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(54) **Door arrangement**

(57) A door (1), e.g. for a motor coach, is mounted for pivotal opening and closing movement and is axially movable to effect engagement of cooperating locking means on the door and door frame. Rotary drive means (8) are coupled to the door by coupling means (10) having a pair of interengaging members configured so as to execute relative axial movement when rotated relative to one another whereby movement of the door between its open and closed position takes place without relative movement of the interengaging members and further movement of the drive means after closure of the door causes axial movement of the door to lock it.

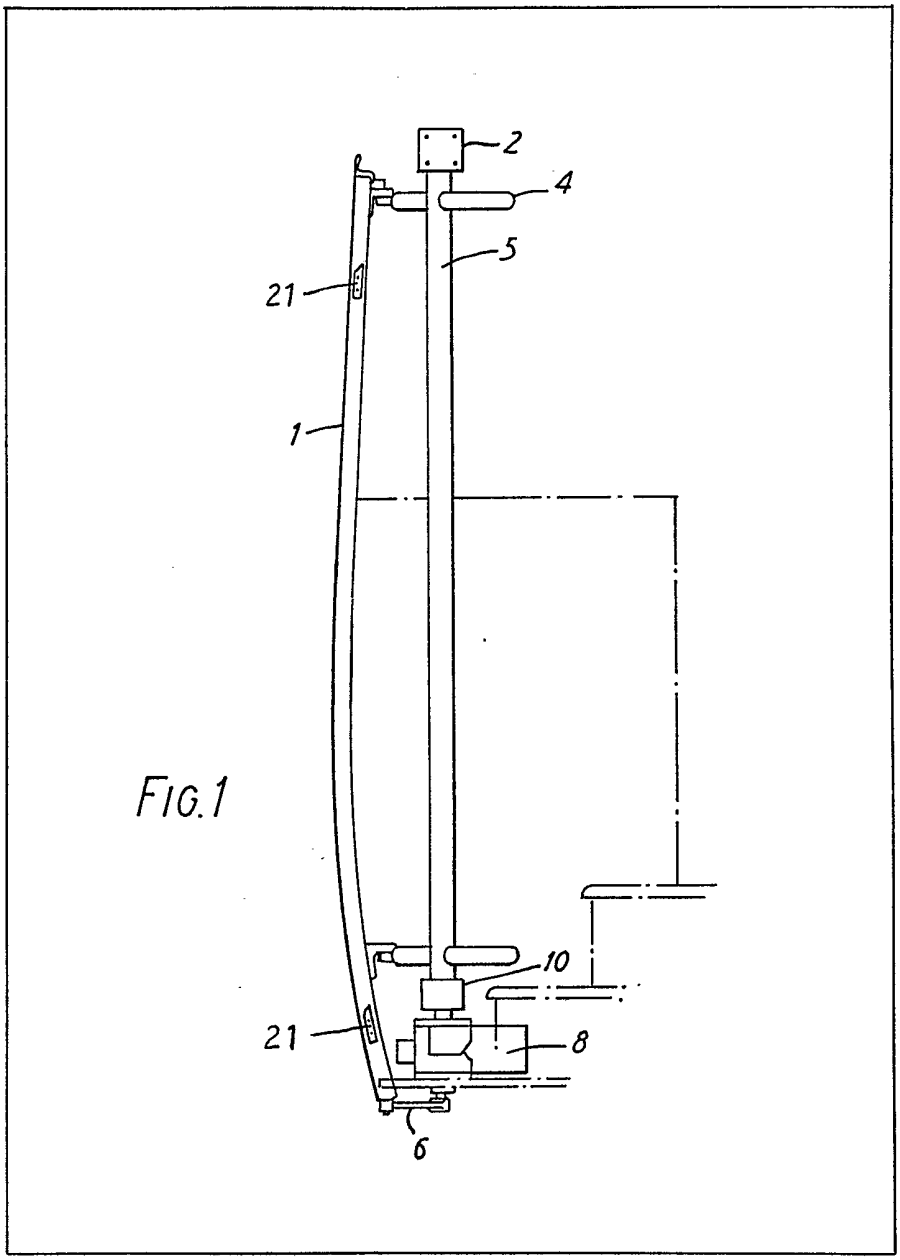

FIG. 1

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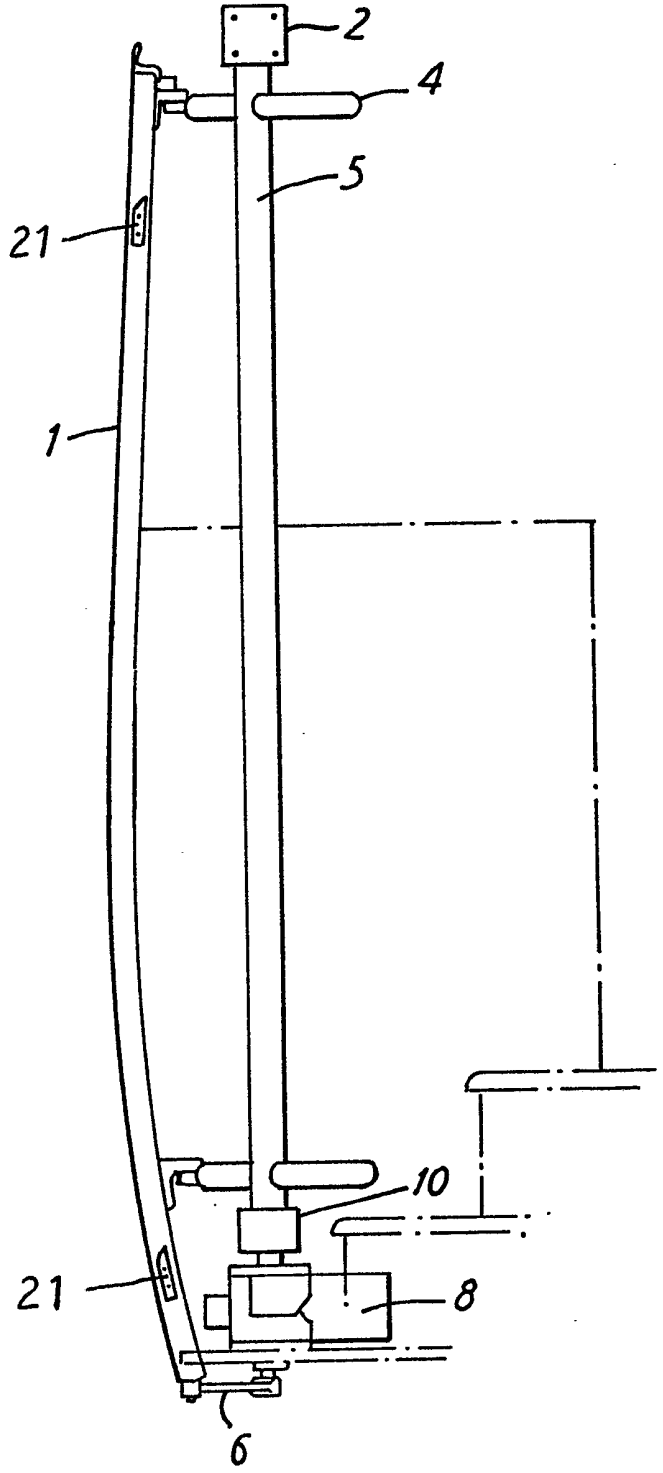

