No. 849,840. PATENTED APR. 9, 1907.

C. FOSTER.

MULTIPLE ELEVATOR SYSTEM.

APPLICATION FILED APR. 12, 1906.

4 SHEETS—SHEET 1.

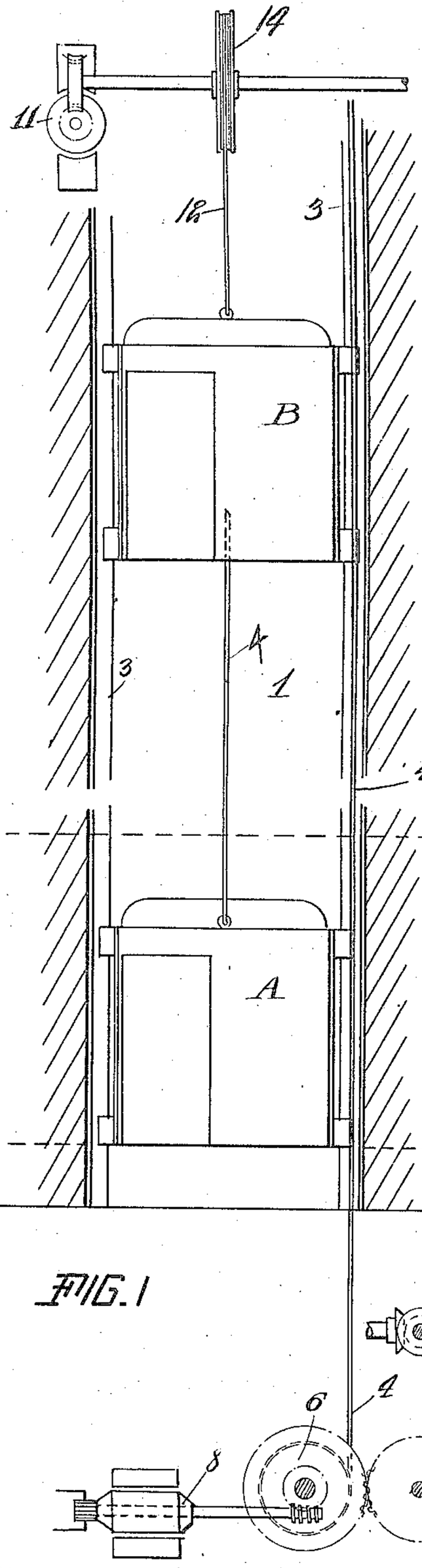

FIG. 1

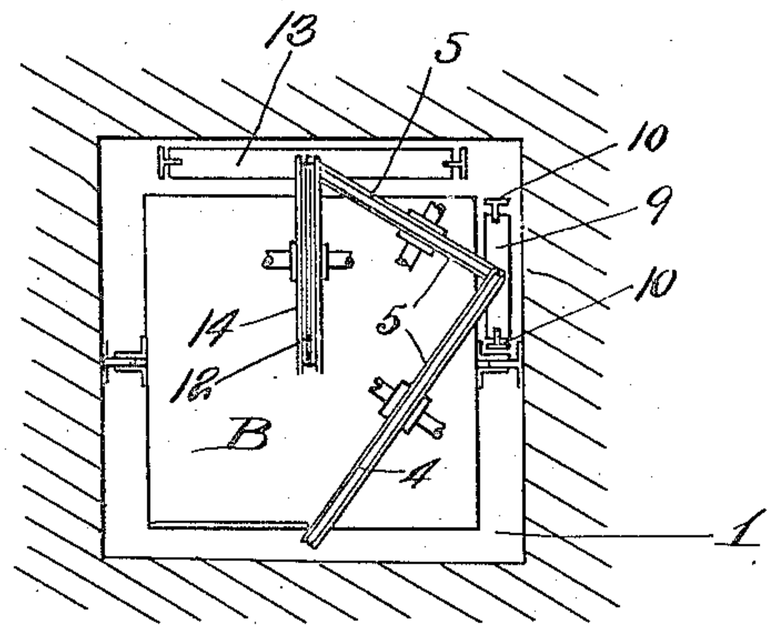

FIG. 2

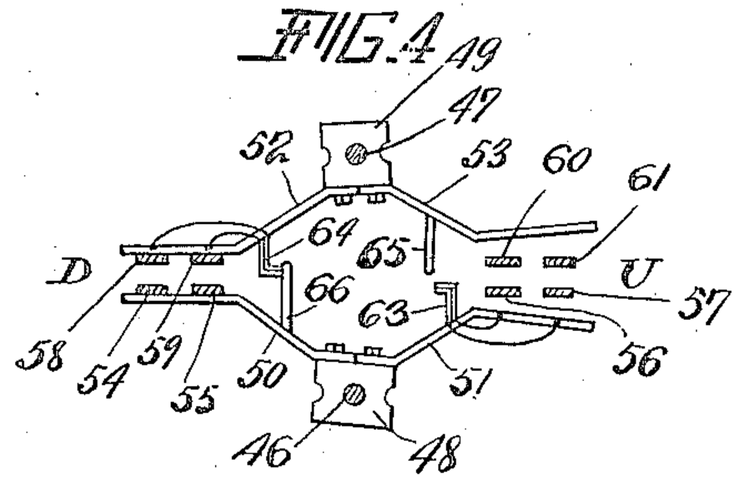

