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Takenaka

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[54] **DOOR CLOSER MECHANISM**

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[51] **Int. Cl.** **E05f 3/12,** E05f 3/22

[58] **Field of Search** 16/62, 64, 69, 79; 74/435

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Primary Examiner—Bobby R. Gay
Assistant Examiner—William E. Lyddane

[57] **ABSTRACT**

In the present door checking mechanism, a piston reciprocates within a cylinder. A pinion shaft carries a pinion which is normally held in meshing engagement with a rack axially formed on the outer surface of the piston. The pinion is partly toothed so that further rotation of the pinion shaft after the pinion has been disengaged from the rack results in a frictional engagement between the end tooth of the rack and the toothless portion of the pinion. In this condition, the door is firmly held until an external force is applied thereto. Another embodiment includes a pinion having a cutaway portion which, in the door fully open position, is held in surface contact with a corresponding portion of the rack to thereby prevent the door from being violently hit against the wall behind, for example, due to a large wind pressure.

8 Claims, 8 Drawing Figures

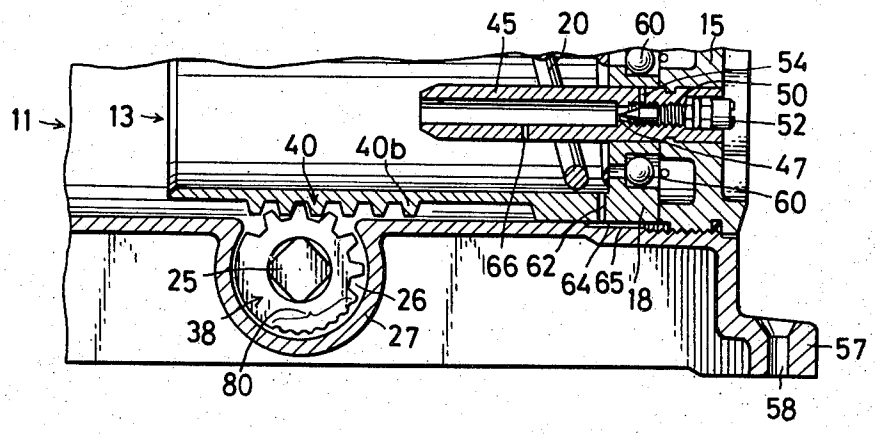


FIG. 1

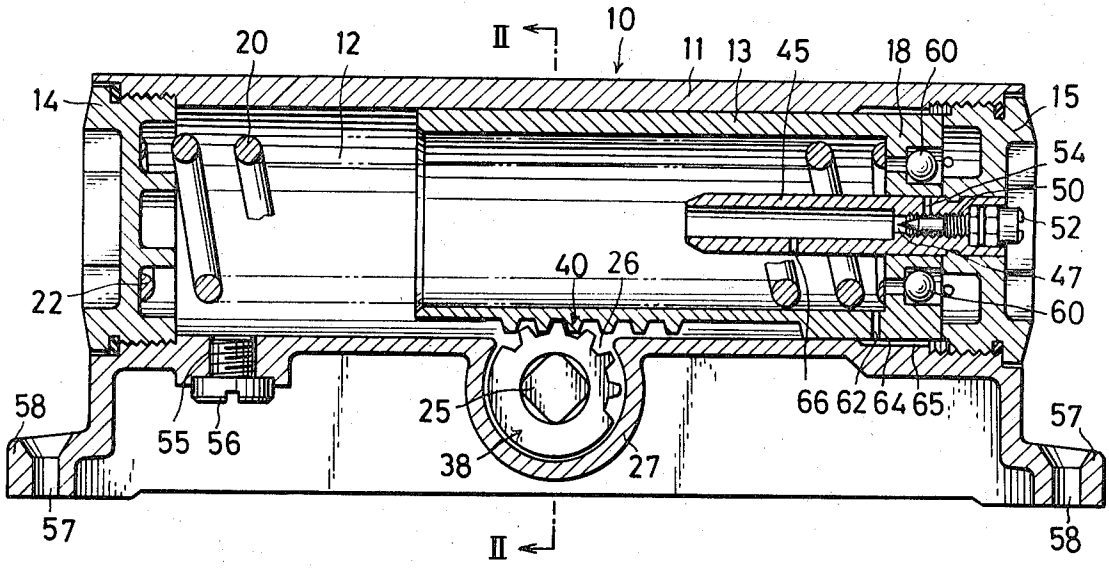


FIG. 3

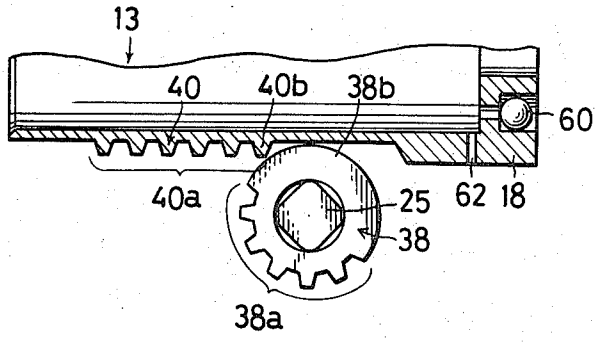


FIG. 2

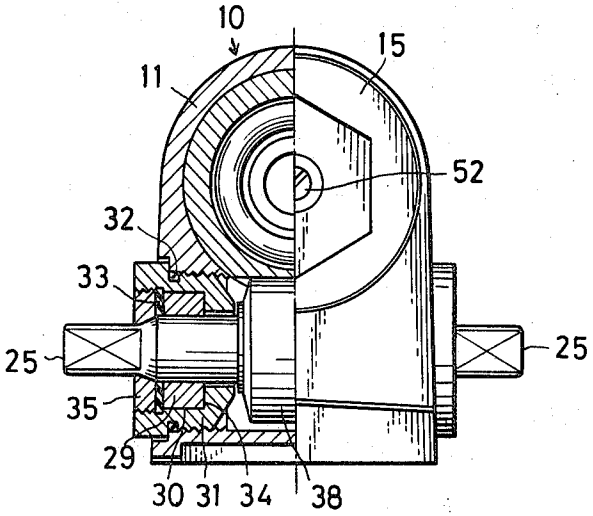


FIG. 4

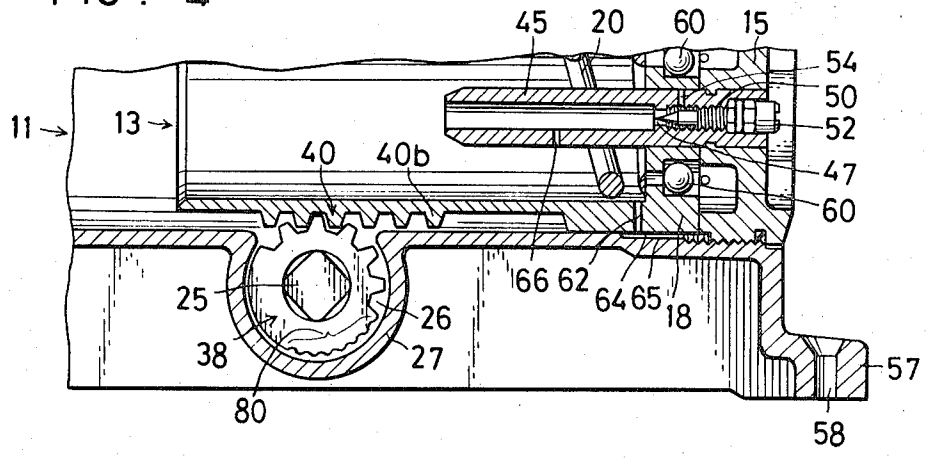


FIG. 5

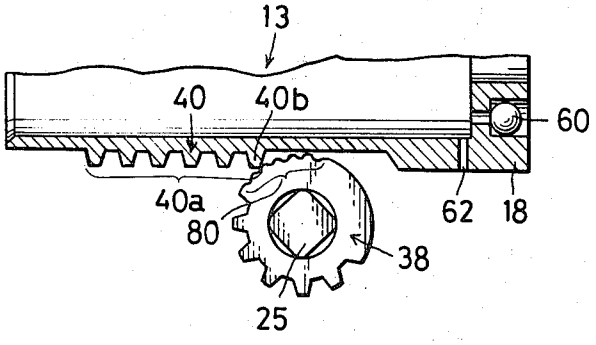


FIG. 6

