Oct. 3, 1939. K. R. NISBET 2,174,524

DOOR

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Fig. 1.



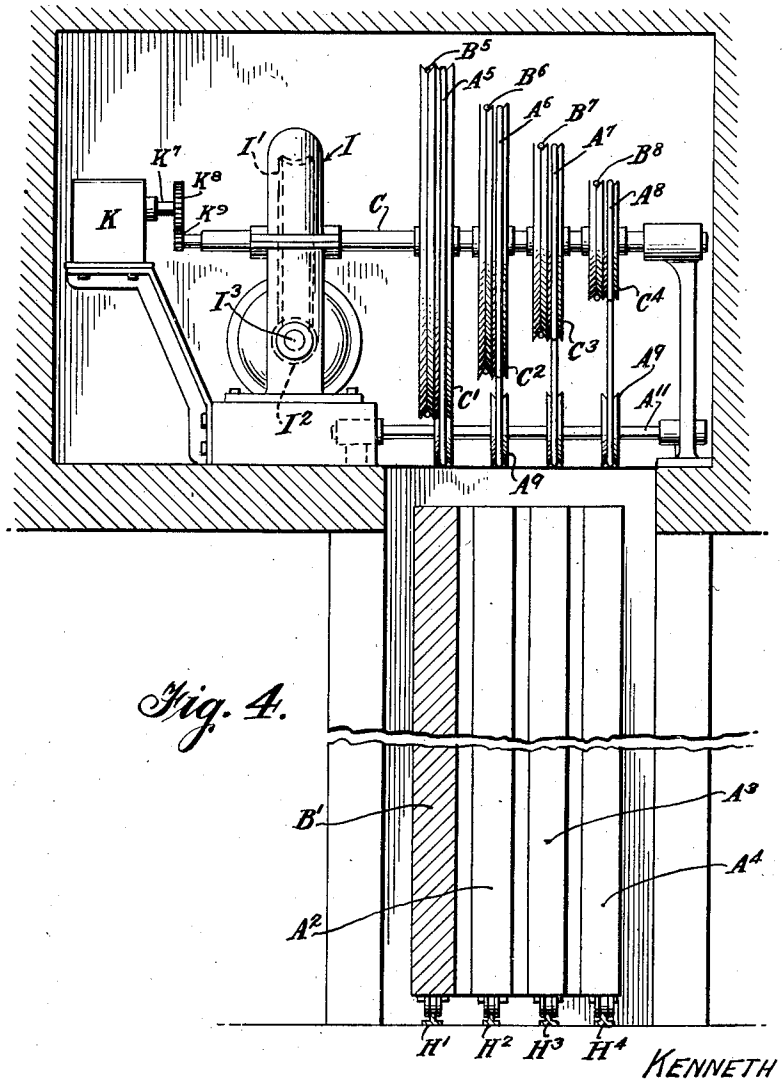


Fig. 4.

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DOOR

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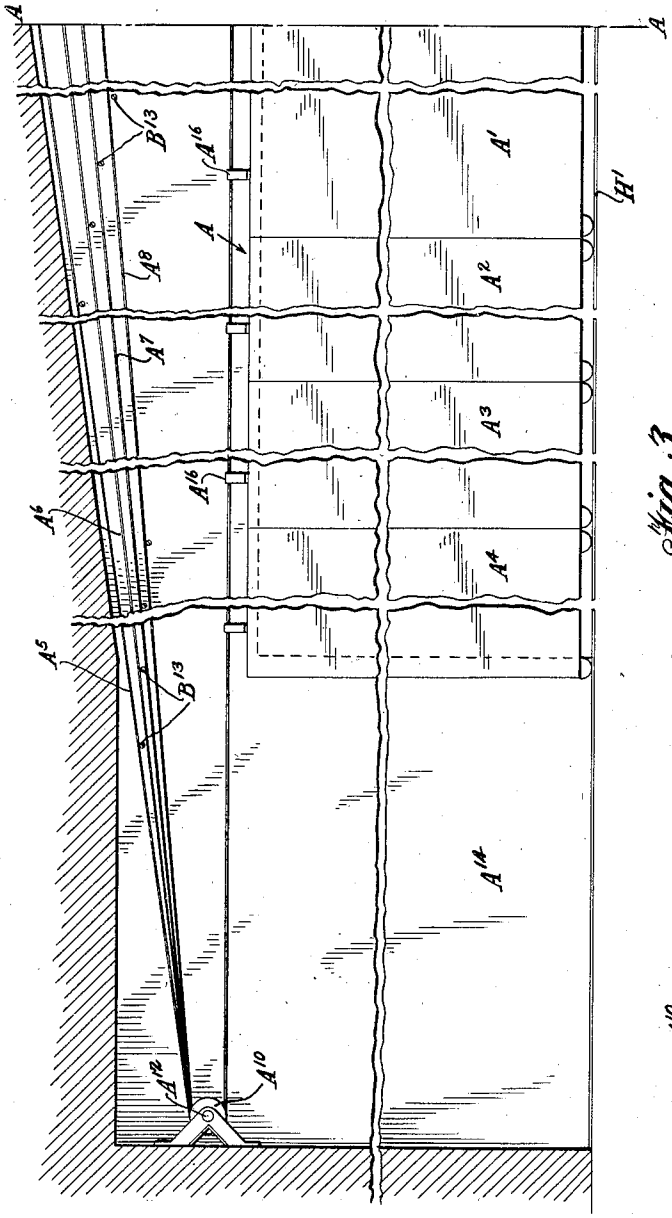


