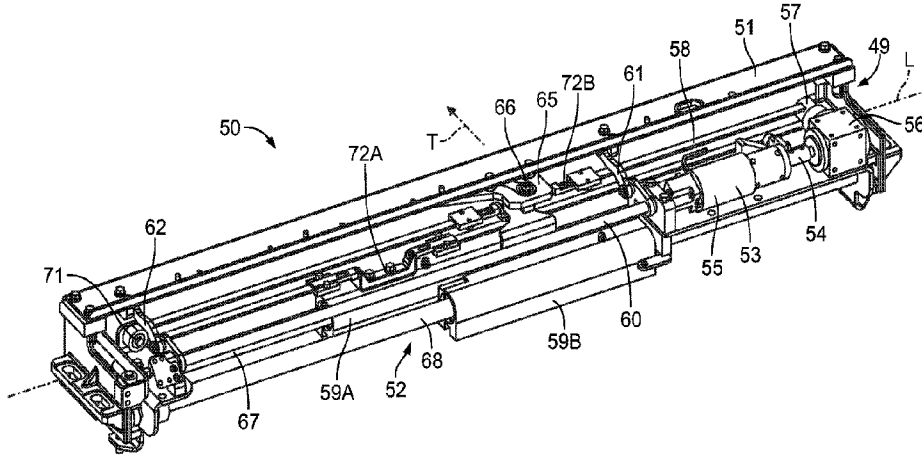




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 (54) Title: VEHICLE DOOR OPERATOR SYSTEM



(57) **Abrégé/Abstract:**

A system with a base configured to be mounted on a vehicle, and a carriage assembly that may be configured to be movably connected to the base and configured to move with respect to the base. The carriage assembly may include a motor including a motor output shaft and motor housing, and a driving mechanism configured to couple to a door and to the motor output shaft or the motor housing. The carriage assembly may also include a coordination bar configured to be coupled to the motor output shaft or the motor housing, the motor output shaft or the motor housing configured to rotate the coordination bar responsive to operation of the motor. At least one linkage assembly may be configured to extend or retract to move the carriage assembly to move the door between an open position and a closed position based on rotation of the coordination bar.

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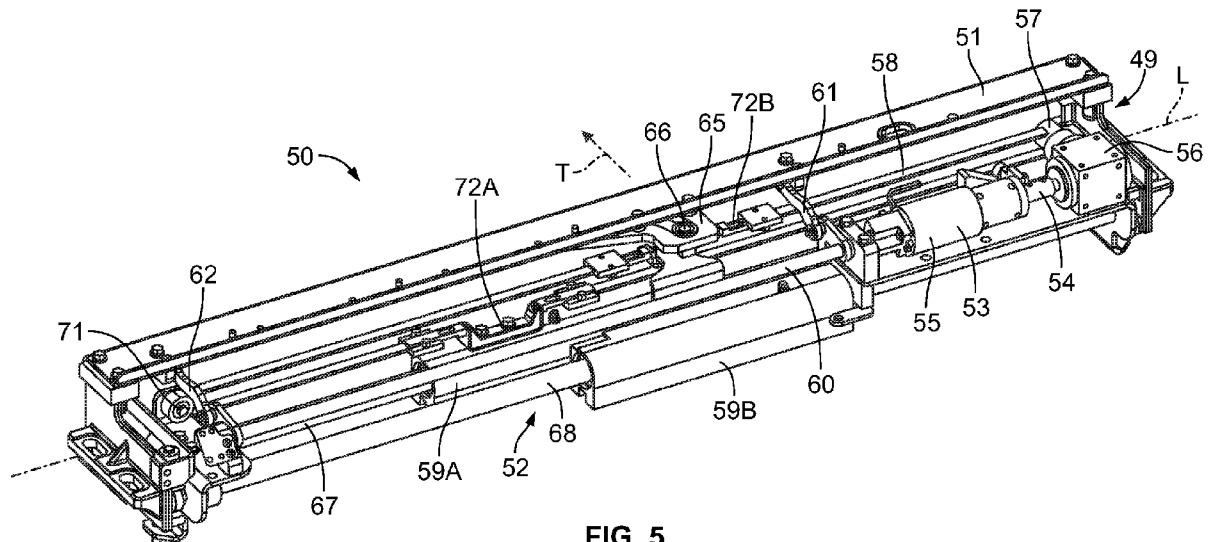


FIG. 5

(57) Abstract: A system with a base configured to be mounted on a vehicle, and a carriage assembly that may be configured to be movably connected to the base and configured to move with respect to the base. The carriage assembly may include a motor including a motor output shaft and motor housing, and a driving mechanism configured to couple to a door and to the motor output shaft or the motor housing. The carriage assembly may also include a coordination bar configured to be coupled to the motor output shaft or the motor housing, the motor output shaft or the motor housing configured to rotate the coordination bar responsive to operation of the motor. At least one linkage assembly may be configured to extend or retract to move the carriage assembly to move the door between an open position and a closed position based on rotation of the coordination bar.



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VEHICLE DOOR OPERATOR SYSTEM

[0001]

BACKGROUND

Technical Field.

[0002] The subject matter described relates generally to a vehicle door operator assembly.

Discussion of Art.

[0003] Vehicle door operator assemblies, such as those on rail vehicles, buses, transit vehicles, or the like, typically open with a sliding and plugging motion. A method for electrically powering an outside sliding plug door system is by using an electric motor having an output shaft that turns a lead screw. The lead screw nut is driven by the lead screw and, in turn, moves the door panels longitudinally, parallel to the door opening of the vehicle. The motor itself is not rigidly attached to a stationary frame, but is instead allowed to move axially. The axial force imparted by the lead screw is used to drive a linkage which plugs and unplugs the door panels laterally into and out of the door opening of the transit vehicle. Door operators utilizing such a configuration suffer from certain disadvantages due to the lead screw being an inherently low-efficiency device and due to the expenses related to replacement of the ball screw.

[0004] Another known method for electrically powering an outside sliding plug door system is by using an electric motor having an output shaft that turns a toothed drive pulley, which drives a toothed belt. The toothed belt is attached to the door panels to drive longitudinal movement of the door panels. The motor housing is rigidly attached to a pin riding in a helical cam, so that when the motor body rotates, it also moves axially due to the helical cam. This axial movement provides the lateral plugging/unplugging motion to the door panels. The system may require the use of two

helical cams, which must be synchronized to ensure that the door panel or panels plug/unplug evenly from the door opening. An example of such a system is disclosed in United States Patent No. 9,931,913, which may be referred to.

BRIEF DESCRIPTION

[0005] According to one or more embodiments, a system may be provided that includes a base configured to be mounted on a vehicle above a door, and a carriage assembly that may be configured to be movably connected to the base and configured to move with respect to the base. The carriage assembly may include a motor including a motor output shaft and a motor housing, and a driving mechanism configured to couple to the door and to couple to the motor output shaft or the motor housing. The driving mechanism may be configured to move in response to operation of the motor. The carriage assembly may also include a coordination bar configured to be coupled to the motor output shaft or the motor housing, the motor output shaft or the motor housing configured to rotate the coordination bar responsive to operation of the motor. The system may also include at least one linkage assembly configured to be coupled between the base and the coordination bar. The at least one linkage assembly may be configured to extend or retract to move the carriage assembly with respect to the base to move the door between an open position and a closed position based on rotation of the coordination bar.