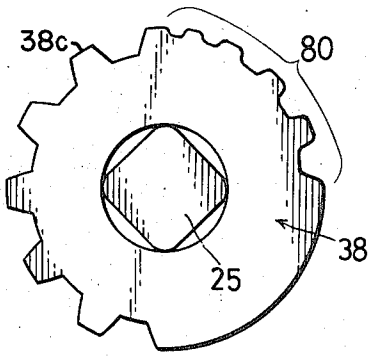


FIG. 7

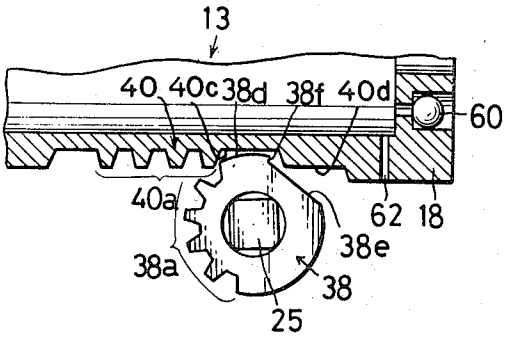
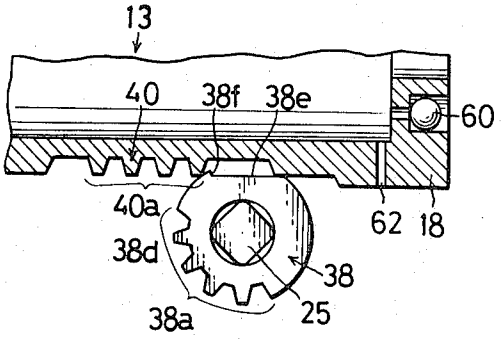


FIG. 8



DOOR CLOSER MECHANISM

This invention relates to an improved door closing and checking mechanism.

In known types of door closer mechanism, a door is automatically closed by the action of potential energy which has been stored in a spring or the like as a result of opening the door. Such mechanisms usually include provision for holding the door in its fully open position and an external force that is greater than that acting to hold the door is required to release the stored energy to move it to the closed position. However, it is impossible to hold the door in any desired position to provide for a desired degree of opening. In order to accomplish this, various units have been incorporated in the door closer mechanisms, but they are not fully satisfactory. Further, these mechanisms have a disadvantage that while the door is held in its fully open position it is likely to be forced to violently hit against the wall behind due to an excessive external force such as wind pressure exerted onto the door in the direction of opening.

Accordingly, it is an object of the invention to provide an improved door closer mechanism that is capable of holding the door in any desired position within a predetermined range of opening degree.

Another object of the invention is to provide an improved door closer mechanism that makes it possible to continuously vary the position in which the door is held within the predetermined range of opening degree.