Fig. 2.

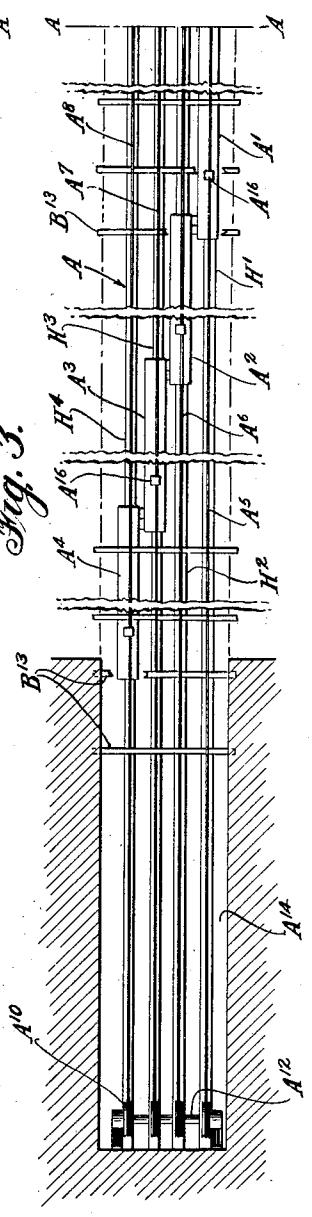


Fig. 3.

