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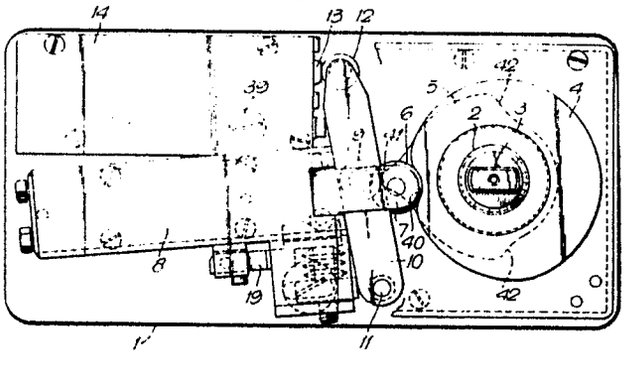
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(54) Automatic door closer.

(57) A door closer in the form of a floor spring has two coaxial cams (4 and 5) fastened to its door spigot (3). One cam (4) acts via a roller (6) on the rod (7) of a restoring spring unit (8). The other cam (5) acts via a roller (9) and lever (10) on the rod (13) of a damper/assist unit (14). This unit (Fig 4) has a spring (25) which acts on a piston (24) arranged to drive oil through a hydraulic circuit (26) in which there is an automatic throttle (27) (Fig 5). The shape of the second cam (5) is such that as soon as the door is "cracked" the force of the spring (25) in the damper/assist unit (14) acts to assist the door to open in opposition to the spring in the restoring unit (8). The throttle (27) is arranged to apply no significant damping to the movement of the piston (24) in this direction. However, when the door is released and closes under the force of the spring in the restoring unit (8) there is a reversal of the flow direction in the hydraulic circuit (26) as the rod (13) of damper/assist unit (14) is pushed in, and the throttle (27) is arranged to apply a significant damping action to the piston (24) in this direction.

Fig 1.



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Automatic Door Closer

The present invention relates to automatic door-closing devices. More especially the invention is concerned with door-closing devices of the kind commonly referred to as floor springs.

The conventional floor spring comprises a unit to be mounted at floor level including a shaft to be coupled to the door so as to turn therewith as the door opens and closes. An energy-accumulating spring is coupled to the shaft via a cam so that as the door is opened the cam turns to compress the spring. In the open position, the spring applies a force to the cam to restore it to its original position, so that when the door is released the cam turns the shaft to close the door once more. Hydraulic damping means are also provided to cushion the closing movement of the door.

One aim of the present invention is to provide a device of the above-described character which is arranged so that, after any initial detent action on the door has been overcome, only a minimal force is required to move the door to its normal open position and compress the restoring spring. Such a device will be of particular benefit to the elderly, handicapped or infirm who may have sufficient strength and mobility to "crack" the door a small initial angle but who would have difficulty in moving a door through its full opening angle against the resistance inherent in a conventional floor spring.

In accordance with the invention an automatic door-closing device comprises: a shaft to be coupled to a door so as to turn therewith as the door opens and closes; first cam means coupled to the shaft; first spring means coupled to the first cam means such as to be loaded thereby as the door is opened and to apply a force to the first cam means tending to restore the door to its closed position; second cam means coupled to the shaft; a piston coupled to the second cam means; second spring means acting upon the piston such as to drive it in a first direction in which it applies a force to the second cam means tending to assist the opening movement of the door; closing movement of the door under the force of the first spring means acting through the second cam means to drive the piston in a second direction opposite the first; the piston causing fluid to flow through a circuit in opposite senses when it is driven in said first and second directions; and said circuit including throttling means responsive to the direction of flow through the circuit and adapted to be effective when the piston is driven in its second direction (as the door closes) but to be ineffective, or less effective, when the piston is driven in its first direction (as the door opens).

These and other features of the invention will become apparent from the following particular description of one embodiment thereof, given by way of example and taken in conjunction with the accompanying drawings, in which:

Figure 1 is a plan view of a floor spring constructed in accordance with the invention, with its top cover removed;

Figure 2 is a plan view of the restoring spring unit employed in the device of Figure 1;

Figure 3 is a partial vertical section and partial side elevation of the unit shown in Figure 2;

Figure 4 is a horizontal section through the damper/assist unit employed in the device of Figure 1;

Figure 5 is a vertical section, to an enlarged scale, through the throttling means of the units shown in Figure 4; and

Figures 6 and 7 are respective plan views of the two cams employed in the device of Figure 1.