FIG.1

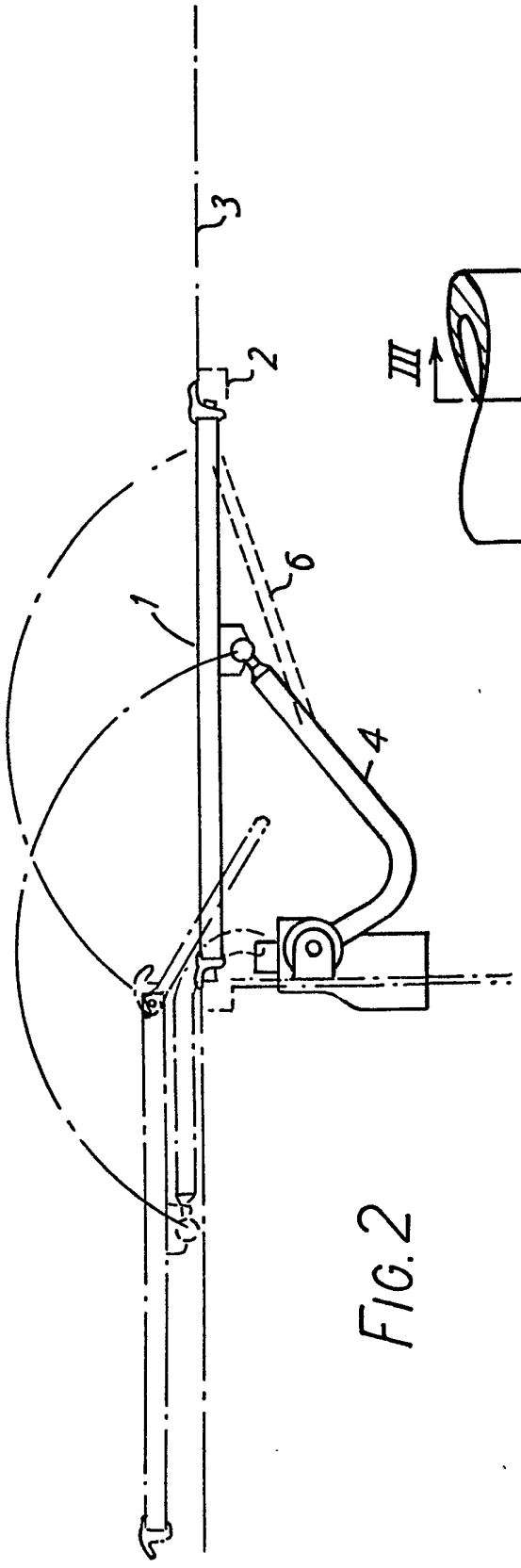

FIG. 2

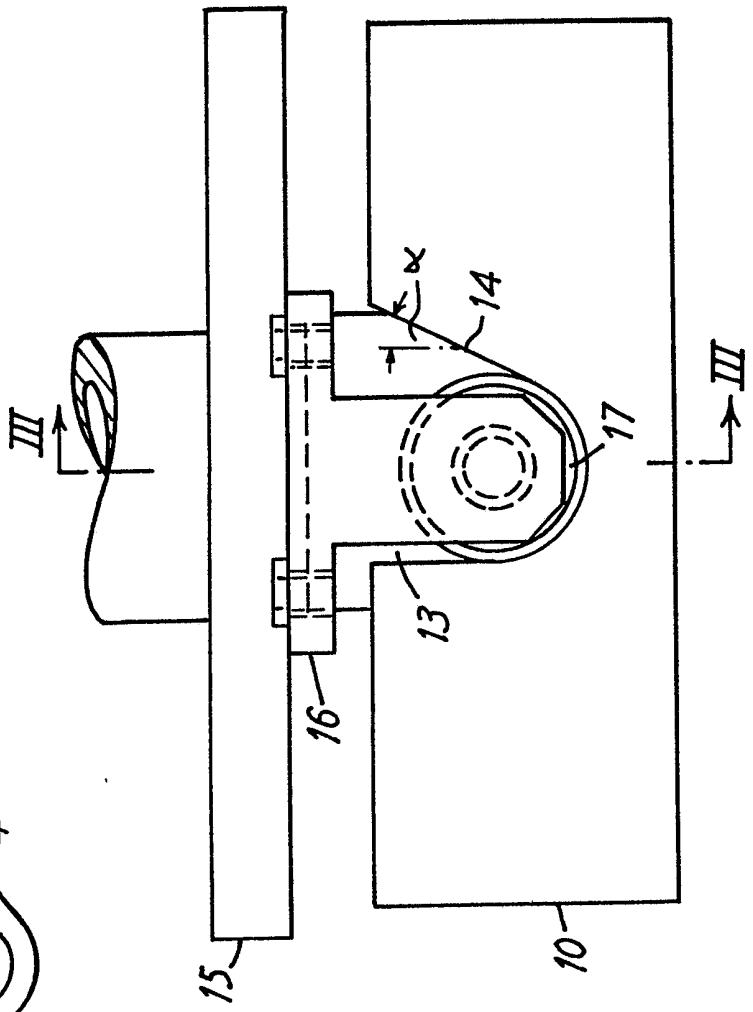

FIG. 4

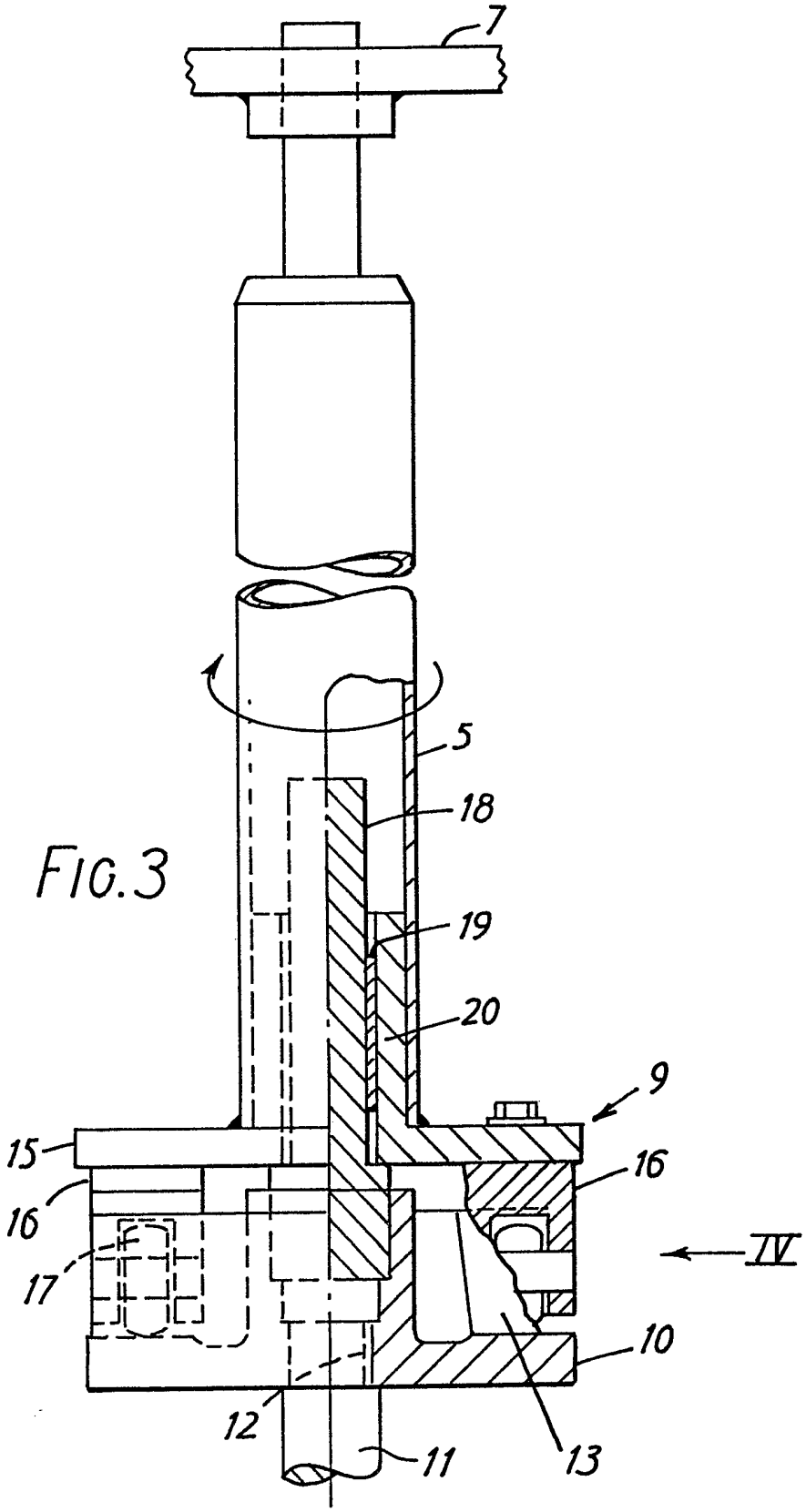

FIG.3

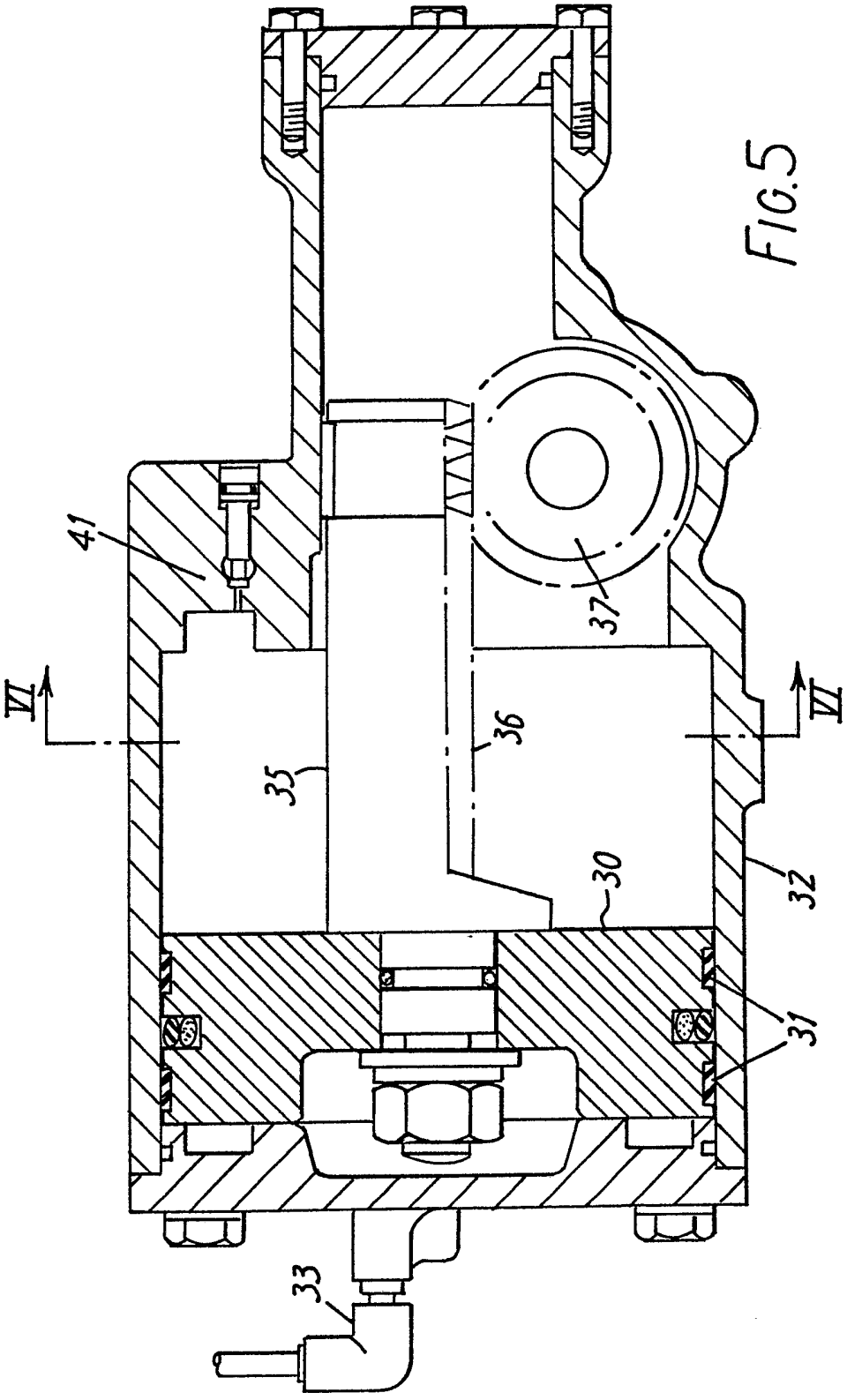

FIG.5

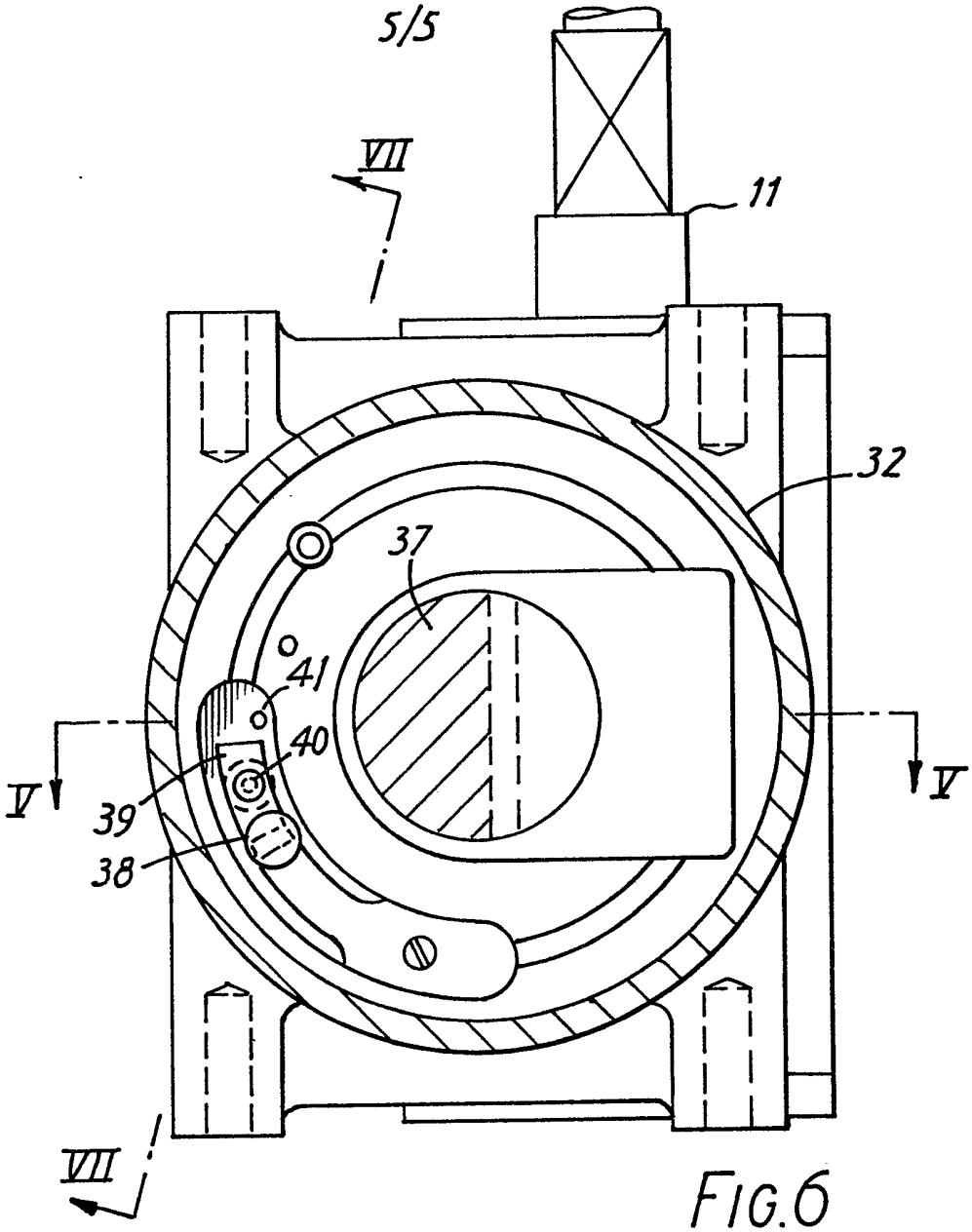

FIG.6

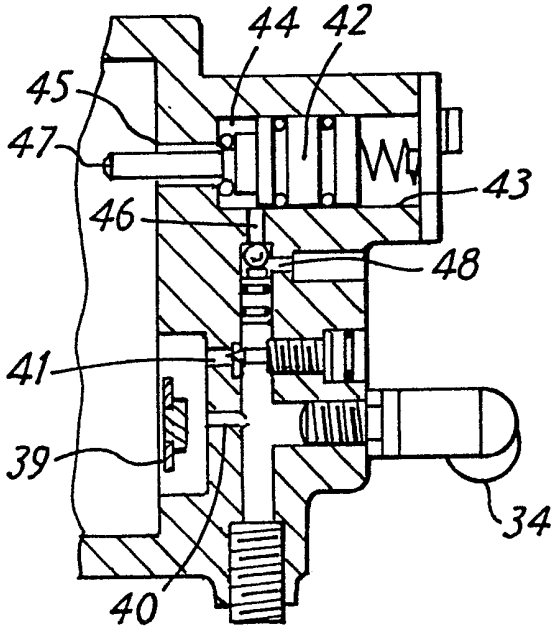

FIG.7

SPECIFICATION

Door arrangement

The present invention relates to door arrangements in which upon closing of the door, the door firstly moves into the door frame and then moves vertically to engage locking devices. It finds application particularly, though not exclusively, in doors for motor coaches where the aero-dynamic forces on the door(s) requires a positive and reliable locking arrangement.

German Patent no. 2062135 describes an arrangement of this type, where an outward gliding plug door is supported on arms by a rotatable column. The column is driven by a pneumatic piston-cylinder unit linked to the column by a screw mechanism: closure of the door is effected by upward movement of the piston. Owing to its weight, the door and column assembly does not lift, but rotates on the screw until it reaches its closed position where further rotation is prevented and further piston movement causes the assembly to lift into its locked position. This, however, involves a relatively complex mechanism with relative movement during the majority of the closing (or opening) stroke. The screw pitch must be relatively large, in order to overcome friction to provide an adequate closing torque without the piston force exceeding the door weight and lifting the door prematurely.