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DOOR

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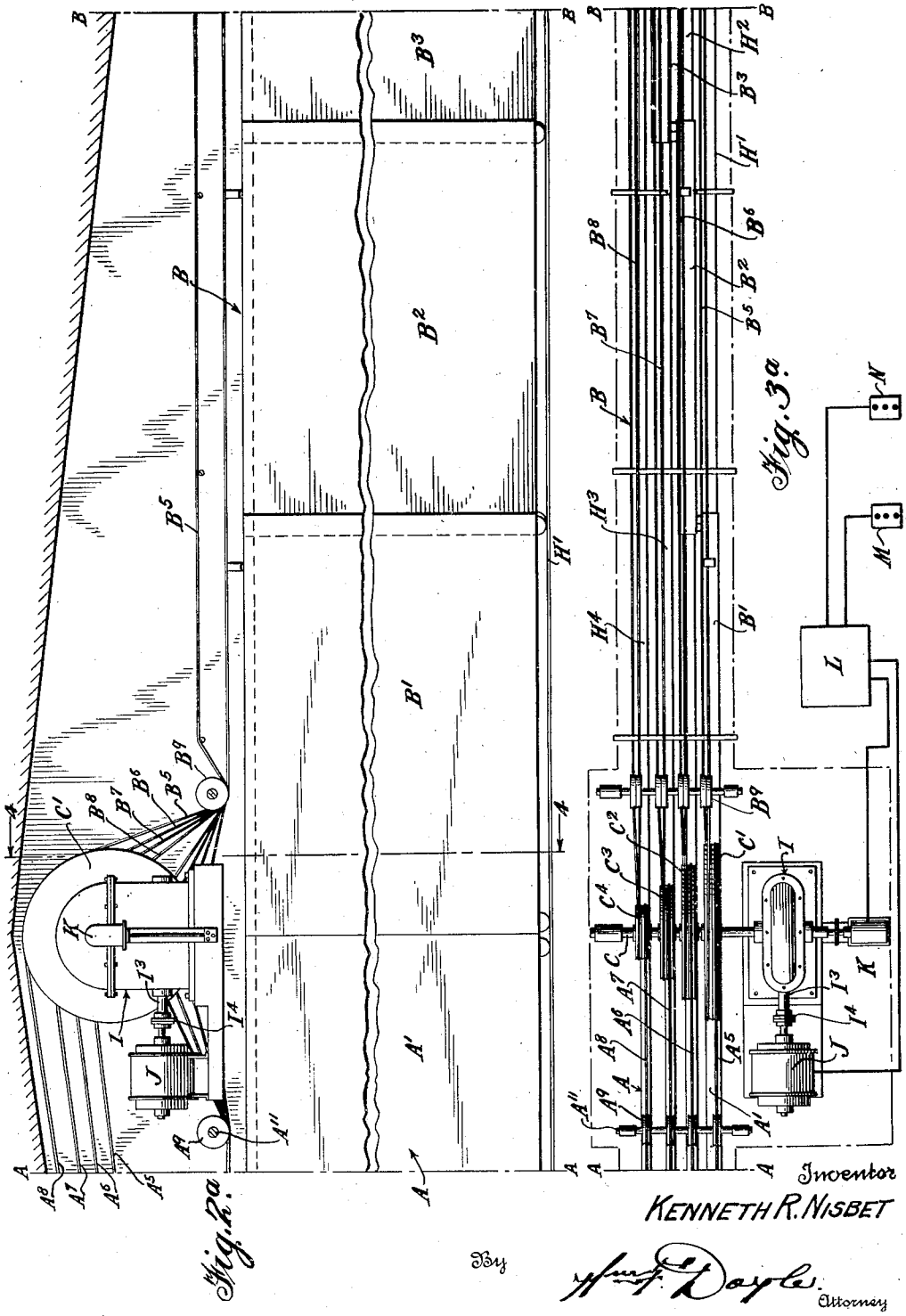


Fig. 2a.

Fig. 3a.

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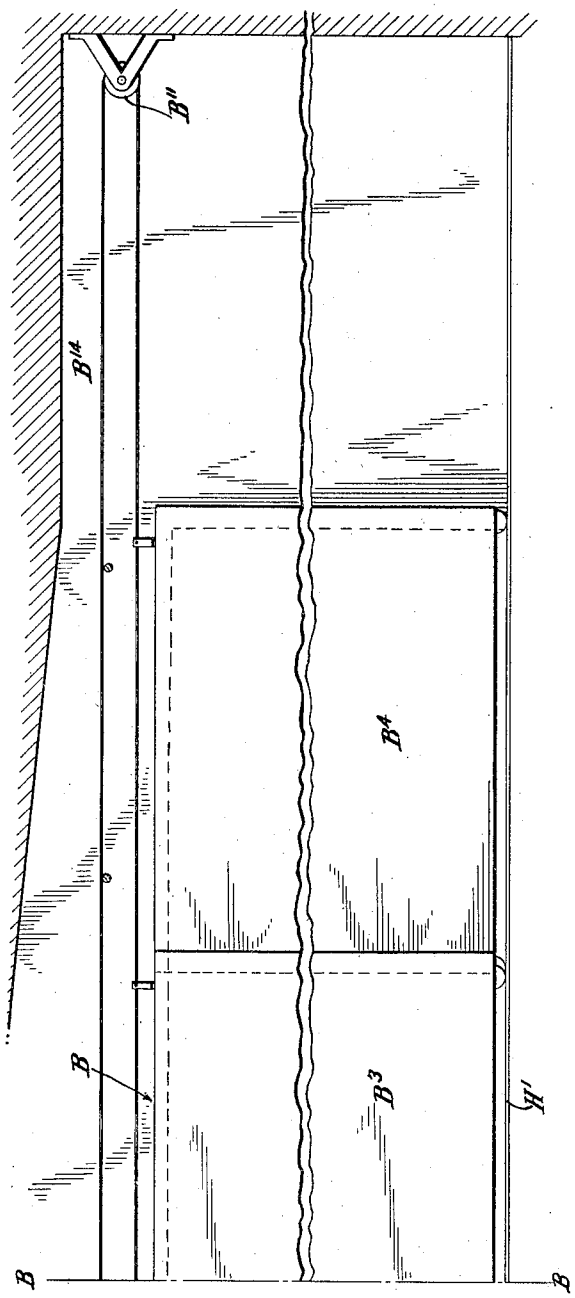


Fig. 2b.

