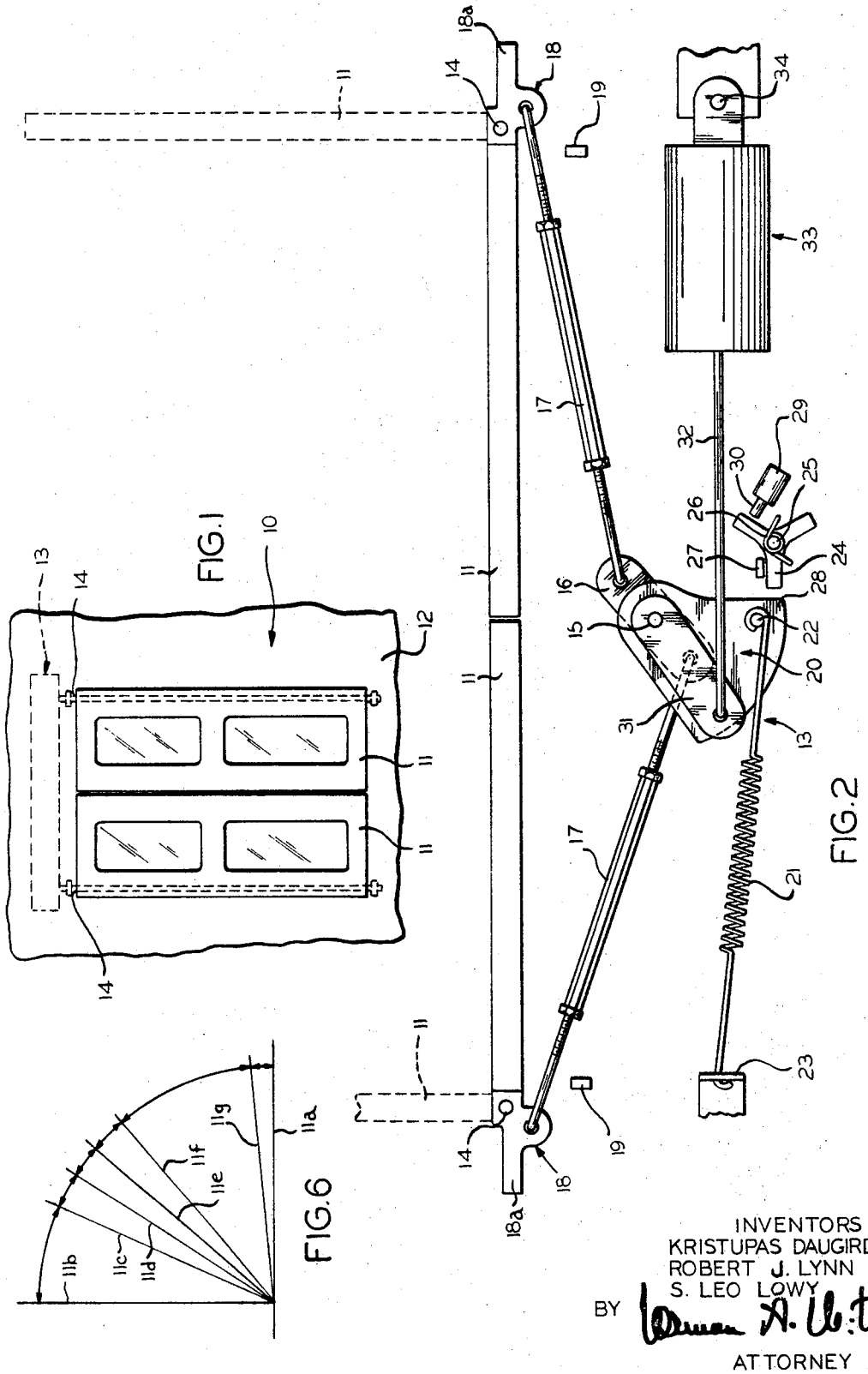
April 30, 1968 K. DAUGIRDAS ET AL 3,380,110

