

June 11, 1968

F. C. PULCRANO ET AL

3,387,570

SEQUENTIAL HOPPER GATE OPERATING MECHANISM

Filed Sept. 22, 1966

6 Sheets-Sheet 1

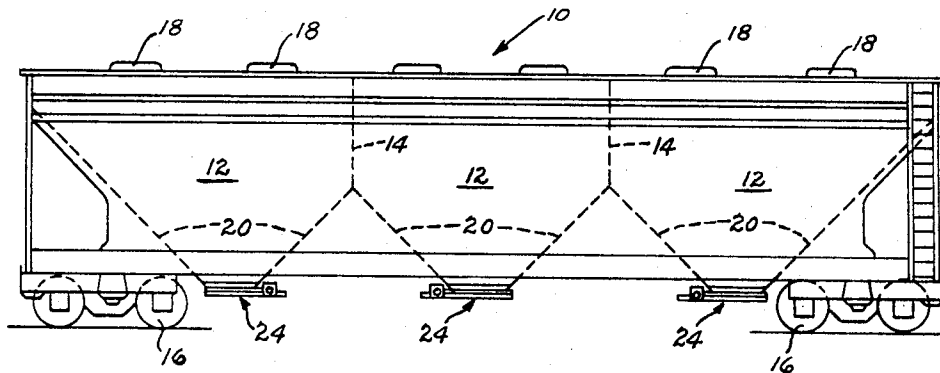


FIG. 1.

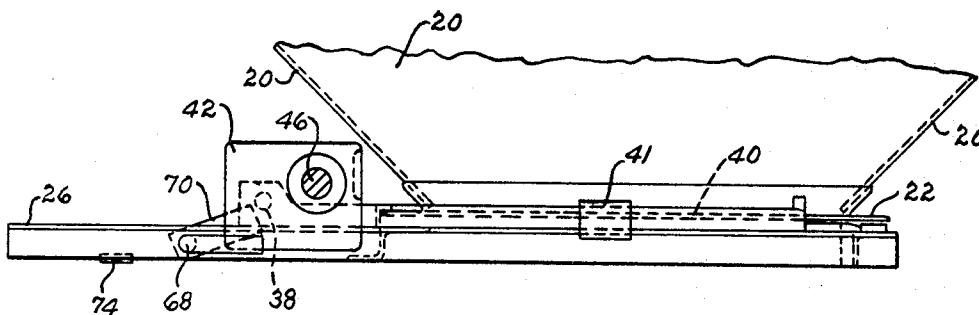


FIG. 2.