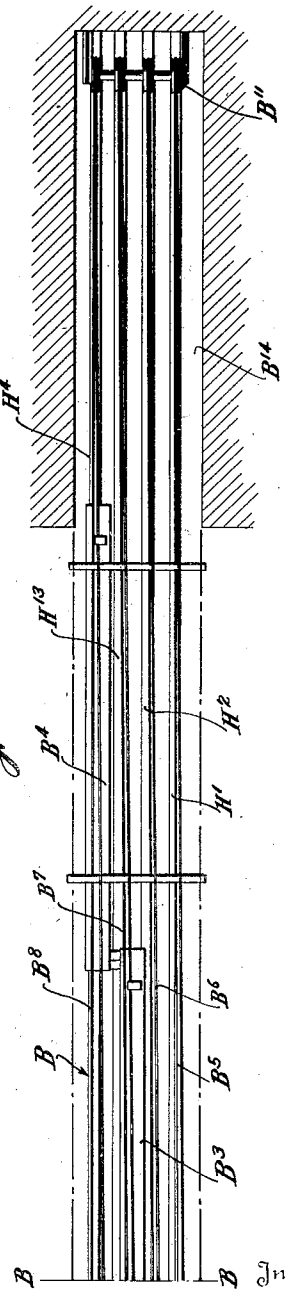


Fig. 3b.

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DOOR

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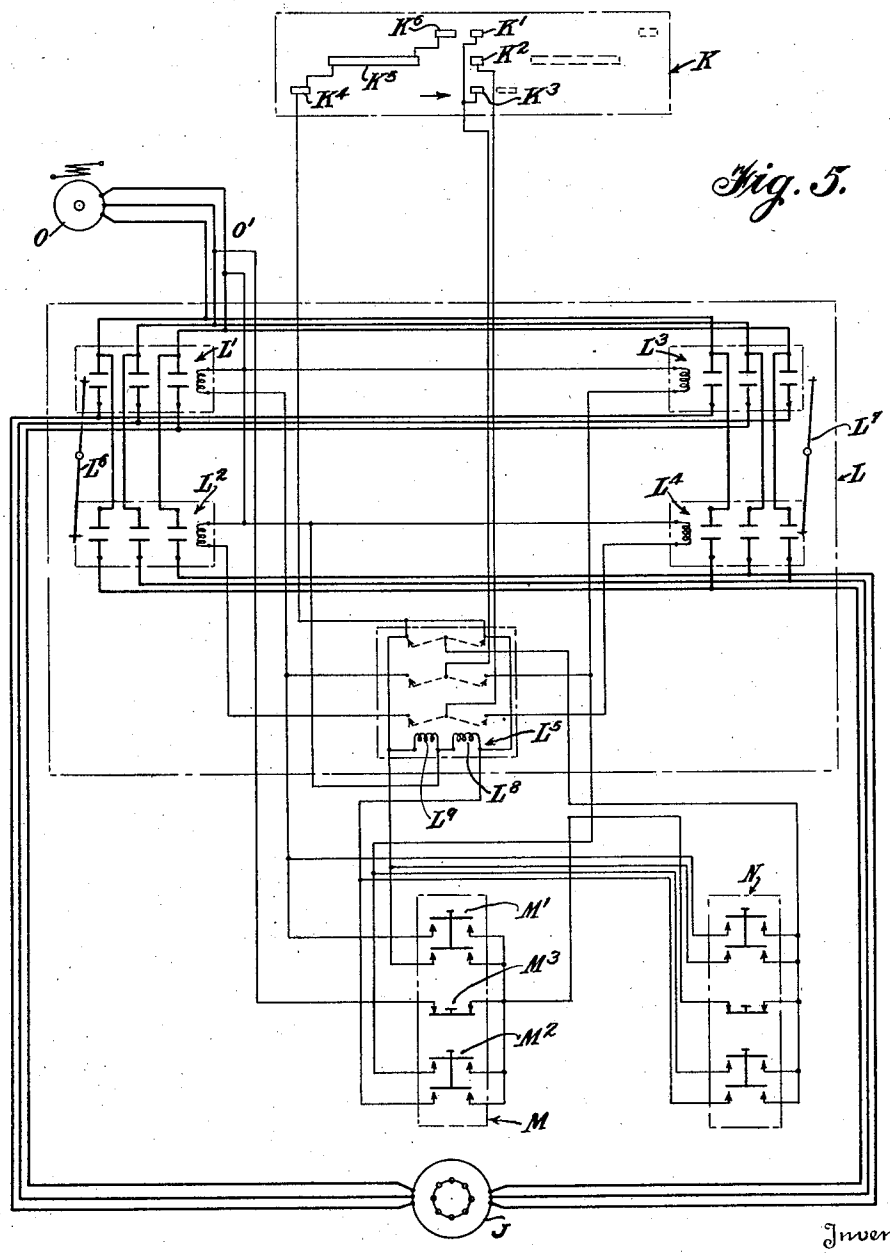


