

Title: Door closer

Description

The invention relates to a door closer according to the generic part of patent claim 1.

Most of the time, spring-hydraulically operating door closers are utilized for the controlled closing of door systems. During the manual opening operation, the door closer shaft is rotated via an arm assembly, and furthermore an energy accumulating spring is pre-loaded via a drive device in the door closer.

For the closing operation, the energy accumulating spring relaxes and, via the drive device of the door closer and the arm assembly, pushes the door back into its zero position without any external energy.

So as not to have this operation happen abruptly and very fast, the entire spring force of the energy accumulator in the door closer is almost completely absorbed by a hydraulic damping device. During the closing operation, as a function of the piston surface, hydraulic pressure, corresponding to the spring force, builds up in the pressure medium compartment of the damping device, which pressure keeps the system of forces almost in equilibrium.

A controlled low fluid backflow from the pressure compartment into a reservoir space of the door closer is adjusted by means of a regulating valve. A slight imbalance of the ratio of forces is thereby created, whereby the door closes relatively slowly as a result of the spring forces.

With just one regulating valve for the entire door closing procedure from any door angle, it is possible to adjust also only one constant closing speed until the door has reached the closed position. So that the door does not impact too hard on the seat at the door frame, when reaching the closed position, the entire closing procedure needs to happen in a controlled manner.

Depending on the material of the door system, the structure and the sealing elements, the door will bounce back from the frame in the event of a too fast closing, and partially pop open again. Thus, a swinging movement might occur, until the door reaches the complete resting position.

However, a slowly regulated closing speed, intended to prevent the above effect, has the disadvantage of requiring an unnecessary long time for the entire closing operation from wider door opening angles. With highly frequented doors, this time frame is very important, because often the door leaves do not return any more completely into the

zero position. Moreover, at low outside temperatures, the long closing period has an adverse effect, because of higher losses of heating energy.

Especially with elevator systems, each second of additional closing time of the respective floor doors results in a longer waiting time for the users on each floor, because the elevator car can only leave once the entire door system is closed. Simply increasing the closing speed is not possible especially in this application case for the following technical reasons: As elevator doors are equipped with limit switches and automatic door latches for the closed position, a leaf, bouncing back on account of a too fast closing speed, would extremely interfere with the control sequences and result in malfunctioning of the entire system.

Only a second closing deceleration range can achieve the solution of this problem, wherein the speed of the door is strongly decelerated shortly before reaching the zero position, such that the door is able to ultimately close slowly. This second closing deceleration range can be adjusted with its own regulating valve. It is thereby possible to adjust the first deceleration range to be considerably faster, which clearly shortens the entire closing operation.

In known door closers, in which the entire hydraulic closing operation is subdivided into two or more ranges, the

various speed ranges are realized by means of differently disposed drainage bores in the working surface of the damping piston, respectively the brake piston. Depending on the piston position corresponding to a respective door angle, drainage channels in the pressure compartment are opened or closed via the piston edges. In the further course, the drainage channels are provided with differently adjusted regulating valves, which allow for adjusting various door speeds.

However, it is disadvantageous in such known door closers that this very simple control method is only suitable for relatively large fluid displacement volumes of the damping piston and thus only for larger door closers, respectively drive arrangements. On account of their low working displacement as well as their small piston surfaces, very small designed door closers, in particular with cam technology, do not have enough displacement volume. On account of tolerances, a more or less large gap width exists inevitably between the housing cylinder and the damping piston, whereby it is possible that leakage fluid drains in an uncontrolled manner.

If, during the closing operation of the door, one of the drainage channels in the pressure compartment is closed off, respectively, depending on the function, opened by the damping piston during the working stroke, a certain volume

of leakage fluid drains regardless in an uncontrolled manner via the gap between the piston and the cylinder wall. The hydraulic fluid always tries to find a way towards the lower pressure reservoir space of the door closer. This leakage fluid does not allow for determining exact angle degrees for the start and the end of a speed range or of a hydraulic function.

With larger door closers having higher fluid displacement volumes per door angle, this effect has only a relatively small influence, however with the smallest designed door closers having a very small fluid volume, some hydraulic functions are not feasible on account of the above explained problems.

