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 [22] Filed **Aug. 13, 1969**
 [45] Patented **Aug. 3, 1971**
 [73] Assignee **Ortner Freight Car Company**
Cincinnati, Ohio
Continuation-in-part of application Ser. No.
546,722, May 2, 1966, now abandoned.

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[54] **RAPID DISCHARGE HOPPER CAR DOOR ACTUATOR**
29 Claims, 37 Drawing Figs.

[52] U.S. Cl. **105/240,**
 64/24, 64/31, 105/253, 105/280, 105/304,
 105/311, 287/58 R, 287/64, 287/103 R, 308/62
 [51] Int. Cl. **B61d 7/18,**
 B61d 7/22, B61d 7/28
 [50] Field of Search 64/24, 31;
 105/240, 241 R, 250, 253, 280, 255, 282 R, 282 A,
 282 P, 290, 299, 304, 311 R, 424; 280/96.1;
 287/58 R, 64, 65, 103 R; 308/62

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Primary Examiner—Arthur L. La Point
Assistant Examiner—Howard Beltran
Attorney—Melville, Strasser, Foster and Hoffman

ABSTRACT: Door-actuating means for use in a hopper car of the type having a plurality of hopper doors arranged in opposing pairs and swingable between a downwardly depending open position and a closed position wherein their bottom edges meet in abutting relationship. The hopper doors have portions capable of being flexed inwardly relative to the normal plane of the door. The operating means for the doors being capable of fine adjustment so as to effect flexure of the doors as they swing from their closed to their open positions. The bottom edges of the doors are provided with sealing means which will not obstruct the discharge of material from the hopper car during the unloading process.

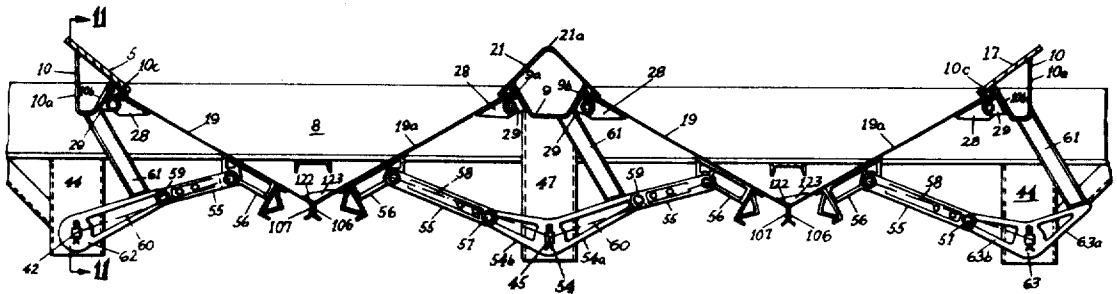


Fig. 1

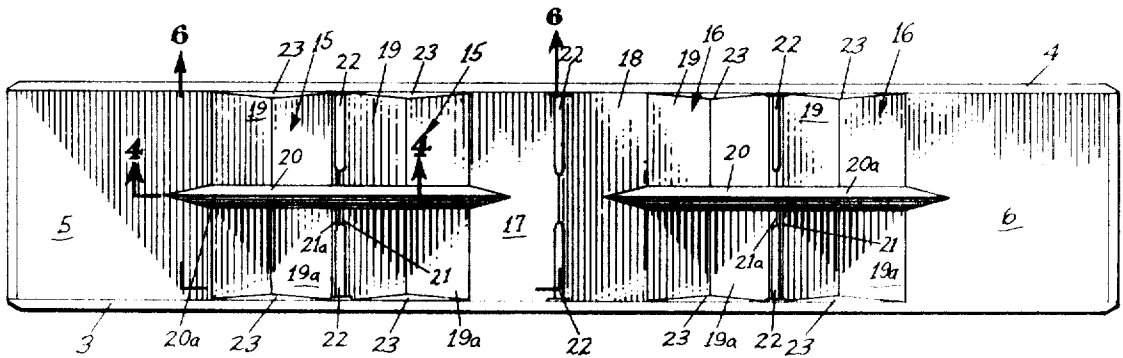
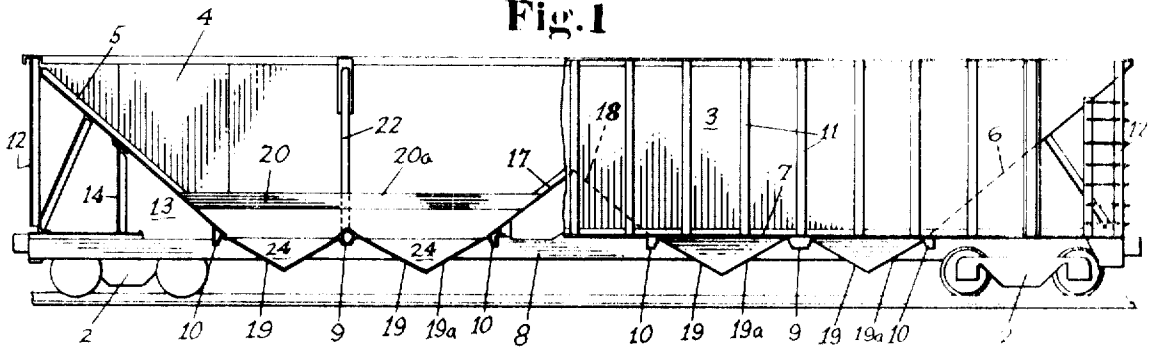


Fig. 2

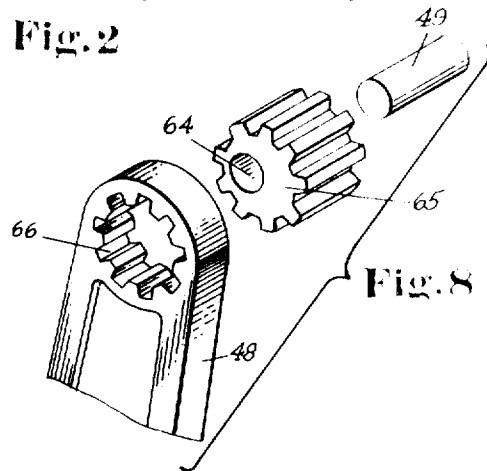
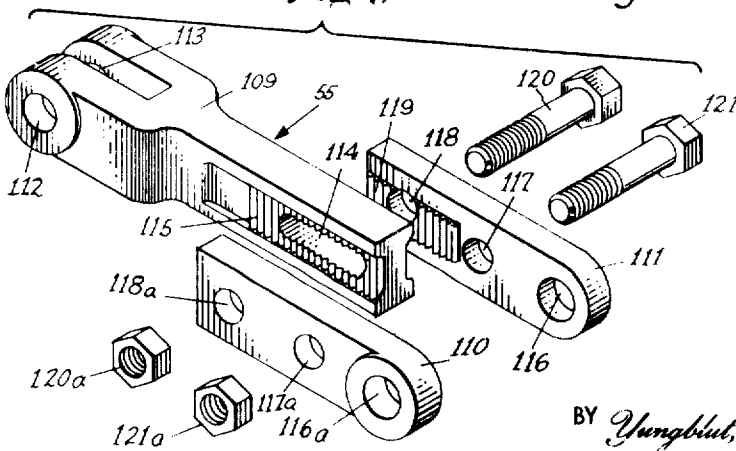


Fig. 9



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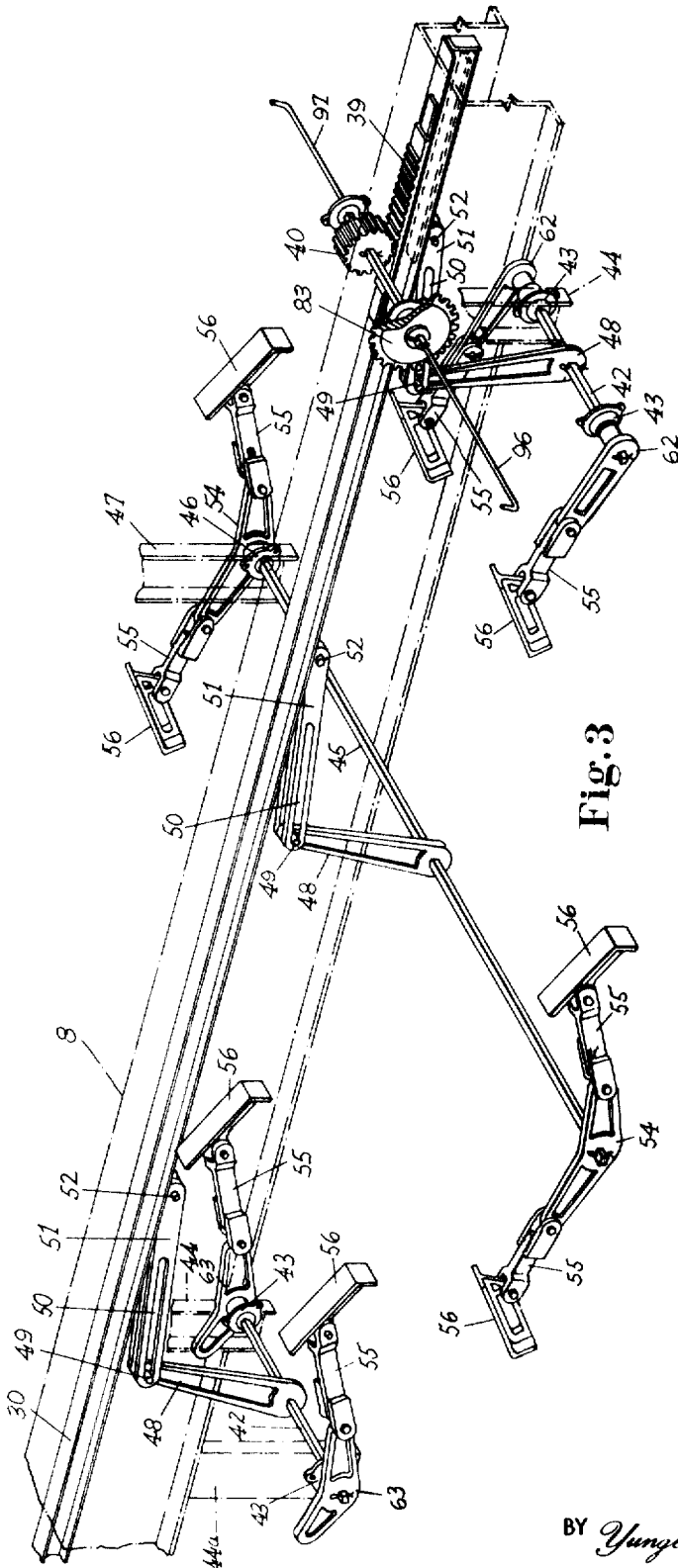


Fig. 3

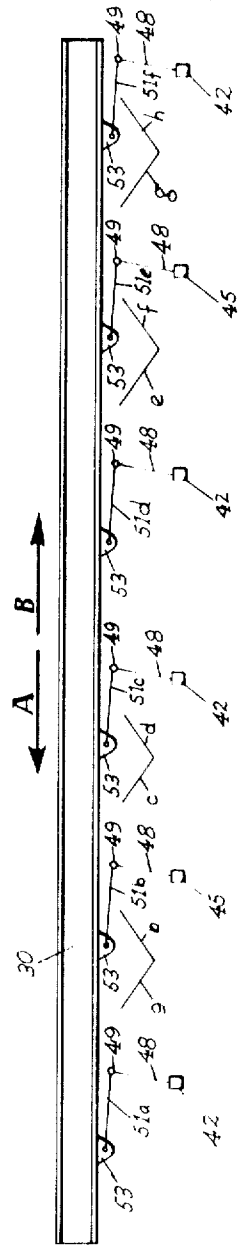


Fig. 23

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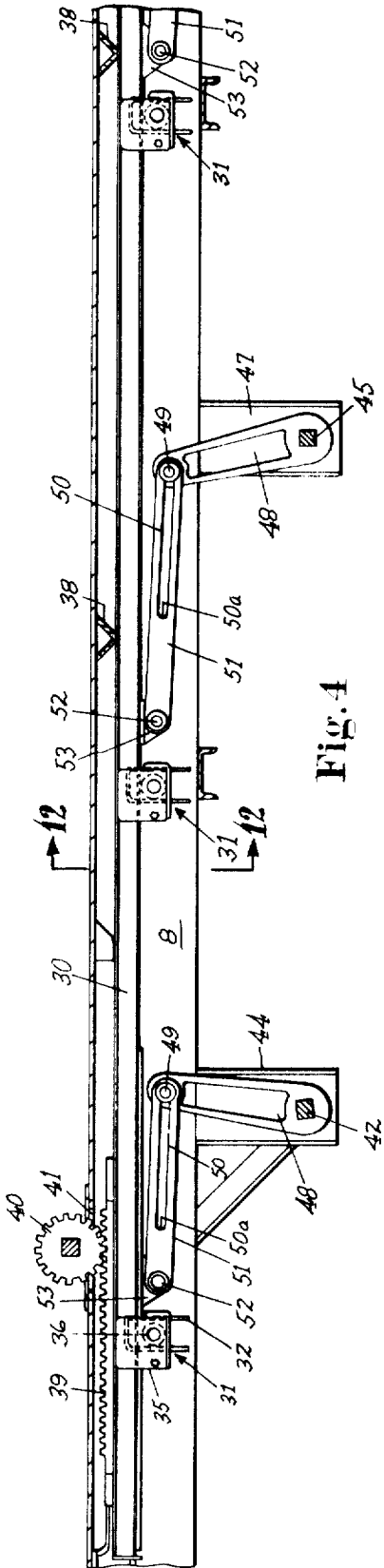


Fig. 4

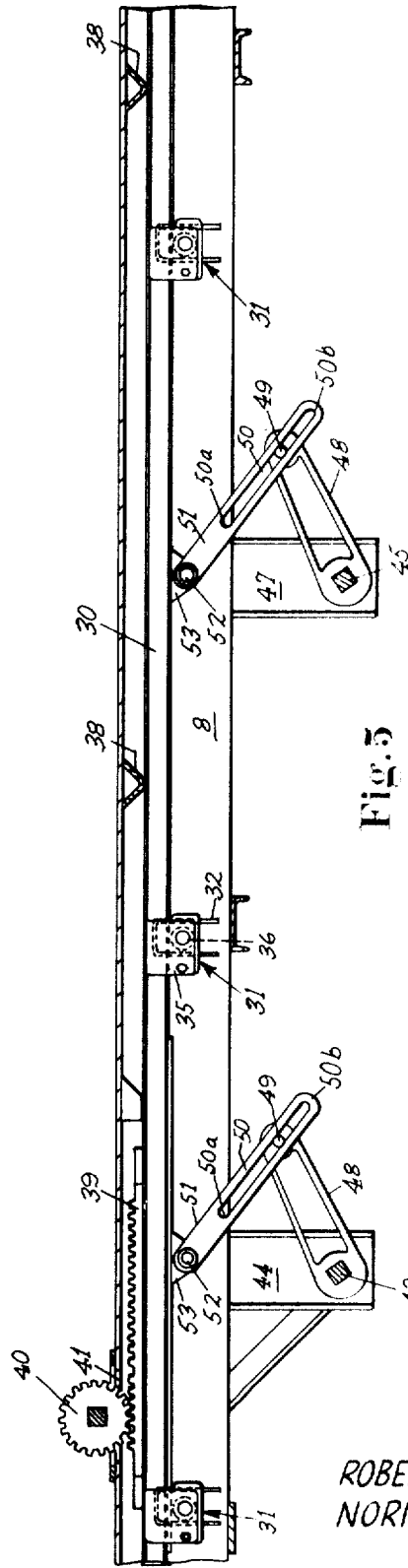


Fig. 5

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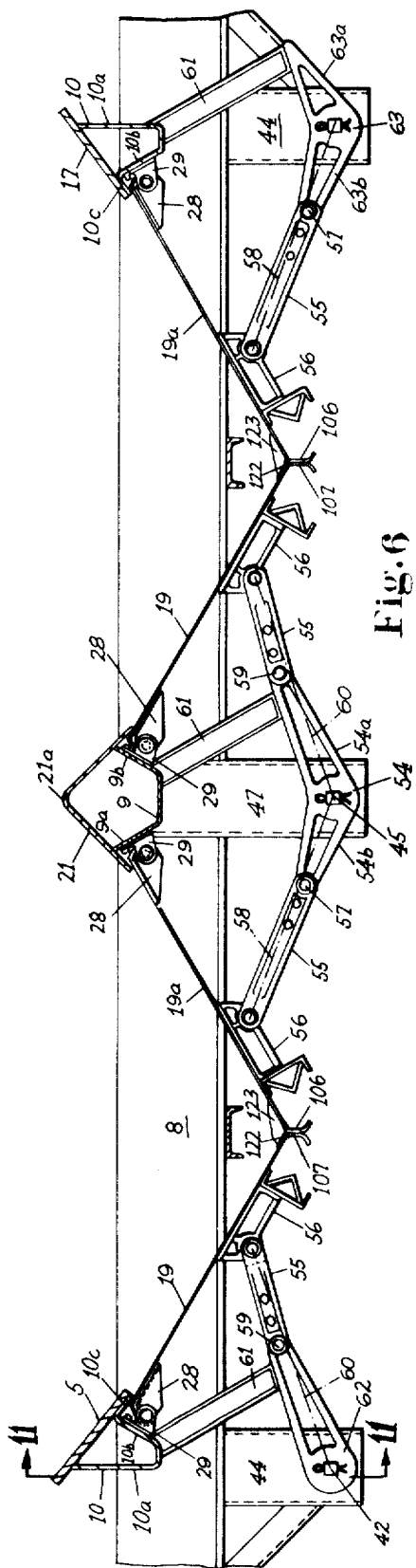


