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(54) Sliding door operator.

(57) A door operator system includes a fluid cylinder (10) that has a cylinder body (12) and a rodless piston (30) adapted for reciprocation in the cylinder body (12). A carriage (50) which is adapted for reciprocation externally along the length of the cylinder body (12) is secured to the piston (30). An arm member (70) connects the cylinder carriage (50) to an associated sliding door. A control circuit is provided for controlling the operation of the fluid cylinder (10) and hence the position of the associated sliding door.

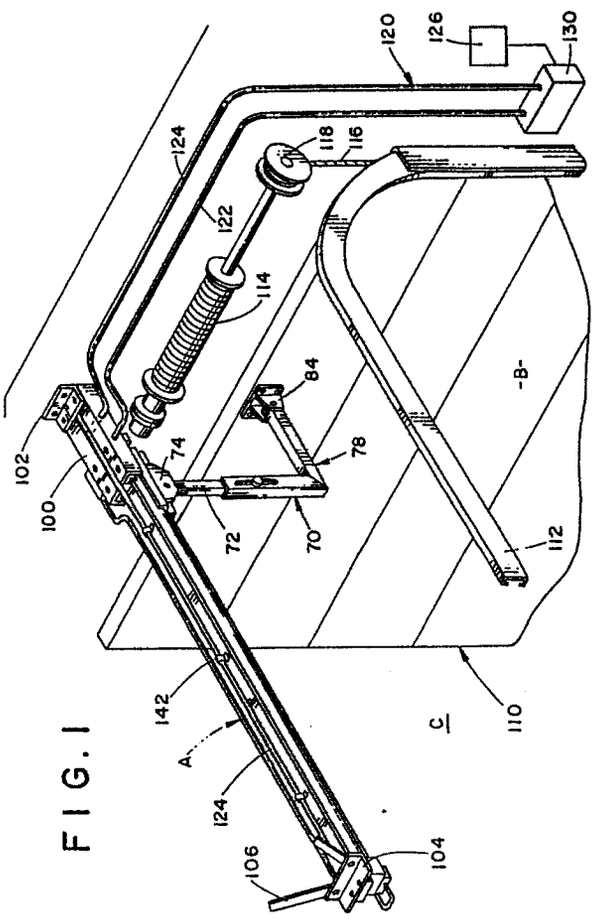

FIG. 1

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SLIDING DOOR OPERATOR

The present invention relates to sliding door operator apparatus.

The invention is particularly applicable to sectional overhead doors of the multiple panel type and will be described with particular reference thereto. However, the invention has broader applications and may also be adapted for use in many other environments, such as single panel overhead doors and even sideward sliding doors or the like.

Most overhead doors are counterbalanced by a torsion spring or a counterweight system for storing energy during door closing, which energy may be released during door opening. During opening, most of the energy for lifting such a door is derived from the energy stored in the spring or counterweight system. If the door is accurately counterbalanced, the amount of manual energy required to open the door need only be sufficient to overcome the frictional and other losses in the system. During door closing, the energy required is that for overcoming the frictional and other losses since most of the energy which is transferred to the spring or counterweight storage system is derived from the weight of the descending door.

In general, conventional overhead doors of this nature are actuated by a cable which is wound around a drum, axially driven by the torsion spring, with the drum being rotated by a chain driven sprocket. Generally, the chain is driven by an electric motor. In some environments, however, the use of electrical motors is undesirable because of the possible danger of a spark causing an explosion or a fire. It has also been found that electric motors are disadvantageous since, if the door becomes jammed, the motor will continue rotating and will probably cause the cable between the drum and the door to unwind which could prove hazardous to personnel and may also damage property.

Also, when such doors are used frequently, such as in car washes or the like, the chains, sprockets, electrical motors, and bearings wear out at a relatively rapid rate and this results in frequent breakdowns of the door opening mechanism. Moreover, malfunctions of the door opening mechanism may also lead to damage to the upper portion of the door which can be relatively expensive to repair.

