June 15, 1926. 1,588,663

T. E. COLLINS

FOLDING DOOR

Filed Feb. 9, 1923 2 Sheets-Sheet 1

Fig. 1.

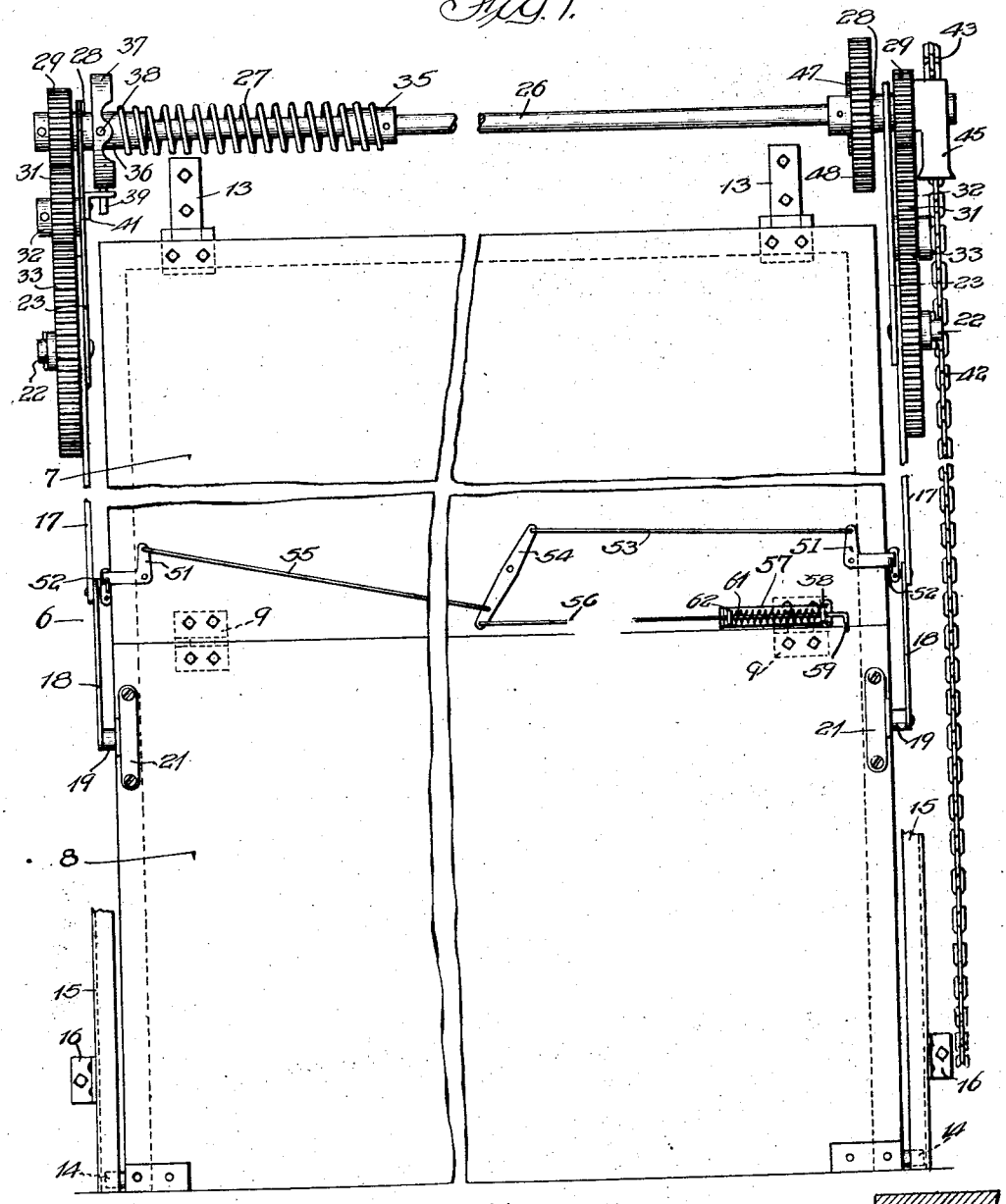
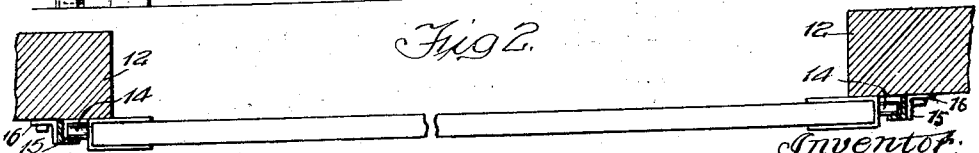