It is a further object of the invention to provide an improved door closer mechanism that permits stepwise control of the position in which the door is held within the predetermined range of opening degree.

It is still another object of the invention to provide an improved door closer mechanism that acts to prevent the door from being violently hit against the wall behind due to a large external force such as wind pressure exerted on the door in the direction of opening.

These and other objects will be readily apparent from the following description of the invention when taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a longitudinal sectional view showing a door closer mechanism of the invention;

FIG. 2 is a cross section taken along the line II—II of FIG. 1;

FIG. 3 shows the relationship between the rack and pinion of the mechanism of FIG. 1 in a door open position;

FIGS. 4 and 5 show another embodiment of the invention;

FIG. 6 is an enlarged view showing the construction of a modified pinion employed in the door closer mechanism;

FIG. 7 is a view similar to FIGS. 3 and 5, showing a modification of the rack and pinion of the door closer mechanism; and

FIG. 8 is a view similar to FIG. 7, but showing the rack and pinion in a door fully-open position.

Referring now to FIG. 1, a door closer 10, embodying the invention, includes a housing 11 having formed therein a cylindrical chamber 12 for slidably receiving a piston 13. The housing 11 is closed or sealed by a plug 14 which is threadedly secured to one end of the housing 11. Also, a plug 15 is threadedly secured to the other end of the housing 11 for sealing the end.

