

Feb. 7, 1933.

H. D. JAMES

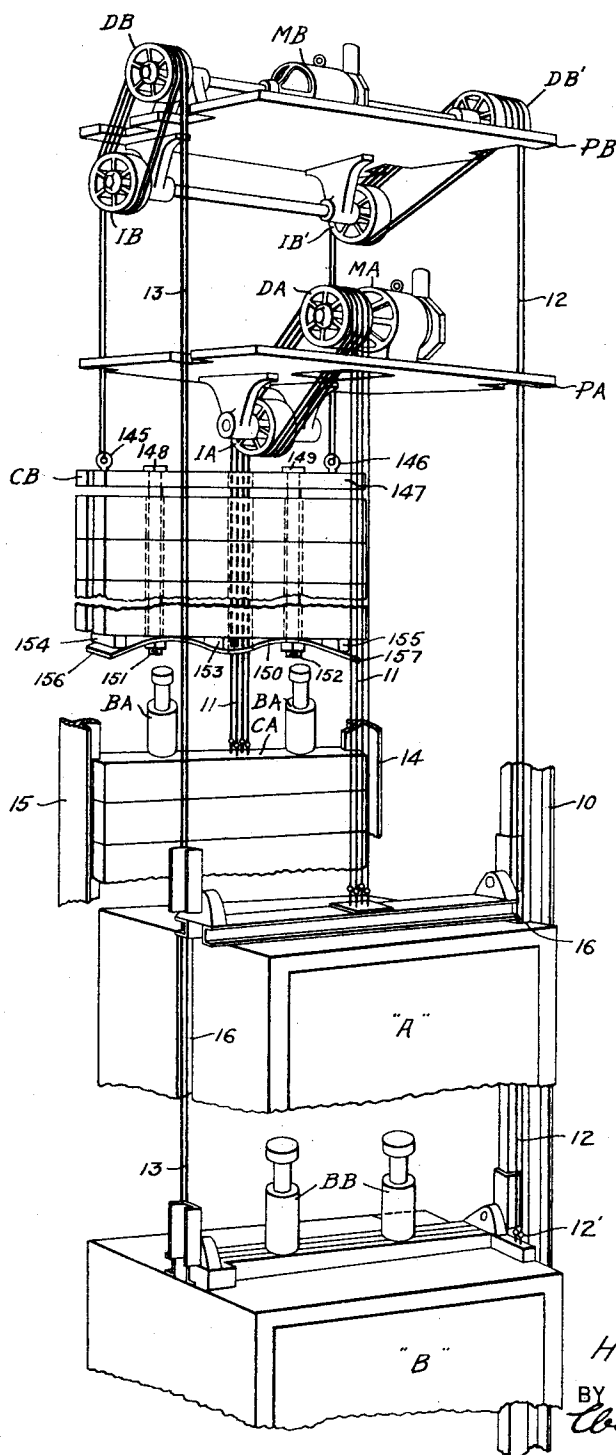
1,896,776

MULTIPLE ELEVATOR SYSTEM

Filed Feb. 17, 1928

5 Sheets-Sheet 1

Fig. 1.



INVENTOR

Henry D. James.

BY

Charles S. Carr
ATTORNEY

Feb. 7, 1933.

H. D. JAMES

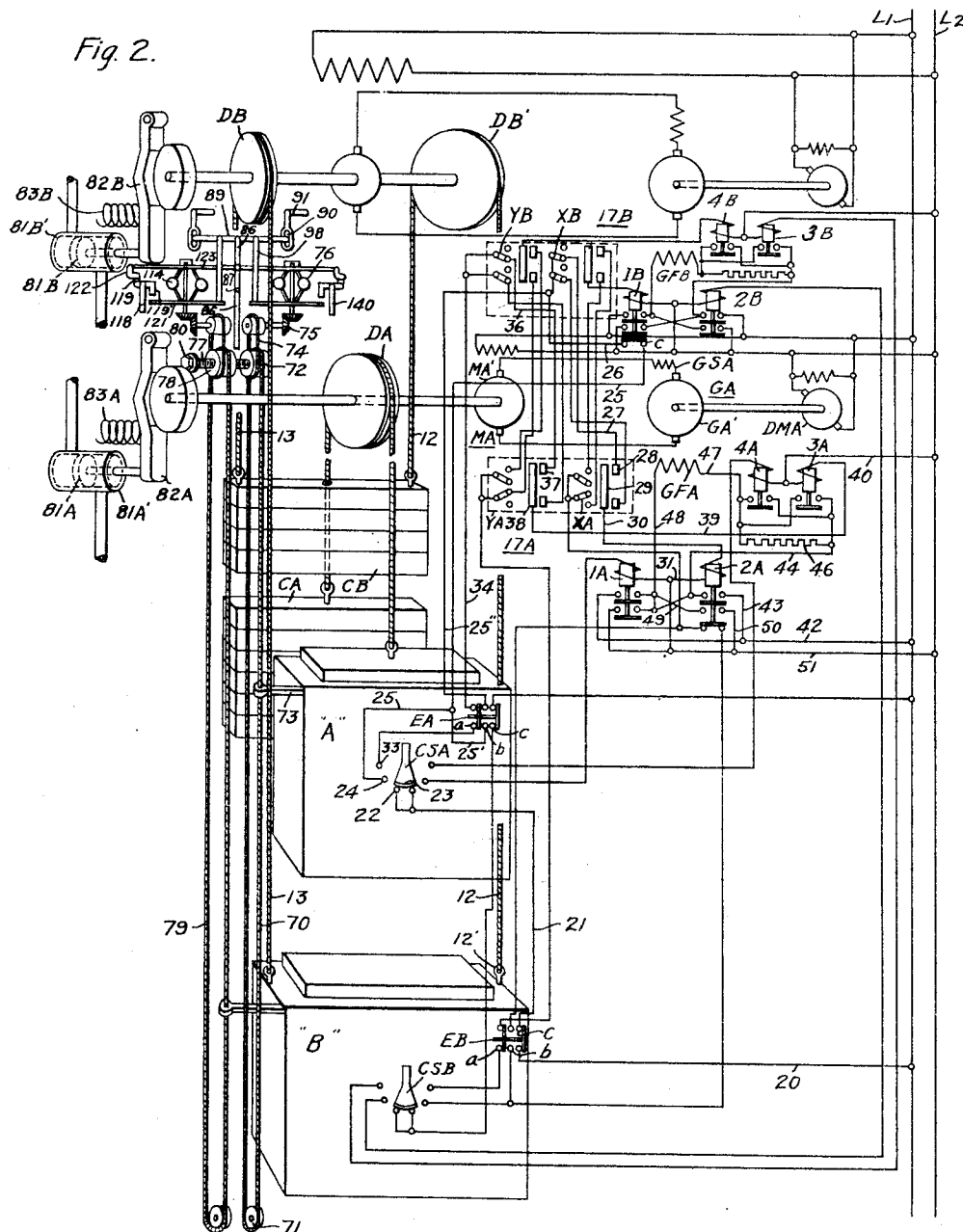
1,896,776

MULTIPLE ELEVATOR SYSTEM

Filed Feb. 17, 1928

5 Sheets-Sheet 2

Fig. 2.



INVENTOR

Henry D. James.

BY

Wesley S. Carr
ATTORNEY

Feb. 7, 1933.