Fig. 6

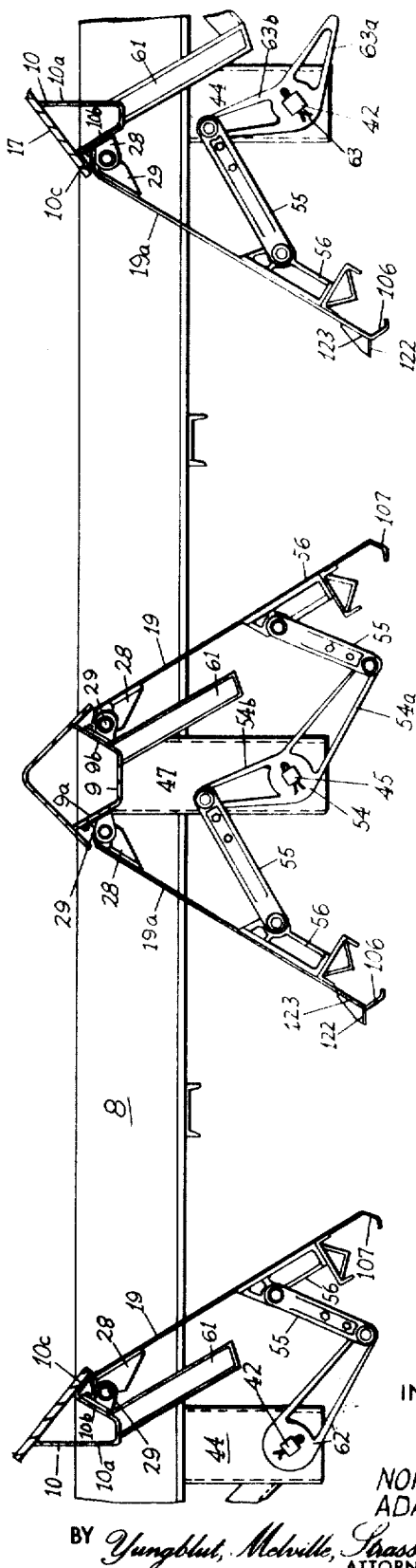


Fig. 7

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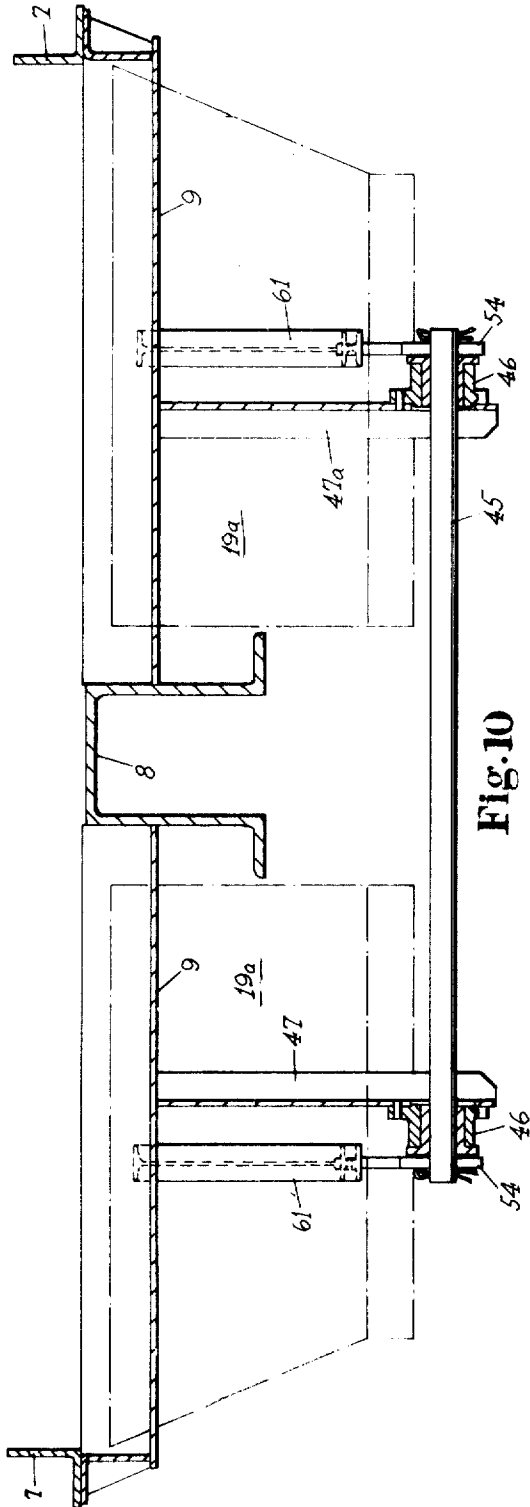


FIG. 10

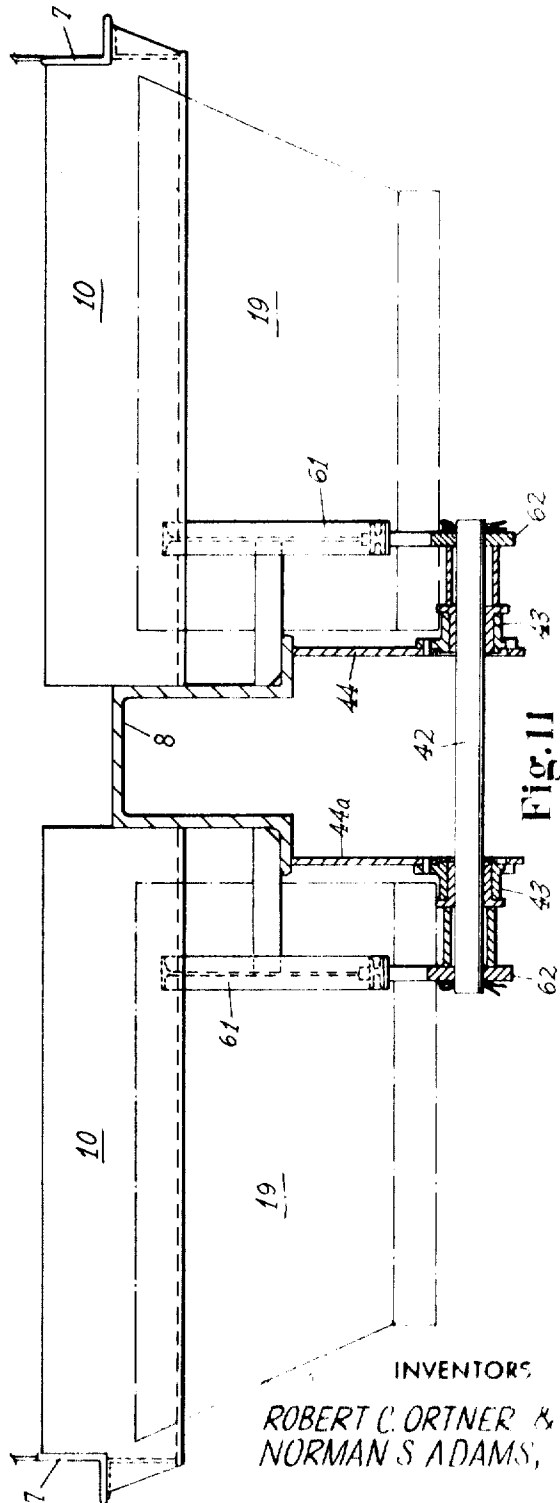


FIG. 11

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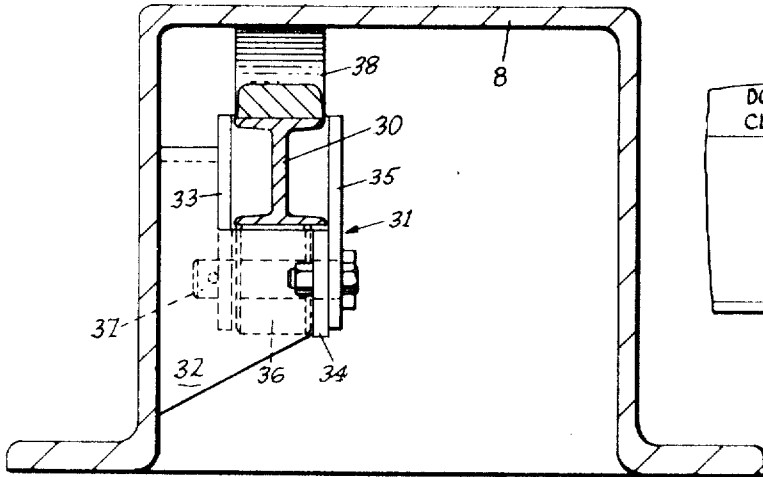


Fig. 12

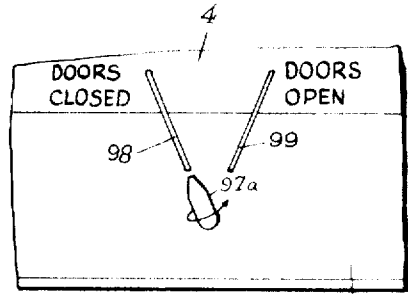


Fig. 15

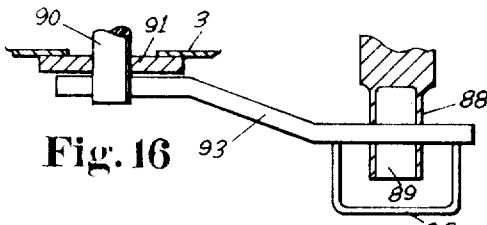


Fig. 16

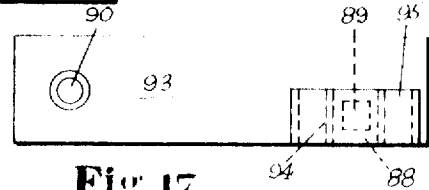


Fig. 17

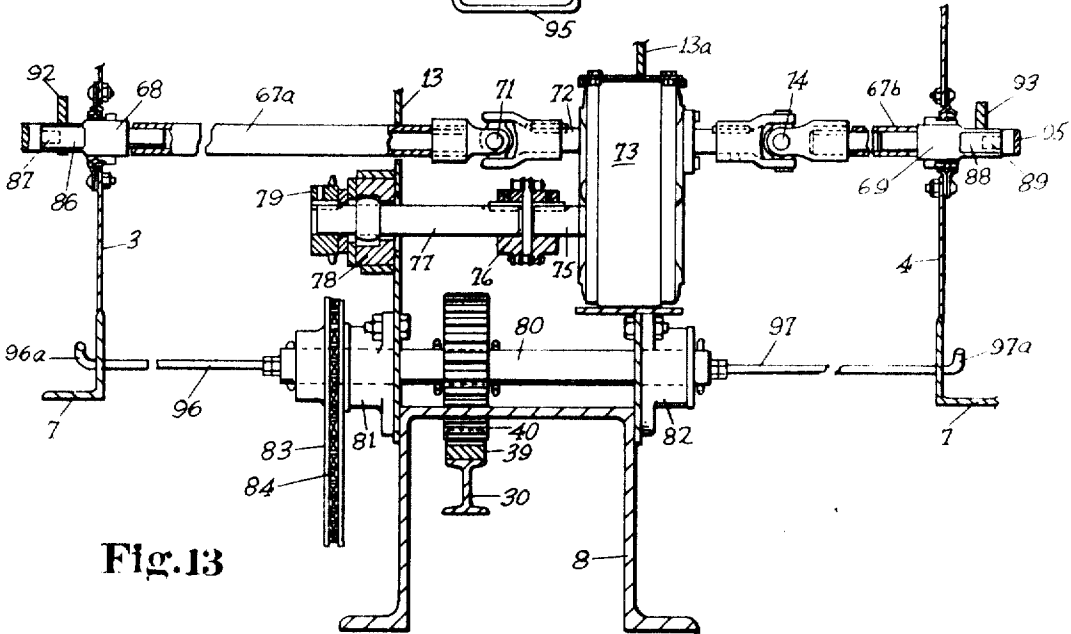


Fig. 13

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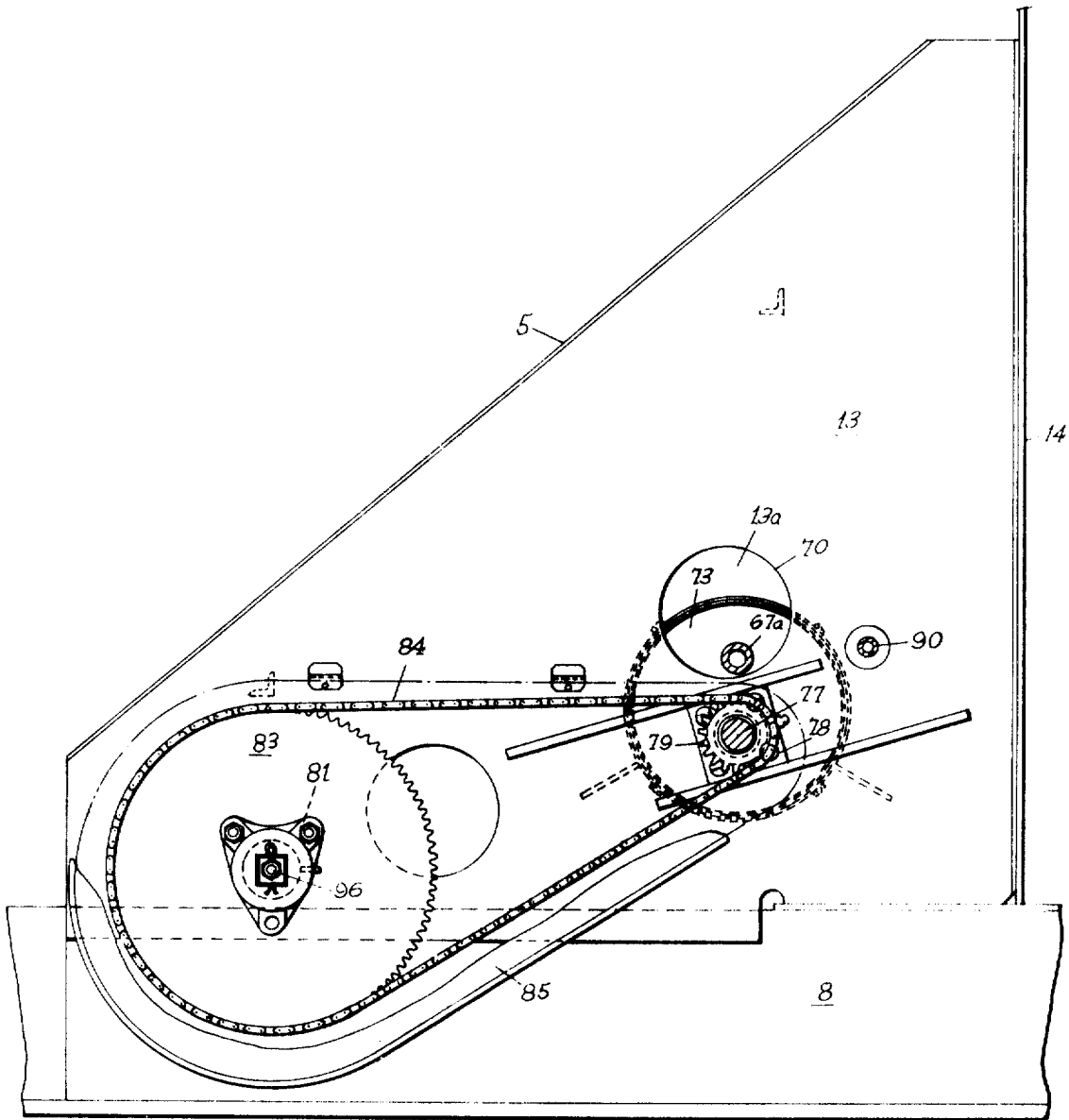


Fig. 14

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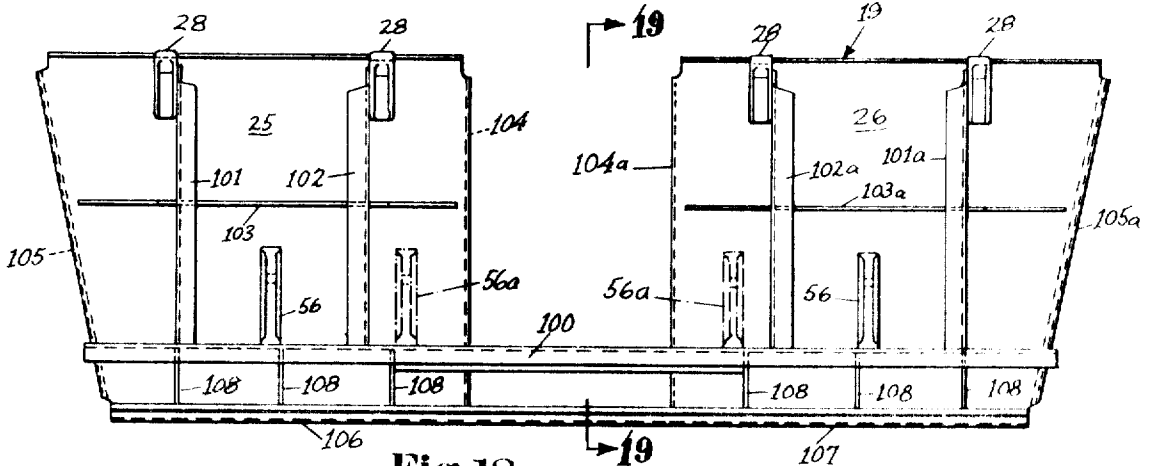


