MULTIPLE HOPPER DOOR ACTUATING MECHANISM

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15 Claims

ABSTRACT OF THE DISCLOSURE

Laterally aligned pairs of longitudinally hinged drop bottom doors at opposite sides of a center sill of a railway hopper car, the doors of each pair opening oppositely to expose an opening extending substantially from the center sill to the sill and the doors of both pairs being swivellable in unison between open and closed positions by a common operating mechanism.

The prior art

The recently introduced unit trains of hopper cars for transporting coal or other bulk lading in large quantities from mines or other sources direct to large consumers, depend for economy of operation upon a quick turn-around at each end of the run. This in turn requires that the cars be both loadable and unloadable quickly. Quick loading is feasible with mechanical loaders now available but quick unloading requires the discharge doors of the cars not only to be openable quickly but to open discharge openings that are much larger than those of a conventional hopper car. Several solutions to these problems of quick unloading have been proposed, some using longitudinally and others laterally hinged doors. Among earlier designs the shallow hopper in which each opening was closed by a pair of oppositely opening laterally hinged doors, had the greatest openable area but this design was abandoned several decades ago because of inadequate strength. With that knowledge the current proposals in general provide a single door for each opening and consequently are limited by the height of the hinged openable area. Further, the track in the dimension of the opening normal to the hinged, an improvement of the old shallow hopper design, shown in Floehr Patent No. 3,242,878, issued Mar. 29, 1966, supplies the strength previously missing in an opening closed by a pair of oppositely opening doors by spanning the opening by a center brace against which the adjoining ends of the doors close and affords the maximum open area practically obtainable with laterally hinged doors. Even so, the limit imposed by track clearance on the length of each door makes it necessary to divide the bottom of a hopper car of conventional length into around a dozen openings, with consequence limitation by the intervening spacings upon the maximum openable area.

Summary of the invention

The hopper door assembly of the present invention eliminates hinge height as a limitation upon a dimension of a hopper discharge opening by closing the opening by a pair of oppositely opening, longitudinally hinged and laterally opening doors and, by hinging the inner door on the center sill and the outer on a side sill and obtaining the necessary center strength by interlocking reinforcing members mounted on the free ends of the doors, permits the bottom of the car to be opened almost entirely from the center sill to each side sill. And the sole reason for the “almost” is the practical one of needing a slight inward slope on the outer door for directing discharging lading into the space between the ends of the ties. The only limit on the length of the opening, length-wise of the car, is that imposed by the weight of the doors and it is quite practicable to cover the bottom of a car of normal length, lengthwise between end sheets, by two openings at each side of the center sill with a narrow divider between them. Not only does the improved assembly enable almost the entire bottom of the car to be opened but it includes operating mechanism by which the doors of at least laterally aligned openings and, if desired, all of the doors can be opened and closed both simultaneously and quickly. Moreover, the operating mechanism is of such construction and arrangement as to be assisted by the weight of any lading in holding the doors locked in closed position and in turn to assist the interlockable members in strengthening the bottom of the car between the sills when the doors are closed.

Objects of the present invention are to provide a hopper door assembly which is quick opening and opens almost the entire bottom of the car between sills for reducing unloading time to a minimum, while closing each opening by longitudinally hinged oppositely opening doors has operating mechanism for simultaneously opening and closing the doors of at least laterally aligned openings, and so swivels and strengthens the joint between the doors of each opening, when closed, as to render cross-bracing of the opening unnecessary.

Other objects and advantages of the invention will appear hereinafter in the detailed description, particularly pointed out in the appended claims and be illustrated in the accompanying drawings, in which:

FIGURE 1 is a fragmentary side elevational view of a railway hopper car fitted with a preferred embodiment of the improved hopper door assembly of the present invention;

FIGURE 2 is a vertical sectional view taken along lines 2—2 of FIGURE 1;

FIGURE 3 is a vertical sectional view taken along lines 3—3 of FIGURE 1;

FIGURE 4 is an enlarged fragmentary view on the section of FIGURE 3 showing the details of the joint between a pair of doors;

FIGURE 5 is an enlarged fragmentary sectional view taken along lines 5—5 of FIGURE 3;

FIGURE 6 is a fragmentary vertical sectional view on an enlarged scale, taken along lines 6—6 of FIGURE 1 and showing an actuator for the door assembly in its door open and closed positions, the latter in dotted line;

FIGURE 7 is a bottom plan view of the structure of FIGURE 6; and

FIGURE 8 is an end elevational view of the structure of FIGURE 6.