One recent suggestion has been to utilize a pair of pneumatic cylinders in a side mounted operator for moving the chain of the chain driven sprocket thereby rotating the sprocket. However, side mounted operators are disadvantageous since any interruption in the door travel results in an unwinding of the cable from the torsion bar drum which makes the door liable to a free fall that could cause grave injury to people as well as damage to objects under the door and to the door itself. The pneumatic cylinder actuated side mounted operator mechanism is also disadvantageous since chains and sprockets which undergo a high number of cycles wear out at a relatively rapid rate resulting in frequent breakdowns of the door operator mechanism and, sometimes, damage to the door.

Accordingly, it would therefore be advantageous to develop a new and improved door operator system which may overcome the foregoing difficulties, and others, while providing improved and more advantageous overall results.

In accordance with the present invention there is provided a new and improved sliding door operator system in which the piston is a rodless piston reciprocable in a cylinder body and is secured to a carriage reciprocable externally along the length of the cylinder body and in that arm means are provided for connecting the carriage to the sliding door.

In accordance with another aspect of the present invention, the system further comprises a bracket means for securing the fluid cylinder to an adjacent wall.

In accordance with still another aspect of the present invention, the system further comprises a switch means located at each end of the cylinder with the switch means being in electrical contact with the control means to activate associated electrical equipment.

In accordance with yet another aspect of the present invention, the arm means comprises a pair of telescopic tubular sections with the first of the sections being secured to the fluid cylinder carriage and a second of the sections being secured to the associated sliding door. The arm means further comprises a resilient means for cushioning the telescopic action of the pair of tubular sections. Preferably, a first pivot means is provided for pivotally securing the first section to the fluid cylinder carriage and a second pivot means is provided for pivotally securing the second section to the associated sliding door.

In accordance with yet still another aspect of the present invention, the control means comprises a source of pressurized fluid and a conduit means for connecting the source of pressurized fluid to the fluid cylinder. A control panel is also provided for controlling the flow of pressurized fluid through the conduit means.

In accordance with a further aspect of the present invention, the source of pressurized fluid is in fluid communication with both ends of the fluid

cylinder so that it can act on either end of the rodless piston. Preferably, the cylinder is provided with seal means for preventing the pressurized fluid from flowing out of the cylinder. Preferably, both ends of the fluid cylinder also include an adjustable valve means communicating with the environment.

One advantage of the present invention is the provision of a door operator system which actuates a door by the movement of a rodless piston which reciprocates in a cylinder.

Another advantage of the present invention is the provision of a door operator system which can actuate most types of overhead doors that have a counter-balance means and can also actuate selected sideward sliding doors.

Yet another advantage of the present invention is the provision of a trolley-type door operator system which eliminates the need for chains, sprockets, bearings, and motors, all of which are prone to breakdowns when frequently used.

A further advantage of the present invention is the provision of a door operator system which opens and closes a door with a minimum of force thereby preventing injury to persons or damage to objects which are inadvertently positioned in the path of the door when the door is being moved.

The invention is described further hereinafter, by way of example only, with reference to the accompanying drawings, in which:

Fig. 1 is a perspective view of one embodiment of a door operator system according to the present invention in conjunction with a door of a building;

Fig. 2 is a side elevational view of the door operator system of Fig. 1;

Fig. 2A is an enlarged side elevational view, partially in cross-section, of an arm member of the door operator system of Fig. 2;

Fig. 3 is an enlarged side elevational view, partially in cross-section, of the cylinder of Fig. 1; and

Fig. 4 is a cross-section through the line 4-4 of Fig. 3.

Fig. 1 shows a door operator system A as it is utilized on a door B which closes an opening in a building C. While the door operator is primarily designed for and will hereinafter be described in connection with a sectional overhead sliding door, it should be appreciated that the overall inventive concept involved could be adapted for use with many other overhead and sideward sliding door arrangements.

With reference to Fig. 3, the operator system A includes a cylinder member 10 which comprises a tubular body 12 that has an outer periphery 13 having two spaced substantially square sides and two spaced rounded sides (Fig. 4) and a longitudinal bore 14 extending therethrough. A first end of the bore is closed by a first end cap member 16 and a second, opposite, end of the bore 14 is closed by a second end cap member 18. Suitable fasteners 20 secure the first and second end caps 16,18 to the tubular body 12. A suitable seal means 22 is provided for each of the end caps 16,18 to prevent pressurized air from leaking therethrough.