[0006] In one or more embodiments, a system may include a base configured to be mounted on a transit vehicle above a door, and a carriage assembly movably connected to the base and configured to move with respect to the base. The carriage assembly may include a motor including a motor output shaft and a motor housing, a driving mechanism configured to couple to the door and coupled to one of the motor output shaft or the motor housing and configured to move in response to operation of the motor, and a coordination bar configured to be coupled to the motor output shaft or the motor housing, the motor output shaft or the motor housing configured to rotate the coordination bar responsive to operation of the motor to move the door between an open position and closed position based on rotation of the coordination bar. The system may also include a lever coupled to the coordination bar and configured to move over center when the carriage assembly is extended with respect to the base to form an over center lock.

[0007] In one or more embodiments, a system may be provided including a base configured to be

mounted on a transit vehicle above a door, and a carriage assembly movably connected to the base and configured to move with respect to the base. The carriage assembly may include a motor including a motor output shaft configured to rotate in a first direction and a motor housing configured to rotate in a second direction opposite the first direction, a driving mechanism configured to couple to the door and coupled to one of the motor output shaft or the motor housing and configured to rotate in the first direction in response to operation of the motor, and a coordination bar configured to be coupled to the motor output shaft or the motor housing, the motor output shaft or the motor housing configured to rotate the coordination bar in the second direction responsive to operation of the motor. The system may also include at least one linkage assembly coupled between the base and the coordination bar and configured to extend or retract to move the carriage assembly with respect to the base to move the door between an open position and a closed position based on rotation of the driving mechanism in the first direction and rotation of the coordination bar in the second direction.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] The inventive subject matter may be understood from reading the following description of non-limiting embodiments, with reference to the attached drawings, wherein below:

[0009] FIG. 1 is a perspective view of a portion of a vehicle;

[0010] FIG. 2 is a perspective view of the portion of the vehicle of FIG. 1 with the door panel in a closed position;

[0011] FIG. 3 is a perspective view of a portion of a vehicle having a bi-parting two-door assembly;

[0012] FIG. 4 is a perspective view of the portion of the vehicle of FIG. 3 with the door panels in a closed position;

[0013] FIG. 5 is a perspective view of a vehicle door operator system;

[0014] FIG. 6 is a reverse perspective view of the vehicle door operator system of FIG. 5;

[0015] FIG. 7A is a longitudinal cross-sectional view of the vehicle door operator system of FIG.

5;

[0016] FIG. 7B is a longitudinal cross-sectional view of the vehicle door operator system of FIG. 5; and

[0017] FIG. 8 is a process flow diagram of a method of operating a vehicle door.

DETAILED DESCRIPTION

[0018] Embodiments of the subject matter described herein relate to a vehicle door operator system that includes a sliding and plugging action. The vehicle door operator system includes a motor that has an output shaft that rotates in a first direction to actuate a driving mechanism to move a door with a sliding action (e.g. longitudinal direction), and a motor housing that rotates in an opposite second direction to actuate a linkage assembly to move the door with a plugging action (e.g. lateral direction). In this manner, the door both moves outwardly from the door opening and slides away from the opening accordingly based on the motor operation.

[0019] FIGS. 1 and 2 illustrate a portion of a vehicle 10, such as a passenger bus, subway car, trolley car, other rail vehicle, etc. The vehicle 10 may include a body 11 extending along a vehicle longitudinal axis V. The vehicle body 11 includes a wall structure with one or more door openings or portals 13 defined therein to allow passengers to enter and exit the vehicle 10. The vehicle 10 also includes a door assembly that includes a single door panel 12 that is moved by a door operator system 50 between open and closed positions with respect to the door opening 13. In particular, the door operator system 50 is configured to move the door panel in a door opening and closing direction X along the door opening 13. The door opening and closing direction X may be substantially parallel to the wall of the vehicle body 11 and possibly the vehicle longitudinal axis V, and in a lateral direction into and out of the door opening 13 transverse to or substantially transverse to the door opening and closing direction X. The opening and closing motion may be referred to as a plugging/unplugging motion.

[0020] To move the door panel 12 to the open position, shown in FIG. 1, the door operator system 50 is activated to move the door panel 12 laterally outward from the door opening 13, i.e., an unplugging motion, and then move the door panel 12 along the door opening 13 in the door opening and closing direction X longitudinally in a sliding motion to the open position to allow passengers

to enter and exit the vehicle 10 through the door opening 13. The door operator system 50 may also be configured to at least partially perform the sliding movement along the door opening and closing direction X simultaneously with the lateral unplugging movement.

[0021] To move the door panel 12 to the closed position, shown in FIG. 2, the door operator system 50 is again activated to slide the door panel 12 longitudinally along the door opening 13 in the door opening and closing position X back toward the closed position and then (or partially simultaneously) move the door panel 12 laterally inward to the door opening 13, i.e., a plugging motion. It is to be appreciated that when in the closed position, the door panel 12 may extend flush with the wall of the vehicle body 11 and may be in a sealed engagement with the wall or a door frame formed in the vehicle body 11.

[0022] FIGS. 3 and 4 illustrate another example vehicle 10. According to this example, the door assembly includes a pair of door panels 12A, 12B that are moved in a coordinated manner by the door operator system 50 between respective open and closed positions with respect to the door opening 13. In particular, the door operator system 50 is configured to move the pair of door panels 12A, 12B opposite to each other along the door opening 13 longitudinally in the door open and closing direction X and in the lateral direction into and out of the door opening 13 transverse to or substantially transverse to the door opening and closing direction X.

[0023] To move the door panels 12A, 12B to the open position, shown in FIG. 3, the door operator system 50 is activated to move the door panels 12A, 12B laterally outward from the door opening 13, i.e., an unplugging motion, and then move the door panels 12A, 12B away from each other along the door opening 13 in a sliding motion in the door opening and closing direction X to the open position. To move the door panels 12A, 12B to the closed position, shown in FIG. 4, the door operator system 50 is again activated to move the door panels 12A, 12B toward each other in a sliding motion along the door opening 13 in the door opening and closing direction X back toward the closed position and then move the door panels 12A, 12B laterally inward to the door opening 13, i.e., a plugging motion.

[0024] The door operator system 50 may be configured such that the plugging and unplugging movements of the pair of door panels 12A, 12B are made at least partially simultaneously with the movements in the door opening and closing direction X. The door operator system 50 may also

be configured such that door panels 12A, 12B may be moved between the open and closed positions in a coordinated, simultaneous manner. It is further to be appreciated that when in the closed position, the door panels 12A, 12B may extend flush with each other and/or with the wall of the vehicle body 11 and may be in a sealed engagement with each other and/or with the wall or a door frame formed in the vehicle body 11.

[0025] With reference to FIGS. 5-7B, an example door operator system 50 is shown. In one example, the door operator system 50 may be used for controlling the motion of the door panels in any of the FIGS. 1-4. To this end, the door operator system 50 may be configured to move a door or a pair of doors of a vehicle along a door opening in a vehicle between open and closed positions in the manner discussed above. As discussed above, the door operator system 50 may be configured to operate a single door panel or a pair of bi-parting door panels in a vehicle, which may be a passenger bus, subway car, trolley car, other rail vehicle, or similar vehicle. More generally, the door operator system could be used in any situation, for example a limited-access transit embarkation platform, where it is desired to provide a door that moves in the manner as set forth herein. For ease of illustration and explanation, FIGS. 5-7B illustrate the top portions of two door panels 59A, 59B connected to the door operator system 50 instead of the entire door panels.

[0026] The door operator system 50 may include a base 51 that is configured to be mounted on the vehicle above the door opening. The base 51 may extend along a longitudinal axis L which, when the base 51 is mounted on the vehicle, extends parallel to the door opening and closing direction X (see FIGS. 1-4) and may also be oriented parallel to the vehicle longitudinal axis V (shown in FIGS. 1-4).