H. D. JAMES

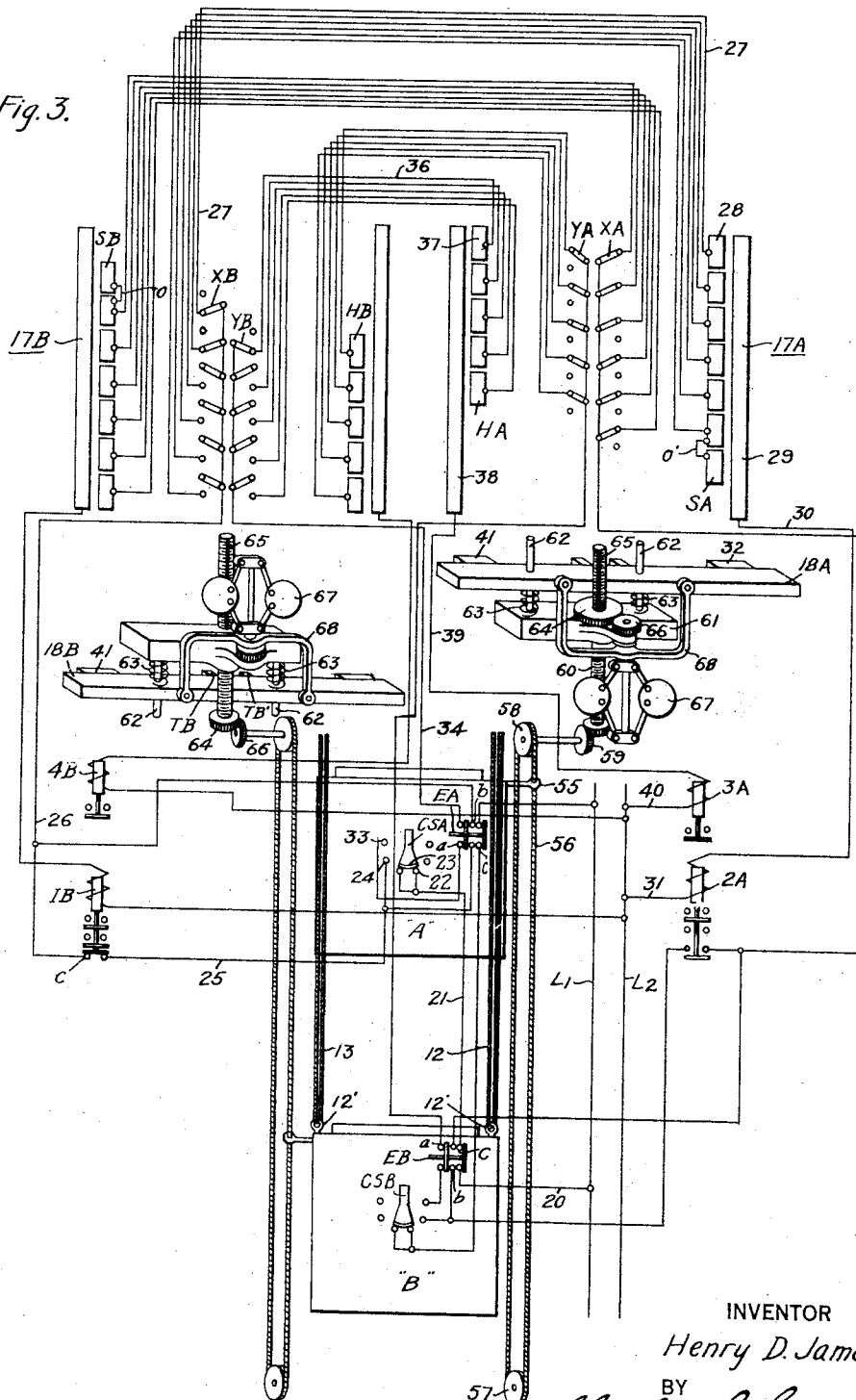
1,896,776

MULTIPLE ELEVATOR SYSTEM

Filed Feb. 17, 1928

5 Sheets-Sheet 3

Fig. 3.



INVENTOR

Henry D. James.

BY

Wesley J. Carr
ATTORNEY

Feb. 7, 1933.

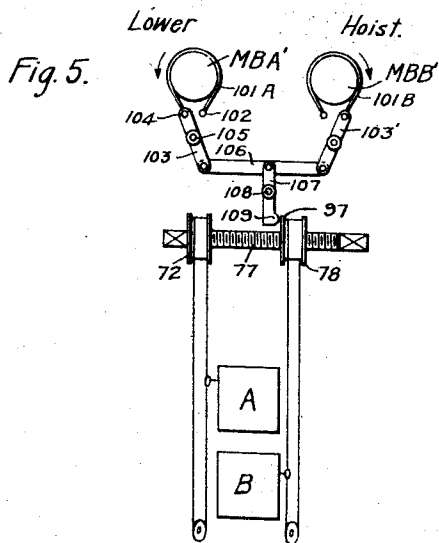
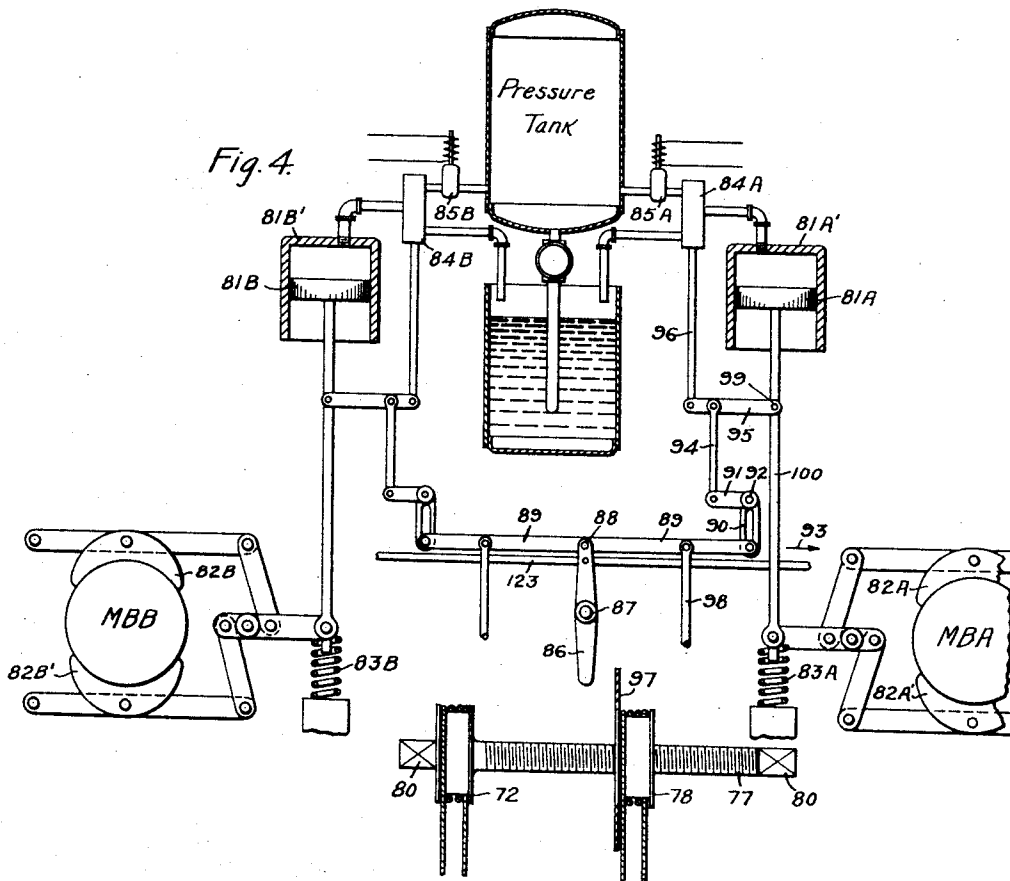
H. D. JAMES

1,896,776

MULTIPLE ELEVATOR SYSTEM

Filed Feb. 17, 1928

5 Sheets-Sheet 4



INVENTOR

Henry D. James.

BY

Lesley S. Carr
ATTORNEY

Feb. 7, 1933.

H. D. JAMES

1,896,776

MULTIPLE ELEVATOR SYSTEM

Filed Feb. 17, 1928

5 Sheets-Sheet 5

Fig. 6.

