(12) UK Patent Application (19) GB (11) 2 193 757 (13) A

(43) Application published 17 Feb 1988

(21) Application No 8716526

(22) Date of filing 14 Jul 1987

(30) Priority data
(31) 8617847 (32) 22 Jul 1986 (33) GB

(71) Applicant
Newman Tonks Engineering Limited

(Incorporated in United Kingdom)

Hospital Street, Birmingham B19 2YG

(72) Inventor
William Raymonds Evans

(74) Agent and/or Address for Service
Marks & Clerk,
Alpha Tower, Suffolk Street Queensway, Birmingham
B1 1TT

(51) INT CL⁴
E05F 3/04

(52) Domestic classification (Edition J):
E2M 12BX 12F1A 15

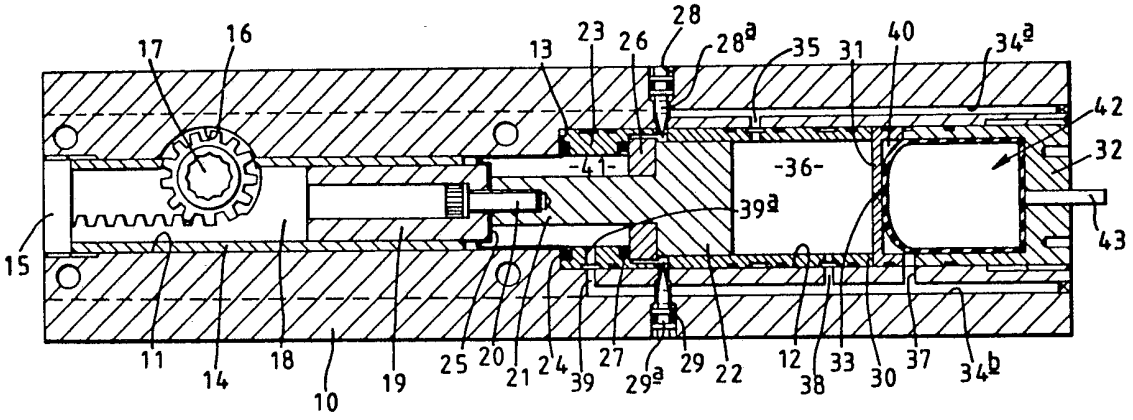
(56) Documents cited
GB 1588519 US 4130888 US 4075734
GB 1214131 US 4102004