Fig 2.



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2 Sheets-Sheet 2

Fig. 3.

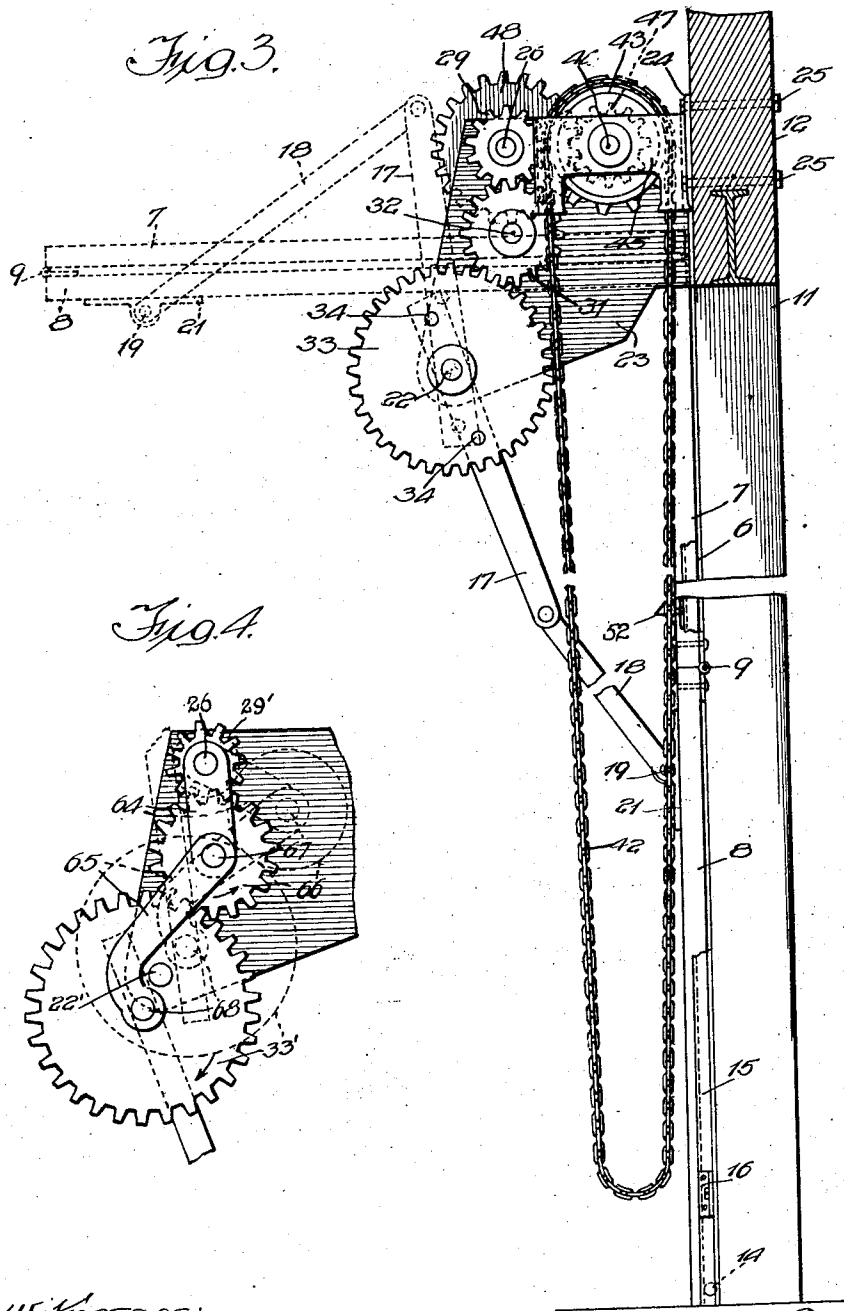


Fig. 4.

