March 16, 1965 A. F. CHARLES ETAL 3,173,381

RAILWAY HOPPER CAR

Filed June 24, 1963 4 Sheets-Sheet 1

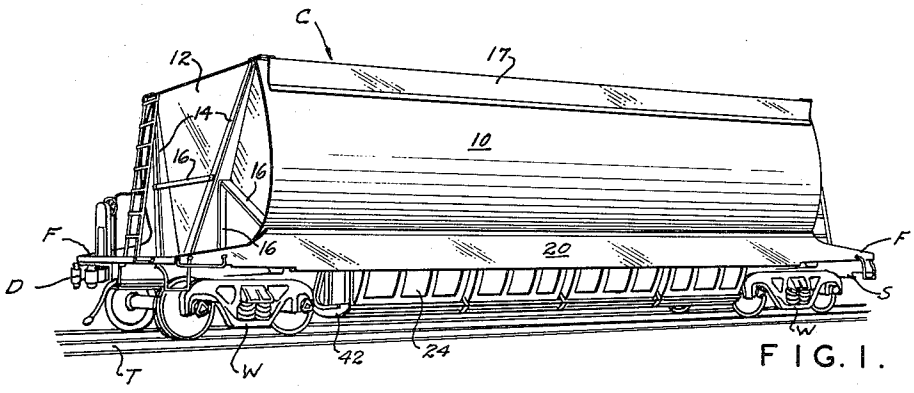


FIG. 1.

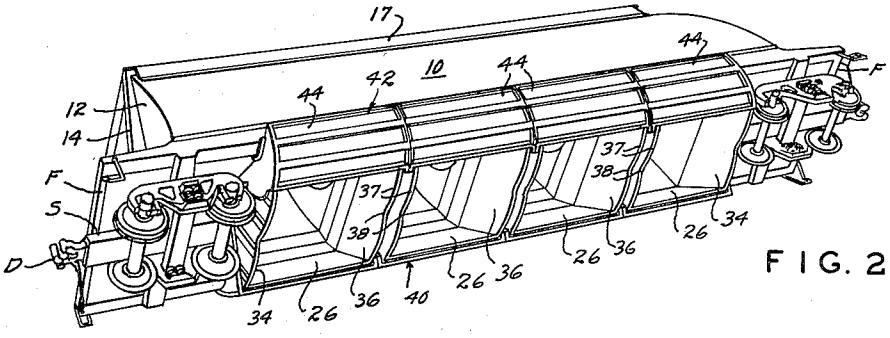


FIG. 2.

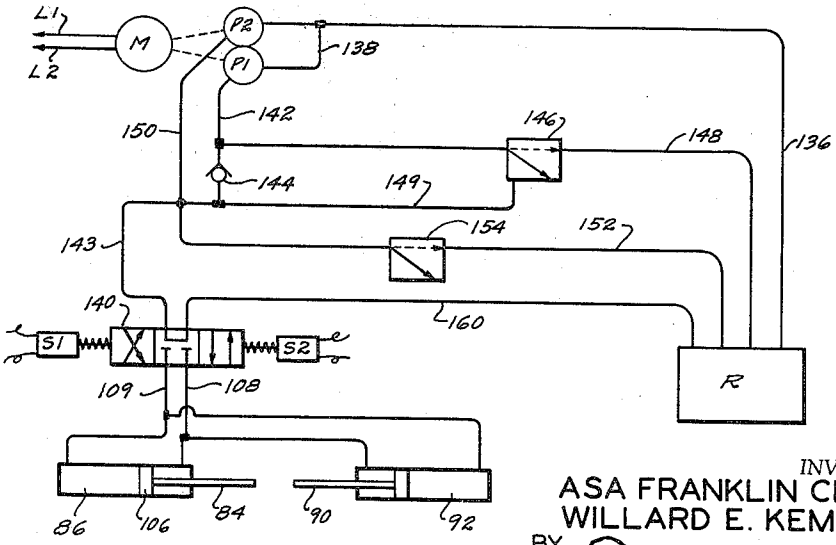


FIG. 15.

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RAILWAY HOPPER CAR

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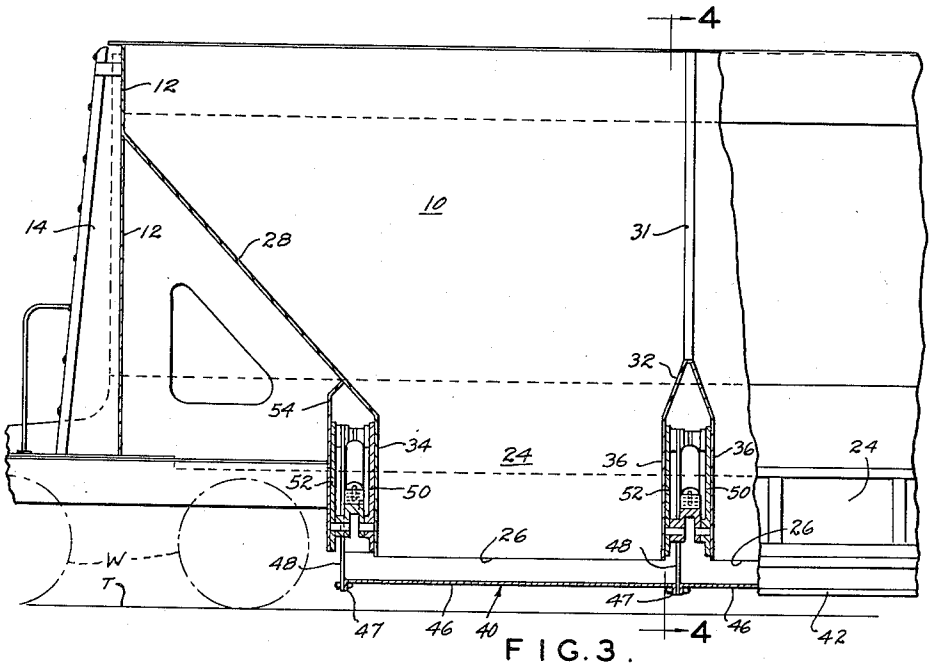


FIG. 3.