As shown in Fig. 4, a slot 24 extends longitudinally along one of the square sides of the tubular body 12 to allow the bore 14 to communicate with the environment. A pair of spaced sealing bands or strips 25,26 seal the slot 24 to isolate the bore 14 and prevent pressurized fluid from leaking therethrough. The bands are secured to the two end caps 16,18.

A piston body 30 is adapted to reciprocate longitudinally in the bore 14 of the cylinder which piston body comprises a pair of identical opposing sections 32,34 which are joined together in a suitable conventional manner. A seal means 36 extends peripherally around each section 32,34 of the piston to provide a seal between the piston section and the cylinder bore 14.

A piston bracket 38 (Fig. 4) is secured at a yoke-like section 39, by suitable conventional fasteners 40, to the first and second sections 32,34 and is adapted to extend through the cylinder slot 24. A section 41 of the bracket 38 is positioned outwardly of the tubular body 12 and extends substantially along the width of one face thereof as is illustrated in Fig. 4. It can be seen that the bracket 38 is substantially T-shaped, with the section 41 of the T-shape extending outside of the cylinder tubular body 12. This outer section 41 has depending sides 42, to each of which an inwardly extending bearing rod 44 is secured. The bearing rods slide in suitably configured grooves 46 formed in the outer periphery 13 of the tubular body so as to allow a smooth sliding motion of the piston bracket 38 as the piston moves. This system allows the cylinder 10 to withstand high axial and radial loads and moments, while eliminating the requirement for external guides and supports.

A carriage 50 is secured to a pair of spaced depending flanges 48 of the piston bracket 38 by suitable conventional fasteners 49. The carriage has a base wall 52, a pair of side walls 54, and a pair of opposing end walls 56. Seal means 58 in the form of wiper seals are provided on the end walls 56 of the carriage and act to clean the second seal band 26 of the cylinder 10.

With reference to Fig. 2, a shock absorbing connecting means such as an arm means 70 is secured to the carriage 50 in suitable conventional manner. The arm means can be substantially L-shaped as illustrated and includes a first tubular arm member 72 which is secured by a bracket 74 to the carriage 50. Preferably, a fastener 76 which

enables a pivoting motion of the arm member 72 with respect to the bracket 74 is provided for securing the arm member to the bracket.

A second arm member 78, having a first section 80 and a second section 82 which is disposed at an approximately 90° angle to the first section is also provided. The second arm member 78 is secured to a bracket 84 by a suitable fastener 86. The bracket 84 is in turn secured to the door B as shown in Fig. 1. Preferably, the fastener 86 enables a pivoting motion of the second arm member 78 with respect of the bracket 84.

With reference now to Fig. 2A, a slot 90 extends in a portion of the second arm member as is illustrated. A stem portion 92 of the first arm member 72 extends outwardly through the slot 90 of the second arm member. As such, a limit means is provided for the telescopic action of the first arm 72 in the second arm 78. Preferably, a rod member 94 extends downwardly from the first arm member 72. In order to provide a resilient biasing means for the arm 70, a spring 96 is disposed within the first section 80 of the second arm member 78 beneath the first arm 72 such that the rod 94 of the first arm extends thereinto. This positions the spring correctly in relation to the first arm member. Preferably, the spring 96 is a compression spring which resiliently biases the telescopic motion of the first arm member 72 into the second arm member 78.

The arm means 70 also acts as a shock absorber during movement of the door B due to the positioning of the compression spring 96 between the telescopic pair of members 72,78. As is evident from Fig. 2, it is necessary for the arm means 70 to pivot in relation to both the door B and the cylinder 10 during the travel of the door from the closed position to the open position, and vice versa.

With reference again to Fig. 1, a mounting pad 100 is secured to a first end of the cylinder 10, with a front mounting bracket 102 securing the mounting pad and hence the cylinder to a suitable wall of the building C. A rear mounting bracket 104 is secured to the cylinder and a pair of hangers 106 are fastened to the mounting bracket and to the adjacent ceiling (not illustrated).

