerals 1^b and 10^b it would be necessary to turn the index 231 to the solid numeral 10^a, and in the same direction in which the cylinder 8 is revolving. This often would be a difficult and inconvenient problem, for the index 2^a might not be at a readily visible position with the result that one might have to wait until the cylinder 8 turned sufficiently far to bring said

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index into view. Further, the cylinder 8 might be revolving faster than it was convenient to turn the index member. On the other hand, the index 232 being displaced 180° from index 231, would be in sight and convenient, with the result that said index 232 could be turned backwards two divisions, or until it got opposite the light Figure 10[b]. Such a turning of index 232 would have the effect of turning the index 231 backwards, or in a direction opposite to the arrow in Figure 10, and making it register with the solid index 10[a], which is a much shorter and more convenient operation than turning it forward or in the direction of the arrow until it reached 10[a].

Referring more particularly now to Figure 12, 240 represents a plurality of recall buttons, which have the convenient function of enabling the operator of the system to close any particular circuit and to recall any particular car from a higher floor to the bottom floor immediately. It is hardly necessary to trace all the circuits for these recall buttons, but one circuit might be briefly traced by considering the recall button 241, for example. In this case, the current would flow from the point 242 across the switch at 241 and reach the point 109, whereupon it would flow along the wire 110, to and through the plug and jack connections 111 and 112 respectively, to the point 113, where it would divide and one portion thereof pass along the wire 115 to the red light 106, on the car, and back to the source of current in the manner already disclosed above. In this way, the car No. 1 carrying the red light 106 would be signalled to return at once to the bottom floor. In like manner it will be seen that each of the other buttons 240 constitutes a switch which when operated closes a shunt circuit for a particular car which "shorts" the circuit to said car operating under a system such as disclosed in the aforementioned application, Serial No. 627,812 and likewise operating under the system of control as disclosed thus far, is sometimes delayed in its round trip, a fact which necessarily puts that particular car behind in its schedule. That is to say, a car may leave the top floor on schedule time, i. e., upon receiving its red light signal but, due to an unexpected increase in the down traffic the said car would receive the signal to start its next up trip before reaching the lower terminal floor. As a result, the subsequent signals received by said car would likely be flashed therein at points in its travel other than at its first floor and top floor parking position. Such a condition of affairs would of course defeat the purpose of this automatic control system.

To avoid such a condition, and thereby improve the efficiency of this system, an auxiliary signal light is flashed in each car after the down signal has been received and at a predetermined time before the flashing of the following up signal therein. This auxiliary signal light is of some color distinctly different from the other two signal lights and, in this connection, green has been found to be a very practical color. This green light may be conveniently grouped with the white and red lights or separated therefrom, but should be so located in the car as to be plainly within the vision of the car operator as he stands in operating position. For convenience this green light has been grouped with the other two signal lights in the car as will be seen by referring to the wiring diagram illustrated in Figure 12.

The flashing of this auxiliary signal is accomplished in a manner similar to the flashing of the other signals. From Figures 7 and 9 it will be seen that the contact points 52 are adapted to momentarily contact with the movable or adjustable fingers 305 as the cylinder 8 revolves. Further, it will be seen that the fingers 305 are provided with the extensions 306 which in turn contact with the fingers 307 which are provided with the terminal posts 309 connecting with the wires 310.

The circuit of this green signal is clearly shown in the wiring diagram, Figure 12, but may be traced as follows: Current derived from a source not shown will flow through wire 76, switch member 75, wire 74 to point 73, thence over wire 77 to the spring contact member 47 which is in engagement as shown with the pin 50 of series 1[a] carried by the cylinder 8. From pin 50 the current will flow along the wire 51 and thus energize the contact point 52 on said cylinder. When this point 52 by revolution of the cylinder, contacts with a finger 305, see Figures 7 and 12, the current will flow through said finger 305, and its connections, to terminal 309, thence along the wire 310 to the portion 311 of the plug 81, through the portion 312 of the corresponding jack member and its wire connection 313, to the green lamp 314, through said lamp, along wire 315, to the point 94, thence over the wire 95 to the point 96, along the wire 97 to point 88, thence over the wire 89 to the point 70, along the wire 69, through the switch member 68 and thence over the wire 67 back to the source of current.