Fig. 18

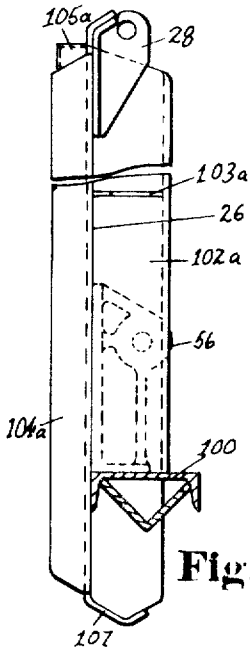


Fig. 19

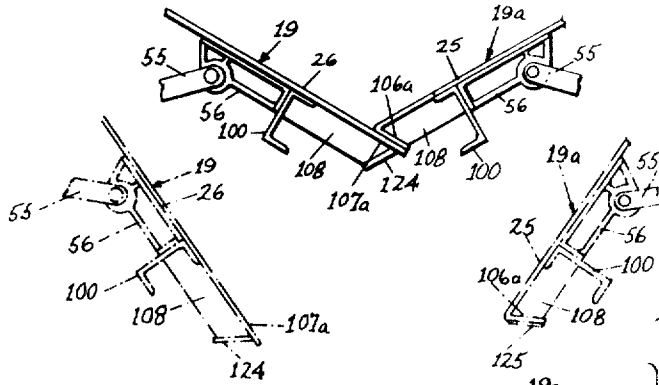


Fig. 20

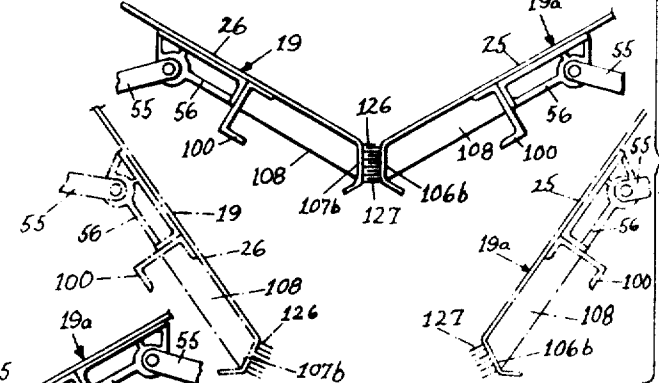


Fig. 21

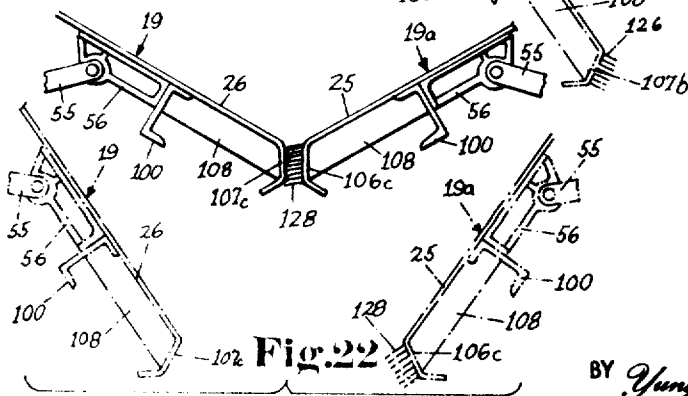
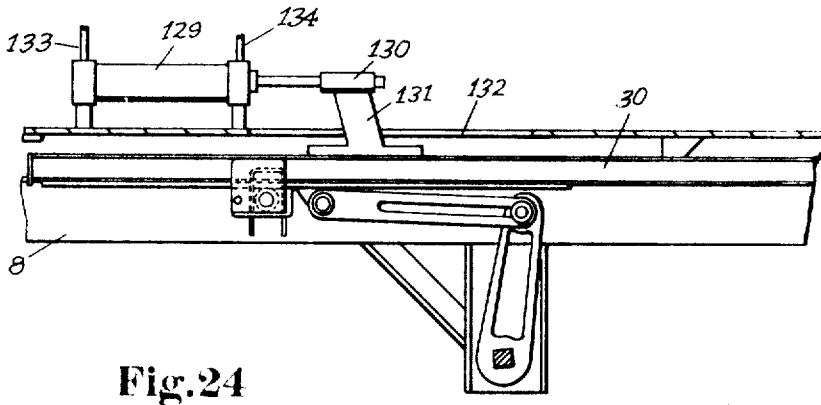
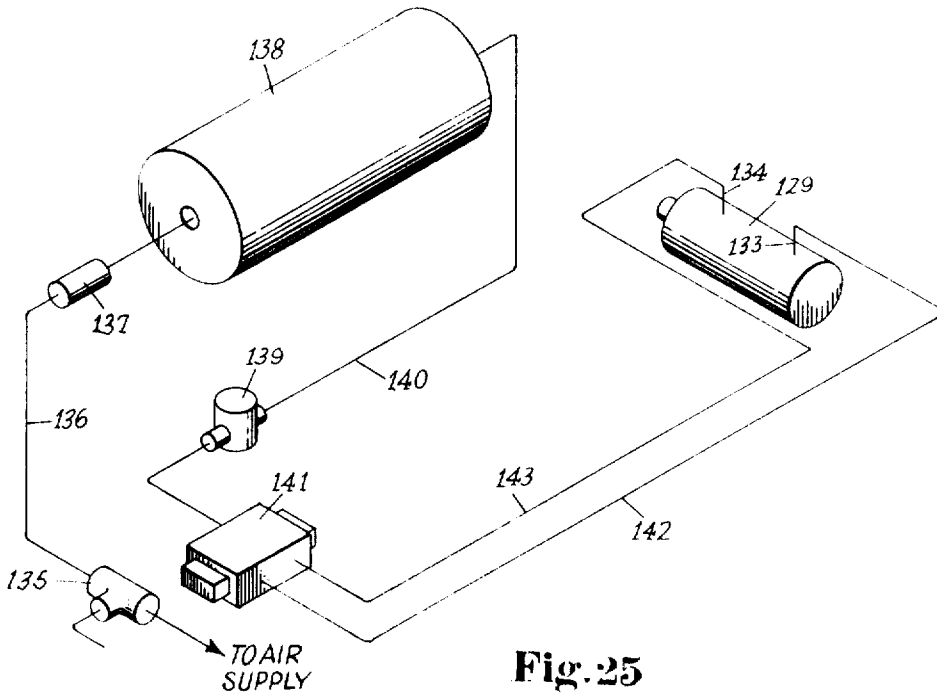


Fig. 22

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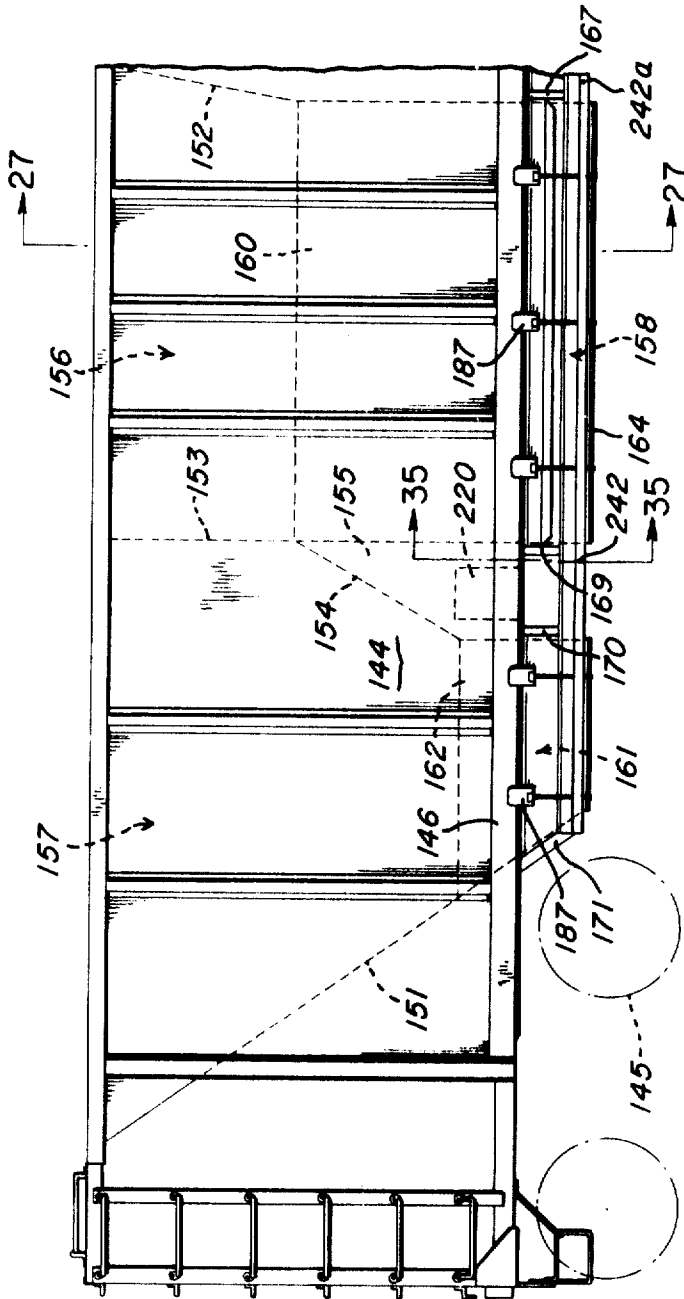


Fig. 26

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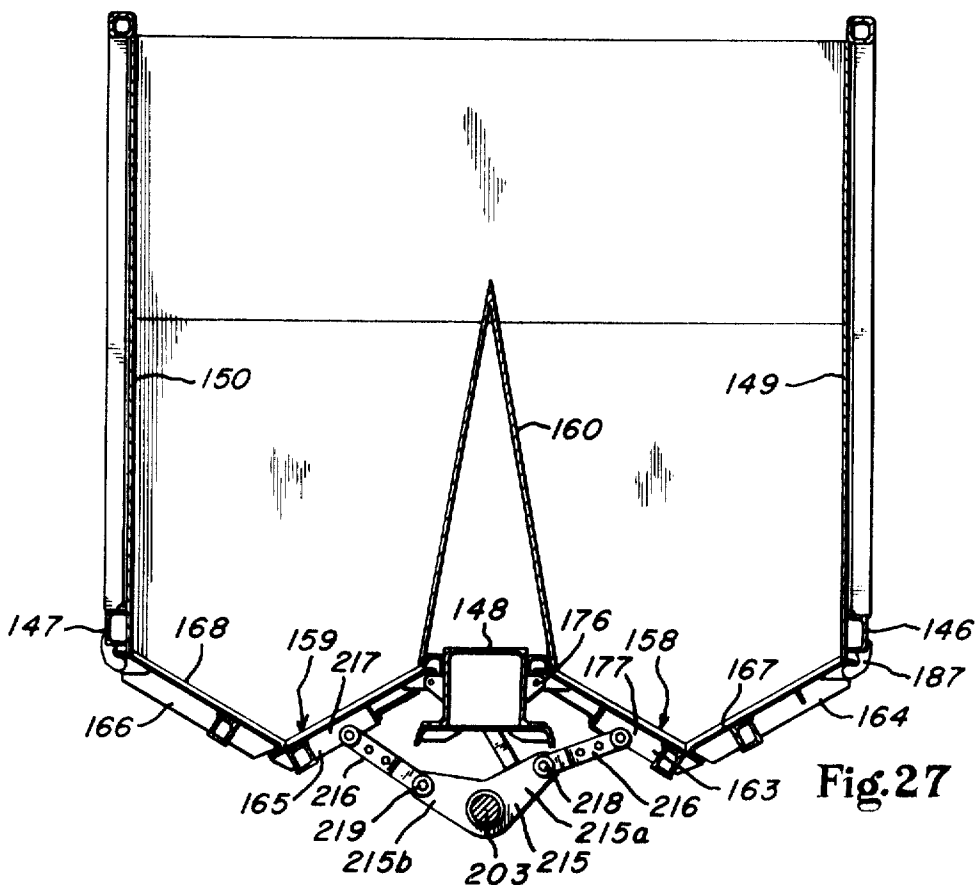


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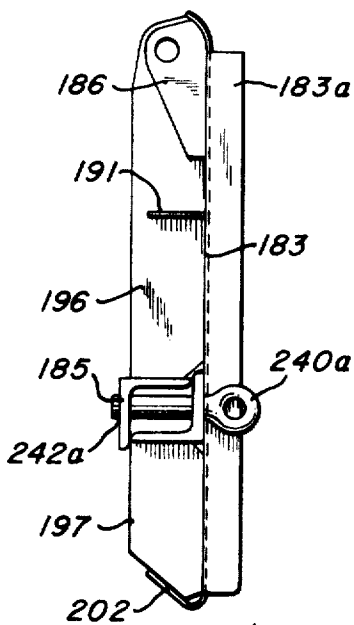


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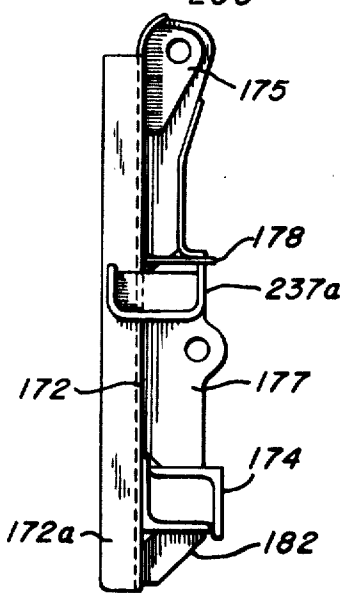
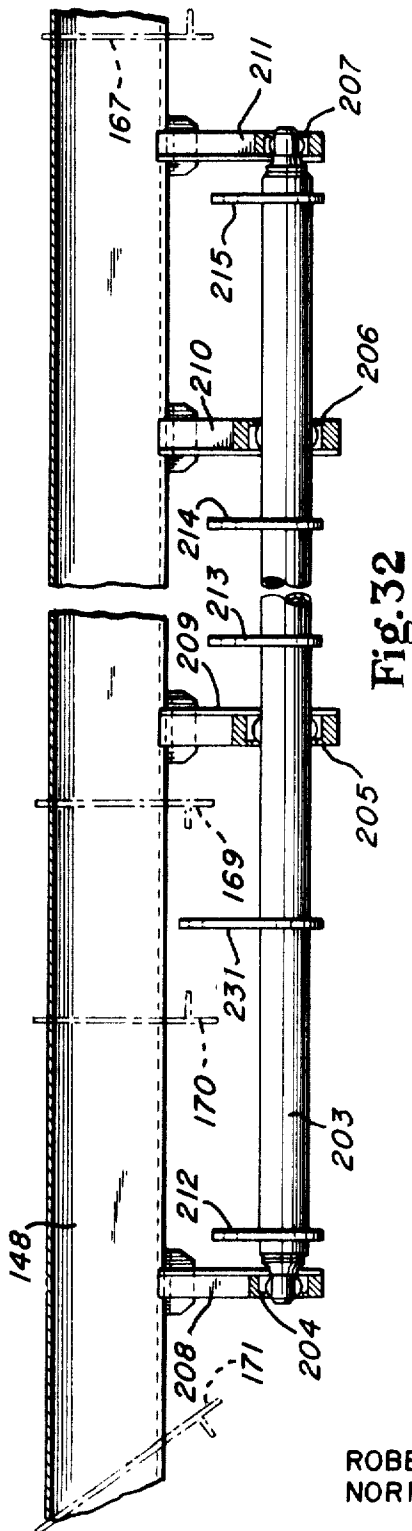
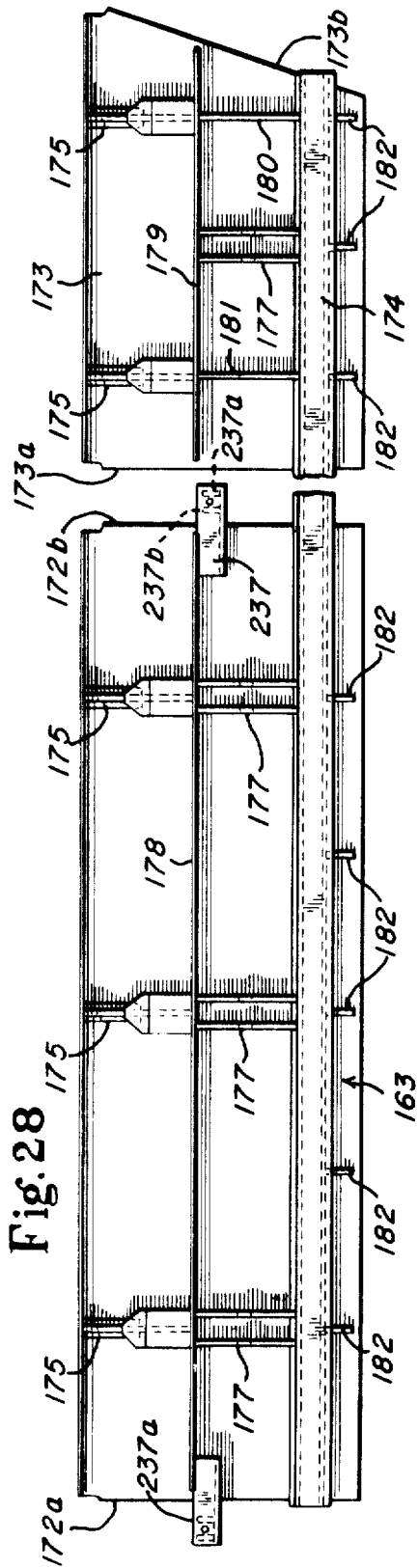