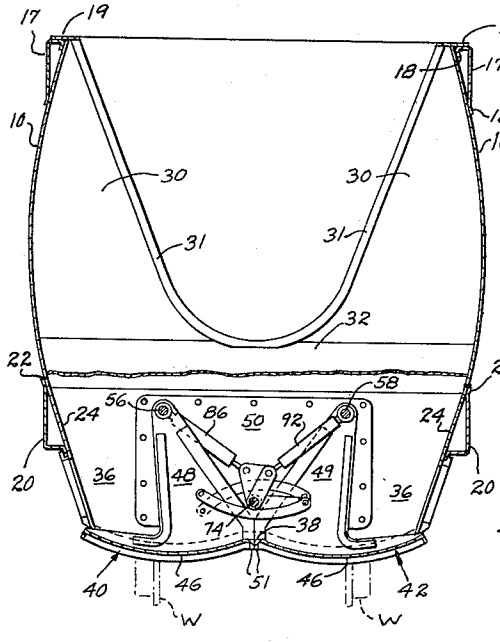


FIG. 4.

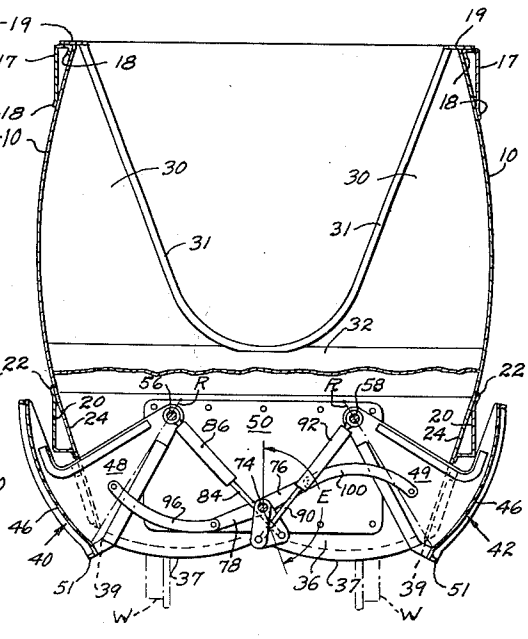


FIG. 5.

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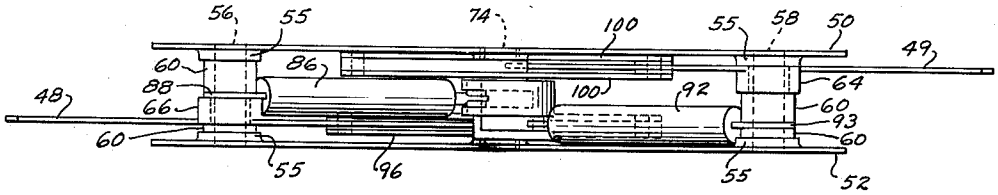


FIG. 7.

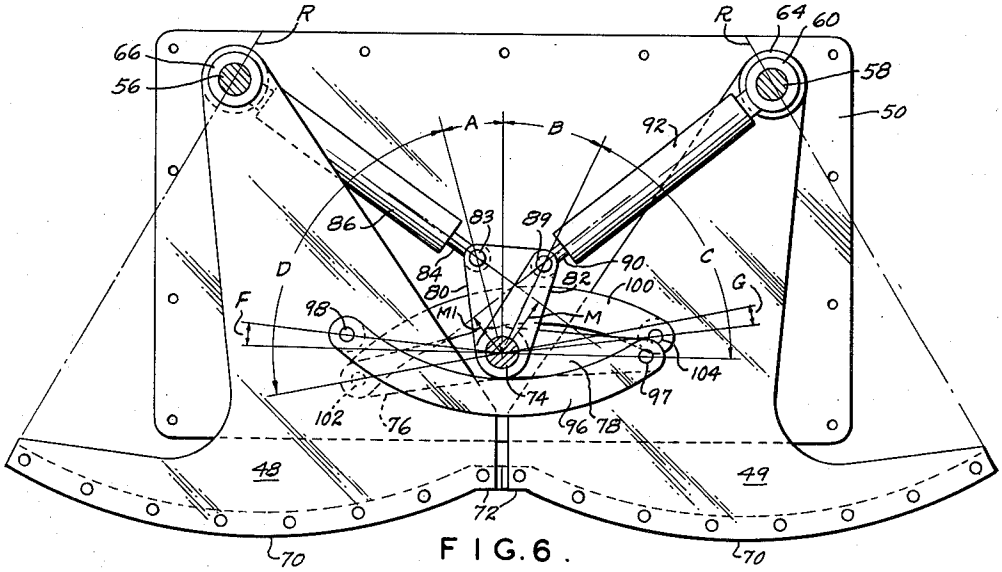
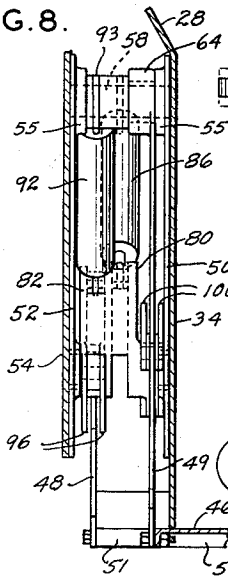


FIG. 6.

FIG. 8.



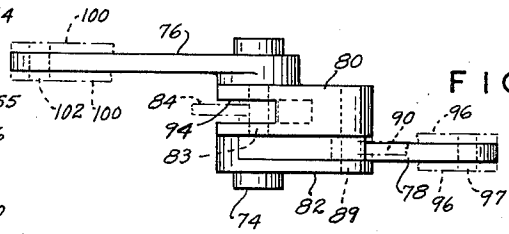


FIG. 10.

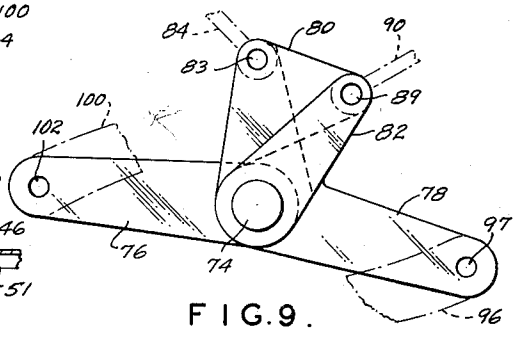
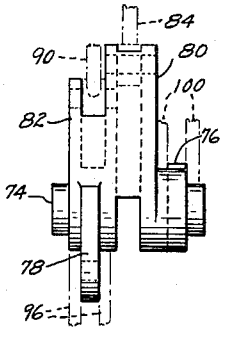


FIG. 9.

