April 3, 1945. L. BESKIN 2,372,648

DOOR OPERATING MECHANISM

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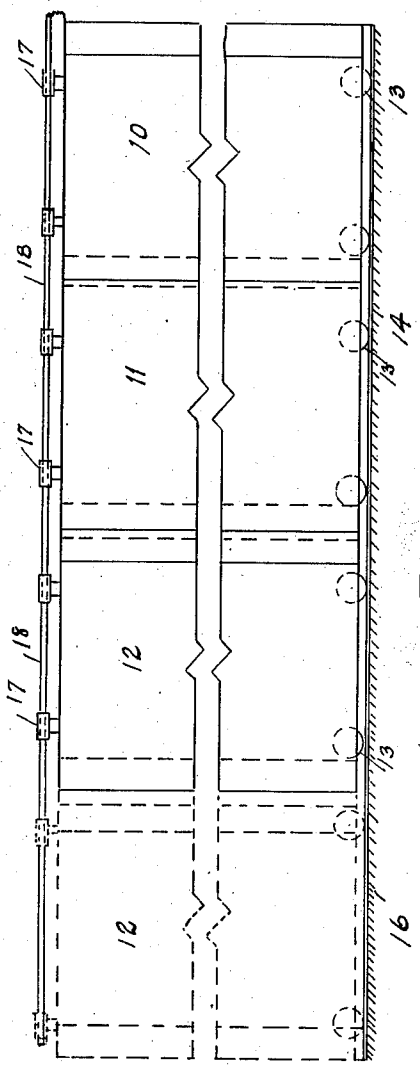


Fig 1

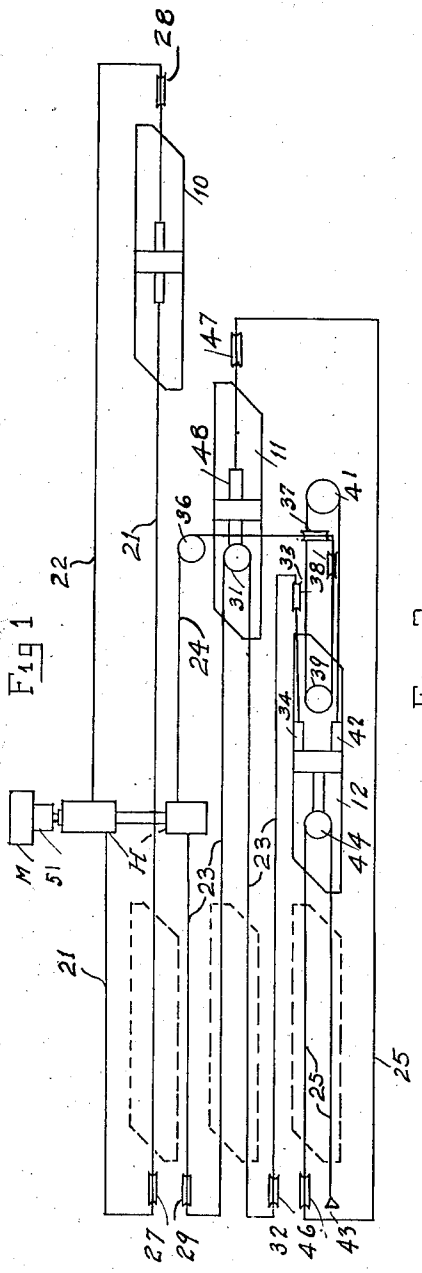


Fig 2

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DOOR OPERATING MECHANISM

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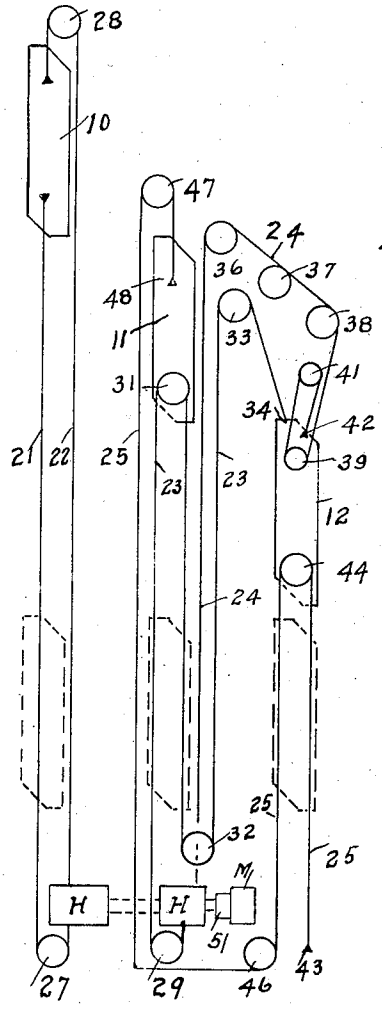