(58) Field of search
E2M
Selected US specifications from IPC sub-class E05F

(54) Door closer

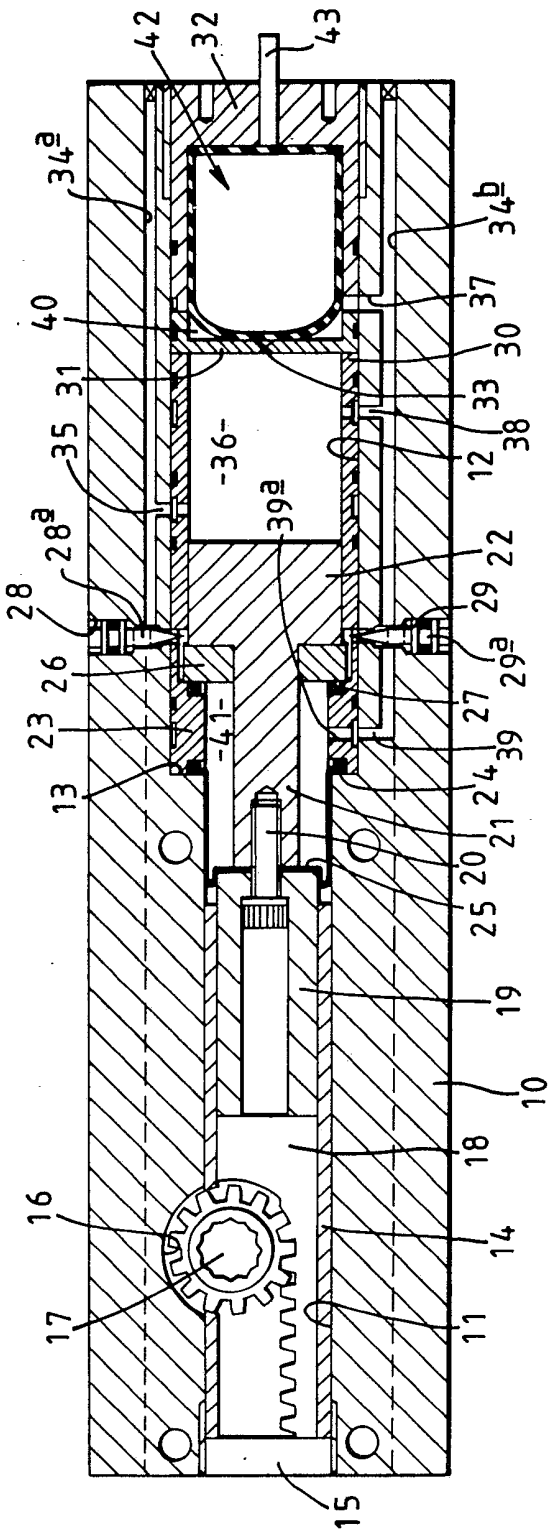
(57) A door closer comprising a body (10), first and second passages (11, 12) in the body, a pinion (17) extending through the first passage and out of the body, a rack (18) engaged by the pinion, a spacer (19) attached to the rack, and a piston, having a head (22) slidable in the second passage, and a stem (21) which is secured to the spacer by a bolt (20). At the junction between the first and second passages is a rubber rolling diaphragm seal (25) which has an outer bead part (24) secured at a shoulder (13) between the passages (11, 12) and an inner flat end wall part sandwiched between the spacer (19) and the piston stem (21). This seal (25) isolates the pinion (17) from the hydraulic fluid of the closer, which is contained in a sealed enclosure defined between the seal and a closed end of the second passage (12).

In a chamber (40) defined in the second passage (12), is a rubber bag-like container (42) having compressed air therein. The container acts as energy storage means to be compressed by hydraulic fluid on movement of the piston in one direction during door opening, and to expand to force the fluid to move the piston in the opposite direction for door closing.



GB 2 193 757 A

2193757


42
32
43
34a
34b
40
37
30
31
33
35
-36-
38
12
39a
28a
22
28
29
29a
26
27
23
-41-
39
13
24
21
20
25
19
10
18
16
14
17
11
15

SPECIFICATION

Door closer

This invention relates to a door closer for controlling the opening and closing movement of a door with which it is associated in use.

A conventional door closer has a body from which extends a pinion. The pinion is attached to a single link or a multiple link arrangement so that as the door is opened or closed, the movement of the door is converted through the link or links into rotational movement of the pinion. The pinion drives a rack in a cavity in the door closer body, the rack either being part of or in contact with a piston, so that opening of the door causes piston movement with hydraulic fluid flowing from one side of the piston to the other, the reverse flow taking place when the door is closed. Valves and/or other restrictions are provided to control the fluid flow, and energy storing means, usually one or more coiled compression springs, are provided to return the piston to its rest position, corresponding to the door being closed, once the door opening force is removed.

The pinion is partly received in the chamber containing hydraulic fluid, usually oil, and a dynamic seal must thus be provided to prevent passage of oil through the opening in the closer body provided for the pinion. Whilst the seal provided is generally satisfactory, leakages do still occur due to faulty or worn seals, a failing of some existing door closers.

As far as the use of springs is concerned, it is possible to alter the return force on the piston by altering the power of the spring. However door closers have to be sent out from the manufacturers with the springs set to a particular force.

The object of the invention is to overcome or at least minimise at least one of the disadvantages referred to.

According to the present invention there is provided a door closer comprising a body, an angularly movable member extending out of the body, a piston slidably movable in a cavity in the body in response to angular movement of said member, movement of the piston in one direction forcing hydraulic fluid ahead of it out of the cavity, energy storage means arranged to store energy on movement of the piston in said one direction, and the hydraulic fluid being contained in the body in a sealed enclosure which is isolated from the angularly movable member.

By isolating the angularly movable member in this manner, there is no risk of leakage of hydraulic fluid from the body by wear of the seal around the angularly movable member. Preferably the isolation is accomplished by the use of a rolling diaphragm seal at one end of the piston.