[0027] As shown in FIGS. 5-7B, the door operator system 50 may also include a carriage assembly 52 that may be movably coupled to the base 51 and can be driven to move with respect to the base in a transverse direction T perpendicular to the longitudinal axis L of the base 51. In one example, the carriage assembly 52 may be movably coupled by rollers 69 disposed on opposite longitudinal ends of the carriage assembly, which engage tracks 70 defined in the respective ends of the base 51. Alternatively, a tongue and groove coupling, sliders, matching patterns, wheels, gearing, etc. may provide the coupling such that the carriage assembly 52 may be movably coupled to the base.

[0028] The carriage assembly 52 may incorporate the components for mounting the one or two

door panels 59A, 59B to the door operator system 50 to drive movement of the door panels 59A, 59B between the open and closed positions. The components for mounting may include fasteners, nuts and bolts, adhesive, welding, or the like.

[0029] The carriage assembly 52 includes a motor 53, which may include a motor output shaft 54 and a motor housing 55. In one embodiment, the motor 53 is not structurally fixed to the carriage assembly 52 and, as such, the motor housing 55 is able to rotate freely counter to the rotation of the motor output shaft 54 in reaction to the torque output to the motor output shaft 54. Alternatively, the housing may be stationary, but gearing is provided to provide an input that rotates in an opposite direction to the motor output shaft.

[0030] In one example, a right angle gear box 56 may be disposed on the carriage assembly 52 and connected to the motor output shaft 54. A driving mechanism 49 is provided that in one example may include a toothed drive pulley 57 that extends from the right angle gear box 56. While in this example a toothed drive pulley 57 may be provided, in other examples other driving mechanism may include a sprocket, gear, etc. Actuation of the motor 53 drives rotation of the motor output shaft 54, which is then translated to the toothed drive pulley 57 via the right angle gear box 56.

[0031] The driving mechanism in one embodiment may include a toothed drive belt 58 that may engage the toothed drive pulley 57 and a return pulley 71 disposed on the carriage assembly 52 away from the toothed drive pulley 57. The drive belt 58 may be operatively coupled to the motor output shaft 54 via the right angle gear box 56 and the drive pulley 57 such that operation of the motor 53 causes rotation of the drive belt 58 in a first rotational direction in a direction parallel to the longitudinal axis L of the base 51. As a result, the drive belt 58 may be driven to rotate around the drive pulley 57 and the return pulley 71 about a rotational axis that is perpendicular or substantially perpendicular to the longitudinal axis L of the base 51.

[0032] The door panels 59A, 59B may each be coupled to the drive belt 58 by a respective clamp 72A, 72B. Alternatively, the door panels 59A, 59B may each be coupled to the drive belt by fasteners, bolts, clips, etc. In one example, one door panel 59B may be attached by the clamp 72B to an upper portion of the drive belt 58. The other door panel 59A may be attached by the clamp 72A to a lower portion of the drive belt 58. In this manner, the drive belt 58 causes the door panels

59A, 59B to slide opposite to each other in the door opening in the closing direction X. The door panels 59A, 59B are slidably mounted and supported on respective support beams 67, 68 for movably and structurally supporting the door panels 59A, 59B on the carriage assembly 52.

[0033] With reference to FIGS. 5-7B, the carriage assembly 52 also may include a coordination bar 60 coupled to the motor housing 55 such that operation of the motor 53 causes rotation of the coordination bar 60 through rotation of the motor housing 55 counter to the rotation of the motor output shaft 54 in a second direction.

[0034] The door operator system 50 further includes two linkage assemblies 61, 62 coupled between the base 51 and the coordination bar 60. In one example, each linkage assembly 61, 62 may include a lever 63 fixedly coupled to the coordination bar 60, and a linkage arm 64 pivotably coupled between the lever 63 and the base 51. Alternatively, the linkage arm may include an extension, or other movable member. Specifically, the linkage assembly does not include a helical member for movement purposed. As shown in FIGS. 7A and 7B, rotation of the coordination bar 60 actuates the linkage assemblies 61, 62 to extend or retract and, thereby, move the carriage assembly 52 with respect to the base 51 in the transverse direction T between the extended and retracted positions, which correspond to the closed and opened positions of the door panels 59A, 59B, respectively.

[0035] As shown in FIG. 7A, when the carriage assembly 52 is in the extended position, the levers 63 and the linkage arms 64 are moved over center with respect to each other so as to form an over center locking mechanism that locks the door panels 59A, 59B in the closed position and prevents or hinders a passenger from pushing or forcing movement of the door panels 59A, 59B out of the door opening to open the pair of door panels. According to an alternative example of the present disclosure, a single linkage assembly 61 may be used to drive movement of the carriage assembly 52 and the door panels 59A, 59B with respect to the base 51.

[0036] To move the door panels 59A, 59B between the open and closed positions, the motor 53 may be actuated via a central or local control to drive rotation of the motor output shaft 54 with respect to the motor housing 55. The motor output shaft 54 is operatively coupled to the drive belt 58 via the right angle gearbox 56 and the drive pulley 57 such that operation of the motor 53 causes the drive belt 58 to move about the drive pulley 57 and the return pulley 71 in the direction parallel

to the longitudinal axis L of the base 51, which causes the door panels 59A, 59B to move opposite to each other along the door opening in the door opening and closing direction X. As discussed above, the motor housing 55 is unfixated and freely rotatable with respect to the carriage assembly 52. The motor housing 55 is coupled to the coordination bar 60 such that rotation of the motor housing 55 opposite to the rotation of the motor output shaft 54 causes the coordination bar 60 to rotate.

[0037] Rotation of the coordination bar 60 causes the linkage assemblies 61, 62 to extend or retract, and thereby drive movement of the carriage assembly 52 with respect to the base 51 in the transverse direction T between the extended and retracted positions and cause the door panels 59A, 59B to move into or out of the door opening in the lateral direction. In this manner, the motor 53 acts as a differential mechanism between the coordination bar 60 and the drive belt 58. In one embodiment, the motor 53 may alternatively be arranged such that the motor output shaft 54 is coupled to the coordination bar 60 and the motor housing 55 is coupled to the right angle gear box 56 and the drive belt 58. Specifically, the motor 53 provides two separate and opposite rotations so that each can be used to actuate the right angle gear box, or coordination bar.

[0038] Accordingly, the door operator system 50 utilizes the output of the motor 53 to actuate movement of the door panels 59A, 59B laterally into and out of the door opening, i.e., a plugging/unplugging motion. The motor also actuates movement of the door panels 59A, 59B along the door opening in the door opening and closing direction X between the open and closed positions illustrated in FIGS. 1-4.

[0039] As shown in FIGS. 5 and 6, the base 51 may also include a curved track 65 thereon. A corresponding guide roller 66 is connected to one of the door panels 59B. The guide roller 66 travels within the curved track 65 to guide the door panel 59B between the open and closed positions. While in this example a guide roller 66 may be provided, other guiding mechanisms may be used to move along the curved track 65 to provide the movement as desired.

[0040] FIG. 8 illustrates a process flow diagram of a method 800 of opening and closing a vehicle door. In one example, the door operator system 50 of FIGS. 1-7 is used to perform the method. While described in relation to a single door, the method may be used to open and close a single door, or a pair of doors within an opening of the vehicle.

[0041] At 802, starting with a door in an open position on the vehicle, a motor is actuated to close the door. The actuation results in rotation of the motor output shaft in a first direction and the motor housing in a second direction. In one example the first direction may be clockwise while the second direction is counterclockwise. Alternatively, the first direction may be counterclockwise while the second direction is clockwise.