Detailed description

Referring now in detail to the drawings in which like reference characters designate like parts, the improved hopper door assembly of the present invention is designed to permit a hopper car, indicated at 1, to have its bottom divided or partitioned into a plurality of discharge openings or outlets 2, each uninterrupted and extending laterally or widthwise from the car's center sill 3 to an adjoining side sill 4. Lengthwise or longitudinally of the car, each opening may be as long as desired but usually there will be at least two openings on each side of the center sill, each laterally aligned with an opening on the opposite side. As the door assemblies of laterally aligned pairs of discharge openings will duplicate each other, a preferred embodiment of but one improved assembly has been illustrated and its description will suffice for an understanding of the invention.

Each of the laterally aligned discharge openings 2, ex-
tending from the center sill 3 to the adjoining side sill 4, is closed by a pair of oppositely opening doors which are hinged longitudinally of the car for swinging, hinging or pivoting laterally or sideways thereof. In each pair are an inner door 5 hinged to or pivotally mounted on one side of the center sill 3 and an outer door 6 hinged to or pivotally mounted on the adjoining side sill 4. The preferred mounting for the inner doors 5 is below the bottom flanges 7 of the center sill on laterally extending arms 8 of a generally T-shaped frame or member 9 which projects upwardly into and is welded or otherwise suitably fixed to the center sill. In their turn, the outer doors 6 are conveniently mounted on brackets 10 fixed to and depending from the side sills. In both cases the mounting is such that the door 5 or 6 is hinged or has its hinging axis beneath or below and within the lateral confines of the related sill so as substantially to clear the adjoining opening when opened. As a result, the common level of the longitudinally extending hinges 11 of the inner doors 5 is considerably below that of the similarly extending hinges 12 of the outer doors 6 and, as befits this difference in level, as well as to enable the doors to be swung downwardly to substantially vertical position without obstruction by the underlying track (not shown) and to strengthen the joint 13 along which the free or distal ends 14 and 15 of the inner and outer doors, respectively, of each pair meet when closed, the inner doors are shorter or of less length between their hinges and free ends than the outer doors.

Together laterally spanning their opening, the inner and outer doors of each pair must each span the opening longitudinally and be of sufficient width to overlap the laterally extending frame members 16 reinforcing the end sheets or partitions 17 at and bounding or defining the ends or longitudinal extremities of the opening. As the span can be far greater than the like dimension of the usual discharge opening, the doors should be suitably reinforced at least widthwise. This in part is accomplished by fixing to the outside of each door intermediate its ends a bulb angle 18 extending horizontally and laterally of the door for substantially its full width. The outer doors 6 are further reinforced toward their free ends 15 by fixing to their outer sides laterally extending webbed or gusseted angles 19. Instead of being straight for their full lengths, the inner and outer doors have squared off end portions 20 and 21, respectively, which are upturned at an oblique angle to their main parts and horizontally disposed in the closed position of the doors, at which time the free ends 14 and 15 of the doors of each pair meet and abut along the vertically directed joint 13.

Engaging at their sides in their closed positions the correspondingly angled bottom portions of the frame members 16 at the ends of their opening 2, the inner and outer door end portions 20 and 21 are reinforced or braced on the outside for substantially their full widths and lengths by horizontally disposed web or gusset reinforced angles 22 and 23, respectively. On each pair of doors one of these end portion angles, here 23, is downwardly obtuse and set back from the end of its door, here 5, while the other, here 22, is downwardly acute and extends beyond the end of its door, here 6. The bottom flanges 24 and 25 of the angles 22 and 23 respectively, have the same slope or inclination and abut when the doors are closed and each obtuse angle 22 forms with the projecting wall 26 of its door an outwardly opening pocket 27 which, when the doors are closed, receives and mates or interlocks with the projection or protuberance 28 formed by the acute angle 23 on the associated outer door 6. Carrying or mounting these interlockable angles or members on their free end portions, the doors of each pair thus not only are reinforced along their end portions but definitely are fixed in their relative closed positions, while the offset of the joint 29 between the bottom flanges 24 and 25 of the angles relative to the vertical joint 13 and consequent brokenness of the common full joint between the doors, effectively seals against the escape of even finely divided lading.