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3,387,570

SEQUENTIAL HOPPER GATE OPERATING MECHANISM

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6 Sheets-Sheet 2

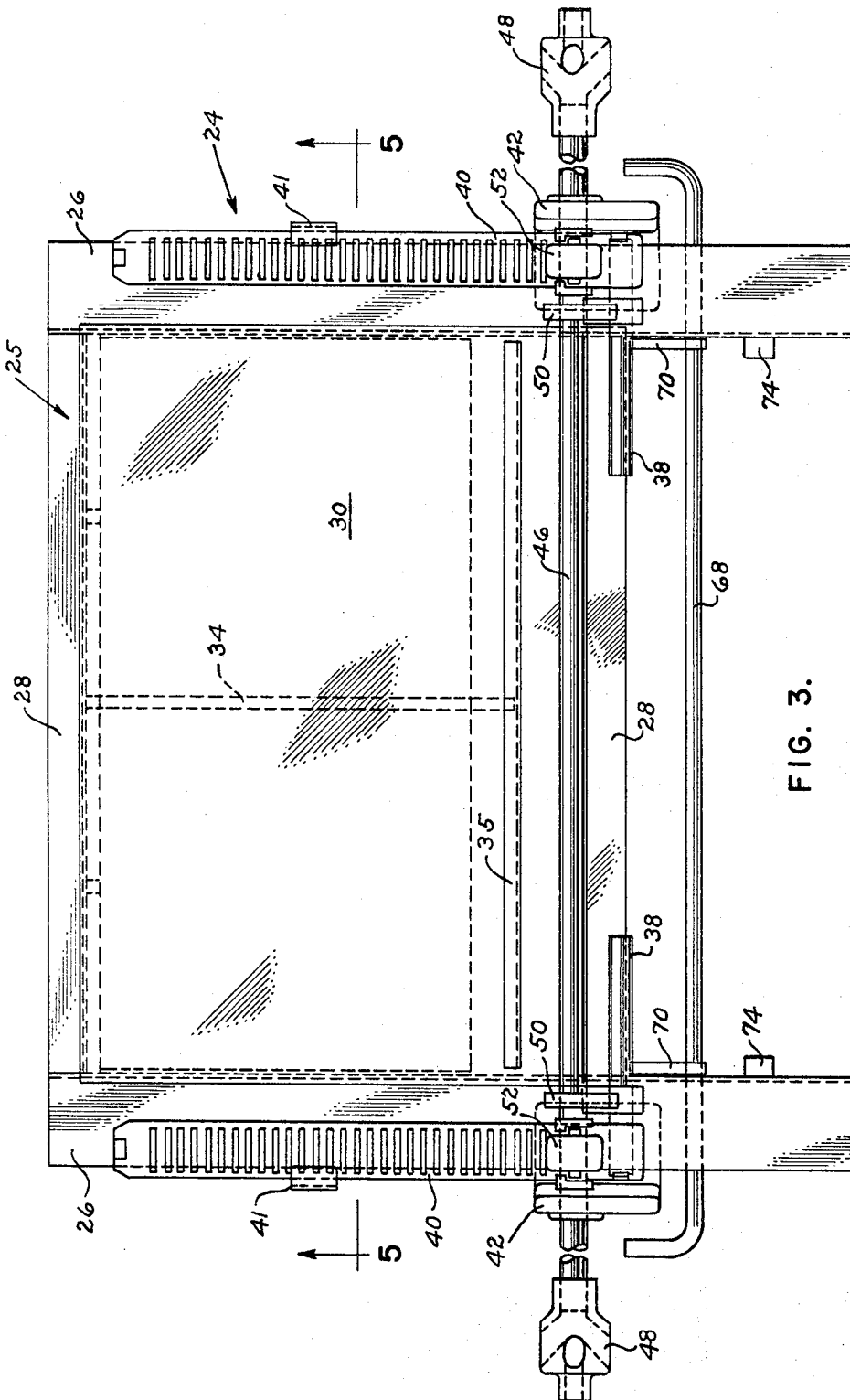


FIG. 3.

June 11, 1968

F. C. PULCRANO ET AL

3,387,570

SEQUENTIAL HOPPER GATE OPERATING MECHANISM

Filed Sept. 22, 1966

6 Sheets-Sheet 3

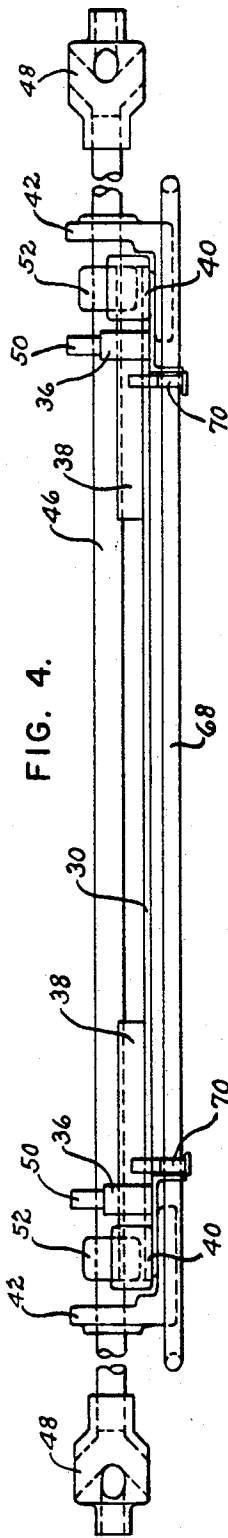


FIG. 4.

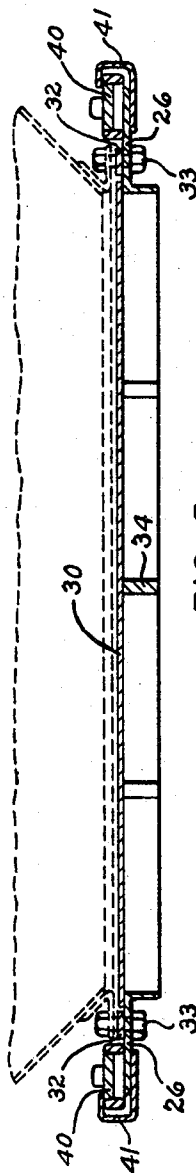


FIG. 5.

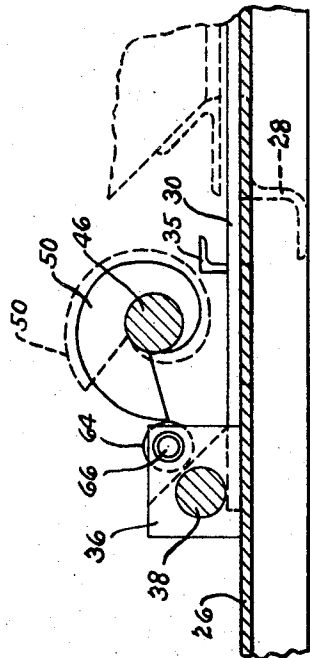


FIG. 9.