Fig. 29

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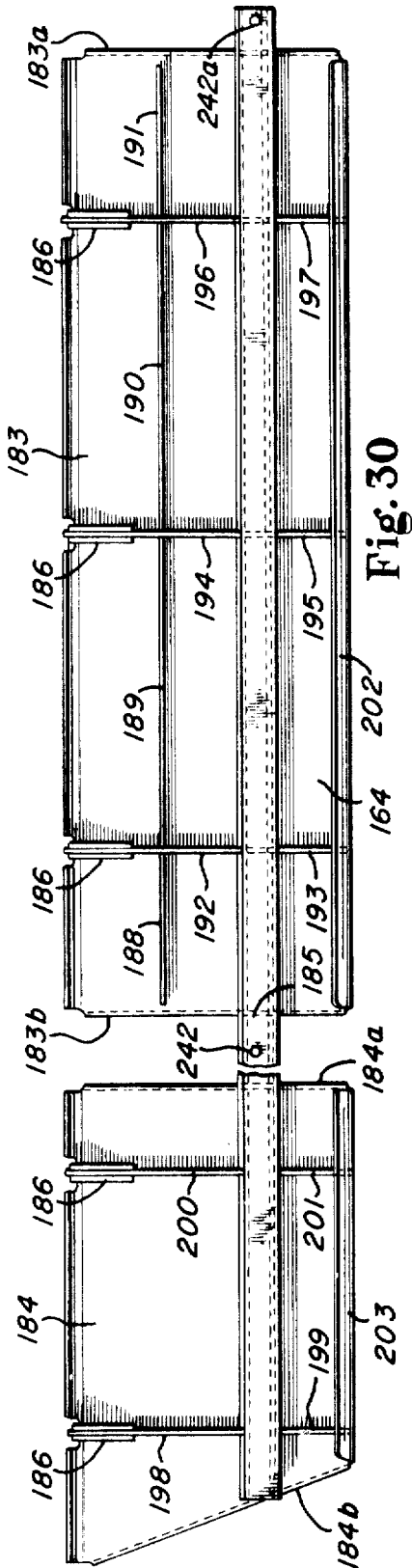


Fig. 30

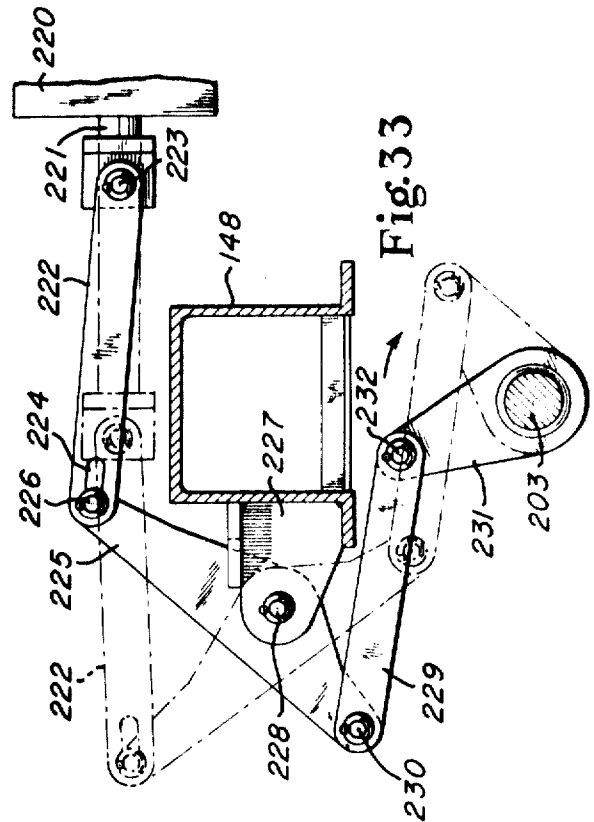


Fig. 33

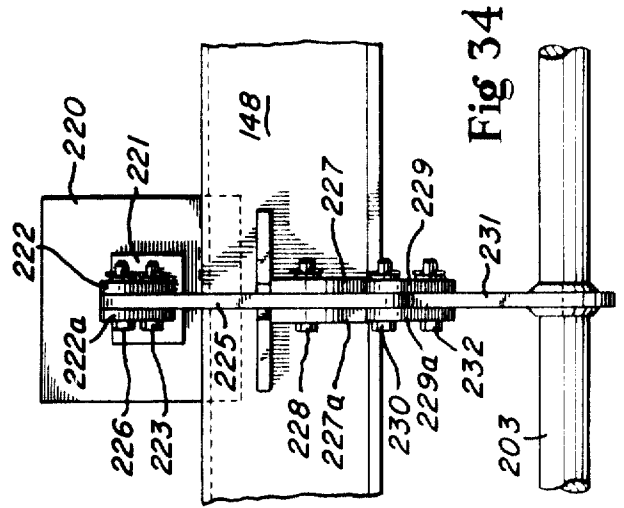


Fig. 34

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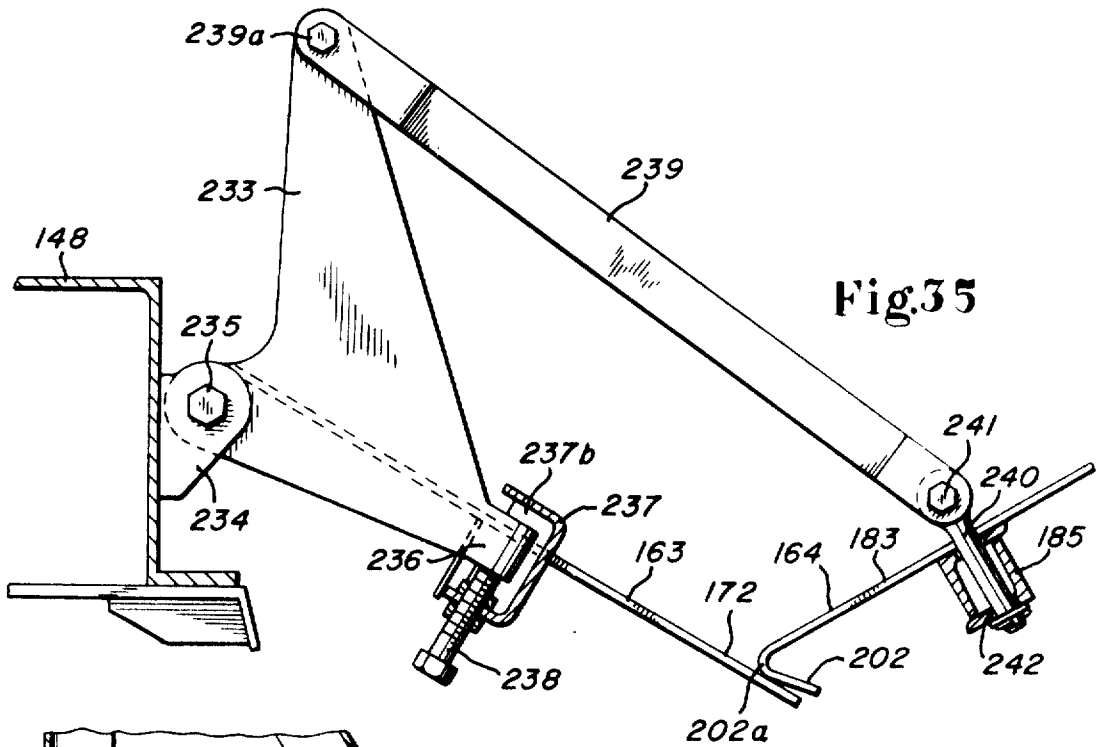


Fig. 35

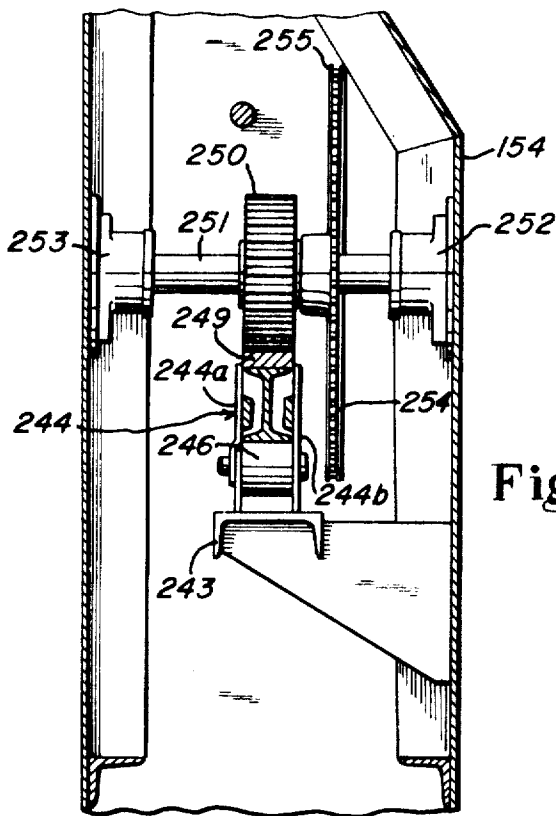


Fig. 37

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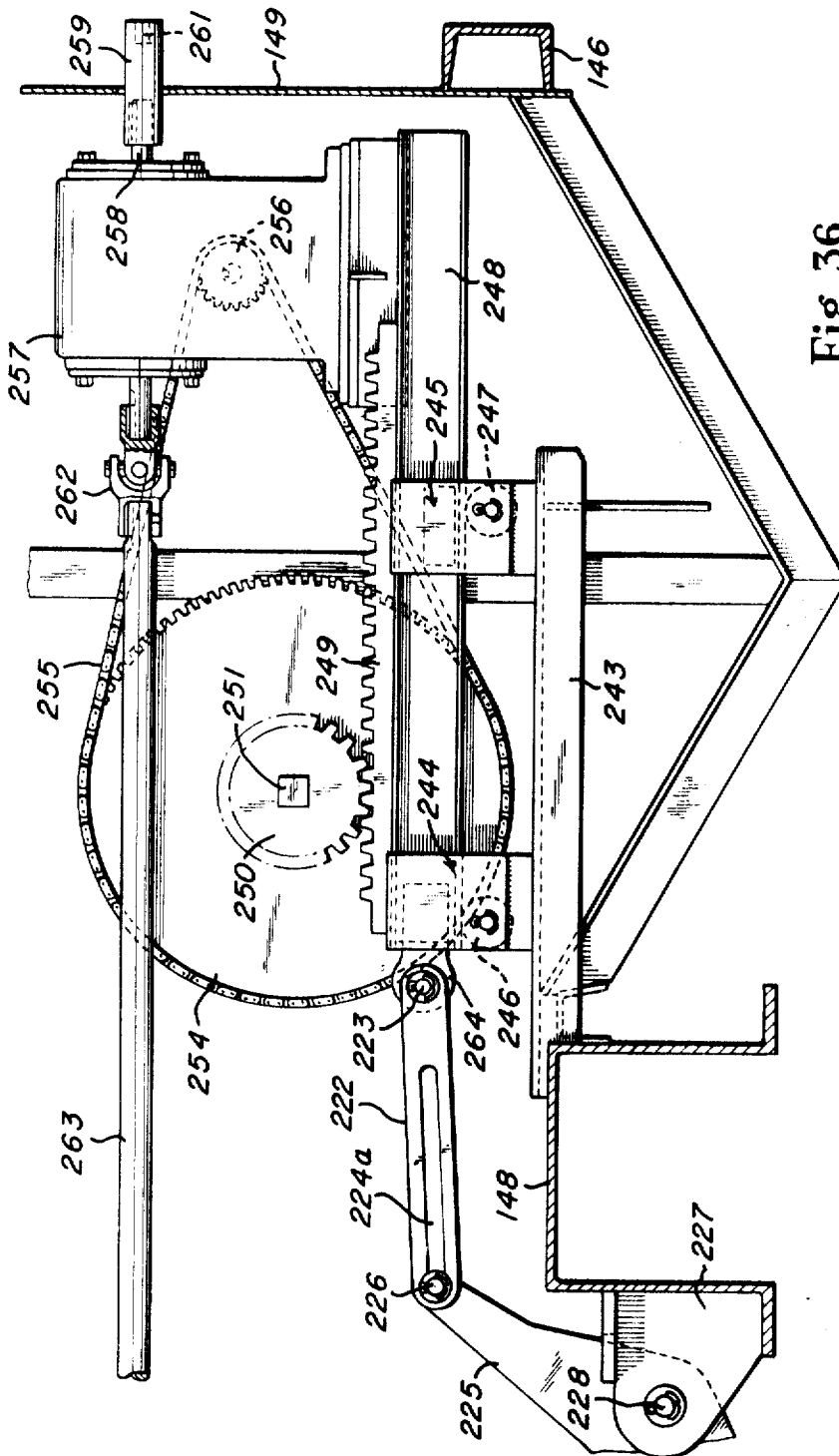


Fig. 36

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RAPID DISCHARGE HOPPER CAR DOOR ACTUATOR

CROSS-REFERENCE TO RELATED APPLICATIONS

This is a continuation-in-part application of the copending application by the same inventors, Ser. No. 546,722, filed May 2, 1966, now abandoned and entitled RAPID DISCHARGE HOPPER CAR DOOR ACTUATOR.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to improvements in railroad freight cars, and more particularly to improvements in freight cars of the type wherein the load is discharged through a plurality of doors in the underside of the car body. Such cars are generally known as hopper cars.

2. Description of the Prior Art

Heretofore various forms and arrangements of discharge openings have been proposed by means of which the contents of the car can be discharged. Until recently, the most common type of hopper car in use comprised an elongated body having high vertical sides. The interior of the car body was divided into a number of chutes, having sloping walls which extended across the interior of the car body. Each chute had a substantially triangular cross section, and the lowermost portion of each chute terminated in a single or a cooperating pair of hopper doors. Each hopper door was provided with one of a number of different types of manually operated latch means. For example, it was common to provide each door with a hook-type latch at each side. To unload the car it was necessary for yardmen or crew members to walk along each side of the car and manually release each of the latches, thereby rendering the doors free to be opened by the weight of the car-load itself. When the load had been discharged it was then necessary to manually reclose and relatch each of the doors.

Hopper cars of the type described presented further problems in addition to the requirement of manual opening and closing of each hopper door. Often it was difficult to completely discharge the contents of the car, particularly where materials such as pulverized coal, wood chips and the like were being carried, since such loads tended to become compacted by the motion of the car. Furthermore, when exposed to the elements during transit, such loads often became frozen or caked. Under such circumstances simply opening the hopper doors was often not sufficient to discharge the load. Frequently it was necessary for the crews to use picks, shovels, vibrators or car shakers to loosen the material of the load so that it would flow from the chutes. Sometimes, depending upon the load being carried, the crew would build fires under the chutes to loosen the frozen material, but this often resulted in considerable damage to the underside of the car, the airbrake system and the like.

Recently, there has been a growing demand for larger hopper cars of greater capacity. In cars of this type, the above-mentioned problems become even more acute.

Steps have been taken to overcome these problems. For example, hopper cars have been developed the interiors of which are not divided into a plurality of separate chutes. Rather, substantially the entire bottoms of such cars are openable by means of a plurality of cooperating hopper doors. Means have also been provided for automatically opening the hopper doors sequentially or simultaneously, reference being made, by way of example, to U.S. Pat. No. 3,187,684 entitled RAPID DISCHARGE HOPPER CAR, issued June 8, 1965, in the name of Robert C. Ortner.

Even in the newer and more advanced types of hopper cars, it has been found that certain conditions still exist which tend to impede the rapid discharge of the load. For example, it has been found that under certain wet and freezing conditions, that portion of the load adjacent the hopper doors will freeze and form a hard frozen layer or crust which will prevent or impede discharge of the car even when the doors are in open position. It has also been found desirable to provide a hopper

car with automatic means for opening the hopper doors simultaneously or sequentially and for closing the hopper doors simultaneously, wherein the door-actuating means is capable of fine adjustment not only to insure the proper opening of the doors, but also to insure their proper and simultaneous closing.

SUMMARY OF THE INVENTION

The present invention is directed to the provision of a hopper car having improved means for automatically opening and closing the hopper doors. The hopper doors are of improved construction, characterized by great strength, and yet capable of sufficient double-acting flexure during the door-opening operation to shear loose from the doors any hardened or frozen crust formed by that part of the load adjacent the door. The door-actuating means are capable of fine adjustment so that the actuating means will effect the desired double-acting flexure of the doors.

In one embodiment, a plurality of hopper doors are arranged in opposing relationship and extend transversely of the hopper car. In another embodiment, a plurality of hopper doors are arranged in opposing relationship and extend longitudinally of the hopper car.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a semidiagrammatic elevational view, with parts in section, of a hopper car in accordance with the instant invention.

FIG. 2 is a semidiagrammatic plan view of the hopper car of FIG. 1.

FIG. 3 is a fragmentary perspective view illustrating the door-actuating mechanism of the present invention.

FIG. 4 is a fragmentary cross-sectional view taken along the section line 4-4 of FIG. 2, showing the center sill of the hopper car of the present invention and a portion of the door-actuating means in the "door-closed" position.

FIG. 5 is similar to FIG. 4 and shows the door-actuating means in the "door-open" position.

FIG. 6 is a fragmentary longitudinal cross-sectional view of the hopper car of the present invention taken along section line 6-6 of FIG. 2 and showing another portion of the door-actuating means in the "door-closed" position.

FIG. 7 is a view similar to FIG. 6 but showing the door-actuating mechanism in "door-open" position.