According to the present invention there is also provided a door closer comprising a body, an angularly movable member extending out of the body, a piston slidably movable in a cavity in the body in response to angular movement of said member, movement of the piston in one direction forcing hydraulic fluid ahead of it out of the cavity, and energy storage means in the body, such means being caused to store energy by the force of hydraulic fluid generated on movement of the piston in said one direction.

The energy storage means is preferably pressurised gas, such as air, contained in an elastically deformable container, which is thus compressed by hydraulic fluid to store energy during door opening, and which expands to force hydraulic fluid to return the piston to its rest position during door closing.

The invention will now be described, by way of example, with reference to the accompanying drawing, the single figure of which is a longitudinal cross-section through a door closer of the invention.

The door closer illustrated has an extruded aluminium body 10 of conventional rectangular external form. Internally there is a first circular-section passage 11 extending from one end of the body, and a larger diameter circular-section passage 12 extending from the other end, the passages meeting at an annular shoulder 13.

Along most of its length the passage 11 has a tubular bearing sleeve 14, extending from said one end of the body, this end having a plug 15. Extending at 90° to the passage axis and breaking through the passage 11 and sleeve 14 is a circular-section opening 16 containing a pinion 17. The pinion has its lower end received in this opening in the body, with its upper end extending out of the body for connection to one or more links in the normal manner.

The pinion 17 is in engagement with a rack 18 which is slidably movable by the pinion in the sleeve 14. The end of the rack remote from the plug 15 is attached to a spacer 19 which is a close sliding fit in the sleeve 14. A threaded shank 20 projects from the end of the spacer remote from the rack and threadedly engaged on the shank is a stem 21 of a piston, having a cylindrical head 22.

In the passage 12 and against the shoulder 13 is an annular retention plate 23, the inner diameter of which is substantially equal to the inner diameter of the passage 11. The plate 23 has an annular cavity in its face abutting the shoulder 13 and in this cavity is retained an annular bead 24 of a rolling diaphragm seal 25 made of rubber. In this position, the diaphragm seal 25 is of generally hollow cylindrical form with its outer cylindrical surface in engagement with the wall of the passage 11 substantially up to the end of the sleeve 14, and its inner cylindrical surface spaced from the stem of the piston. The flat, circular end

wall of the diaphragm is sandwiched tightly between the spacer and the piston stem, with the shank 20 passing centrally through it. Thus as the rack moves and causes the spacer and thus the piston to advance to the right as viewed in the drawing, the diaphragm rolls over the outer surface of the spacer to maintain a leakproof seal.

Carried on the piston stem for limited sliding movement thereon is a steel seal plate 26 which is cylindrical and, in its one extreme position illustrated, abuts and thus seats on a side of the plate 23 formed as an annular shoulder by the adjacent end of the plate 23 having an internal diameter which is increased to be somewhat greater than the external diameter of the plate 26 thereby to accommodate the plate 26 in said end of plate 23. The side abutted by the plate 26 contains a seal 27. The retention plate 23 extends up to the axial position of a pair of radially disposed, diametrically opposed, stepped bores 28, 29, extending from the outer face of the body, and which are threaded to receive respective restricting needle valves 28a, 29a. From the bores 28 to the end of the passage 12, the passage is provided with sleeves 30, one of which also provides a transverse wall 31 to form two separate compartments in the passage 12, and an end one of which forms an integral end plug 32. At the centre of the wall 31 is a small, restricted orifice 33. The sleeves can however be omitted and replaced by suitable configuration of the passage 12.

The inner diameter of the sleeves 30 is less than the diameter of the seal plate 26 so that as the piston moves to the right the seal plate 26 can only slide a short distance on the piston stem before it abuts the end of the sleeve 30 which terminates at the bores 28, 29. The piston is a precision sliding fit in the sleeves 30 and can slide up to the wall 31.

At sides of the passage 12 there are provided galleries 34a, 34b extending parallel thereto, the galleries extending from the end of the body containing the plug 32 and themselves being plugged. The galleries are angularly arranged around the passage 12 so as to communicate with the bores 28, 29 respectively.