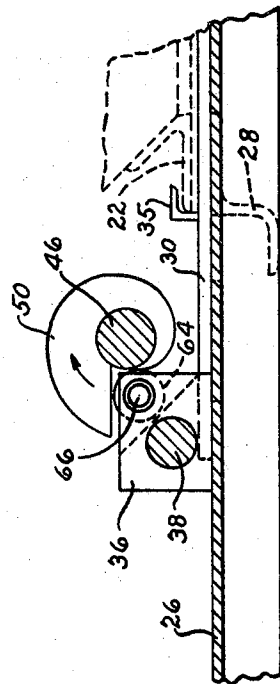


FIG. 10.

June 11, 1968

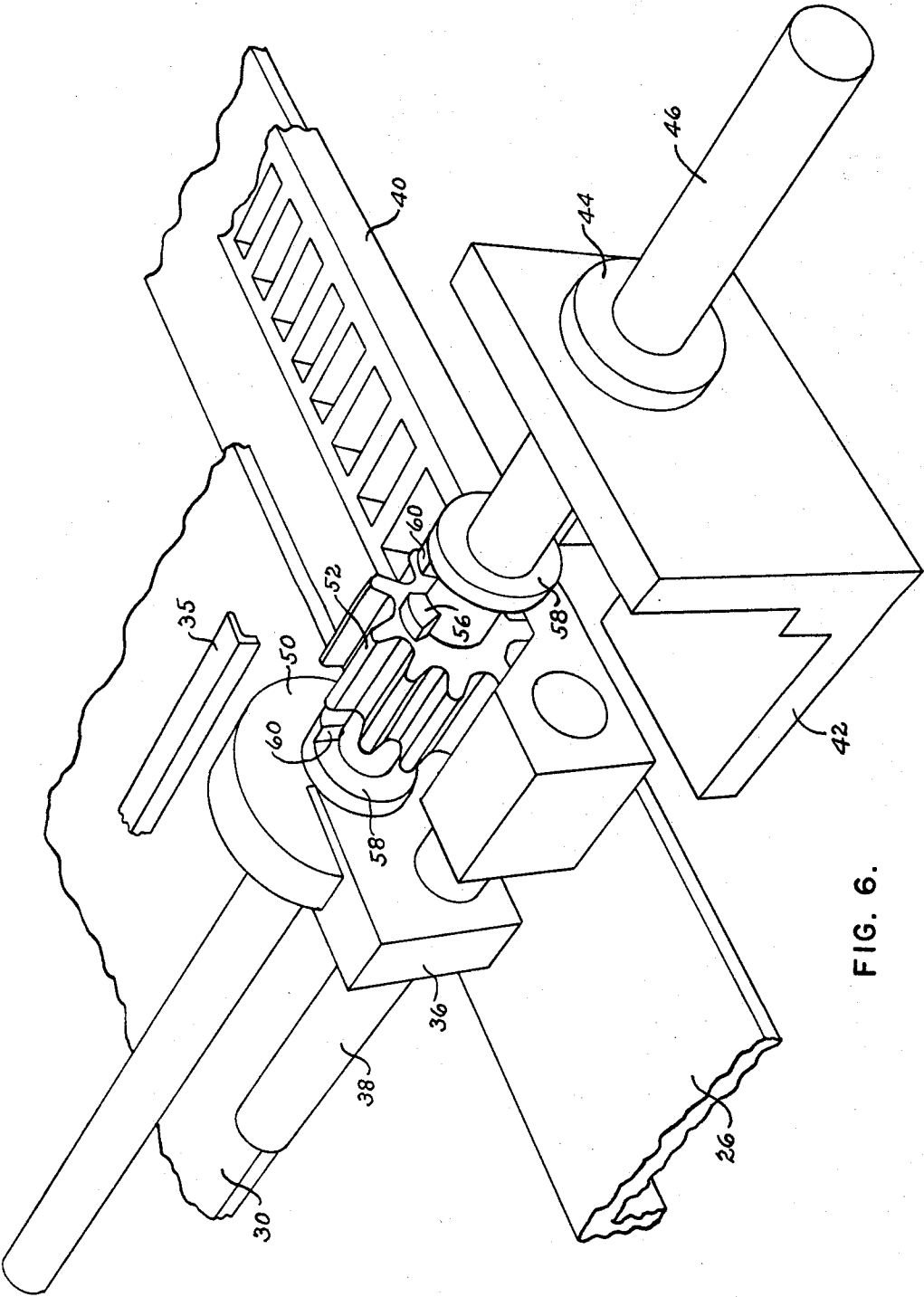
F. C. PULCRANO ET AL

3,387,570

SEQUENTIAL HOPPER GATE OPERATING MECHANISM

Filed Sept. 22, 1966

6 Sheets-Sheet 4



June 11, 1968

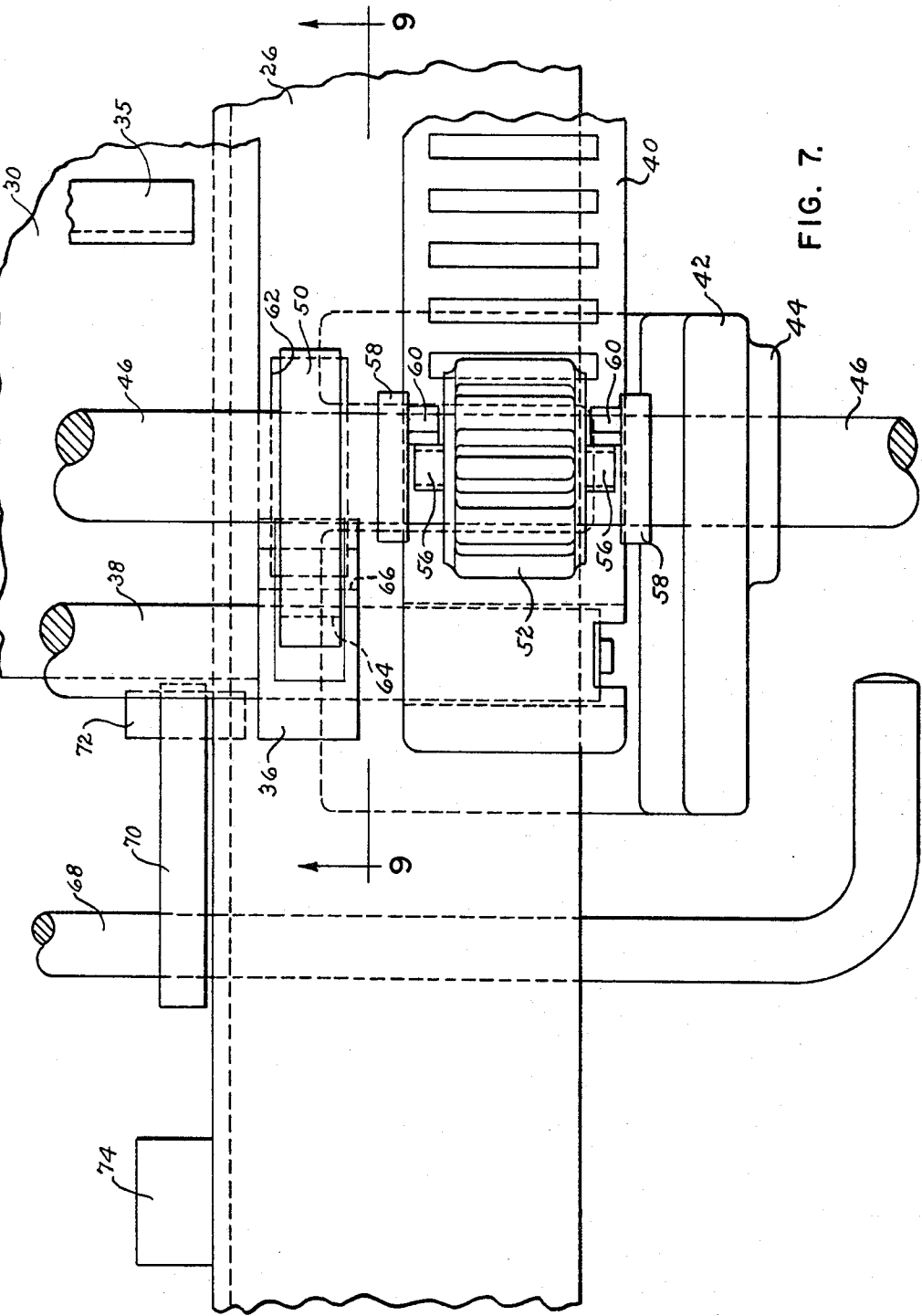
F. C. PULCRANO ET AL

3,387,570

SEQUENTIAL HOPPER GATE OPERATING MECHANISM

Filed Sept. 22, 1966

6 Sheets-Sheet 5



June 11, 1968

F. C. PULCRANO ET AL

3,387,570

SEQUENTIAL HOPPER GATE OPERATING MECHANISM

Filed Sept. 22, 1966

6 Sheets-Sheet 6

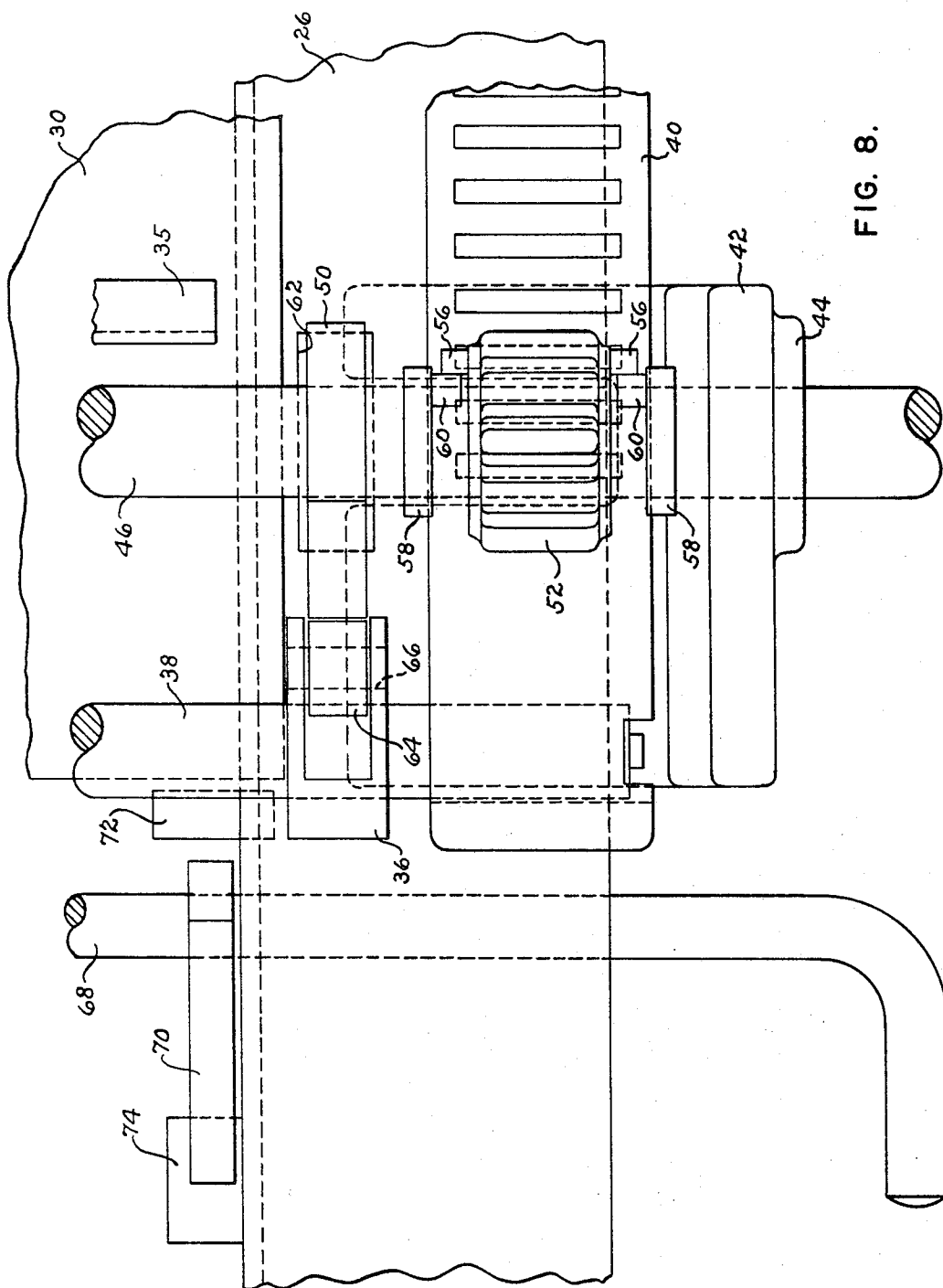


FIG. 8.

1

3,387,570

SEQUENTIAL HOPPER GATE OPERATING MECHANISM

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7 Claims. (Cl. 105-282)

ABSTRACT OF THE DISCLOSURE

An operating mechanism for a sliding hopper gate especially for initially breaking the gate open from a fully closed position and having, a rack and pinion combination for opening and closing the gate, cam means mounted on a pinion shaft for rotation therewith and initially breaking the gate open independently of the rack and pinion combination upon an initial rotation of the pinion shaft from the fully closed position of the gate, and a lost motion connection between the rack and pinion to permit the independent actuation of the cam for initially breaking the gate open. After the gate has been initially opened by the cam, the rack and pinion combination effects subsequent movement of the gate to full open position upon continued rotation of the pinion shaft. The cam provides a relatively high mechanical advantage to provide a relatively high opening force at a slow opening speed, and the rack and pinion combination drives the gate to its full open position at a relatively fast opening speed and a relatively low mechanical advantage after the gate has been initially opened.

