May 29, 1934. E. F. ALLEN 1,960,860

SLIDING DOOR

Filed Aug. 5, 1931 4 Sheets-Sheet 1

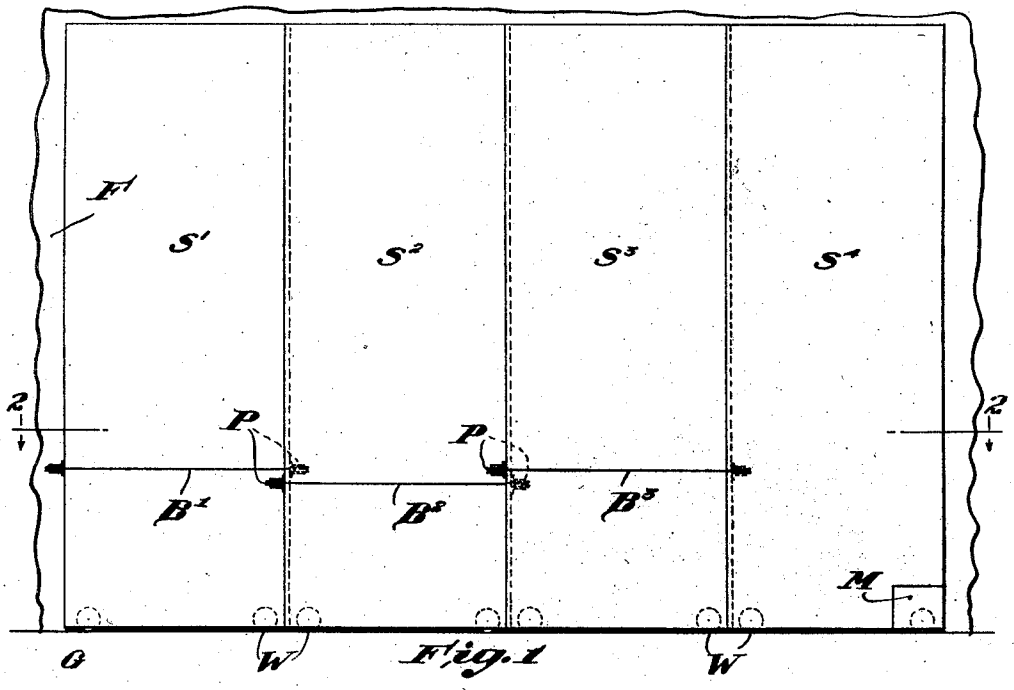


Fig. 1

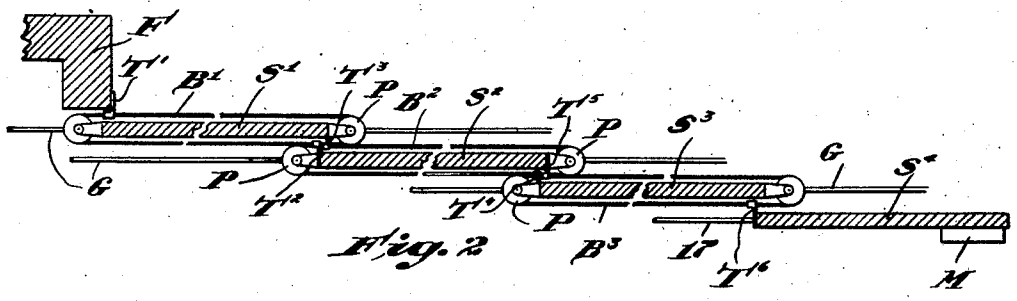


Fig. 2

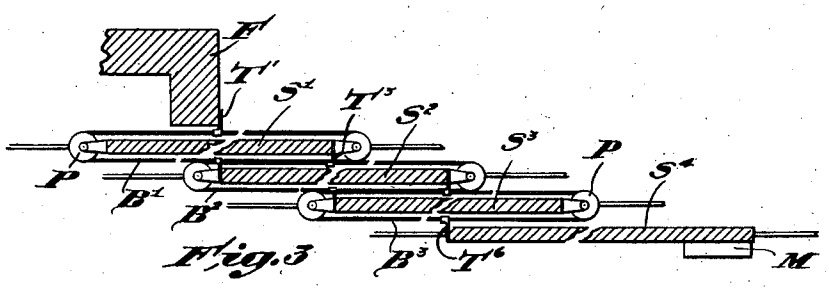


Fig. 3

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SLIDING DOOR