The gallery 34a terminates at the bore 28 and has a short branch passageway 35 extending through the body 10 and sleeve 30 to communicate with a cavity 36 shown formed between the head of the piston and the wall 31 with the piston in its extreme leftwards position of movement.

The gallery 34b has three branch passageways 37, 38 39 into the passage 12. The branch 37 extends into a chamber 40 formed between the wall 31 and plug 32. The branch 38 extends into the cavity 36, but much nearer the wall 31 than the passageway 35 so as to be closed later by the piston when it moves to the right, and the branch 39 extends through the body 12 to be aligned with a passageway 39a in the plate 23, which leads into a variable volume cavity 41 between the diaphragm and the seal plate 26. The clearance around the external periphery of the plate 26 allows communication between the bores 28, 29 and the cavity 41, when plate 26 moves off its seal 27, or the cavity between the piston head and plate 26 when plate 26 abuts plate 23 and the piston has moved to the right.

In the chamber 40 is an accumulator 42 formed as a neoprene bag containing pressurised gas, in this example compressed air, which operates as the energy storing means of the closer to return the piston to its extreme left position to close the door, when the door opening force is removed.

The operation of the closer will now be described, starting from the position shown in the drawing which corresponds to the door closed position. In this position hydraulic fluid, normally oil, fills the whole sealed enclosure defined between the right hand side of the diaphragm and the plug 32, i.e. the chamber 40, cavities 36 and 41, galleries 34a and 34b, and branch passageways 35 and 37 to 40.

It will thus be appreciated that no oil is in contact with either the pinion or the rack which remain isolated from the oil enclosure. This thus overcomes the problem of seal failure around the pinion which with previous closers has resulted in oil leakage from the pinion opening. This isolation is achieved by use of the rolling diaphragm which allows sealing on a linearly movable component with negligible seal friction. This reduced seal friction results in increased efficiency as compared to existing door closers. Accordingly the only other oil seals required are encapsulated static seals which are not prone to leakage. The pinion can be provided with a suitable dynamic bearing which can provide any lubrication required.

In use, as the door is opened, the pinion 17 rotates anti-clockwise to move the rack 18 to the right, with resultant movement of the piston to the right. Oil in the cavity 36 is thus forced out through the passageway 38, gallery 34b and passageway 37 into the chamber 40. Oil in the cavity 41 is forced out through the passageways 39a and 39 by the movement of the spacer 19, this oil also being forced into the chamber 40. Accordingly the air accumulator is compressed by the oil, causing it to store energy. As the piston moves it firstly closes the passageway 35 and then the passageway 38. When this latter passageway closes the main flow path from the cavity 36 to the accumulator chamber is cut off, slowing down any tendency for the door to accelerate beyond a 90° open position. Further outflow of oil from the cavity 36 then occurs through the restricted orifice 33.

At the commencement of door opening, the seal plate 26 is lifted off the seal 27, allowing oil to flow around it. Upon continued movement of the piston to the right, oil flows into the cavity created behind the piston head and around the piston stem.

On removal of the door opening force, the bag in chamber 40 expands and the energy stored by the air accumulator is thus released to force oil out of the chamber 40, initially through orifice 33. This initial oil flow causes slight leftwards movement of the piston which in turn causes a slight increase in the pressure of oil in the cavity behind the piston head 22. This slight pressure increase forces seal plate 26 onto its seat thus trapping oil between the seal plate and the rear of the piston. This trapped oil is now at a pressure which is slightly greater than the pressure of oil in cavities 36, 40 and 41. This trapped oil is metered out via restrictor valve 29a into increasing volume chamber 41, via passage 39a, and into increasing volume chamber 36 via passageway 38. The piston movement and force is transmitted via the spacer 19 to the rack and pinion, thus closing the door at a controlled angular velocity determined by the oil flow through restrictor valve 29a.

Passageway 35 is uncovered just before piston movement to the left is completed, and this uncovering allows an increased volume of oil to be metered out from the reducing volume chamber between the seal plate 26 and piston head 22. This metering out is through the restrictor valve 28a into the chamber 36 via passageway 35, this speeding up the piston movement to the left, causing the door to accelerate over the latch to secure the door. The oil pressure on the unbalanced piston results in a positive closing force to move the door to its closed position and thereafter maintain it closed. The high fluid flow during operation of the closer gives good speed control.