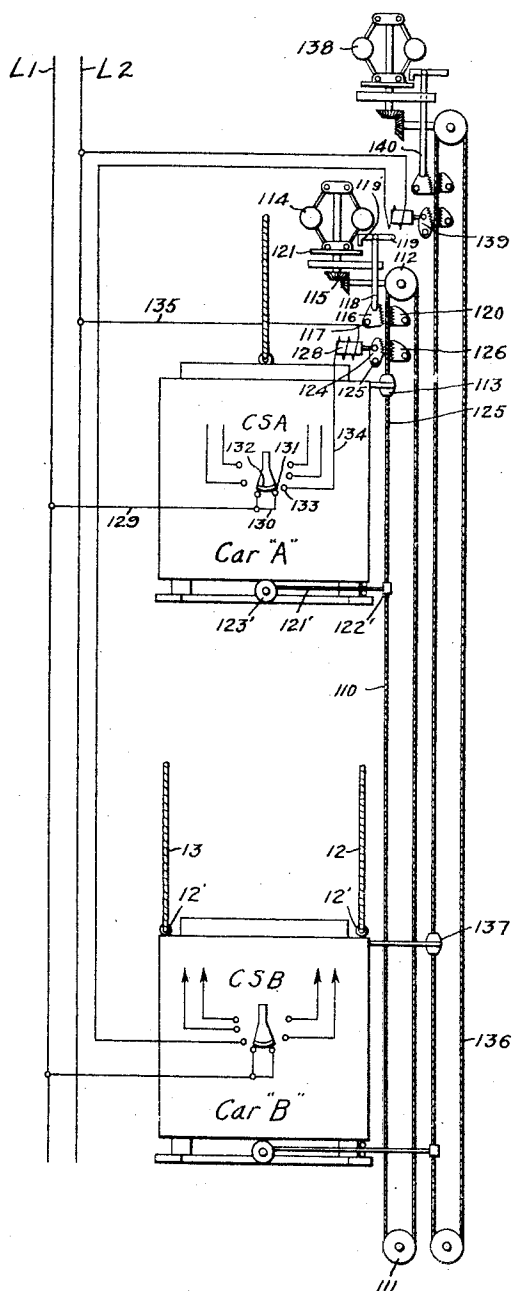
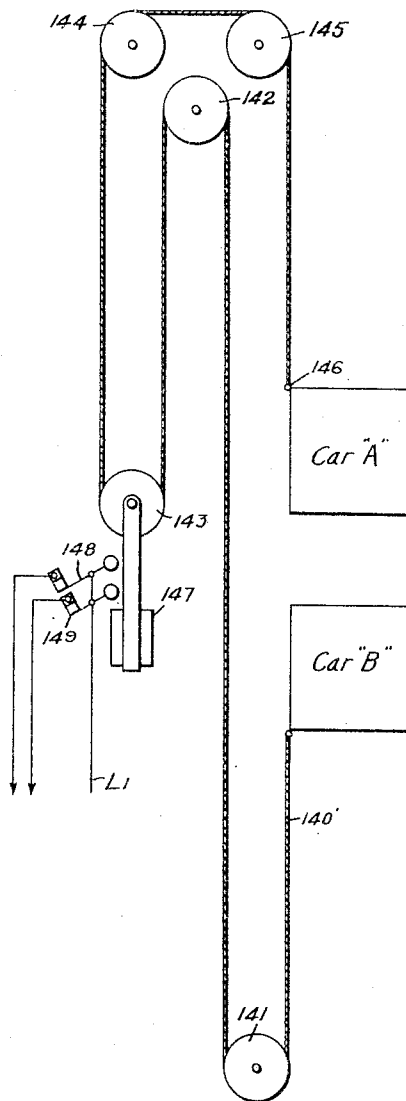


Fig. 7.



INVENTOR

Henry D. James.

BY Wesley S. Carr
ATTORNEY

UNITED STATES PATENT OFFICE

HENRY D. JAMES, OF EDGEWOOD, PENNSYLVANIA, ASSIGNOR TO WESTINGHOUSE
ELECTRIC & MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA

MULTIPLE ELEVATOR SYSTEM

Application filed February 17, 1928. Serial No. 255,049.

My invention relates to elevator systems and has particular relation to systems of control and safety for a plurality of elevator cars operating in the same hatchway.

5 An object of my invention is to provide an elevator system for operating two or more cars in the same hatchway with a minimum of danger of collision between the several cars.

10 Another object of my invention is to provide a control system for a plurality of elevators operating in the same hatchway wherein the motive power for the several cars will be automatically controlled so as to re-
15 duce the danger of collision between the cars to a minimum.

Another object of my invention is to provide a control system for a plurality of elevator cars operating in the same hatchway
20 wherein none of the cars may be operated toward another of the cars except at a slow speed.

Another object of my invention is to provide a control system of the type described
25 in the preceding paragraph wherein all of the elevator cars may be operated at high speeds when traveling in the same direction but may be operated only at a creeping speed whenever the cars are moving in such man-
30 ner as to approach each other.

Another object of my invention is to provide a system of retarding means for a plurality of elevators operating in the same hatchway wherein the retarding means for
35 only the elevator car which is approaching the other of said cars will be applied when that car approaches within a predetermined distance of the other, and wherein the re-
40 tarding force applied is proportional to the speed with which the car approaches and proportional to the distance between the elevator cars.

Another object of my invention is to provide a control system for a plurality of elevator cars operating in the same hatchway wherein the clamp safety grip device usually provided for stopping runaway elevator cars will be applied to stop the car whenever the
45 control system is set to operate the elevator

in one direction and the elevator starts to move in an opposite direction.

Another object of my invention is to provide an elevator system wherein two or more elevators are to be operated in the same
55 hatchway with means for mechanically absorbing the shock of collision when any two of the cars are brought into contact with each other.

Another object of my invention is to provide a system for operating two or more elevators in the same hatchway with means for operating the safety grip usually carried by each car at different speeds of the cars in accordance with the distance between the
65 cars.

Another object of my invention is to provide a system for operating a plurality of elevator cars in a single hatchway wherein the elevator cars cannot approach each other
70 within a fixed distance except when the elevators approach a terminal floor.

Another object of my invention is to provide a system for operating a plurality of elevators in the same hatchway wherein the cars are normally prevented from moving
75 but wherein when two of the cars are moving in the same direction one of them may be reversed for movement toward the other at a slow speed and at the same time causing
80 the other of the cars to be stopped.

My invention will be described with reference to the accompanying drawings, wherein:

Figure 1 is a diagrammatic perspective view of two elevators showing the arrange-
85 ment of roping between the several cars.

Fig. 2 is a diagrammatic view of a wiring system illustrating the control of the elevator cars and the application of brakes and safety grip devices to the elevator cars,
90

Fig. 3 is a diagrammatic view of the wiring system which I propose to utilize for the purpose of preventing the elevator cars from approaching within predetermined distances of each other,
95

Fig. 4 is a detail diagrammatic view of a system of brakes for the two elevator cars utilizing fluid pressure as the braking medium,

Fig. 5 is a diagrammatic view showing a 100

modified form of the braking system shown in Fig. 4,

Fig. 6 is a detail diagrammatic view of the safety grip applying device, and

Fig. 7 is a diagrammatic view of a modified form of electrical safety system for stopping the elevator cars when approaching each other within predetermined distances similar to that illustrated in Fig. 2.

In modern building construction, the tendency to increase the height of buildings renders it necessary to provide adequate transportation to the upper floors of such buildings and since it is desirable to give the same elevator service to the upper floors as to the lower floors, it is necessary to run the cars at increasingly high speeds to compensate for the distance through which the elevator car must travel to reach such floors. Another means for providing adequate elevator service for the upper floors has been suggested in the form of a plurality of superposed elevator cars operating in the same hatchway. This type of system allows the use of a much smaller portion of the floor space on each of the floors to be occupied by elevator hatchways thereby releasing this space for rental purposes.