The operating mechanism 30 of the improved assembly by which the doors 5 and 6 of the laterally aligned openings 2 are opened and closed in unison or simultaneously, includes an operating shaft 31 extending longitudinally of and centered on the center sill 3 and the associated outer door 6 mounted therebelow, conveniently in bearings 32 carried in the bottom portions of the longitudinally spaced downward or vertical walls 33 of the preferred double-walled supporting frame 9. Above the bearings 32, the walls are interrupted, longitudinally of the center sill, by vertically elongated central slots 34 in which the engaging pivot 35 and guide to which the corresponding curved or curved portion of the center sill 3 toggle is hinged or pivotally supported. The engaging pivot or toggle pin 35 of a toggle 36. Connected at their adjoining ends by the toggle pin 35, the arms 37 of the toggle 36 are pivotally connected at their far ends to brackets 38 fixed on the outside to the walls 26 of the inner doors 5 and preferably backed by the bulb angles 39 thereon. The slots 34 are of sufficient extent to accommodate the toggle pin 35 over movement of the toggle 36 from an extended condition or position in which the arms 37 are fully extended and substantially parallel to the joint 13, to a collapsed condition or position in which the arms are retracted and the doors in a vertical open position. Movement between extended and collapsed conditions is applied or imparted to the toggle 36 on rotation of the operating shaft 31 by a crank arm 39 fixed at one end to the shaft and pivotally connected at the other to the toggle pin 35 by counterpart links 40 extending between the walls 33 and embracing or straddling both the crank arm and the connected ends of the toggle arms 37. As indicated, the crank arm 39 preferably downwardly extends vertically from the shaft 31 in the toggle's extended condition and the links 40 clearly the shaft at that time by being curved or arcuate.

For operating or opening and closing the outer doors 6 simultaneously or in unison with the inner doors 5, the operating shaft 31 has fixed to it beyond opposite sides of the frame 9 at opposite ends of the doors a pair of axially spaced double or double-armed or ended cranks 41. Each of these double cranks is connected at its opposite ends to the outer doors 6, the connection preferably being made in each case by a compound or composite link 42 having an inner arcuate or curved portion 43 folding into the crank in the door's closed position and, as an outer part, a rod 44 fixed at its inner end to the inner part. Instead of directly, each rod preferably is adjustable connected to the related or associated outer door 6 to permit any adjustment found needed on assembly in the closed position of the inner and outer doors of each pair. In the illustrated embodiment the desired adjustability is obtained by threading the outer ends of the rods and extending each through a collar or boss 45 pivoted to a bifurcated bracket 46 mounted on an extension of the angle 19 between the adjoining side of the door. Each collar has a pair of centrally apertured spaced webs 47 through which the threaded outer end portion 48 of the associated rod extends.

Adjustment of the closed position of the door 6, at which time the compound link 42 is in tension, is made by an adjusting nut 49 threaded onto the rod 44 beyond the collar 45 and acting against the outer of the webs 47 therein. Conversely, a second adjusting nut 50 for enabling the rod to press against and fix the open position of the door, is threaded onto the rod between the webs. With this arrangement, the alternate positions of the doors of each pair independently adjustable but it is also possible to adjust each side of each door independently of the other to compensate for any warpage. Also, when the doors are closed, the operating mechanism 30, which itself is braced by the center sill 3, braces the doors, the inner doors at the center by the toggle arms 37 in compression and the outer doors at
the sides by the compound links 42 in tension. This bracing and the interlock between and across stiffening of the doors, provide adequate strength and obviate the need for interrupting the discharge openings 2 by fixed cross braces.

Rotation or turning of the operating shaft 31 in one direction will open and the other close the illustrated laterally aligned pairs of doors in unison and, if the shaft is extended and drivably connected to the operating mechanism, the other like pairs of doors on the car, it can serve as the common operator for all of the doors.