Fig. 5.

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Patented Oct. 3, 1939 2,174,524

UNITED STATES PATENT OFFICE

2,174,524

DOOR

Kenneth R. Nisbet, Earlington, Ky.

Application April 1, 1938, Serial No. 199,402

3 Claims. (Cl. 268—30)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

The invention described herein, if patented, may be manufactured and used by or for the Government for governmental purposes without the payment of any royalty thereon.

This invention relates to doors and more particularly to mechanically operated, electrically controlled doors having a plurality of sections operating on parallel lines at different speeds, adapted to compactly nest at one side of the opening in full open position and be extended to closed position, and provided with means for discontinuing the movement of the door sections at intermediate positions of their movement, to provide a partial opening of the door.

Doors of the character here disclosed are particularly adapted for use in hangers wherein the door openings are very large and to meet requirements for increase in width and heighth, due to the continual increase in size of airships.

An object of this invention is to provide means regardless of the number, the size, or weight of the door sections, to fully accomplish the desired movement of the doors in a safe prompt and economical manner.

A further object is to provide means whereby the movement of the door sections in either direction may be interrupted, in any position and then continue from said position in either direction, a full open or closed position of the doors not being at all times required.

A further object is to provide means if required, at a plurality of adjacent or remote points, for the operation of the doors.

Another object is to provide a mechanism suitable not only for the operation of a single door of a plurality of sections as a closure, but also one that when the opening is of a size to demand it, is suitable for operation of two sectional doors each adapted to close one half of the opening, said doors operating in opposite directions to provide a central opening of any desired width up to the maximum, under control of an operator from a number of remote or adjacent points.

With the above and other objects and advantages in view, the invention consists of features of construction, arrangement and operation of parts, which will appear in the specification and be fully pointed out in the claims.

While a preferred embodiment of the invention is shown, it will be understood that changes in form and minor details of construction may be resorted to without departing from the spirit of the invention and fall beyond the scope of the claims.

Similar numerals indicate corresponding parts in all the figures of the drawings in which:

Fig. 1 is a diagrammatic plan view showing the relative positions of the sections of a door.

Figs. 2–2ª and 2ᵇ combined, show an elevation on an enlarged scale, of a door, parts being broken away.

Figs. 3–3ª and 3ᵇ combined, show a plan view of the parts shown in Figs. 2–2ª and 2ᵇ, the electric control mechanism being shown diagrammatically.

Fig. 4 is a transverse section of the operating mechanism at the top of the doors.

Fig. 5 is a wiring diagram of the various elements for the electrical control of the improved door operating mechanism. The black heavy lines indicate motor leads carrying normal motor current, the light lines indicate conductors for the control current and the dot-dash lines indicate a complete assembly of a particular unit.

Reference now being had to the drawings, A is one of a pair of door members each consisting of a plurality of sections, adapted to operate toward and from each other to close an opening of large dimensions such as are common in present hangar construction. B is the other door corresponding in construction to door A and operating with same in an opposite direction, said doors adapted to reach full closed or full open or any intermediate positions simultaneously.