Should two cars be in operation the contact member 47 would be rotated to engage the pin 50 of series 2[a] as explained heretofore with reference to the other signal circuits. Current from a source would then pass over wires 76, 74 and 77 through member 47 to the pin 50 engaged thereby, and thence along the wire 51 to the contact points 52, energizing the latter. Upon the

rotation of cylinder 8 the first contact point 52 of this series 2^a would pass current exactly as did the contact point 52 of series 1^a and as clearly traced above. When the second contact point 52 contacted with its respective finger 305 then current would flow through said finger 305 and its connections to its corresponding terminal 309, thence along the wire 310^a to plug 311^a, jack 312^a, along the wire 313^a to the green light 314^a located in car number 2, through said light, along wire 315^a to point 94^a, thence back to the source along the common return wires 95, 97, 89 and 67.

From Figures 5, 7, 9 and 11 it will be seen that the insulated contact finger carrying block 300 is rotatably supported and capable of being locked in an adjusted position by means of the set screw 304 clamping against the upper portion of the supporting bracket member 34 which may carry a scale 320.

The purpose of this auxiliary signal, as heretofore stated, is to warn the operator of the car that he will soon receive his signal for starting his up trip. In a building of ten stories this green signal light should flash under normal efficient running conditions, in each car when the same had, for example, reached the third floor level in its descent, thus allowing the car ample time to make the necessary remaining stops on its continued down trip and discharge its load of passengers at the lower terminal floor before receiving the next up signal. If the warning signal is flashed after the car has passed the third floor then the operator will know that his car is ahead of schedule. On the other hand, should this green signal be flashed in a car before it reaches the third floor, then that car is behind schedule and, under instructions for such a contingency, the operator of that car would not make any more stops until he reached the lower terminal floor. The timing of the auxiliary signal before the following up signal would of course be sufficient to allow a car, behind in its schedule, to "express" or go to the first floor without stopping from a relatively high floor.

As was the case with the rotatable member 37, the block 300 carrying the contact fingers 305 is capable of circular adjustment to conform with the volume of traffic. That is to say, when the traffic is heaviest going up, as in the early morning rush hour, the member 300 would be positioned as shown in full lines in Figure 7, causing the circuit, for flashing the green warning light in each car, to be closed just preceding the closing of the circuit controlling the white, or up signal. When the down traffic was heaviest, as in the late afternoon office closing period, then the member 300 would be moved to a position such as indicated by the dotted lines in said Figure 7, thus causing the warning signal circuit for each car to be closed more in advance of the closing of the up signal circuit for each car. The operator of each car is told by the superintendent of traffic, or other person having supervision of the elevator service, each time the member 300 is repositioned so that each operator may know at which floor of the building, if his car is running on efficient schedule, he should expect to receive his warning signal. Passengers for down cars which are behind schedule would of course be picked up by the following cars which were either on time or ahead of schedule.

Figure 4 discloses the utilization of this device in a system where more than ten cars are in use. In the said figures, the numerals used in the preceding figures are repeated in so far as they apply, but the shaft 4 is extended as by the shaft 243 to a disk 244, which operates a second disk 245, and a second shaft 246, as well as a second cylinder 247, which is in all respects similar to cylinder 8 and which is associated with parts which are duplicates of the parts associated with said cylinder 8.

It will be observed in Figure 12 that there extends from the connection 47 a wire 250. This said wire in Figure 4 is shown as extending to the cylinder 247, and of course a system of circuits not shown, but exactly similar to the circuits shown in Figure 12 is provided in connection with said cylinder 247, and bearing the precise relation thereto that the circuits in Figure 12 bear to cylinder 8. For example, in Figure 4 the wire 310^c corresponds to the wire 310 in Figure 12, the wire 108^c corresponds to the wire 80, the plug 83^c corresponds to the plug 83, and the recall buttons 240^c in Figure 4 correspond to the recall buttons 240 in Figure 12. It will be further observed from the point 88 in Figure 12 there extends a wire 248. In Figure 4 this wire 248 extends from the board 1, which is substantially the same as the board 1 in Figure 1, to the board 1^c in Figure 4, which is substantially a duplicate of a portion of the said board 1 in Figure 1.