FIG. 4

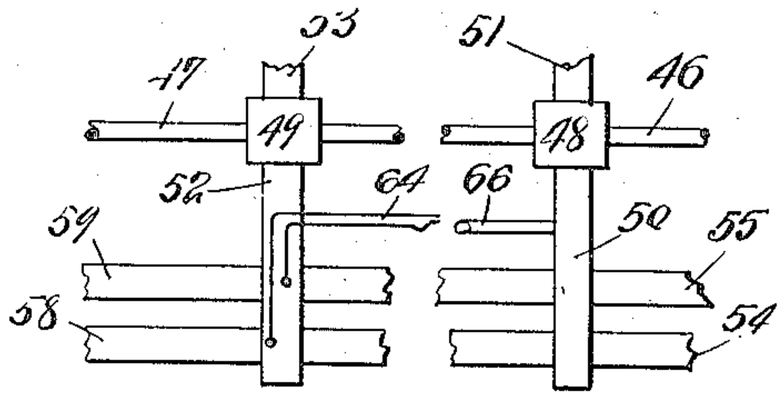

FIG. 5

Witnesses

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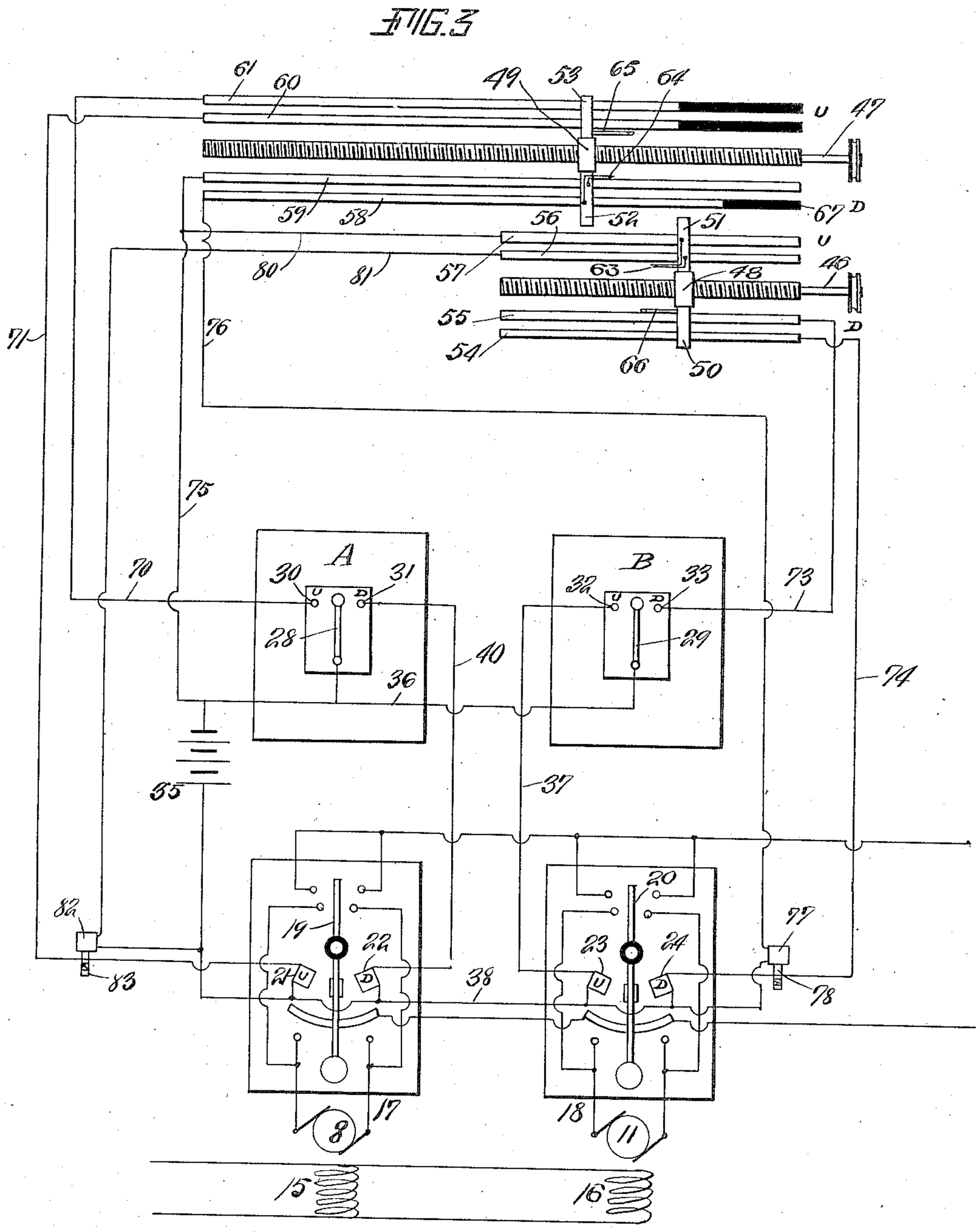
4 SHEETS—SHEET 2.

FIG. 3



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4 SHEETS—SHEET 3.