Referring to Figure 1, the illustrated floor spring has a casing 1 in which is borne a shaft 2 with a spigot 3 adapted to fit into a socket in the underside of a swing door, so that the shaft turns with the door as the latter opens and closes to either side of a central position. Keyed to the shaft are two cams 4 and 5. Cam 4 cooperates with a roller 6 carried at one end of a rod 7 which extends from a restoring spring unit 8, to be more particularly described below. Cam 5 cooperates with a roller 9 borne at an intermediate position on a lever 10 which is pivoted at one end on a pin 11 in the casing and passes beneath the rod 7. At its other end the lever 10 carries a roller 12 which cooperates with a rod 13 adapted to extend from a damper/assist unit 14, which will also be more particularly described below.

The restoring spring unit 8 is more fully shown in Figures 2 and 3. Within its casing 15 is housing a coil spring 16 of high stiffness. One end of this spring engages an abutment plate 17 at one end of the casing 15, and the other end of the spring engages a second abutment plate (not shown) carried by the rod 7 so that the action of the spring is to urge the rod strongly to the right (as viewed in the Figures) to an extended position with respect to the casing. The force with which the spring so acts is adjustable, and can be relieved eg for maintenance, by adjusting the axial position of the plate 17 in the casing 15 by means of four screws 18 threaded through the end of the casing and against which the plate 17 is thrust by the spring. The

illustrated unit also has a pivoted latch arm 19 to engage a side roller 20 on the rod 7 under an adjustable spring pressure 21, to provide a detent action against retracting movement of the rod.

Turning to Figure 4, the damper/assist unit 14 has a casing 22 defining a hydraulic cylinder 23. Within this cylinder is a slidable piston 24, mounted on the rod 13. A coil spring 25 is trapped between the piston and one end of the cylinder, the action of which is to urge the piston rightwards (as viewed in the Figure) to extend the rod 13 from the casing. Figure 4 shows this unit with the rod in a fully extended position, which in practice is not quite reached in operation of the floor spring. The two ends of the cylinder are also connected together through a passage 26 bored in the casing, and the whole of the cylinder 23 and passage 26 is filled with oil. Movement of the piston 24 to the right under the action of the spring 25, therefore, has the effect of displacing oil from the right hand end of the cylinder 23 to the left hand end by flow in the clockwise sense (as viewed in the Figure) through passage 26. Movement of the piston 24 to the left, on the other hand, (which is under the action of the cam 5 as explained below), displaces oil from the left hand end of the cylinder 23 to the right hand end, by flow in the reverse sense through the passage 26. Connected to the cylinder 23 is an overflow/accumulator chamber (not shown) for the oil, to compensate for changes in the effective volume of the cylinder 23 as the rod 13 moves in and out, and within the passage 12 is an automatic throttling device 27 which will now be described with reference to Figure 5.

In Figure 5 the portions of the passage 26 which lead to the throttling device from the right and left hand ends of the cylinder 23 are denoted as 26R and 26L respectively. For oil to flow between these portions of the passage it has to pass between a conical drilling 28 and the conical head 29 of a jumper 30 which extends to a greater or lesser degree into that drilling. The jumper 30 is itself borne in a block 31 mounted in a cavity 32 in the casing, and is permitted a limited degree of axial movement relative to the block. To this end the jumper has a cylindrical portion 33 which is a sliding fit in the block 31. A pair of cross bores 34 extend diametrically across the jumper, and an axial bore 35 also leads through the jumper from the cross bores 34 to its tail. A pin 36 held by the block 31 extends through one of the cross bores 34. With this arrangement the lower limiting position of the jumper in the block is defined by the abutment of the pin 36 with the flat upper surface of the cross bore 34 within which it lies. The upper limiting position of the jumper in the block is defined by the abutment of the tail of the jumper with the inner end wall 37 of the block.