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UNITED STATES PATENT OFFICE.

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FOLDING DOOR.

Application filed February 9, 1923. Serial No. 617,939.

The present invention relates to folding doors, and more particularly to improvements in folding or jack-knife doors of the vertically moving type.

One of the principal objects of the invention is to provide a construction of vertically folding door, which will fold into a compactly nested structure with the door sections substantially parallel so that the door in its folded position requires only a comparatively small amount of head room.

Another object is to provide operating mechanism for the door which is of compact dimension vertically so as to require only a minimum amount of head room. The advantage of the two foregoing objects will be apparent when it is considered that doors of the present type are frequently installed in freight warehouses, packing houses, etc., where the head room above the top of the door is very small.

A further object is to provide operating mechanism which will dispense with vertically moving weights, etc., which, for practicable operation, require to be housed in large weight boxes. The weight boxes are an objectionable protrudance adjacent the doorway, and, where heavy trucking is carried on back and forth through the doorway, are always susceptible to being crushed or damaged.

A further object of the invention is to provide an improved construction of folding door and door operating mechanism wherein the latter will first exert a substantially horizontal force at the hinge line of the door, for "breaking" the hinge, and will thereafter exert an upward pulling force for folding the door sections vertically. This avoids the necessity of first manually "breaking" or folding the hinge line before the door can be raised.

A further object is to provide an improved arrangement of compensating mechanism which will cooperate with the counterbalancing spring so that as the counterbalancing tension of this spring decreases with the raising of the door the effective lever arm through which this counterbalancing tension is transmitted to the door will be increased. This compensating mechanism is an alternative feature which may or may not be employed in the improved door operating mechanism above described; its compensating action being an advantage, however, in doors which are of more than the average height.

Referring to the accompanying drawings illustrating a preferred embodiment of my invention:

Figure 1 is a front elevational view of the folding door and its improved operating mechanism;

Fig. 2 is a horizontal sectional view through the door, showing its lateral guiding support;

Fig. 3 is a transverse vertical sectional view through the wall and door opening, showing the door and its operating mechanism in side elevation; and

Fig. 4 is a fragmentary view similar to Fig. 3, illustrating my improved compensating gear.

The door is generally designated 6 and comprises two folding sections 7 and 8 which are joined along a horizontal line by the hinges 9—9. This door is adapted to close an opening or doorway 11 in a wall 12, the door consisting of the usual wood construction comprising wood panels or of metallic construction comprising sheet metal panels mounted on frames of angle bars or other rails. The upper section 7 of the door is hung on hinges 13—13 bolted to the wall 12, whereby the two sections of the door are permitted to fold upwardly in the manner of a jack-knife into the dotted line position illustrated in Figure 3. The lower edge of the door is guided in this upward folding motion by laterally extending rollers 14 projecting from the sides of the lower section 8 adjacent the bottom and engaging in lateral guide rails 15 of angle section. These guide rails extend upwardly along the sides of the doorway 11, being secured to the wall 12 at spaced points by angle brackets 16 which bolt to the rails 15 and to the wall 12. The door is raised and lowered through the instrumentality of the two operating arms 17 which connect through links 18 with laterally extending pivot pins 19 carried on the brackets 21 which are secured to the edges of the lower door section 8. These operating arms 17 have pivotal support on short pivot shafts 22 carried in the lower ends of two bracket plates 23 mounted on each side of the doorway. These bracket plates have lateral attaching flanges 24 by which the bracket plates are bolted to the wall 12 by bolts 25.