FIG. 6

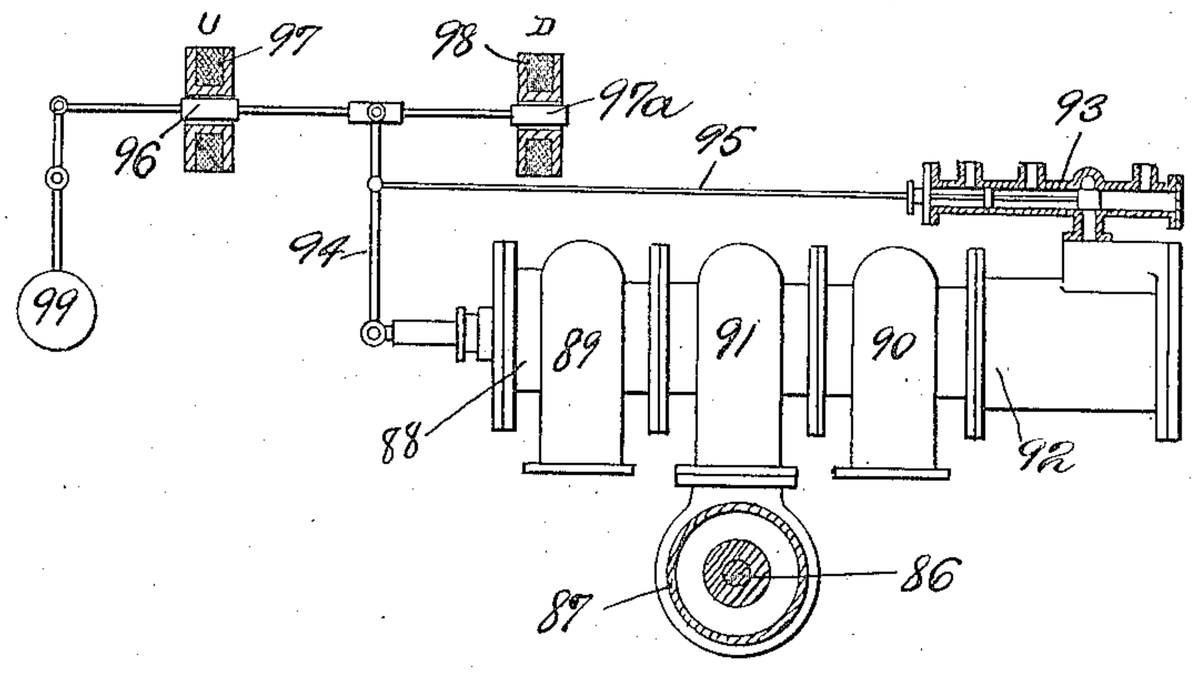


FIG. 11

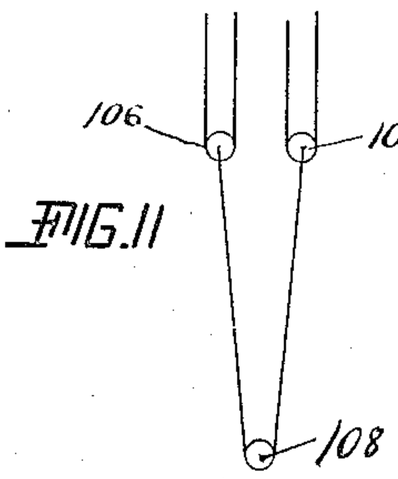


FIG. 13

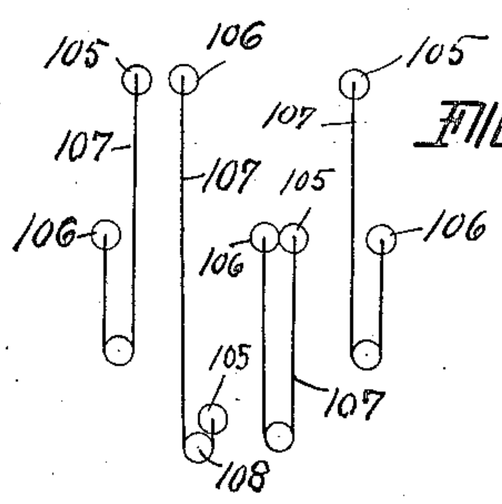
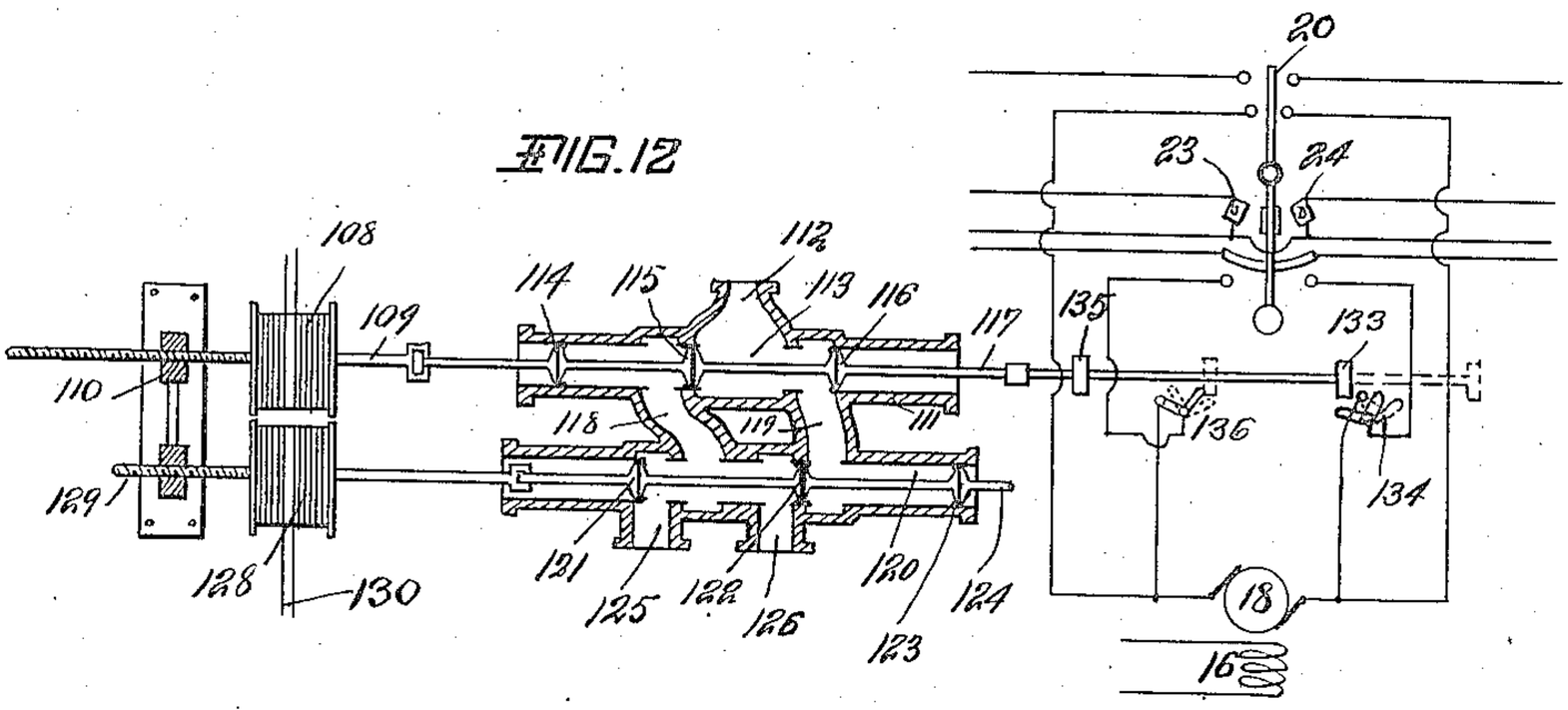


FIG. 12



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4 SHEETS—SHEET 4.