The effect of this throttle is as follows. Suppose the piston 24 is driven to the left in Figure 4. This causes pressurised oil to flow to the throttle through passage 26L. The pressure in this passage is communicated via bores 34 and 35 to the space 38 at the tail of the jumper and causes the jumper to shift down to its position illustrated in Figure 5 in which the head 29 is thrust into the drilling 28 and restricts the area available for flow into the passage 26R. The restriction thus caused effectively damps the leftward movement of the piston. Suppose instead the piston 24 is driven to the right in Figure 4. This causes pressurised oil to flow to the throttle through passage 26R.

The pressure here acting on the underside of the head 29 lifts the jumper to open up the flow area between head 29 and drilling 28 and the oil therefore flows into passage 26L with little restriction. There is thus little or no effective damping action on the rightward movement of the piston 24. The flow of oil through the throttle in this direction will also tend to flush out dirt which could become trapped between the surface 28/29.

The degree of damping imparted by the throttle 27 can be adjusted by altering the position of the block 31 in the cavity 32 to take the lower position of the jumper towards or away from the drilling 28 as required. To this end the block has a threaded extension 39 by which it can be screwed down or up in the cavity 32.

Turning now to Figure 6 this shows the profile of the cam 4 which cooperates with the restoring spring unit 8. It is symmetrical about a central axis X to provide equivalent action in both opening directions of the door. Its central part is a depression 40 defining the closed position of the door. From here the profile rises quite steeply to positions approximately 12-15° either side of the axis and then rises gradually to positions slightly beyond 90° either side. Past the latter positions the profile is of constant radius.

The profile of the cam 5 which cooperates with the damper/assist until 14 is shown in Figure 7. Again this cam is configured to provide equivalent action in both opening directions of the door but it is not geometrically symmetrical about its central axis Y because the roller 9 with which it cooperates moves not in a straight line but in an arc about the pivot pin 11; the profiles of the two "sides" of the cam are therefore adjusted to take account of this movement. Its central part is a cusp 41 from which the profile falls, initially quite steeply, to positions approximately 35-40° either side of the centre. The profile is then of constant radius to positions slightly beyond 90° either side, at which there are steps 42.

The operation of the device is as follows.

Figure 1 shows the positions adopted when the door is in its central, closed condition. The roller 6 of the restoring spring unit lies in the depression 40 of the cam 4 to resist turning of the shaft 2 and thus opening of the door. In addition to the spring force urging the roller into this position the latch 19 acts to resist inward movement of the rod 7 and thus applies an additional restraint on opening of the door. This may be necessary where the door is, for example, exposed to wind pressure, but may be omitted or reduced in other circumstances. The roller 9 of the lever 10 lies on the cusp 41 of the cam 5.

To open the door, in either direction, a certain effort is required in order to begin to turn the cam 4 so that the roller 6 begins to ride out of the depression 40, thus compressing the spring 16 in unit 8, and to overcome the detent action of the latch 19. As soon as the door is "cracked" a few degrees, however, the cam 5 is turned to present a steeply falling side of its cusp 41 to the roller 9. This is being pressed inwards against the cam 5 by the spring 25 in unit 14 acting via the piston rod 13 and lever 10. The force of the spring 25 therefore now acts in a sense that assists the opening movement of the door and thus greatly reduces the manual force which must be applied to continue opening the door and compress the restoring spring 16. From the description above it will be recalled that the throttle 27 applies no significant damping action on the movement of the piston rod 13 in this direction. The assistance to door opening from the spring 25 continues while the cam 5 turns with the roller 9 on its decreasing-profile portion, corresponding to a useful opening angle for the door. Beyond that, the restoring spring 16 will continue to be compressed by the cam 4. If the door should be pushed beyond a 90° position, the roller 9 will pass one of the steps 42 on the cam 5 thus allowing the rod 13 to be pushed further out from the unit 14 by the spring 25.

The limiting opening angle from which the restoring spring 16 can act to close the door in the illustrated embodiment is approximately 110° - corresponding to the position at which the roller 6 reaches the end of the increasing-profile portion of the cam 4, and at this position suitable stop means will be provided either internally or externally of the floor spring to prevent further movement of the door. Clearly, any other effective angle can be chosen in this respect by suitable configuration of the cam surface.