Fig 3

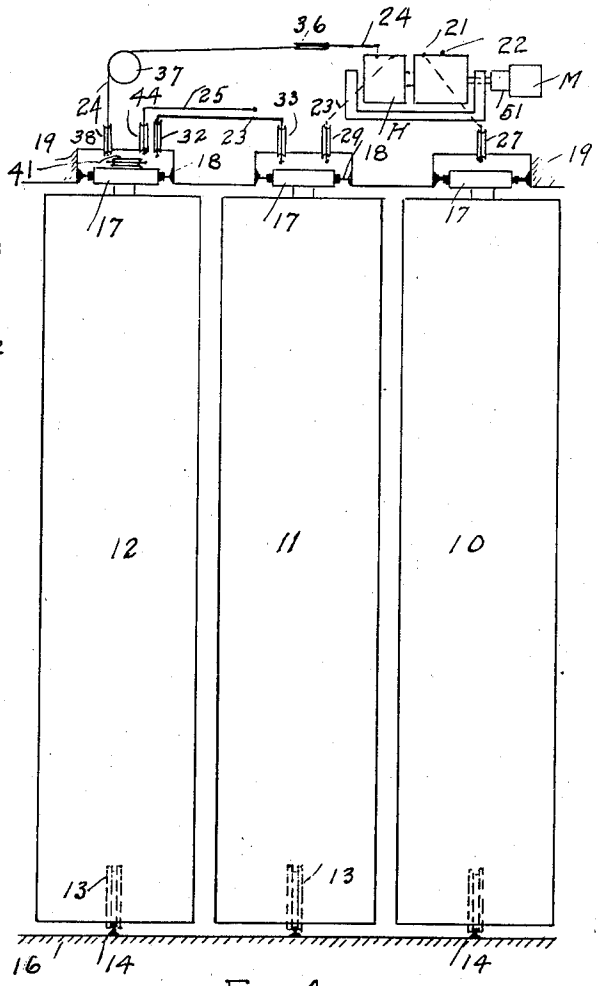


Fig 4

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DOOR OPERATING MECHANISM

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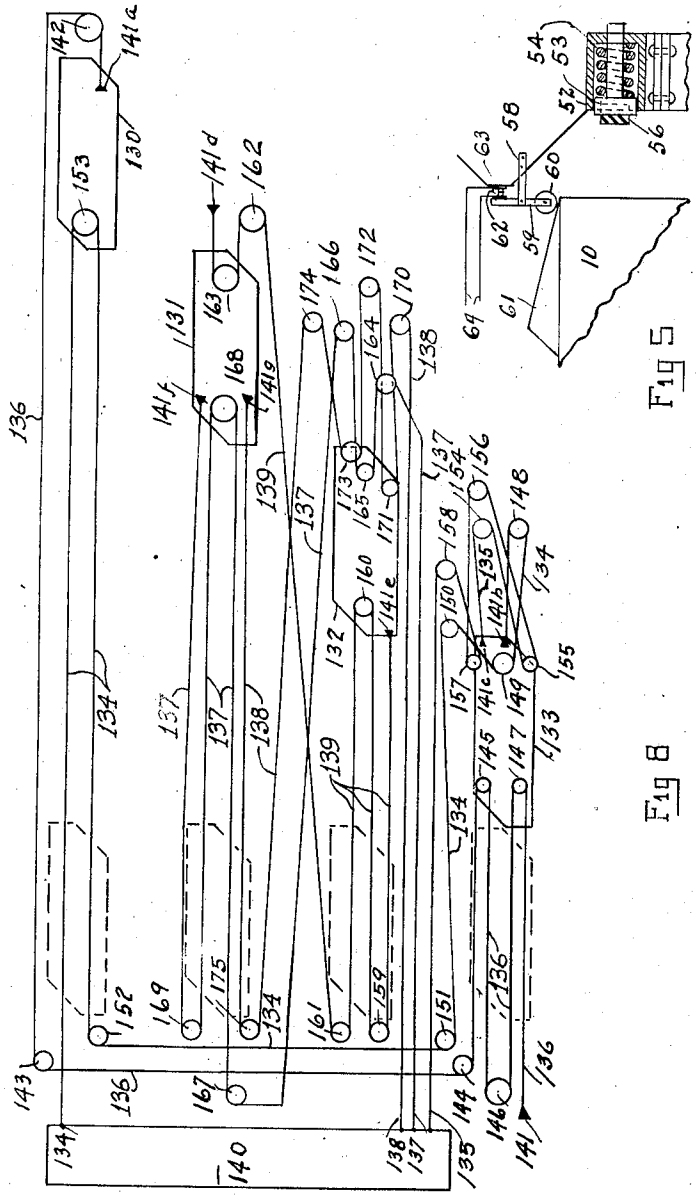