However, the operation of two or more elevators in the same hatchway presents problems of safety in addition to those presented in prior elevator systems. I propose to operate superposed elevator cars in accordance with the herein described system in which the fundamental principles of mechanics are utilized to reduce the danger of collision of cars to a minimum.

Since the greatest danger in elevator systems of this type lies in the possibility of the elevator cars colliding with each other, to prevent this, I propose to utilize two fundamental principles of elevator operation, namely speed of approach and distance between the cars. Referring to the drawings, I have illustrated in Fig. 1 two elevator cars A and B respectively, disposed to operate in a single hatchway defined by guide rails 10. Car A is suspended upon suitable hoisting cables 11 which pass over a hoisting drum DA to a suitable counterweight CA. It will be observed that the cables 11 are connected to the center of the elevator car A and to the center of the counterweight CA. Elevator car B is suitably suspended upon two sets of cables 12 and 13 attached at the extreme outer edges of the car B and passing over hoisting drums DB and DB' respectively, to a counterweight CB to which the cables are attached at the extreme outer edges thereof. Counterweights CB and CA operate upon common guide rails 14 and 15, counterweight CB being provided with an opening through the center thereof to permit the passage of cables 11 to the counterweight CA.

The cables 12 and 13 which pass to elevator

B are disposed to operate along the sides of elevator car A and may be arranged in any suitable manner within the hatchway preferably in such manner to provide the greatest possible space for the elevator car A. One arrangement for permitting cables 13 to pass car A is that of providing a recess 16 in the side of elevator car A of sufficient dimensions to permit ready passage of the cables.

It will be observed that the cables 12 are secured by means of eye-bolts 12' to the top of elevator car B at a position which is slightly forward of the longitudinal axis of this car while the cables 13 are attached in a similar manner slightly to the rear of the longitudinal axis of the car. The positioning of the attachment of the cables in this manner ensures a substantially balanced suspension of the elevator car B since the point of attachment for the sets of cables is such as to lie on equal and opposite sides of the center of gravity of the car. While I have illustrated but four cables as supporting the car, it is to be understood that the number of cables may be increased or decreased in multiples of two provided one cable of each pair by which the number is increased or decreased, is attached to the car at equal and opposite sides of the center of gravity.

Hoisting motors MA and MB are illustrated as furnishing the motive power for cars A and B respectively, which motors are suitably mounted upon platforms PA and PB respectively. The platforms are illustrated as being superposed at the top of the elevator hatchway and each of the platforms mounts the idler sheaves IB and IB' and IA used to provide the necessary traction for the cables supporting each of the cars A and B respectively.

Referring to Figure 2, I have illustrated the complete control system for the elevator cars wherein the driving device is illustrated as being of the variable-voltage or Ward-Leonard type wherein hoisting drum DA is directly coupled to the armature MA' of hoisting motor MA, the shunt field of which is permanently connected to a source of current designated by reference characters L1 and L2. Motor armature MA' is connected in loop circuit with the armature GA' of a suitable generator GA, preferably of the compound wound type, having a series field winding GSA and a separately excited field winding GFA. The generator GA is suitably driven by a driving motor DMA illustrated as of the shunt wound type.

The direction and speed of the elevator car is controlled through the actuation of up and down direction switches 1A and 2A, respectively, and up and down speed switches 4A and 3A, respectively. The operation of switches 1A, 2A, 3A and 4A controls the direction and amount of current supplied to the separately excited field winding GFA for

the generator GA, which in turn controls the direction and amount of voltage supplied to the armature MA' of the hoisting motor MA. Thus the energization of down-direction switch 2A will start the elevator car downwardly at slow speed.

The operation of my system will be best understood with reference to an assumed operation of the elevator cars. Assuming that the upper elevator car A is at the top of the hatchway, that is at the eighth floor, in condition to start downwardly and that elevator car B, the lower car, has just passed the 5th floor and is traveling downwardly. In order to initiate a downward movement of the elevator car A the car switch CSA will be moved to the left to complete circuits for controlling the down-direction switch 2A and the down high-speed switch 3A associated with this car. The circuit for the down-direction switch 2A extends from line conductor L1 through conductor 20, contact members c of switch EB, conductor 21, contact members 22, 23 and 24 of car switch CSA, conductor 25, normally closed contact members c of up-direction switch IB for car B, conductor 26, thence in parallel to a plurality of throw-over switches XB of the type commonly used in elevator floor selectors, one of which is provided on a floor selector device for each of the floors past which elevator car B moves, thence by way of conductor 27 to contact segment 28 of a group SA on a similar floor selector 17A associated with elevator car A, contact strip 29, conductor 30, the coil of down-direction switch 2A and conductors 31 and 51 to line conductor L2.

Referring to Fig. 3, I have illustrated in this figure in more detail suitable floor selector devices 17A and 17B which are only partially illustrated in Fig. 2. These devices are preferably of the floor selector type such as are commonly used in elevator signaling systems and elevator control systems in which a movable arm 18A passes over two series of contact strips HA and SA in correspondence with the movements of elevator car A over its operating path in the hatchway. In like manner a movable arm 18B operates over two series of contact strips HB and SB in correspondence with the movements of elevator car B over its path of travel in the hatchway.

It will be observed that the movable arm 18A is provided with a suitable contact segment 32 to be moved over contact strip 29 and its associated group of contact segments SA.

Referring again to Fig. 3, it will be observed that if the car switch CSA is moved to a still further position toward the left a circuit will be completed for energizing the down high speed switch 3A which circuit extends from line conductor L1 through con-

ductor 20, normally closed contact members c of emergency switch EB on car B, conductor 21, contact members 22, 23 and 33, on car switch CSA, normally closed contact members of emergency switch EA on car A conductor 34, group of throw-over switches YB on the floor selector 17B for the car B, conductor 36 to a contact segment 37, which forms one element of the group of high speed contact segments HA on floor selector 17A associated with elevator car A, thence by way of contact segments 38 and conductor 39 the coil of down high speed relay 3A and conductor 40 to line conductor L2. The movable arm 18A, it will be observed, is suitably provided with a contact brush 41 for the purpose of bridging contact segments of the group HA and contact strip 38.

Referring again to Fig. 2, it will be observed, that the circuit for the generator field winding GFA extends from line conductor L1 through conductors 42 and 43, contact members of down direction switch 2A, conductor 44, resistor 46, conductor 47, field winding GFA, conductors 48 and 49, contact members of down-direction switch 2A and conductors 50 and 51 to line conductor L2. Hence, the actuation of down high speed relay 3A shunts resistor section 46 from the field winding circuit and permits the elevator car A to move downwardly at its highest speed.

Assuming that elevator car B in Fig. 3 is moving downwardly, a pair of tripping members TB and TB' will engage and move the switches of the groups XB and YB, respectively, as the elevator car B passes corresponding floors. It will be observed, that when the elevator car B is above any of its floors the switch for that floor is in open circuit position and cannot be closed until the car passes the associated floor. It will also be observed that as elevator car A moves downwardly, brush members 41 and 32, contact successively with contact segments of the groups HA and SA associated with each of the floors past which it travels and the circuit for switch 3A can only be completed when the elevator cars are a predetermined distance apart. In the illustrated embodiment this distance is three floors, hence should elevator car A approach more closely than three floors from the lower car B the circuit for speed relay 3A would be broken since contact brush 41 would be resting upon a segment of the group HA, the circuit for which has not yet been completed by operation of the associated switch of the group YB for elevator car B and the speed of elevator car A will be automatically reduced to a low value as determined by resistor 46, shown in Fig. 2.

In like manner, the circuits for the down-direction switch 2A for elevator car A can only be completed when the elevator cars are at least two floor distances apart, since only

under these conditions will a contact segment of the group SA be connected in circuit by an associated switch of the group XB.