Another disadvantage of this control method with drainage bores in the cylinder wall is that most of the time no sealing ring can be employed on the damping piston, because the sealing ring would be very quickly destroyed when traveling over the drainage bores. There are only very few sealing designs which allow for traveling over drainage bores. However, these special seals require larger assembly dimensions, which are not available in very small door closers.

Another known possibility to control door closing speeds, is the use of one or more control valves, which are disposed

in the screwed sealing plug of the cylinder compartment of the door closer. Depending on the door angle, and therefore corresponding to the displacement position of the damping piston, these control valves are opened by mechanical contact with the front face of the piston. In this case, a drainage channel is unblocked, which in turn controls the backflow of the hydraulic fluid into the reservoir space of the door closer by means of a downstream located adjustable regulating valve. The control valves are kept closed against the fluid pressure in the damping compartment by means of appropriately strong springs or an electro-magnetic unit. The control valve is opened only upon mechanical contact with the damping piston. The position of the damping piston and therefore the switching point are respectively allocated to a certain door opening angle. The control valve needs to come along as well for the remaining stroke of the damping piston, starting at the point of contact, to the zero position of the door, and correspondingly penetrate into the screwed sealing plug.

However, these door closing mechanisms have the disadvantage that the speed of the door can only be adjusted from a slow to a faster level. As a drainage bore is additionally opened by the control valve, more throttle opening occurs, which increases the closing speed. On account of the control valve penetrating into the screwed

sealing plug, the latter needs to be dimensioned relatively wide corresponding to the remaining stroke of the piston. This circumstance increases the construction length of the entire door closer.

Furthermore, door closers are provided with a hollow tube for controlling the drainage in a hydraulic hold-open function. In this case, the hollow tube housing is secured to one of the lateral screwed sealing plugs and, at a defined stop, penetrates into a rotating sealing ring of the piston. The hydraulic fluid flows through the hollow tube to a magnetic valve. When the magnetic valve is energized, no hydraulic fluid can flow back into the reservoir space of the door closer, which effects a hold-open function.

During the opening operation of the door, the hollow tube penetrates pressure-less into the rotating sealing ring of the piston. It is only once the opening operation is terminated, that the energy accumulating spring attempts to relax, whereby hydraulic pressure is building up. However, such door closers operate at a relatively low working pressure and with a relative high fluid volume.

In summarizing, it should be noted that the described control options of known door closers are not suitable for very small door closers with high working pressure, because the leakage losses are too high, respectively the

spring forces are too low for reliably keeping the control valves closed.

Therefore, it is the object of the present invention to provide a door closer of the species indicated in the generic part of claim 1, which, even with small dimensions and at high working pressures, allows for controlling the door closing movement from a fast initial closing to a controlled slow closing of the door.

The solution of this problem is achieved by the features of claim 1.

As, depending on the weight, door width and closing speed, a closing door has a relatively high mass inertia, shortly prior to reaching the closed position, an important speed reduction needs to be achieved, in order to decrease a lot of door energy. Thereby, the hydraulic pressure in the pressure compartment of the damping device rises and surges to a very high level.

On account of the small piston surfaces, small door closers already work basically at a very high pressure level in the damping cylinder. Furthermore, on account of the small working strokes, only very little displacement volumes are available.

It is therefore necessary to very precisely control the transition to the second deceleration range, without occurrence of uncontrolled leakage losses.

The inventive door closer fully complies with these functional requirements, because the backflow channel, provided for the first and faster deceleration range, can be closed with angular accuracy and absolutely tightly, whereby it is achieved that, for the slow closing movement of the door, the hydraulic fluid displaced by the damping piston can only flow back through the second drainage channel into the reservoir space. A sufficiently high damping pressure is thus generated, whereby it is ensured that the door is sufficiently delayed in order to prevent it from returning too fast to the zero position.

Advantageous further developments of the invention are the subject matter of the dependent claims.

In particular by disposing an extension, respectively a rod at the damping piston, it is possible to achieve a switching point, which depends on the door angle, respectively depends on the stroke position.

The sealing is realized completely free of leakages at a defined position by means of the extension cooperating with a sealing element. Therefore, the disposition is

likewise suitable for the smallest door closer systems having a low fluid displacement (fluid volume).

The immediate and complete sealing of the faster valve range results in avoiding any overtravel, respectively slippage.