[0042] At 804, the rotation of the motor output shaft in the first direction actuates a driving mechanism configured to slide the door in a longitudinal direction. In one example, the driving mechanism may include a right angle gear box that may be coupled to a pulley system. The pulley system in one example may include a toothed drive pulley, a return pulley, and a drive belt as described herein. In one embodiment, the motor output shaft is coupled to a coordination bar instead of the driving mechanism. As a result, the rotation results in the coordination bar actuating a linkage assembly to provide a plugging motion to the door, moving the door laterally towards the opening. Because the driving mechanism and coordination bar are both actuated by a rotational actuator, and the motor has two rotating elements, the output shaft, and the housing, the motor may be reversible within the system. Specifically, the system functions as a differential mechanism between the driving mechanism and coordination bar.

[0043] At 806, the rotation of the motor housing in the second direction actuates a coordination bar configured to plug the door in a lateral direction towards the door opening. The rotation of the motor housing and plugging of the door may occur simultaneously as the door is slid as a result of the motor output shaft. In one example, the coordination bar may couple to a linkage assembly that includes a lever that pushes the door towards the opening. In one embodiment, the motor housing is coupled to a driving mechanism instead of the coordination bar. As a result, the rotation results in the driving mechanism actuating a drive belt to provide a sliding motion to the door, moving the door longitudinally within the door opening.

[0044] At 808, the linkages move past an over center position to lock the door in place. The door at this point is in a closed position. Specifically, in one example, the linkage assembly may include a lever and linkage arm that are both moved over center with respect to each other such that lateral movement does not cause rotation of the linkage arm about its center axis, forming a locking mechanism. In this manner, an individual pushing against the door cannot force the door open,

and instead, only the rotational movement of the actuating member (e.g. coordination bar and linkage assembly) causes movement of the door in a lateral direction.

[0045] At 810, the motor is reversed, causing rotation of the driving mechanism and coordination bar in opposite directions. As a result, the driving mechanism actuates to slide the door longitudinally to an opened position, while the coordination bar actuates to move the door laterally away from the opening to the open position. Similar to the previous steps, the coupling of the motor may be reversed such that both the motor output shaft, and motor housing may drive the actuation of the driving mechanism and coordination bar.

[0046] Thus, provided is a door operator system 50 that uses the natural counterrotation of the motor to provide an additional function in opening and closing a door within a door opening for a vehicle. The rotation in the first direction may be used to provide a sliding motion of a door or doors, while the counterrotation in the second direction may be used to provide a plugging motion of the door or doors. Consequently, efficient use of the motor is provided, and expenses reduced.

[0047] In one or more embodiments, a system that may be provided that includes a base configured to be mounted on a vehicle above a door, and a carriage assembly that may be configured to be movably connected to the base and configured to move with respect to the base. The carriage assembly may include a motor including a motor output shaft and a motor housing, and a driving mechanism configured to couple to the door and to couple to the motor output shaft or the motor housing. The driving mechanism may be configured to move in response to operation of the motor. The carriage assembly may also include a coordination bar configured to be coupled to the motor output shaft or the motor housing, the motor output shaft or the motor housing configured to rotate the coordination bar responsive to operation of the motor. The system may also include at least one linkage assembly configured to be coupled between the base and the coordination bar. The at least one linkage assembly may be configured to extend or retract to move the carriage assembly with respect to the base to move the door between an open position and a closed position based on rotation of the coordination bar.

[0048] Optionally, the carriage assembly may also include a gearbox and drive pulley configured to operatively couple the motor to the driving mechanism. In another embodiment, the at least one linkage assembly may include a lever configured to be fixedly coupled to the coordination bar and

a linkage arm configured to be pivotably coupled with the base. Alternatively, the lever and the linkage arm may be configured to move over center while the carriage assembly is extended with respect to the base to form an over center lock.

[0049] In another aspect, the system may also include a curved track may be configured to be connected to the base and a roller configured to be coupled to the door. The roller may be configured to travel within the curved track to guide the door between the open position and the closed position. Optionally, the door may comprise a pair of door panels, and the carriage assembly may be configured to move the pair of door panels between the open position and the closed position. In another example, the carriage assembly may also include a support beam configured to have the door slidably mounted thereon.

[0050] Optionally, the carriage assembly may be movably coupled to the base by at least one roller engaged within tracks defined in opposing ends of the base. In another aspect, the motor may not be fixed to the carriage assembly. Optionally, the driving mechanism may be a drive belt.

[0051] In one or more embodiments, a system may include a base configured to be mounted on a transit vehicle above a door, and a carriage assembly movably connected to the base and configured to move with respect to the base. The carriage assembly may include a motor including a motor output shaft and a motor housing, a driving mechanism configured to couple to the door and coupled to one of the motor output shaft or the motor housing and configured to move in response to operation of the motor, and a coordination bar configured to be coupled to the motor output shaft or the motor housing, the motor output shaft or the motor housing configured to rotate the coordination bar responsive to operation of the motor to move the door between an open position and closed position based on rotation of the coordination bar. The system may also include a lever coupled to the coordination bar and configured to move over center when the carriage assembly is extended with respect to the base to form an over center lock.

[0052] Optionally, at least one linkage assembly may be coupled between the base and the coordination bar that includes the lever, and is configured to extend or retract to move the carriage assembly with respect to the base to move the door between a locked open position and the closed position based on the rotation of the coordination bar. Alternatively, the at least one linkage assembly may include a linkage arm that is configured to move over center when the over center

lock is formed. In one embodiment, the at least one linkage assembly may not include a helix spring. In another example, the motor housing may be configured to rotate in an opposite direction to the motor output shaft to rotate the coordination bar in an opposite direction compared to the driving mechanism. The system may also include a curved track connected to the base and a roller configured to be coupled to the door, wherein the roller travels within the track to guide the door between the open position and the closed position. In one embodiment, the door may comprise a pair of door panels, and the carriage assembly may be configured to move the pair of door panels between the open position and the closed position.

[0053] In one or more embodiments, a system may be provided including a base configured to be mounted on a transit vehicle above a door, and a carriage assembly movably connected to the base and configured to move with respect to the base. The carriage assembly may include a motor including a motor output shaft configured to rotate in a first direction and a motor housing configured to rotate in a second direction opposite the first direction, a driving mechanism configured to couple to the door and coupled to one of the motor output shaft or the motor housing and configured to rotate in the first direction in response to operation of the motor, and a coordination bar configured to be coupled to the motor output shaft or the motor housing, the motor output shaft or the motor housing configured to rotate the coordination bar in the second direction responsive to operation of the motor. The system may also include at least one linkage assembly coupled between the base and the coordination bar and configured to extend or retract to move the carriage assembly with respect to the base to move the door between an open position and a closed position based on rotation of the driving mechanism in the first direction and rotation of the coordination bar in the second direction.

[0054] Optionally, the driving mechanism may be a drive belt coupled to a drive pulley to move the door between the open position and the closed position.

[0055] In another example, the at least one linkage assembly may be configured to move the door outwardly away from a door opening as the door moves laterally between the open position and the closed position.

[0056] The singular forms “a”, “an”, and “the” include plural references unless the context clearly dictates otherwise. “Optional” or “optionally” means that the subsequently described event or

circumstance may or may not occur, and that the description may include instances where the event occurs and instances where it does not. Approximating language, as used herein throughout the specification and claims, may be applied to modify any quantitative representation that could permissibly vary without resulting in a change in the basic function to which it may be related. Accordingly, a value modified by a term or terms, such as “about,” “substantially,” and “approximately,” may be not to be limited to the precise value specified. In at least some instances, the approximating language may correspond to the precision of an instrument for measuring the value. Here and throughout the specification and claims, range limitations may be combined and/or interchanged, such ranges may be identified and include all the sub-ranges contained therein unless context or language indicates otherwise.