The piston 13 is in the form of a hollow tube which is closed at one end by an end wall 18. A coiled spring 20 is located within the chamber 12 so as to urge the piston 13 in a right hand direction as viewed in FIG. 1. The coiled spring 20 is received at one end by an annular groove 22 formed in the plug 14 and extends therefrom through the hollow piston 13 to the end wall 18 thereof.

A pinion shaft 25 is provided within a chamber 26 defined by a semi-cylindrical casing 27 formed integrally with the housing 11. As is best seen in FIG. 2, the casing 27 is so formed that the pinion shaft 25 extends perpendicularly of the axis of the cylindrical chamber 12 in offset relationship thereto, and the pinion shaft 25 is rotatably supported by a pair of bearing rings 29, one of which is shown in FIG. 2. Each bearing ring 29 is accommodated within a bore 30 coaxially formed in a bearing support 31 which is threadedly secured to the housing 11 with a sealing ring 32 interposed therebetween. Another sealing ring 33 is mounted in the bore 30 to prevent the escape or leakage of a hydraulic fluid contained in the chambers 12 and 26. The bore 30 has an internally threaded portion into which a closure member 35 is screwed to urge the bearing ring 29 against a shoulder 34 formed in the bore 30 by means of the sealing ring 33.

The pinion shaft 25 has a pinion 38 provided centrally thereof for meshing engagement with a rack 40 axially formed on the outer wall of the piston 13. As illustrated, the pinion 38 is partly toothed to provide a toothed portion 38*a* and a toothless portion 38*b* for the purpose to be described later. The length of the rack 40 is determined to be equal to the circumferential length of the toothed portion 38*a*. The function of the pinion 38 and the rack 40 is to move the piston 13 leftwards from the position shown in FIG. 1 against the action of the coiled spring 20. Each end of the pinion shaft 25 is adapted to receive an arm (not shown) for connecting the door with the door closer.

The plug 15 is centrally apertured to threadedly receive a stem 45 which provides therein a restricted passage 47 for the hydraulic fluid. The stem 45 has a threaded bore 50 for receiving a regulating screw 52. The bore is increased in diameter at the left end portion of teh stem 45 and opens to the interior of the piston 13. An opening 54 is formed in the wall of the stem 45 to communicate with the bore 50. The regulating screw 52 has a tapered end for coacting with the bore 50 to restrict the flow of hydraulic fluid from the chamber 12 on the right side of the piston end wall 18 to that on the left side thereof as the piston 13 moves rightwards. The housing 11 is provided with a threaded hole 55 for introducing the hydraulic fluid into the chamber 12, which hole is normally closed by a screw 56. The housing 11 is further provided with integral flanges 57 having screw holes 58 for receiving screws (not shown) by means of which the present door closer 10 may be secured to the door frame.

The end wall 18 of the piston 13 is centrally apertured to slidably and sealingly receive the stem 45 in telescoping relationship. The end wall 18 is also provided with non-return valves 60 for permitting flow of the hydraulic fluid in one direction only, i.e., from the interior of the piston 13 to the chamber 12 on the right side of the piston end wall 18. In order to provide passage for the hydraulic fluid when the piston 13 is moved rightwards, an opening 62 is formed in the cylindrical

wall of the piston **13** adjacent the non-return valve **60,** which opening communicates the interior of the piston **13** with the chamber **12** on the right side of the piston end wall **18** through an annular passage **64** defined between the outer cylindrical surface of the piston **13** and the cylindrical surface of an increased-diameter portion **65** formed at the right end of the chamber **12.** A opening **66** is also formed in the wall of the stem **45** intermediate its length to provide fluid communication between the interior of the piston **13** and the chamber **12** on the right side of the piston end wall **18** when the piston **13** is positioned on the left side of the opening **66.** The position of each opening **62** and **66** can be varied to cause the door to be closed in differently controlled manners.

As described above, the pinion **38** is partly toothed depending upon the desired degree of full swing of the door. For example, if it is desired to be able to open the door through 90°, the pinion **38** is formed or toothed so that the circumferential length of the toothed portion **38***a* corresponds to 60°, i.e., two-thirds of the desired degree of the door's full swing. The rack **40** is also formed or toothed to provide a toothed portion **40***a* of a length equal to that of the pinion's toothed portion **38***a*. The toothless portion **38***b* of the pinion **38** which corresponds to the remaining 30°, i.e., one-third of the desired degree of the door's full swing, is adapted to effect frictional engagement with the rightmost tooth **40***b* of the rack **40.** In this case, it would be preferable to select the effective tooth number of the pinion **38** and the rack **40** to a multiple of three.