FIG. 11.



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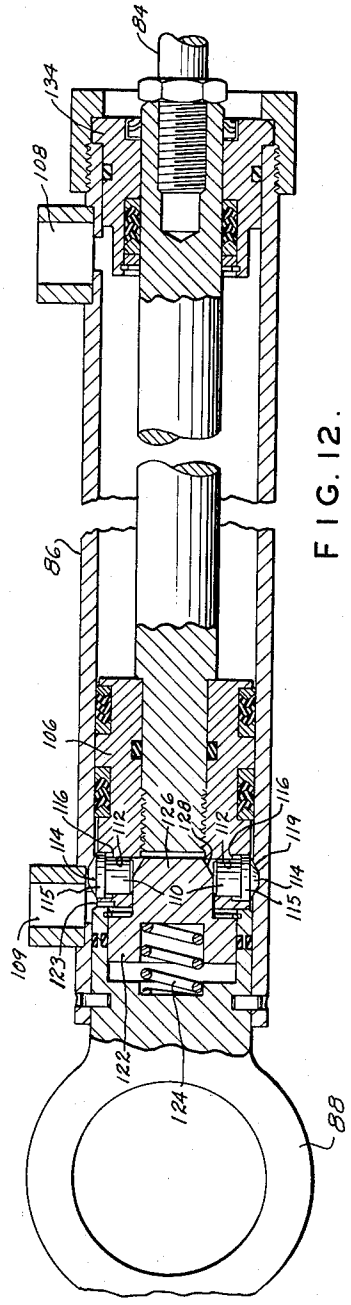


FIG. 12.

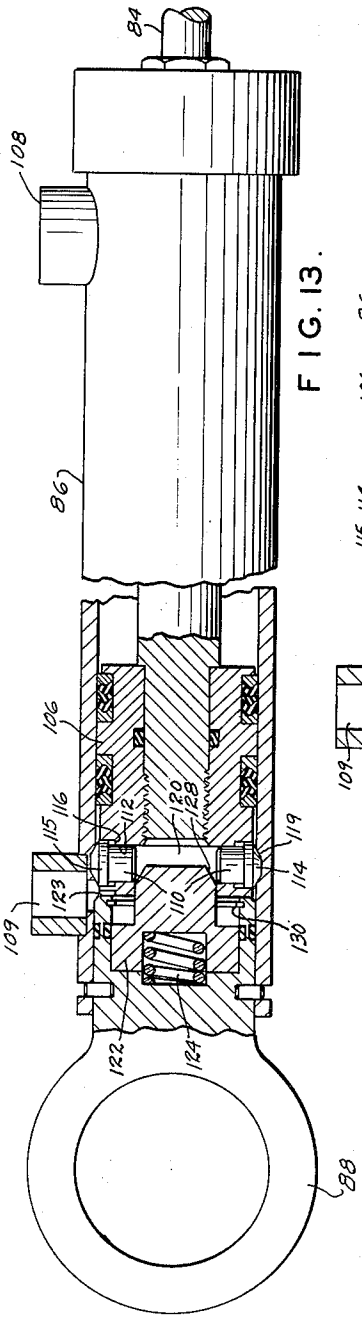


FIG. 13.

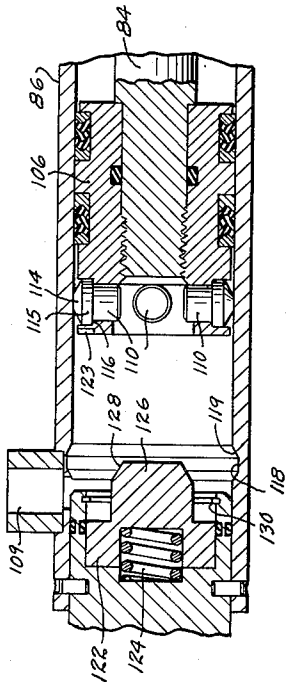


FIG. 14.

United States Patent Office 3,173,381 Patented Mar. 16, 1965

3,173,381

RAILWAY HOPPER CAR

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Filed June 24, 1963, Ser. No. 290,054
17 Claims. (Cl. 105—240)

This invention relates to a railway hopper car and more particularly to a railway hopper car of a type having a bottom discharge outlet with doors for closing and opening the outlet.

Among the several objects of this invention may be noted the provision of a railway hopper car which may be unloaded in a minimum of time from a bottom discharge outlet while the car is moving along a track; the provision of such a railway hopper car in which the closure of the bottom discharge outlet forms a floor along the longitudinal center of the car and provides a maximum unobstructed discharge opening when the doors forming the closure are opened with an increased self-cleaning of the car being effected as a result of the relatively large discharge opening; the provision of such a closure for a hopper car which may be controlled automatically, the employment of workmen for operating the hopper car being at a minimum with the unloading operation being effected in a minimum of time; the provision of such a hopper car in which the doors swing by gravity toward closed position when released after being opened, and are biased when closed toward closed position by the weight of the doors and the lading in the car; the provision of such a hopper car having a body arranged and constructed in such a manner as to obtain a maximum utilization of storage space and to minimize unfilled areas within the car; the provision of an open hopper car having the structural advantage of a tubular or tank-shaped car body which functions as a column beam to strengthen the car against the buff and draft and have a minimum number of parts thereby to minimize the labor and time involved in its fabrication; and the provision of such a hopper car which is simple in operation and economical in construction.

Briefly described, the hopper car embodying the present invention comprises a pair of doors, each pivotally suspended from a generally horizontal axis and adapted to swing between open and closed positions relative to a bottom discharge outlet of the hopper car, a shaft disposed generally between the doors with a linkage structure connecting each door to the shaft, and power means operatively connected to the shaft for oscillating the shaft to actuate the linkage structure for opening and closing of the doors. More specifically, the hopper car, in order to obtain a maximum unobstructed discharge opening along the longitudinal center of the car and to provide a maximum utilization of storage space, comprises a body having arcuate side slope sheets and side sills (the usual center sill being eliminated by such a design to provide an unobstructed discharge opening along the longitudinal center line of the car). Other objects and features will be in part apparent and in part pointed out hereinafter.

The invention accordingly comprises the constructions hereinafter described, the scope of the invention being indicated in the following claims.

In the accompanying drawings, in which one of several possible embodiments of the invention is illustrated.