MODULATING DOOR CHECK

Filed Sept. 12, 1966 2 Sheets-Sheet 1



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MODULATING DOOR CHECK

Filed Sept. 12, 1966 2 Sheets-Sheet 2

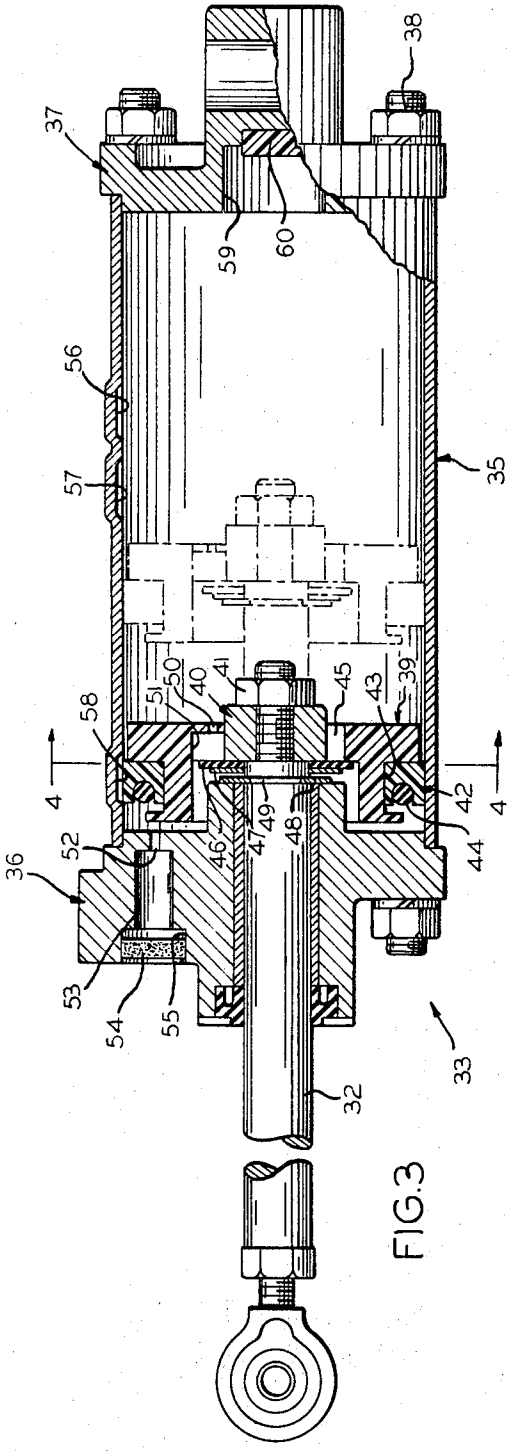


FIG.3

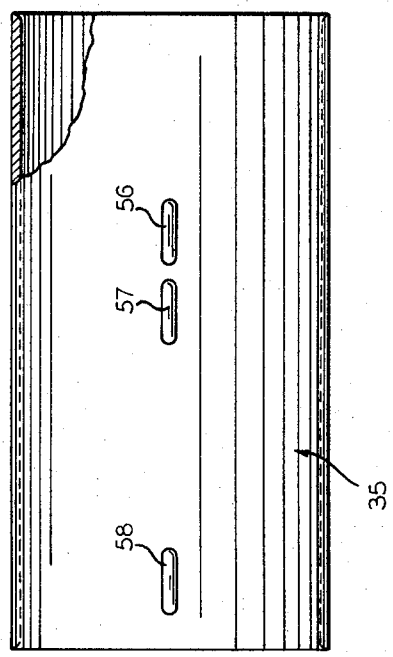


FIG.5

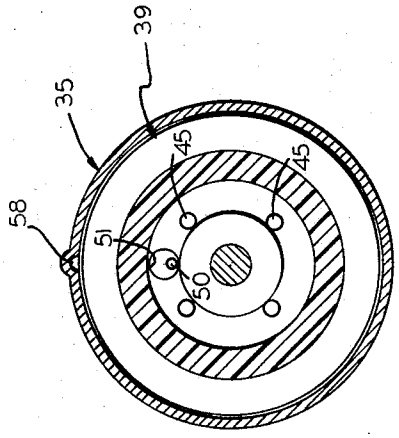


FIG.4

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MODULATING DOOR CHECK

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ABSTRACT OF THE DISCLOSURE

Modulating door check for controlling the closing action of a vehicle door normally opened by egressing passengers including a cylinder having a piston movable therein, wherein a flap valve is provided in the piston to permit uninhibited movement thereof toward the closed end, an orifice is provided in the piston for bleeding air during door closing action, an orifice is provided in the rod end of the cylinder to bleed air from the rod side of the piston during door closing action, and piston seal breaking means is provided in the cylinder wall to aid in controlling door closing action.