FIG. 8 is a fragmentary exploded view showing the upper end of a center lever, and the splined adjustment means for the center lever pin.

FIG. 9 is an exploded view of the door link illustrating means for adjusting its length.

FIG. 10 is an enlarged cross-sectional view taken along the section line 10-10 of FIG. 6.

FIG. 11 is an enlarged cross-sectional view taken along the section line 11-11 of FIG. 6.

FIG. 12 is an enlarged cross-sectional view taken along the section line 12-12 of FIG. 4.

FIG. 13 is an elevational view, with parts in section, of the driving mechanism for the door-actuating means.

FIG. 14 is a side elevation of the driving mechanism with parts in cross section.

FIG. 15 is an enlarged fragmentary elevational view of the hopper car side showing the means for indicating the positions of the hopper doors.

FIG. 16 is an enlarged fragmentary plan view of the locking means for the door-actuating assembly.

FIG. 17 is an elevational view of the locking means of FIG. 16.

FIG. 18 is an elevational view of a hopper door assembly of the present invention.

FIG. 19 is an enlarged cross-sectional view taken along the section line 19-19 of FIG. 18.

FIG. 20 is a fragmentary elevational view of a pair of cooperating hopper doors, illustrating an improved form of door-sealing means.

FIG. 21 is similar to FIG. 20 showing yet another form of door-sealing means.

FIG. 22 is a view similar to that of FIG. 20 showing an additional door-sealing means.

FIG. 23 is a diagrammatic representation of the door-actuating mechanism illustrating the sequential door-opening operation.

FIG. 24 is a fragmentary elevational view with parts in cross section showing fluid-actuated cylinder means for imparting movement to the door-actuating beam.

FIG. 25 is a diagrammatic representation of one form of fluid-actuated cylinder means.

FIG. 26 is a fragmentary, semidiagrammatic elevational view of a hopper car of the type having longitudinally extending hopper doors.

FIG. 27 is a cross-sectional view taken along the section line 27-27 of FIG. 26.

FIG. 28 is an elevational view of an inner door of the hopper car of FIG. 26.

FIG. 29 is an end view of the door of FIG. 26 as seen from the left in FIG. 26.

FIG. 30 is an elevational view of an outer door of the hopper car of FIG. 26.

FIG. 31 is an end view of the door of FIG. 30 as seen from the right in FIG. 30.

FIG. 32 is a fragmentary side elevational view of the door actuating shaft.

FIG. 33 is a fragmentary side elevational view of the assembly for rotating the door-actuating shaft.

FIG. 34 is a fragmentary end elevational view of the assembly of FIG. 33 as seen from the left in FIG. 33.

FIG. 35 is a fragmentary, semidiagrammatic side elevational view of the outer door actuating linkage.

FIG. 36 is a fragmentary elevational view of an alternate assembly for rotating the door-actuating shaft of FIG. 32.

FIG. 37 is a fragmentary end elevation of the assembly of FIG. 36 as seen from the right in FIG. 36.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The teachings of the present invention may be applied to any suitable form of hopper car. Without constituting a limitation on the present invention, the invention will be described with respect to a hopper car of the type having four pairs of cooperating hopper doors and a center sill extending throughout the length of the car. FIGS. 1 and 2 constitute respectively an elevational and a plan view of a hopper car of the type described, and like parts have been given like index numerals.

The hopper car comprises an elongated body generally indicated at 1 and mounted on conventional trucks 2. The body comprises vertical sides 3 and 4 with inclined end walls 5 and 6, conventionally called slope sheets.

The car body is provided with a base framework, comprising elongated side frame members or sidewalls (one of which is shown at 7), a longitudinally extending center frame member or sill 8, and a plurality of additional frame members 9 and 10 extending transversely of the car body from the center sill to the side sills 7. It will be understood by one skilled in the art that the ends of the car frame are provided with suitable bracing members, not shown. The sides 3 and 4 of the car are provided with a plurality of vertical braces generally indicated at 11, which extend upwardly from the side sills 7. The ends of the car body also have vertical brace members generally indicated at 12. The slope sheets 5 and 6 are additionally supported by a plurality of triangular braces 13 (see FIGS. 1 and 13) extending upwardly from the base frame of the car body to the slope sheets. The vertical edges of the triangular braces 13 support a vertical panel or body bolster 14 (see FIGS. 1 and 13).

As is most clearly shown in FIG. 3, the slope sheets 5 and 6 extend downwardly to pairs of rectangular discharge openings generally indicated at 15 and 16, the pairs of openings being separated by small oppositely slanted slope sheets 17 and 18.

Each of the discharge openings 15, 16 is closed by a cooperating pair of hopper doors 19 and 19a. The hopper doors 19 and 19a are split so as to provide room for the passage of the center sill 8, and are supported by the transversely extending sets of frame members 9 and 10. As will be described more fully hereinafter, the split doors 19 and 19a are substantially identical. It will be further understood by one skilled in the art that it would be within the scope of this invention to provide the car of FIGS. 1 and 2 with an additional set of cooperating doors comparable to the doors 19 and 19a in replacement of the slope sheets 17 and 18.

As most clearly shown in FIG. 2, the center sill 8 may be provided with a hood or cover 20 having inclined wall surfaces tapering outwardly and downwardly from a ridge 20a. The frame elements 9 extending transversely across the openings 15 and 16 may similarly be provided with hoods or covers 21 having inclined wall surfaces tapering downwardly and outwardly from ridges 21a. The hoods or covers 20 and 21 serve not only to break up the load, but also to guide it during the discharge operation. As indicated in FIG. 2 the transversely extending supports 9 and the slope sheets 17 and 18 may be additionally supported by struts generally indicated at 22. The struts extend upwardly and outwardly from the frame members 9 or the slope sheets 17 and 18 to the car body sides. Preferably these struts are tubular in configuration, being of elliptical cross section so as to provide maximum strength and minimum resistance to the discharge flow of the carload.

The car body has a plurality of downwardly depending inwardly sloping triangular members 23 which form the outside closure means for cooperating pairs of hopper doors. The triangular members 23 depend from the side frames 7. Similarly, additional triangular members 24 are provided to form the inside closures for cooperating pairs of hopper doors. The triangular members 24 are suitably supported from the car frame adjacent the center sill, or they may be affixed to the center sill.

Referring to FIG. 6, it will be noted that the transversely extending frame members 9 and 10 differ slightly in configuration. This is due to the fact that the frame members 9 are located at the center of the openings 15 and 16 while the frame members 10 are located at the lowermost edge of the slope sheets, such as the slope sheets 5 and 17 shown in FIG. 6. The frame members 9 are generally U-shaped in cross section, the legs of the U-shaped configuration sloping upwardly and outwardly to provide door hinge mounting surfaces 9a and 9b. The frame members 10 are also of U-shaped cross sectional configuration, but one leg 10a of the U-shaped configuration is vertically oriented and forms a support for the lower edge of the adjacent slope sheet, while the other leg slants upwardly and outwardly to form a door hinge mounting surface 10b, the leg terminating in a bent over portion 10c forming an additional slope sheet support.

Referring to FIG. 18, a typical hopper door 19 is shown. It will be understood by one skilled in the art that a cooperating hopper door 19a will be substantially identical. The hopper door 19 comprises two closure members 25 and 26 which constitute mirror images of each other and which are joined by an elongated brace. This construction is necessary since the closure members 25 and 26 will lie on either side of the center sill 8. The uppermost edges of the closure members 25 and 26 are provided with hinge means 28. As shown in FIG. 6, the hinge members 28 coact with cooperating hinge members 29 located on the hinge-supporting surfaces of the frame members 9 and 10.

The hopper door actuating means is most clearly shown in FIGS. 3, 4 and 6. The center sill 8 of the car body frame is of U-shaped cross section with downwardly depending legs. A door-actuating beam 30 is slidably mounted within the center sill. For purposes of illustration, the door-actuating beam is shown as an I-beam. The inside surface of one of the legs of the center sill bears a plurality of beam-supporting brackets generally indicated at 31. As best seen in FIG. 12, each beam supporting bracket 31 comprises a member 32 permanently

affixed to the inside surface of the leg of the center sill and extending perpendicular thereto. The bracket 32 supports a pair of parallel plates 33 and 34. An additional plate 35 is bolted to the plate 34. The plates 33 and 35 constitute side guides for the door-actuating beam. A roller 36 is rotatably mounted to the bracket by means of a pin 37 passing through the plates 33, 34 and 35, and serves as a support for the door-actuating means permitting its sliding motion longitudinally of the center sill. The inside horizontal surface of the center sill is provided with a plurality of spaced downwardly depending V-shaped members 38, serving as top guide members for the door-actuating beam.

At one end the upper surface of the door-actuating beam is provided with a rack 39, seen in FIG. 3 and 4. The rack is engaged by that portion of a gear 40 which extends downwardly through a slot 41 in the center sill 8. It will be understood that rotation of the gear 40 will cause longitudinal movement in the door actuating beam, as will be more fully described hereinafter.

Beneath each door supporting frame member 9 and 10 there is located a shaft extending transversely of the car body. Thus, beneath each frame member 10 there is located a shaft 42 rotatably supported in suitable bearings 43 affixed to a spaced pair of downwardly depending beams 44 and 44a. Similarly, beneath each door supporting frame member 9 there is located a shaft 45 supported in suitable bearings 46 on a spaced pair of downwardly depending beams 47 and 47a. The shafts 42 and 45 differ from each other only in length. The reason for this is clearly shown in FIGS. 10 and 11. As seen in FIG. 10, the downwardly depending beams 47 and 47a, supporting the shaft 45, are themselves affixed to the frame members 9 and are spaced from the center sill 8. In FIG. 11, on the other hand, it will be noted that the downwardly depending beams 44 and 44a, supporting the shaft 42, do not depend from the frame member 10, but rather from the center sill 8 itself. Thus, the door lever shafts 42 are shorter than the door lever shafts 45.

Each door lever shaft 42 and 45 is provided with a center lever 48 nonrotatably affixed to the shaft and located beneath the center sill 8. The upper or free end of each center lever 48 is provided with a center lever pin 49, which will be more fully described hereinafter. The pin 49 is slidably engaged in slots 50 in a pair of elongated elements 51, which pair of elements is hereinafter referred to as a push rod. Each pair of elements, or push rods 51, is pivotally affixed by means of a pin 52 to a push rod fulcrum 53 affixed to the bottom surface of the door-actuating beam 30.

While the action of the door-actuating means will be fully described hereinafter, particular reference is made to FIG. 4 wherein it will be clear that if the gear 40 is rotated in a counterclockwise direction, causing the door-actuating beam 30 to move to the right, the center lever pin 49 of each center lever 48 will be engaged by the forward end 50a of the slot 50 of each push rod, causing the center levers 48 to rotate in a clockwise direction. This in turn will cause each of the shafts 42 and 45 to rotate in a clockwise direction. Similarly, if the gear 40 is rotated in a clockwise direction, the door-actuating beam 30 will move to the left, and the center lever pins 49 will be engaged by the tail end 50b of each of the slots 50 in the push rods 51, causing a counterclockwise rotation of the center levers 48 and the shafts 42 and 45.

Door lever means are affixed to the outer ends of the door lever shafts 42 and 45. As is most clearly shown in FIGS. 3 and 6, the door levers 54 affixed to the ends of the door lever shaft 45 are identical and each comprise a long arm 54a and a short arm 54b. The ends of the arms 54a and 54b of the door levers have pivotally affixed to them link elements 55. The link elements 55 will be more fully described hereinafter. The link elements are, in turn, pivotally attached to door fulcrum elements 56. The door fulcrum elements 56 are permanently affixed to the closure members 25 and 26 of the hopper doors 19 or 19a (see FIG. 18).

In FIG. 6 the assembly comprising the door lever 54, links 55 and door fulcrums 56 are illustrated in the position they would assume when the hopper doors 19 and 19a are in closed position. In this position, it will be noted that the pivot point 57 between the door lever arm 54b and the attached link 55 lies beyond the dead center line of this linkage represented by the broken line 58. Similarly, the pivot point 59 between the door lever arm 54a and the attached link 55 lies beyond dead center of this assembly represented by the broken line 60. Thus, the doors 19 and 19a are effectively locked in closed position, and the weight of the hopper doors and the load pressing thereagainst act to maintain the linkage in closed and locked position. Preferably a stop 61 depending from the frame member 9 is provided to establish the fully closed position of the door lever.

As indicated above, the door lever shafts 42 are located beneath the frame members 10, which in turn, are associated with the ends of the slope sheets. Thus the door lever shafts 42 are intended to operate only one hopper door assembly. To the left in FIG. 6, a door lever shaft 42 is shown, adapted to actuate a hopper door assembly 19 located to the right of the shaft and at the bottom edge of the slope sheet 5. It will be understood by one skilled in the art that the same assembly (not shown) will occur at the bottom of the slope sheet 18. The linkage with respect to the shaft 42 is substantially the same as that described with respect to the door lever shaft 45, and like parts have been given like index numerals. In this instance, however, the door levers indicated at 62 have only one arm equivalent to the arms 54a on the door levers 54. The door levers 62 are pivotally attached to links 55, which, in turn, are pivotally connected to door fulcrum members 56. Since the shaft 42 is shorter in length than the door lever shaft 45, it will be understood that the position of the door fulcrums 56 on the closure members 25 and 26 of the door 19 will be located as indicated in dotted lines at 56a in FIG. 18. Again, a stop 61 is provided to coact with the door lever 62 to determine its fully closed position. When this linkage is in its fully closed position, the pivot point 59 will be located beyond the dead centerline 60.

To the right in FIG. 6 there is shown a door lever shaft 42 adapted to actuate a single door assembly 19a located to the left of the shaft. This door-actuating assembly is shown lying substantially beneath the lower edge of the slope sheet 17, and it will be understood by one skilled in the art that a similar assembly will be located beneath the lower edge of the slope sheet 6. Again, the assembly is substantially the same as that described with respect to the shaft 45, and like parts have been given like index numerals. In this instance the door levers 63 have arms 63a equivalent to the arms 54a on the door levers 54. The sole purpose of the arms 63a is to cooperate with the stops 61. The door levers 63 are also provided with arms 63b which are pivotally attached to links 55, which, in turn, are pivotally joined to door fulcrums 56. The door fulcrums 56 will be located on the closure members 25 and 26 of the door 19a in the positions indicated in dotted lines at 56a in FIG. 18. Again, it will be noted that when the door 19a is in its closed and locked position, the pivot point 57 will lie beyond the dead center line 58.

The operation of the door-actuating mechanism may be described as follows. Reference is made to FIGS. 4 and 6 wherein the door-actuating mechanism is shown in the "door-closed" position and to FIGS. 5 and 7 wherein the door-actuating mechanism is shown in the "door-open" position. Starting with the parts in the positions illustrated in FIGS. 4 and 6, if the gear 40 is rotated in a counterclockwise direction, its coaction with the rack 39 will cause the door-actuating beam to move to the right, the push rods 51 will move the right along with the door-actuating beam and the center lever pins 49 will ultimately be contacted by the forward ends 50a of the slots 50 in the push rods. As the center lever pins 49 are so contacted, the center levers 48 will be rotated in a clockwise direction. This, in turn, will cause the shafts 42 and 45 to rotate in a clockwise direction. The clockwise rotation

of the shafts 42 and 45 will cause a clockwise rotation of the door levers 54, 62 and 63 respectively. It is only necessary to impart sufficient rotation to these door levers to cause the pivot points 57 and 59 to pass beyond their respective dead centerlines 58 and 60. From that point onward, further rotation of the door-actuating assembly will be caused by the weight of the doors 19 and 19a themselves and the weight of the load in the car bearing upon them. When the fully open position of the hopper door has been reached, the door-actuating assembly will be in the positions shown in FIGS. 5 and 7. That portion of the rotation of the door levers and door lever shafts imparted by the weight of the doors and the load of the car will cause the center lever pins to travel in the slots 50 in the push rods 51 to a position at or near the trailing ends 50b of the slots 50. This is indicated in FIG. 5. The coaction of the parts thus far described not only insures proper opening of the hopper doors without backlash, but also places the door actuating mechanism in proper position for the hopper door-closing action next described.

Referring particularly to FIGS. 5 and 7, it will be understood that clockwise rotation of the gear 40, coacting with the rack 39, will cause the door-actuating beam 30 to move to the left. As the beam 30 moves to the left, the center lever pins 49 will be approached and ultimately contacted by the trailing ends 50b of the push rod slots 50. This, in turn, will cause counterclockwise rotation of the center levers 48, the door lever shafts 42 and 45, and the door levers 54, 62 and 63 respectively. The counterclockwise rotation of the door levers to the position where the pivot points 57 and 59 have passed their respective dead center lines 58 and 60, will cause the hopper doors 19 and 19a to assume a fully closed position as shown in FIG. 7. As described above, since the pivot points have gone beyond dead center, the weight of the hopper doors themselves and any additional load they may bear will tend to hold the doors in closed and locked position.

It will be understood by one skilled in the art that if the push rod fulcrums 53 are properly located on the door-actuating beam, and if the forward ends 50a and trailing ends 50b of the push rod slots 50 all occupy the same relative positions with respect to their coacting center lever pins, all of the hopper doors 19 and 19a will open simultaneously and will close simultaneously. This is true because the same amount of travel of the door-actuating beam will cause all of the center lever pins to be contacted by the forward ends of the push rod slots simultaneously during the door-opening operation, and all of the center lever pins to be contacted simultaneously by the trailing ends 50b of the push rod slots during the door-closing operations. If, however, the relative positions of the trailing ends of the push rod slots with respect to their cooperating center lever pins is the same, but the position of the forward end 50a of each push rod slot 50 is at a relatively greater distance from the cooperating center lever pin, the doors will close simultaneously, but will open sequentially.