An important advantage of this system resides in the fact that the signals being given for a certain car may be transferred to any other car. That is to say, suppose five cars of a bank of more than five elevators should be in operation and something should happen to one of said five cars such as car No. 1. This particular car could be switched out of the operating schedule and one of the idle cars be switched into said schedule without interfering with the operation of the other four cars. This is accomplished by simply removing from its jack-socket the jack-plug such as 81, see Figure 12, controlling car No. 1 and inserting it in

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the jack-socket identified with and controlling one of the idle cars, such for example, as car No. 6. Therefore, as the cylinder revolves, signals will be flashed as heretofore in cars No. 2, No. 3, No. 4, and No. 5, and at the same time intervals, and signals will be flashed in car No. 6 and its corresponding lamps at the operating station, instead of in the disabled car No. 1 and its corresponding station lamps.

In other words, by this substitution of jack-sockets, car No. 6 will receive its signals between the signals given to car No. 5 and car No. 2, and as five cars are still being operated, it will not be necessary to change the position of the selective contact element 47. Instead of car No. 6, any one of the idle cars could be utilized in place of the disabled car by such a transfer as above disclosed, or in other words, by the substitution of the jack-socket associated with the selected car control the car which was taken out of service.

It will thus be seen that this system comprises a plurality of stationary contacts such as 40, each of which is adapted to make circuit through a suitable connection such as 38 or 39, with a row of contacts 52 circumferentially disposed around the cylinder 8 as is indicated for example by the dotted line 199 in Figure 9. This system also comprises a plurality of stationary contacts 53, each of which is adapted to make circuit with each of the contacts 52 in each row such as that indicated by the said line 199. That is to say, this system involves the use of a pair of stationary contacts such as 40 and 53 for each circumferential row of contacts such as those indicated by the dotted lines 199, 200, 201, etc. It will further be seen that each contact 40 controls a pair of white lights such as 85 and 93, one being stationary and the other on the car or elevator. It is also clear that each contact 53 controls a pair of red lights such as 105 and 106, one being stationary and the other on the car. Likewise, the pairs of red lights are flashed simultaneously. The intervals of time between the flashings of the white and red lights may be made equal, or unequal, by the rotating of the contact elements 37 and 38, around the cylinder 8. It will also be clear that each circumferential row of contacts such as 199, 200, etc., contains but one contact 52 belonging to any one series of contacts 1^a, 2^a, etc. In other words, when a contact member such as 40 or 53 touches a particular contact member such as 520 in a given row of contacts such as 200, Figure 10, no circuit is made unless all of the contacts of the series such as 6^a, to which the particular contact 520 belongs, have been selected for operation. This selection is accomplished by turning the member 47 to such a position as will include in the operating circuit all the contacts of the series 6^a, as previously described.

It thus results that this invention constitutes an elevator controlling system, comprising a plurality of series of contacts 1^a, 2^a, 3^a, etc., rotating with the cylinder 8 and that each contact 52 of each series is located in a different circumference or row 199, 200, etc., of the cylinder. The system also comprises a pair of white and red lights such as 95 and 106 or signals carried by each car, as well as a pair of stationary white and red lights such as 85 and 105 that are flashed in connection with said first mentioned pair. Further, each pair of these signals is governed by a single rotating contact 52 in the particular series to which the car in question belongs because each contact 52 makes circuit at different times with a pair of contacts 40 and 53. From the foregoing it will also be seen in addition to being able to automatically control the times of travel of each car in making its up and down trips and causing the time allotted for an up trip to be different from the time allotted for a down trip, that by this invention one is enabled to transfer the signals of one car to another without interfering with the signals being given to the remaining cars, and to automatically signal each car when it is behind its schedule. This additional or warning signal when flashed on each car lets the operator thereof know when he is behind in his schedule, so that he can proceed without further stops to a terminal, and be ready to start his next round trip on schedule time.