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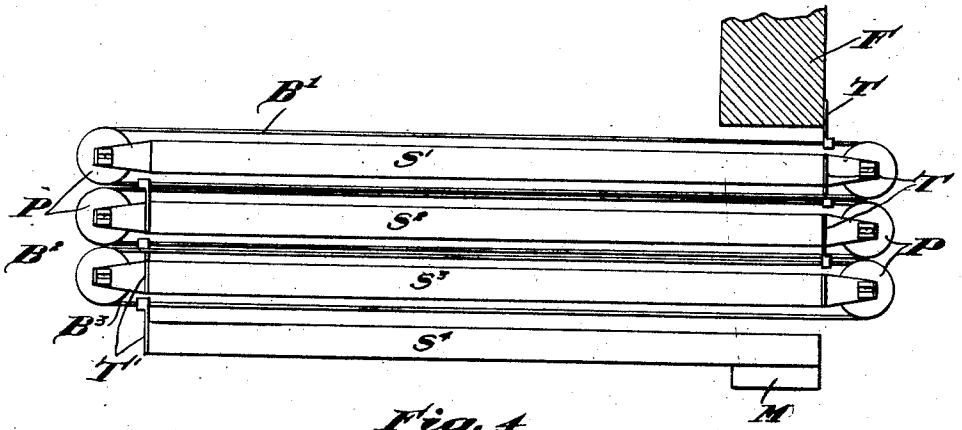


Fig. 4

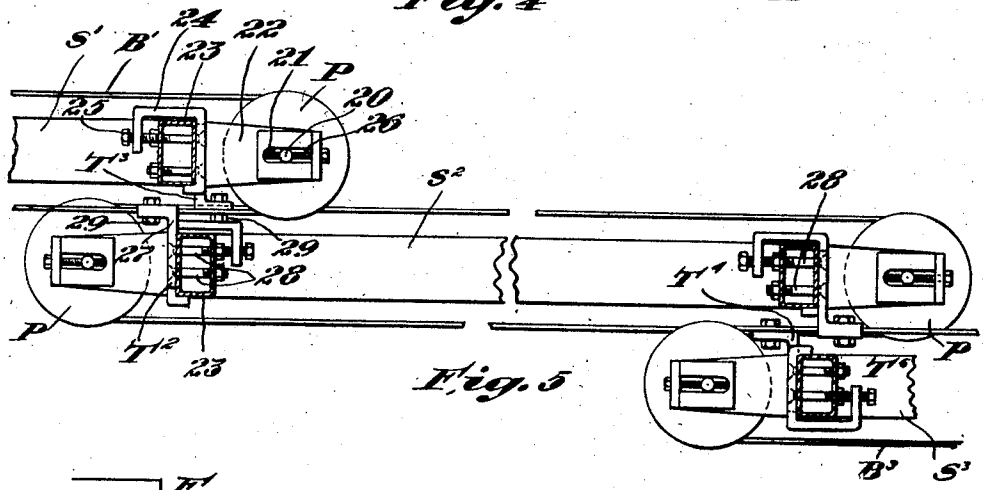


Fig. 5

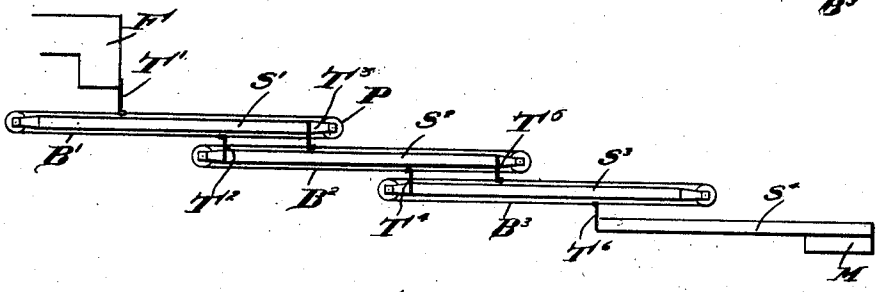


Fig. 6

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May 29, 1934. E. F. ALLEN 1,960,860