FIG. 7

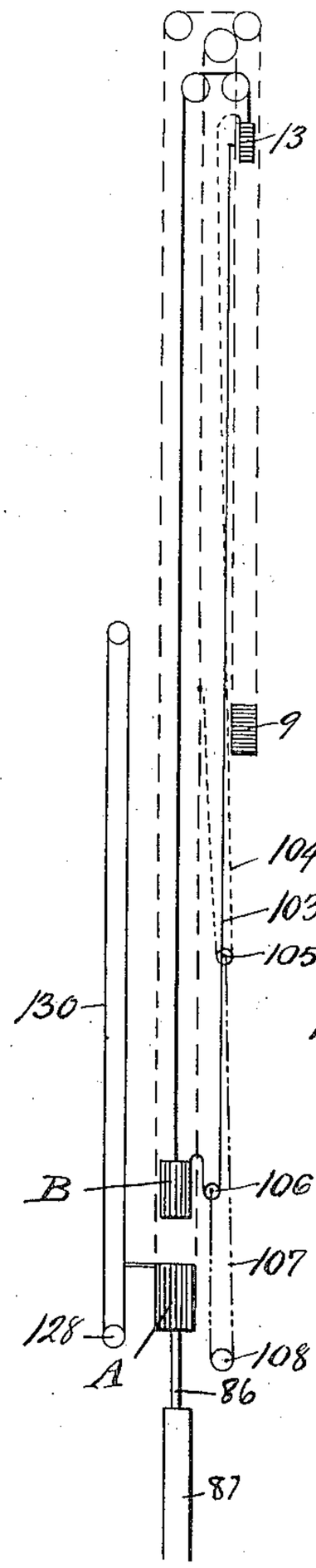


FIG. 8

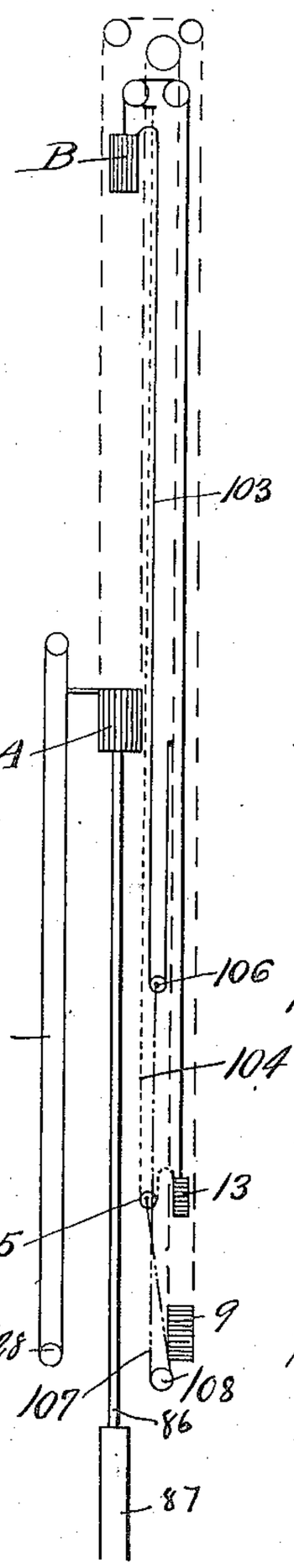


FIG. 9

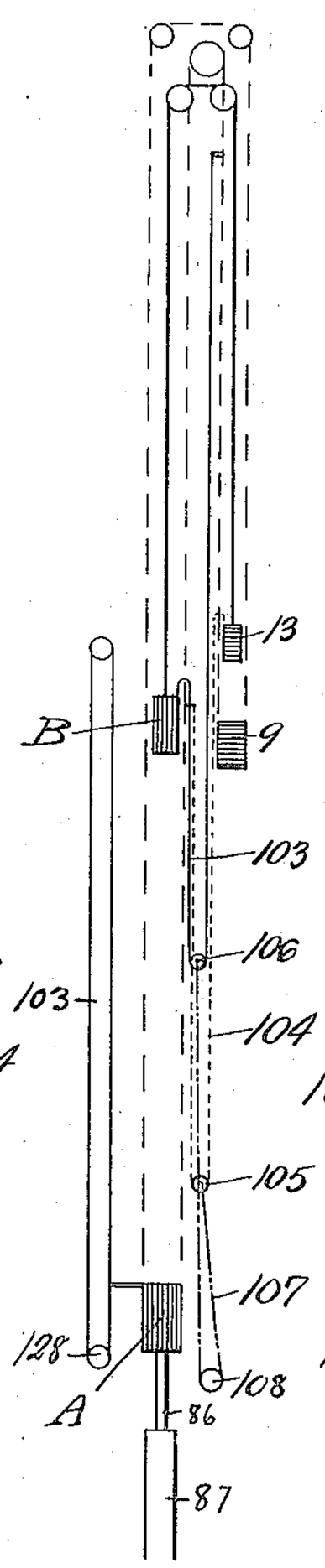
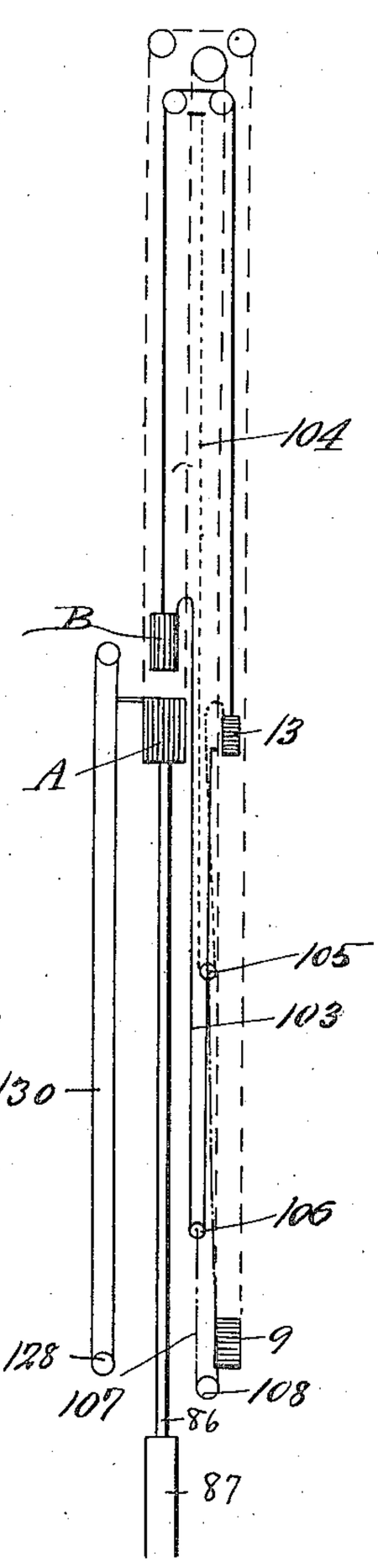


FIG. 10



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UNITED STATES PATENT OFFICE.

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MULTIPLE ELEVATOR SYSTEM.

No. 849,840. Specification of Letters Patent. Patented April 9, 1907.

Application filed April 12, 1906. Serial No. 311,266.

To all whom it may concern:

Be it known that I, CLAIR FOSTER, a citizen of the United States, residing at Douglaston, in the county of Queens and State of New York, have invented certain new and useful Improvements in Multiple Elevator Systems, of which the following is a full, clear, and exact specification.