The operation of the present door closer mechanism is as follows: As the door is gradually opened, the pinion shaft **25** is rotated in a counter-clockwise direction by means of the arm or any suitable linkage mechanism (not shown). Due to the meshing engagement of the pinion **38** with the rack **40,** the piston **13** is moved leftwards against the action of the coiled spring **20.** During this movement of the piston **13,** the non-return valves **60** are opened, permitting flow of the hydraulic fluid from the chamber **12** on the left side of the piston end wall **18** to that on the right side thereof.

When the door is opened up to 60°, the rack **40** is disengaged from the pinion **38.** Upon disengagement, no further leftward movement of the piston **13** takes place even when the pinion shaft **25** is further rotated in a counter-clockwise direction. In this condition, the rightmost tooth **40***b* of the rack **40** is strongly urged against the toothless portion **38***b* of the pinion **38** by the action of the coiled spring **20.** This will result in a strong frictional engagement between the pinion **38** and the rack **40,** so that the door is firmly held. In order to increase the opening of the door, an external force that is greater than the frictional force acting to hold the door is required to be applied thereto. The door is held in the position that it assumes when the external force is released. If it is desired to hold the door at the opening angle of 90°, it will only be sufficient to rotate the door to the corresponding position and release it. With this arrangement, it will be appreciated that the door is held in any desired position between the opening angle of 60° and 90°.

At the start of the closing cycle, an external force is applied to the door to move it towards the closed position. When the door is moved to the opening angle of 60°, the pinion **38** is brought into meshing engagement with the rightmost tooth **40**b of the rack **40.** Once the meshing engagement is effected, the piston **13** is moved rightwards by the action of the coiled spring **20,** so that the pinion shaft **25** is automatically rotated in a clockwise direction. At this time, the door is allowed to move at a first speed determined by the size of the opening **66** and the restricted passage **47,** both of which permit flow of the hydraulic fluid from the chamber **12** on the right side of the piston end wall **18** to that on the left side thereof.

When the piston **13** is moved to the position in which the opening **66** is blocked by the end wall **18,** a second speed takes over. The second speed is slower than the first speed, since the second speed is determined by the size of the restricted passage **47** only.

When the door is allowed to move further, the piston **13** reaches the position in which the opening **62** formed in the piston's cylindrical wall is in communication with the annular passage **64.** Since, at this time, the opening **54** formed in the wall of the stem **45** is blocked by the piston end wall **18,** a third speed takes over which is determined by the size of the opening **62.** The door closing and checking mechanism of the present invention automatically effects the transition from the first speed to the second speed and then to the third speed and these speeds are fully adjustable.

Although the invention has been described with a door closer mechanism having the maximum opening angle of 90°, it should be understood that the invention is not restricted thereto.

In FIG. **4,** there is shown another embodiment of the invention in which the door can be held stepwise within a certain range of opening degree. The purpose of holding the door stepwise rather than continuously is to avoid any possible instability in its being held in position which results from the fact that the door is held merely by the frictional engagement of the rightmost tooth **40***b* of the rack **40** with the toothless portion **38***b* of the pinion **38.** To accomplish this, there are provided in the toothless portion **38***b* of the pinion **38** a plurality of axial grooves **80** arranged with a desired spacing and which are shallower in depth than that of the spaces between the teeth of the toothed portion, as clearly shown in FIG. **5.** As is best seen in FIG. **5,** the axial grooves **80** are adapted to receive the edged portion of the rack's rightmost tooth **40***b* when the pinion shaft **25** is rotated in a counter-clockwise direction after the pinion **38** has been disengaged from the rack **40.** As in the case of the embodiment shown in FIGS. **1, 2** and **3,** an external force is required to disengage the rightmost tooth **40***b* of the rack **40** from one axial groove **80** for engagement with the adjacent axial groove **80** so as to further open the door.