SLIDING DOOR

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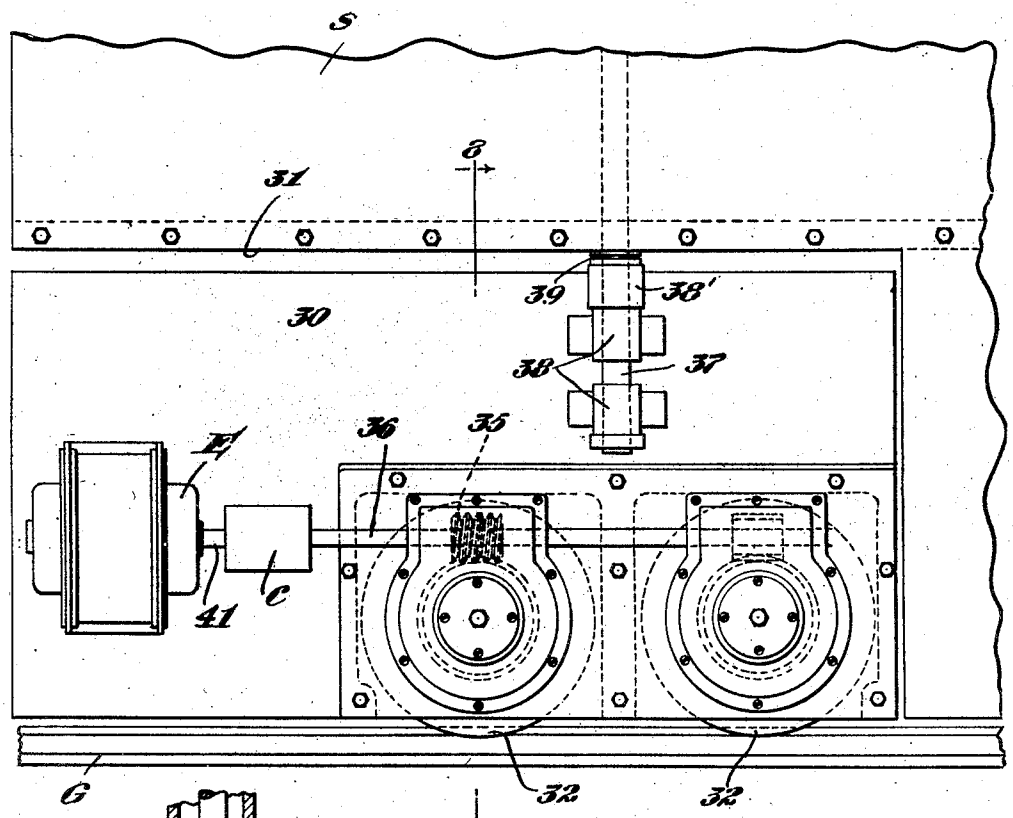


Fig. 7

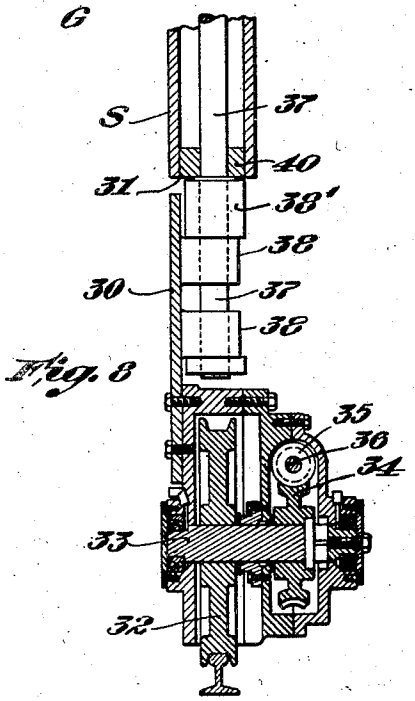


Fig. 8

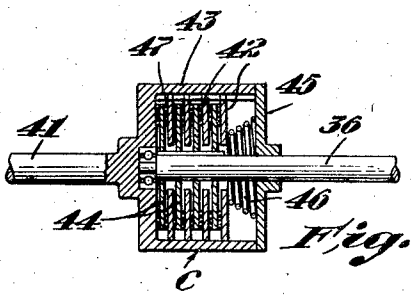


Fig. 9

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SLIDING DOOR

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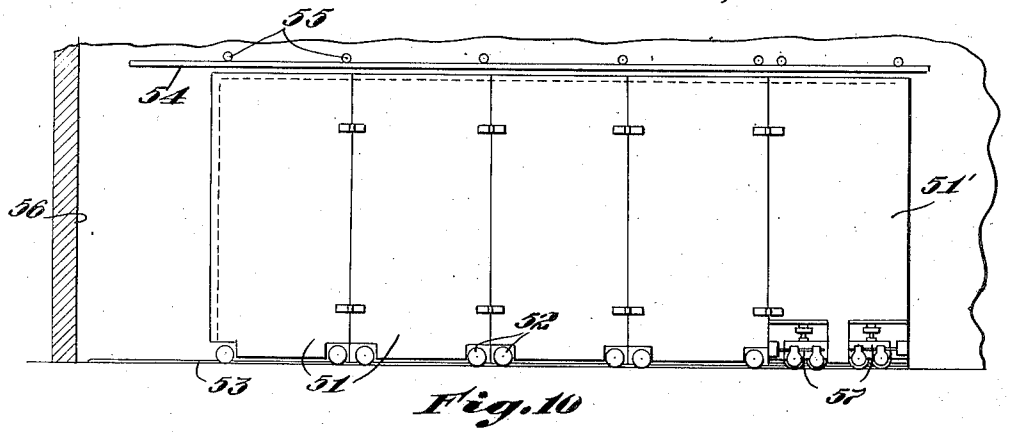