This invention relates to multiple elevator systems, and more particularly has reference to an elevator system adapted for use in high buildings, whereby a plurality of elevator-cars can be operated in the same shaft; and the object of my invention is to provide an elevator system wherein two or more cars are independently operated in the same shaft, thereby economizing in space and in other ways, automatic controlling means being provided for preventing collisions either by one car overtaking the other or by the cars running oppositely toward each other. To prevent one car from overtaking the other, means are provided for automatically stopping the overtaking car without affecting the other, and to prevent them from running oppositely toward each other devices are provided to prevent the lower car from being started upward until the higher car has gone up a predetermined distance, and the latter car cannot be started downward until the former car is below a predetermined point.

My invention is especially adapted for high buildings having an express service to the upper floors and a local service to the lower floors. As such systems are now arranged these cars are in separate shafts, and as the height of the building increases the necessary additional elevators required to accommodate the increased number of tenants necessarily increases the total well-room, thereby placing a practical limit upon the height to which modern buildings may be erected. By utilizing my invention this limit is removed. The invention may also be applied to systems now installed where it is desirable to increase the elevator capacity without requiring additional elevator-shafts. By arranging and operating a plurality of cars in a single shaft a very considerable economy in space is secured, both as regards that taken up by elevator-shafts and that required by the motive-power devices, controlling devices, and connections. This economy in space is not dependent upon any particular character and mode of power employed, but is still further increased by making the upper car to be actuated by a cable mechanism or suspended and the lower car to be supported and directly actuated by a direct hydraulic-plunger mechanism.

The invention will be more particularly described with reference to the embodiment thereof shown in the accompanying drawings, wherein—

Figure 1 is an elevation of an elevator system according to my invention. Fig. 2 shows a plan view. Fig. 3 is a diagram of the electric circuits. Fig. 4 is a detail view of the automatic controlling-switches. Fig. 5 is a detail showing one of the overtaking stop-switches. Fig. 6 shows my invention applied to a controlling-valve for a hydraulic plunger-elevator. Figs. 7, 8, 9, 10 show another application of the invention; and Figs. 11, 12, and 13 are detail views.

1 represents an elevator-well containing a low-rise car A and a high-rise car B starting from different sets of terminals and traveling both upward and downward in said shaft between guides 3 3. The car A is operated by cables 4, passing over overhead sheaves 5 to a winding-drum 6, which is driven by a motor 8. 9 is the counterweight for car A sliding between guides 10 10. The car B is similarly operated by cables 12, having counterweight 13 and drum 14, which is geared to a motor 11. This arrangement of counterweight connections enables one car to be operated without interfering with the other and also leaves the shaft unobstructed. The motor 11 and drum 14 are preferably located at the top of the well in order to save space and rope lengths.

The cars will be controlled in any suitable manner according to individual conditions. For the purposes of illustration I have herein shown and described an electrical and a mechanical control; but any convenient method, either rope, hydraulic, air, mechanical, or otherwise, may be employed.

Fig. 3 shows the motor-circuit connections, which are as follows: 15 16 are the field-circuits and 17 18 the armature-circuits. 19 20 are pivoted weighted reversing-switches for the cars A B, respectively, controlled by magnets 21 22 23 24, so as to reverse the ar-

mature connections for running in opposite directions, and no particular description of this apparatus is necessary, as it is well-known in various forms. Whenever the magnets are deënergized, the weights throw the switches, so as to open the motor-circuit. Various forms of automatic rheostat or starters may be used for the motors, as is also well-known in the art.. 28 29 are controlling-switches for the cars A B, having up contacts 30 32, respectively, and down contacts 31 33, respectively.

The circuits are so arranged that car B can go up independently of A and the up-controlling circuit of B leads from the battery 35 by wire 36 to switch 29, contact 32, wire 37, magnet 23, wire 38 to battery. When this circuit is closed, the lower arm of switch-arm 20 will be pulled to the left in Fig. 3 and close the armature-circuit of motor 11 to cause B to go up. In the same manner A can always go down without possibility of damage to B. The down-circuit of A is from battery 35, wire 36, switch 28, wire 40, magnet 22, wire 38, causing the motor 8 to revolve in such direction that the car will descend. The danger to be apprehended in running two cars in the same shaft is collision of the cars either when going toward each other or when one overtakes the other, one being stationary, or both going in the same direction.

In order to prevent the cars from going toward each other, means is provided whereby car B cannot descend while car A is ascending, and car A cannot ascend if B is descending. To prevent collision when both cars are going in the same direction, means is provided whereby the overtaking car will be automatically stopped when within a predetermined distance of the other car. For instance, if both are going up A will be automatically stopped until B has gotten out of the way, and if both are descending B will be automatically stopped until A has gotten out of the way. To prevent A and B from moving toward each other, there are interposed in the up-controlling circuit of A and in the down-controlling circuit of B directional switches with connections such that B cannot go down until A starts to go down, and A cannot go up until after B starts to go up. 46 and 47 are screw-shafts carrying nuts 48 49 and geared, respectively, to the shafts of motors 8 and 11, so as to be rotated thereby at a somewhat reduced speed, but so that each nut always has a position on its screw-shaft corresponding to the position of its respective car in the well. Carried by each of the nuts 48 49 are two brushes 51 50 52 53, respectively, which travel over contact-strips 54 55 56 57 58 59 60 61, proportioned according to the travel of the respective cars. Brush 50 bridges contact 54 and 55 when A is going down, and brush 53 bridges contact 60 61 when B is going up. Brushes 51 52 when on the respective contacts 56 57 58 59 do not bridge them, except when the normally open overtaken switches 63 64 are closed. These switches are respectively rocked by the rotation of shafts 46 47 into the path of lugs 65 66, carried on the brushes 53 50, and when the cars get within a predetermined distance of each other—say, for instance, four floors—one or the other of switches 63 64 is closed to thereby stop the overtaking car. It being advisable to start the cars from the basement and first floor, respectively, means is provided so that the cars can come within one floor of each other when at the basement and first floor, as by providing a dead place 67 in one of the strips 58 59, so that when the nut 48 is at or near its limit of travel corresponding to the lowest position of car A, car B will not be stopped, even if the switch 64 is closed. In this connection it may be said that automatic end stop devices of any desired type are to be applied to both cars, so that they will be stopped independently of the operator at their respective limits; but it is not considered necessary to illustrate such devices in this connection, as they are well known and my improvements are concerned more particularly with the general combination of the two cars in a single shaft operated in such manner as to prevent colliding.