Background of the invention

Sliding hopper gates of a relatively large size, such as twenty-four (24) inches by forty-two (42) inches, require relatively high initial opening forces, especially under severe cold weather conditions and with ladings, such as cement, that tend to bind and adhere to the gates. Heretofore, gear reduction units having mechanical advantages varying from around three-to-one to twelve-to-one have been employed to overcome the high initial opening forces. However, with gear reduction units, the rate of gear travel and the rate of gate movement are reduced by the ratio of the mechanical advantage. Thus, particularly with gear units having a relatively high mechanical advantage, a low opening rate is obtained which results in a long gate travel time.

Description of the invention

The present invention provides an opening mechanism for sliding hopper gates in which a high opening force at a low gate travel is applied for initially opening the gate a distance of around two (2) inches. Then, a fast opening rate for the remainder of gate travel is obtained by a direct drive. Thus, the slow gate travel is employed only when the gate is initially "cracked" open and thereafter, a fast gate travel is obtained to open the gate in a minimum of time. The gate opening mechanism is operated by a continued rotation of the pinion shaft without any separate operations or steps being involved.

Briefly described, the present invention comprises a pinion and rack combination for opening and closing the gate, the pinion being mounted on a pinion shaft for engaging the rack in a direct drive to slide the gate to a full open position at a fast gate travel rate. Separate means are mounted on the pinion shaft for initially

2

breaking the gate open independently of the rack and pinion and is operable only during the initial opening movement of the gate from a fully closed position. Thus, the initial rotation of the pinion shaft from the full closed position of the gate first actuates a mechanism for initially breaking the gate open at a low travel rate and continued rotation of the pinion shaft actuates the pinion for the full opening of the gate at a fast gate travel rate.

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

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

FIGURE 1 is a side elevation of a covered hopper railway car having a plurality of bottom outlet structures comprising the present invention;

FIGURE 2 is an enlarged side elevation of a bottom outlet structure;

FIGURE 3 is a top plan of the sliding gate structure shown in FIGURE 2;

FIGURE 4 is an end elevation of the bottom outlet structure shown in FIGURES 2 and 3;

FIGURE 5 is a section taken generally along line 5-5 of FIGURE 3;

FIGURE 6 is an exploded perspective of the operating mechanism for opening the sliding gate;

FIGURE 7 is an enlarged top plan of the mechanism for opening the sliding gate illustrating the gate in a fully closed position;

FIGURE 8 is an enlarged top plan similar to FIGURE 7 but showing the gate operating mechanism after the gate has been initially opened and in position for movement to fully open position;

FIGURE 9 is a section taken generally along line 9-9 of FIGURE 7 and illustrates the cam mechanism for initially breaking the gate open with the gate in fully closed position; and

FIGURE 10 is a section similar to FIGURE 9 but illustrating the gate and cam mechanism after the gate has been initially opened by the cam mechanism.

Referring now to the drawings for a better understanding of this invention, and more particularly to FIGURE 1, a covered hopper railway car is generally designated 10 and has a plurality of hopper structures 12 separated by partitions or bulkheads 14. A truck assembly 16 is arranged at each end of car 10. Spaced along the top of car 10 are hatch covers 18 for loading of the car with finely-divided materials, such as corn, wheat, granulated potash. Hopper sheets 20 of each hopper structure 12 slope downwardly to a bottom discharge opening defined by an outer peripheral flange 22.

Secured to peripheral flange 22 beneath each bottom discharge opening is a bottom outlet structure generally indicated 24. Each bottom outlet structure 24 comprises an upper generally rectangular peripheral flange 25 formed by the upper horizontal legs of angle-shaped end frame members 26 and side frame members 28. Mounted on the upper surfaces of end members 26 and side members 28 for sliding movement is a gravity gate 30. Spacers 32 on end members 26 and on one side member 28 fit between peripheral flanges 22 and 25 adjacent gate 30 to provide clearance for gate 30 between flanges 22 and 25. Flange 22 is spaced from the other side member 28 adjacent the gate operating mechanism to form a slot to receive gate 30. Suitable bolt and nut combinations 33 extend through spacers 32 and flanges 22, 25 to secure bottom outlet structure 24 to flange 22. An intermediate support 34 secured between side members 28 supports gate 30 between its ends. An angle 35 secured to the upper surface of gate 30 is adapted to fit over adjacent flange 22 in the closed position of the gate illustrated in

FIGURE 9 thereby to prevent the entry of foreign matter between flange 22 and gate 30.

Secured to opposed side edges of gate 30 are blocks 36 supported on the upper surface of end members 26 and adapted to move therealong with gate 30. Stub shafts 38 are secured to gate 30 and blocks 36. Mounted for pivotal movement on the outer end of each stub shaft 38 is a rack 40 supported for sliding movement with gate 30 along the upper surface of the subjacent end frame member 26. A rack retainer clip 41 is secured to each end frame member 26 to guide the associated rack 40 as shown in FIGURE 5.