[0057] This written description uses examples to disclose the embodiments, including the best mode, and to enable a person of ordinary skill in the art to practice the embodiments, including making and using any devices or systems and performing any incorporated methods. The claims define the patentable scope of the disclosure, and include other examples that occur to those of ordinary skill in the art. Such other examples are intended to be within the scope of the claims if they have structural elements that do not differ from the literal language of the claims, or if they include equivalent structural elements with insubstantial differences from the literal language of the claims.

WHAT IS CLAIMED IS:

1. A vehicle door operator system comprising:
 - a base configured to be mounted on a vehicle above a door;
 - a carriage assembly configured to be movably connected to the base and configured to move with respect to the base, the carriage assembly comprising:
 - a motor including a motor output shaft and a motor housing configured to rotate in opposite directions during movement of the door;
 - a driving mechanism configured to couple to the door and to couple to the motor output shaft, the driving mechanism configured to move the door in a longitudinal direction in response to operation of the motor; and
 - a coordination bar configured to be coupled to the motor housing, the motor housing configured to rotate the coordination bar responsive to operation of the motor to move the door in a lateral direction; and
 - at least one linkage assembly configured to be coupled between the base and the coordination bar, the at least one linkage assembly configured to extend or retract to move the carriage assembly with respect to the base to move the door between an open position and a closed position based on rotation of the coordination bar.
2. The system according to claim 1, wherein the carriage assembly further comprises a gearbox and drive pulley configured to operatively couple the motor to the driving mechanism.
3. The system according to claim 1, wherein the at least one linkage assembly comprises a lever configured to be fixedly coupled to the coordination bar and a linkage arm configured to be pivotably coupled with the base.
4. The system according to claim 3, wherein the lever and the linkage arm are configured to move over center while the carriage assembly is extended with respect to the base to form an over center lock.

5. The system according to claim 1, comprising a curved track configured to be connected to the base and a roller configured to be coupled to the door, wherein the roller is configured to travel within the curved track to guide the door between the open position and the closed position.

6. The system according to claim 1, wherein the door comprises a pair of door panels, and wherein the carriage assembly is configured to move the pair of door panels between the open position and the closed position.

7. The system according to claim 1, wherein the carriage assembly further comprises a support beam configured to have the door slidably mounted thereon.

8. The system according to claim 1, wherein the carriage assembly is movably coupled to the base by at least one roller engaged within tracks defined in opposing ends of the base.

9. The system according to claim 1, wherein the motor is not fixed to the carriage assembly.

10. The system according to claim 1, wherein the driving mechanism comprises a drive belt.

11. A vehicle door operator system comprising:

a base configured to be mounted on a transit vehicle above a door;

a carriage assembly movably connected to the base and configured to move with respect to the base, the carriage assembly comprising:

a motor including a motor output shaft and a motor housing configured to rotate in opposite directions during movement of the door;

a driving mechanism configured to couple to the door and coupled to the motor output shaft, the driving mechanism configured to move the door in a longitudinal direction in response to operation of the motor; and

a coordination bar configured to be coupled to the motor housing, the motor

housing configured to rotate the coordination bar responsive to operation of the motor to move the door in a lateral direction between an open position and closed position based on rotation of the coordination bar; and

a lever coupled to the coordination bar and configured to move over center when the carriage assembly is extended with respect to the base to form an over center lock.

12. The system according to claim 11, comprising at least one linkage assembly coupled between the base and the coordination bar that includes the lever, and is configured to extend or retract to move the carriage assembly with respect to the base to move the door between a locked open position and the closed position based on the rotation of the coordination bar.

13. The system according to claim 12, wherein the at least one linkage assembly includes a linkage arm that is configured to move over center when the over center lock is formed.

14. The system according to claim 12, wherein the at least one linkage assembly does not include a helix spring.

15. The system according to claim 11 comprising a curved track connected to the base and a roller configured to be coupled to the door, wherein the roller travels within the track to guide the door between the open position and the closed position.

16. The system according to claim 11, wherein the door comprises a pair of door panels, and wherein the carriage assembly is configured to move the pair of door panels between the open position and the closed position.

17. A vehicle door operator system comprising:

a base configured to be mounted on a transit vehicle above a door;

a carriage assembly movably connected to the base and configured to move with respect to the base, the carriage assembly comprising:

a motor including a motor output shaft configured to rotate in a first direction and

a motor housing configured to rotate in a second direction opposite the first direction during rotation of the motor output shaft;

a driving mechanism configured to couple to the door and the motor output shaft, the driving mechanism configured to rotate in the first direction in response to operation of the motor to slide the door in a longitudinal direction; and

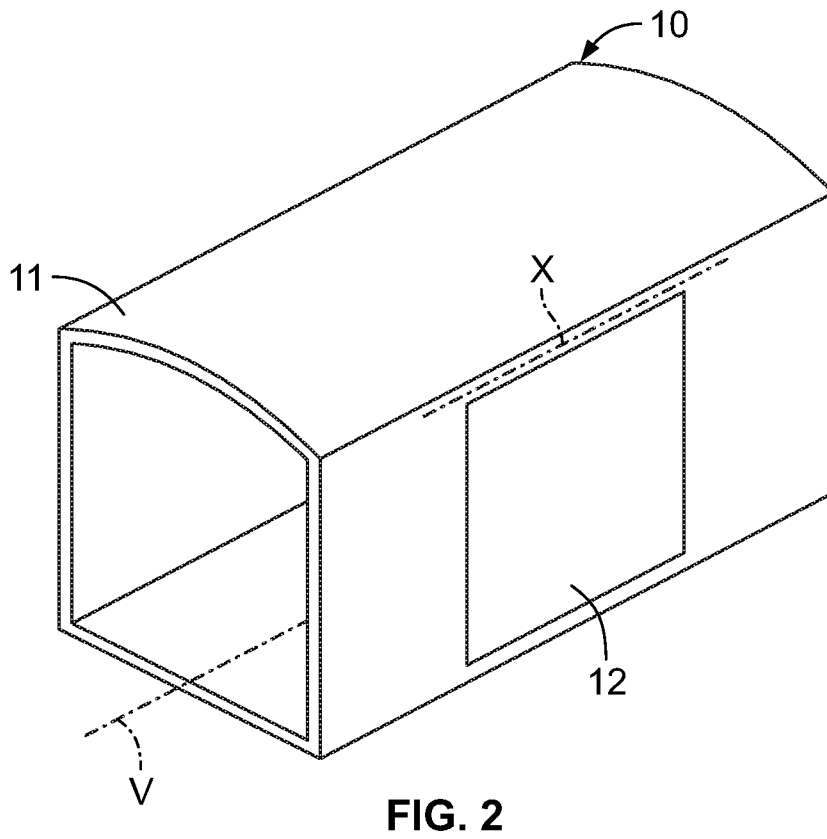
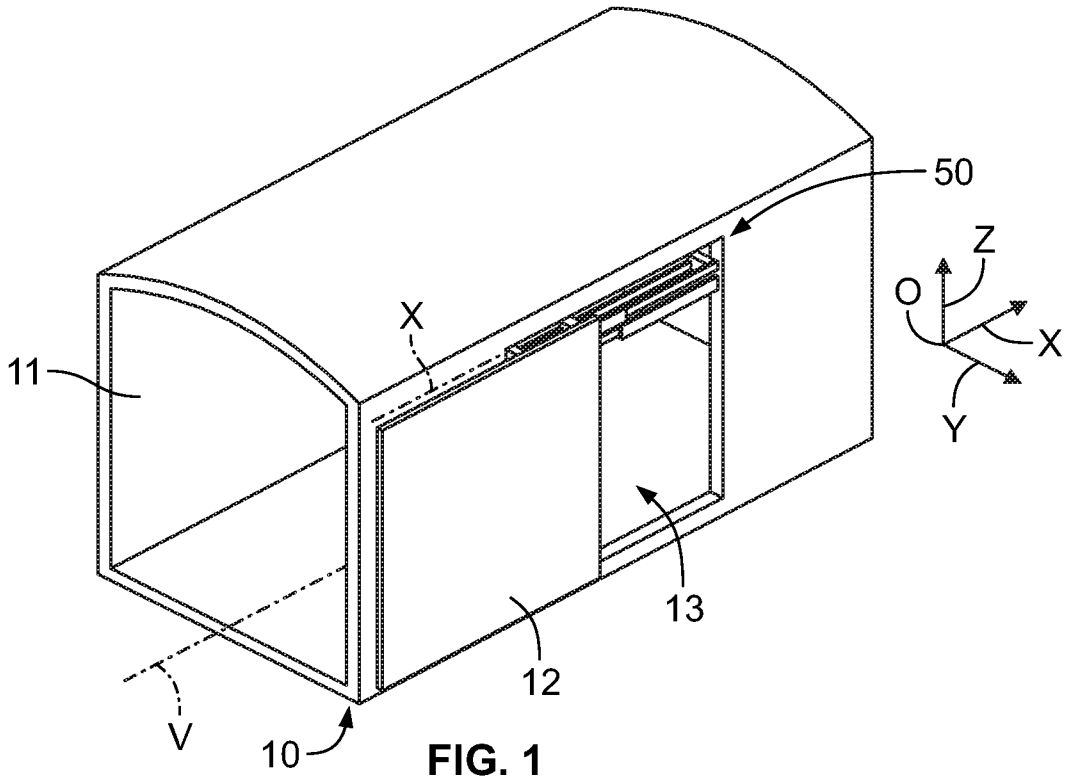
a coordination bar configured to be coupled to the motor housing, the motor housing configured to rotate the coordination bar in the second direction responsive to operation of the motor to move the door in a lateral direction; and