When the door is released, the force of the spring acting on the cam 4 through the roller 6 drives that cam, and hence the door, back towards the closed position. Assuming that the door has opened beyond the 90° position, as the cam 5 also turns back the roller 9 will encounter the rising surface of the step 42, thus pivoting the lever 10 to press the piston rod 13 back into the unit 14. As will be appreciated, as the piston 24 now moves leftwards (as viewed in figure 4) it will act against the spring 25 and also the throttle 27 will restrict the flow of oil through the passage 26 in this sense of movement of the piston. The damper unit 14 therefore applies a delayed-closing action to the door at this position, the delay time depending upon the profile of the step and the degree of damping imparted by the throttle 27.

Having passed back over the step 42, the roller 9 is initially on the constant-radius portion of cam 5 and the door will therefore have a fast, undamped closing speed until the roller begins to rise up to the cusp 41. The rod 13 is now pushed further back into the unit 14 to damp the final part of the closing movement of the door, the damping reaching a maximum as the roller 9 rises up the steepest part of the cusp 41, which corresponds to movement of the roller 6 into the depression 40 of cam 4, to ensure gentle closure. In point of fact the flutes 43 of the cam 5 are slightly overcut with respect to the splines (not shown) of the shaft 2 with which they engage, so that there is a small degree of lost angular motion between the shaft and cam. This means that when the door reaches its closed position, from either opening direction, the roller 9 does not reach up exactly to the top of the cusp 41, and the spring 25 continues to exert a certain load against the side of the cusp. This has been found to assist considerably in the definition of a stable zero position for the door.

From the above description of the operation of the illustrated floor spring, it will be appreciated how the springs 16 and 25, cams 4 and 5 and automatic throttle 27 interact to provide programmed opening forces and a programmed closing sequence for the door. The "programme" so provided in devices made in accordance with the invention is open to considerable variation by appropriate selection of the cam profiles and throttle characteristics.

Claims

1. An automatic door-closing device characterised by: a shaft (2) to be coupled to a door so as to turn therewith as the door opens and closes; first cam means (4) coupled to the shaft (2); first spring means (16) coupled to the first cam means (4) such as to be loaded thereby as the door is opened and to apply a force to the first cam means (4) tending to restore the door to its closed position; second cam means (5) coupled to the shaft (2); a piston (24) coupled to the second cam means (5); second spring means (25) acting upon

the piston (24) such as to drive it in a first direction in which it applies a force to the second cam means (5) tending to assist the opening movement of the door; closing movement of the door under the force of the first spring means (16) acting through the second cam means (5) to drive the piston (24) in a second direction opposite to the first; the piston (24) causing fluid to flow through a circuit (26) in opposite senses whin it is driven in said first and second directions; and said circuit (26) including throttling means (27) responsive to the direction of flow through the circuit (26) and adapted to be effective when the piston (24) is driven in its second direction (as the door closes) but to be ineffective, or less effective, when the piston (24) is driven in its first direction (as the door opens).

2. A device according to claim 1 wherein said first spring means (16) and said piston (24) are disposed in structures (8,14) located side by side and with their respective lines of action generally parallel; the line of action of one of said first spring means (16) or piston (24) intersecting the axis of said shaft (2), or nearly so, while the line of action of the other of said first spring means (16) or piston (24) is offset from the axis of said shaft (2); and said other of said first spring means (16) or piston (24) is coupled to the respective cam means (4 or 5) by a lever (10) pivoted at one end (11), intersecting said offset line of action at its other end (12) and carrying follower means (9) intermediate its ends for engagement with the cam means (4 or 5).

3. A device according to claim 1 or claim 2 wherein it is arranged that in a set position of said shaft (2) corresponding to the intended closed position of the door said second spring means (25) applies a force to said second cam means (5) in a direction to open the door which force is opposed and resisted by the force of said first spring means (16) acting upon said first cam means (4), whereby to stabilise said set position of said shaft (2).