Referring now to the door operating mechanism which is mounted on these two bracket plates 23, it will be seen in Figure 1 that a connecting shaft 26 extends between the two bracket plates 23 for connecting up the two sets of door operating mechanisms at each side of the door, and for mounting the counter-balancing spring 27. The ends of the shaft 26 have bearing support in bearings 28 carried by the bracket plates 23, and project beyond these bearings for mounting small spur gears 29 at each end. These spur gears 29 mesh with idler gears 31 which are mounted on pivot studs 32 supported on each of the bracket plates 23. Each of the idler gears 31 meshes with a relatively large spur gear 33 which is journaled on the stub shaft 22 on each of the bracket plates. The operating arms 17 extend diametrically of these large spur gears 33, and are secured thereto by rivets 34 or the like so that both operating arms 17 rotate with the gears 33. These two gears rotate in synchronism through their geared connection with the cross shaft 26, as above described.

The counterbalancing spring 27 consists of a helical coil spring surrounding the shaft 26 and secured at one end thereto through the collar 35. The other end of the spring is secured to a sleeve 36 in which the shaft 26 is free to rotate, this sleeve having an enlarged flanged periphery 37 having locking holes 38 therein. This is for the purpose of adjusting the tension of the spring 27 as will now be described. After the desired tension has been imparted to the spring 27 by the rotation of the flanged wheel 37, a bolt 39 or some similar stop pin is inserted through one of the adjacent apertures 38 down into an aperture in a stop bracket 41 which is riveted to the inner wall of the adjacent bracket plate 23. This holds the spring 27 under its predetermined tension, and affords readily operable means for increasing or decreasing the tension if desired. The tension of the spring opposes the descent of the door 6, this tension being properly proportioned so that it naturally counterbalances the weight of the door and thereby facilitates the rapid opening and closing of the door.

This opening and closing of the door is performed through the manipulation of a hand chain 42 which hangs in a loop from a sprocket wheel 43. This sprocket wheel is mounted on a shaft 44 which is journaled adjacent one end in the bracket plate 23, and at the other end in a hub formed on the outer wall of the chain guide 45. This chain guide 45 may be integral with the bracket plate 23, or may be a separate casting secured to it, and is formed with bell-mounthed sheath openings which guide the links of the hand chain 42 into mesh with the teeth of the sprocket wheel 43. The shaft 44 is extended inwardly beyond the outer wall of the bracket plate 23, where it supports the spur pinion 47. This small spur pinion meshes with a larger spur gear 48, the hub of which is rigidly pinned to the cross-connecting shaft 26.

The operation of the door will be obvious from the foregoing:—Pulling downwardly on the hand chain 42 on one side of the loop is operative to swing the two operating arms 17 outwardly and upwardly through the train of gearing before traced, and thereby the two sections of the door are folded upwardly into the dotted line position shown. The counterbalancing action of the spring 27 is effective throughout the entire motion of the door for taking the weight of the door off of the operating chain 42, and when the door is entirely raised, the tension of this spring is sufficient to hold the door in this upper position. It will be observed that the two operating arms 17 are so positioned on the gears 33 that their initial movement is outwardly and away from the door so that they exert an outward pull on the door through the links 18 for first "breaking" or folding the knuckle of the door along the line of hinges 9 before any direct upward pull is exerted on the door. Thereafter the upward rotation of the operating arms 17 results in these arms taking an upward motion and pulling upwardly on the lower door section 8 for folding the same under the upper door section as shown, the two door sections folding upwardly between the operating arms 17 and the bracket plates 23.

By grouping the operating units for each side of the door on the bracket plates 23 the door sections can be folded up between the bracket plates so that the requisite head room is reduced to a minimum. The action of the two operating arms and their pivot connection to the door is such that the two door sections fold up into a compact arrangement with the sections parallel to each other and extending substantially horizontally just above the doorway. This also reduces the head room necessary for the door. The operating mechanism is also compactly disposed laterally of the door edges so that only a narrow lateral space is required on each side of the doorway, and all weight boxes, etc., are eliminated.