To prevent car A from being started up when car B is going down or is at the bottom, the controlling-circuit of up-magnet 21 of car A leads from battery 35, through switch 28, contact 30, wire 70, to contact 61, brush 53 to contact 60, wire 71 to magnet 21 and to battery, thus permitting A to be started upward only when contacts 60 61 are bridged by the upward movement of B, which, as before stated, can be accomplished at any time. To prevent A from being started upward too soon, the contacts 60 61 may be made of such a length as not to be bridged until B has moved upward a certain distance. In like manner car B cannot be started downward unless A is going down or is at the bottom. This down-circuit of B is through wire 36, switch 29, contact 33, wire 73, contact 55, brush 50, contact 54, wire 74, magnet 24, and wire 38, so that B cannot go down until A commences to go down and shifts brush 50 to bridge contacts 54 and 55. Figs. 4 and 5 show the positions of parts when B descending is overtaking A descending and about to close switch 64. When this occurs, a stopping-circuit is completed from the battery by wire 75 to contact 59, switch 64, contact 58, wire 76, magnet 77, and wire 38, causing the armature 78 to break the circuit of down-magnet 24 of car B, and thereby stop motor 11. Motor 11 cannot again be started until the lug 66 has

moved sufficiently to open switch 64. In like manner when A is overtaking B in going up the up-controlling circuit of A is broken by the closing of switch 63. This stopping-circuit is from battery through wires 75 80, contact 57, switch 63, contact 56, wire 81, magnet 82, to battery, armature 83 breaking the circuit of up-magnet 21 of car A and stopping motor 8. The lugs 65 and switch 63 and also the lugs 66 and switch 64 project toward each other, as shown, so that the switches close while the cars are still some distance apart, and if B is a high-speed car it might be desirable to stop it going down when at a greater distance from A than when A, overtaking B, is to be stopped going up. As will be seen from Fig. 4, as soon as one of the switch-arms has rocked the switches 63 64 are moved out of engagement with their respective lugs 65 66, so that the stop-magnets are deënergized, thus permitting the car to be started, except in the case of A, which cannot be started until B has moved far enough upward to bridge contacts 60 61.

Fig. 6 shows a hydraulic plunger-cylinder and controlling-valve for a plunger-elevator, which can be used instead of the suspended lower car A. (Shown in Fig. 1.) Plunger-elevators have well-known advantages in that they require much less space than a cable-hydraulic machine, are economical for a low rise, and cheap to maintain. In this figure the car will have the overhead counterweight-cables 4, sheaves 5, and counterweight 9 and will be mounted on the end of a hydraulic plunger 86, operating in the cylinder 87 in a well-known manner. 88 is the main valve controlling the hydraulic pressure and having a supply-port 89, exhaust-port 90, and to-and-from passage 91. The main valve is operated by differential pressure in a motor-cylinder 92, which is itself controlled by a pilot-valve 93. This pilot-valve is of a well-known type which is closed by the opening of the main valve and which has to be opened to open or close the main valve. The main-valve stem carries a lever 94, to which the pilot-valve stem 95 is pivoted. The upper end of lever 94 carries two armatures 96 97^a, which are actuated by two solenoids 97 98 and a weight 99, one of which solenoids causes the car to go up and the other down. These magnets correspond to the magnets 21 22, and will be similarly connected. Whenever one of the magnets is energized, the pilot-valve will be opened to supply or exhaust and the main valve moved accordingly to start the car. When this takes place, the pilot-valve is returned to closed position automatically; but the weight 99 is held raised in one or the other direction as long as the corresponding magnet remains energized. When a stop is to be made, the magnet is deënergized, which permits the weight to fall, opening the pilot-valve and closing the main valve. The pilot-valve also automatically closes at the same time, so that the car stops with the parts in their original positions. I also propose to operate the high-rise car by means of a hydraulic-cable machine in the same manner as described for the low-rise plunger-machine.

In Figs. 7 to 13 the invention is shown applied to two elevator-motors by means of mechanically-controlled valves and switches. As in the construction before described the cars are automatically prevented from moving toward each other and the overtaking car will be automatically stopped when within a predetermined distance of the other. Figs. 7, 8, 9, 10 show diagrammatically my method of control applied to two cars. A represents a hydraulic-plunger elevator, and B a cable-machine, having the respective counterweights 9 13. Connected from car B to the counterweight side of counterweight-rope of car A is a running cable 103, and from the car side of counterweight-cable of car A to the counterweight of car B is a similar running-rope 104. As will be seen, these ropes are of sufficient length to form bights, and in these bights run sheaves 105 106. These sheaves are connected by a rope 107, which is wound around a drum 108, (see Fig. 12,) so that as sheaves 105 106 rise or fall with the movement of one or both cars, the drum 108 will be revolved in one or the other direction. The drum 108 is splined to a screw-shaft 109, which latter rotates in a fixed nut 110, so as to be moved longitudinally when rotated by the drum. 111 is a valve-casing having passage 112 leading to the plunger elevator-cylinder of car A, valve-chamber 113, containing pistons 114, 115, 116, the pistons being on a stem 117 and controlling supply and exhaust passages 118 119, leading to a similar valve-chamber 120, containing pistons 121 122 123, mounted on a stem 124 and controlling supply and discharge passages 125 126, connected with the main valve of the car A. The valve 120 is the automatic end stop valve of the car A and is actuated according to the direction of the car to close one or the other of passages 125 126 to stop A at the ends of its travel. This is accomplished by a drum 128 operating a screw 129 similarly to drum 108 and screw 109. The drum 128 is operated by cables 130, attached to the car A, so as to move therewith and close the passages when near the ends of travel. The rod 117 has a lug 133, which opens the down motor-circuit of motor 18 of car B at switch 134 whenever the rod 117 reaches its extreme left position in Fig. 12—that is, when piston 115 closes communication between passages 112 and 118, thus preventing car A from being started up when B is down. The lug 135 opens the up-motor circuit of motor 18 at switch 136 whenever piston 115 closes communication

between passages 113 and 119, upon movement of rod 117 to its extreme right position, thus preventing car A from being started downward when car B is at the top.