Fig 8

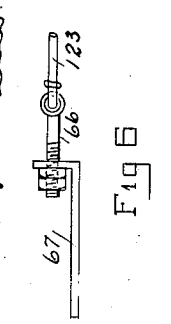


Fig 5

Fig 6

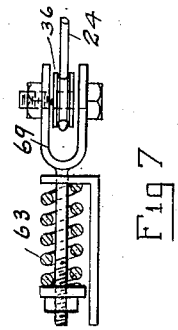


Fig 7

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DOOR OPERATING MECHANISM

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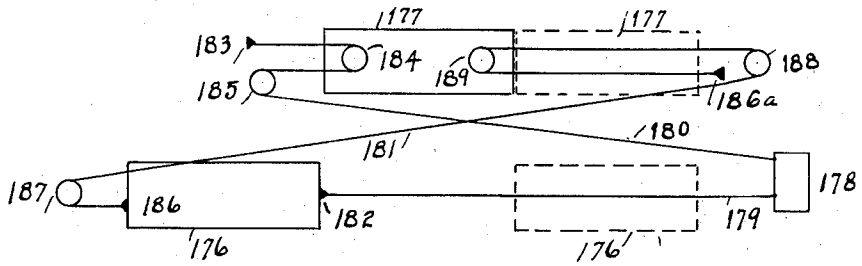


Fig 9

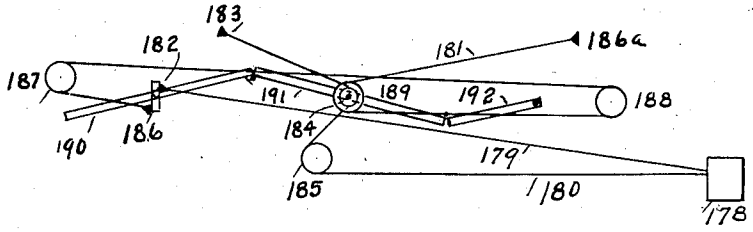


Fig 10

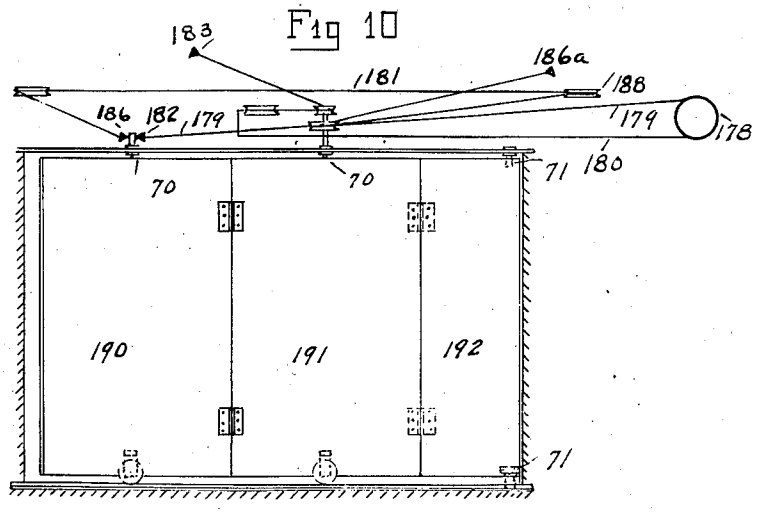


Fig 11

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DOOR OPERATING MECHANISM

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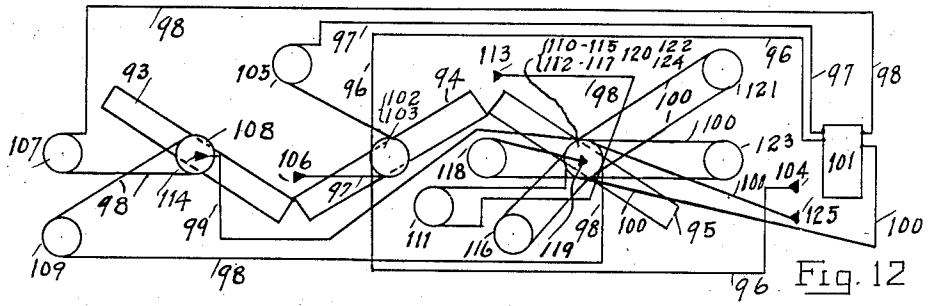
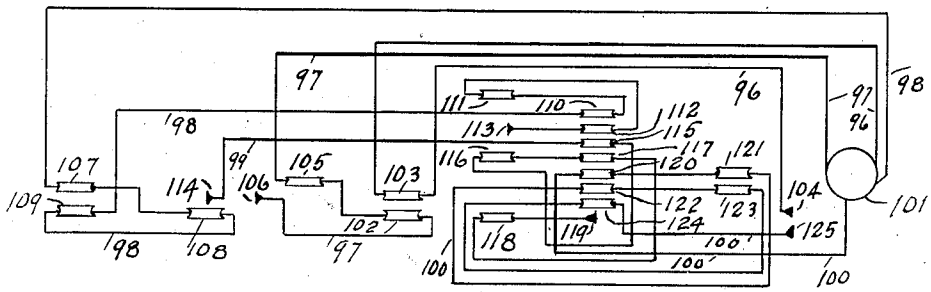