Fig. 10



Fig. 11

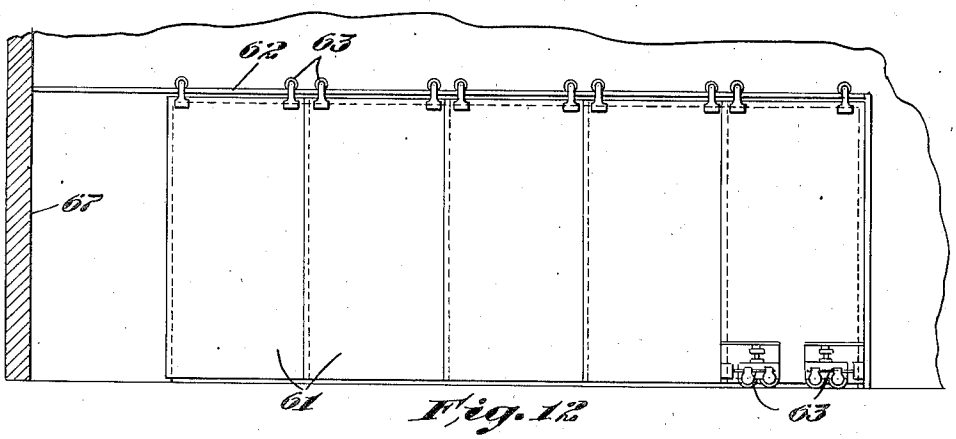


Fig. 12

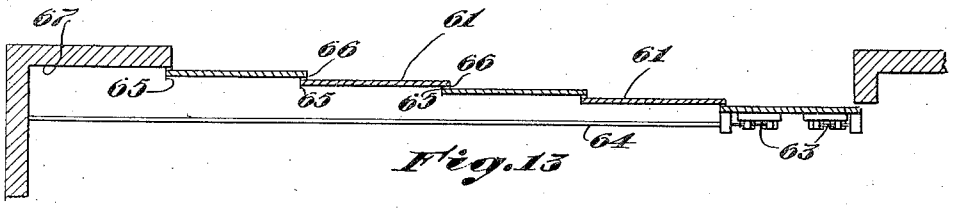


Fig. 13

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Patented May 29, 1934 1,960,860

UNITED STATES PATENT OFFICE

1,960,860

SLIDING DOOR

Earle F. Allen, Cambridge, Mass., assignor to Allen-Drew Company, Cambridge, Mass., a corporation of Massachusetts

Application August 5, 1931, Serial No. 555,231

14 Claims. (Cl. 20—19)

This invention relates to motor-operated door for airplane hangars, balloon sheds, garages or the like, and has for its principal object the provision of a sliding door comprising a plurality of interconnected sections arranged in offset relation and movable relatively to each other, and improved means for automatically operating the door so that the respective sections are moved simultaneously, said means preferably including a motor driving unit mounted on one of the sections for opening or closing the door. The present application is a continuation in part of my pending application, Serial No. 283,829, filed August 6, 1929, in which I have disclosed the improved driving unit herein more particularly described.

Further objects of the present invention reside in the provision of apparatus for flexibly interconnecting the door sections in such a manner that the respective sections move at a progressive rate and uniformly overlap adjacent sections at all times, whereby all sections arrive simultaneously at their fully opened or closed positions; and in the improved construction and arrangement of the automatic driving mechanism for operating the door.

Recommended embodiments of the invention are illustrated in the accompanying drawings, in which:

Fig. 1 is an elevation of a four-section door equipped with the improved apparatus, the door being fully closed;

Fig. 2 is an enlarged section on line 2—2 of Fig. 1;

Figs. 3 and 4 are views similar to Fig. 2, showing intermediate and opened positions of the door;

Fig. 5 is a sectional detail to larger scale, illustrating the connecting apparatus between adjacent door sections;

Fig. 6 is a diagrammatic view, indicating the operative arrangement of the apparatus;

Fig. 7 is an enlarged elevation of one of the improved motor drive units;

Fig. 8 is a section on line 8—8 of Fig. 7;

Fig. 9 is a detail of the clutch mechanism shown in Fig. 7;

Fig. 10 is an elevation of a modified type of door equipped with the driving unit of Figs. 7 and 8;

Fig. 11 is a central horizontal section of Fig. 10; and

Figs. 12 and 13 are views similar to Figs. 10 and 11, illustrating another type of sectional door.

In the preferred embodiment chosen for the purpose of illustration in Figs. 1 to 6, the hangar door comprises four sections S^1, S^2, S^3 and S^4 slidable relatively to each other for closing one half of the entrance to an airplane hangar or the like. It will be understood that a similar door may be provided for closing the other half of the opening, or that a single sectional door may be arranged to extend entirely across the entrance of the building. It will also be apparent that the number of sections may be varied to suit particular purposes, and that the subject matter of the present invention has especial utility when a large number of door sections, for example eight or more, are interconnected as herein described.