4. A device according to claim 3 wherein said shaft (2) is adapted to turn away from said set position in opposite directions; said first cam means (4) has a depression (40) within which follower means (6) of said first spring means (16) lie in said set position; said second cam means (5) has a cusp (41) with which follower means (9) of said second spring means (25) engage in said set position; and said second cam means (5) is mounted with a limited degree of lost angular motion relative to said first cam means (4) so that, upon return of the shaft (2) to said set position following displacement therefrom in either direction as the door is opened, said follower means (9) of said second spring means (25) remain in engagement with a portion of said cusp (41) to that side of the crown thereof which was presented to said follower means (9) when the door was open.

5. A device according to any preceding claim wherein said second cam means (5) has a stepped profile (42) for engagement with follower means (9) of said piston (24) and second spring means (25) when the door has opened to a specified angle, thereby to delay closure of the door from that angle under the force of the first spring means (16).

6. A device according to any preceding claim wherein said throttling means (27) comprises a jumper (30) having a head portion (29) cooperating with a complementary flow passage (28) which forms part of said circuit (26), the jumper (30) being borne for limited axial movement relative to said passage (28) such as to vary the effective area available for fluid flow therethrough; one end of said flow passage (28) communicating through conduit means (26R) with a cylinder (23) space to one side of said piston (24); the other end of said flow passage (28) opening to a cavity (32) which communicates through conduit means (26L) with a cylinder (23) space to the other side of said piston (24); the jumper (30) having one or more openings (34) at an intermediate portion thereof which communicate with said cavity (32) in all positions of the jumper (30) and by which fluid pressure in said cavity (32) is transmitted through a passage (35) in the jumper (30) to a closed space (38) at the tail end thereof; whereby movement of the piston (24) to compress the cylinder (23) space to said one side thereof, under the action of said second spring means (25), pressurises said one end of said flow passage (28) causing the jumper (30) to move such as to increase the effective area available for fluid flow through that passage (28), while movement of the piston (24) to compress the cylinder (23) space to said other side thereof, under the force of said first spring means (16) acting through the second cam means (5), pressurises said cavity (32) and thereby said closed space (38) at the tail end of the jumper (30) causing the jumper (30) to move such as to decrease the effective area available for fluid flow through said flow passage (28).

7. A device according to claim 6 wherein the jumper (30) is borne for limited axial movement in a carrier (31) which is itself operatively adjustable in position to move towards or away from said flow passage (28), thereby to adjust the limiting positions of the head portion (29) of the jumper (30) with respect to said flow passage (28).