It will now be clear that if one observes a selected group of elevators, and determines the average total time required by any car in the group to make a quick efficient round trip, then divides the total time so determined by the number of elevators in the group, and then signals the cars successively to start their trips at intervals of time so obtained, then the carrying capacity of said group of elevators will be increased whereby all of said elevators will become more efficient than before. However, in determining these efficient running schedules it is necessary to take into consideration such factors as the speed of the car, the acceleration of the car, the distance to be travelled by the car, the parking time at the upper and the lower terminals, the average number of stops, the average number of passengers, and the time required to open and close the doors at said stops. From the foregoing disclosure it will be readily seen that, by this construction, the operation of said elevators can be controlled automatically so as to cause them to start or stop or otherwise operate in the selected group with reference to said interval of time therebetween.

As a specific example, take a building in which there are twenty floors to be served,

the distance from the upper terminal to the lower terminal being 280 feet, and suppose that the speed of the elevators including the car acceleration is say 10 feet per second. Further, suppose the average time consumed by each elevator in making the up trip is 28 seconds; that the average number of stops on the up trip is 9, and it requires 6 seconds for each stop, or that 54 seconds is consumed in the stops on the up trip; that the average time of parking or stopping the elevators at the end of the up trip is 5 seconds; that the running time on the average of the down trips is 28 seconds; that the floor stops on the down trips also average 9 in number, and also consume say 6 seconds each or 54 seconds in all; and that the time for loading the average elevator on the up trip is 11 seconds. The foregoing times when added up would consume an average round trip operating period, under these conditions, of 180 seconds of time. If this 180 seconds be divided by 6, the number of elevators being controlled, it will be seen that the elevators can be most efficiently run on an operating schedule of 30 seconds between the startings of successive elevators.

Actual practice has shown in a large number of tall buildings that this method of automatically controlling a group of elevators results in an increase of the service of said group amounting to as much as 20%. That is, in a large number of cases a group of 5 elevators have been made to do the work of 6, over long periods of time. In other words, it has been demonstrated repeatedly that a group of 6 elevators each found to require about 180 seconds to complete their round trips under average working conditions, can be operated with intervals of 30 seconds between successive startings from the bottom and be made to do the work of 7 elevators operating under the regulations and rules heretofore employed. Likewise, a group of 5 elevators operated with intervals of 36 seconds between successive startings will do the work of 6 elevators operated as heretofore, and similar economies exist in operating other groups according to this method. Especially evident are these economies in the operation of elevators in groups when one employs different periods of time for the up and down trips to correspond with the flow of travel as above disclosed. That is if the travel on the up trip is very heavy and correspondingly light on the down trip, a total period of 180 seconds can economically be consumed by each elevator if for example 120 seconds is assigned to the up trip and 60 seconds to the down trip. On the other hand, when the travel is very heavy on the down trip and correspondingly light on the up trip, these periods may be reversed by assigning 120 seconds to the down trip and 60 seconds to the up trip.

Further it will be obvious that the signals to start each car successively at intervals of time obtained as above, whether the signals be for an up trip, or a down trip, said intervals will be in cycles, the sum of the up trip and the down trip being equal to the total round trip time. Thus there will be established operating schedules which will prove more efficient because of the automatic control, and as a result the carrying capacity of the bank of elevators will be increased, because each car will be automatically governed in its time for leaving the terminal floor which in turn reduces the inefficiency thereof due to the human element. Further it will be obvious that the warning signal could as well be given prior to the next down signal, or a warning signal could be given in each car prior to the next up signal and prior to the next down signal, or in other words, two warning signals could be given if necessary. Such a necessity might arise in an extremely tall building where the traffic in one direction covered an appreciable time. From the foregoing, therefore, it will be seen that upon signalling each car prior to one of its starting signals (either up or down) to indicate a late condition in its schedule; the efficiency of said schedules will be maintained, because a car which is late, upon receiving its warning signal, will express to the specified terminal in order that it may leave and operate on the usual schedule and upon the receipt of its subsequent signal.

It will now also be clear that while this broad method of economically running elevators is conveniently carried out by the mechanism disclosed above, it may also be carried out by those skilled in the art with other mechanisms. Further, it will be obvious that the steps and combinations of steps constituting this method may be varied without departing from the spirit of the invention, and therefore it is not desired to be limited to the above disclosure except as may be required by the claims.