The respective door sections are preferably supported by wheels W traveling on parallel tracks or guides G, and suitable overhead mechanism may be provided for guiding the upper ends of the movable sections. The sectional door may thus be located either outside or inside the front wall of the building, which is indicated in the drawings by the frame member F at one side of the doorway. The door sections open toward the frame F, and it will be observed that the juxtaposed sections of the opened door occupy a relatively small space. The rectangular sections S may be of any suitable size, and may be made of any desired material, for example steel; for the precise construction thereof is not essential to this invention.

The several door sections are transversely offset from each other, and the corresponding ends of adjacent sections normally overlap to provide a weather-proof closure when the door is closed (Fig. 2). The sections slide relatively to each other when moving in either direction over the tracks G, and they are mutually interconnected so that a uniform, relative overlapping of adjacent sections is constantly preserved during movement of the door. By reason of such interconnecting means the sections are constrained to move or to come to rest simultaneously; and the uniform overlapping of the ends of the respective sections increases or decreases at a constant rate, so that the sections may be fully extended or moved into juxtaposition. The sliding movement of the sectional door is preferably effected by a motor driving unit associated with the outermost section S^4, as indicated at M, but it will be apparent that the unit may be connected to either of the sections or that other means may be employed for sliding any one of the sections to operate the door.

As best shown in Figs. 2 to 5, the mechanisms for interconnecting the door sections in the manner above set forth preferably comprises a plu-

rality of belts B^1, B^2, and B^3 transversely encircling the respective sections S^1, S^2, and S^3 and passing over pulleys P or other anti-friction devices at the opposite ends of said sections. Each of said belts is connected by means of transverse brackets or tie members T^1 to the adjacent door sections at its opposite sides, except that the bracket T^1 of belt B^1 is secured to the building frame F and constitutes the sole fixed point of the door connecting system. The distance between the ties T^1 and T^2 taken along the belt B^1 is the same in either direction; and the ties T^3, T^4, and T^5, T^6 are similarly located, on belts B^2 and B^3, respectively. The opposite ends of said ties (except T^1) are fastened to corresponding portions of the next adjacent door sections, preferably at the ends thereof. Hence, it is apparent that the variable distance between the ties T^2 and T^3 will always equal the corresponding interval between ties T^4 and T^5, irrespective of the position of the door, thereby ensuring the uniform overlapping above mentioned.

Steel bands or cables, or straps of other durable flexible material may be employed as the belts B; and the belts roll freely over the idler pulleys P. The position of the pulleys may be adjusted by means hereinafter described, so that the tension of the respective belts may be uniformly regulated. It will be understood that the door sections are of approximately the same width, and that one or more similarly equipped sections may be interposed between sections S^2 and S^3. The outermost section S^4 need not be provided with a revolving belt, and in the illustrated embodiment this section carries the motor driving unit M for operating the several sections.

A recommended form of the interconnecting elements is more particularly illustrated in the detail view of Fig. 5. In this embodiment, the pulleys P have their axles 20 mounted in slots 21 of forked brackets 22 which are fixed to the end frames 23 of the door sections S by means of a clamp 24 having a securing bolt 25. Adjusting screws 26 thread through the axles 20 for varying the position of the pulleys with respect to the door end, thereby to regulate the tension of belts B. It is apparent that the pulley mounting is substantially the same at the opposite sides of each of the respective sections S^1, S^2 and S^3; and it will be observed from Fig. 1 that the pairs of pulleys mounted on any one of the sections are vertically offset from those of the adjacent section to avoid interference. Hence, the belts B^1, B^2 and B^3 extend horizontally, in staggered relation to each other.

The tie members T for connecting the slidable belts to adjacent door members may comprise metal brackets 27 secured to the door frames 23 by means of bolts 28 and having flanged portions clamped to the corresponding belts as by bolts 29. As previously indicated, the tie member T^1 is fixed to the building frame F by suitable securing means; and it is obvious that the particular instrumentalities employed for the purpose of connecting the belts of one section to the door frames of each adjacent section (or to the building frame F), or for attaching the pulleys to the door sections, are not essential to my invention, considered in its generic aspect.