The operating shaft must of course be rotated by suitable actuating means but whether that means is automatically or manually actuable and the number of doors made responsive to it, will depend upon the unloading facility available at the destination of particular runs unless the actuating means is inbuilt into the car or the train. As not requiring a special unloading facility and therefore more versatile, an inbuilt actuator has been selected for illustration as exemplary of suitable actuators.

Designated as 51, the illustrated car is both inbuilt into the particular car and manually actuable and in the illustrated door assembly is part of the door operating mechanism 30. For the convenience and safety of an operator, the actuator 51 should be actuable from at least one and preferably both sides of the car door. It is accomplished only if the actuator extends either between the sides or at least from one side to the centrally located operating shaft 31 and there otherwise would be interference with the doors 5 and 6, the necessarily laterally extending actuator itself should be located beyond an end of a laterally aligned pair of openings 2 in a clear space either between pairs of openings or in an end portion of the car.

So located longitudinally and extending laterally of the car, the actuator 51 includes a rotary actuating shaft 52 extending across the car below the center sill 3 and suitably headed at opposite ends for turning or rotation by an appropriate turning tool or actuating bar (not shown). Bevel gearing 53 transmits the rotary movement of the laterally directed actuating shaft 52 to a longitudinally directed pinion shaft 54 and a pinion 55 on the latter shaft and a downwardly facing rack 56 drivably engaged thereby. The movement of the pinion shaft into translational or reciprocal movement of a slide plate or member 57 extending and slidable laterally of the car normal to and below the center sill 3. In turn the translational movement of the slide bar 57 is converted by the rotating movement of the operating shaft 31 through a link 58 connected at one end to the slide bar and a crank 59 fixed against relative rotation to the operating shaft and pivotally connected at its free end to the other end of the link.

All of the above moving parts of the actuator, except for the crank 59 and one end of the actuating shaft 52, are conveniently mounted on and supported by an outer frame work or frame 60 suspended at its inner end, as by riveting, from the bottom flanges 7 of the center sill 3 and projecting laterally outwardly toward the sides of the car. The illustrated frame work 60 has laterally spaced side rails 61 suitably formed by angle irons and connects and braces the side rails adjacent their outer ends by surmounting cross braces 62, again suitably formed by angle irons. The pinion shaft 54 is suspended from the outer ends of the side rails 61 by bearings 63 fixed to the undersides thereof and journaling its ends and the adjoining end of the actuating shaft 52 is journaled in a bearing 64 fixed to an extension of the inner of the cross braces 62. The slide plate 57 slides directly beneath the bottom flanges 7 in confronting slots 55 formed by laterally spaced guide members 66 positioned between the side rails 61 and having a generally outstanding tabs 67 projecting between the side rails and the bottom flanges 7 and fixed with the rails to those flanges. In addition to their slots 65, the guide members 66 have formed on their undersides guide rails 68 which, except adjacent their inner extremities, are flat and coplanar.

The slide plate 57 has on its underside the tar rack 56 over its outer portion and a longitudinally slotted connector or lost motion member 69 over its inner portion, both of which are centered laterally on the plate inside or laterally inwardly of the guide members 66. Suitably formed of side plates 70 connected and spaced by spacers 71, the slotted connector member 69 receives in its side-opening, longitudinally elongated slot 72 a pivot or connecting pin or shaft 73 on which the actuator-connected end of the link 58 is pivoted, the preferred link being a double link having its duplicate parts spaced by or straddling the slotted member 69 and in turn straddled or embraced by the guide members 66. Guide rollers 74 rotatably mounted on the pin 73 outside the link 58, are aligned with and roll on the downwardly facing guide rails 68 and the several components mounted on the pin are held in assembled relation thereon by heading one end of the pin and threading the other end or nut 75. The lost motion connection in the actuator 51 between the slotted member 69 and the link 58, is to enable any doors controlled by the actuator to swing open freely once their opening has been initiated, and the slot 65 is of a length to accommodate the travel of the connected end of the link 58 in requiring for such free opening.