FIGURE 1 is a perspective view of a hopper car embodying the present invention having a plurality of hopper discharge outlets and doors mounted adjacent the outlets for movement between open and closed positions;

FIGURE 2 is a further perspective view of the hopper car of FIGURE 1 taken from the bottom and showing the hopper doors in an open position;

FIGURE 3 is a partial longitudinal section of the hopper car of FIGURE 1, a certain portion being shown in elevation;

FIGURE 4 is a transverse section of the hopper car taken generally along line 4—4 of FIGURE 3, the doors being in a closed position;

FIGURE 5 is a transverse section similar to FIGURE 4, the doors being shown in an open position;

FIGURE 6 is an enlarged elevation of means for supporting and moving the doors between open and closed positions, the means being removed from the hopper car and showing the linkage structure for actuating the doors;

FIGURE 7 is a top plan of the means of FIGURE 6;

FIGURE 8 is a side elevation of the means of FIGURE 6;

FIGURE 9 is an enlarged side elevation of a certain crankshaft and crank arms thereon removed from the linkage structure shown in FIGURE 6;

FIGURE 10 is a plan of the crankshaft of FIGURE 9;

FIGURE 11 is a side elevation of the crankshaft of FIGURE 9;

FIGURE 12 is a longitudinal section of a certain cylinder in the hydraulic fluid system for locking the doors in a closed position;

FIGURE 13 is an enlarged section, partly in elevation of the locking means of FIGURE 13, the locking means being shown in a different position;

FIGURE 14 is a fragment of FIGURE 13, the locking means shown in an additional position; and

FIGURE 15 is a diagrammatic view of the hydraulic fluid system for actuating the doors.

Referring to the drawings and more particularly to FIGURES 1–5, a hopper car indicated generally at C is supported at each end on a wheel assembly W adapted to be shifted on track T by couplers D. The car is mounted on stub underframes F and has conventional brake rigging and train line connections (not shown). Couplers D are mounted within a center sill structure S on underframes F. Center sill structures S are provided with the customary draft gear and the like for mounting couplers D within the ends of the center sill structures.

Hopper car C has an arcuate side sheet **10** on each side, each of which comprises a plurality of transversely welded portions. Welded to the ends of sheets **10** are transversely extending end sheets **12**. Reinforcing end sheet **12** are two tapered angled end stiffeners **14**, diverging from the stub underframe F. Supporting ribs **16** on each end plate **12** additionally reinforce end sheet **12**. An upper longitudinal extending stiffener angle **17** (see FIGURES 4 and 5) has legs with welding bases **18** to which side sheets **10** are welded. A gusset plate **19** is welded to each angle **17** and the adjacent slope sheet. A bottom side sill **20** on each side of side sheet **10** is welded to side sheet **10** at a welding base **22** on side sill **20**. Also welded to each welding base **22** on side sills **20** are hopper side sheets **24** which form one side of a plurality of hopper discharge outlets or openings **26** (see FIGURE 2) spaced longitudinally along the length of the car.

Welded to end sheet **12** at each end of car C is an end slope sheet **28**. Slope sheet **28** is preferably disposed at an angle between about 30 and 50 degrees with respect to the horizontal axis of the car. The angle will vary according to the contents of the car. For example, when coal is carried by the car an angle of about 50 degrees is desired. If grain is carried, a smaller angle is preferred. Spaced between end slope sheets **28** along the length of the car are transversely extending crossridge gussets **30** welded to side sheets **10** and aiding in directing the contents of the car to hopper outlets **26**. A tubular stiffener

31 extends along the inner edge of gussets 30. At the lower edges of crossridge gussets 30 are crossridge sheets 32, extending between side sheets 10 and secured thereto, such as for example, by welding. Crossridge sheets 32 provide a partial partition adjacent hopper outlets 26 and aid in directing the contents of the car through outlets 26.

Secured to each lower edge of end slope sheets 28, such as by welding, is a hopper end sheet 34 (see FIGURE 3). Likewise secured to the lower edge of each side of crossridge sheet 32 is a hopper end sheet 36. Hopper outlets 26 are formed between hopper end sheets 34, 36 and hopper side sheets 24. Each hopper end sheet 34, 36 has a pair of arcuate edge portions 37 connected by a center horizontal portion 38 (see FIGURE 5). Outer corners of end sheet 36 are indicated at 39.

It should be noted that discharge openings 26 are disposed along the longitudinal center line of the car and provide a maximum discharge opening. For example, the width of opening or outlet 26 is about seven and one-half feet with a car having a width between side slope sheets of around ten and one-half feet. While the car is illustrated as an uncovered hopper car, it is to be understood that hopper car C may be a covered hopper car, if desired. Also, a separate compartment for each hopper discharge opening may be provided. Hopper side sheets 24 and the adjacent portions of arcuate side sheets 10 are preferably of an angle between about 45 degrees and 70 degrees with respect to the horizontal axis of the car. The angle will vary according to the contents of the car. For example when the car is employed in the loading unloading of coal, an angle of 70 degrees is desirable. The arrangement of side sheets 10 and end slope sheets 28 at a relatively large angle with respect to the horizontal axis of the car permits the car to be easily unloaded with a self-cleaning of the car being effected. End sheets 12 and crossridge gussets 30 along with crossridge sheets 32 provide a jig structure on which the side slope sheets are easily welded.

In accordance with an important feature of this invention, a clam shell-type door 40 on one side of hopper outlets 26 and a clam shell-type door 42 on the other side of hopper outlets 26 are arranged for opening and closing relative to outlets 26. Each door 40, 42 extends substantially the length of the car and is divided into a plurality of connected door sections 44. Door sections 44 are generally identical and each includes a single arcuate bottom plate 46. Hanger arms 48 and 49 on respective doors 40 and 42 extend in a generally perpendicular direction from plates 46. Only a single hanger arm 48 or 49 is secured to adjacent bottom plates 46. Outturned end flanges 47 (see FIGURE 3) on adjacent bottom plates 46 are secured to the hanger arm therebetween by suitable bolt and nut combinations. Bottom plates 46 at their inner edges have downturned side flanges 51 which contact each other when the doors are closed (see FIGURE 4).