The sheave 106 will always go up when car B goes up relatively to car A, and 105 down at the same time, and when B goes down relatively to A sheave 106 will go down and 105 up. Whenever 106 goes up and 105 down, the rope 107 will revolve drum 108 and screw-shaft 109, so as to throw rod 117 to the right, and vice versa. When both cars move together at the same speed, no movement of sheaves 105 106 takes place, and the rod 117 does not move. Starting with the positions of parts shown in Figs. 7 and 12, car A is locked against downward movement by piston 122 closing communication between passages 119 and 126 and against upward movement by piston 115 closing communication between 112 and 118. Car B can move upward, because switch 136 is closed. As soon as B commences to move upward rod 117 moves toward the right, opening the passage to the supply through passage 125, permitting A to start upward. This cannot take place until B has gone a predetermined distance. If now A starts at the same speed as B, both cars can move in the same direction; but should A go faster than B sheave 105 will go up relatively to 106 and revolve drum 108 backward, so as to shut off the supply of A, so that A cannot overtake B going up. A will be automatically stopped at its upper limit by piston 122 closing passages 125. Assuming A stopped at the top and B still going up, the rod 117 travels to the right until lug 135 opens the up-motor circuit of B. At the same time piston 115 closes passage 119 and stops the descent of A, Fig. 8. As B goes down rod 117 moves to the left and opens 119, so that A can go down until stopped by the closing of passage 119 by piston 122. The faster B moves in overtaking A in going down the faster the rod 117 moves to the left until it opens the down circuit of motor 18 to stop car B. In this position the piston 115 closes the passage 118, so that A cannot go up, but can go down. It will thus be seen that the movement of rod 117 is proportional to the differential movement of the two cars, and the travel of the valves and rod 117 will be proportioned, so that it will not be possible for the cars to come together. In Fig. 9 B will be stopped by switch 136 when it has proceeded above A a distance equal to the distance B rises above the top limit of A and also at intermediate points whenever the same condition occurs and cannot again move in that direction until switch 136 is closed by rod 117 by the upward movement of A. In Fig. 10 B can go no farther down until A has gone down, this being permitted because while B moved down rod 117 moved to the left, Fig. 12, so as to open passage 112 to both supply and exhaust passages 118 119; but piston 122 still closes the supply 125, so that A can go down, but not up. The controller for car B will preferably be the same as in Fig. 3, so that B cannot go down before A starts down. In this position A will be free to move down, because piston 115 will not entirely close exhaust-passage between 112 and 119. For A the usual lever-shifting controller connected with a pilot-valve and main valve may be used.

It will thus be seen that my invention is applicable to all of the systems now in common use, both electric and hydraulic. Ordinarily in practice the low-rise car A starts from the basement or subbasement and the high-rise express-car B from the first floor.

The amount of space required by elevators in modern high buildings is an important factor in determining the rental value, and my invention will in some instances enable practically twice a given amount of traffic to be handled with only the additional space required to install the operating-motor of the low-rise car, which in the case of a hydraulic plunger-machine will be almost negligible when compared with the advantages secured. By the use of my elevator system two cars can be operated in the same well practically independently of each other, save that they cannot move toward each other. By preventing the cars from moving toward each other one possibility of collision is avoided, and by automatically stopping the overtaking car when both are going in the same direction the other possibility of collision is avoided. The cars will both be equipped with the customary safety devices in addition. Furthermore, it will be seen that the car which overtakes and is stopped automatically cannot again start until the other car has started in the same direction and moved onward out of the way. A further important advantage of my invention is that it can be applied to elevator systems now in use to increase the elevator capacity of a building at a comparatively small expense.

Inasmuch as the principles of my invention are capable of application in various ways, I do not restrict myself to the specific construction herein shown and described.

Having thus described my invention, I declare that what I claim as new, and desire to secure by Letters Patent, is—

1. In an elevator system, the combination of two separately-controllable cars operating between different sets of terminals in the same shaft, and means for preventing said cars from colliding.

2. In an elevator apparatus, the combination of a shaft, a plurality of independently-actuated cars movable both upward and downward in said shaft between different sets of terminals and means for preventing

the cars from colliding, substantially as described.

3. In an elevator apparatus, the combination of a shaft, a plurality of independently-actuated cars starting from different terminals and movable both upward and downward in said shaft, and automatic mechanism for preventing the cars from colliding, substantially as described.

4. In an elevator system, the combination of a high-rise, and a low-rise car operating between different sets of terminals in the same shaft, and means for preventing said cars from colliding, substantially as described.

5. In an elevator system, the combination of two cars operating between different sets of terminals in the same shaft, and means whereby the actuating mechanism of one is controlled by the other, substantially as described.

6. In an elevator system, the combination of a high-rise and a low-rise car operating between different sets of terminals in the same shaft, and means whereby the actuating mechanism of one is controlled according to the position of the other, substantially as described.

7. In an elevator apparatus, the combination of a shaft, a plurality of independently-actuated cars starting from different terminals and movable both upward and downward in said shaft, and mechanism controlled by each car for limiting the approach of the other car, substantially as described.

8. In an elevator system, the combination of two cars operating in both directions in one shaft, one car being at all times above the other, and means for preventing said cars from colliding, substantially as described.

9. In an elevator system, the combination of two cars operating in the same shaft from different terminals, the upper car having its lower terminal at a floor above the lower terminal of the other car, and at all times remaining above said other car, and means for preventing said cars from colliding, substantially as described.

10. In an elevator system, the combination of a high-rise and a low-rise car operating in the same shaft, the low-rise car being at all times below the high-rise car and controlling the descent of the high-rise car, and the high-rise car controlling the ascent of the low-rise car, substantially as described.

11. In an elevator apparatus, the combination of a shaft, a plurality of independently-actuated cars starting from different terminals and movable both upward and downward in said shaft, and automatic mechanism for stopping the upper car when it approaches to within a predetermined distance of the lower car, and for stopping the lower car when it approaches to within a predetermined distance to the upper car, substantially as described.

12. In an elevator apparatus, the combination of a shaft, a plurality of independently-actuated cars starting from different terminals and movable both upward and downward in said shaft, means for limiting the ascent of the lower car to an elevation intermediate the permitted travel of the upper car, and automatic mechanism for limiting the approach of the cars to a predetermined distance apart when both are below the upper limit of the lower car, substantially as described.

13. In an elevator apparatus, the combination of a shaft, a plurality of independently-actuated cars starting from different terminals and movable both upward and downward in said shaft, manually-controlled means on each car for independently controlling said cars, and automatic mechanism for stopping the upper car going down and the lower car going up, upon the approach of the two cars to within a predetermined distance of each other, substantially as described.

14. In an elevator system, the combination of two independently-actuated cars operating in one shaft, and means for preventing said cars from moving oppositely toward each other, substantially as described.

15. In an elevator system, the combination of two cars operating between different terminals in one shaft, one car being always above the other, means permitting operation of one or both cars simultaneously in the same direction, and means for automatically stopping the overtaking car when it is a predetermined distance from the other, substantially as described.

16. In an elevator system, the combination of two cars one above the other and operating between different terminals in the same shaft, and means whereby the upper car is prevented from going downward when the lower car is going upward, substantially as described.