Door member A consists of sections A—1, A—2, A—3 and A—4 supported on rollers, operating on parallel rails separated a sufficient distance to permit each door section to pass the adjacent section and reach a nested retracted position, with the door entirely or partly open or extended into entirely or partly closed position. The door sections when operated in either direction travel at relatively different speeds to provide for the arrival of same at the extreme limits of their travel simultaneously.

Endless door operating cables or the like A—5, A—6, A—7, A—8 are connected to door sections A—1, A—2, A—3 and A—4 respectively and operate over idler pulleys A—9 and A—10 loosely mounted on shafts A—11 and A—12, the slack of said cables being supported on anti-friction rollers B—13 and are secured in any preferred manner to door sections A—1, A—2, A—3 and A—4 at A—16.

A main driving shaft C is rotatably mounted, preferably above the center of the opening traversed by the doors A and B. Rigidly mounted on shaft C are four double grooved power pulleys C—1, C—2, C—3 and C—4 over which endless

door cables A—5, B—5, A—6, B—6, A—7, B—7 and A—8 and B—8 operate. Said power pulleys are of relatively different diameters to cause the cables to operate the respective door section to which they are attached at such rates as will cause them to reach their full open or closed and intermediate positions simultaneously.

It will be understood that the bite of the door operating cables attached to sections of doors A and B, encircle their respective driving pulleys in opposite directions thus causing the door sections of door members A and B to move toward or from each other when the driving shaft is rotated in one direction or the other. The above is accomplished as shown by arranging the portion of the cables to which the sections of door A are secured to travel beneath, up and out from the above power pulleys and by arranging the cables of corresponding sections of door B to pass over and out from beneath their respective power pulleys when for instance, the door sections are closing. By said arrangement of the cables, a movement of the power shaft will cause doors A and B to move in opposite directions.

By reference to Fig. 2 of the drawings it will be seen that additional separate idler pulleys B—9 are mounted on shaft B—11 which permits the threading of the cables as above described, and cause the movement of the sections of doors A and B in opposite directions.

The sections of doors A and B if preferred may be nested, when they are in their fully open positions in door pockets A—14 and B—14 respectively.

The door members A and B, each section in many instances, weighing over two tons, and requirements calling for increases in size and weight continually as the openings are increased, are for structural reasons operated on rails H—1, H—2, H—3, H—4 beneath the doors and require means of a positive and powerful character to move the gross weight of over eighty tons, to speed up the movement of the doors, then check the momentum of such a weight and finally bring the entire mass to a full stop at a definite point without damage to the operating parts, and the structure here shown is adapted to accomplish said accurate control automatically, the element of possible human failure being entirely eliminated, it being necessary only to manually throw a switch to start an operation and the door comes to a gentle stop automatically at the end of its travel.

Door sections A—1, A—2, A—3, and A—4 and door sections B—1, B—2, B—3 and B—4 operated on rails H—1, H—2, H—3 and H—4 respectively, in opposite directions at corresponding speeds and reach full open, and full closed or any of their intermediate positions at the same time. Said door sections may be stopped in any position between the limits of their movements by manually operating a stop switch and from said position be operated in either direction, by tripping the operating mechanism for operation in the desired direction.

To accomplish the above, the power shaft C is extended and has mounted thereon the worm gear of a non-reversible form of worm drive I, wherein the worm gear I—1 has meshing with it the worm I—2, its shaft I—3 being coupled at I—4 to the shaft of a two speed, two winding squirrel cage induction motor J.

A drum switch K, having shaft K—7 on which spur gear K—8 is mounted is geared by pinion K—9 to the power shaft C and is adapted to be operated approximately one half of one revolution during the movement of the doors from fully open to fully closed positions, said distance of rotation of the drum may be varied but must not exceed one complete revolution. By reference to Fig. 5 of the drawings said drum switch is provided with stationary contacts K—1, K—2, K—3 and K—1 and K—3 being the low speed contacts and K—2 being the high speed contact. Said switch is further provided with moving contacts K—4, K—5, K—6; K—4–K—6 being low speed contacts and K—5 being the high speed contact. When the moving contacts travel in the direction of the arrow, K—6 first contacts K—1 and as it leaves K—1, K—5 contacts K—2 and as the movement continued K—4 contacts K—3 and finally said moving contacts occupy the position shown in dot and dash lines, after having passed through phases from stationary first into low speed with K—6 and K—1 in contact, then high speed with K—5 and K—2 in contact, then again into low speed with K—4 and K—3 in contact and finally to stationary, a movement of the drum in the opposite direction reverses the order of the contacts, and the door moves in an opposite direction.