A bearing support bracket 42 is secured to the underside of each end frame member 26 and has a bearing 44 thereon. A pinion shaft 46 is mounted in bearings 44 for rotation and has a capstan 48 fixed to each end thereof. A suitable handspike (not shown) or the like may be inserted in suitable openings of capstans 48 to rotate shaft 46 for opening and closing gate 30.

To provide a mechanical advantage and a relatively high force for initially opening gate 30, the present invention comprises a cam 50 fixed to pinion shaft 46 adjacent each side thereof and acting against an adjacent block 36. A pinion 52 adjacent each end of shaft 46 is mounted for free rotation on shaft 46 and has a pair of lugs 56 extending therefrom. Fixed to shaft 46 are drive rings 58 each having a lug 60 adapted to engage an associated lug 56 for driving the adjacent pinion 52. As shown in FIGURE 8, an opening 62 in the horizontal leg of each side member 26 beneath cam 50 receives cam 50 upon rotation thereof. Positioned adjacent cam 50 on each block 36 is a roller 64 mounted on an axle 66 for rotation and in engagement with cam 50 for minimizing frictional contact between cam 50 and block 36.

To secure gate 30 in closed position, a latch rod 68 is mounted for rotation on side members 26 and has latch bars 70 thereon adapted to swing behind an adjacent stub shaft when gate 30 is in closed position to prevent opening of the gate. Latch bars 70 are supported on tabs 72 in the closed position of the gate indicated in FIGURE 7 and on tabs 74 in the open position of gate 30 shown in FIGURE 8.

For initially opening gate 30 from the fully closed position shown in FIGURES 7 and 9, latch rod 68 is rotated to the position of FIGURE 8 and pinion shaft 46 is rotated manually by a suitable handspike in capstan 48 from either side of gate 30. Initial rotation of shaft 46 rotates cams 50 in a clockwise direction as viewed in FIGURE 9. Cams 50 are in engagement with rollers 64 and urge blocks 36 outwardly to move gate 30 in an opening direction. Pinions 52 since mounted for free rotation on shaft 46, are rotated by the movement of racks 40 upon the initial opening of gate 30 with the rotational movement of pinions 52 equal to the linear movement of gate 30. Upon rotation of cams 50 around three hundred fifty degrees (350°) as shown in solid lines in FIGURE 10, gate 30 opens a distance of around two (2) inches. The outer circumferences of pinions 52 are rotated a distance of two (2) inches by racks 40 upon the initial opening of gate 30 by cams 50 and thus, lugs 56 on pinions 52 are moved around forty-five degrees (45°) from their initial position shown in FIGURE 7 to the position of FIGURE 8 in which lugs 60 engage lugs 56 in driving relation. The position of cams 50 when pinions 52 are engaged by drive lugs 60 is indicated in broken lines in FIGURE 10 and thereafter, gate 30 opens at a relatively high rate of speed as cams 50 are out of engagement with rollers 64. The mechanical advantage of cams 50 is around five-to-one so a large opening force is obtained for initially breaking gate 30 open.

When the gate 30 is fully opened and it is desired to move the gate toward a closed position, shaft 46 is rotated in an opposite direction and lugs 60 then engage the opposite side of lugs 56 to drive pinions 52 and to move gate 30 toward closed position.

When gate 30 reaches its remaining two (2) inches of movement, lugs 60 and cams 50 are positioned so that cams 50 will be rotated into the position of FIGURE 9 upon the full closing of gate 30. Thus, the positioning and dimensions of lugs 56 and 60 are such that cams 50 move into the position of FIGURE 9 upon the full closing of gate 30. Therefore, when gate 30 is fully closed, cams 50 are in proper position for again opening gate 30.

From the foregoing, it is to be understood that the present invention provides a gate opening mechanism which has a high force for initially breaking the gate open and then has a high rate of travel for moving the gate to fully open position after the initial opening of the gate.

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

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

What is claimed is:

1. A hopper outlet structure comprising, a chute-like enclosure defining a bottom discharge opening, a gate for said discharge opening movable in a generally horizontal direction between open and closed positions relative to the opening, support means on opposite sides of said enclosure on which said gate is movable beyond one side of the enclosure to open position, a rack and pinion combination operatively connected to the gate for moving the gate between open and closed positions relative to the discharge opening, said combination including a rack and a pinion mounted on a pinion shaft for engaging the rack and moving the gate, and separate drive means actuated from a rotation of the pinion shaft to initially open the gate a predetermined amount independently of said rack and pinion from the full closed position of the gate, said separate drive means being operable to move the gate during the initial opening of the gate and having a relatively high mechanical advantage to provide a relatively high opening force at a relatively slow opening rate, said pinion after opening of the gate said predetermined amount by said separate drive means driving the rack independently of said separate drive means to move the gate to a full open position at a relatively fast opening rate.