Neu eingereicht / Newly filed
Nouvellement déposé

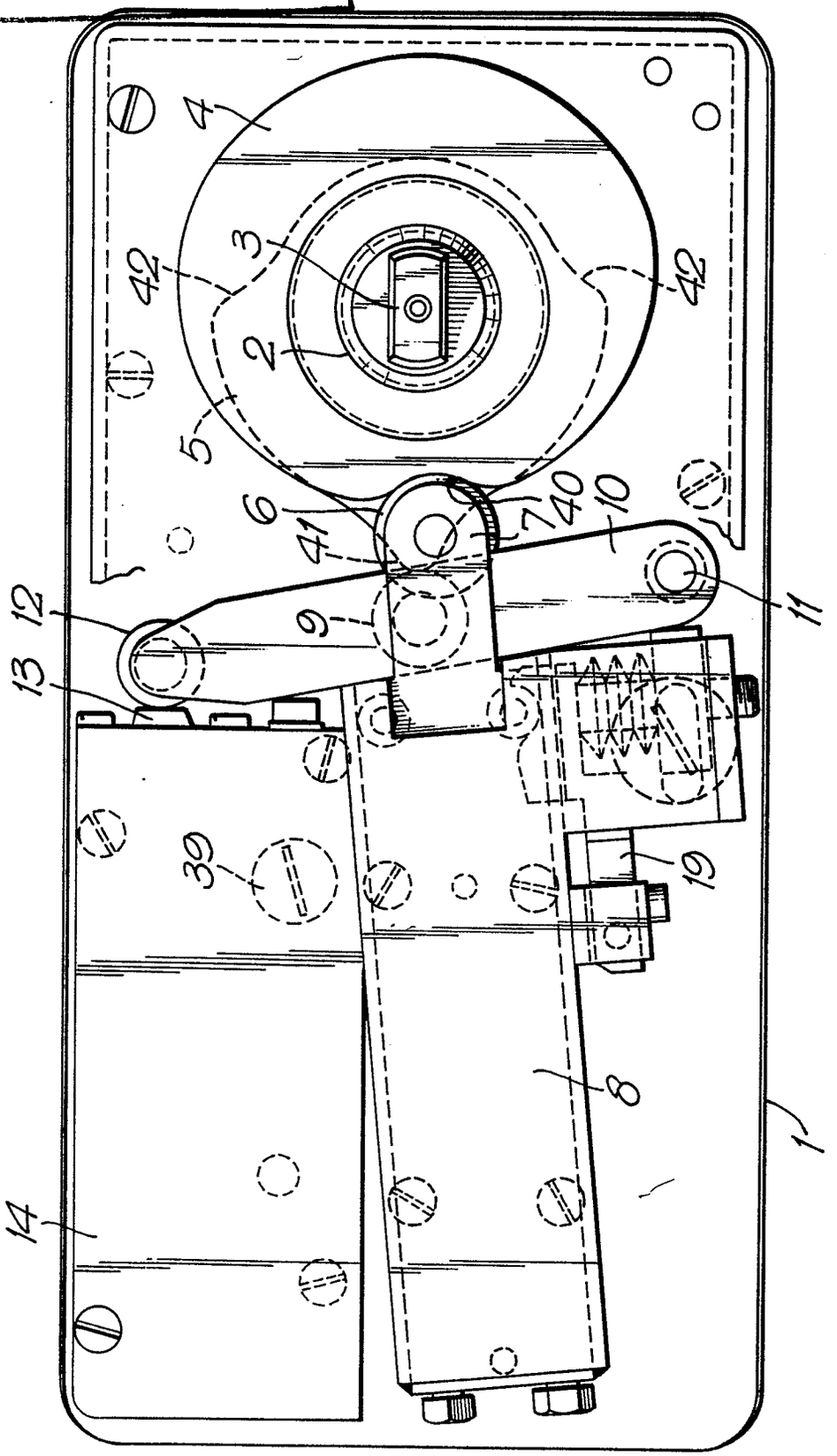


Fig. 1.

Fig.2.

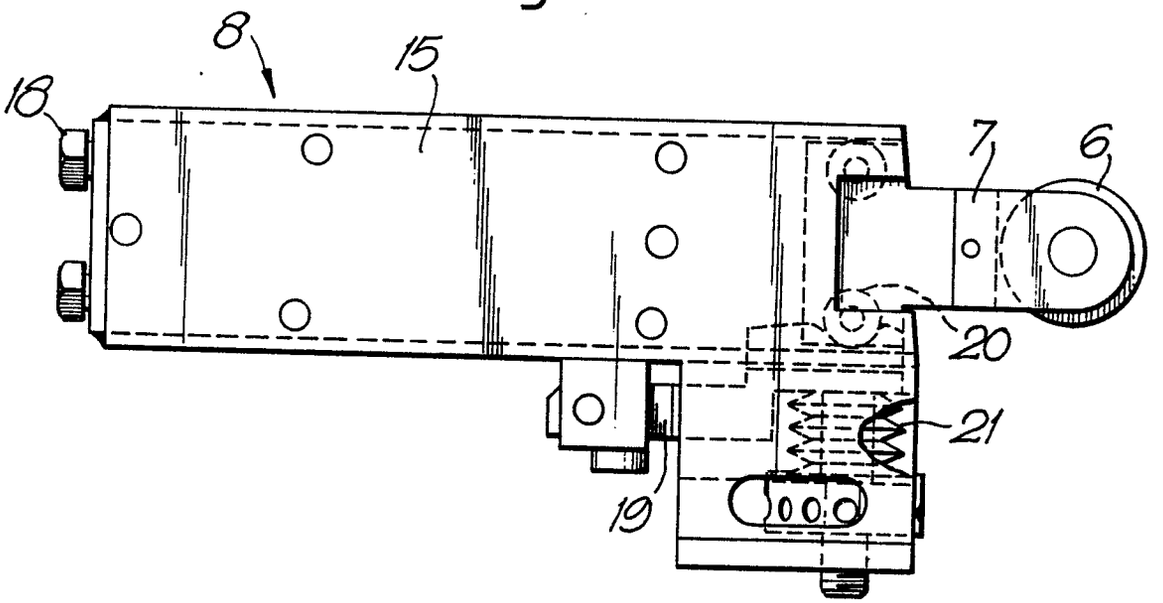
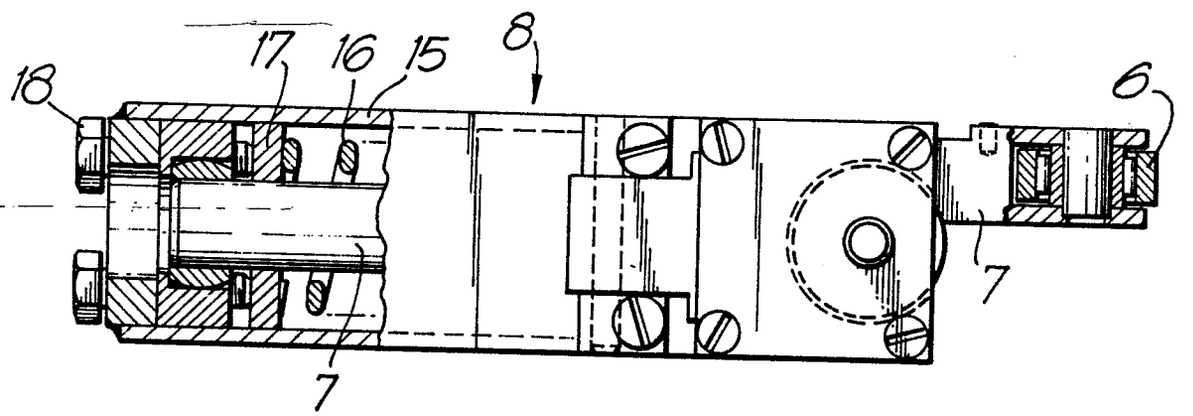