This invention relates in general to a door closing device, and more particularly to a modulating door check employed in a door closing device, and still more particularly to a modulating door check useful for controlling door closing action for doors employed on passenger carrying vehicles that are opened by a passenger during egress from the vehicle, although other uses and purposes may be apparent to those skilled in the art.

The modulating door check of the invention is especially useful in a door closing device employed in a passenger carying vehicle where the doors are normally opened by the passengers during egress from the vehicle. It is quite common to have the rear doors on a passenger bus mounted for opening by the passengers during egress from the bus, and such doors are provided with a door closing device that operates to close the doors after the passenger has released the doors from the open position. Such door closing devices include door checks in combination with springs which power the doors to a closed position, but heretofore known door checks have been unsatisfactory since they have included needle valves and troublesome ball check valves. Since a door check controls the door closing speed and a vehicle cannot move until the doors are in fully closed position, some drivers have been known to greatly increase the door closing speeds on heretofore used door checks having needle and ball check valves so that they can make faster getaways from stops and reduce the running time between terminals. Such an increase in closing speed nearly always results in causing the doors to slam which is injurious to the doors and door closing mechanism causing early maintenance and/or repair. Further, heretofore known door checks generate considerable back pressure in the door closing mechanism during opening of the door thereby making it more difficult for a passenger to open the doors, either from a fully closed position or a partially closed position.

The modulating door check of the present invention is adapted to be used in known door closing mechanisms for self-closing doors, while serving to precisely control door closing action, and even modulating the door closing movement so that the best possible door action consistent wtih passenger egressing is obtained. Further, the door check of the present invention is not adjustable, and therefore cannot be tampered with by the drivers, and controls door closing movement in order to eliminate possible equipment abuse thereby extending the life of the equipment.

It is therefore an object of the present invention to provide a new and improved door check for use in a door closing device.

Another object of this invention is in the provision of a modulating door check that precisely controls door closing action in a manner to extend the life of the doors and associated mechanism and to better facilitate the egressing of passengers through the doors.

Still another object of this invention resides in the provision of a modulating door check for use in the door closing device employed in passenger carrying vehicles such as buses, wherein door closing movement is closely controlled while door slamming is eliminated.

A further object of this invention is to provide a modulating door check for a door closing device to be employed on passenger carrying vehicles which is capable of producing a pause in door closing action as the door starts to close from a fully opened position ahead of a fast movement to a position where the door is cushioned before being fully closed, and to provide a final snap shut action to the fully closed position.

A still further object of this invention is in the provision of a modulating door check for use in a self-powered door closing device, wherein needle and ball check valves have been eliminated, a fewer number of parts are employed over heretofore known door checks, manufacturing costs have been reduced, and maintenance requirements have been lessened.

Other objects, features and advantages of the invention will be apparent from the following detailed disclosure, taken in conjunction with the accompanying sheets of drawings, wherein like reference numerals refer to like parts, in which:

FIG. 1 is a fragmentary elevational view of the side of a vehicle having a set of doors to be opened by passengers and illustrating the arrangement of a door closing mechanism in block form for the doors which employs the modulating door check of the present invention;

FIG. 2 is a somewhat schematic top plan view of a door closing mechanism for use on doors of a vehicle such as shown in FIG. 1, and illustrating the position of the modulating door check of the present invention;

FIG. 3 is an axial sectional view taken through the door check of the present invention and showing the piston in full lines in the position attained when the doors are closed;

FIG. 4 is a cross sectional view taken through the piston of the door check of the present invention, and taken substantially along line 4—4 of FIG. 3;

FIG. 5 is a plan view of the cylinder for the door check of the present invention, removed for purposes of clarity, and illustrating the position of the grooves formed in the cylinder wall; and

FIG. 6 is a diagrammatic showing of the door closing movement to illustrate the modulating door closing action.