In FIG. **6,** there is shown a modification of the pinion **38** which is provided with a plurality of axial grooves having different depths and which are shallower in depth than that of the spaces between the teeth of the toothed portion, as clearly shown in FIG. **6.** As illustrated, the depth of the grooves **80** increases as their distance from the end tooth **38***c* increases. With the pinion **38** of such construction employed, if the closing of the door is desired, the pinion shaft **25** is rotated rather smoothly in a clockwise direction, since the rightmost tooth **40***b* of the rack **40** jumps over the intermediate axial grooves **80** of successively decreasing depth. In this connection, it should be noted that by providing in the pinion **38** a plurality of axial grooves

80 of different widths the same effect can be obtained.

In FIG. 7, there is shown a third embodiment of the present invention which is adapted to prevent the door from being violently hit against the wall behind due to a sudden external force acting thereupon such as wind pressure. In this embodiment also, the circumferential length of the toothed portion 38*a* of the pinion 38 and the length of the corresponding toothed portion 40*a* of the rack 40 are selected to cover only a portion of the desired degree of the door's full swing. The circumferential portion of the pinion 38 which corresponds to the remaining angle of the door's swing is divided into a toothless section 38*d* and a cut-away section 38*e*. As illustrated, the toothless section 38*d* has a substantial circumferential length and terminates with a radially inwardly extending edge 38*f*. The cut-away section 38*e* has a flat surface formed at least at its end opposite to the edge portion 38*f* for the purpose to be described below.

On the right hand side of the toothed portion 40*a* of the rack 40 there is provided a first groove or cut-away portion 40*c* which is of such size that the toothless section 38*d* of the pinion 38 is received thereby, as is best seen in FIG. 7. The first cut-away portion 40*c* is bounded on its right hand side by a second cut-away portion 40*d* which is flattened at least at the left hand end thereof.

In determining the size of the first cut-away portion 40*c* formed in the outer cylindrical surface of the piston 13, care must be exercized to ensure that when the pinion shaft 25 is further rotated in a counter-clockwise direction from the position of FIG. 7 the end of the flat cut-away section 38*e* of the pinion 38 comes into surface contact with the end of the second, flat cut-away portion 40*d* of the rack 40, as is seen in FIG. 8. It should be noted that, in this condition, the circumferential surface of the toothless section 38*d* is also held in surface contact with the tooth surface of the rightmost tooth 40*b* of the rack 40. With the pinion shaft 25 positioned as shown in FIG. 8 so that the pinion 38 and the rack 40 are held in surface contact with each other, there is no further rotation of the pinion shaft 25 in a counter-clockwise direction. Thus, it will be appreciated that with the embodiment shown in FIGS. 7 and 8 the door is prevented from being violently hit against the wall behind and causing damages to the wall or the door itself even when a large external force such as wind pressure is applied to the door in the direction of opening.

It is to be understood that the forms of the invention herewith shown and described are to be taken as preferred examples of the same and that various changes in the shape, size and arrangement of parts may be resorted to without departure from the spirit of the invention or the scope of the subjoined claims.

What is claimed is:

1. A door checking mechanism comprising:
- an elongated housing having a chamber formed therein;
- a piston reciprocably mounted within the chamber and having an end wall;
- a rack axially formed on the outer surface of the piston;
- biasing means for biasing the piston in one direction;
- valve means for permitting flow of a hydraulic fluid from the chamber on one side of the piston end wall to that on the other side thereof as the piston moves in the opposite direction;
- passage means for restricting the flow of the hydraulic fluid from the chamber on the other side of the piston end wall to that on the one side thereof as the piston moves in the one direction;
- a pinion shaft rotatably mounted on the housing and extending therethrough perpendicularly of the axis of the chamber;
- a pinion carried by the pinion shaft and having a toothed portion adapted for meshing engagement with the rack on the piston, the toothed portion covering only that portion of the circumference of the pinion which corresponds to a portion of the door's full swing, said pinion further having a plurality of axial grooves on the periphery adjacent the toothed portion for receiving the edge of the end tooth of the rack, the axial grooves being shallower in depth than that of the spaces between the teeth of the toothed portion, whereby further rotation of the pinion shaft after the toothed portion of the pinion has been disengaged from the rack results in the pinion being firmly held by the end tooth of the rack so that the door is held in steps in any desired step position within the remaining portion of the door's full swing.