While in the illustrated embodiment of my invention, the relation of the switches in the group XB and the contact segments in the group SA is such as to cause an opening of the circuit for the down-direction switch 2A when the elevator cars approach more closely than two floor distances, it is to be understood that in actual practice the point at which the circuit for the down-direction switch 2A will be opened will be such as will insure the stopping of the elevator car A at a safe distance from elevator car B. However, as soon as elevator car B continues its downward movement, the safety zone defined by the floor selectors 17A and 17B, as described, will move downwardly and elevator car A may continue its downward movements.

In like manner when the two cars are ascending, the circuits for the up-direction switch 1B and the up high speed relay 4B for elevator car B can be completed only when switches in the groups XA and YA respectively, on the floor selector 18A are in closed circuit position indicating that the elevator car A is two floors or three floors, respectively, spaced from elevator car B. These circuits are completed through suitable groups of contact segments SB and HB on floor selector 18B.

It is desirable that the cars be permitted to move to terminal floors which are adjacent and for this reason I have illustrated the segments in group SB corresponding to the sixth and seventh floors as connected together by a removable conductor O thus extending the operative zone for car B to the seventh floor at such times as car A is standing at the eighth floor.

In like manner segments in group SA corresponding to the second and third floors are connected by removable conductor O' permitting car A to move to the second floor when car B is standing at the first floor. Hence, the limit of travel for car A is between the second and eighth floor levels while that for car B is between the first and seventh floors.

It is well known, that to stop masses which are in motion, a given retarding force must be exerted over a time period proportional to the speed with which the masses are moving, hence, when under our assumed condition of both cars traveling downwardly, if elevator car A is moving slowly it can be stopped within a shorter distance of travel than when it is moving rapidly. I have, therefore, provided a device for increasing the length of the "safety zone" for initiating the reduction in speed and the stopping of elevator car A when the cars are a greater distance apart and car A is oper-

ating at a higher speed than when the car A is operating at a lower speed. This device comprises mechanism for adjusting the position of the movable arm 18A relative to the position of the elevator car A in its movements in the hatchway. Referring to Fig. 3 it will be observed, that elevator car A has associated therewith a projecting arm 55 to which is attached the ends of a cable 56 passing over a sheave 57 at the lower portion of the hatchway and a sheave 58 at the upper portion of the hatchway thereby mounting the cable 56 for movement in correspondence with the movements of elevator car A. This cable 56 is similar to the cable usually used for driving the floor selector for signal systems and the like. Through utilization of suitable gearing 59 and a screw 60, a slide member 61 is moved over the floor selector 17A in correspondence with the movements of car A. The movable arm 18A of the floor selector is adjustably mounted for movement with the member 61 by means of rods 62 and springs 63 in such manner that the movable arm 18A may be adjusted vertically with reference to the member 61. The slide member 61 mounts a spur gear 64 suitably engaging a slot 65 in the screw 60. The gear 64 is so mounted on the screw 60 as to be slidable over the screw in correspondence with the movements of the member 61. A suitable spur gear 66 also mounted upon the member 61, has its teeth engaged at all times with those of the gear 64. The gear 66 drives a ball governor device 67 at a speed which is proportional to the speed with which the elevator car A is moving in its hatchway. A U-shaped arm 68 is attached to the movable arm 18A and to the ball governor 67 in such manner that as the speed of elevator car A increases the movable arm 18A is drawn downwardly toward members 61 against the force of the springs 63. Since the point of cut-off for elevator car A when moving downwardly should be advanced in the downward direction as the speed of the car increases, I accomplish this effect by moving the arm 18A to an advanced position in correspondence with the speed of the moving car.

In a like manner it is desirable that when the cars are driven upwardly the speed with which the lower car B approaches the upper car A, should be utilized to advance the point of cut-off for the up high speed switch 4B and the up-direction switch 1B, a similar device is provided for adjusting the movable arm 18B upwardly in this instance instead of downwardly. The mechanism for accomplishing this result is similar in all respects to that associated with the elevator car A and the description will not, therefore, be repeated.

Referring to Fig. 2, it will be observed, that the floor selector devices 18A and 18B

described with reference to Fig. 3 are illustrated diagrammatically in connection with the complete system of control for the elevator cars. It will be observed, however, that

6 it is impossible for the elevator car A to move downwardly at any time under control of the operator when the lower car B is moving upwardly and also it is impossible for the elevator car B to move upwardly under control of the operator whenever elevator car A is moving downwardly since the circuits for the up-direction switch IB for the car B extends through normally closed contact members on the down-direction switch 2A for elevator car A and the circuit for the down-direction switch 2A for elevator car A extends through normally closed contact members on the up-direction switch IB for elevator car B. It may be desirable, in case of emergency to permit the elevator cars to travel towards each other and for this reason emergency switches EA and EB are provided for cars A and B respectively for shunting the normally closed contact members of switches IB and 2A respectively. However, this system may be modified to permit leveling the car at the floors in the manner proposed in the copending application of F. E. Lewis and E. M. Bouton, Serial No. 509,959, filed October 20, 1921, in which event, the reversed operation will be limited to a relatively narrow zone.

Emergency switch EA is provided with three sets of contact members designated by reference characters *a*, *b*, and *c*. The contact members *b* are illustrated as being normally open and closed by actuation of the switch EA, thus completing a circuit extending from conductor 25, through conductor 25', the contact member *b* of the switch EA and conductor 25'' to the switches of group XB on the floor selector 17B. Emergency switch EB is provided upon the elevator car B for performing a similar service for this car.

45 It is desirable, however, upon permitting motion of the elevator cars toward each other through the actuation of emergency switch EA that elevator car A should only move at its lowest or creeping speed. For this purpose, I have illustrated the circuit for the high speed down switch 3A as normally extending as previously described through normally closed contact members *a* on emergency switch EA and hence the actuation of emergency switch EA allows downward movement of car A only at the slow speed.

In addition to the controlling of the speed of car A, it may be desirable that car B should be prevented from moving upwardly at any time that car A moves downwardly. Therefore, I have illustrated the power connection for the car switch CSB for car B as extending through normally closed contact members *c* on emergency switch EA. Thus, each time

the switch EA is actuated, power will be cut off from the controlling circuits for car B and this car will thus be automatically stopped until such time as switch EA is released.

In Fig. 2, I have illustrated diagrammatically a system for mechanically applying a retarding force to the two cars A and B whenever they approach within predetermined distances of each other, thus providing an additional safety feature in the event of failure of the electrical safety device just described. A cable 70 suitably mounted upon sheave wheels 71 and 72 at the lower and upper portions of the hatchway, respectively, is attached to elevator car A by means of an arm 73. The sheave 72 is, therefore, driven in correspondence with the degree and speed of movement of elevator car A. Suitably attached to the sheave 72, a belt 74 drives, through suitable gearing 75, over-speed governor 76, such as is usually provided for stopping elevator cars when their speed exceeds a predetermined value. The sheave wheel 72 is suitably secured to a screw 77 in such manner that the screw 77 is rotated in correspondence with the movements of the car A.

A sheave 78 is driven by elevator car B in a manner similar to that described for the sheave wheel 72 by means of a cable 79. The sheave wheel 78 is provided with a threaded interior which engages the threaded portion of screw member 77. The screw member 77 is suitably supported for rotation in bearing members such as is illustrated at 80.

Thus the movement of the cars toward and away from each other is translated into a lateral movement of sheave wheel 78 to the right and left respectively. Assuming car B to be stationary, downward movement of car A will rotate screw 77 to move sheave 78 to the right, while if car A is stationary, upward movement of car B will move sheave 78 to the right. If both cars are moving in the same direction, any relative speeds of the two cars which will tend to cause one to overtake the other will cause movement of sheave 78 to the right.