Fig. 12

Fig. 13



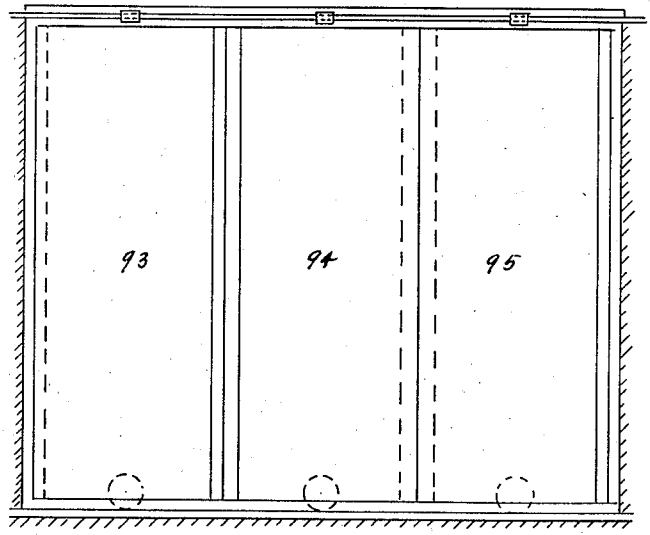


Fig. 14

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Patented Apr. 3, 1945 2,372,648

UNITED STATES PATENT OFFICE

2,372,648

DOOR OPERATING MECHANISM

Leon Beskin, New York, N. Y., assignor to The Ingalls Iron Works Company, a corporation of Delaware

Application January 15, 1943, Serial No. 472,437

8 Claims. (Cl. 160—193)

This invention relates to mechanical devices for operating a plurality of relatively moving parts at different speeds along predetermined paths of different lengths. It finds its application partly in means for closing or opening large openings such as the exterior or partition doors of large buildings, such as hangars, factories, warehouses and the like, and wherein the doors are formed of several sections moving on horizontal or vertical tracks or guides, or are hinged together or are arranged in combinations of such construction.

My invention contemplates the provision of improved means for moving sections or combinations of sections of the character described simultaneously and at different speeds so that they will arrive simultaneously at their terminal positions.

A further object of my invention is to provide positive and direct means for moving sections of the character mentioned from a common source of power; also to provide means comprising one or several members differentially operated for effecting the proper relative rate of movement of the door sections.

A still further object of my invention is to provide adjustable attachments for connecting the linear members employed by my invention to the sections, independently of each other whereby the sections may be quickly and accurately adjusted relative to each other, and to provide effective devices for slowing down or stopping the movement of the sections as they approach their terminal positions or any intermediate predetermined positions.

An apparatus embodying features of my invention is illustrated in the accompanying drawings forming a part of this application in which

Figure 1 is an elevational view of a sectional door with certain parts demoved to which my improved operating system is applied;

Fig. 2 is a plan view of the door shown in Fig. 1, showing the positioning of the sheaves on the door sections and frame and showing diagrammatically the arrangement of the cables for operating the sections;

Fig. 3 is a diagrammatic view of the door shown in Figs. 1 and 2 with cables and sheaves shown diagrammatically;

Fig. 4 is an end elevational view of the door sections in closed position;

Fig. 5 is a detailed view showing by way of example a snubber and limit switch arrangement which may be used in connection with a door section;

Fig. 6 is a detailed view showing an adjustable anchor which may be used for applying tension to the cables;

Fig. 7 is a detailed view of a spring mounted sheave which may be employed with my invention for maintaining tension on the cables;

Fig. 8 is a diagrammatic plan view showing my invention applied to a four section door;

Fig. 9 is a similar diagrammatic view showing my invention applied to a two section door;

Fig. 10 is a diagrammatic plan view of my invention applied to a sectional door in which the sections are hinged together;

Fig. 11 is a diagrammatic elevational view of the arrangement shown in Fig. 10;

Fig. 12 is a diagrammatic plan view showing a further modified form of my invention applied to a sectional door in which the sections are hinged together;

Fig. 13 is a diagrammatic elevational view of the operating mechanism shown in Fig. 12; and

Fig. 14 is an elevational view of the doors operated by the mechanism shown in Figs. 12 and 13.

Referring to the drawings, particularly Figs. 1 to 4, my invention is illustrated in connection with a door opening by horizontal movement, though it will be apparent that the same system of operation may be applied to vertically moving door sections. Also I have illustrated my invention as adapted to close one half of an opening although it will be apparent that it may be adapted for closing any part, or all of an opening. Further I have shown my improved operating system as being placed on top of the door sections whereas it may be as readily applied to the bottom of the sections.