Referring to FIGURES 6, 7 and 8, hanger arms 48, 49 are shown between pairs of parallel mounting plates 50 and 52 for suspending doors 40, 42. Plates 50 and 52 are suitably secured, such as for example, by riveting or suitable nut and bolt combinations to hopper end sheets 34, 36 (see FIGURE 3). Secured to each end slope sheet 28 is a support plate 54 to which a mounting plate 52 of another pair of mounting plates may be suitably secured at each end of the car. Mounted within hubs 55 on each pair of mounting plates 50 and 52 are shafts 56 and 58. Spacer sleeves 60 extend around shafts 56, 58. A collar 64 on hanger arm 49 fits about shaft 58 and mounts hanger arm 49 for pivotal movement. A collar 66 on hanger arm 48 is pivotally mounted about shaft 56. The center of gravity of each door 40, 42 is such that when in fully open position it is biased or urged by gravity about respective pivots 56, 58 toward a closed position. The lower edge of each hanger arm 48, 49 has an arcuate edge 70 corresponding generally to the curvature of bottom plates 46 and terminating inwardly in a generally flat horizontal edge portion 72. Hanger arms 48 and 49 are offset from each other as shown in FIGURES 7 and 8 thereby permitting side flanges 51 on the bottom plates to contact each other when the doors are closed.

For swinging doors 40 and 42 on shafts 56 and 58, a crankshaft 74 is mounted for partial rotation between each pair of mounting plates 50 and 52. Secured to crankshaft 74 are crank arms 76, 78, 80 and 82. Pivoted on a pin 83 on crank arm 80 is piston rod 84 of cylinder 86. A collar 88 (FIGURE 7) on cylinder 86 is mounted around shaft 56 for pivotal movement. Pivoted to pin 89 on crank arm 82 is a piston rod 90 extending from cylinder 92. A collar 93 on cylinder 92 is mounted for pivotal movement on 58. Slot 94 permits the piston rod 84 to swing between the arm portions of crank arm 80 and across the axis of shaft 74 when the shaft 74 is rotated clockwise from its position of FIGURES 4 and 6 to its position of FIGURE 5. A pair of parallel side-by-side spaced links 96 are pivoted at one end to crank arm 78 by pin 97. Links 96 extend along opposite faces of hanger arm 48 and are pivoted by pin 98 to hanger arm 48. Similarly, a pair of parallel links 100 are pivoted by pin 102 to crank arm 76 and by pin 104 to hanger arm 49. Links 96 and 100 are arcuate in shape to permit the links to clear crankshaft 74 during a cycle of operation of opening and closing doors 40 and 42 and to provide an over-center arrangement in the closed position of the doors as will be explained. Links 96 and 100 constitutes a linkage structure between crankshaft 74 and doors 40, 42.

Referring to FIGURE 6 and in accordance with a feature of this invention, a specific arrangement of hydraulic cylinders 86, 92 for rotating crankshaft 74 and actuating doors 40, 42 is indicated. When the doors 40, 42 are closed, pivot pin 83 of piston rod 84 is disposed at an angular distance A with respect to the axis of crankshaft 74 from a vertical plane passing through the longitudinal axis of crankshaft 74. Angle B represents the angular disposition between pivot pin 89 of piston rod 90 and the vertical plane passing through the longitudinal axis of crankshaft 74. Between pivot 89 and pivot 97 on hanger arm 49 is an angular distance C. Pivot 83 and pivot 102 on hanger door 48 form angle D therebetween. It is noted that angles A, B, C, and D are shown in FIGURE 6 with doors 40, 42 in closed position and upon actuation of cylinders 86, 92 from the closed position of the door such angles will change. Crankshaft 74 may rotate back and forth through an angle E (see FIGURE 5) when the doors are opened and closed during a cycle of operation. Likewise, crank arms 76, 78, 80 and 82 rotate through the same angle since the crank arms are secured to crankshaft 74. Links 96 and 100 being arcuate provide an over-center relationship for crank arms 76, 78 when the doors are closed as shown in FIGURE 6. Angle F indicates the extent of overtravel past the dead center position of crank arm 78 (the position at which the longitudinal axes of crankshaft 74 and pins 97, 98 are aligned), while angle G indicates the extent of overtravel past the dead center position of crank arm 76 (the position at which the longitudinal axes of crankshaft 74 and pins 102, 104 are aligned).

Such an arrangement results in doors 40 and 42 being biased inwardly toward closed position by the weight of the doors and the lading within the car when the doors are in the closed position shown in FIGURE 6. Crankshaft 74 is biased to oscillate or rotate in a counterclockwise direction as viewed in FIGURE 6 when a load is placed on the doors when in closed position. The load, while having an initial tendency to bias the doors outwardly, results in the associated crank arms being biased in a counterclockwise direction as long as the links remain in an over-center relationship (a position in which

pins 98 and 104 are past lines passing through the axis of crankshaft 74 and respective crank arms 78 and 76 such as indicated by angles F and G). This arrangement effectively locks the doors in a closed position. Once the crank arms and associated links move past their dead-center position (the position reached when links 96 and 100 move through angles F and G from closed position) the load within the car and the weight of the doors bias the crankshaft 74 in a clockwise position and the doors outwardly away from each other. Pivots 56, 58 for doors 40, 42 are on the radius R extending to the outer corner of the associated edge portion 37 of hopper end sheets 34, 36 thereby permitting doors 40, 42 to swing away from the outer corners 39 and the arcuate edges 37 of the hopper end sheets as the doors move from closed position to open position (see FIGURE 5). This eliminates any binding of the doors when opened and closed.

As a specific example, angle A is 15 degrees, angle B is 25 degrees, angle C is 66 degrees, and angle D is 86 degrees. Angles F and G are 5 degrees which allow crank arms 76 and 78 to act through the over-center linkage arrangement. Angle E (see FIGURE 5) is 170 degrees and indicates the angle through which crankshaft 74 is rotated, the doors being moved between fully open position and fully closed position upon rotation of the crankshaft 170 degrees.

When the doors are in fully closed position as viewed in FIGURE 6, pivot pin 89 is past the dead center position of cylinder 92 (the position at which the longitudinal axes of crankshaft 74 and pivots 58, 89 are aligned) and cylinder 92 biases crankshaft 74 in a counterclockwise direction. In this position cylinder 92 is acting against cylinder 86, cylinder 92 biasing crankshaft 74 in a counterclockwise direction while cylinder 86 is biasing crankshaft 74 in a clockwise direction. However, since angle A is 15 degrees while angle B is 25 degrees, for example, actuation of cylinders 86 and 92 results in the swinging of crank arm 82 past dead center position (the position at which the longitudinal axes of crankshaft 74 and pins 58, 89 are aligned) by cylinder 86 since the effective moment or lever arm action of crank arm 80 indicated by line M through which cylinder 86 is acting is greater than that of crank arm 82 through which cylinder 92 is acting indicated by line M1. Once crank arm 82 moves pivot 89 past dead center position, cylinder 92 is effective to rotate shaft 74 in a clockwise direction as viewed in FIGURE 6.