at least one linkage assembly coupled between the base and the coordination bar and configured to extend or retract to move the carriage assembly with respect to the base to move the door between an open position and a closed position based on rotation of the driving mechanism in the first direction and rotation of the coordination bar in the second direction.

18. The system according to claim 17, wherein the driving mechanism is a drive belt coupled to a drive pulley to move the door between the open position and the closed position.

19. The system according to claim 17, wherein the at least one linkage assembly is configured to move the door outwardly away from a door opening as the door moves laterally between the open position and the closed position.

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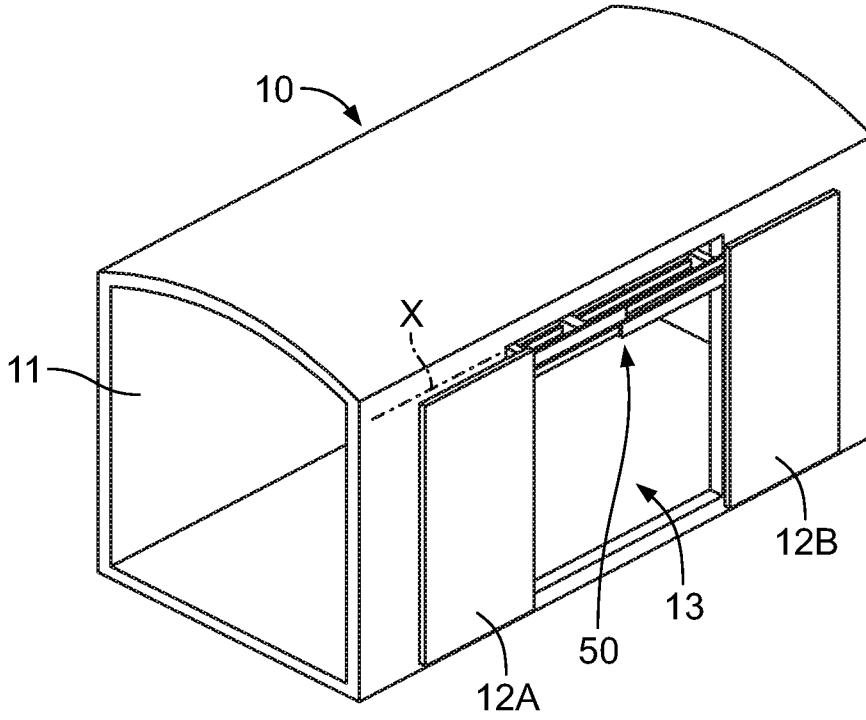