In the embodiment illustrated in Figs. 1 to 4 the door comprises the sections 10, 11, and 12 of equal width, which are preferably mounted outside the building with which they are associated. They are upright and parallel and are transversely off set with respect to each other, so that they are movable relative to each other across the opening. When in closed positions the sections are relatively extended to form a closure substantially as wide as the sum of the widths of the sections with the adjacent edges overlapping. In open position the sections are side by side with their corresponding ends in substantial alignment, as seen in the dotted position in Fig. 2. Each of the door sections is provided at its bottom with rollers or wheels 13 which support the door sections and are mov-

able over tracks 14 in a floor 16. Each door section is provided at its top with rollers 17, engaging between guides 18, which are supported by a suitable frame work 19, which frame work may in turn be supported in any suitable manner (not shown). The front part of the girder 19 and guides 18 are not shown in Fig. 1 for the sake of clarity.

In order to move the door sections 10, 11, and 12 to open or closed position, I provide a drum or hoist H and linear members such as cables 21, 22, 23, 24, and 25. The cable 21 is attached to the drum H and passes over a fixed sheave 27 located to the left of the open position of the door section 10 as viewed in Figs. 1 and 2. The cable 22 is connected to the drum H and passes around a fixed sheave 28 positioned beyond the opposite extreme limit of travel of the section 10, and thence to the door section 10. It will be seen that with this arrangement, the door section 10, upon rotation of the drum H, will be moved to open or closed position, depending upon the direction of rotation, one of the cables 21 or 22 being wound on to the drum H and the other being paid off. It will also be seen that the door section 10, under such circumstances, will travel at the same speed as the cable which is moving it.

The door section 11 is operated in an opening direction by the cables 23 attached to and wound upon the drum H. The cable 23 passes from the drum around a fixed sheave 29, thence to a floating sheave 31, mounted on the door section 11; thence to a fixed sheave 32, and thence to a fixed sheave 33, and back to the door section 12, where it is attached to an anchor 34. Cable 24 passes from the drum H to a fixed sheave 36; thence to a fixed guide sheave 37; thence over a guide sheave 38, to a floating sheave 39, mounted on the door section 12; thence to a fixed sheave 41, and back to be attached to the door section 12, at an anchor 42.

The cable 25 is secured to a fixed anchor 43, and passes from the anchor 43 to a floating sheave 44, mounted on the door section 12; thence back and around a fixed sheave 46, and thence to a fixed sheave 47 to the door section 11 where it is attached to an anchor 48. It thus acts to move section 12 toward starting position and section 11 toward extended position, the latter moving at all times at twice the rate of the former due to the two pulling units on section 12 and one pulling unit on section 11.

The three cables 23, 24, and 25 provide for the opening and closing of the door sections 11 and 12. The cable 24, winding on the drum H, insures the closing of section 12, and passing of the cable 24 over the stationary sheaves 36 and 41, and the floating sheave 39, on the door section 12, insures that said section will travel at one third the speed of section 10, which travels at the same speed as that of the cables 21 and 22 which actuate it.

Section 11 is actuated in a closing direction from section 12 through intermediate cable 25. It will be seen that cable 25 is connected to the fixed anchor 43, and is reeved around the floating sheave 44 to pass thence to the section 11, by way of the fixed sheaves 46 and 47. This causes section 11 to move at twice the speed of section 12, or two thirds the speed of section 10. The cables 23 and 25, cooperating together, insure the simultaneous movement of sections 11 and 12, at speeds equal to two thirds and one third the speed of section 10, respectively. The sections will thus arrive at their fully open or fully closed positions simultaneously.

Thus, it can be readily seen that in both directions of movement, the apparatus described insures a positive motion of the different sections at speeds proportional to the lengths of travel of the different sections, which are respectively: one panel length for section 12, two panel lengths for section 11, three panel lengths for section 10, the motion of the whole system being insured by the drum H, or several drums (not shown) having the same diameter and the same speed. The drum H may be driven by any suitable means such as by an electric motor M which is preferably connected to the drum by means of a speed reducer 51.

At the end of their movement, the door sections may be stopped by any suitable means, such as by manually cutting off the power supply of the motor M. Preferably, adjustable stoppers for instance, electrical limit switches automatically acting on the power supply, can be placed at the ends of the path of each section. Moreover, as the positive simultaneous movement of all the sections is insured, the stoppers can be placed at the ends of the path of one section only. Preferably, this section will be chosen to be section 10 which has the greatest travel, and thus insures more precision in the stopping of the whole system because, for a given displacement of section 10, the displacements of sections 11 and 12, are, respectively, two-thirds and one-third. Thus, the errors decrease by using section 10, and would increase if sections 11 or 12 were used. Also with limit switches controlled by section 10, if the cables should stretch, the inaccuracies in positions of sections 11 and 12 are smaller than those of section 10; whereas if sections 11 or 12 should command the positions of the whole system, the inaccuracies would be greater.