When the doors are in fully opened position as viewed in FIGURE 5, crank arm 80 and pivot 83 are past a dead center position (the position in which the longitudinal axes of crankshaft 74 and pivots 56, 83 are aligned and the moment arm is zero). Thus cylinder 86 is biasing crankshaft 74 in a counterclockwise direction while cylinder 92 is effective to bias crankshaft 74 in a clockwise direction.

It is highly desirable to have a varying force applied to the linkage structure for the doors throughout the cycle of operation of the crankshaft. A large force is needed to open the doors initially (and to close the doors under adverse conditions such as the lodging of material between the doors) while a smaller force is needed to swing the doors to fully open position after the doors have been opened. An increased force is desired to hold the doors in open position as the weight of the doors may be considerable. A rotation of the crankshaft of around 170 degrees has been found to perform satisfactorily in order to provide such a varying force to the crankshaft.

The arrangement of the linkage structure and the associated crank arms 76, 78 is such that upon the initial opening of the doors, a relatively large mechanical advantage is obtained (the linkage structure between crankshaft 74 and doors 40, 42 having a relatively small moment arm in such position). However, as the doors move toward open position, the mechanical advantage of the crank arms 76, 78 and the associated links 96, 100 decreases as the moment arm of the linkage structure between crankshaft 74 and doors 40, 42 increases. It is desirable to have a high mechanical advantage for the linkage structure upon the initial opening of the doors since a relatively large opening force may be necessary when conditions are encountered such as freezing temperatures and the adhering of the contents of the car, such as coal, to the doors. At the end of the opening stroke (see FIGURE 5) the mechanical advantage of crank arms 76, 78 and the associated linkage structure increases which tends to counteract the increased effective weight of the doors in such position. While the doors have been illustrated as swinging about axes parallel to the longitudinal axis of the car, it is to be understood that the doors could be mounted adjacent a single hopper outlet for swinging movement about axes generally perpendicular to the longitudinal axis of the car.

Cylinder 86 has an internal locking arrangement to lock the doors in closed position which will permit the fluid pressure to be shut off and yet insure locking of the doors, such as would be desired during normal travel of the car. Referring to FIGURES 12, 13 and 14, cylinder 86 has a piston 106 secured to piston rod 84 and adapted to reciprocate within cylinder 86. Connected to cylinder 86 adjacent one end is fluid line 108. Fluid line 109 is connected to the opposite end of cylinder 86. Carried by piston 106 at one end thereof are four locking lugs 110 two of which are shown in FIGURES 12–14 mounted for sliding movement within openings 112 of the piston. Lugs 110 have frustoconical outer end portions 114 and integral cylindrical rim portions 115. Rim portions 115 seat on abutments 116 when piston 106 is in unlocked position as shown in FIGURE 14. A circumferential retaining seat 118 in the inner wall surface of cylinder 86 has a cam surface 119 and is adapted to receive and retain the conical ends 114 of lugs 110 when piston 106 reaches its rearmost position as viewed in FIGURES 12 and 13. An end bore 120 in piston 106 communicates with openings 112 and lugs 110 project inwardly within bore 120 during travel of piston 106 (see FIGURE 14). A cam plunger member 122 is mounted within an end of cylinder 86 and spring 124 biases cam member 122 toward piston 106. A projection 126 is adapted to fit within bore 120 and cam surface 128 engages and cams lugs 110 into circumferential seat 118 when piston 106 reaches its rearmost position. A retaining ring 130 retains and limits forward movement of cam member 122. Piston 106 is retained in retracted position upon seating of lugs 110 on circumferential seat 118 by projection 126 (this position is reached when the doors are closed). When lugs 114 are forced into locking engagement by projection 126, the flow of fluid may be stopped and piston 106 will be retained in this position. Spring 124 is of a strength sufficient to hold plunger 122 projected within bore 120 during the return of fluid to the reservoir R through line 109 thereby to lock lugs 110 in position. Inadvertent opening of the doors from vibration or impact load is prevented by the locking arrangement.

In the closed position of doors 40, 42 pivots 98 and 104 are past dead center positions (angles F and G measuring the movement of the linkage structure connecting doors 40, 42 and crankshaft 74 past the dead center position) and as a result, any lading within the hopper car biases crankshaft 74 in a counterclockwise direction and the doors 40, 42 against each other. This removes the weight of any lading in the hopper car from locking cylinder 86 and a relatively small locking force effectively locks doors 40, 42 regardless of the weight of the lading. Also, since a relatively high mechanical advantage is obtained in the linkage structure connecting crankshaft 74 and doors 40, 42 in closed position, a relatively small

locking force on piston 106 effects a relatively large locking action on doors 40, 42.

To release locking lugs 110 and piston 106 upon reversing the flow of fluid to cylinder 86, fluid pressure in line 109 flows through spaced ports 123 between piston 106 and the adjacent face of cam member 122. Cam member 122 is moved against the bias of spring 124 to the position shown in FIGURE 13 at which cam surfaces 128 permit locking lugs 114 to cam inwardly against the adjacent inclined cam surface 119 of circumferential seat 118, lugs 110 seating against abutments 116. In this position piston 106 is free to move to the projected position of piston rod 84 as shown in FIGURE 14. A sealing assembly 134 within the forward end of cylinder 86 receives piston rod 84.