As the medium for storing the energy generated by opening the door is compressed air, it is easy to set the power of the closer by inflating the air bag to the required pressure. This can be done by either connecting a canister of compressed air at the correct pressure to a valve 43 extending out of the body from the air accumulator, or by operating a pump connected to the valve 43. Thereafter the power of the closer can be adjusted by increasing or decreasing the air pressure. Additionally it is possible to change one size of air bag for another in order to alter the rate of energy storage. If required the air bag could be made integrally with the plug 32. Accordingly the door closer can be sent out by the manufacturer with the air bag uninflated, so that the distributor can set the pressure of the restoring means as required.

CLAIMS

1. A door closer comprising a body, an angularly movable member extending out of the body, a piston slidably movable in a cavity in the body, in response to angular movement of said member, movement of the piston in one direction forcing hydraulic fluid ahead of it out of the cavity, energy storage means arranged to store energy on movement of the piston in said one direction, and the hydraulic fluid being contained in the body in a sealed enclosure which is isolated from the angularly movable member.

2. A door closer as claimed in claim 1, wherein said sealed enclosure is isolated from the angularly movable member by a rolling diaphragm seal.

3. A door closer as claimed in claim 2, wherein one end of the seal is fixed relative to the body and the other end of the seal is fixed for movement with the piston.

4. A door closer as claimed in claim 3, wherein said one end of the seal is in the form of an outer peripheral bead, and said other end is in the form of a flat wall, these two ends being connected by a peripheral wall which can roll back within itself, or alternatively over itself, upon movement of the piston.

5. A door closer as claimed in claim 4, wherein in an extended state the seal is of hollow cylindrical form, with said bead being annular, said peripheral wall being cylindrical and said flat wall being circular.

6. A door closer as claimed in claim 5, wherein said flat surface is retained between an end of a stem of the piston and an end of an element slidable with a rack engaged with said angularly movable member, said peripheral wall of the diaphragm seal rolling over the outer surface of said element during movement of the piston.

7. A door closer as claimed in claim 6, wherein said flat wall of the diaphragm seal has a central opening through which extends a stem of a fixing element which secures said element to said piston stem, with said flat surface being sandwiched therebetween.

8. A door closer as claimed in claim 6 or claim 7, wherein the closer body has a first passage and a longitudinally aligned, larger, second passage therein, the passages meeting at a shoulder against which said bead of the seal is held by a retention member which though disposed in said second passage has a bore therethrough forming a continuation of the first passage, the rack and said element sliding, in use, within said first passage, which is isolated from said sealed enclosure formed by the second passage by said diaphragm seal.

9. A door closer as claimed in claim 8, wherein when the rack is at one extreme rest position, said element is wholly within said first passage and the peripheral wall of the diaphragm seal engages the interior wall of

the first passage, said peripheral wall rolling off said interior wall onto the outer peripheral surface of said element upon sliding movement of said element as a result of said rack moving from said one extreme position, towards the second passage.

10. A door closer device as claimed in claim 9, wherein a seal member is slidably received on the piston stem for movement between a first rest position, in which it sealingly engages an end face of the retention member facing away from the first passage, and a second, rest position where it is spaced from said retention member at a position along said second passage, a variable volume cavity being defined between said rolling diaphragm seal and the face of the seal member which can seal against the retention plate.

11. A door closer device as claimed in claim 10, wherein the second passage is divided into first and second compartments by a wall, the first compartment constituting said cavity and being that in which the piston slides, and the second compartment containing said energy storage means.

12. A door closer device as claimed in claim 11, wherein a gallery extends in the body parallel to the second passage, with respective branch passageways extending therefrom into said variable volume cavity, said first compartment and said second compartment, a restrictor being provided in a bore to allow communication between said gallery and a further variable volume cavity created, when said seal member is in its first rest position, between a rear face of the piston and said seal member, flow of hydraulic fluid through said restrictor corresponding to controlled door closing, in use.

13. A door closer device as claimed in claim 12, wherein a further gallery is provided in the body parallel to the second passage, with a further branch passageway extending therefrom into said first compartment, a further restrictor being provided in a further bore to allow communication between said further variable volume cavity and said first compartment towards the end of the door closing movement, in use, thereby to effect a latching of the door.