Preferably, the door B includes a door member 110 comprising a plurality of articulated longitudinally extending slats or planks. The door is adapted to slide up and down on a pair of spaced tracks 112, only one of which is illustrated in Fig. 1. In general, doors of this nature conventionally include a counterbalancing means such as an axial torsion spring 114 which is secured above the door B. Cooperating with the torsion spring is a cable 116 which is secured on a first end to the door B (not visible in Fig. 1) and wound at its second end on a drum 118 axially driven by the torsion spring 114.

In order to actuate the cylinder 10, a pressurized fluid circuit 120, preferably pneumatic, is provided. The circuit includes a first fluid conduit 122 and a second fluid conduit 124 each of which is contiguous with a respective end of the cylinder through the cylinder end caps 16,18. A source of pressurized fluid 126 such as a compressor is contiguous with a respective one of the conduits 122,124 as directed by a control means 130. The control means can be in the form of a control panel which is interposed between the conduits 122,124 and the source 126 in order to control the movement of the rodless piston in the cylinder.

The control means 130 can be either a straight pneumatic control provided with a conventional three position directional valve that includes open, close, and stop (not shown) or a conventional control module with electrical push buttons for the operations open, close, and stop.

A bore 140 in the first end cap 16 enables pressurized fluid from the first conduit 122 to enter one end of the cylinder behind the piston first section 32 to urge the piston 30 toward the second end cap 18 of the cylinder. The second conduit 124 extends longitudinally down the cylinder 10 and is secured thereto by suitable hose clamps 142. The second conduit 124 communicates through a bore 144 in the second end cap 18 with the second end of the cylinder. A suitable conventional adjustable valve means such as a needle valve, of which a bore 146 is illustrated, can be provided in each end cap 16,18 to cushion the movement of the piston 30 adjacent the two ends of the cylinder.

As shown in Fig. 2, if desired, suitable conventional micro switches 150,152 can be secured to the end caps 16,18 to activate additional electronic functions in conjunction with the opening and closing of the door is desired. The micro switches 150,152 are connected to the control means 130 by suitable wiring 154. Alternatively, proximity switches can be utilized at the ends of the cylinder. Also, conventional magnetic reed switches could be positioned alongside the cylinder for position sensing of the piston between the ends of the cylinder.

When a pressurized fluid such as compressed air or another suitable compressed gas is supplied by the pressurized fluid source 126 and the control means 130 is switched to a door open position, the rodless piston 30 and its attached carriage 50 are urged, by pressurized air flowing through the first end cap 16, to move from a front end of the cylinder 10 towards a rear end thereof. At this time the air supply port 144 and the second conduit 124 act as an exhaust means for the air flowing from a section of the cylinder between the second piston section 34 and the end cap 18 through the control means 130 to the environment. The carriage 50

thus moves pulling the door B with it thereby opening the door. The piston 30 slows down just before contacting the cylinder body second end cap 18, the speed of movement of the piston 30 adjacent the end caps 16,18 being regulated by means of the adjustable valve means. Generally, the piston's speed of movement can be regulated through the directional valve in the control means 130.

The piston 30, and hence the carriage 50 remains under pressure while the door B is in the open position until the control means 130 receives a signal electrically or manually to shift to another position.

When the valve 130 shifts to the closing position, the bore or port 144 in the rear end cap 18 becomes an air supply while the bore or port 140 in the front end cap 16 becomes the exhaust. Therefore, the speed with which the door closes can be different from the speed with which the door opens. In some cases, for example in automated car washes, the door B is required to open relatively rapidly. This operating speed can be regulated by the adjustable valve means such as by adjusting the conventional exhaust restrictors of the directional valve in the control means 130. On the other hand, for safety reasons, the closing cycle may be required to be at a normal speed, which is, at a maximum, approximately 1 second per foot (0.31 m per sec.) as is recommended by the Canadian Door Institute.

However, the door's speed could be set to slow, normal, or rapid speed to suit the particular door application involved. This setting can be achieved through an adjustment in the combination of the air flow and the exhaust restrictors. To stop the door at any intermediate position, it is merely necessary to change the three position control valve to a neutral or stop position in which it will block the flow of pressurized air to either end of the cylinder 10. Also, the motion of the door can instantly be reversed by causing the directional valve to shift from one direction to the other. This can be done either manually or electrically depending upon the type of controls used.