In turning the operating shaft 31 through the crank 59, the actuating link 58 swings or shifts between a door open position in which it is vertically disposed and the crank 59 is in a lower quadrant far to one side of a central vertical plane through the axis of the shaft 31 and an open position in which it is oblique and the crank has been swung upwardly (clockwise as viewed in FIGURE 5) into an upper quadrant on the opposite side of that plane. In these door closed and open positions, the link's slide-connected upper end is adjacent respectively the inner and outer ends of the frame work 60 and it moves substantially horizontally between these positions, guided by the guide rollers 74 riding on the guide rails 68. For fixing and holding or locking the link 58 in its vertical closed position, the guide rails 68 are terminated or ended inwardly by downward projecting stops or shoulders 76 which, by engagement therewith, stop or limit the inward movement of the guide rollers 74 and in that position the rollers are engaged on their opposite or outer sides by detents 77 on and downwardly from the guide rail in advance of or outwardly beyond the stops 76. As in approaching and leaving the stops 76 the guide rollers 74 must roll over the detents 77 and the consequent downward deflection of the rollers must be accommodated by a corresponding downward deflection of the inner end of the slide 57, the detents and the stops together effectively lock or hold the rollers and thereby the slide-connected ends of the links 58 in the latter's vertical position. An assist to the detents in holding the link in closed position is given by the outer ends or end walls 78 of the slots 65 which at that time engage the outer side of the pin 73 between the guide rollers 74 after pushing the shaft and then through the slide-connected end of the link 58 to closed position in a closing operation. With the link 58 vertical and its upper end thus locked in closed position, the link cannot then be moved by any force applied to it through the crank 59 and the doors 5 and 6 are effectively locked against opening.

The inward sliding or shifting of the slide 57 by which the operating shaft 31 is caused in the above manner to turn in a closing direction in a closing operation, is imparted to the slide through the bevel gearing 53 and the pinion and rack 55 and 56 on turning of the actuating shaft 52 of the actuator 51 in a closing direction. In an opening operation, the slide 57 must first slide outwardly to take up the lost motion in the slots 65 and engage the inner side of the pin 73 by the corresponding ends of the slots 65. Further turning of the actuating shaft 52 in an opening direction will first cause the slide 57 to pull the guide rollers 74 under the detents...
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7. A door assembly according to claim 1, including at least a pair of laterally aligned discharge openings at opposite sides of the center sill, and operating means for opening and closing the doors of said pair in unison.

8. A door assembly according to claim 7, wherein the operating means includes an operating shaft common at least to the doors of a pair of laterally aligned discharge openings.

9. A hopper door assembly according to claim 8, wherein the inner doors of the laterally aligned pair of openings are drivably connected to the common operating shaft separately from the outer doors thereof.

10. A hopper door assembly according to claim 9, wherein the driving connection between the operating shaft and the inner doors includes toggle means link-and-crank connected to the operating shaft and having arms extending oppositely laterally of the car and each connected to one of the inner doors.

11. A hopper door assembly according to claim 9, wherein the driving connection between the outer doors and the operating shaft includes double ended crank means fixed against rotation to the shaft, and link means each connecting an end of the crank means to one of the outer doors.

12. A door assembly according to claim 11, wherein the link means are adjustable in length for adjusting the fit between the doors of each outlet in the closed position thereof.

13. A hopper door assembly according to claim 12, wherein the crank means includes a pair of double ended cranks spaced axially of the operating shaft and substantially laterally aligned with opposite sides of the outer doors, and the link means includes for each door a pair of individually adjustable links each connecting a side thereof to an end of an aligned crank.

14. A hopper door assembly according to claim 13, wherein the driving connection between the inner doors and the operating shaft includes a crank fixed to the operating shaft substantially midway between the outer door cranks, a toggle having oppositely extending arms each connected to and substantially centered laterally on one of the inner doors, and a link connecting said toggle to said crank.

15. A hopper door assembly according to claim 14, wherein the operating means includes actuating means acting through said operating shaft for positively driving the doors to closed position, said actuating means including means for locking the doors in closed position and lost motion means operative on unlocking thereof for enabling the doors to swing by gravity to open position without restraint by said actuating means.

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