14. A door closer device as claimed in any one of claims 11 to 13, wherein the wall has a restricted opening therethrough providing direct communication between the first and second compartments.

15. A door closer device as claimed in any one of the preceding claims, wherein the energy storage means is in the form of an elastically deformable container with pressurised gas therein, the hydraulic fluid compressing the container when the piston moves, in use, in said one direction, and the container expanding from its compressed state to force the hydraulic fluid to move the piston in the opposite direction when the force moving the piston in said one direction is removed.

16. A door closer device as claimed in claim 15, wherein the container is made of rubber and contains compressed air.

17. A door closer device comprising a body, an angularly movable member extending out of the body, a piston slidably movable in a cavity in the body in response to angular movement of said member, movement of the piston in one direction forcing hydraulic fluid ahead of it out of the cavity, and energy storage means in the body, such means being caused to store energy by the force of hydraulic fluid generated on movement of the piston in said one direction.

18. A door closer device as claimed in claim 17, wherein the energy storage means is disposed in a compartment separated from said cavity, fluid communication between the cavity and the compartment being provided by passage means.

19. A door closer device as claimed in claim 18, wherein the passage means define separate first and second flow paths for fluid flow between the cavity and the compartment, the piston being movable in said cavity in said one direction to a position where said first flow path is closed, further piston movement in the same direction causing restricted fluid flow through the second flow path, fluid entering the compartment causing storage of energy by said energy storage means.

20. A door closer device as claimed in claim 19, wherein said cavity and said compartment are separated by a wall across a passage in the body, said second flow path being a restricted aperture through the wall, and the first flow path comprising a gallery parallel to the passage in the body, with respective branch passages leading from the gallery into the cavity and compartment.

21. A door closer device as claimed in claim 20, wherein the gallery has a further branch passage for fluid communication with a further cavity defined at the opposite side of the piston from the cavity in which the piston moves, the further cavity being closed at one end by a seal to isolate the hydraulic fluid from the angularly movable member.

22. A door closer device as claimed in claim 21, wherein the gallery has a still further branch passage leading to a still further cavity defined between the piston and a seal member slidably disposed on a stem of the piston, the still further branch passage containing a restrictor valve to meter out fluid to said further cavity, which is defined between said seal and said seal plate, via said further branch passage.

23. A door closer device as claimed in claim 22, wherein further restricted passage means are provided for fluid flow from the still further cavity to said cavity in which the piston moves to increase fluid flow when the piston is moving in a direction opposite to

said one direction, thereby to increase piston speed.

24. A door closer device as claimed in claim 22 or claim 23, wherein an outermost part of the seal is fixed at one end of said passage in the body, and has an innermost part fixed between said piston stem and a member which moves with a rack engaged with said angularly movable member.

25. A door closer device as claimed in claim 24, wherein the seal is a rolling diaphragm seal, the part of the seal between its fixed outermost and innermost parts rolling back within itself, or alternatively over itself, upon movement of the piston.

26. A door closer device as claimed in any one of claims 17 to 25, wherein the energy storage means is an elastically deformable container having pressurised gas therein, the container thus being compressible, in use, by the force of hydraulic fluid when the piston moves in said one direction, and expandable from its compressed state to force the fluid to move the piston in the opposite direction.

27. A door closer device as claimed in claim 26, wherein the container is made of rubber and contains compressed air.

28. A door closer device as claimed in claim 26 or claim 27, wherein the container has a valve extending out of the body for enabling a required gas pressure to be produced within the container.

29. A door closer device as claimed in any one of claims 26 to 28, wherein the container is disposed in the body adjacent an open end thereof, which is closed by a plug formed integrally with the container.

30. A door closer device substantially as hereinbefore described, with reference to, and as shown in the accompanying drawing.

Published 1988 at The Patent Office, State House, 66/71 High Holborn, London WC1R 4TP. Further copies may be obtained from The Patent Office, Sales Branch, St Mary Cray, Orpington, Kent BR5 3RD. Printed by Burgess & Son (Abingdon) Ltd. Con. 1/87.