The mode of operation of the improved sectional door is diagramatically illustrated in Fig. 6 which shows the door partially closed, it being understood that the door is preferably propelled by the motor unit M carried by the outer or forwardmost section S^4. If, for example, the door is to be opened (or moved to the left in the arrangement illustrated), the motor is operated to drive the section S^4 in that direction. Such propelling force will be communicated through the interconnected door sections to the belt B^1 which is rigidly fixed by tie T^1 to the frame F; for it is apparent that sections S^2 and S^3 can not travel toward closed position until the rearward section S^1 and its belt B^1 are set in motion. Section S^1 can, and will, move by reason of the communicated force of the propelling motor. Said section accordingly moves to the left, its belt B^1 revolves clockwise on its pulleys, thereby allowing section S^2 to move in the same direction, and causing clockwise movement of its belt B^2; and the remaining sections are propelled in a similar manner. As the distance along each belt between the tie members fastened thereto is the same in either direction, and as these ties are fixed to corresponding portions of the adjacent door sections, it is obvious that the distance between ties T^2 and T^3 will equal that between ties T^4 and T^5 in any relative position of the sections. It therefore follows that the door sections overlap each other uniformly at any position of the door with respect to the frame F.

It is also evident that the respective door sections are constrained to move at progressively varying rates of speed, and that the distance covered by the sections varies according to an arithmetic progression, so that all sections simultaneously arrive at closed position wherein their respective end portions are substantially aligned in a plane at right angles to their path of movement (Fig. 4). To illustrate, let it be assumed that section S^1 moves a distance d with respect to the frame F. As tie T^1 is fixed to the frame, it will accordingly move the same distance d relative to section S^1 upon rotation of the belt B^1; hence the opposite tie T^2 of this belt will have moved a distance $2d$ with respect to the frame F: $1d$ by reason of the movement of section S^2 and $1d$ by reason of the rotation of its belt. Section S^2 (connected by tie T^2) consequently moves a distance $2d$ with respect to the frame and $1d$ with respect to section S^1. Similarly, tie T^3 moves $1d$ with respect to frame F and also $1d$ relative to section S^2 upon rotation of belt B^2; consequently the opposite tie T^4 of belt B^2 will have moved a distance $3d$ with respect to point F: $2d$ because of the movement of section S^2 and $1d$ relative to said section. Therefore section S^3 moves an equivalent distance ($3d$) with respect to the wall F; and $1d$ relative to section S^2.

In the same manner tie T^6 and section S^4 to which it is fastened move a distance $4d$ with relation to wall F: $3d$ as a result of the movement of section S^3 and $1d$ or a consequence of the rotation of belt B^3 relative to said section. Any number of sections may be interconnected for simultaneous progressive movement in this manner; and it will be found that all sections move simultaneously and continuously when the door is propelled by driving one section, the rearmost section (at the end nearest the building wall F) moving one unit of distance while the succeeding sections move 2, 3, 4, etc. units during any time interval, whether the door is being closed or opened.

While in certain aspects of my invention, I may employ any suitable means or mechanism for supplying the operative force for moving one of the sections of my improved door, I prefer to

provide the forwardmost section S⁴ with a motor driving unit M of the type shown in Figs. 7 and 8. This unit may be mounted at the bottom of the section so that its driving wheel or wheels may travel along one of the tracks or guides G, and may be driven by a reversible motor located adjacent thereto and connected in a suitable electric circuit. The driving mechanism which I have illustrated and shall now describe contains several features of structure and arrangement which may beneficially be employed in hangar doors of various types.

In the arrangement shown, the motor unit M is preferably mounted upon a panel 30 supported in upright position within a recess or opening 31 in the base of the section S, and comprises one or more driving wheels 32 engaging the track G and rotatable by an electric motor E operating through cluch mechanism C of friction type. Each driving wheel may have an axle 33 carrying a spur gear 34 which engages a worm 35 splined to a driving shaft 36, the wheels, shafts and gears being mounted upon suitable brackets or casing members securely bolted together and to the panel 30 (Fig. 8).

Panel 30 and its operating mechanism is supported by the driving wheels, and is preferably held in vertical position by means of an upright shaft 37 which is suitably secured at its upper end within the door section S and which is mounted at its lower end in bosses or bearings 38 fixed to the panel, so that the panel may swing angularly with respect to the door section and may have slight vertical movement in its recess 31. A collar 38' provided with a ball race 39 may surround the shaft 37 at the top of the panel to provide a roller bearing against an abutment 40 of the door section. In case two driving wheels are provided, the axis of the shaft 37 preferably passes between the wheels so that the wheels may follow any curves or irregularities in the track without straining the driving mechanism or the door section.