Fig.3.



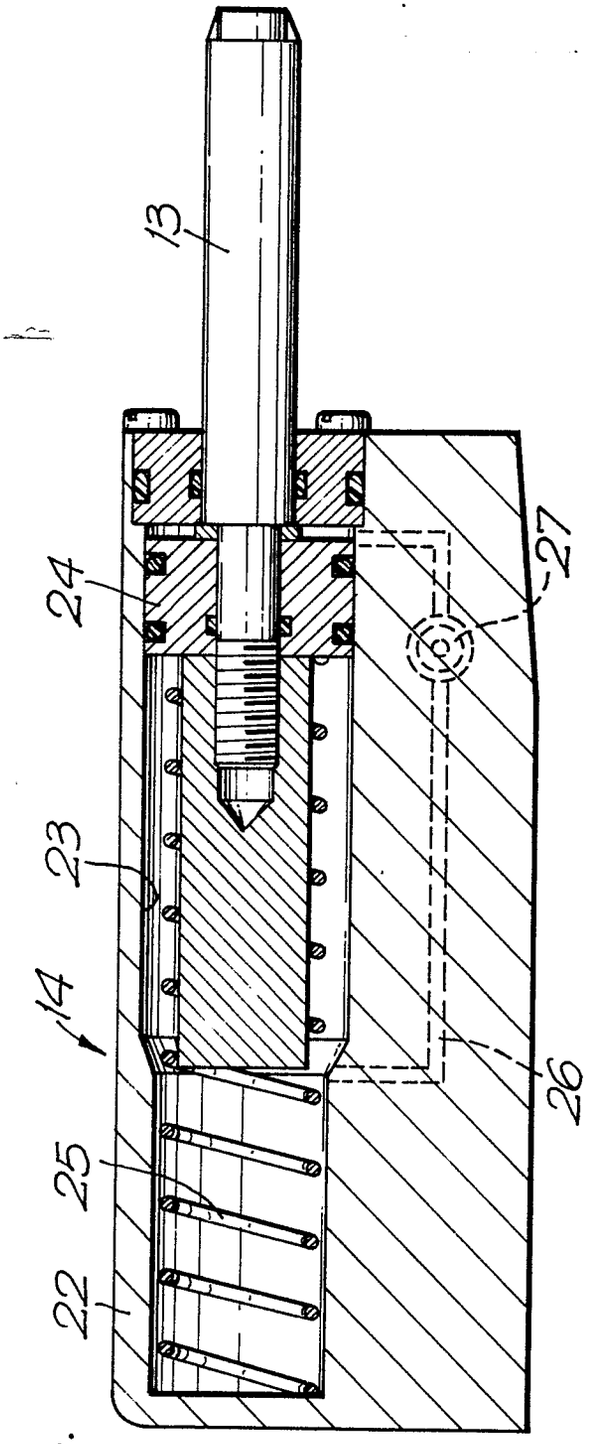

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14
26
25
22

Fig. 4.