The door may be latched or locked in its closed position by a pair of bell crank latch members 51 which are pivoted adjacent the edges of the upper door section 7 in close proximity to the hinge line 9. The horizontal arms of these latch members are adapted to snap over hook lugs 52 which are riveted or bolted to the guiding rails 15. A rod 53 extends inwardly from the upper end of the righthand latch 51 and has

pivotal connection with the upper end of a rocking arm or lever 54 pivoted substantially centrally to the upper door section 7. A similar rod 55 extends inwardly and downwardly in an inclined position from the lefthand latch and has connection with the rocking lever 54 adjacent its other end. An actuating rod 56 has pivotal connection with this lower end of the lever 54 and extends towards the edge of the door where it passes through a tubular sheath 57 which is carried on a bracket 58 secured to the door. The end of the rod 56 projects beyond the bracket 58 and carries an operating handle 59 having a flange which is adapted to abut the bracket 58 and act as a limiting stop for inward motion of the operating handle. A spring 61 is contained within the sheath 57 and normally tends to thrust a collar 62 on the rod 56 to the left for swinging the latch members 51 downwardly into locking position. It will be apparent that a pull on the operating handle 59 is effective to swing the two latch members 51—51 inwardly, and upwardly thereby releasing them from the hook lugs 52 and permitting the hinged edges of the door to swing outwardly for raising the door.

The compensating mechanism which may be employed as an alternative construction, is illustrated in Figure 4. In this form the connecting train of gears is substantially a duplication of the preceding embodiment up to the relatively small pinion 29′ which is intended to correspond to the pinion 29 before described. Swinging from the shaft 26 of this gear is a link 64 which cooperates with a second link 65 in forming a toggle or knuckle joint for supporting a swinging gear 66. The two links 64 and 65 are connected by the pivot stud 67 on which the gear 66 is journaled. This arrangement is, of course, also duplicated on the other side of the door. The two gears 66—66 are adapted to transmit the drive from the gears 29′ to the large gears 33′ through a varying radius arm of the latter. The gears 33′ are arranged for eccentric rotation about eccentrically disposed bearing studs 22′ on which the gears are journaled. The links 65 curve outwardly over the pivot studs 22′ and have pivotal connection with the gears 33′ through stub ends 68, which are disposed concentrically in the gears 33′. The links 64 and 65 are so related and proportioned to the eccentric spacing between the pivot 22′ and the stud 68 that as the gears rotate in the directions indicated by the arrows, the gears 66 will swing upwardly and away under the folding action of the toggle so as to accommodate the greater radius of the other side of the gear 33′. In the full line position shown, the door is in its closed position, and at this time the drive is transmitted to the gear 33′ through its shortest length of radius arm extending from the pivot 22′ to the point of mesh with the gear 66. The counterbalancing spring 27 is under its maximum tension at this time, and this shorter lever arm of the gear 33′ compensates for this greater tension. As the door folds upwardly, the tension of the counterbalancing spring decreases gradually, and this is compensated for by the gradual increase of effective lever arm from the pivot 22′ to the pitch circle of the gear teeth. When the door has been raised to its uppermost position, the counterbalancing spring is at its lowest tension, but at this time a maximum length of lever arm is effective through the meshing of the gear 66 with the gear 33′ at the largest radius of the latter. Thus, the reduced tension of the spring is compensated for by the increased leverage through which the gear 66 transmits the torque of the spring.

As I have previously stated, the foregoing compensating gear is an arrangement which may or may not be employed in my improved door operating mechanism, as desired. The compensating action is advantageous, however, in the case of doors of considerable height, or which must move through a considerable height, owing to the increased rotation of the counterbalancing spring necessary for the greater range of movement of the door, which increased rotation of the spring results in a greater change in tension.

I claim:—

1. In a device of the class described, the combination of a vertically moving door comprising a pair of sections hinged together, a pivotally swinging operating arm, a link pivoted thereto and having pivotal connection with said door, near the top of the lower section, and actuating means comprising toothed wheels for driving said operating arm.