The friction clutch C which connects the driving shaft 36 with a stub shaft 41 of the reversible motor E, preferably comprises one or more disks or plates 42 slidably mounted in the usual manner within a drum 43 fixed to shaft 41, a complemental series of plates 44 splined to the shaft 36, a head 45 surrounding shaft 36 and suitably secured to the end of drum 43, and a coiled spring 46 or other resilient member interposed between the head 45 and the adjacent disk 42 and bearing against said disk normally to hold the disks and plates in mutual engagement. Suitable facing strips or friction rings 47 are located between adjacent plates of the clutch so that the clutch is normally operative to cause rotation of the shaft 36 when the motor E is in operation. The yielding tension of spring 46 is sufficient to ensure the necessary contact for this purpose, but preferably allows the clutch plates to slip or rotate relatively to each other under the initial impetus of the motor shaft 41. Accordingly speed of rotation of the driving shaft 36 will increase gradually under the automatic action of the friction clutch, thereby relieving both the motor and the door sections from the shock and strain of a suddenly applied propelling force.

One or more motor driving units constructed as above described may be advantageously employed for operating hangar doors of various types in addition to the preferred form of door shown in Figs. 1 to 5. For example, in the modified arrangement of Figs. 10 and 11, the door comprises several sections 51 suitably hinged together at their adjoining sides and mounted on wheels or rollers 52 traveling on a common track 53; and guide means, such as the rail 54 and cooperating pulleys 55, may be provided at the top of the sectional door to support the section in upright position. The track 53 and guide rail 54 may extend across the doorway of the building, curve rearwardly at the building corner 56, and then pass beside the building wall, so that the door may be conveniently rolled away from the entrance and occupy but little space within the hangar or shed. The motor driving units 57 are mounted in the manner above indicated at the bottom of the outermost door section 51'.

In the further modification shown in Figs. 12 and 13, the door sections 61 are offset transversely from each other and are suspended from an overhead rail 62 by means of roller hangars 63 which may be suitably offset from the respective sections so that the hangar rollers are guided by the common rail 62. The motor driving units 63 are mounted in the usual manner at the base of the forwardmost section, and the sections slide relatively to each other when propelled by the motor, which may travel in a track 64. The respective sections have flanges or abutments 65 and 66 projecting transversely at their opposite sides and cooperating with corresponding flanges on the next adjacent section or sections, so that the sections are successively moved in one direction or the other. Hence, the door sections may be extended as shown in the drawings to close the entrance to the building, or may be moved to juxtaposed relation at the corner 67 of the hangar. Other modifications of the structural details herein set forth may be practiced to suit particular purposes without departing from the essence of this invention as defined in the appended claims.

It is evident that a sliding door constructed in accordance with this invention will operate smoothly and efficiently without the objectionable jars and shocks which are characteristic of the common "pick-up" type of sliding doors; that the improved door is adapted to close the entrance of a hangar or other building, irrespective of the size of the entrance or doorway; and that the door is easy to operate by reason of the improved driving unit, durable in use, and not unduly cumbersome.

I claim:

1. A sliding door comprising a plurality of parallel, upright sections transversely offset with respect to each other and movable relatively to each other as the door is propelled from open to closed position, the sections being relatively extended when the door is closed and being juxtaposed with their respective end portions substantially aligned in a plane at right angles to the path of movement when the door is open, and flexible means interconnecting adjacent sections for causing simultaneous movement of the interconnected sections when one of said sections is propelled to open position and similar movement when one of said sections is propelled to closed position, so that the respective sections arrive simultaneously at either position.

2. A sliding door comprising a plurality of parallel, upright sections transversely offset with respect to each other and movable relatively to each other as the door is propelled from open to closed position, the sections being relatively extended when the door is closed and being juxta-

posed with their respective end portions substantially aligned in a plane at right angles to their path of movement when the door is open, and flexible means interconnecting adjacent sections constructed and arranged to vary the movement of the interconnected sections and to preserve a substantially uniform overlapping relation between said sections, during movement thereof in either direction.

3. A sliding door comprising a plurality of parallel, upright sections transversely offset with respect to each other and movable relatively to each other as the door is propelled from open to closed position, the sections being relatively extended when the door is closed and being disposed in overlapping, substantially juxtaposed relation when the door is open, movable belts transversely encircling adjacent sections, and connecting members fastened to the respective belts and attached respectively to corresponding parts of adjacent door sections, whereby the interconnected sections are constrained to move simultaneously when one of them is propelled.

4. A sliding door comprising a plurality of parallel, upright sections transversely offset with respect to each other and movable relatively to each other as the door is propelled from open to closed position, the sections being relatively extended when the door is closed and being disposed in overlapping, substantially juxtaposed relation when the door is open, movable belts transversely encircling adjacent sections, and a pair of connecting members fixed to each belt at opposite sides of the door sections and respectively attached to the side portions of adjacent sections, whereby the interconnected sections are constrained to move simultaneously when one of them is propelled.