It has been found in practice that it takes approximately the same amount of force exerted on the beam 30 to rotate two of the shafts 42 (each controlling a single door) as it does to rotate one of the shafts 45 (controlling two doors). Thus, by providing push rods 51 having slots 50 of varying lengths, it is possible to cause a sequential opening of the doors, whereby the shafts 45 and pairs of shafts 42 are opened sequentially. Such an arrangement enables the entire door actuating mechanism to be made less expensively, of lighter construction, and of longer life. This type of arrangement is diagrammatically illustrated in FIG. 23. In this figure the shafts 42 and 45, the center levers 48, the center lever pins 49, the push rod fulcrums 53 and the actuating beam 30 are shown. The push rods are indicated at 51a through 51f. The hopper doors are diagrammatically indicated at a through h. The trailing ends of the slots in all of the push rods occupy the same relative position with respect to the center lever pins 49 so that movement of the actuating beam in the direction of the arrow A will cause a simultaneous counterclockwise rotation of the shafts 42 and 45 and hence a simultaneous closing of all of the

hopper doors a through h. The length of the slots in the push rods 51a and 51d will be such that their forward ends will contact their respective center lever pins simultaneously and before any of the remaining center lever pins are contacted by their respective push rods. In a similar fashion the push rod 51e will have a slot of such length that its forward end will contact its center lever pin next. Contact of the center lever pin by the forward slot end of push rod 51b will follow. Push rods 51c and 51f will be adapted to actuate their center levers last. Thus, as the actuating beam 30 moves in the direction of the arrow B, shaft 42 operatively connected to push rods 51a and 51d will be turned and hopper doors a and e will open. Next, push rod 51e will actuate the shaft 45 opening hopper doors f and g. Hopper doors b and c will then be opened through the action of push rod 51b. Finally hopper doors d and h will be opened through the action of push rods 51e and 51f respectively.

FIG. 8 is a fragmentary exploded view of the upper end of a center lever 48, showing the adjustable mounting of the center lever pin 49. The center lever pin 49 is permanently held in an eccentrically located perforation 64 in a splined adjustment means 65. The adjustment means 65 is frictionally held in a suitably configured perforation 66 in the upper end of the center lever 48. By suitably orienting the adjustment means 65 in the perforation 66, the center lever pin can be held in a range of adjusted positions with respect to the center lever. This range of positions of the center lever pin permits a fine adjustment of the pin with respect to the slot 50 in a push rod assembly 51. In this way, a given center lever pin in a given push rod slot can be adjusted to be properly contacted by both the forward and trailing ends of the push rod slot insuring proper opening of the hopper doors and proper simultaneous closure of the doors as well.

FIGS. 13 and 14 illustrate an exemplary form of operating means for the door-actuating assembly. The operating mechanism comprises coaxial main shaft elements 67a and 67b rotatively mounted in suitable bearings 68 and 69 in the car body sides 3 and 4. The shaft 67a passes through a perforation 70 in one of the triangular braces 13 (see FIG. 1) and is connected by means of a universal joint 71 to the input shaft 72 of a geared reducing means 73. The geared reducing means is suitably supported in a perforation in a second triangular support 13a. The main shaft element 67b is connected by means of a universal joint 74 to the input shaft of the reducer 73. The output shaft 75 of the reducer is connected by means of a flexible coupling 75 to an intermediate shaft 77. The intermediate shaft 77 is rotatively mounted in suitable bearing means 78 in the triangular brace member 13 and is provided at its end with a sprocket 79. A third shaft 80 is rotatively mounted in suitable bearing means 81 and 82 affixed to the triangular braces 13 and 13a respectively. That portion of the shaft 80 extending between the braces 13 and 13a bears the gear 40 which coacts with the rack 39 on the door-actuating beam 30 as described above. That end of the shaft 80 which extends beyond the bearing 81 is provided with a sprocket 83. The sprocket 79 on the shaft 77 and the sprocket 83 on the shaft 80 are connected by means of an endless chain 84. The sprockets 79 and 83 and the connecting endless chain 84 may be provided with a cover plate 85 removably affixed to the triangular brace 13.

The end 85 of the shaft 67a which extends beyond the car body side 3 is of square cross section, and is provided with a square perforation 87. Similarly, the end 88 of the main shaft element 67b is of square cross section and provided with a square perforation 89.

It will be obvious to one skilled in the art that the hopper doors of the car of the present invention may be operated by an individual crewman located on either side of the car. The end 86 of the shaft element 67a or the end 88 of the shaft element 67b may be engaged by a hand operated or automatic tool adapted to impart rotation thereto. Such tools are well known in the art, and may be provided with a male engagement means adapted to be inserted in the perforation 87 or the

perforation 89, or a female engagement means adapted to engage the shaft end 86 or the shaft end 88.

When rotation is imparted to either the main shaft element 67a or the main shaft element 67b the intermediate shaft 77 will be caused to turn at a slower speed by virtue of the reducer 73. Rotation of the shaft 77 will, in turn, be imparted to the shaft 80 by the cooperation of the sprockets 79 and 83 and the connecting endless chain 84. As was indicated with respect to FIGS. 4 and 5, rotation of the shaft 80 and its gear 40 in a counterclockwise direction will cause the doors to assume an open position. Rotation of the shaft 80 and gear 40 in a counterclockwise direction will cause the doors to close.

It will be understood by one skilled in the art that it is within the scope of this invention to provide the shaft ends 86 and 88 with handwheels, or with friction wheels adapted to cooperate with rail elements associated with the load-receiving means. Similarly, it is within the scope of the invention to provide prime mover means in association with the hopper car to cause rotation of the main shaft elements 67a and 67b.

FIGS. 13, 16 and 17 illustrate locking means for the door-operating and door-actuating mechanism. A shaft 90 extending transversely of the car passes through suitable bearing means (one of which is shown at 91 in FIG. 16) in the car body sides 3 and 4. The locking means, generally indicated at 92 and 93 in FIG. 13, are fixedly secured to the opposite ends of the shaft 90. The locking means 93 is shown in FIGS. 16 and 17 and comprises a straplike element one end of which is secured to the shaft 90 and the other end of which is provided with a rectangular notch 94. The locking means 93 and the shaft 90 are so positioned that the squared end 88 of the shaft element 67b may be engaged by the notch 94, whereby rotation of the shaft element 67b is prevented. In FIG. 17, the latch element 93 is shown in its locking position. Rotation of the latch element in a counterclockwise direction will disengage the shaft end 88 from the notch 94. The latch may also be provided with a U-shaped guard 95 which will cover the shaft end 88 and its square perforation 89.

The latch means 92 is a mirror image of the latch 93 and is otherwise identical to it. The latch 92 is adapted to engage and lock the end 86 of the main shaft element 67a. The latches 92 and 93 are so oriented on the shaft 90 that they will engage and lock the respective shaft ends 86 and 88 simultaneously, and will release the shaft ends simultaneously upon rotation of the shaft 90. When the latches 92 and 93 are in locking position, the operating mechanism and consequently the door-actuating mechanism and the doors themselves are locked as well.

The hopper car of the present invention may also be provided with exteriorly located indicating means, so that it may be ascertained at a glance whether the door actuating mechanism is in "door-open" or "door-closed" position. This indicating means is illustrated in FIGS. 13 and 15. The ends of the shaft 80 are provided with extensions in the form of rods 96 and 97. The rods 96 and 97 extend through perforations in the side sills or frame members 7, and are provided with bent over ends 96a and 97a respectively. FIG. 15 is a fragmentary elevational view of the car body side 4 illustrating the indicating end 97a of the extension 97. The car body side 4 may be provided with indicia 98 and 99 indicating respectively a "door-closed" and "door-open" position. Thus, as the shaft 80 and the gear 40 are rotated in a counterclockwise direction, the indicating end 97a will also rotate in a counterclockwise direction as indicated by the arrows. As the door-actuating assembly moves to a "door-open" position the indicating end 97a will move to a position pointing to the indicia 99. Similarly clockwise rotation of the shaft 80 and gear 40 will cause the hopper doors to close and will cause the indicating end 97a to assume the position illustrated in FIG. 5. It will be understood by one skilled in the art that the indicating end 96a of the extension 96 will cooperate in a similar manner with indicia on the car body side 3. This indicia will be identical to that shown in FIG. 15, but in reverse position.

FIGS. 18 and 19 show a typical hopper door 19, it being understood that a typical hopper door 19a will be substantially the same. The closure members 25 and 26 are joined by a transverse brace member 100 so that they form an integral unit. The hinge means 28 and the door fulcrum elements 56 and 56a have been described above. The closure member 25 has two vertically extending brace members 101 and 102 and a horizontal brace member 103. The inside edge of the closure member 25 is provided with an outwardly extending flange 104 adapted to cooperate with and overlap one of the triangular panels 24 (see FIG. 1). The other edge of the closure member is slanted and has a flange 105 which cooperates with one of the triangular members 23 which extend downwardly and inwardly from the car frame 7 (see FIG. 1).

The closure member 26 is a mirror image of the closure member 25 and is similarly provided with bracing means 101a, 102a and 103a. The closure member 26 also has a flange means 104a and 105a.

Each of the closure members 25 and 26 are provided with bottom edges 106 and 107 respectively which cooperate with similar edges on the opposing closure members of an opposing hopper door 19a. The edges 106 and 107 may take various forms and will be more fully described hereinafter. The edges 106 and 107 may be additionally supported by brace members (indicated at 108) extending between the edges and the transverse brace member 100.

The brace members 101, 102 and 103 on closure member 25 and 101a to 103a on closure member 26 are so formed and so arranged that when pressure is applied to the closure members at the fulcrums 56, the closure members are capable of slight flexure throughout their areas. This flexure is sufficient to shear loose from closure members any crust or frozen layer of the material with which the car is loaded. This flexure of the hopper door closure members occurs at that point in the door-opening operation when the pivot points 57 and 59 between the door levers and the links 55 pass their respective dead center lines 58 and 60. This is due to the fact that the effective length of a given door lever arm and its respective link is greater as it crosses the dead center line than is the distance between the adjacent door lever shaft and the adjacent door.

As illustrated in FIGS. 18 and 19, the closure members 25 and 26 of the door 19 are normally planar, and remain so when the door is in its closed and open positions (see FIGS. 6 and 7). As the door 19 moves between its closed and open positions and the pivot points between its respective door levers and links pass through dead center, the closure members 25 and 26 are first flexed inwardly toward the load and then are returned to their normal planar condition. Thus, the flexure of the closure members may be characterized as a double-acting flexure. It is this double-acting flexure which enables the shearing of the crust or frozen layer of material from the closure members.

FIG. 9 illustrates a typical link 55 which is adjustable in length so that proper double-acting flexure of the hopper door closure member to which it is pivotally affixed may be achieved. The link 55 comprises a link stem 109 and a cooperating pair of link plates 110 and 111. The link stem 109 is bifurcated at one end, and the bifurcations are provided with coaxial perforations 112 and 113. A door fulcrum 56 is adapted to be received between the bifurcations and pivotally affixed thereto by a pin or other suitable means (not shown) extending through the perforation 112, a perforation in the fulcrum and the perforation 113. The other end of link stem 109 is provided with a slot 114 and a set of teeth on each side. One set of teeth is shown at 115.

The link plate 111 is provided at one end with a perforation 116. Two additional perforations are shown at 117 and 118. The inside surface of the plate 111 is provided with a set of teeth 119. The link plate 110 is identical to the plate 111 and has similar perforations 116a, 117a and 118a. It, too, has a set of teeth (not shown).

In assembly, the link plates 110 and 111 are affixed to the link stem 109 by means of a bolt 120 passing through the per-

foration 118, the slot 114, the perforation 118a and engaged by a nut 120a. A second bolt 121 passes through the perforations 117 and 117a and is engaged by a nut 121a. The ends of the link plates 110 and 111 are adapted to lie on either side of an end of a door lever and to be pivotally affixed thereto by a pivot pin or other suitable means passing through the perforation 116, a perforation in the door lever and the perforation 116a.

It will be understood by one skilled in the art that the teeth 119 on the link plates will engage the teeth 115 on the link stem. Thus, by loosening the bolts 120 and 121 the length of the link 55 can be adjusted and maintained by the proper interengagement of the teeth 115 and 119. With this arrangement, the lengths of the links 55 will be adjusted so that, as the door-actuating mechanism is moved from the closed to the open position, a positive force will be exerted acting to flex the hopper doors toward and away from the load to shear loose from the closure members any surface crust formed in the load contacting the doors. By this action of the doors, the load will drop without obstruction upon movement of the hopper doors to their open position.

It is important that the bottom edges 106 and 107 of cooperating hopper doors meet in such a way that none of the material forming the carload can pass therebetween and consequently be lost during transit. This becomes particularly important when the load is of a relatively finely divided nature such as pulverized coal, wood chips or the like. Heretofore the bottom edges 106 and 107 have been configured as shown in FIGS. 6 and 7. It will be noted that when the doors are in closed position the edges 106 and 107 depend downwardly and abut each other. The abutting surfaces of the edges 106 and 107 have heretofore been provided with sealing means (not shown) such as strips of gasket material or the like, but such sealing means tend to age and be abraded by the carload material.

As shown in FIG. 6 one of the doors 19a of a cooperating pair may be provided with an additional flange 122 which overlies the opposing hopper door as shown. The flange 122 may be supported by a plurality of brace members 123. While such flange will effectively seal the edges of the doors, such arrangement is objectionable for some uses in that the flange 122 tends to impede the discharge of the load due to its substantially horizontal position when the doors are open (see FIG. 7).

FIG. 20 illustrates a novel form of door sealing means which cures the foregoing objections. The bottom edge 107a of the door 19 is coplanar with the closure member 26. An additional brace 124 is affixed to the edge 107a and the brace means 108. The bottom edge 106a of the door 19a lies at a substantial angle to the closure member 25 and is supported by the brace means 108. When the hopper doors 19 and 19a are in closed position (as shown in solid lines) the edge 107a will overlie and abut the edge 106a. The edge 106a may be provided with strips of gasket material or other sealing means generally indicated at 125 in that portion of FIG. 20 showing the door 19a in open position. It will be understood that when the door 19a is in open position the sealing material 125 is protected from the discharging load since it lies in a substantially horizontal position beneath the cover member portion 25 of the door.

FIG. 21 shows another form of sealing means. In this embodiment, the bottom edges 106b and 107b lie at an angle to their respective cover member portions 25 and 26 such that when the doors 19 and 19a are in closed position the edges 106b and 107b will lie in parallel spaced relationship. For purposes of clarity, the spaced between the edges 106b and 107b has been exaggerated. The opposing surfaces of these edges are provided with brushlike sealing means 126 and 127 having outwardly extending bristles. The bristles may be made of wire or synthetic material of appropriate strength. When the doors 19 and 19a are in closed position, the bristles of the sealing means 126 and 127 will be in interdigitated condition. In this way finely divided material will be prevented from passing between door edges 106b and 107b.

FIG. 22 is similar to FIG. 21 and differs in that only the edge 106c is provided with brushlike sealing means 128. The bristles of the sealing means 128 are slightly longer and are adapted to contact and be distorted by the edge 107c when doors 19 and 19a are in closed position.

It is within the scope of the invention to cause the door-actuating beam 30 to be moved by a cylinder actuated by fluid under pressure (FIG. 24). A cylinder 129 is mounted on the base frame of the car (for purposes of an exemplary showing it is illustrated as mounted on center sill 8). The piston rod 130 of the cylinder is affixed at its end to a downwardly depending element 131, which in turn is affixed to the door-actuating beam 30. The element 131 extends through an elongated slot 132 in the upper surface of the center sill 8. The cylinder 129 has inlet means 133 and 134. As a fluid medium under pressure is introduced into the cylinder via inlet 133, the piston rod 130 and the door actuating beam will be caused to move to the right in FIG. 24. As the fluid medium under pressure is introduced via inlet 134, the piston rod 130 and the door actuating beam will be caused to move to the left. Such movement of the door actuating beam 30 will cause the hopper doors to open and close as described above.

It will be understood by one skilled in the art that the cylinder 129 may be operated by a suitable liquid, air or steam under pressure. The introduction of the fluid medium via inlets 133 and 134 may be controlled by any suitable means. Furthermore, the fluid medium may be derived from a reservoir carried by the hopper car itself or may be derived from an independent source at the place of unloading.

FIG. 25 shows an exemplary arrangement for the cylinder 129. While the invention is not so limited, FIG. 25 shows the cylinder as being actuated by air under pressure, the air coming from the train supply. The air under pressure enters the system through a cutout cock 135 and passes through a conduit 136 and a check valve 137 to a reservoir 138. From the reservoir 138 the air is conducted through a filter 139 via conduit 140 to a four-way solenoid valve 141. The valve 141 controls the flow of air under pressure through conduits 142 and 143, connected respectively to cylinder inlets 133 and 134. Actuation of the valve 141 may be accomplished in any suitable fashion. For example, electrical contact may be made with an appropriately positioned track side structure, or the valve may be remotely controlled by radio signal or the like. It will further be understood that the valve 141 could be a hand-operated valve if desired.

FIGS. 26 through 37 illustrate the principles of the present invention, as applied to a hopper car of the type having longitudinally extending hopper doors. Reference is first made to FIGS. 26 and 27. FIG. 26 is a side elevation illustrating one half of the hopper car. It will be understood by one skilled in the art that the remainder of the car, not shown, is a mirror image of that part shown. The hopper car comprises an elongated body generally indicated at 144. The hopper car is mounted on conventional trucks, illustrated in dotted lines at 145.