Referring to Fig. 4, I have illustrated one form of a brake comprising drums associated with the hoisting motors for cars A and B. The brake drum for elevator car A is designated by the reference character MBA and that for elevator car B is designated by the character MBB. It is to be understood that brake drums MBA and MBB are in addition to those normally provided for elevator equipments with which an electromagnetically operated brake device cooperates, though it is possible that the same brake drum may be used for both the usual electromagnetic brake and for the mechanical brake hereinafter described. While, in the present case, the retarding force is shown as applied to a braking drum, it will readily be

apparent that such retarding force might well be applied in any other suitable manner.

A brake piston 81A operable in a cylinder 81A' is utilized to apply brake shoes 82A and 82A' to the brake drum MBA for the elevator car A against the force of a spring 83A. The operation of the piston 81A is accomplished by the introduction of a fluid pressure into the cylinder 81A' by means of a three-way valve 84A such as is generally used in railway brake devices. A suitably normally open electromagnetically operated valve 85A is provided for preventing pressure from the pressure tank suitably labeled 15 passing to the valve 84A under conditions hereinafter described, hence the brakes will not be applied when the valve 85A is operated. I propose to include the operating magnet for valve 85A in some circuit which will be closed at such times as the elevator car A is moving upwardly.

Similarly piston 81B operating in a cylinder 81B' is provided for the brake MBB for operating the brake for elevator B. A three-way valve 84B is provided for this brake as well as an electromagnetic valve 85B, the operating coil of which is in circuit with the control devices for operating car B downwardly. As a means for operating the three-way valve 84A, I have illustrated a system of links and bell crank levers comprising a main operating lever 86, pivoted at 87, and connected at 88 to a link 89, the outer end of which engages an elongated slot 90 in a bell crank lever 91. The pivot point 92, of the bell crank lever 91, is such that lateral movement of the link 89 in the direction of the arrow 93 will cause a downward movement of the links 94, 95 and 96 and consequently, cause a movement of the valve 84A to apply pressure to the cylinder 81A and the piston 81A. The lowermost end of lever 86 is so positioned as to be engaged by a disk 97 mounted upon and carried with the sheave wheel 78. Hence, as described with reference to Fig. 2, either downward movement of the upper elevator car A or upward movement of the elevator car B will cause sheave wheel 78 and the disk 97 to move to the left in Fig. 4 to engage the lever 86. Movement of the lever 86 will, therefore, operate the valves 84A and 84B, and, depending upon the condition of the valves 85A and 85B, will set the brakes for one or the other of the cars. Should both cars be moving downwardly and the upper car overtake the lower, it is only the upper car which need be stopped, therefore, by arranging the magnet of the valve 85B in the down-direction circuits for car B the brakes will not be applied to this car and it may continue its downward travel undeterred.

As described with reference to the electrical safety device, described in Fig. 3, it is desirable that speed as well as distance be com-

pensated for in application of the retarding means and for this reason I have provided a link 98 suitably secured to link 89 and arranged to be moved vertically by actuation of the governor 76 (see Fig. 2). Referring again to Fig. 4, it will be observed that an upward movement of the link 98 will move link 89 upwardly within the slot 90 of the bell crank lever 91, thus shortening the leverage of this portion of the bell crank lever and render only a slight movement of the lever 86 necessary for operating the valve 84A. In this manner the greater the speed of the elevator car A at the time disk 97 contacts with lever 86 the more rapid will be application of the brakes to the brake drum MBA.

Similarly, in the event that the elevator cars are moving upwardly and the lower car overtakes the upper, the relative rotation of the screw 77 and the sheave wheel 78 will cause movement of the disk 97 to the right in Fig. 2 and cause actuation of the brake applying lever 86.

It will be readily understood from an inspection of Fig. 4 that movement of the lever 86 will operate both valves 84A and 84B through identical systems of linkage. With both cars moving upwardly, however, valve 85A will have its magnet energized thus preventing application of the brakes to the upper elevator car but permitting application of the brakes to the lower elevator car.

Since it is desirable only to apply such pressure to the brake shoes 82A and 82A' as is necessary to retard the movement of car A, I have illustrated the right-hand end 99 of lever 95 as being connected to the piston rod 100. Hence, when lever 95 is actuated through link 94 to operate valve 84A, application of the brakes by reason of depression of piston rod 100 will tend to move link member 96 in the upward direction to close valve 84A. Thus, it will be observed, that the degree of movement of the piston rod 100 will be only sufficient to balance the displacement of the brake applying lever 86, thus if the elevator car is moving slowly and checks its speed rapidly, only a minimum of pressure will be exerted upon the brake shoes 82A and 82A'. A similar arrangement is provided for the brakes 82B and 82B' for elevator B.

In Figure 5, I have illustrated a modified form of brake which may be utilized in place of that illustrated in Fig. 4. In this modification sheave wheels 72 and 78 and screw 77 will operate in the same manner as that described with reference to the form of my invention illustrated in Figures 3 and 4. In the modification shown in Fig. 5, I have illustrated brake drums MBA' and MBB' as having associated therewith a strap brake 101A and 101B. The strap brake 101A comprises a band, one end of which is stationarily secured at 102 and the other end of which is secured to a lever 103 as at 104. The lever 103 is

suitably pivoted at 105 and has its lower end secured to a cross link 106. The link 106 is reciprocated in a horizontal direction by means of a lever 107 pivoted at 108 and having its lower extremity 109 so positioned as to be engaged by the disk 97 carried by sheave wheel 78.

The arrows indicate the direction of movement of the brake drums MBA' and MBB' when the upper car is moving downwardly and the lower car is moving upwardly, respectively. With this type of brake, it will be observed, that the greatest pressure will be applied when the direction of rotation of the brake drum is away from the point of stationary attachment of the brake band. Hence, if both cars are moving downwardly the direction of movement will be counterclockwise and brake band 101A will be caused to exert a large pressure, while brake band 101B will be caused to exert only a minimum of pressure since the rotation of the brake drum MBB' tends to oppose the movement of link 103' rather than to add to it.

As a further means for insuring safe operation of two elevators in the same shaft, I have illustrated in Fig. 6 a means for applying the usual wedge clamp safety device for gripping the car rails whenever the control for the upper car is set to move the car upwardly and this car starts to move downwardly. For example, should the cables suspending car B, break or should the control circuits get out of order, so that actuation of the car switch to start the car upwardly permits closing of the down-direction circuits, it is desirable that the safety grip be applied to prevent the car from moving downwardly or, in other words, to support the car against further downward movement. For this purpose, I have illustrated a cable 110, suitably supported by sheaves 111 and 112 at the lower and upper limits of the hatchway and suitably detachably secured to elevator car A by means of an attachment 113. This cable may be identical with that usually used to operate the over-speed governor such as cable 70 (Fig. 2) and the safety grip devices, such as are usually provided for elevator cars. A suitable ball governor 114 which may be the same governor as is illustrated in Fig. 2 as 76, is driven from the sheave 112 by means of any suitable gearing 115, the function of which is to cause a tripping of a clamp device 116. The clamp 116 is pivoted at 117 and is normally supported in a raised position, by means of a link 118, the upper end of which is attached to a cross arm 119. The cross arm 119 is provided with a downwardly projecting end portion 119' so positioned as to lie in the plane of vertical movement of the disk 121 carried by the ball governor 114 and moved in a vertical direction in accordance with the speed of car A. Hence the relative positions of the link 118 and the disk 121

is so adjusted as to cause a tripping of the gripping member 116 whenever the speed of elevator car A reaches a predetermined value.

The clamp 116, therefore, descends and grips the cable 110 between itself and a stationary clamping member 120. This operation causes the cable 110 to be stopped and further movement of the elevator car A will release the detachable connection 113. Further, movement of the car will cause the standing cable 121' which is attached as at 122' to the cable 110, to be unwound from the safety drum 123' and causing the consequent application of the safety grip device. All of the above described apparatus is quite common in elevator operation.