According to one aspect of the present invention there is provided a door arrangement comprising a door mounted for pivotal opening and closing movement and axially movable to effect engagement of cooperating locking means on the door and door frame, rotary drive means, and means coupling the drive means and the door, the coupling means comprising a pair of interengaging members configured so as to execute relative axial movement when rotated relative to one another whereby movement of the door between its open and closed position takes place without relative movement of the interengaging members and further movement of the drive means after closure of the door causes axial movement of the door to lock it. Preferably the interengaging portions of the coupling means consist of a cam portion and a cam follower portion. The cam portion may comprise an annular member having recesses with inclined cam surfaces in the axial face thereof, the follower portion having projections, e.g. wheels which engage in those recesses.

The invention also provides a pneumatic actuator for operating a door arrangement whose closing movement is followed by axial movement of the door to effect engagement of co-operating locking means on the door and door frame, the actuator comprising a double-acting piston cylinder unit with first control means arranged at a predetermined position of the piston toward the end of its stroke to restrict egress of gas from the cylinder to cushion the piston movement, and second control means arranged at a second predetermined position of the piston nearer to the end of that stroke to facilitate egress of gas from the cylinder to permit substantially unimpeded piston movement for the remainder of the stroke.

In a preferred arrangement, the first and second control means each include a member extending axially into the cylinder to different positions so as to be successively engaged by the piston during its stroke, and axially moved to bring into effect, respectively, a choke and a venting valve.

One embodiment of the invention will now be described with reference to the accompanying drawings, in which:

Figures 1 and 2 are, respectively a side elevation and plan view of a door arrangement;

Figure 3 is a partially sectioned elevation of one form of coupling for use in the arrangement of Figure 3;

Figure 4 is a side view in the direction IV on Figure 3;

Figure 5 is a transverse cross-section through one form of pneumatic actuator suitable for use in the arrangement of Figure 1;

Figure 6 is a cross-section on line VI—VI of Figure 5; and

Figure 7 is a cross-section on line VII—VII of Figure 6;

Figures 1 and 2 show the overall arrangement, with a door leaf 1 shown in its closed position in a door frame 2 in the side 3 of a vehicle such as a motor coach. The door is supported by arms 4 on a vertical rotatable column 5 and is guided by a link arm 6 so that it remains parallel to the side of the coach as it moves to its fully open position (shown dotted in Figure 2). The column is supported at its upper end by a bearing 7 which permits a small vertical movement of the door and column assembly, and its lower end by a rotary pneumatic actuator assembly 8.

The actuator 8 is coupled to the column by means of a coupling 9, which can be seen in greater detail in Figures 3 and 4. The coupling has a lower, cam portion 10 supported by, and rotatable by, the output shaft 11 of the actuator 8 which is engaged by means of splines 12. The cam portion 10 has, in its axial face a pair of recesses 13 whose anticlockwise faces 14 (viewed from above), are inclined at any angle α of 25° to the axis of rotation (see Figure 4). The upper, follower portion of the coupling comprises a disc 15, welded to the column 5, carrying on its lower face brackets 16 each with a wheel 17 which engage in a corresponding recess 13 in the cam portion 10. Lateral movement of the lower end of the column 5 is prevented by a shaft 18, welded to the cam portion 10 and located in bush 19 in a boss 20 integral with the disc 15.

The operation of the door from the open to the closed position is as follows. The actuator is energised so that its output shaft 11, and hence the cam portion 10 of the coupling, rotate clockwise (as viewed from above). The disc 15, and hence the column 5 are likewise rotated by virtue of the wheels 17 being securely held in engagement with the recesses 13 of the cam portion by the weight of the door/column

assembly. When the door leaf 1 reaches its closed position, however, it is prevented from further lateral movement and hence the column 5 can no longer rotate: further rotation of the actuator shaft 11 and cam portion 10 therefore causes the wheels 17, and hence the column 5 and door leaf, 1 to be lifted upward by the inclined cam faces 14. This motion serves to lock the door by engagement of tapered locking plates 21 (Figure 1), secured to the door, behind similar plates (not shown) secured to the door frame 2.