Since the cylinder 10 operates with a low volume of pressurized gas or air, the cylinder does not move with enough force to cause damage to the door. More importantly, the door does not move with enough force to cause damage to objects or be hazardous to personnel.

When the cylinder 10 reaches the end of its stroke, the door will be in a closed position and will be locked automatically without any additional locking mechanism being necessary since the arm means 70 will be located at a 90° angle to the door B as is indicated in Figs. 1 and 2. Thus, if it was attempted to force the door open, the arm means 70 would simply be forced against the cylinder 10 and the door would not open.

The cylinder 10, carriage 50, and end caps 16,18 may all be made from any suitable material such as anodized aluminium. The piston 30 and the piston bracket 38 may be made from a suitable conventional material such as aluminium or steel. The sealing bands 25,26 may be made from a high density oil, resistant plastic, or another suitable material and the various seals may be made from Buna N or another suitable rubber. One such suitable cylinder assembly is sold by the Norgren Martonair Co. under the designation LINTRA C/45000.

The present invention thus provides a door operator system which minimizes frequent breakdowns, hazard to personnel, and damage to the door or objects which might be in the way of the door. Such a door operator may also have a greatly improved life cycle in relation to the conventional electrically driven chain drive trolley door operators.

Claims

1. A sliding door operator system which comprises a fluid cylinder mechanism (10) having a piston (30) and adapted to be coupled to the sliding door and control means for controlling the operation of the fluid cylinder (10) and hence the position of the sliding door, characterised in that the piston (30) is a rodless piston reciprocable in a cylinder body (12) and is secured to a carriage (50) reciprocable externally along the length of the cylinder body (12) and in that arm means (70) are provided for connecting the carriage (50) to the sliding door.

2. A system as claimed in claim 1 further comprising bracket means (102) for securing said fluid cylinder (10) to an adjacent wall.

3. A system as claimed in claim 1 or 2 further comprising a switch means (150, 152) located at each end of said cylinder (10), each of said switch means (150, 152) being in electrical contact with said control means to activate associated electrical components.

4. A system as claimed in claims 1, 2 or 3, wherein said arm means (70) comprises a pair of telescope tubular sections (72, 78), the first (72) of said sections being secured to said fluid cylinder carriage (50) and a second (78) of said sections being secured to the associated sliding door and a resilient shock absorber means for cushioning the telescope action of tubular sections.

5. A system as claimed in claim 4 further comprising a first pivot means (76) for pivotally securing said first section (72) to said fluid cylinder

carriage (50) and a second pivot means (86) for pivotally securing said second section (78) to the associated sliding door.

6. A system as claimed in claim 4 or 5 further comprising guideways which extend upwardly alongside a door opening and then rearwardly, and also comprising guides secured to said door and engaging said guideway means so as to facilitate an overhead movement of said sliding door wherein said first telescopic tubular section is substantially uniformly elongate (72) and said second section is substantially L-shaped (78), one (80) of the elongate portions of the L-shaped section (78) being adapted to receive said first section (72).

7. A system as claimed in claim 6 further comprising a counterbalance means for counterbalancing the weight of said door.

8. A system as claimed in any of the preceding claims wherein said control means comprises a source of pressurized fluid (126), a conduit means (122, 124) for connecting said source of pressurized fluid (126) to said fluid cylinder (10) and, a control panel for controlling the flow of pressurized fluid through said conduit means.

9. A system as claimed in claim 8, wherein said source of pressurized fluid (126) is contiguous, via a selective valve means (130) with both ends of said fluid cylinder (10) so that it can selectively act on either of the faces of said rodless piston (30).

10. A system as claimed in any of the preceding claims wherein said cylinder (10) comprises a pair of end caps (16, 18) for sealing a respective end of said cylinder body (10), adjustable valve means (146) being located in each of said end caps (16, 18), for communication between the interior and exterior of said cylinder body (10).

11. A system as claimed in any of claims 8 to 10, wherein said cylinder is provided with seal means (22) for preventing the pressurized fluid from flowing out of said cylinder (10).