When two elevators are to be operated in the same hatchway, however, the speed required for the tripping of clamping member 116 should be lowered as the cars approach each other, since as the cars approach, the condition requiring a setting of the safety grips becomes dangerous and the length of travel distance during which such safety grip will be operative is materially decreased, it is most desirable that the speed of approach of the cars should also be decreased. This is especially true in connection with my electrical safety system such as described with reference to Fig. 2, wherein the high speed switches are to be dropped out when the cars approach within a predetermined distance of each other. In the event that the speed is not reduced by reason of the operation of such electrical safety and the car enters such slow speed zone at a speed greater than that desirable for that zone, the safety grips may be actuated to stop the elevator car. For this reason, I have illustrated in Fig. 2 the link member 119 as engaging the end of a bell crank lever 122, the other arm of which is secured to one end of a rod 123. The rod 123 may be pivotally secured to the operating lever 86 for the brake-applying device in such manner that movement of the lever 86 causes a lifting of the right-hand end of link 119 with a consequent depression of the downwardly projecting finger 119' to a position closer to the disk 121. It will be observed therefore, that the lifting of disk 121 by the ball governor, an amount corresponding to a much lower than normal tripping speed, will now be sufficient to lift the rod 118 and release clamping member 116. Hence the setting of the safety grips will be controlled not only in correspondence with the speed of movements of the car, but also in correspondence with the distance between two cars.

I propose to provide an additional means for gripping and stopping the governor cable 110 which comprises a clamping device 124 pivoted at 125 and so arranged to normally be in a position to grip the cable 110 between

itself and a cooperating gripping member 126. A suitable magnet 128 is provided for withdrawing the clamp member 124 from engagement with the cable 110 whenever the car switch CSA is moved to start elevator car A downwardly. The circuit for magnet 128 extends from line conductor L1 through conductors 129 and 130, contact members 131, 132 and 133 on the car switch CSA (these contact members corresponding to those closed by movement of the car switch CSA to its first position for upward travel) conductor 134, the coil of magnet 128 and conductor 135 to line conductor L2. Thus should the elevator car A start downwardly, the cable 110 would be gripped between clamping members 124 and 126 and the safety grip device operated by drum 123' would be set to grip the guide rails and stop the elevator car in the same manner as though the over-speed governor had operated to perform this function.

A governor cable 136 attached to elevator car B as at 137 and operating a governor 138 performs a similar function for car B. However, in this case the magnetic operated clamping member 139 is arranged to be normally in engagement with the cable 136 and is retracted only at such times as the elevator car switch CSB is actuated to start car B downwardly.

A system of links similar to that described for tripping member 116 is provided for elevator car B to cause a similar tripping of clamping member 140, which system of links is entirely similar to that described for elevator car A and such description will not, therefore, be repeated. The arrangement of the gripping members and the magnets may be varied to cause operation of the safety grips in any desired manner, for example, that for car A, may be arranged as described while that for car B may be arranged to be set on upward movement of the car when the controlling circuits are set up to cause downward movement of this car.

In Fig. 7, I have illustrated a modified form of an electrically operated safety device for stopping the cars when they approach each other to take the place of that described with reference to Fig. 2. In this form of my invention elevator cars A and B are connected together by means of a cable 140', which passes over a sheave 141 at the lower end of the hatchway and a sheave 142 at the upper end of the hatchway and thence, to a movable sheave 143. The cable continues over sheaves 144 and 145 at the upper end of the hatchway to an attachment 146 with elevator car A. The length of the cable is such that when two elevator cars approach each other, the sheave wheel 143 is moved upwardly to such position as will cause its counter-weight members 147 to engage and operate a pair of switches 148 and 149 to open the control

circuits for car switches CSA and CSB, respectively, to thereby cause stopping of the elevator cars. It will be readily observed, that the only condition under which the switches 148 and 149 can be operated will be upon the approach of the cars A and B within a predetermined distance of each other, since, if both cars are moving upwardly at the same speeds, there will be no resultant upward or downward movement of the sheave 143. In a like manner, there will be no such movement if both cars are traveling downwardly at the same speed. If car A moves upwardly and car B downwardly, the sheave 143 will be moved downwardly out of a position to engage the switches 148 and 149.

As has been previously set forth, it is desirable to prevent collision between the cars, but in the event that such collision occurs, I provide means for cushioning both the elevator cars and the counterweights such as suitable buffers preferably of the oil spring type upon both the elevator cars and the counterweights. The buffers carried by car B are designated by the reference character BB while those carried by the counterweights are designated by the reference character BA. Hence, a double cushioning effect is provided since the counterweights for elevator car B (the lower car) are disposed above the counterweights CA for the upper car A and thus should the cars approach each other the counterweights will also approach each other and the speed of the cars will be reduced and the cars will be stopped with a cushioned retardation through the compression of the buffers BA on the counterweights as well as through the compression of the buffers BB upon contact of the two cars.

Another element of danger in operating two or more elevators in the same hatchway is that of the necessity for operating the counterweights for all of the cars on common guide rails. In the event of breakage of the cables, connecting the lower elevator car B with the upper counterweight CB, the counterweight CB would be free to fall upon the lower counterweight CA thus subjecting elevator car A to an overbalanced condition due to the fact that it must support both counterweights CA and CB. The effect of such overbalancing of car A would be to create a dangerous overhauling condition tending to cause elevator car A to ascend at a dangerous speed and possibly causing a condition wherein the brakes, designed for normal operation of elevator car A, to be insufficient to hold the car when such added weight is placed on the counterweights.

To avoid this condition, I have illustrated the sets of cables 12 and 13 as attached to the counterweights by means of eye bolts 145 and 146 suitably screwed to a counterweight supporting bar 147. A pair of counterweight supporting rods 148 and 149 depend

from the bar 147 and extend to the lower portion of the counterweight structure and through a spring member 150, suitable shoulder members 151 and 152 being formed on the rods 148 and 149 to prevent withdrawal of the rods. Between the center of the counterweight structure and the spring member 150, a spacing block 153 may be placed, while similar spacing blocks 154 and 155 are similarly placed near the outer extremities of the counterweight structure. With this construction under normal conditions the force exerted by the rods 148 and 149 will cause a flexure of the spring 150 causing spring 150 to assure a contour, such as is illustrated in Fig. 1.

By suitably selecting the length of spring 150, such that in its flexed condition the outer ends 156 and 157 of the spring will just clear the counter-weight guide rails 14 and 15, it will be apparent that upon breakage of the cables of either or both sets 12 and 13, the flexing force exerted by rods 148 and 149 will be released and the spring will tend to move to a straightened position thus engaging its extremity 157 or 156 with the adjacent guide rail and causing the counterweight CA to be brought to rest and supported in a stationary position between the rails 14 and 15.

It will readily be observed, therefore, that I have disclosed an elevator system for two or more elevators in the same hatchway, wherein the two cars may be operated with a maximum degree of safety and, wherein both speed and distance has been utilized for effecting the actuation of the electric circuits for the elevator and for effecting the application of mechanical brakes and safety devices for preventing the elevator cars from either colliding with each other or from approaching a dangerous condition of operation.

It is to be understood that the embodiment of my invention as described is merely illustrative and I do not desire to be limited to the details shown except as defined in the appended claims.

I claim as my invention:

1. The combination with a plurality of elevator cars operating in the same hatchway, of means for controlling the movements of said cars in accordance with the distance between said cars and the speed of movement of said cars.

2. The combination with two or more elevator cars operable in the same hatchway, of means for automatically reducing the speed of said cars when they approach each other within a predetermined distance and means operable in correspondence with the speed of said cars for varying said predetermined distance.

3. The combination with two or more elevator cars operable in the same hatchway, of means for automatically reducing the speed

of said cars when they approach each other within a predetermined distance and means operable in correspondence with the speed of the approaching car for varying said distance.

4. The combination with two or more elevator cars operable in the same hatchway, of control means for said cars operable when one of said cars is approached by the other of said cars within a predetermined distance at a speed greater than a predetermined slow speed, for reducing the speed of the approaching car.