L is a reversing type, automatic controller for a two speed motor J, containing four, 3-pole contactors L—1, L—2, L—3 and L—4 and also selector relay L—5.

In Fig. 5 are shown L—1 which indicates the low speed contactor for the door closing operation, L—2 the high speed contactor for the door closing operation, L—3 the low speed contactor for the door opening operation, and L—4 the high speed contactor for the door opening operation.

L—5 indicates the relay with normally open contacts for the selection of the proper contactors to operate as the doors are opened or closed, and is a 3-pole double throw unit provided with two operating coils, one each L—8, for the door opening and L—9 for the door closing operations. Contactors L—1 and L—2 and also L—3 and L—4 are mechanically interlocked by levers L—6 and L—7 respectively, to prevent both closing at the same time, thus providing for the opening of both contactors of each group at the same time but permitting only one to close, which is safety precaution for the electrical circuits.

M indicates a push button control station having (Fig. 5) M—1 a push button to close the doors, M—2 a button to open the doors and an emergency button M—3 to stop the doors while they are in motion in either direction. Push buttons M1 and M—2 for both double contact with all contacts normally open, M—3 has single contacts normally closed.

N indicates a remote push button control station similar to station M showing the hook up of wiring with control station M and relay L—5.

O indicates a three phase, 3 wire, alternating current generator.

The electrical units provided for in the above are all standard equipment and no claim is made for novelty therein, it being understood that various types of units for performing the functions described are available on the market. It is claimed, however, that the combined arrangement of said elements with the mechanical elements arranged as described provide a door operating mechanism particularly adapted for present requirements.

The mechanical operation of the door is obvious wherein the motor through worm gear drives the power shaft on which pulleys of differ-

ent diameters are rigidly mounted, over which cables secured to doors on opposite sides of the power shaft, travel in opposite directions, thus causing corresponding door sections connected to said cables to travel toward and away from each other, which either closes the opening or opens same.

The action of the electrical control based upon both doors being closed and it is desired to fully open them, is as follows:

The electrical system is energized by generator O, all current for the controls or pilot circuit is taken at point O1.

Button M—2 is depressed by the operator and held for a short interval, as the contacts of this button are closed, the opening coil L—3 of the selector switch is energized thus closing the three selector switch contacts noted on the right side, and at the same time closing contactor L—3 and placing a voltage on drum switch contacts K—6 and K—1. As contactor L—3 is closed motor J starts at low speed which movement causes the drum of switch K to rotate, which in turn brings K—6 in contact with K—1 at which instant the push button M—2 may be released, further action being automatic.

As long as K—6 is in contact with K—1, contactor L—3 is closed and motor J rotates at low speed and drum switch K is rotated by virtue of its mechanical connections. As K—6 breaks contact with K—1, K—5 makes contact with K—2 and this action de-energizes contactor L—3 which opens and energized L—4 which closes thus causing the motor J to go from low to high speed. The motor continues to operate at its high speed which action in turn causes contact K—5, to move over K—2 until finally K—5 breaks contact with K—2 which energizes and opens contactor L—4. At this instant K—4 contacts K3 which energizes and closes contactor L—3 thus throwing the motor back on low speed. The motor then operates at this low speed as long as K—4 makes contact with K—3 and when this contact is broken, contactor L—3 is de-energized which in turn stops the motor and at the same time coil L—3 is de-energized and the selector switch L—5 is brought to its normally open position.

If for some reason a slight further movement of the door is desired, the push button M—2 may be depressed and quickly released to give inching or slight further movement to the doors.

To close the doors, button M—1 is depressed and the action is as described above but with closing contactors L—1 and L—2 and selector switch coil L—2 utilized in lieu of the opening elements.