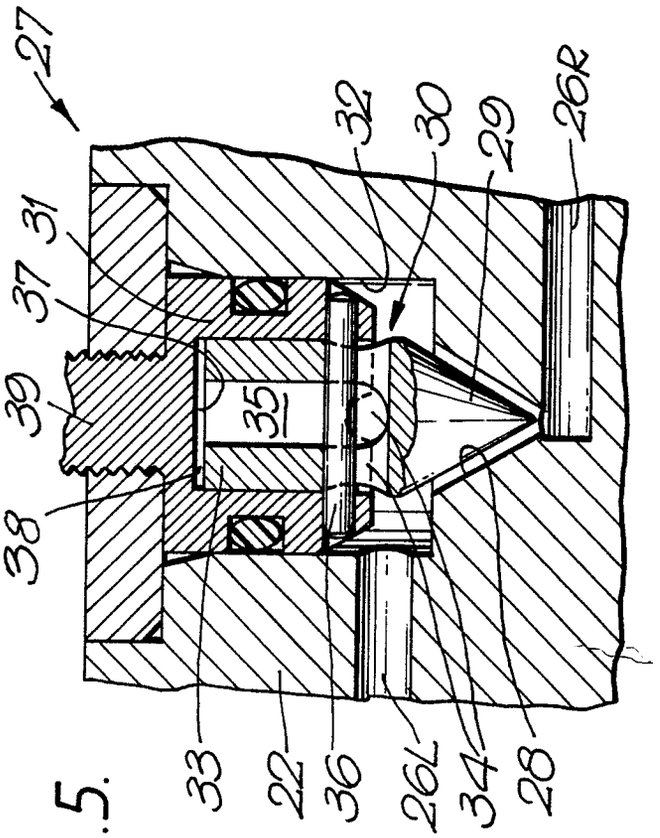

27
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26R
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26L
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Fig. 5.

Fig.6.

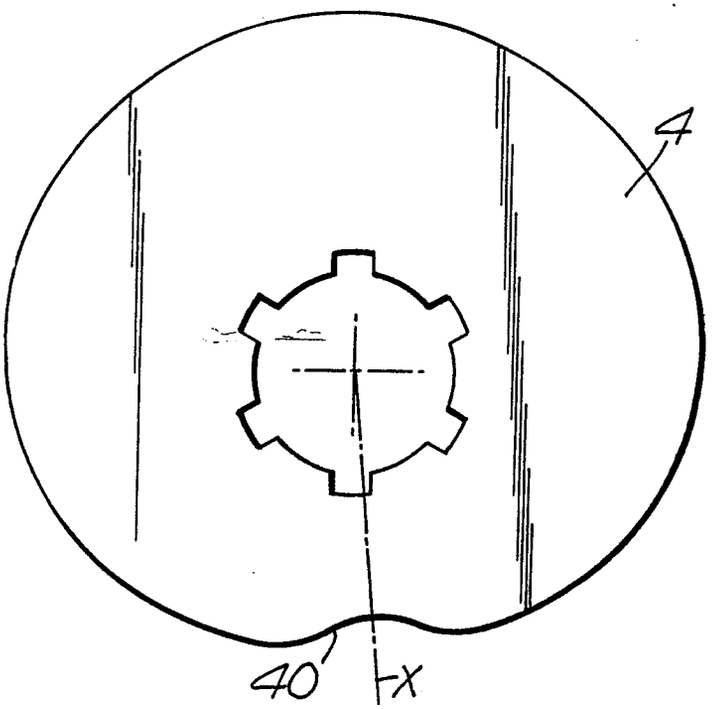


Fig.7.