12. A system as claimed in any of claims 1 to 5, and 8 to 11 except when appendant to claim 6 or 7, further comprising guideway means (112) in which said door is movable, and guides secured to said door, said guides engaging said guideway means (112).

13. A system as claimed in any of claims 6, 7, or 8 to 11 when appendant thereto, or 12, wherein said cylinder longitudinal axis is substantially parallel to a longitudinal axis of said guideway means (112).

14. A system as claimed in claim 9 or any of claims 10 to 13 when appendant thereto wherein said control means for actuating said valve means further comprises a pair of micro switches (150,152) one micro switch being located at each end of said cylinder (10), said micro switches (150, 152) being in electrical contact with said control means.

15. A system as claimed in any of the preceding claims wherein said fluid comprises one of either air or gas.

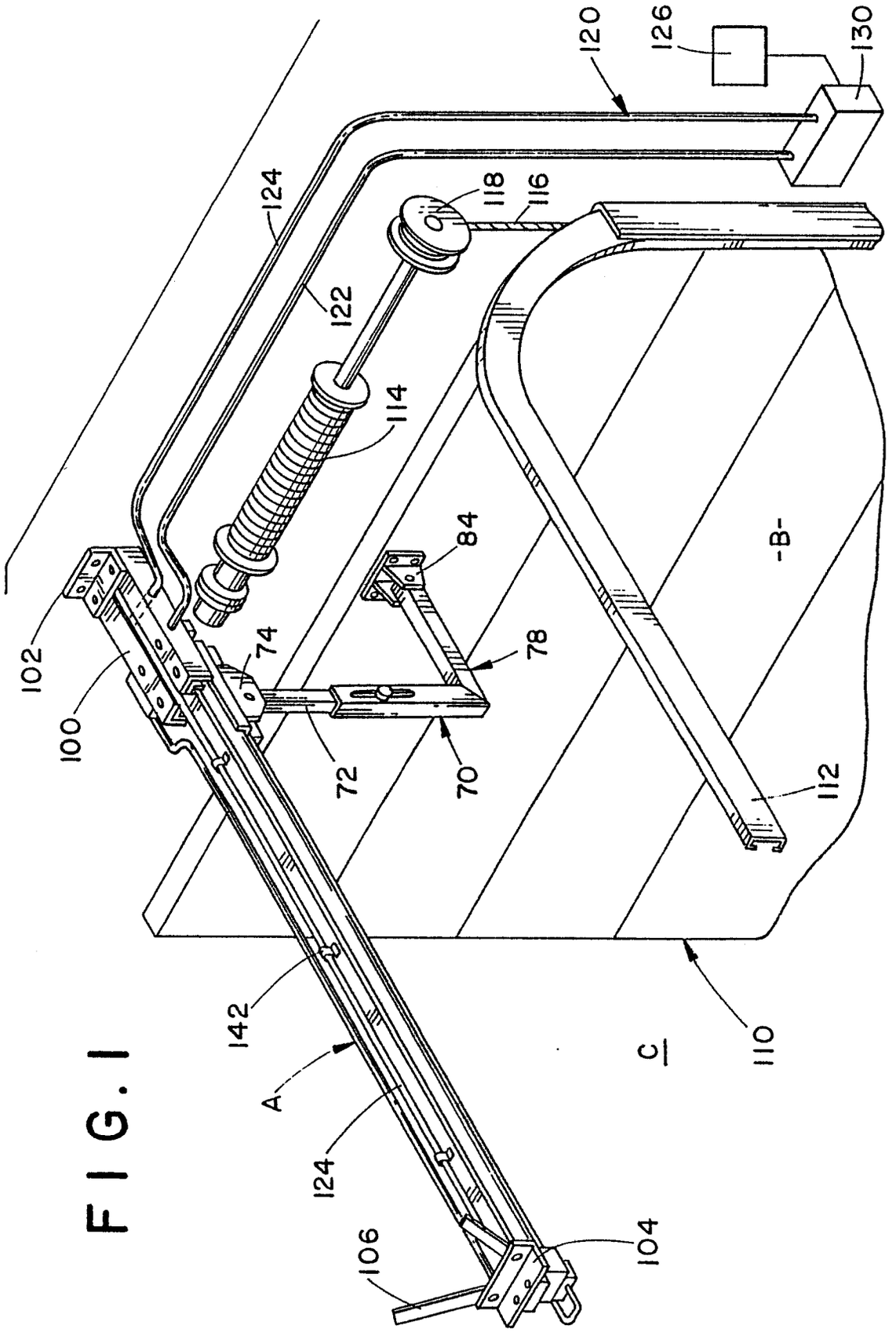
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FIG. 1