5. A sliding door comprising a plurality of parallel, upright sections transversely offset with respect to each other and movable relatively to each other as the door is propelled from open to closed position, the sections being relatively extended when the door is closed and being disposed in overlapping, substantially juxtaposed relation when the door is open, movable belts transversely encircling adjacent sections, and a pair of tie members fixed to each belt at opposite sides of the door section and respectively attached to the side portions of the adjacent sections, the distance between the ties being approximately the same in either direction along the belt, thereby to vary the speed of the said sections and to preserve a substantially uniform overlapping relation therebetween during movement of the door from one position to the other.

6. A sliding door comprising a plurality of parallel, upright sections transversely offset with respect to each other and movable relatively to each other as the door is propelled from open to closed position, the sections being relatively extended when the door is closed and being disposed in overlapping, substantially juxtaposed relation when the door is open, pulleys mounted at opposite sides of adjacent sections, movable belts carried by the pulleys of said sections and transversely encircling the respective sections intermediate the upper and lower ends thereof, each complemental pair of pulleys being vertically offset from those on the next adjacent door section, and a pair of connecting members fastened to each belt at opposite sides of the section and attached respectively to the sides of the next adjacent section, whereby the interconnected sections are constrained to move simultaneously when one of them is propelled.

7. A sliding door comprising a plurality of parallel, upright sections transversely offset with respect to each other and movable relatively to each other as the door is propelled from open to closed position, the sections being relatively extended when the door is closed and being disposed in overlapping, substantially juxtaposed relation when the door is open, pulleys mounted at opposite sides of adjacent sections, movable belts carried by the pulleys of said sections and transversely encircling the respective sections intermediate the upper and lower ends thereof, each complemental pair of pulleys being vertically offset from those on the next adjacent door section, and a pair of tie members fixed to each belt and spaced apart at opposite sides of the door section so that the distance between the ties is approximately the same in either direction along the belt, the respective ties being attached to the sides of the next adjacent door sections, thereby flexibly to interconnect said sections so that the interconnected sections are constrained to move simultaneously.

8. A sliding door comprising a plurality of parallel, upright sections transversely offset with respect to each other and movable relatively to each other as the door is propelled from open to closed position, the sections being relatively extended when the door is closed and being disposed in overlapping, substantially juxtaposed relation when the door is open, pulleys mounted at opposite sides of adjacent sections, movable belts carried by the pulleys of said sections and transversely encircling the respective sections intermediate the upper and lower ends thereof, each complemental pair of pulleys being vertically offset from those on the next adjacent door section, a pair of connecting members fastened to each belt at opposite sides of the section and attached respectively to the sides of the next adjacent door sections, one of the connecting members upon the belt carried by the rearmost section being fixed in position, and a motor driving unit carried by the forwardmost door section for simultaneously propelling the several sections.

9. A sliding door comprising a plurality of sections transversely offset from each other and movable with respect to each other from relatively extended to relatively overlapping relation, flexible means interconnecting adjacent sections so that said sections are constrained to move together in either direction, and a motor driving unit carried by the forwardmost section for simultaneously propelling all the sections.

10. A sliding door comprising a plurality of sections transversely offset from each other and movable with respect to each other from relatively extended to relatively overlapping relation, flexible means interconnecting adjacent sections so that said sections are constrained to move together, the forwardmost section having a recess adjacent to one edge, a panel located in said recess and pivotally connected to said section for angular movement relatively thereto, and a motor driving unit mounted on said panel and having a driving wheel for propelling the door upon operation of the driving unit.

11. A sliding door comprising a plurality of upright sections movable from open to closed position, the forwardmost section having a recess adjacent to one edge, a panel pivotally mounted in said recess and angularly movable with respect to said section about a vertical axis, and a motor

driving unit mounted on said panel for propelling the door, said unit comprising a driving wheel supporting the panel and driving unit and a motor for operating said wheel.

12. A sliding door comprising a plurality of upright sections movable from open to closed position, the forwardmost section having a recess adjacent to one edge, a panel pivotally mounted in said recess and angularly movable with respect to said sections about a vertical axis, and a motor driving unit mounted on said panel for propelling the door, said unit comprising a driving wheel supporting the panel and driving unit, a motor for operating the wheel, and a friction clutch automatically operative to regulate the starting speed of the driving wheel.

13. A sliding door composed of individual sections and having a motor driving unit connected to one section for propelling the door over a track, said unit comprising a motor having a shaft, a driving wheel traveling on the track, a shaft for driving the wheel, and a friction clutch connecting the two shafts and automatically operative to regulate the starting speed of the wheel.

14. A sliding door composed of individual sections and having a motor driving unit connected to one section for propelling the door over a track, said unit comprising a motor having a shaft, a driving wheel traveling on the track, a shaft for driving the wheel, and a friction clutch connecting the two shafts and automatically operative to regulate the starting speed of the wheel, said door section having a panel pivotally mounted to swing about a vertical axis, and said unit being mounted on said panel with the driving wheel supporting the weight of the panel and unit.

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