2. A door checking mechanism as set forth in claim 1, in which the valve means comprises at least one non-return valve provided in the end wall of the piston.

3. A door checking mechanism as set forth in claim 1, in which the passage means includes a hollow stem fixed to the end wall of the chamber and extending inwardly of the chamber, and an adjustable screw mounted in the hollow stem to form a restricted passage therewith, the hollow stem having an opening in the wall thereof which communicates the chamber on the other side of the piston end wall with the restricted passage.

4. A door checking mechanism as set forth in claim 3, in which the hollow stem has an opening in the wall thereof which communicates the chamber on the other side of the piston end wall with the interior of the stem.

5. A door checking mechanism as set forth in claim 3, in which the piston has an opening formed in the cylindrical wall thereof adjacent its end wall; the chamber in the housing has an increased-diameter portion adjacent its end wall which forms with the outer cylindrical surface of the piston an annular passage through which the opening in the piston communicates the interior of the piston with the chamber on the other side of the piston end wall.

6. A door checking mechanism as set forth in claim 1, in which the pinion shaft extends through the housing in offset relationship to the axis of the chamber.

7. A door checking mechanism comprising:
- an elongated housing having a chamber formed therein;
- a piston reciprocably mounted within the chamber and having an end wall;
- a rack axially formed on the outer surface of the piston;
- biasing means for biasing the piston in one direction;

valve means for permitting flow of a hydraulic fluid from the chamber on one side of the piston end wall to that on the other side thereof as the piston moves in the opposite direction;

passage means for restricting the flow of the hydraulic fluid from the chamber on the other side of the piston end wall to that on the one side thereof as the piston moves in the one direction;

a pinion shaft rotatably mounted on the housing and extending therethrough perpendicularly of the axis of the chamber;

a pinion carried by the pinion shaft and having a toothed portion adapted for meshing engagement with the rack on the piston, the toothed portion covering only that portion of the circumference of the pinion which corresponds to a portion of the door's full swing, said pinion further having a plurality of axial grooves on the periphery adjacent to the toothed portion for receiving the edge of the end tooth of the rack, the depth of the axial grooves being shallower than the depth of the spaces between the teeth of the toothed portion and increasing as their distance from the end of the toothed portion increases, whereby further rotation of the pinion shaft after the toothed portion of the pinion has been disengaged from the rack results in the pinion being firmly held by the end tooth of the rack so that the door is held in steps in any desired step position within the remaining portion of the door's full swing.

8. A door checking mechanism comprising:

an elongated housing having a chamber formed therein;

a piston reciprocably mounted within the chamber and having an end wall;

a rack axially formed on the outer surface of the piston and having a cut-away portion extending from the end tooth of the rack, and a flat surface parallel to the axis of the piston and separated from the end tooth by the cut-away portion;

biasing means for biasing the piston in one direction;

valve means for permitting flow of a hydraulic fluid from the chamber on one side of the piston end wall to that on the other side thereof as the piston moves in the opposite direction;

passage means for restricting the flow of the hydraulic fluid from the chamber on the other side of the piston end wall to that on the one side thereof as the piston moves in the one direction;

a pinion shaft rotatably mounted on the housing and extending therethrough perpendicularly of the axis of the chamber;

a pinion carried by the pinion shaft and having a toothed portion adapted for meshing engagement with the rack on the piston, the toothed portion covering only that portion of the circumference of the pinion which corresponds to a portion of the door's full swing, said pinion further having a toothless portion adjacent the toothed portion, the toothless portion being received in the cut-away portion of the rack during rotation of the pinion, the end tooth of the rack being strongly urged against the toothless portion by the action of the biasing means to provide frictional engagement between the pinion and the rack upon further rotation of the pinion shaft after the toothed portion of the pinion has been disengaged from the rack, and a flat surface adjacent the toothless portion, the flat surface on the pinion being engageable with the flat surface on the rack to prevent rotation of the pinion, whereby further rotation of the pinion shaft after the toothed portion of the pinion has been disengaged from the rack results in the pinion being firmly held by the end tooth of the rack so that the door is held in any desired position within the remaining portion of the door's full swing, and rotation of the pinion shaft to the door fully open position brings the flat surface on the pinion into surface contact with the flat surface on the rack and the door is prevent from further opening movement even when an external force is applied thereto.

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