Referring now to the drawings, and particularly to FIG. 1, a vehicle **10** for transporting passengers is shown with a pair of outwardly swinging doors **11** arranged in the side wall **12**, the closing action of which is controlled by the door closing device or mechanism **13** illustrated in block phantom. The doors **11** are mounted on vertically extending shafts **14**, suitably bearingly supported at their upper and lower ends, and coupled to the door closing mechanism **13** at their upper ends which effects control of the doors during closing movement.

The door closing mechanism **13**, as seen in FIG. 2, includes generally a main shaft **15** arranged vertically and suitably bearingly supported. A teeter lever **16** is secured to the shaft for rotation therewith, and is pivotally connected at opposite ends to connecting rods **17** that are in turn pivotally connected to brackets **18** that are secured

to the doors **11**, whereby pressure against either door **11** to move it to open position simultaneously through the connecting rods **17** and teeter bar **16** causes opening movement of the other door **11**. Lugs **18***a* are formed on the brackets **18** which engage stops **19** when the doors are in fully open position as shown in dotted lines for limiting the opening movement. Thus, opening of one door **11** causes opening of the other door at the same time and the doors can only be opened to a predetermined position.

A cam plate **20** is also secured to and rotatable with the main shaft **15**. In order to supply power to close the doors **11**, a heavy extension spring **21** is attached at one end to a pin **22** on the cam plate **20** and at the other end to a fixed bracket **23**, whereby a moment arm is established through the cam plate **20** on the main shaft **15** for applying closing power to the doors when they are in open position and also for holding the doors in closed position. It should be appreciated that the power of the spring **21** may be adjusted or the spring may be easily changed depending upon the closing force desired for the doors **11**. Further, the connecting rod **17** may be adjusted to properly position the doors in their closed position.

In order to prevent opening of the doors when the vehicle is in motion, a locking mechanism including a latch **24** pivotally mounted on a shaft **25** coacts with the cam plate **20** to prevent rotation of the main shaft **15**. A spring **26** is provided to continually urge the latch **24** against a stop **27** which places the latch in interfering position to a nose portion **28** of the cam plate **20** to prevent rotation of the cam plate and shaft **15** in the direction to cause opening of the doors **11**. When the driver of the vehicle is halted for allowing egressing of passengers from the vehicle, he may energize a solenoid **29** to cause a plunger **30** to rotate the latch **24** in a counter clockwise direction against the force of the spring **26** and out of interference with the nose portion **28** of the cam plate **20** to thereby allow rotation of the cam plate and cam shaft **15** and opening of the doors **11**. When the solenoid **20** is de-energized and the cam plate **20** again attains the position shown in FIG. 2, the latch **24** moves to locking position against the stop **27** to again block movement of the cam plate **20** and shaft **15**. Any other type of locking mechanism may be provided.

A crank arm **31** is also mounted on the main shaft **15** for rotation therewith and is pivotally connected at its outer end to a rod **32** of the door check **33** that comprises the present invention. The door check **33** is pivotally anchored on a fixed pin **34**. It will be understood that the door closing mechanism **13** is of a type heretofore generally known, and that the door check **33** is the improvement in the door closing mechanism and therefore comprises the present invention.

Referring now to FIGS. 2–5, the door check **33** includes a cylinder **35** having opposed end caps **36** and **37** suitably tied together by fasteners **38** at each end thereof. A piston assembly **39** is slidably received within the cylinder **35** and secured on the inner end of the rod **32** which is bearingly supported in the end cap **36**. The inner end of the rod **32** is shouldered to receive the piston **40** of the piston assembly, and a nut **41** is threadedly received on the end of the rod to securely fasten the piston **40** thereto. The external diameter of the piston **40** is slightly less than the internal diameter of the cylinder **35**, and a piston cup **42** is received in an annular groove **43** formed in the outer periphery of the piston. The piston cup is provided with an O-ring **44** which expands the cup and causes firm sealing engagement between the cup and inner wall surface of the cylinder **35**.