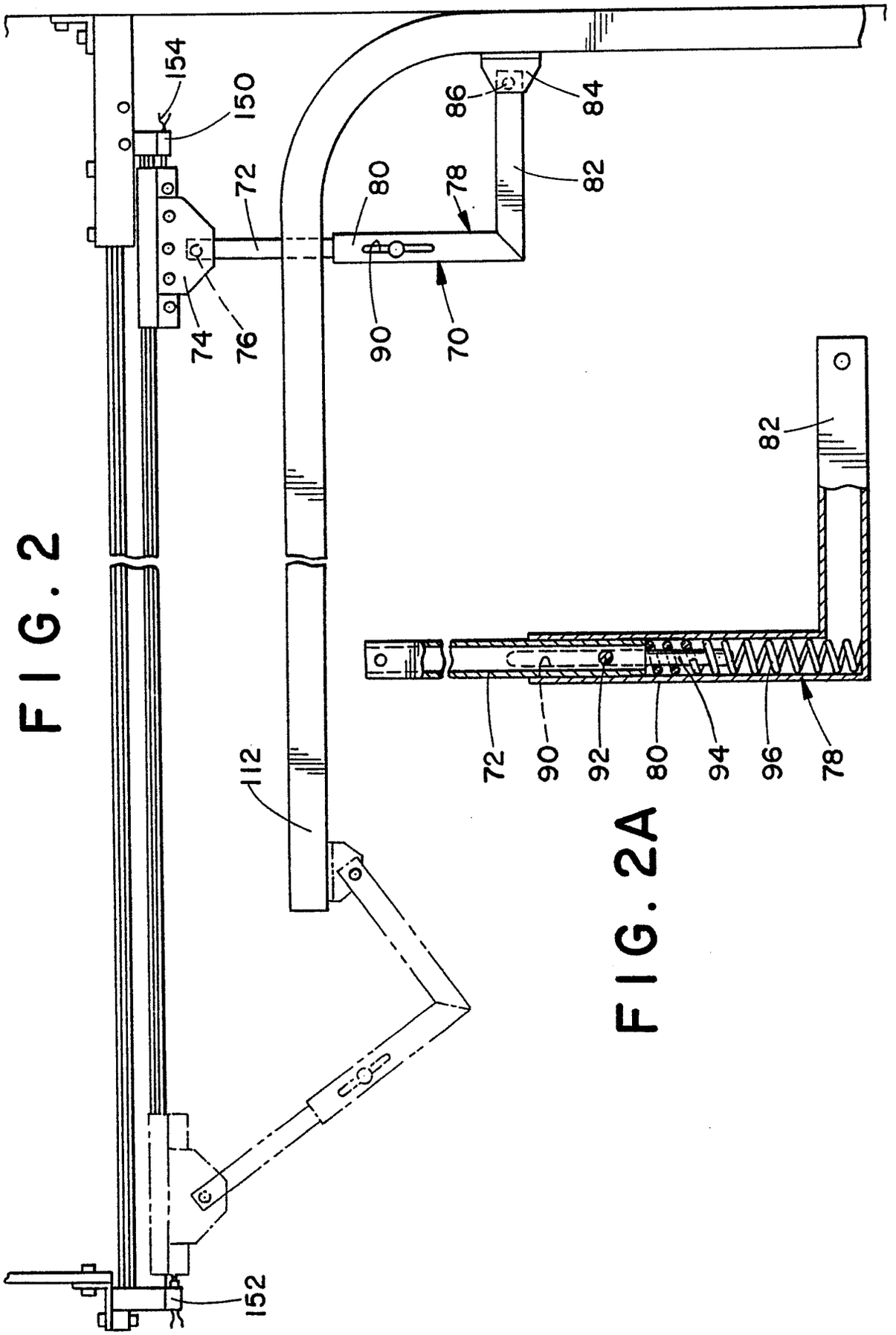

FIG. 2

FIG. 2A

FIG. 3

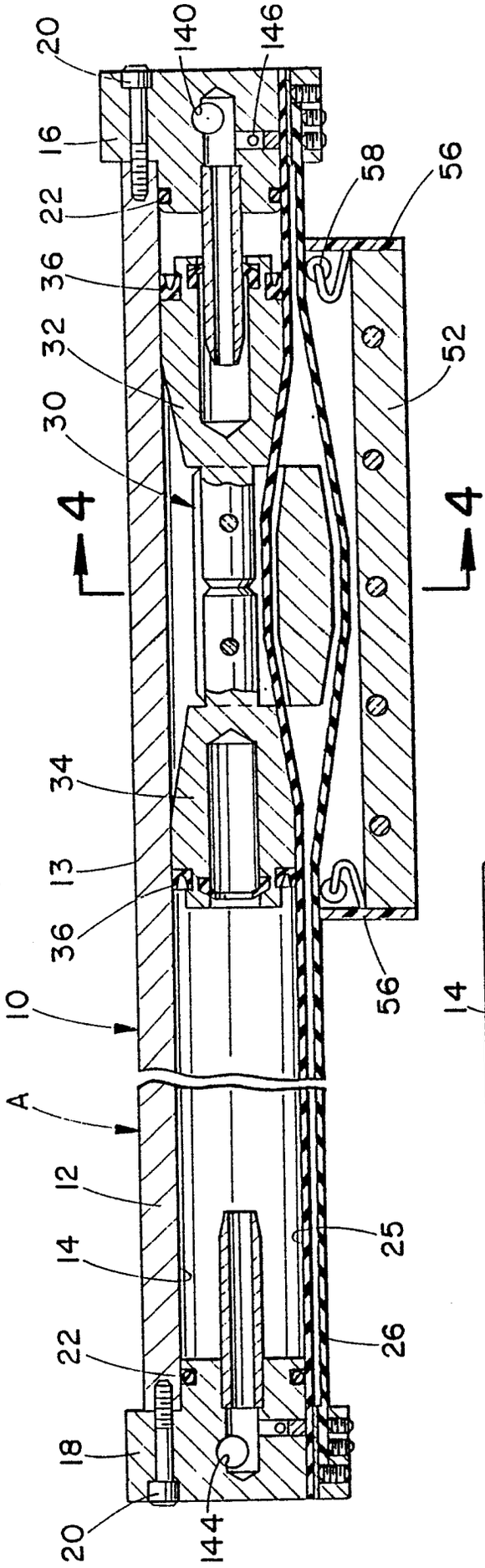