5. The combination with two elevator cars operable in the same hatchway, of motive means individual to each of said cars for actuating that car, and means controlled by the position and speed of movement of each of said cars for automatically rendering the motive means for one of said cars inoperative when said one car approaches said other car within a predetermined distance at a speed greater than a predetermined speed.

6. The combination with two elevator cars operable in the same hatchway, of means defining zones of operation of said elevators in said hatchway and means operable by the presence of any of said elevators in a zone for preventing any other of said elevators from moving within said zone so defined at greater than a predetermined slow speed.

7. In combination with two or more elevator cars operable in a single hatchway, of means operable by movement of one of said cars in one direction for defining a movable zone of predetermined dimension immediately following said car, means operable by movement of a following car in the same direction for stopping itself upon entry into said zone so defined and means operable in correspondence with the speed of said following car for varying the dimensions of said zone.

8. In a combination with two or more elevator cars operable in a single hatchway, of means operable by movement of one of said cars in one direction for refining a movable zone of predetermined dimension immediately following said car, means operable by movement of a following car in the same direction for stopping itself upon entry into said zone so defined and means operable in correspondence with the speed of said following car for increasing the dimension of said zone as the speed increases.

9. In a system for operating a plurality of elevators in a single hatchway, a plurality of cars, means for defining zones of operation for said cars, means for preventing said two of said elevators from operating in the same zone except at the terminals of said hatchway, auxiliary means for rendering said preventing means ineffective, and means operable by actuation of said auxiliary means for limiting the speed of said cars.

10. In a system for operating a plurality of elevators in a single hatchway, a plurality of cars, means for defining zones of operation of predetermined dimension between the terminals of said hatchway and zones of lesser dimension at the terminals thereof, and means operable by the presence of any of said cars in any of said zones for preventing another of said cars from entering that zone.
11. In a system for operating a plurality of elevator cars in the same hatchway, motive means for each of said cars, control means individual to said cars for controlling the direction of movement of the associated car, means operable by actuation of the control means for any two cars to cause said cars to move toward each other for rendering the motive means for one of said cars inoperative.
12. In a system for operating a plurality of elevator cars in the same hatchway, motive means for each of said cars, control means individual to said cars for controlling the direction of movement of the associated car, means operable by actuation of the control means for any two cars to cause said cars to move toward each other for rendering the motive means for said cars inoperative and emergency means for rendering said last-named means ineffective.
13. In a system for operating a plurality of elevator cars in the same hatchway, motive means for each of said cars, control means individual to said cars for controlling the direction of movement of the associated car, means operable by actuation of the control means for any two cars to cause said cars to move toward each other for rendering the motive means for said cars inoperative and emergency means for rendering said last named means ineffective and for permitting said cars to move toward each other only at a low speed.
14. In a system for operating a plurality of elevator cars in the same hatchway, motive means for each of said cars, control means individual to said cars for controlling the direction of movement of the associated car, means operable by actuation of the control means for any two cars to cause said cars to move toward each other for rendering the motive means for said cars inoperative, and emergency means operable to render said last named means for that car ineffective and for stopping the other of said cars during actuation of said emergency means.
15. In combination with a plurality of elevator cars operable in the same hatchway, independent motive means and brake means for each of said cars, a brake for each car independent of said first named brake and means controlled in accordance with the distance between said cars and the speed of movement of said cars for controlling the effective application of said last named brakes.
16. In combination with a plurality of elevator cars operable in the same hatchway, a mechanical brake for each of said cars, and mechanical means operable in accordance with the distance between any two of said cars and the speed of movement of said cars for applying said brakes.
17. In a system for operating two or more elevators in the same hatchway, a brake for each elevator, and means operable upon the approach of any of said elevators within a predetermined distance of another for applying a braking force to said approaching elevator proportional to the speed of said elevator.
18. In a system for operating two or more elevators in the same hatchway, a brake for each elevator, and means operable upon the approach of any of said elevators within a predetermined distance of another for applying the brake to the approaching elevator and means operable in correspondence with the speed of said elevator for varying said predetermined distance.
19. In a system for operating two or more elevators in the same hatchway, a brake for each elevator, means for controlling the application of said brakes, means operable upon the approach of any of said elevators within a predetermined distance of another for actuating said brake controlling means for both of said elevators, and means for rendering the brake controlling means for the leading elevator ineffective.
20. In a system for operating a plurality of elevator cars in a single hatchway, a plurality of cars, a safety grip for each car and means for controlling the operation of said safety grips in accordance with the distance between said cars and the speed of movement of said cars.
21. In a system for operating a plurality of elevator cars in the same hatchway, a plurality of cars, a safety grip for each car, means responsive to the speed of each car for actuating the safety grip for the associated car, and means operable in accordance with the distance between said cars for varying the speed value at which said speed responsive means will actuate said safety grip.
22. In a system for operating a plurality of elevator cars in the same hatchway, a plurality of cars, a safety grip for each car, means responsive to the speed of each car for actuating the safety grip for the associated car, and means operable in accordance with the reduction of the distance between any two of said cars for lowering the speed at which said speed responsive means will operate.
23. In a system for operating a plurality of elevator cars in the same hatchway, motive means for each of said cars, control means individual to each of said cars for controlling the direction of movement of the associated car, normally effective means for each car independent of said motive means for

stopping downward movement of the associated car and means operable by actuation of said control means for any car to cause downward movement of said car for rendering said stopping means ineffective.

24. In a system for operating elevator cars in the same hatchway, motive means for each of said cars, control means individual to each of said cars for controlling the direction of movement of the associated car, normally effective means for each car independent of said motive means for stopping downward movement of the associated car and means operable by actuation of said control means for any car to cause downward movement of said car for rendering said stopping means ineffective and means operable responsive to movement of said car above a predetermined speed for actuating said stopping means.

25. In an elevator brake system, an elevator, brake for transmitting braking force to said elevator, friction means cooperating with said brake, power means for applying said brake means to said friction means, and means dependent upon the speed of said elevator for controlling the amount of said braking force applied to said braking means, and means dependent upon the direction of movement of said elevator for determining the amount of braking force applied to said braking means.

26. In a system for operating a plurality of elevator cars in a single hatchway, motive means for each of said cars and control means therefor, a retarding means for each elevator, and means operable by the approach of any of said elevators within a predetermined distance of another of said elevators for applying said retarding means to said approaching elevator independently of the control means for that car.

27. In a system for operating a plurality of elevator cars in a single hatchway, motive means for each of said cars and control means therefor, retarding means for each elevator, and means operable by the approach of any of said elevators within a predetermined distance of another of said elevators for applying said retarding means only to said approaching elevator independently of the control means for that car.

28. In combination, a counterweight for an elevator car, spaced guide members for defining a path of movement for said counterweight, means normally supporting said counterweight, and means operably responsive to failure of said normally supporting means for supporting said counterweight, said operably responsive means including an integral resilient member having a length greater than the distance between said guide members for wedging therebetween and thereby supporting the counterweight upon failure of the normally supporting means, and means for biasing said resilient member

in at least one point to thereby free it from engagement with the said guide members when the counterweight is supported by said normally supporting means.

29. In combination, a plurality of elevator cars operable one above the other in the same hatchway, a plurality of counterweights one for each car disposed one above the other and operable in the same path, spaced guide members for defining said path for said counterweights, flexible means for connecting and supporting said cars and their corresponding counterweights, and means operable to support said counterweights upon the failure of the corresponding said flexible supporting means, said means including an integral resilient member for each counterweight, said resilient member having a length greater than the distance between said guide members for wedging therebetween and thereby supporting the corresponding counterweight upon failure of the flexible supporting means connected thereto, and means for connecting said flexible supporting means to the corresponding counterweights to, simultaneously, bias the said resilient member in at least one point and thereby free it from engagement with the said guide members.

In testimony whereof, I have hereunto subscribed my name this 10th day of February, 1928.

HENRY D. JAMES.

100

105

110

115

120

125

130