As in the case of the hopper car shown in FIG. 1, the car of FIGS. 26 and 27 is provided with an underframe comprising elongated side frame members 146 and 147 and a center sill 148. A plurality of additional underframe members (not shown) will be provided, as is well known in the art.

The body of the car comprises vertical sides 149 and 150, together with inclined end walls, one of which is shown at 151.

At the centerline, the car is divided transversely by partition means 152. A portion of the partition means may be sloping to aid in the discharge of the carload. The half of the car illustrated in FIG. 26 is again divided by a transverse partition member 153. The partition 153 may have an additional sloping portion 154 so as to form a space between bins, designated at 155. It will thus be seen that the half of the car shown in FIG. 26 will be divided into two bins, generally indicated at 156 and 157. It will be understood by one skilled in the art that the half of the car not shown will be similarly divided, so that the car will have a total of four bins.

The bin 156 has two discharge openings, generally indicated at 158 and 159 (see FIG. 27). The discharge openings 158 and 159 are separated by the hood or covering 160 for the center sill 148. The bin 157 is similarly provided with two discharge openings (one of which is generally indicated at 161 in FIG. 26), again separated by a somewhat smaller hood or covering 162 for the center sill 148.

As shown in FIGS. 26, 27, an inner door 163 and an outer door 164 extend longitudinally of the car and serve as closure means for both the discharge opening 158 of the bin 156 and the discharge opening 161 of the bin 157. Similarly, an inner door 165 and an outer door 166 are provided to serve as closure means for both the discharge opening 159 of the bin 156 and the second discharge opening (not shown) of the bin 157. The ends of all of the discharge openings will have a triangular configuration against which the doors will seal. Such triangular configurations are shown, for example, at 167 and 168 in FIG. 27. Additional triangular configurations are shown at 169 through 171 in FIG. 26.

FIGS. 28 and 29 illustrate the inner door 163. It will be understood by one skilled in the art that the inner door 165 will be a mirror image of the door 163, but will otherwise be identical. The inner door 163 comprises closure members 172 and 173 joined by a transverse brace member 174. The closure member 172 will serve to close one half of the discharge opening 158 in the bin 156. Similarly, the closure member 173 will serve to close one half of the discharge opening 161 in bin 157.

The closure members 172 and 173 are provided with a plurality of substantially identical hinge means 175, adapted to be pivotally affixed to cooperating hinge means on the center sill of the car. One such cooperating hinge means is illustrated at 176 in FIG. 27.

The closure means 172 and 173 also have fulcrum means 177, similar to the fulcrum means 56 in FIG. 18. The closure member 172 has a longitudinal brace member 178. Similarly, the closure member 173 has a longitudinal brace member 179 and transverse brace members 180 and 181.

The end edges of the closure member 172 are intumed as at 172a and 172b. Similarly, the end edges of the closure member 173 are intumed as at 173a and 173b. These intumed edges of the closure members are adapted to overlap the triangular discharge opening ends so as to form a seal when the door is in closed position. The lowermost edges of the closure members 172 and 173 may be additionally supported by brace means 182. The door closure means 172 and 173 are so constructed as to be capable of the same double-acting flexure, as was described with respect to the closure members of FIG. 18.

FIGS. 30 and 31 illustrate the outer door 164. It will be understood that the outer door 166 will be a mirror image of the outer door 164, but otherwise will be identical. The outer door 164 comprises a large closure member 183 and a small closure member 184, joined by a transverse brace 185. The large closure member 183 will cooperate with the closure member 172 on the inner door to close the discharge opening 158 of bin 156. Similarly, the closure member 184 will cooperate with the closure member 173 of the inner door to close the discharge opening 161 of the bin 157.

The closure members 183 and 184 are provided with hinge means 186. The hinge means 186 are pivotally connected to cooperating hinge means 187 mounted on side frame member 146 (see FIGS. 26 and 27).

The closure member 183 is provided with longitudinal brace means 188 through 191 and vertical brace means 192 through 197. The closure means 184 has vertical brace means 198 through 201.

The ends of the closure means 183 are intumed as at 183a and 183b. Similarly, the ends of closure means 184 are intumed as at 184a and 184b. These intumed edges serve the same purposes as the intumed edges on the closure means of the inner door.

The lowermost edge of closure member 183 is turned outwardly as at 202. Similarly, the lowermost edge of closure

member 184 is turned outwardly as at 203. The purpose for this is to enable the lowermost edges of the closure members of the inner door 163 to overlies the outwardly turned edges of the closure members of the outer door 164 (see FIG. 27) so as to form a seal therebetween, of the general type described with respect to FIG. 20. It will be noted, however, that the outwardly turned edges 202 and 203 are turned to a greater degree than the edge illustrated in FIG. 20. This is most clearly shown in FIG. 35 wherein it will be seen that the edge 202 does not lie flush with the lower edge of inner door closure member 172. Rather, there is a line contact at 202a. As a result of this configuration, any material sticking to the lower edge of closure member 172 will be removed by a wedging action of outwardly turned edge 202 so that a substantially continuous metal-to-metal seal can be achieved at 202a.

It will be understood by one skilled in the art that the lowermost edges of the inner and outer doors may be configured in any desired manner, as for example in the manner shown in FIGS. 21 or 22.

The means for moving the doors between their open and closed positions will best be understood from FIGS. 27 and 32. As shown therein, a door actuating shaft 203 is mounted directly below the center sill 148 by suitable bearing means 204 through 207. The bearing means are affixed to the center sill by appropriate braces 208 through 211. The triangular ends 167 and 169 of discharge opening 158 and the triangular ends 170 and 171 of discharge opening 161 are diagrammatically represented to show the relative positional relationship of the parts.

The door-actuating shaft 203 has, nonrotatively affixed thereto, a plurality of identical door levers 212 through 215. Each of these door levers has two arms, connected by link members to the door fulcrum elements on the inner doors 163 and 165. Since all of the door levers, links and door fulcrum elements are identical, it will suffice to describe one such assembly, as shown in FIG. 27.

In FIG. 27, the door lever 215 is shown nonrotatively to the shaft 203. The door lever 215 has a long arm 215a and a short arm 215b. The arms 215a and 215b are connected, by identical links 216 to the fulcrum 177 of inner door 163 and the fulcrum 217 of inner door 165, respectively. The links 216 are preferably adjustable in length and may be identical to the link member described with respect to FIG. 9.

The functioning of the door lever 215, links 216 and the inner doors 163 and 165 is substantially identical to that described with respect to the assemblies of FIGS. 6 and 7 above. In FIG. 27, the inner doors are shown in their closed position. In this position, the pivot point 218 between the link 216 and the door lever arm 215a and the pivot point 219 between the door lever arm 215b and its respective link 216, both will lie in a beyond dead center position tending to lock the doors in their closed position. When the car is loaded and pressure is exerted on the inner doors 163 and 165, this locking effect will be enhanced.

When the shaft 203 is turned in a clockwise direction (as seen in FIG. 27) the pivot points 218 and 219 will pass through dead center and then the inner doors 163 and 165 will open. As described above with respect to FIGS. 6 and 7, it is only necessary to turn the shaft by an amount sufficient to cause the pivot points 218 and 219 to pass through dead center. Thereafter, the load on the doors will enhance the action of the shaft 203 to cause the doors to go to their full open position.

Since the pivot points 218 and 219 must pass through dead center during the door-opening operation, the action of the door levers and their respective links will cause the door closure means to flex first toward the load and then away from the load, immediately prior to opening. Thus, the door closure means are subjected to the same double-acting flex as described with respect to the doors of the hopper car of FIG. 1. Counterclockwise rotation of the shaft 203 (as seen in FIG. 27) will cause the inner doors 163 and 165 to attain their closed positions, and will cause the pivot points 218 and 219 to achieve their past dead center position.

Downwardly depending stop means 148a are affixed to the center sill 148. These stop means (see FIG. 27) are adapted to contact the door levers when they are in closed position. Thus the stop means 148a serve the same purpose as those shown at 61 in FIGS. 6 and 7.

FIGS. 33 and 34 illustrate the means for rotating the door-actuating shaft 203. A cylinder 220 is so oriented as to have its piston rod 221 extending in a direction transverse the hopper car. The cylinder 220 is mounted by suitable bracket means (not shown) in that space 155 between the bins 156 and 157 (see FIG. 26). A pair of link members 222 and 222a are pivotally affixed to the forward end of the piston rod 222 by any suitable means such as bolt 223. The forward ends of the links 222 and 222a are slotted (one slot being shown at 224 in FIG. 33). The forward ends of the links 222 and 222a are pivotally affixed to either side of arm 225 by means of a bolt 226, or the like, passing through the link slots and a perforation in the end of the arm 225. The arm 225, itself, is pivotally affixed between a pair of spaced hinge means 227 and 227a, affixed to the center sill 148. This is accomplished by means of a bolt 228, or other suitable pivot means, passing through coaxial perforations in the arm 225 and the hinge means 227 and 227a.

Another pair of links 229 and 229a are pivotally affixed to either side of the lower end of the arm 225, by any suitable means such as bolt 230. The other ends of the links 229 and 229a are pivotally affixed to either side of a shaft lever 231, by means of bolt 232. The shaft lever 231 is nonrotatively affixed to the door-actuating shaft 203. The relative position of the shaft lever 231 is illustrated in FIG. 32.

In FIG. 33, the actuating mechanism for the shaft 203 is shown in the door-closed position. It will be understood by one skilled in the art that when the piston rod 221 of the cylinder 220 is caused to move to the left in FIG. 33, the links 222 and 222a will cause the arm 225 to rotate in a counterclockwise direction. This, in turn, will cause the links 229 and 229a to move to the right in FIG. 33. This motion will cause the shaft lever 231 (and thus the shaft 203, itself) to assume the door-open position, shown in dotted lines. Movement of the piston rod 221 to the right in FIG. 3, will reverse the above-described action and will cause the shaft lever 231, and thus the shaft 203, to assume the door-closed position.

From the above, it will be evident that the inner doors 163 and 165 will be moved between their open and closed positions through the agency of cylinder 220. The cylinder 220 may be fluid actuated, or it may be actuated by compressed air or steam. It is within the scope of the invention to actuate the cylinder 220 in the same manner as described with respect to cylinder 129 in FIGS. 24 and 25. Controls for actuating the cylinder 220 may be located at any convenient position on the car.

The outer doors 164 and 166 are actuated by linkage means operatively connected to the inner doors 163 and 165, respectively. There will be two sets of linkage means between inner door 163 and outer door 164. Similarly, there will be two sets of linkage means between inner door 165 and outer door 166. All of these sets of linkage means are substantially identical, so that it will be necessary only to describe one such set between inner door 163 and outer door 164. Reference is made to FIG. 35, which may be considered to be a fragmentary cross-sectional view taken along the section line 35-35 of FIG. 26. The figure illustrates the car center sill 148, the closure means 172 of inner door 163 and the closure means 183 of outer door 164. For purposes of clarity, the inturned edge 172b of closure means 172 and the inturned edge 183b of closure means 183 have been deleted.

As shown in FIG. 35, one corner of a substantially triangular arm 233 is pivotally affixed between spaced hinge means, one of which is shown at 234. The hinge means are permanently affixed to the center sill 148. The pivotal connection is accomplished by any suitable means such as bolt 235. The lowermost corner of the arm 233 is squared, as at 236. The squared corner is adapted to lie within a U-shaped pocket means 237, affixed to the closure means 172 of the inner door 163.

Referring also to FIG. 28, it will be seen that the U-shaped pocket member 237 extends beyond the inturned edge 172b of the closure means 172 and is provided with spaced fillers 237a and 237b. The squared corner 236 of the arm 233 is adapted to lie between the filler members 237a and 237b. The pocket means 237 is provided with an adjusting bolt 238, adapted to contact the squared corner 236 of the arm 233. The purpose of the adjustment bolt 238 will be described hereinafter.

The uppermost corner of the arm 233 has, pivotally affixed thereto, a link 239. The end of the link 239 is bifurcated and lies on either side of the upper corner of the arm 233 and is affixed thereto by bolt 239a or other suitable means. The lowermost end of the link 239 is also bifurcated, and lies on either side of a ring bolt 240. The link 239 is pivotally affixed to the ring bolt 240 by any suitable means such as bolt 241. The ring bolt 240, itself, passes through coaxial perforations in the longitudinal brace means 185 of the outer door 164. These coaxial perforations are indicated at 242 in FIGS. 26, 30 and 35.

From the above description, it will be evident that as the inner door 163 is caused to move downwardly by the action of cylinder 220, the squared end 236 of the triangular arm 233 will be caused to move downwardly by virtue of its engagement in pocket means 237. As the arm 233 pivots about bolt 235 in a clockwise direction (as seen in FIG. 35) the pivot point 239a will also move in a clockwise direction. This, in turn, through the agency of link 239 will cause the outer door 164 to achieve its open position.

When the inner door 163 is moved to its closed position through the agency of cylinder 220, the arm 233 will be caused to move in a counterclockwise direction. Counterclockwise movement of the pivot point 239a will, through the agency of link 239, cause the outer door 164 to achieve its closed position.

Adjustment screw 238 contacts the squared corner 236 of the arm 233. Adjustment of the position of the screw 238 in the pocket 237 will adjust the rotational position of the arm 233 about the pivot 235. This, in turn, through the link 239 will adjust the closed position of the outer door 164. In this way, it can be assured that the inner and outer doors will close simultaneously, with the proper overlapping relationship.

As indicated above, each opposed pair of inner and outer doors will have two sets of the linkage illustrated in FIG. 35. In FIG. 28 it will be noted that the inner door carries a second pocket 237a adjacent the inturned end 172a of the closure means 172. Similarly, it will be noted from FIG. 30 that the longitudinal brace 185 of the outer door carries a second pair of coaxial perforations 242a adjacent the inturned end 183a of the closure member 183. The coaxial perforations 242a are adapted to receive a second eye bolt 240a (see FIG. 31).

It will be understood by one skilled in that art that that half of the car not shown in FIG. 26 will be similarly provided with two pairs of opposed inner and outer doors. The inner doors will again be actuated by an actuating shaft substantially identical to that shown in FIG. 32. The shaft will bear identical door levers, connected to the inner door fulcrums by identical link means. The second door actuating shaft (not shown) will be actuated by a cylinder substantially identical to cylinder 220 of FIG. 33 and the linkage between the cylinder and the actuating shaft will be the same. In similar manner, each pair of opposed inner and outer doors will be provided with two sets of link means of the type shown in FIG. 35 so that the outer doors will be moved between their closed and open positions by movement of the inner doors.

The structure described with respect to FIGS. 26 through 35 may be modified without departing from the spirit of the invention. For example, the hopper car of FIG. 26 may be divided into a greater or lesser number of bins. It is also within the scope of the invention to provide a door-actuating shaft extending the full length of the car so that only one cylinder of the type shown at 220 in FIG. 33 need be used to actuate all of the hopper doors, throughout the length of the hopper car.

FIG. 36 and 37 illustrate an alternative means which may be substituted for the cylinder 220 in FIG. 33. All of the remaining linkage illustrated in FIG. 33 will be the same.

FIGS. 36 and 37 illustrate a bracket means 243 extending transversely of the car and appropriately affixed to the partition 154 (see FIG. 26). The bracket 243 supports two pairs of spaced guide means, generally indicated at 244 and 245. The guide means 244 and 245 are substantially identical. As can be most clearly seen from FIG. 37, the guide means 244 is made up of two spaced elements 244a and 244b with a roller 246 pivotally mounted therebetween. The guide means 245 similarly supports a roller 247. An actuating bar 248, of I-beam cross section, is supported in the guide means 244 and 245 on the rollers 246 and 247. Thus, the actuating bar 248 is capable of longitudinal movement. The top surface of the actuating bar supports a rack 249. The rack cooperates with a toothed gear 250. The toothed gear is nonrotatively affixed to a shaft 251. The shaft, in turn, is rotatively mounted in bearings 252 and 253 affixed to the partitions or bin walls 154 and 153, respectively.

A sprocket 254 is also nonrotatively affixed to the shaft 251. The sprocket 254 is connected by means of chain 255 to a sprocket 256 on the output shaft of a geared reducing means 257.

One end of the input shaft 258 of the gear reducing means 257 may be provided with a fitting 259 extending through a perforation in the car side 149. The fitting 259 may be of square cross section and may be provided with a square perforation 261. Thus, the fitting 259 may be similar to the end members 86 or 88 shown in FIG. 13. As described with respect to FIG. 13, rotation may be imparted to the input shaft 258 of the geared reducing means 257 by an individual crewman through the engagement of the element 259 by a hand-operated or automatic tool.

In a similar manner, the other end of the input shaft 258 of the geared reducing means may be connected through a universal joint 262 to a shaft 263. The end of the shaft (not shown) may extend through a perforation in the opposite side of the car and be provided with a fitting similar to the fitting 259. In this way, rotation may be imparted to the input shaft of the geared reducing means from either side of the hopper car.

The operation of the assembly of FIGS. 36 and 37 may be described as follows. The forward end of the beam 248 will be provided with a fitting 264 to which the links 222 and 222a of FIGS. 33 and 34 will be pivotally affixed. When rotation is imparted to the input shaft 258 of the geared reducing means 257 in such a way as to turn the sprocket 254 and gear 250 in a clockwise direction (as seen in FIG. 36) the beam 248 will move to the left in the figure. Since the beam is the equivalent of the piston rod 221 in FIG. 233, it will be seen that such movement of the beam will cause the shaft lever 231 to move to its open position. When the input shaft of the geared reducing means 257 is turned in the opposite direction, the output 256, the sprocket 254 and the gear 250 will turn in the opposite direction and will cause the beam 248 to move to the right in FIG. 36. This, in turn, will cause the shaft lever 231 to return to its closed position.