FIG. 3

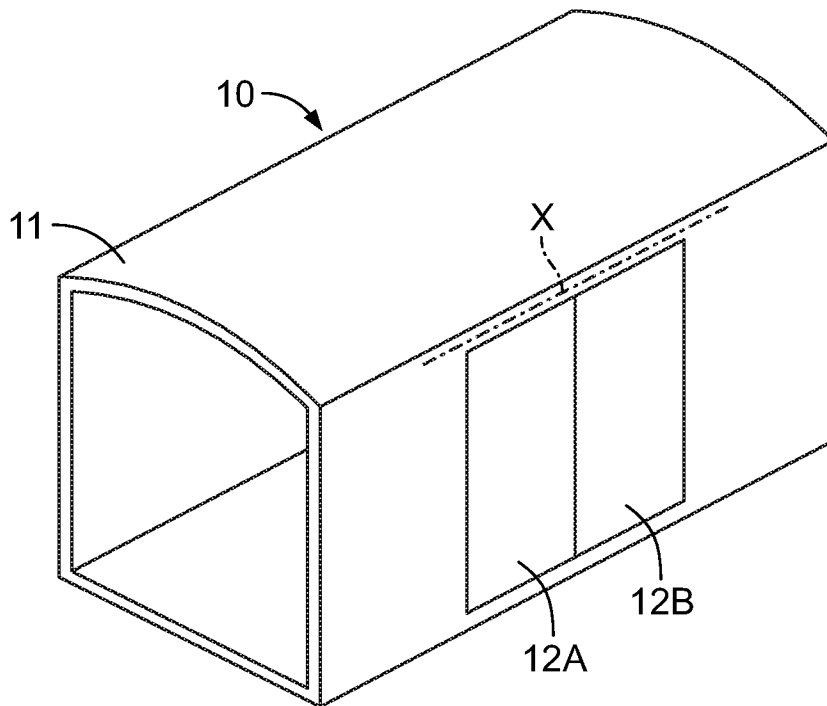


FIG. 4

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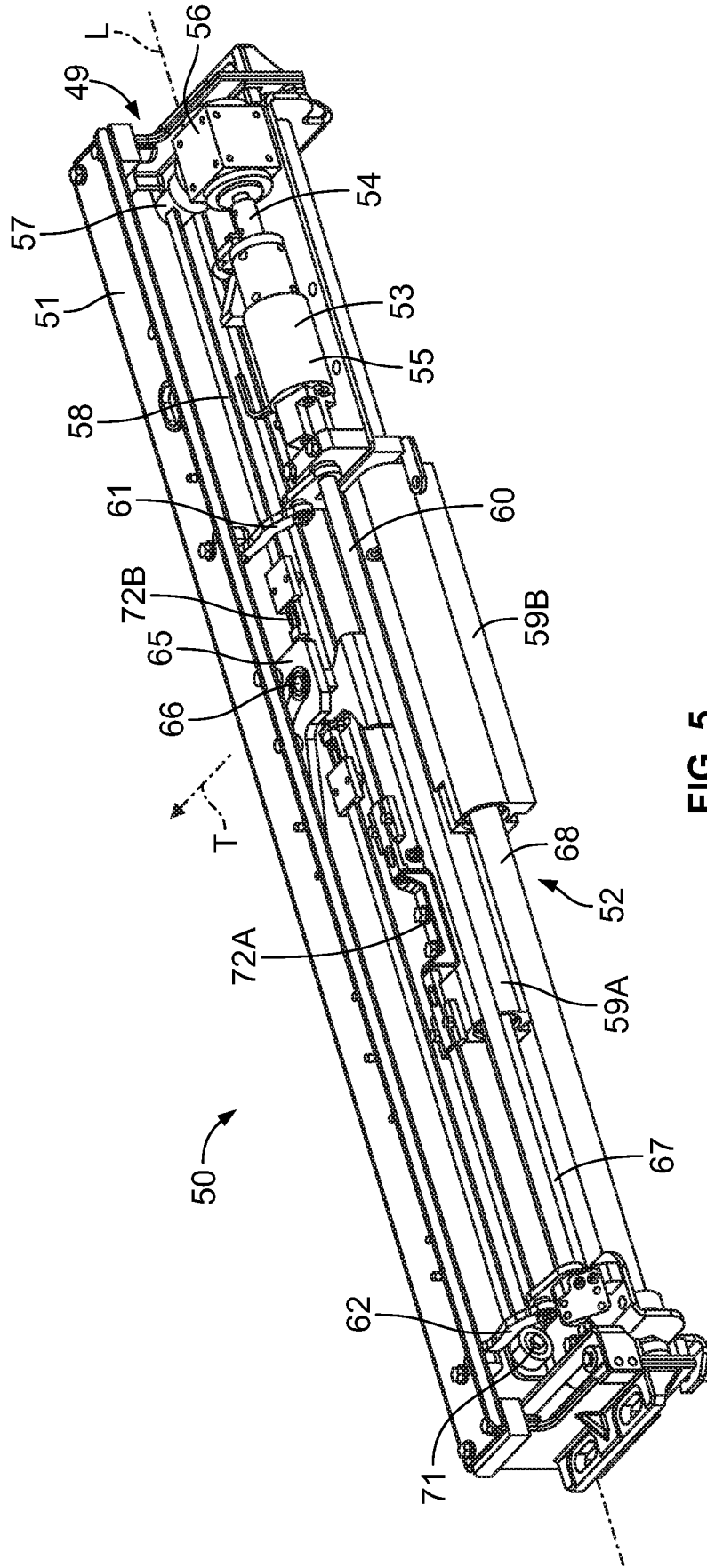


FIG. 5

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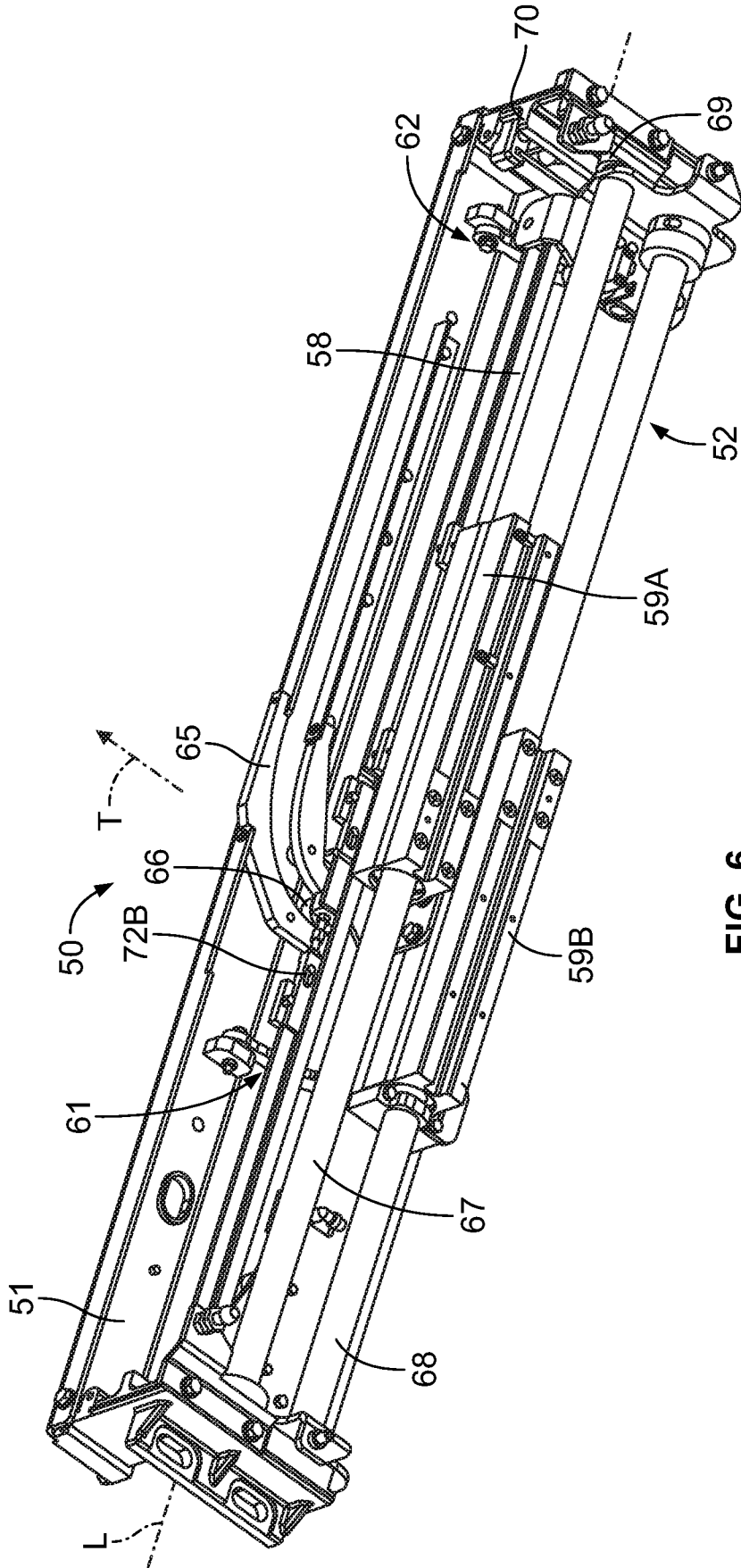