Referring to FIGURE 15, the fluid system for actuating cylinders 86 and 92 for opening and closing the doors is shown schematically. An electric motor is supplied with electrical energy through power lines L1 and L2 from a suitable power source (not shown), such as a power source on a train. Hydraulic fluid pumps P1 and P2 are driven in series from motor M through suitable connections. Pump P1 is a large volume low pressure pump while pump P2 is a low volume high pressure pump. Fluid is supplied from fluid reservoir R through fluid lines 136 and 138 to pumps P1 and P2. A four-way spring centered valve 140 is connected by fluid lines 142 and 143 to pump P1. Solenoids S1 and S2 control the movement of fourway valve 140. A check valve 144 in line 142 prevents back pressure from reaching pump P1. A relief valve 146 is positioned within a return line 148 to reservoir R. A pilot line 149 extends between relief valve 146 and line 143. Valve 146 is set for actuation at a relatively low fluid pressure being reached in line 149, such as 400 p.s.i. for example. Fluid line 150 from pump P2 communicates with line 143 to four-way valve 140 and a fluid return line 152 communicates with reservoir R. Relief valve 154 in return line 152 is set for actuation at a relatively high fluid pressure, such as 1600 p.s.i. for example. Fluid lines 108 and 109 extend between four-way valve 140 and cylinders 86, 92. Return line 160 returns fluid to reservoir R from valve 140. The operation is as follows: Energizing of motor M drives pumps P1 and P2 which are coupled in series. For opening the doors, solenoid S1 is energized and fluid is supplied from reservoir R through fluid line 109 to cylinders 86, 92 for projecting piston rods 84, 90. Locking lugs 110 are retracted to permit travel of piston 106 and piston rod 84 as explained. Upon the unlocking of piston 106, cylinder 86 and crank arm 80 will rotate crankshaft 74 in a clockwise direction, piston rod 90 being swung past dead center position. Fluid is supplied by both pumps P1 and P2 and relief valves 146 and 154 remain in closed position during normal operation. In the event doors 40, 42 are stuck, such as might occur from adhering of the contents of the car to the doors, fluid pressure in lines 109, 142, 143, and 150 will increase and upon a predetermined fluid pressure being reached in lines 142 and 149, such as 400 p.s.i., relief valve 146 is actuated to return fluid to the reservoir. A drop in fluid pressure in line 142 which results from the opening of relief valve 146 causes check valve 144 to close which prevents back pressure to pump P1. Fluid pressure in line 149 holds relief valve 146 open until the pressure in line 149 drops below 400 p.s.i. Pump P2 (a low volume high pressure pump) then supplies all of the fluid to cylinders 86, 92 through lines 150, 143, 109 at a pressure in excess of the pressure at which relief valve 146 was actuated. Upon breaking the doors loose, the pressure immediately drops and effects closing of relief valve 146 from a reduction in fluid pressure in line 149. Fluid is again supplied by both pumps P1 and P2 when relief valve 146 closes. When the doors are fully opened as viewed in FIGURE 5, solenoid S1 may be deenergized by suitable controls (not shown) and valve 140 will return to its centered position, the doors being held in opened position. To close the doors, solenoid S2 is energized and fluid is supplied through line 108 to close the doors. In many instances the doors will swing by gravity to closed position and be held in such position with locking lugs 110 engaged. The retraction of piston rod 84 will result in the locking of the doors whether the doors are closed by fluid pressure, by gravity or a combination of fluid pressure and gravity. The momentum from the swinging of the doors is usually adequate to close the doors but in the event particles are lodged between the doors, fluid pressure is necessary to move the doors to fully closed position. A timing device may be operatively connected to solenoids S1 and S2 to hold the doors open for a predetermined amount of time.

Suitable controls (not shown) may be placed on car C to be easily accessible to an operator of the hopper doors. It may be desirable to provide remote controls, such as in locomotives or control towers, for the doors. Such remote controls may, for example, be magnetic or narrow band radio signals. In the event the contents of the car, such as coal, tend to adhere to the doors when in fully opened position, a vibrator (not shown) may, for example, be operatively connected to the doors for shaking the material from the doors. It is to be understood that the doors when opened may be held open for a predetermined amount of time and then allowed to close. It is to be understood that cylinders 86, 92 may be positioned at each end of the car only, if desired, or at only one end of the car.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

As various changes could be made in the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

We claim:

1. In a railway hopper car having a bottom discharge opening for unloading lading from the car, a pair of doors pivotally mounted about two generally horizontal spaced axes parallel to the longitudinal axis of the car and adapted to swing transversely of the car between open and closed positions relative to the opening, the doors being pivotally suspended to swing by gravity toward closed position after being opened, a separate link pivotally connected to each door, a crankshaft mounted for rotation about an axis parallel to the longitudinal axis of the car and having a plurality of crank arms secured thereto for rotative movement, a separate crank arm being pivotally connected to each link for swinging the doors open and closed, and fluid pressure means pivotally connected to said crankshaft for rotating the crankshaft first in one direction for opening the doors and then in the opposite direction for locking the doors in closed position.

2. In a railway hopper car as set forth in claim 1 wherein the fluid pressure means comprises a pair of fluid cylinders pivoted from the pivots of said doors, each of said fluid cylinders having a projecting piston rod pivotally connected to another one of said crank arms respectively for moving said crankshaft and actuating the doors, the projecting piston rods acting along moment arms of different lengths with respect to the rotational axis of the crankshaft when the doors are closed, one of the fluid cylinders biasing the crankshaft for rotation in one direction and the other fluid cylinder biasing the crankshaft for rotation in an opposite direction when the doors are closed.

3. In a railway hopper car having a bottom discharge opening for unloading the contents of the car, a pair of doors pivotally mounted on said car and suspended respectively from two generally horizontal parallel axes and adapted to swing between open and closed positions relative to the opening, a generally horizontally extending

shaft adjacent the generally horizontal axes, a linkage operatively connected between each door and said shaft, the linkages being effective to swing the doors open when said shaft is rotated in one direction and effective to close the doors upon rotation of the shaft in an opposite direction, and power means operatively connected to the shaft for rotating the shaft first in one direction for opening the doors and then in the opposite direction for closing the doors, said power means comprising a pair of fluid cylinders each having a projecting piston rod operatively connected to said shaft for rotating the shaft and effecting opening and closing of the doors, said cylinders being arranged with respect to said shaft at different length moment arms when the doors are closed, one of the cylinders biasing the shaft for rotation in one direction and the other fluid cylinder biasing the shaft for rotation in an opposite direction when the doors are closed.

4. In a railway hopper car as set forth in claim 3, means within the cylinder having the shorter moment arm at the closed position of the door to retain its associated piston rod in retracted position upon closing of the doors.

5. In a railway hopper car as set forth in claim 3, said shaft being a crankshaft and having a plurality of crank arms secured thereto for movement, a different one of said crank arms being pivotally connected to each linkage, and each of the piston rods being pivotally connected to a different crank arm for rotating the crankshaft.