What is claimed is:—

1. The method of increasing the carrying capacity of a bank of elevator cars which are running below normal carrying capacity which consists in determining the average total time required by any one of the cars in the bank to make an efficient round trip; dividing this time by the number of cars in the bank; and signalling each of the cars successively to start its round trip from any given point at intervals of time so obtained.

2. The method of increasing the carrying capacity of a bank of elevator cars which are running below normal carrying capacity which consists in determining the average total time required by any one of the cars

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in the bank to make an efficient up trip and an efficient down trip; dividing the sum of times so determined by the number of cars in the bank; signalling each car successively to start its up trip at intervals of time so obtained; and then signalling each car to start its down trip at the interval of time after the start of its up trip which has been determined for such up trip.

3. The method of increasing the carrying capacity of a bank of elevator cars which are running below normal carrying capacity which consists in determining the average total time required by any one of the cars in the bank to make an efficient round trip from the following factors, car speed, car acceleration, height of building, top parking time, bottom parking time, average number of stops, average number of passengers, and the time required to open and close the doors at each stop; dividing the total time so determined by the number of cars in the bank; and signalling the cars successively to start their trips at intervals of time so obtained.

4. The method of increasing the carrying capacity of a bank of elevator cars which are running below normal carrying capacity which consists in determining the average total time required by any one of the cars in the bank to make an efficient up trip and an efficient down trip for each of several different portions of a day from the following factors, car speed, car acceleration, height of building, top parking time, bottom parking time, average number of stops and the average number of passengers on the up trip, average number of stops and the average number of passengers on the down trip, and the time required to open and close the doors at each stop; dividing the sum of the time for an up trip and for a down trip by the number of cars in the bank; signalling each car to start its up trips and signalling each car to start its down trips during any portion of the day at intervals of time for the up trips and down trips so determined for that portion of the day; and causing the signal for the start of the up trip for each car to successively occur at the interval of time so obtained.

5. The method of increasing the carrying capacity of a bank of elevators which are running below normal carrying capacity which consists in determining the average total time required for any car to complete an efficient round trip for each of several portions of a day including the time required to make an efficient up trip and an efficient down trip; making signals for each car to start its successive up trips in cycles of intervals of time so obtained; making signals for each car to start its down trips at other intervals within the cycle; varying these intervals during different portions of the day to correspond to the time determined for that portion of the day without interrupting the making of the signals; dividing the interval of the cycle time by the number of cars in the bank; and causing the signal for the start of the up trip for each successive car to be made at intervals of time so obtained.

6. The method of increasing the carrying capacity of a bank of elevators which are running below normal carrying capacity which consists in determining the average total time required for any car to complete an efficient round trip; dividing this time by the number of cars in the bank; making signals to start each car successively at intervals of time so obtained, thus causing the signal for the start of the successive up trips for any car to be made in cycles equal to the total round trip time; determining the time required for an efficient up trip and an efficient down trip for each of several different portions of a day; making signals to start each car on its down trip at other intervals within the cycle previously determined and without interrupting the making of the signals; and varying these other intervals during any portion of the day in accordance with the times determined for that portion of the day.

7. The method of increasing the carrying capacity of a bank of elevator cars which are running below normal carrying capacity which consists in determining the average total time required by any one of the cars in the bank to make an efficient round trip; dividing this time by the number of cars in the bank; signalling each of the cars successively to start its round trip from any given point on schedules at intervals of time so obtained; and maintaining said schedule by signalling a delayed car to proceed to said given point.

8. The method of increasing the carrying capacity of a bank of elevators which are running below normal carrying capacity which consists in determining the average total time required for any car to complete an efficient round trip; dividing this time by the number of cars in the bank; making signals to start each car successively on schedules at intervals of time so obtained, thus causing the signal for the start of the successive up trips for any car to be made in cycles equal to the total round trip time; determining the time required for an efficient up trip and an efficient down trip in one of said cycles; making signals to start the down trip of each car successively on schedules according to the intervals of time so obtained; and signalling each car prior to one of its starting signals to indicate a late condition whereby said schedules may be maintained.

In testimony whereof I affix my signature.

FRANK E. BOARDMAN.