The inventive door closer being completely free from leakage is a principal pre-condition for quicker pressure built-up in the damping cylinder with systems with very little fluid displacement. This is preferably achieved with the inventive door closer, such as to allow for strongly decelerating the door system close to the zero position.

In order to achieve a speed staggering from fast to slow, the regulating valves are preferably disposed such that both regulating valves are open in parallel before the switching point of the speed ranges, namely at the faster closing speed. From this switching point on, the hydraulic fluid can thus only drain from the pressure compartment of the damping cylinder via the slow regulated valve.

Further details, features and advantages of the invention will become apparent from the following description of a preferred embodiment example, reference being made to the drawing, in which:

Figure 1: shows a longitudinal section through an inventive door closer,

Figure 2: shows an enlarged illustration corresponding to Figure 1 of the area of the door closer, in which the damping device is disposed, wherein, for simplifying the illustration, the door closer housing is not shown,

Figure 3: shows an illustration corresponding to Figure 2 with the drainage channel being closed for the faster closing of the door, and

Figure 4: shows an illustration corresponding to Figure 3 of a second embodiment of the inventive door closer.

An inventive door closer 1, which is provided with a housing 6, is illustrated in Figure 1. A drive device 20 is disposed in the housing 6, which device can be coupled to a door, which is not-illustrated in detail in the Figures, via a door closer shaft 19 and an arm assembly 18. The drive device 20 is preferably configured as a cam drive, which has a cam disc 29, which is torque-proof disposed on the closer shaft 19, and has two rollers 30 and 31 which bear against the cam disc 29. In this case, the roller 30 is supported at a damping piston 24, whereas the roller 31 is disposed at a drive piston 32, which is in operative

connection with an energy accumulating spring 21 which is disposed in the housing 6.

Furthermore, the door closer 1 has a hydraulic damping device 23. This device includes the damping piston 24 which is guided in a damping cylinder 5, disposed in the housing 6. As described above, the damping piston 24 is in operative connection with the drive device 20.

Furthermore, the damping device 23 has a first fluid drainage channel 9 allocated to a fast closing movement of the door and a second fluid drainage channel 14 allocated to a slow closing movement of the door. According to the invention, seen in the direction of movement R of the damping piston 24, the first fluid drainage channel 9 is disposed behind the second fluid drainage channel 14.

In the embodiment of the door closer 1 illustrated in the Figures 1 and 2, the damping piston 24 is provided with a lance-shaped extension 2, which extends in the closing direction R of the damping piston 24. In the illustrated embodiment, the extension 2 is realized via a special safety valve unit 3, which is incorporated into the damping piston 24. However, the fundamental function and the fundamental configuration of the extension 2 can be achieved by means of a simple direct rod at the damping piston 24 or by the extension of the latter.

In the particularly preferred embodiment of the Figures 1 and 2, the extension 2 is provided with a centering chamfer 26.

A sealing element 7 with a sealing ring 8 is inserted into a hollow chamber 9' of a screwed sealing plug 4 of the damping cylinder 5, respectively of the door closer housing 6.

The sealing ring 8 may be configured in different ways and be made from different materials, and likewise have differently executed profiles. In the illustrated embodiment, an O-ring is provided as the sealing ring 8. By means of another smaller screwed sealing plug 16, the hollow chamber 9' is fluid-tightly closed off with regard to the outside surroundings of the door closer 1.

As can be seen in Figures 1 and 2, the drainage channel 9 for the hydraulic fluid is provided in the screwed sealing plug 4 in continuation of the sealing element 7, which channel leads into an annular channel 10. A bore 11 leads from the annular channel 10 to a regulating valve 12, which allows for a fast closing of the door by means of an appropriate adjustment.

Past the regulating valve 12, a backflow channel 13 in the door closer housing 6 leads back to a low pressure reservoir space 17 of the door closer 1.

Directly from the pressure compartment of the damping cylinder 5, the drainage channel 14 leads to another regulating valve 15, which allows for slowly closing the door by appropriately adjusting it.

Furthermore, as shown in Figures 1 to 3, in the exemplary case, the sealing element 7 is assembled from two bucket-shaped configured halves 41, 42, which can be linked to each other. In the exemplary case, the two halves 41 and 42 are screwed to each other and, in the condition, illustrated in the Figures 2 and 3, they delimit an internal reception compartment 43.