The described arrangement thus provides a relatively simple and thus robust construction for effecting the desired two-stage rotary/vertical movement. Relative movement between the two parts of the coupling 9 occurs only during the final, locking, action, thus keeping wear relatively low. Also, the possibility of friction in the coupling causing premature lifting of the door obviously cannot arise. Although, as in the case of the arrangement proposed in the German Patent referred to above, the maximum closing torque that can be applied is theoretically limited by the tendency for the door to lift (since if the applied torque were excessive for a given door weight and cam angle, the wheels 17 might be lifted on the inclined surfaces 14). In practice, however, this is not found to be a problem, since the cam angle α can be made relatively steep (e.g. the 25° suggested) without any corresponding increase in the amplitude of actuator movement.

Whilst any suitable actuator may be used with the described arrangement, a preferred embodiment of actuator is shown in Figures 5 to 7. A piston 30, with seals 31 is accommodated in a double acting cylinder 32 with pneumatic connections 33, 34. A piston rod 35 has a rack 36 engaging a pinion 37 secured to the actuator output shaft 11 to convert the linear motion of the piston into rotary motion of the shaft. The latter is mounted by means of suitable bearings (not shown). In operation, air is admitted under pressure via the connection 33 to move the piston 30 from the "door open" position (i.e. the position shown in Figure 5) toward the closed position, the connection 34 being vented, via if necessary, a suitable choke to control the speed of movement.

As the closed position is approached, in order to cushion the movement, the piston comes into contact with a projection 38 (Figure 6) thereby moving a cushioning spring 39 so as to close an air passage 40: air can then be exhausted from the cylinder to the pneumatic connection 34 only via an additional choke 41. A similar cushioning arrangement (not shown) operating during door opening is provided to connection 33 at the opposite end of the cylinder.

To provide a suitable force for the locking movement at the end of the closing stroke, the cushioning arrangement is bypassed so that full power is available. This is achieved by a spring-loaded plunger 42 movable in a bore 43. In its normal position it closes off (seal 44) an opening 45 between the cylinder and a vent passage 46. The final piston movement serves to depress an extension 47 of the plunger to open the opening 45, venting the cylinder to atmosphere. In order that this does not prevent application of air pressure at the beginning of the subsequent opening stroke, a ball valve 48 responds to the application of air pressure to the connection 34 to close the passage 46.

CLAIMS

1. A door arrangement comprising a door mounted for pivotal opening and closing movement and axially movable to effect engagement of cooperating locking means on the door and door frame, rotary drive means, and means coupling the drive means and the door, the coupling means comprising a pair of interengaging members configured so as to execute relative axial movement when rotated relative to one another whereby movement of the door between its open and closed position takes place without relative movement of the interengaging members and further movement of the drive means after closure of the door causes axial movement of the door to lock it.

2. A door arrangement according to claim 1, in which the interengaging portions of the coupling means consist of a cam portion and a cam follower portion.

3. A door arrangement according to claim 2, in which the cam portion comprises an annular member having recesses with inclined cam surfaces in the axial face thereof, the follower portion having projections which engage in those recesses.

4. A door arrangement according to claim 1, 2 or 3, in which the rotary drive means is a pneumatic actuator comprising a double-acting piston cylinder unit with first control means arranged at a predetermined position of the piston toward the end of its stroke to restrict egress of gas from the cylinder to cushion the piston movement, and second control means arranged at a second predetermined position of the piston nearer to the end of that stroke to facilitate egress of gas from the cylinder to permit substantially unimpeded piston movement for the remainder of the stroke.

5. A door arrangement according to claim 4, the first and second control means each include a member extending axially into the cylinder to different positions so as to be successively engaged by the piston during its stroke, and axially moved to bring into effect, respectively, a choke and a venting valve.

6. A door arrangement substantially as herein described with reference to the accompanying drawings.

7. A pneumatic actuator for operating a door arrangement whose closing movement is followed by axial movement of the door to effect engagement of co-operating locking means on the door and door frame, the actuator comprising a double-acting piston cylinder unit with first control means arranged at a predetermined position of the piston toward the end of its stroke to restrict

egress of gas from the cylinder to cushion the piston movement, and second control means arranged at a second predetermined position of the piston nearer to the end of that stroke to facilitate egress of gas from the cylinder to permit substantially unimpeded piston movement for the remainder of the stroke.

8. An actuator according to claim 7, the first and second control means each include a member extending axially into the cylinder to different positions so as to be successively engaged by the piston during its stroke, and axially moved to bring into effect, respectively, a choke and a venting valve.

9. A pneumatic actuator substantially as herein described with reference to the accompanying drawings.

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