A typical example of a combined snubber and limit switch arrangement is shown in Fig. 5. Mounted on a suitable stationary part adjacent the door section 10 at each side near the top, is a cylinder 52, in which is mounted a piston 53, which is biased to its outward position by means of a spring 54. As both snubber and limit devices are the same in construction, only one will be described. A bumper element 56, on the outer end of the piston, is adapted to engage with the door section 10, near the end of its travel. This causes the piston 53 to move inwardly, compressing the spring 54, and also compressing the air ahead of the piston, and gradually brings the door section to rest. A bracket 58 is provided on the stationary frame structure of the door and pivotally mounted on the bracket is an arm 59 carrying a roller 60, which is engaged by a wedge shaped track 61 on the door section 10 as it approaches the limit of its travel. The outer end of the arm 59 carries a contact member 62 which is normally engaged with a contact 63, thus closing a circuit 64, controlling the motor M. When the roller 60 is engaged by the track 61, the arm 59 rotates counterclockwise on its pivot, thus breaking the motor controlling circuit. It will be understood that the construction shown in Fig. 5 is merely illustrative, and many other means for slowing down and stopping any or all of the door sections will readily suggest themselves to those skilled in the art.

In order to provide for the stretching of the operating cables, all the anchors heretofore described should be of the adjustable type and pre-

formed cables are preferably used. For example, in Fig. 6, I show the cable 23 as anchored by means of an adjustable eyebolt 66 mounted in a bracket 67. The adjustment of the anchors compensates for the stretching of the cables and positions the sections accurately to their theoretical end locations. While I have shown the cables as ending at and attached to the winding and unwinding drum H, it will be obvious that the cables 21 and 22 may be connected end to end into a single cable, and also the cables 23 and 24 may be connected end to end into a single cable, making several turns on the drum and taking by friction the power imparted to the drum. In such case, the cables must all be under tension in order to insure the requisite friction. In order to obtain such result, each part of the cable winding on the drum must pass through a tension device. For instance, the cables may be put in tension by means of a spring 68 surrounding an anchor bolt 69 passing through one of the brackets 67 and holding a sheave such as 36 in place as shown in Fig. 7.

The arrangements shown in Figs. 1 to 4 can be applied to two-section doors by merely omitting the equipment related with the operation of section 10. With the arrangements shown in Figs. 1, 2, and 4 it can be readily seen that, assuming the resistance to movement of each section is the same for all sections, the tension in all the cables is substantially the same. Also, it can be seen that the winding or unwinding of all the cables on the drum is at the same rate. If different drums should be used, all drums should be of the same diameter, and be driven at the same speed from the same power.

Fig. 8 represents in the same diagrammatic way as Fig. 3, the operating system of a door comprising four sections numbered 130, 131, 132, and 133. The sections 130 and 133 are operated together by means of power cables 134 and 135, and intermediate cable 136. The sections 131 and 132 are operated together by means of power cables 137 and 138 and intermediate cable 139.

A fifth section could be added to the arrangement shown in Fig. 8, which would operate independently in the same way as section 10 in Fig. 3. The cables operating such a fifth section would wind on the drum H at a speed which would insure its proper movement relative to the other sections. Assuming 1, 2, 3, 4 the relative speeds of sections 133, 132, 131, 130, respectively, the speeds of the cables on the drum for the fifth section would be 5. All the speed and power characteristics of the scheme shown in Fig. 3 are similar to that shown in Fig. 8.

The intermediate cable 136 operating sections 130 and 133, terminates at a fixed anchor 141, and at a floating anchor 141*a*, on section 130. It is reeved on stationary sheaves 141, 143, 144, and 146, and on floating sheaves 145 and 147 on section 133. Cable 134 ends at an anchor 141*b* on section 133, and is wound at the other end on the drum 149. It is reeved on stationary sheaves 148, 150, 151, and 152. It is wound on floating sheave 149, mounted on section 133, and on floating sheave 153, mounted on section 130. Cable 135 ends on a floating anchor 141*c*, on section 133, and is reeved on stationary sheaves 154, 156, and 158; and on floating sheaves 155, and 157, mounted on section 133.

Intermediate cable 139 has one end secured to a fixed anchor 141*d*, and the other to a floating anchor 141*e*, on section 132; and is reeved on stationary sheaves 159, 161, and 162, and on floating sheaves 160 and 163, mounted on sections 132 and 131, respectively. Cable 137 is wound on the drum 140, and ends on anchor 141, on section 131, and is reeved on stationary sheaves 164, 166, and 167; and on floating sheaves 165 and 160 mounted on sections 132 and 131, respectively. Cable 138 is wound on the drum 140, and ends on anchor 141*g*, on section 131, and is reeved on stationary sheaves 170, 172, 174, and 175; and on floating sheaves 171 and 173 mounted on section 132.

As seen from the examples shown in Fig. 3 and in Fig. 8, the speed of winding in the cables, when an even number of sections is used, is equal to the speed of the next section of odd rank, as section 10 in Fig. 3, or as the fifth section not represented in Fig. 8. Fig. 9 represents an arrangement for two sections only, 176 and 177. In this arrangement, the speed of winding on drum 178 is the same as the rate of movement of section 176, which is moved toward its starting position by the cable 179, winding on the drum and connected to section 176 at 182. Section 177 is actuated by cable 180, winding on drum 178. Cable 180 is reeved on a fixed sheave 185, and on floating sheave 184, mounted on section 177, and ends at a fixed anchor 183. The sections 176 and 177 are connected together by a cable 181, ending on an anchor 186 fixed to section 176, reeved on fixed sheaves 187 and 188, and on floating sheave 189, fixed to section 177, and ending at a fixed anchor 186*a*. In contrast to the arrangements heretofore described, cable 181 is not submitted to the same tension as the cables 179 and 180.