A compression spring 22, which bears against the sealing element 7 with one end pointing towards the housing end 25, is disposed in the internal reception compartment 43. At the other end, the compression spring 22 bears against a spring cap 33, which is disposed in the reception compartment 43 and can be brought into operative connection with the extension 2.

Another compression spring 27 is disposed about the sealing element 7, one end of this spring bearing against the screwed sealing plug 4, respectively against the smaller screwed sealing plug 16 disposed in the former. At the other end, the compression spring 27 bears against a locating shoulder 44 of the sealing element 7.

In the embodiment illustrated in the Figures 1 to 3, the compression spring 22 has a harder spring rate than the second compression spring 27.

Furthermore, a third compression spring 34 is disposed between the damping piston 24 and the screwed sealing plug 4.

The Figures 1 to 3 illustrate furthermore that, in continuation of the second regulating valve 15, the fluid drainage into the reservoir space 17 takes place via the backflow channel 13, disposed in the door closer housing 6.

In the following, the functional sequence of the above described door closer 1 will be explained.

When manually opening the door, a torque is introduced into the door closer shaft 19 via the arm assembly 18. With the assistance of the drive device 20, a reciprocating movement can be generated from the rotational movement, whereby the energy accumulating spring 21 is pre-loaded.

At the same time, the damping piston 24, together with the extension 2, travels in the direction of the door closer shaft 19, whereby hydraulic fluid can flow, via a bore and a non-return valve in the damping piston, from the reservoir

space 17 of the door closer 1 into the pressure compartment, respectively the damping cylinder 5.

After the door is released, the energy accumulating spring 21 attempts to relax and, via the drive device 20 of the door closer 1, introduces the torque, required for closing, into the door closer shaft 19. In order to prevent this operation from happening abruptly, via another redirection of the rotational movement of the door closer shaft 19 into a reciprocating movement of the damping piston 24, hydraulic counter-pressure is building up in the damping cylinder 5.

On account of a wider opening angle of the door, for example of 75° for achieving a more comfortable access situation, once the door is released, the damping piston 24 is disposed in a position close to the closer shaft 19. The extension 2, located at the damping piston 24, is thereby completely lifted off the sealing element 7.

During the closing operation, the damping piston 24 approaches again the screwed sealing plug 4 at the housing end 25. The position of the damping piston 24 corresponds to the point of contact of the extension 2 at the sealing element 7. The sealing element 7 is still open.

In this case, the hydraulic fluid, displaced by the damping piston 24 during the closing operation, is able to flow

through an inclined bore 28 in the screwed sealing plug 4 into the hollow chamber 9' of the screwed sealing plug 4.

Prior to the contact with the piston extension 2, the sealing element 7 is pushed, by the compression spring 27, out of the sealing seat of the smaller screwed sealing plug 16 and is thus kept in an opened position.

The fluid, displaced by the damping piston 24 out of the pressure compartment 5 during the closing operation, with the sealing seat being open, then flows in an unhindered manner from the hollow chamber 9' into the housing 6 via the other drainage bores 9, 10, and 11. Further on, the fluid flows to the faster adjusted regulating valve 12. Thereupon, further drainage of the fluid takes place via the backflow bore 13 into the reservoir space 17 of the door closer 1. Thereby, the door is able close relatively quickly.

Depending on the layout, for the start of the second closing speed, the length of the extension 2 located at the damping piston 24 is adapted to the desired switching point, respectively to the desired door angle.

When reaching this door angle, initially the extension 2 presses against the spring cap 33, which is disposed at the rear side of the sealing element 7. The spring cap 33 itself is pressed against a delimitation of the sealing element 7 by the compression spring 22 inside the sealing element 7,

which spring has a harder spring rate than the external spring 27.

During the further closing stroke of the damping piston 24, on account of the different spring rates, initially the external spring 27, disposed about the sealing element 7, is essentially compressed, whereby the entire sealing element 7 is pushed into the sealing seat 8' of the internal screwed sealing plug 16. The drainage channel 9 to the faster adjusted regulating valve 12 is thereby abruptly and leakage-free closed.

The hydraulic fluid is thus only able to drain to the slower adjusted regulating valve 15 via the second drainage channel 14, which is additionally provided in the damping piston 5. Thereby, a very high pressure increase immediately builds up, whereby the door is considerably decelerated and slowly travels into the zero position.