6. A railway hopper car comprising a side sheet on each side of the hopper car, a side sill outwardly of each side sheet and extending longitudinally of the car, at least a pair of transverse sheets extending between the side sheets and forming with the side sheets a hopper having an unobstructed bottom discharge outlet extending generally centrally of the width of the car, a pair of doors mounted on the car and suspended about generally horizontally extending pivots for swinging movement between closed and open positions, a generally horizontally extending shaft adjacent said pivots, a linkage operatively connected between each door and the shaft, the linkage being effective to swing the doors open when the shaft is rotated in one direction and effective to close the doors upon rotation of the shaft in an opposite direction, and a fluid pressure cylinder supported from the pivot of each door each having a piston rod operatively connected to said shaft for rotating the shaft back and forth to open and close the doors.

7. A railway hopper car as set forth in claim 6 wherein each of said doors comprises an arcuate bottom plate and a hanger arm secured at each end of the bottom plate, said hanger arms extending generally perpendicularly to the bottom plate and suspended from said horizontally extending pivots to mount the doors for swinging movement.

8. A closure for a hopper discharge outlet of a railway hopper car comprising a pair of oppositely facing doors suspended from a pair of spaced axes extending generally parallel to the longitudinal axis of the car, said doors swinging toward and away from each other between open and closed positions relative to the discharge outlet, a separate link operatively connected to each door, a shaft adjacent the doors having its longitudinal axis extending in a direction generally parallel to the longitudinal axis of said car, a plurality of crank arms secured to the shaft for rotation therewith, a separate one of said crank arms pivotally connected to each link, and fluid pressure means operatively connected to another one of said crank arms to rotate the shaft back and forth for opening and closing the doors.

9. A closure for the hopper discharge outlet of a railway hopper car as set forth in claim 7 wherein each of the doors comprises an arcuate bottom plate and a hanger arm secured to each end of the bottom plate, said hanger arms extending generally perpendicularly to the respective bottom plate and suspended from the horizontal axis of the associated door.

10. A closure for the bottom hopper outlet of a railway hopper car as set forth in claim 9 wherein said shaft is a crankshaft and each link is pivotally connected adjacent one end to a separate hanger arm and pivotally connected adjacent the opposite end to its associated crank arm.

11. In a railway hopper car having a lower discharge outlet, an arcuate side sheet on each side of the hopper car, a side sill outwardly of each side sheet and extending longitudinally substantially the length of the car, an end slope sheet adjacent each end of the car, a hopper end sheet adjacent each end of the bottom discharge outlet and extending in a generally vertical plane, a pair of oppositely facing doors suspended from a pair of spaced axes extending parallel to the longitudinal axis of the car, said doors swinging about said axes between open and closed positions relative to the discharge outlet, a linkage operatively connected to each door, and a hydraulic fluid cylinder operatively connected to each linkage for opening and closing the doors.

12. In a railway car having a bottom discharge outlet, a pair of oppositely facing hopper end sheets forming the ends of a hopper and each extending in a generally vertical plane, a mounting plate secured to each of the hopper end sheets, a pair of oppositely facing doors each comprising a bottom plate and a hanger arm secured to each end of the bottom plate, the arms extending along the adjacent mounting plates and pivotally suspended from the mounting plates about spaced axes extending generally parallel to the longitudinal axis of the car to mount the doors for swinging movement toward and away from each other between open and closed positions relative to the bottom discharge outlet, a crankshaft mounted on at least one of the mounting plates, a plurality of crank arms secured to the crankshaft for rotation therewith, a separate link for each door pivotally connected at one end to one of the hanger arms and pivotally connected at the opposite end to one of the crank arms, the link on each door being pivoted past a dead center position with respect to the rotational axis of the crankshaft when the doors are in closed position, and power means operatively connected to the links for opening and closing the doors.

13. In a railway car as set forth in claim 12, said power means including a pair of hydraulic fluid cylinders each pivotally connected to a crank arm to rotate the crankshaft back and forth through an angle of about 170 degrees, the fluid cylinders being pivotally supported from one of said mounting plates.

14. In a railway car as set forth in claim 13, means within one of said cylinders to retain the piston therein in retracted position upon closing of the doors thereby to lock the doors in closed position, said means being released upon a reversal of flow of fluid in said cylinder to permit opening of the doors.

15. In a railway car as set forth in claim 14, said means to retain the piston comprising a plurality of locking lugs carried by the piston and adapted to move toward and away from the inner circumference of the associated cylinder, the associated cylinder having a seat therein to receive and retain the locking lugs when the piston reaches its fully retracted position, and means within the associated cylinder to move the lugs into seated locking engagement with the seat.

16. A closure for the bottom hopper outlet of a railway hopper car comprising a pair of oppositely facing doors suspended from a pair of spaced axes extending parallel to the longitudinal axis of the car, the doors swinging toward and away from each other between open and closed positions relative to the discharge outlet, a shaft adjacent the doors having its longitudinal axis extending in a direction generally parallel to the longitudinal axis of said car, a plurality of crank arms secured to the shaft, a separate linkage operatively connected to each door and to a separate one of said crank

arms, and a fluid cylinder for each linkage having a projecting piston rod pivotally connected to one of the crank arms and adapted when actuated to rotate the shaft back and forth through an angle of about 170 degrees for opening and closing of the doors, one of the cylinders acting to rotate the shaft in one direction and the other cylinder acting to rotate the shaft in an opposite direction at the fully open and closed positions of the doors whereby the cylinders are acting against each other at each end of the rotation of the shaft, both of said cylinders acting to rotate the shaft in the same direction at positions intermediate the fully open and closed positions of the doors.

17. A railway hopper car having a bottom discharge outlet for unloading lading from the car, a pair of oppositely facing doors each comprising a bottom plate and a hanger arm secured to each end of the bottom plate, the arms at each end of the doors pivotally suspended about two generally horizontal parallel axes extending generally parallel to the longitudinal axis of the car to mount the doors for swinging movement from open position toward closed position relative to the bottom discharge outlet, each door being suspended from a position to swing by gravity toward closed position after being opened, a crankshaft mounted for rotation about an axis generally parallel to the longitudinal axis of the car, a plurality of crank arms secured to the crankshaft for rotation therewith, a separate linkage for each door operatively connected at one end to one of the hanger arms and operatively connected at the opposite end to one of the crank arms, and power means operatively connected to the crankshaft for rotating the crankshaft first in one direction for opening the doors and then in the opposite direction for closing the doors.

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