2. A hopper outlet structure as set forth in claim 1 wherein said separate drive means to initially open the gate comprises a cam, means mounting the cam for rotation, and means connected to said gate in contact with said cam to effect initial opening of the gate upon rotation of the cam.

3. A hopper outlet structure comprising, a chute-like enclosure defining a bottom discharge opening, a gate for said discharge opening movable in a generally horizontal direction between open and closed positions relative to the opening, support means on opposite sides of said enclosure on which said gate is movable beyond one side of the enclosure to open position, a rack and pinion combination operatively connected to the gate for moving the gate between open and closed positions relative to the discharge opening, said combination including a rack and a pinion mounted on a pinion shaft for engaging the rack and moving the gate, and separate drive means to initially open the gate a predetermined amount independently of said rack and pinion upon rotation of the pinion shaft from the full closed position of the gate, said separate drive means being operable to move the gate during the initial opening of the gate and having a relatively high mechanical advantage to provide a relatively high opening force at a relatively slow opening rate, said pinion being mounted on said shaft for free relative rotational movement and being rotated a distance about its outer periphery substantially equal to the linear movement of

the gate during the initial opening of the gate by said separate drive means and, after said initial opening movement, engaging the pinion shaft in driving relation to move the gate to a full open position at a relatively fast opening rate.

4. A hopper outlet structure comprising, a chute-like enclosure defining a bottom discharge opening, a gate for said discharge opening movable in a generally horizontal direction between open and closed positions relative to the opening, support means on opposite sides of said enclosure on which said gate is movable beyond one side of the enclosure to open position, a rack adjacent each side of the gate, means connecting the racks to the gate for movement therewith between open and closed positions relative to the discharge opening, a pinion shaft adjacent the racks and having a pinion adjacent each end thereof adapted to engage an associated rack, said pinions being mounted for free rotational movement relative to the pinion shaft, a cam fixed to the pinion shaft and means fixed to the gate cooperating with said cam effective to initially open the gate a predetermined amount from full closed position upon initial rotation of the pinion shaft relative to the pinions, said cam being operable to move the gate only during the initial opening of the gate and providing a relatively high opening force at a relatively slow gate travel rate, and means driving the pinions with said pinion shaft after opening of the gate said predetermined amount whereby additional rotation of said pinion shaft after said initial gate opening moves the gate to full open position at a relatively fast gate travel rate independently of said cam.

5. A hopper outlet structure as set forth in claim 4 wherein said racks are pivotally connected to said gate about generally horizontal axes and adapted to pivot in a generally vertical plane relative to the gate, said means driving the pinions with said pinion shaft comprising drive lugs fixed to the shaft for rotation therewith and cooperating lugs on said pinions adapted to be engaged by said drive lugs for rotation of the pinions in driving relation.

6. A hopper outlet structure comprising, a chute-like enclosure defining a bottom discharge opening, a gate for said discharge opening movable in a generally horizontal direction between open and closed positions relative to the opening, support means on opposite sides of said enclosure on which said gate is movable beyond one side of the enclosure to open position, a rack and pinion combination operatively connected to the gate for moving the gate between open and closed positions relative to the discharge opening, said combination including a rack

and a pinion mounted on a pinion shaft for engaging the rack and moving the gate, and a cam on the pinion shaft operable to initially open the gate a predetermined amount from full closed position upon rotation of the pinion shaft, said cam being operable to move the gate independently of said rack and pinion only during the initial opening of the gate and having a relatively high mechanical advantage to provide a relatively high opening force at a relatively slow opening rate, said pinion after opening of the gate said predetermined amount upon rotation of said cam engaging the rack in driving relation to move the gate to a full open position at a relatively fast opening rate.

7. A hopper outlet structure comprising, a chute-like enclosure defining a bottom discharge opening, a gate for said discharge opening movable in a generally horizontal direction between open and closed positions relative to the opening, support means on opposite sides of said enclosure on which said gate is movable beyond one side of the enclosure to open position, a rack and pinion combination operatively connected to the gate for moving the gate between open and closed positions relative to the discharge opening, said combination including a rack and a cooperating pinion mounted on a pinion shaft, lost motion means in said rack and pinion combination to permit an initial opening of the gate independently of said rack and pinion combination, a cam fixed to the pinion shaft and operable to initially open the gate a predetermined amount from full closed position upon initial rotation of the pinion shaft independently of the rack and pinion combination, said cam being operable to move the gate only during the initial opening of the gate and providing a relatively high opening force at a relatively slow gate travel rate, and means connecting said rack and pinion combination in driving relation to said gate after opening of the gate said predetermined amount whereby additional rotation of said pinion shaft after said initial gate opening moves the gate to full open position at a relatively fast gate travel rate.

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