On account of the pressure increase, the sealing element 7 is additionally pressed into the sealing seat 8'. The sealing seat 8' represents a rigid position delimitation for the sealing element 7.

This is why the remaining stroke of the damping piston 24, from the switching angle up to the zero position of the door, is compensated by the compression spring 22 which is

incorporated into the sealing element 7. In this case, the sealing seat 8' remains continuously closed.

On account of the higher rate of the compression spring 22, a distinct compression of the spring happens only after having reached the sealing position. A sequence control is thereby achieved, which at first results in closing the sealing seat 8' by the sealing element 7, and only thereupon allows for compensating the length of the remaining piston stroke. Consequently, the length compensation is completely incorporated into the sealing element 7, thus allowing for a very compact construction type.

In the following, a second embodiment will be explained based on Figure 4. All elements consistent with the ones in the Figures 1 to 3 are identified by the same reference numerals. Accordingly, it is possible to refer to the above discussion.

In the embodiment illustrated in Figure 4, the extension 2 is configured as a guiding bushing 35, which is connected to the damping piston 24. In the illustrated embodiment, the guiding bushing 35 is screwed to the damping piston 24.

In this embodiment, the sealing element 7 is disposed in an internal compartment 45 of the guiding bushing 35. In this case, the sealing element 7 is pre-loaded by means of a

compression spring 36 to bear against an abutment 40 of the guiding bushing 35, which abutment is disposed neighboring the housing end 25.

The sealing element 7 has a frontal flat sealing surface 46, which can abut against a sealing surface 8' at the housing-side. In the illustrated embodiment, the sealing surface 8' is disposed at the smaller screwed sealing plug 16, which is screwed into the larger screwed sealing plug 4.

Furthermore, the illustration of Figure 4 explains the disposition of three sealing rings 37, 38, and 39 between the larger screwed sealing plug 4 and the housing 6, respectively between the screwed sealing plug 16 and the screwed sealing plug 4.

As, in this embodiment, the sealing element 7 is disposed in the screwed sealing plug 16, the sealing element 7 including the length compensation may be disposed in this case in the damping piston 24, respectively in the guiding bushing 35 thereof.

Thereby the sealing element 7 is pressed against the abutment 40 of the guiding bushing 35 by means of the compression spring 36, which is additionally disposed in the guiding bushing 35, and travels along during the entire working stroke of the damping piston 24.

In this case, the incorporated compression spring 36 serves as the length compensation for the remaining stroke of the damping piston 24, which still occurs from the switching point of the deceleration ranges on up to the zero position of the door. In addition, the compression spring 36 guarantees that the sealing seat 8' is consistently pressed shut until the door reaches the zero position.

All embodiments explained above have in common that at a defined switching point for the deceleration ranges, the sealing element 7 always travels into a sealing seat 8' located in the screwed sealing plug 4 or 16, and closes a following drainage bore, respectively a drainage channel towards the faster adjusted regulating valve 12.

In this case, the sealing seat 8' may be disposed directly in the main screwed sealing plug 4 or in the other smaller screwed sealing plug 16, disposed in the former.

When utilizing the further internal, respectively smaller screwed sealing plug 16, the sealing seat position and therefore the switching point of the deceleration ranges can become adjustable.

After having closed the sealing seat 8', a considerable pressure increase happens, which additionally pushes the sealing element 7 into the sealing seat 8' and ensures a leakage-free condition. For the further closing operation,

the hydraulic fluid needs to flow back into the reservoir space 17 through the slower adjusted regulating valve 15, which makes the closing of the door slow.

List of reference numerals

1	door closer
2	extension (rod)
3	safety valve unit
4	screwed sealing plug
5	damping cylinder
6	door closer housing
7	sealing element
8	sealing ring (O-ring)
8'	sealing seat
9	drainage channel for fast opening
9'	hollow chamber
10	annular channel
11	bore
12	regulating valve for fast opening
13	drainage channel
14	drainage channel for slow opening
15	regulating valve for slow opening
16	second smaller screwed sealing plug
17	reservoir space
18	arm assembly
19	door closer shaft