17. In an elevator system, the combination of two cars operating between different sets of terminals in the same shaft, one car being always above the other, and means whereby the lower car cannot move upward until the upper car has moved a predetermined distance from said lower car, substantially as described.

18. In an elevator apparatus, the combination with a plurality of independently-actuated cars starting from different elevations, of means whereby the ascent of the lower car is controlled by the ascent of the upper car, and means whereby the descent of the upper car is controlled by the descent of the lower car, substantially as described.

19. In an elevator apparatus, the combi-

nation with a plurality of cars starting from different elevations in the same shaft, of means whereby the ascent of the lower car is controlled by the ascent of the upper car, and means whereby the descent of the upper car is controlled by the descent of the lower car, substantially as described.

20. In an elevator apparatus, the combination with a plurality of cars starting from different elevations in the same shaft, of means for keeping said cars at least a predetermined distance apart except when at their lower limits, substantially as described.

21. In an elevator apparatus, the combination with a plurality of cars starting from different elevations in the same shaft, of means whereby the lower car can go down independently of the upper car, and the upper car up independently of the lower car, means for controlling the ascent of the upper car, and means for controlling its descent by the descent of the lower car, substantially as described.

22. In an elevator apparatus, the combination with a plurality of cars starting from different elevations in the same shaft, of means whereby the lower car can go down independently of the upper car and the upper car go up independently of the lower car, means for controlling the ascent of the upper car, and means for automatically stopping the lower car going up and the upper car going down, when approaching within a predetermined distance of the other, substantially as described.

23. In an elevator apparatus, the combination of a shaft, a plurality of independently-actuated cars starting from different terminals and movable both upward and downward in said shaft between different terminals, and means for keeping said cars at least a predetermined distance apart except when at their lower terminals, substantially as described.

24. In an elevator apparatus, the combination of a shaft, a plurality of independently-actuated cars starting from different terminals and movable both upward and downward in said shaft, means whereby the lower car can go down independently of the upper car and the upper car can go up independently of the lower car, means for limiting the ascent of the upper car, and means for controlling its actuating mechanism by the descent of the lower car, substantially as described.

25. In an elevator apparatus, the combination of a shaft, a plurality of independently-actuated cars starting from different terminals and movable both upward and downward in said shaft, means whereby the lower car can go down independently of the upper car and the upper car can go up independently of the lower car, means for controlling the ascent of the upper car, and means for preventing the cars from moving in opposite directions toward each other, substantially as described.

26. In an elevator apparatus, the combination of a plurality of cars operating independently of each other in the same shaft both upward and downward, one car being below the other and having its starting-terminal below the starting-terminal of the upper car, the upper car having its upper terminal at a higher level than the upper terminal of the lower car, said cars being capable of stopping at all points between their respective terminals, and means whereby the cars are prevented from coming within a predetermined distance of each other except at their lower terminals, substantially as described.

27. In an elevator apparatus, the combination of a single shaft, an upper and a lower car starting from different terminals and movable both upward and downward in said shaft, a direct hydraulic plunger mechanism for supporting and actuating the lower car, cable mechanism from which the upper car is suspended and actuated, manually-controlled mechanism on each car for controlling it, and automatic mechanism for limiting the approach of the cars to within a predetermined distance apart, substantially as described.

28. In an elevator apparatus, the combination of a shaft, a plurality of independently-actuated cars in said shaft, said shaft having a portion which is common to the travel of all of said cars in both directions, manual mechanism on each car for controlling it in both directions, and automatic mechanism for preventing each car from approaching the other car within a predetermined distance thereof, substantially as described.

29. In an elevator system, the combination in a single shaft, of a suspended cable-actuated elevator and a direct hydraulic-plunger-actuated elevator, said elevators operating between different terminals and the cable-elevator being at all times above the plunger-elevator, independent actuating and controlling means for said elevators and means whereby the ascent of the plunger-elevator is controlled by the position of the cable-elevator, and the descent of the cable-elevator controlled by the position of the plunger-elevator, substantially as described.

30. In an elevator system, the combination in a single shaft, of a high-rise suspended cable-actuated elevator and a low-rise direct hydraulic-plunger-actuated elevator, said elevators having different lower terminals and the high-rise elevator being at all times above the low-rise elevator, independent actuating and controlling means for said elevators, and means whereby the ascent of the low-rise elevator is controlled by the position

of the high-rise elevator and the descent of the high-rise elevator controlled by the position of the low-rise elevator, substantially as described.

31. In an elevator system, the combination in a single shaft, of two elevators operating in both directions between different terminals and having separate cable-connected counterweights, independent actuating and controlling mechanism for said elevators, and coacting connections between said cars and counterweights whereby one car is stopped when it comes within a predetermined distance of the other car, substantially as described.

32. In an elevator system, the combination in a single shaft, of two elevators operating in both directions between different terminals, independent actuating and controlling mechanism for said elevators, and automatic stopping mechanism actuated according to the differential movement between said elevators, whereby to stop one car when it comes within a predetermined distance of the other car, substantially as described.

33. In an elevator system, the combination in a single shaft, two elevators operating in both directions between different terminals, hydraulic mechanism for actuating the lower of said elevators, and electric mechanism for actuating the upper of said elevators, independent controlling mechanism for said elevators, and automatic stopping mechanism actuated according to the differential movement between said elevators, whereby to cut off the power from one car when it comes within a predetermined distance of the other car, substantially as described.

34. In an elevator system, the combination with a high-rise cable-elevator, and a low-rise hydraulic-plunger elevator, of independent operating and controlling means for said elevators, and means for automatically stopping the ascent of the plunger-elevator when it comes within a predetermined distance of the cable-elevator, substantially as described.

35. In an elevator system, the combination with an upper cable-elevator and a lower hydraulic elevator operating between different terminals in the same shaft and having independent operating and controlling means, of an automatically-actuated valve controlled by the differential movement between said elevators for stopping the ascent of the plunger-elevator when it comes within a predetermined distance of the cable-elevator, substantially as described.

36. In an elevator system, the combination with an upper electrically-actuated cable-elevator, and a lower hydraulic elevator, said elevators operating between different terminals in the same shaft and having independent actuating and controlling mechanism, of a controlling-valve varying in position according to the direction of, and differential movement between said elevators, and means operated by said valve for controlling the motor-circuits of said electric elevator, said valve controlling the hydraulic elevator, and acting to stop one or the other elevator when about to overtake the other, substantially as described.

In testimony whereof I affix my signature in presence of two witnesses.

CLAIR FOSTER.

Witnesses:

JULIAN S. WORSTED,

GEO. A. HOFFMAN.