All the arrangements indicated above can be used for folding doors of the type represented in Figs. 10 and 11. If these schemes are used without any change, one of the folding elements must be half the width of the other elements, and must be hinged. Comparing Fig. 10 to Fig. 9, it will be seen that sections 190 and 191 there shown corresponds exactly to sections 176 and 177, but that there must be added a hinged section 192, which is half the width of 190 and 191. All the sheaves, ropes, drums and anchors are identical to those of Fig. 9 and are numbered alike. Sections 190 and 191 are provided with guide rollers 70, located at top center while section 192 is provided with pivots 71 located at the top and bottom adjacent the edge of the opening.

Figs. 12 and 13 represent a folding door in which all the folding sections have the same width. They are numbered 93, 94, and 95. It may be seen that the displacements of their centers are respectively equal to 2½ sections, 1½ sections, and ½ section, i. e. they are proportional to the numbers 5, 3, and 1. Due to the odd number of sections represented in Fig. 12 the middle section 94 is moved separately at half the speed of the drum winding by means of the two cables 96 and 97 reeved on sheaves 102, and 103 on the section 94, and on the stationary sheave 105. These cables 96 and 97 end at anchors 104 and 106. In operation, they transmit a tension equal to half the tension of all the other cables 98, 99, and 100. This peculiarity exists only in case of an odd number of sections. Where there are an even number of sections, all cables transmit equal tension.

The two sections 93 and 95 are operated simultaneously in the same manner as the pairs of sections shown in Figs. 4, 8, and 9. The power cable 100 operates section 95 alone, constituting a six-unit line reeved on stationary sheaves 121 and 123, and on floating sheaves 120, 122, and

124, mounted on section 95, and ends at stationary anchor 125. Cable 98 from drum 101, is reeved on stationary sheaves 107 and 109, and on floating sheave 108, mounted on section 93, thus operating said section. It is then reeved on sheaves 110 and 112 on section 95, and on stationary sheave 111, thus operating said section, and ends at stationary anchor 113. The intermediate cable 99 ends at anchors 114 and 119, fixed to sections 93 and 95, respectively, and is reeved on stationary sheaves 116 and 118, and on sheaves 115 and 117, on section 95 thus insuring the ratio of 5 to 1 between the speeds of sections 93 and 95.

In all the arrangements herein illustrated and described, it will be seen that I have applied a simple cable and pulley combination to a plurality of movable sections in which I have provided that number of pulling cable units to each section for each direction of movement, which represents its rate of movement compared with other associated sections. For example in Fig. 3, comprising three sections, section 10 is moved independently in each direction by a single cable unit at the same rate of movement as the cable is wound on the drum H. Section 12 being actuated by cable 24 passing from the drum H around sheaves 41 and 39 and anchored to floating anchor 42 is acted upon by three cable pulling units and thus moves at only one third the rate of section 10. An inspection of the arrangement of intermediate cable 25, shows at once that it supplies two cable pulling units to section 12 and only one to section 11, thus effecting movement of section 11 toward extended position at a rate one half that of section 12. Cable 23 passing from the drum around floating sheave 31 on section 11, moves the section back toward starting position at a rate of movement one half that of section 10, or twice that of section 12. The sections are all thus actuated by cable pulling units corresponding in number to the relative rates of movement of the sections.

From the foregoing it will be apparent that I have devised an improved operating system for moving simultaneously a plurality of massive sections from a common starting position to various extended positions, and back again, at speeds proportional to their respective extended positions as compared to their initial or starting positions. It will further be apparent that my improved system involves a minimum of mechanism and is simple of design and reliable in operation.

While I have shown my invention in several forms, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various other changes and modifications, without departing from the spirit thereof, and I desire, therefore, that only such limitations shall be placed thereupon as are specifically set forth in the appended claims.

What I claim is:

1. In an apparatus of the character described, a plurality of movable sections having a common starting position and extended positions to form a closure equal substantially to the sum of the widths of the sections, a fixedly mounted operating drum of constant diameter, a system of actuating cables wound on the drum and connected to the sections, a system of fixed sheaves and floating sheaves mounted on the sections around which said cables are passed and disposed to afford to each section a number of cable pulling units corresponding to the rate of movement of said section relative to its associated sections, whereby when the drum is rotated in one direction the cables effect simultaneous movements of said sections toward their extended positions at rates of movement proportional to the respective distances from said extended positions to their starting positions, and a similar system of cables and sheaves similarly mounted to effect simultaneous movement of said sections at similar rates toward their starting positions.