Movement of the piston assembly **39** toward the end cap **37** is unrestrained and easy due to a plurality of axially extending holes **45** being formed in the piston **40** which allow substantially unrestricted movement of air from one side of the piston to the other side. During movement of the piston assembly **39** from the closed end of the cylinder to the rod end, a flapper valve **46** seals the holes **45** and prevents the movement of air therethrough between opposite sides of the piston. The flapper valve **46** is in the form of a resilient washer, such as of rubber, that freely fits over the rod **32**. A thin metal washer **47** backs up the flapper valve **46** and is prevented from unrestricted movement along the rod **32** by an E-ring **48** locked into an annular groove **49** on the rod. Sufficient movement is allowed the flapper valve **46** to permit complete opening of the piston toward the closed end of the cylinder.

A small fixed orifice **50** is provided in the piston **40** and in continual communication with both sides of the piston. A counterbore **51** extends inwardly from the rod side of the piston to the orifice **50** and is arranged so that it is not covered by the flapper valve **46** when the piston moves toward the closed end of the cylinder. Thus, on movement of the piston from the closed end toward the rod end, air is transferred through the orifice **50** to control the rate of movement of the piston.

To further control piston movement, an orifice **52** is provided in the end cap **36** at the bottom of a counterbore **53**. This orifice also serves to replenish air lost during the cycle. In order to prevent contaminants from entering the cylinder, a filter **54** is mounted in counterbore **55** leading to the counterbore **53** and the orifice **52**, whereby air entering the cylinder on the rod side of the piston through the orifice **52** is filtered.

In order to further control movement of the piston assembly **39** and piston rod **32** toward the rod end of the cylinder so as to properly control door closing movement, a pair of axially spaced pockets or grooves **56** and **57** are formed in the wall of the cylinder **35** to cause air flow intercommunication between opposite sides of the piston **40** when the piston cup **42** passes thereover to the extent that door closing speed is set. While a pair of grooves **56** and **57** are shown, a single groove could be employed within the scope of the present invention in order to control the closing action. A third groove or pocket **58** is formed in the wall of the cylinder **35** closely adjacent to the rod end of the cylinder to define the snap shut closing action of the doors by releasing the differential air pressure between the opposite sides of the piston when the piston cup passes thereover.

Referring now to FIG. 6, the door is shown in closed position and designated **11***a*, and in open position designated by the numeral **11***b*. Applying pressure on either door **11** to move them to open position from the position **11***a* to the position **11***b* causes the piston assembly **39** to move toward the closed end of the cylinder adjacent to the end cap **37**. A counterbore **59** is provided in the closed end of the cylinder to facilitate receiving the protruding portion of the piston rod assembly, and a resilient stop **60** is provided in the bottom of the counterbore to cushion against an unexpected bottoming of the piston. During movement of the piston assembly **39** toward the closed end of the cylinder, the flapper valve **46** moves away from the rod end of the bypass holes **45** to freely allow the passing of air between opposite sides of the piston. Heretofore, it was necessary to move the piston assembly against needle and/or ball check valves, wherein the present invention permits much easier movement of the piston and therefore requires less power by a passenger egressing through the doors **11**. Further, since air is allowed to freely pass from one side of the piston to the other side of the piston, the air within the cylinder is utilized and there is need for very little additional air to be provided therein through the orifice **52** which precludes the possibility of allowing unwanted contaminants within the cylinder.

Upon release of pressure on the doors **11** by the passenger, the spring **21** applies a force to the doors in a closing direction which is opposed by the door check **33**. Because the flapper valve **46** now closes the holes **45** extending between both sides of the piston, the orifice **50** is then brought into action. Immediate movement of the

piston assembly **39** toward the rod end of the cylinder effects rarefying of the air at the closed end cap side of the piston causing a pause in the door closing movement and a slow closing movement between the positions **11***b* and **11***c* as seen in FIG. 6. The piston cup **42** when passing over the groove **56** loses its seal with the cylinder wall whereby a fast movement of the piston toward the rod end of the cylinder is produced between the positions **11***c* and **11***d*. The seal of the piston cup is again made as the leading edge of the piston cup passes over the rod end of the groove **56** to again slow the movement of the piston toward the rod end between the door positions **11***d* and **11***e*. The piston cup **42** then moves across the pocket or groove **57** and again loses its seal with the cylinder wall, allowing air to readily pass between opposite sides of the piston thereby resulting in a fast movement of the piston toward the rod end of the cylinder from the position **11***e* to the position **11***f*. As the leading edge of the piston cup completes its travel across the pocket or groove **57**, sealing action with the cylinder wall is once again established to again build up pressure differential and effectively maintain the same speed of the piston until the doors reach the position **11***g*. During movement from the pocket **57**, the orifice **50** again functions to allow a controlled air movement between opposite sides of the piston. The orifice **52** in the end cap **36** now becomes active also, restricting the bleed of the air from the cylinder, thus resulting in increased pressure differential to provide cushioning action near the fully closed position of the doors. Just ahead of the fully closed position, the piston cup **42** comes under the influence of the pocket **58** allowing quick air transfer between opposite sides of the pistons so that the doors can snap into the fully closed position. However this movement does not result in slamming of the doors.