When the structure of FIGS. 36 and 37 is substituted for the cylinder 220 of FIGS. 33 and 34, all of the remaining structure illustrated in FIGS. 33 and 34 will remain the same with the exception that the slots 224a in links 222 and 222a must be elongated. Thus, the slots 224a will serve the same purpose as slots 50 in the push rods 51 of FIGS. 4 and 5. As indicated above, once the door levers and attached links have been turned beyond their past dead center position the doors will tend to open under the influence of the load. While the cylinder 220 can compensate for this, the rack and gear assembly cannot and hence the slots 224a must be lengthened.

It will be understood by one skilled in the art that the structure shown in FIGS. 36 and 37 may be provided with locking means of the type shown in FIGS. 16 and 17 and may have position indicating means of the general type shown in FIG. 15.

Modifications may be made in the invention without departing from the spirit of it.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows.

We claim:

1. In a hopper car of the type having a bottom comprising at least one discharge opening closed by at least one hopper door hingedly secured to said hopper car and swingable between a closed position and a downwardly depending open position, said hopper door having at least one planar portion capable of being flexed between a normal planar condition and an inwardly distorted position, door-actuating means operative to move said door between said closed and open positions and adapted to impart a double-acting flex to said planar portion from said planar condition to said inwardly distorted condition and back to said planar condition as said door moves from said closed to said open position.

2. For use in a hopper car of the type having a bottom comprising at least one discharge opening closed by a plurality of hopper doors arranged in opposing relationship and hingedly secured at their top edge to door-supporting members extending transversely of the hopper car, said doors being swingable between a downwardly depending open position and a closed position in which their bottom edges meet in abutting relationship, said hopper doors each having one planar portion capable of being flexed between a normal planar condition and an inwardly distorted condition, a plurality of door-actuating means operative to move said doors between their open and closed position, each of said door-actuating means comprising a shaft underlying one of said door-supporting members and extending transversely of said hopper car, at least one door lever fixedly secured to said shaft, said door lever having at least one door-actuating arm projecting in the direction of the adjacent hopper door, an adjustable link member pivotally connected at one end to the projecting end of said door lever arm and pivotally connected at its opposite end to said flexible portion of said adjacent hopper door, said door lever being rotatable by said shaft to move the hopper door between its open and closed positions, said door lever arm and said adjustable link pivoting relative to each other through a dead center position and between a door-open position and a beyond dead center door-closed position, said adjustable link being axially adjustable to vary its length so that the length of said link will be sufficient to exert a positive force on said portion of said hopper door effective to flex said portion from said planar condition to said inwardly distorted condition and back to said planar condition as said door lever arm and link move through said dead center position.

3. The structure claimed in claim 2 wherein said link comprises a link stem and a pair of link plates, said link stem having a forward end, a rearward end and sides, the forward end being pivotally affixed to said flexible portion of said hopper door, the rearward end of said stem having a set of teeth on each side thereof, each of said link plates having a forward end, a rearward end, and sides, one of said sides adjacent said forward end having a plurality of teeth, said link plates being removably affixed to the sides of said link stem with said link plate teeth engaging said link stem teeth, the rear ends of said link plates being pivotally connected to said door lever arm.

4. The structure claimed in claim 2 including an actuating beam extending longitudinally of said hopper car, a push rod pivotally connected to said beam, said push rod having an elongated slot therein with a trailing end and a forward end, a center lever having an end nonrotatively affixed to said shaft, the opposite end of said center lever having a pin slidably engaged in said push rod slot, said beam being slidable in one direction longitudinally of said hopper car so as to cause said center lever pin to be engaged by the forward end of said push rod slot to cause said center lever, said shaft and said door lever to move said hopper door from the closed to the open position, said beam being slidable in the opposite direction longitudinally of said car, whereby said center lever pin is engaged by the trailing end of said push rod slot causing said

center lever, said shaft and said door lever to rotate in the opposite direction to close said door, said center lever pin being adjustable through a range of positions with respect to the end of the center lever whereby the engagement of the center lever pin by the trailing end and the forward end of said push rod slot may be varied.

5. The structure claimed in claim 4 wherein said center lever pin is eccentrically mounted with respect to a splined adjustment member selectively engageable in a correspondingly configured socket in said center lever.

6. The structure claimed in claim 4 including means for moving said actuating beam, said means including a cylinder, a piston and a piston rod in association with said cylinder, means for connecting said piston rod to said actuating beam, a source of fluid medium under pressure, said piston and piston rod being actuated by the introduction of said pressurized fluid medium into said cylinder, and means for controlling the said introduction of said pressurized fluid medium.

7. The structure claimed in claim 4 including means for moving said actuating beam, said means including a drive shaft and gear means operatively connected to said drive shaft and said actuating beam for converting rotary movement of said drive shaft into axial movement of said beam, and releasable means operative to lock said drive shaft against rotation.

8. The structure claimed in claim 7 wherein said drive shaft extends transversely of said hopper car and has an outwardly projecting end configured to receive a shaft-rotating element, and wherein the releasable means for locking said shaft against rotation comprises a lever arm pivotally mounted on said hopper car and movable from an inoperative position to an operative position in which said arm engages the configured end of said shaft.

9. The structure claimed in claim 8 including means operatively connected to said drive means for indicating whether said actuating beam is in the door-open or door-closed position.

10. In a hopper car of the type having sidewalls, end walls and a bottom comprising at least one discharge opening closed by a plurality of hopper doors arranged in opposing relationship and hingedly secured to door-supporting members extending between said sidewalls, certain of said door-supporting members having two doors hingedly affixed thereto, the remaining supporting members having a single door affixed thereto, said doors being swingable between a downwardly depending fully open position and a closed position wherein edge portions of opposing pairs of said doors abut each other and form a seal therebetween, said hopper doors each having at least one planar portion capable of being flexed between its normal planar condition and an inwardly distorted condition, door-actuating means for moving said hopper doors from said open position to said closed position, for locking said doors in said closed position and for releasing said doors from said closed and locked position whereby they will drop to said open position, said door-actuating means comprising a plurality of shafts extending transversely of said hopper car, one of said shafts being located below each of said door-supporting members, a door lever affixed to each end of each of said shafts, each of said door levers, affixed to those of said shafts located beneath said supporting members having two doors hingedly affixed thereto, having two door-actuating arms, each of said door levers affixed to the remaining ones of said shafts having one door-actuating arm, a link pivotally affixed to each of said door-actuating arms and said flexible portion of an adjacent hopper door, said door levers being rotatable by said shafts between a first position wherein said doors are in said closed position and a second position wherein said doors are released, stop means positioned to contact said door levers to establish said first position, said door levers and said attached links having a dead center position, said door levers and said attached links lying to one side of said dead center position when said door levers are in said first position, whereby said hopper doors are biased to said closed position, and to the other side of said dead center position when said

door levers are in said second position, whereby said hopper doors are biased to said open position, said door lever arms and said attached links having an effective length when in said dead center position sufficient to cause said flexible portions of said hopper doors to flex from said planar condition to said inwardly distorted condition and back to said planar condition when said door levers are rotated from said first to said second positions, and means for rotating said shafts.

11. The structure claimed in claim 10 including adjustment means for varying the effective combined lengths of said lever arms and said attached links.

12. The structure claimed in claim 10 wherein said seal-forming edge portion of a first door of each of said opposing pairs is coplanar with said first door, said seal-forming edge portion of a second door of each opposing pair being turned beneath and rearwardly of said second door, said edge portion of said second door overlying and abutting said edge portion of said first door when said first and second doors are in said closed position.

13. The structure claimed in claim 10 including bristle means on said seal forming edges of said opposing pairs of hopper doors, said bristle means of said adjacent edge portions being in interdigitated relationship when said doors are in said closed position, whereby to form said seal.

14. The structure claimed in claim 10 including bristle means affixed to one of said adjacent edge portions of each of said opposing pairs of doors, said bristle means being contacted and distorted by the other of said adjacent edges of each of said pairs of doors when said doors are in said closed position.

15. The structure claimed in claim 10 wherein said means for rotating said shafts comprises an actuating beam extending longitudinally of said hopper car, a plurality of push rods pivotally affixed to said beam, each of said push rods having a slot with a trailing end and a forward end, a plurality of center levers, each of said center levers having an end nonrotatively affixed to one of said shafts, the opposite end of each of said center levers having a pin slidably engaged in one of said push rod slots; said beam being slidable in one direction longitudinally of said car whereby said center lever pins are engaged by the forward ends of said push rod slots causing said center levers, said shaft and said door levers to rotate to said second position, said beam being slidable in an opposite direction longitudinally of said car whereby said center lever pins are engaged by the trailing end of said push rod slots causing said center levers, said shafts and said door levers to rotate to said first position, said center lever pins being adjustable through a range of positions with respect to the ends of their respective center levers whereby the engagement of the center lever pins by the trailing ends and the forward ends of their cooperating push rod slots may be finely adjusted, and means for sliding said beam.

16. The structure claimed in claim 15 wherein each of said links comprises a link stem and a pair of link plates, said link stem having a forward end, a rearward end and sides, the forward end being pivotally affixed to said flexible portion of one of said hopper doors, the rearward end of said stem having a set of teeth on each side thereof, each of said link plates having a forward end, a rearward end, and sides, one of said sides adjacent said forward end having a plurality of teeth, said link plates being removably affixed to the sides of said link stem with said link plate teeth engaging said link stem teeth, whereby the effective length of the link stem can be adjusted to insure said flexure of said flexible portion of said hopper door, said rear ends of said link plates being pivotally affixed to one of said door lever arms.

17. The structure claimed in claim 15 including a splined adjustment member in association with each of said center levers, each of said center levers having a perforation configured to receive said splined adjustment member in a plurality of selected positions, each of said center lever pins being eccentrically mounted with respect to one of said splined adjustment members.

18. The structure claimed in claim 15 including means for sliding said actuating beam in said longitudinal directions, said means comprising a main drive shaft extending transversely of said hopper car and operatively connected to a geared speed reducer means, said speed reducer means having a shaft parallel to said main drive shaft, a first sprocket at one end of said speed reducer shaft, a third shaft parallel to said main shaft and said reducer shaft, a second sprocket affixed to said third shaft, said first and second sprockets operatively connected by an endless chain, a gear nonrotatively affixed to said third shaft, a rack affixed to said actuating beam and engaged by said gear, whereby rotation of said main shaft will be transmitted by means of said reducer, reducer shaft, endless chain and said third shaft to said gear, causing longitudinal movement of said beam through the engagement of said gear with said rack.

19. The structure claimed in claim 18 wherein the ends of said main shaft extend through said sidewalls of said hopper car, a fourth shaft extending transversely of said hopper car and in parallel spaced relationship to said main shaft, the ends of said fourth shaft extending through said sides of said hopper car and being rotatively affixed thereto, locking means nonrotatively affixed to each end of said fourth shaft, said locking means and said fourth shaft being rotatable between an unlocking position and a locking position wherein said locking means engage said ends of said main shaft preventing rotation of said main shaft.

20. In a hopper car of the type having sidewalls, end walls and a bottom comprising at least one discharge opening closed by at least one pair of hopper doors arranged in opposing relationship, said doors being swingable between a downwardly depending open position and a closed position wherein adjacent edge portions of said pair of doors form a seal therebetween, said seal-forming edge portion of a first door of said pair being coplanar with said first door, said seal-forming edge portion of the second door of said pair being turned beneath and rearwardly of said second door, said edge portion of said second door overlying and abutting said edge portion of said first door when said first and second doors are in said closed position.

21. For use in a hopper car of the type having a bottom comprising longitudinally extending frame means extending centrally of and along the sides of said car and at least one discharge opening on each side of said central frame means, at least one inner door and at least one outer door arranged in an opposing pair for each of said discharge openings, said pairs of inner and outer doors extending longitudinally of said hopper car, each of said outer doors being hingedly secured at its top edge to the adjacent one of said side frame means, each of said inner doors being hingedly secured at its top edge to said central frame means, each of said inner and outer doors of said opposed pairs being swingable between a downwardly depending open position and a closed position in which their bottom edges meet in abutting relationship, said inner hopper doors each having at least one planar portion capable of being flexed between a normal planar condition and an inwardly distorted condition, inner door-actuating means operative to move said inner doors between their open and closed positions, outer door-actuating means operatively connected between the outer and inner doors of each opposed pair to move the outer door of each pair between its open and closed positions simultaneously as the inner door of the same pair moves between its open and closed positions, said inner door-actuating means being configured to exert a positive force on said flexible portions of said inner doors to flex said portions from said planar condition to said inwardly distorted condition and back to said planar condition as said inner doors move from their closed to their open positions.

22. The structure claimed in claim 21 wherein edge portions of said opposing pairs of hopper doors abut each other and form a seal therebetween when said doors are in said closed position, said seal-forming edge portion of a first door of each pair being coplanar with said first door, said seal-forming edge

portion of the second door of each pair being turned beneath and rearwardly of said second door, said edge portion of said second door overlying and abutting said edge portion of said first door when said first and second doors of each pair are in said closed position.

23. The structure claimed in claim 21 wherein the inner doors for the discharge openings on each side of said central frame means lie opposite each other on each side of said central frame means, said inner door actuating means comprising at least one door actuating shaft underlying said central frame means and extending longitudinally of said hopper car between said inner doors, at least one door lever fixedly secured to said shaft, said door lever having two arms, one of said arms projecting in the direction of said inner door on one side of said central frame means, the other arm projecting in the direction of the inner door on the other side of said central frame means, each of said arms being connected to its adjacent inner door by an adjustable link member, each link member being pivotally connected at one end to the projecting end of its respective door lever arm and pivotally connected at its opposite end to said flexible portion of the adjacent inner hopper door, said door lever being rotatable by said shaft to move the inner hopper doors between their open and closed positions, each of said door lever arms and the adjustable link connected thereto pivoting relative to each other through a dead center position and between a door-open position and a beyond dead center door-closed position, said adjustable links being axially adjustable to vary their length so that their length will be sufficient to exert said positive force on said flexible portion of said hopper door effective to flex said portion from said planar condition to said inwardly distorted condition and back to said planar condition as said door lever arm and link move through said dead center position, and means to rotate said shaft between a position wherein said inner doors are open and a position wherein said inner doors are closed.

24. The structure claimed in claim 23 wherein each of said links comprises a link stem and a pair of link plates said link stem having a forward end, a rearward end and sides, the forward end being pivotally affixed to said flexible portion of said adjacent hopper door, the rearward end of said stem having a set of teeth on each side thereof, each of said link plates having a forward end, a rearward end, and sides, one of said sides adjacent said forward end having a plurality of teeth, said link plates being removably affixed to the sides of said link stem with said link plate teeth engaging said link stem teeth, the rear ends of said link plates being pivotally connected to said respective door lever arm.

25. The structure claimed in claim 23 wherein said means for rotating said door-actuating shaft comprises a cylinder, a piston and piston rod in association with said cylinder, said piston rod being oriented with its axis transverse the axis of said shaft, a source of fluid medium under pressure, said piston and piston rod being movable between extended and retracted positions by the introduction of said pressurized fluid medium into said cylinder, means for controlling said introduction of said pressurized fluid machine, a shaft lever nonrotatively affixed to said shaft, linkage means operatively connecting said shaft lever to said piston rod whereby as said piston rod is moved between said extended and retracted positions, said shaft is rotated between said door open and door closed positions.

26. The structure claimed in claim 23 wherein said means for rotating said door actuating shaft comprises an actuating beam oriented with its axis transverse the axis of said door-actuating shaft, a drive shaft oriented parallel to said beam and transverse said hopper car, gear means operatively connected to said drive shaft and said beam for converting rotary motion of said drive shaft to axial motion of said beam between an extended and a retracted position, a shaft lever nonrotatively affixed to said door-actuating shaft, linkage means operatively connecting said shaft lever and said beam whereby as said beam is moved between said extended and retracted positions,

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said door-actuating shaft is rotated between said door-open and door,closed positions.

27. The structure claimed in claim 23 wherein said outer door-actuating means comprises at least one substantially triangular arm for each of said pairs of inner and outer doors, the lowermost corner of said arm being connected to said inner door of a pair, the intermediate corner of said arm being pivotally connected to said central frame means, and the uppermost corner of said arm being connected by an elongated link to the outer door of said last-mentioned pair.

28. In a hopper car of the type having a bottom comprising at least one discharge opening closed by a plurality of hopper doors arranged in opposing relationship and hingedly secured to said hopper car, said hopper doors being swingable between a downwardly depending open position and a closed position wherein edge portions of opposing pairs of said hopper doors abut each other and form a seal therebetween, certain at least

of said hopper doors having at least one planar portion capable of being flexed between a normal planar condition and an inwardly distorted position, door actuating means operative to move said doors between said closed and open positions and adapted to impart a double-acting flex to said planar portions from said planar condition to said inwardly distorted condition and back to said planar condition as said doors move from said closed to said open position.

29. The structure claimed in claim 28 wherein said seal-forming edge portion of a first door of each of said opposing pairs is coplanar with said first door, said seal-forming edge portion of a second door of each opposing pair being turned beneath and rearwardly of said second door, said edge portion of said second door overlying and abutting said edge portion of said first door in a line contact when said first and second doors are in said closed position.

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