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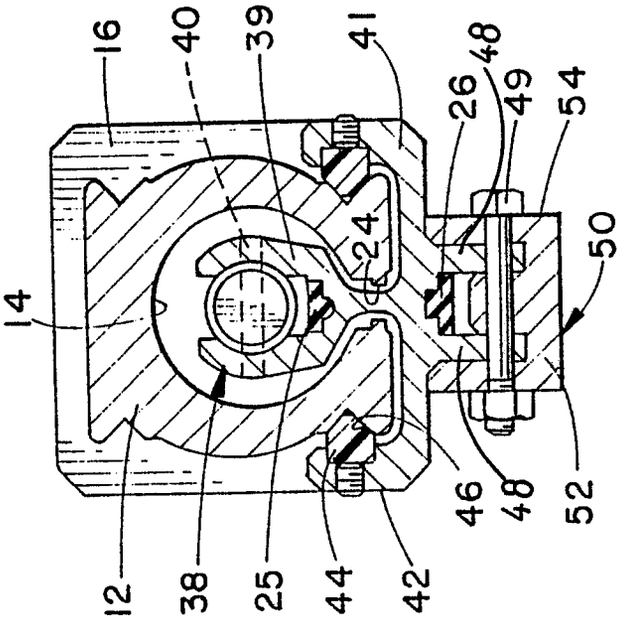
FIG. 4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