2. In combination, a vertically moving folding door comprising two door sections hinged together, a rigid radius member pivotally supported, said radius member having pivotal jointed link connection with said door below the hinged connection, manual actuating means, and gear mechanism connecting said actuating means with said radius member.

3. In combination, a pair of vertically moving folding door sections, a pair of bracket plates mounted adjacent the edges of the upper door sections, a shaft extending between said bracket plates, spur pinions on the ends of said shaft, relatively large spur gears pivotally supported on said bracket plates, idler gears meshing with said spur pinions and said relatively large gears, an operating arm extending from

each of said relatively large gears, a link pivotally connected with the end of each operating arm and having pivotal connection to the lower door section, a counter-balancing spring on said shaft, a sprocket wheel journaled on one of said bracket plates, an actuating chain trained over said sprocket wheel and gearing connecting said sprocket wheel with said shaft.

4. In combination, a vertically moving folding door, an operating arm for swinging said door outwardly and upwardly, counter-balancing means connected to said door, through said arm and compensating means for progressively increasing the torque arm through which the force of said counter-balancing means is transmitted to said door when said door is raised.

5. In combination, a vertically moving folding door, a pivotally swinging operating arm, said arm having pivotal attachment to said door, counter-balancing means, and compensating means connected between said counter-balancing means and said operating arm for varying the effective torque arm between said counter-balancing means and said operating arm.

6. In combination, a movable door, operating means for moving said door, counter-balancing means, and compensating means between said counter-balancing means and said operating means comprising an eccentrically pivoted gear for varying the effective torque connection between said counter-balancing means and said operating means.

7. In combination, a movable door, counter-balancing means therefor, and operating means connected between said counter-balancing means and said door and comprising an eccentrically pivoted gear, means operatively connecting said eccentric gear to said door, a pinion connected to said counter-balancing means, a pair of links pivotally connected together and to said pinion and said eccentric gear, and an idler gear pivoted upon the common pivotal connection between said links and meshing with the gear and pinion.

8. In combination, a movable door, counter-balancing means therefor, and operating means between said counter-balancing means and said door comprising an eccentrically pivoted gear, means operatively connecting said eccentric gear with said door, a pinion adapted to be rotated by said counter-balancing means, a first link pivoted concentrically with said pinion, a second link having pivotal support in the center of said eccentric gear, said links being pivoted together, and an idler gear moving with the point of common pivotal connection between said links.

9. In a device of the class described, the combination of vertically movable hinged door sections, a radius member having pivotal connection with said sections, actuating means comprising a depending loop chain, gear mechanism connecting said actuating means with said radius member, a counter-balancing spring co-operating with said radius member through the gear mechanism, and compensating means for increasing the torque arm through which the force of said counterbalancing means is transmitted to said door sections when said door sections are in a raised position.

10. In combination, a vertically moving folding door, an operating arm forming a part of an articulated joint for swinging said door outwardly and upwardly, counter-balancing means connected to said door through said arm, and compensating means for increasing the torque arm through which the force of said counter-balancing means is transmitted to said door when said door is in a raised position.

11. In combination, a pair of folding door sections hinged together on a substantially horizontal line, a supporting member, a rigid operating arm pivotally mounted on said supporting member and extending downwardly in acute-angled relation to the door and having a link extending at an obtuse angle for connection with the door, whereby initial motion of the arm is operative to move said door sections laterally and horizontally, and subsequently to move the same vertically in horizontal position and in contact with one another, and gear actuating mechanism independent of weights, for actuating said arm, said mechanism being positioned at opposite sides of the door sections for movement of the latter therebetween.

12. In combination, a vertically moving folding door comprising upper and lower hinged door sections adapted to close a door opening, an operating member supported on a pivot spaced laterally from said door, and including mechanism between which the doors operate, means pivotally connecting said operating member with said lower door section adjacent the hinged line between said sections, and means whereby upon the actuation of the operating member, the initial movement of said operating member will exert a horizontal force to draw the hinged line outwardly and away from said door opening and then to raise the same.

In witness whereof, I hereunto subscribe my name this 31st day of January, 1923.

THOMAS E. COLLINS.