2. In apparatus of the character described, a pair of sections movable along parallel tracks having a common starting position and extended positions to form a closure equal substantially to the sum of the widths of the sections, a fixedly mounted operating drum of constant diameter, a system of cables wound on the drum and connected to the sections, and a system of fixed sheaves and floating sheaves mounted on the sections around which said cables are passed and disposed to afford to each section a number of cable pulling units corresponding to the rate of movement of said section relative to its associated sections, whereby when the drum is rotated in one direction one of the sections moves at twice the rate of the other to assume an extended position beyond the other section, and a similar system of fixed sheaves and floating sheaves mounted on the sections around which said cables are passed and similarly disposed to move said sections toward starting position so that the farthest extended section moves toward the starting position at a rate of movement twice that of the other section, and both sections arrive at the starting position substantially simultaneously.

3. In apparatus of the character described, a pair of movable sections having a common starting position and extended positions adapted to form a closure equal substantially to the sum of the widths of the sections, a fixedly mounted power operated drum of constant diameter, a cable wound on the drum and connected directly to the section having the longer travel and adapted to move said section from extended to starting position, a fixed positioned sheave and an anchor located beyond the limit of advancing travel of the section having the shorter travel, a floating sheave mounted on the section having the shorter travel, a cable wound on the drum and reeved around both of said sheaves and connected to the anchor to effect movement of said section having the shorter travel toward extended position at a rate one half that of its actuating cable, a fixed position sheave located beyond the section having the longer travel, a fixed positioned sheave and an anchor mounted beyond the limit of retracting travel of the section having the shorter travel, a second floating sheave mounted on the section having the shorter travel, and an intermediate cable connected directly to the section having the longer travel and to the last mentioned anchor and reeved around said last mentioned sheaves to effect simultaneous relative movement of said sections at rates proportional to their respective travels from starting to extended positions.

4. In apparatus of the character described, a trio of movable sections having a common starting position and extended positions to form a closure equal substantially to the sum of the widths of the sections, a fixedly mounted power operated drum of constant diameter, a fixed positioned sheave located beyond the limit of travel of the section having the longest travel, a cable wound on the drum and passing around said fixed postioned sheave to connect to said section and

move it toward extended position, a second cable wound on the drum and connected directly to said section to move it toward starting position, a floating sheave on the section having intermediate travel on the side toward starting position, a third cable wound on the drum and reeved around said floating sheave to move said section toward starting position, a fixed sheave beyond the extended position of the section having the shortest travel around which said third cable is passed, an anchor on said section having the shortest travel on the side toward extended position to which said third cable is secured, a fourth cable wound on the drum, a fixed positioned sheave around which said fourth cable is passed and located beyond the extended position of the section having the shortest travel, a floating sheave on the section having the shortest travel on the side towards its extended position around which said fourth cable is passed, a second fixed positioned sheave associated with the section having the shortest travel around which said fourth cable is passed, an anchor on said latter section to which said fourth cable is secured, an anchor adjacent the starting position of the section having the shortest travel, a fifth cable secured to said anchor, a floating sheave on the section having the shortest travel on the side adjacent starting position around which said fifth cable is passed, a fixed positioned sheave beyond the extended position of the section having the intermediate travel around which said fifth cable is passed, and an anchor on said section having intermediate travel on the side toward extended position to which said fifth cable is secured to effect movement toward extended position of the section having intermediate travel and movement of the section having shortest travel toward starting position when the drum is rotated to cause movement of the other sections in corresponding directions.

5. Apparatus as defined in claim 3 in which the movable sections are mounted to move horizontally and are hinged together along adjacent vertical edges, a third section hinged to the movable section having the shorter travel on the side toward starting position, a guide roller mounted centrally at the top of each of the first mentioned movable sections, guide means cooperating with the rollers to constrain movement of the sections laterally, and supporting rollers at the bottom of each of said first mentioned movable sections.

6. Apparatus as defined in claim 4 in combination with combined snubber and movement limiting means associated with the section having the longest travel to prevent overtravel of all the sections.

7. In a door operating system embodying a door comprising a plurality of movable sections having a common starting point and extended positions to form a closure equal substantially to the sum of the widths of the sections, a cable for each of the sections to move it toward extended position, another cable for each of the sections to move it toward starting position, a fixedly mounted operating drum of constant diameter on which the actuating cables are wound, and a system of fixed sheaves and sheaves mounted on the respective sections around which the actuating cables pass and providing cable pulling units for both directions on the respective sections proportional to the relative travel of each from starting to extended position.

8. A door operating system as set forth in claim 7 including a trio of movable sections with an intermediate cable cooperating between the section having intermediate travel and the section having the shortest travel, and adapted to move the section having intermediate travel toward extended position and the section having shortest travel toward starting position, an anchor adjacent the starting position of the section having the shortest travel to which said cable is attached, a floating sheave on the section having the shortest travel towards the side nearest starting position, and a fixed sheave beyond the limit of travel toward extended position of the section having intermediate travel whereby said intermediate cable effects movements of said sections at rates proportional to the length of travel of each from starting to extended position.

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