Thus, it can be seen that the dimensions of the pockets **56**, **57** and **58**, together with the diameter of the orifice **50** coact with the closing force supplied by the spring to establish the closing speed of the doors, yet this predetermined closing speed cannot be significantly changed by the driver of the vehicle. Indeed, the dimension of the pockets, once established, cannot be changed and therefore control of the doors will always be present. The closing cycle as illustrated generally in FIG. 6 merely represents diagrammatically the closing action provided by the preferred embodiment disclosed, and it should be appreciated that this closing action could be changed by placement of the pockets in other positions along the cylinder, different sizing of the orifice **50**, and different sizing of the closing spring. Further, as already mentioned, a single pocket may be provided instead of a pair of pockets at the end of the cylinder adjacent to the closed end for establishing the closing speed following the pause.

It will be understood that modifications and variations may be effected without departing from the scope of the novel concepts of the present invention, but it is understood that this application is to be limited only by the scope of the appended claims.

The invention is hereby claimed as follows:

1. In a door closing device having a spring for supplying power to close a door and a check device for opposing the action of the spring and modulating the closing action of the door, said check device including an anchored cylinder having a piston slidable therein and connected to a piston rod extending from one end of the cylinder, said piston rod being connected to said door, said piston having opening means therethrough closable by a flapper valve positioned on the rod side of the piston when the piston is moving toward the rod end of the cylinder, said flapper valve and opening means operable to open and allow substantially unrestricted movement of said piston during movement thereof toward the closed end of the cylinder during door opening and to close during movement toward the rod end of the cylinder during door closing, a continuously open orifice extending through said piston for continuously bleeding air between opposite sides thereof at a controlled rate, an air control hole in the rod end of the cylinder, and means for breaking the seal of the piston with the cylinder wall and enabling air to readily pass between opposite sides of the piston including an elongated recess along the inner cylinder wall sized to release the seal of the piston with the cylinder and intercommunicate both sides of the piston when it travels thereover toward the rod and during door closing and allow fast movement of the piston for a predetermined distance.

2. In a door closing device having a spring for supplying power to close a door and a check device for opposing the action of the spring and modulating the closing action of the door, said check device including an anchored cylinder having a piston slidable therein and connected to a piston rod extending from one end of the cylinder, said piston rod being connected to said door, said piston having opening means therethrough closable by a flapper valve positionad on the rod side of the piston when the piston is moving toward the rod end of the cylinder, said flapper valve and opening means operable to open and allow substantially unrestricted movement of said piston during movement thereof toward the closed end of the cylinder during door opening and to close during movement toward the rod end of the cylinder during door closing, a continuously open orifice extending through said piston for continuously bleeding air between opposite sides thereof at a controlled rate, an air control hole in the rod end of the cylinder, and means for breaking the seal of the piston with the cylinder wall and enabling air to readily pass between opposite sides of the piston including a pair of longitudinally extending and spaced elongated recesses adjacent the closed end along the inner cylinder wall sized to release the seal of the piston with the cylinder wall and intercommunicate both sides of the piston when it travels thereover toward the rod end during door closing and allow fast movement of the pison for a predetermined distance, said pair of recesses being spaced a sufficient distance from the closed end of the cylinder to first permit a pause in door closing action as the piston moves toward the rod end of the cylinder, said pair of recesses setting the door closing speed for most of the door closing movement, and an elongated longitudinally extending recess closely adjacent the rod end along the inner cylinder wall sized to release the seal of the piston with the cylinder wall and intercommunicate both sides of the piston when it travels thereover toward the rod end during door closing to allow fast movement of the piston for a predetermined distance and effect a snap shut closing action for the door.

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