It is to be noted that worm drive I affords mechanical advantage to motor J during the periods of acceleration and uniform motion and permitting the use of a motor of comparatively small rating. In addition, worm drive I affords braking effort during the deceleration and stopping periods which is explained in the following manner: For example, if the door is in motion and approaching the fully opened position, sections A—1, A—2, A—3, A—4, are all moving in the same direction but with different velocities. If the energy to the motor is suddenly interrupted, the individual momentums of the sections tend to equalize, thus throwing the resultant force to shaft C. Worm drive I, being fully non-reversible, tends to stop immediately but is prevented from doing so by the momentum of the rotor of motor J, which must of necessity rotate a few revolutions. The net result of the combination of the elements of driving mechanism is positive deceleration and a definite stop without the use of a separate braking means. This is of particular importance in automatic stopping at the closed position for it is obvious that all sections must reach a definite stopping point without jarring the parts. It follows that in automatic stopping only close limits are permissible possibly not to exceed one-half inch, hence any form of direct braking will only result in unsatisfactory operation due to the maintenance problem in frequent adjustments. This is particularly true in regards to double doors wherein there is no center support for the structural members over the doors. Under certain conditions, however, such as with extremely slowly moving doors, the driving mechanism may be so modified as to meet such a condition.

What I claim and desire to secure by Letters Patent is:

1. A mechanically operated electrically controlled sliding door comprising oppositely arranged door members each having a plurality of offset sections movable relative to each other as the door members and their door sections are operated in opposite directions from open to closed position, the door sections of each door member being relatively extended when the door is closed and relatively retracted into parallelism with their positions in alignment at right angles to their movement when the door is open, a power shaft, door operating pulleys of different diameters rigidly mounted on said shaft, idler pulleys loosely mounted on shafts on opposite sides of said power shaft, in alignment with said operating pulleys, endless flexible members operating in opposite directions over said operating pulleys and their respective idler pulleys, and connected to the sections of their respective door members adapted to cause relatively simultaneous movement of corresponding door sections at the same speeds in opposite directions to open and to closed positions, means for operating said power shaft in alignment with said operating pulleys in either direction including, a reversible motor geared to and adapted to operate said power shaft in either direction, means for automatically controlling the movement of the motor in either direction, manually operated means for selecting the direction of rotation of the motor and initiating the movement of the door sections to full open and to full closed positions and means for interrupting the movement of the door at any intermediate position.

2. A mechanically operated electrically controlled sliding door comprising oppositely arranged door members each having a plurality of correspondingly offset sections movable relative to each other as the door members and their door sections are operated in opposite directions from open to closed position, the door sections of each door member being relatively extended beyond its adjacent section when the door is closed and relatively retracted when the door is fully open, a power shaft, a plurality of dual door operating pulleys of different diameters rigidly mounted on said shaft, idler pulleys loosely mounted on shafts on opposite sides of said power shaft, in alignment with said operating pulleys, endless flexible members extending in opposite directions and operating over said dual operating pulleys and their respective idler pulleys, and connected to the sections of their respective aligned door members adapted to cause relative

simultaneous movement of corresponding sections of the door members at different speeds in opposite directions to open and to closed positions, means for operating said power shaft in either direction, including a reversible motor geared to said power shaft adapted to operate same in either direction, electrical means for automatically controlling the movement of the motor in either direction, manually operated means for selecting the direction of rotation of the motor and initiating the movement of the door, means for automatically operating the motor and the movement of the doors in either direction at low, high and then low speeds, means for tripping said automatic means and means for interrupting movement of the door.

3. A mechanically operated electrically controlled sliding door comprising oppositely arranged door members each having a plurality of correspondingly offset sections movable relative to each other as the door members and their door sections are operated in opposite directions from open to closed position, the door sections of each door member being relatively extended beyond its adjacent section when the door is closed and relatively retracted when the door is fully open, a power shaft, a plurality of dual door operating pulleys of different diameters rigidly mounted on said shaft, idler pulleys loosely mounted on shafts on opposite sides of said power shaft, in alignment with said operating pulleys, endless flexible members extending in opposite directions over said operating pulleys and their respective idler pulleys, and connected to the respective sections of the door members adapted to cause relative simultaneous corresponding movement of respective sections of the door members at different corresponding speeds in opposite directions to open and to closed positions, means for operating said power shaft in either direction, a worm drive geared to said power shaft, and adapted to operate same in either direction, a reversible motor adapted to operate said power shaft in either direction, means for automatically controlling the movement of the motor in either direction including manually operated means for selecting the direction of rotation of the motor and initiating the movement of the doors, means for automatically operating the motor and the movement of the doors in either direction at low, high and then low speeds, means for tripping said automatic means, means for interrupting said automatic movement of the doors, and means for continuing the movement in either direction after interruption as and for the purposes specified.

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