FIG. 6

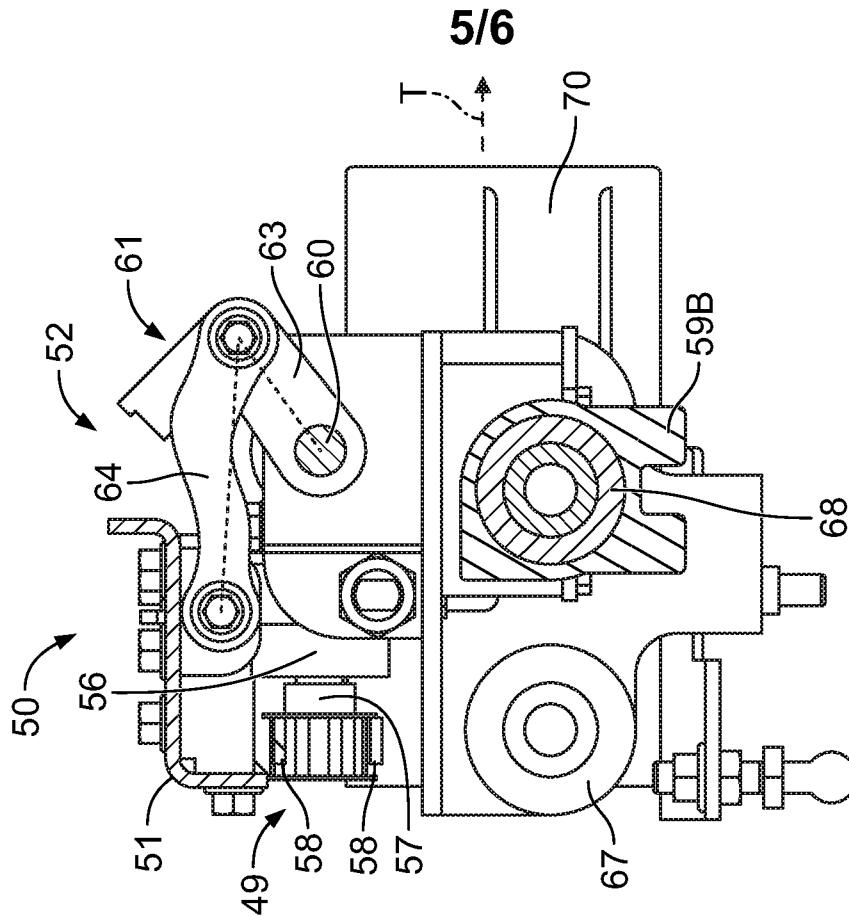


FIG. 7A

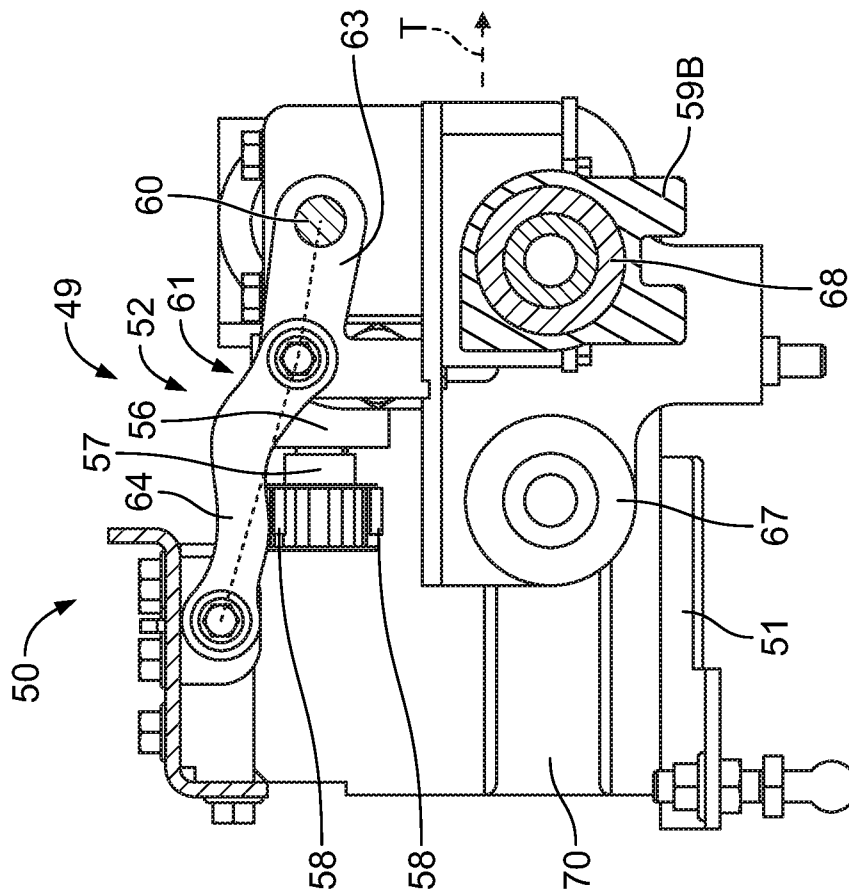


FIG. 7B

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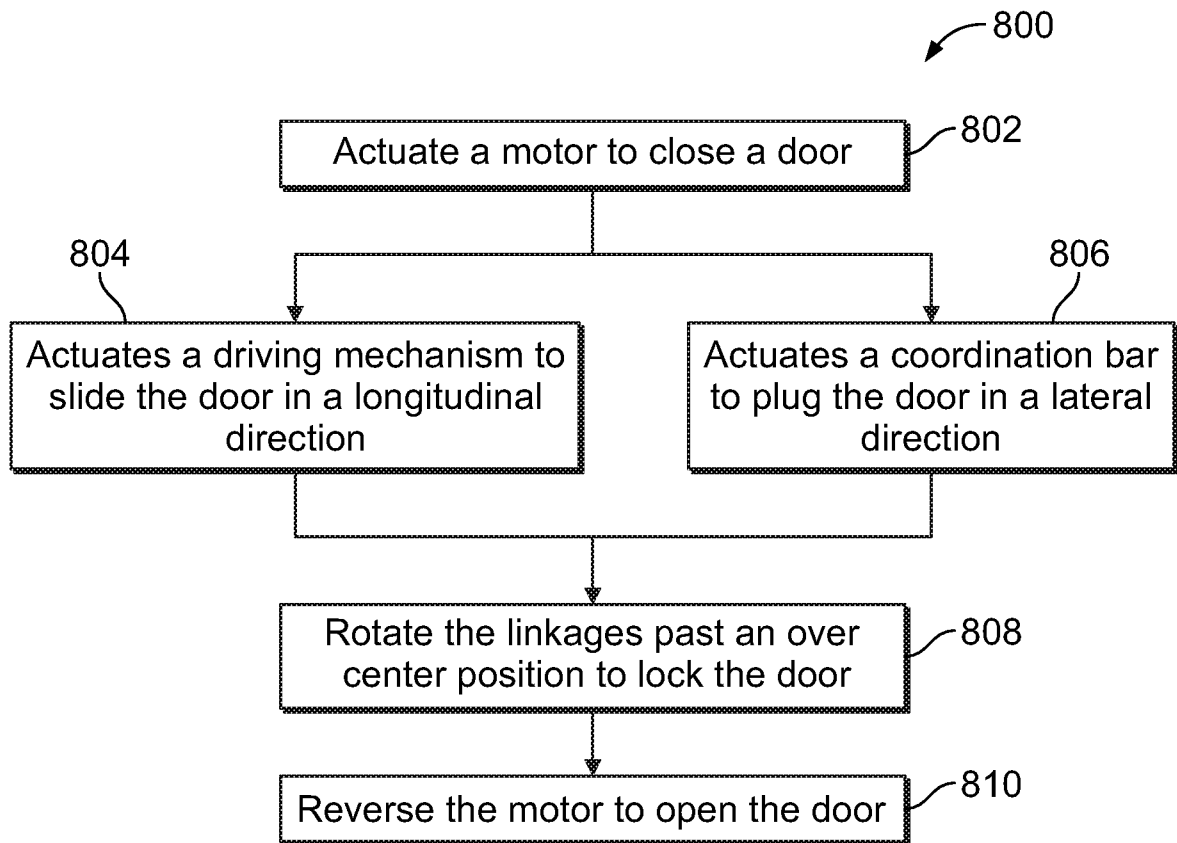


FIG. 8