20	drive device
21	energy-accumulating spring
22	hard spring
23	damping device
24	damping piston
25	housing end
26	chamfer
27	compression spring
28	inclined bore
29	cam disc
30	rollers
31	rollers
32	drive piston
33	spring cap
34	third compression spring between the screwed sealing plug 4 and the damping piston 24
35	guiding bushing
36	compression spring
37	sealing ring
38	sealing ring
39	sealing ring
40	abutment

- 41 halves
- 42 halves
- 43 reception compartment
- 44 locating shoulder
- 45 internal compartment
- 46 sealing surface

- R direction of movement

Patent claims

1. A door closer (1)
 - with a door closer housing (6);
 - with a drive device (20), which is disposed in the door closer housing (6) and can be coupled to a door via a door closer shaft (19) and an arm assembly (18); and
 - with a hydraulic damping device (23), which has a damping piston (24) guided in a damping cylinder (5) of the door closer housing (6) and being in operative connection with the drive device (20), which piston cooperates with a first fluid drainage channel (9) allocated to a fast closing movement of the door, and with a second fluid drainage channel (14) allocated to a slow closing movement of the door,
 - wherein the first and the second drainage channels (9, or 14), seen in the direction of movement (R) of the damping piston (24) are disposed one behind the other, **characterized in that**

- seen in the direction of movement (R) of the damping piston (24) towards the housing end (25), the first fluid drainage channel (9) is disposed behind the second fluid drainage channel (14).

2. A door closer according to claim 1, **characterized in that** the first drainage channel (9) is provided with a first regulating valve (12) for a fast opening of the door.
3. A door closer according to claim 1 or 2, **characterized in that** the second drainage channel (14) is provided with a second regulating valve (15) for a slow opening of the door.
4. A door closer according to any of the claims 1 to 3, **characterized in that** the first drainage channel (9) and the second drainage channel (14) are connected to a backflow channel (13), which is in communication with a reservoir space (17).
5. A door closer according to any of the claims 1 to 4, **characterized in that** the damping piston (24) is provided with an extension (2), which points towards the neighboring housing end (25).

6. A door closer according to claim 5, **characterized in that** the extension (2) cooperates with a sealing element (7), which is disposed in a hollow chamber (9') of a screwed sealing plug (4), which is inserted into the housing end (25) neighboring the damping piston (24).
7. A door closer according to claim 6, **characterized in that** the sealing element (7) has a frontal sealing area, which can abut against a sealing seat (8') which points towards it.
8. A door closer according to claim 7, **characterized in that** the sealing area is configured as a sealing ring (8), preferably in the shape of an O-ring.
9. A door closer according to any of the claims 6 to 8, **characterized in that** the sealing element (7) has two bucket-shaped configured halves (41, 42), which are connectable to each other, preferably screwable, and which delimit an internal reception compartment (43) in their connected condition.
10. A door closer according to claim 9, **characterized in that** a compression spring (22) is disposed in the reception compartment (43), which spring, at an end pointing towards the housing end (25),

bears against the sealing element (7), and, at the other end, bears against a spring cap (33) disposed in the reception compartment (43), which cap can be brought into an operative connection with the extension (2).

11. A door closer according to any of the claims 6 to 10, **characterized in that** another compression spring (27) is disposed about the sealing element (7), which spring, at one end, bears against the screwed sealing plug (4, or 16) and, at the other end, bears against a locating shoulder (44) of the sealing element (7).
12. A door closer according to claim 11, **characterized in that** the compression spring (22) in the reception compartment (43) has a harder spring rate than the compression spring (27).
13. A door closer according to any of the claims 1 to 12, **characterized in that** a third compression spring (34) is disposed between the damping piston (24) and the screwed sealing plug (4).
14. A door closer according to claim 5, **characterized in that** the extension (2) is configured as a

guiding bushing (35), which is connectable, preferably screwable to the damping piston (24).

15. A door closer according to claim 14, **characterized in that** the sealing element (7) is disposed in the internal compartment (43) of the guiding bushing (35).
16. A door closer according to claim 15, **characterized in that** the sealing element (7) is pre-loaded by means of a compression spring (36) to bear against an abutment (40) of the guiding bushing (35), which abutment is disposed neighboring the housing end (25).
17. A door closer according to any of the claims 16 or 17, **characterized in that** the sealing element (7) has a frontal planar sealing surface (46), which can bear against a sealing surface (8') disposed at a housing side, preferably at the screwed sealing plug (4, or 16).