

Title: Door operator, in particular swing door operator

Description

The invention relates to a door operator, in particular a
5 swing door operator according to the generic part of patent
claim 1.

Such a door operator is known from DE 295 21 068 U1. An
overhead door closer with a slide rail linkage is known from
DE 40 38 720 C2, which has a cam drive unit allowing for
10 an optimum door moment curve and a comfortable
operation. In principle this overhead door closer would thus
be suitable as door operator as well; however, experiments
conducted during the course of the invention have shown
that applying oil pressure to the drive unit results in a very
15 unfavourable transformation of the hydraulic pressure into
the resulting movements of stroke/rotation and repeated
stroke. Since about 75% of the output capacity to be
applied is required for tensioning the spring force
accumulator of such a door closer, whereas only about
20 25% of the output capacity needs to be delivered by the
system for accelerating the door. As it is furthermore
desirable to keep the narrow structure of such a door
closer for door operators as well, the dimensions of the
structural components can hardly be adapted to the
25 extremely high loads. Thus, although functionally and

technically advantageous, the known overhead door closer is not suitable as a door operator.

Another swing door operator is known from DE 197 56 496 C2. This swing door operator has an electromechanical drive unit, which is provided with a drive motor and a gear and with a subsequent power transmission unit for the connected door. The power transmission unit has a spindle with a spindle nut partially overlapping the former, which spindle is non-positively and positively connected to a toothed rack. Although this swing door operator can be installed concealed, the door moment curve is not as optimal as with the above described door closers having the cam technology. Moreover on account of the larger construction width, installation in standard profiles is not possible.

Therefore, it is the object of the present invention to provide a door operator of the species indicated in the generic part of patent claim 1, which can be installed completely concealed within the door profile or frame profile, and also be mounted on the door and does not require any special constructions of the door system.

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

On account of its compact structure, the inventive door operator allows for a concealed installation within a door

profile or a frame profile and thus allows for a total integration with the door system.

Particularly, the installation in common narrow door profiles is possible.

5 As an advantage, neither special door profiles nor any special constructions, which would interfere with the design of the door system, are necessary. Another advantage results from an economical mounting combined with a wide applicability and, moreover, it is possible to retrofit existing
10 door systems with the inventive door operator. Another advantage results from the fact that, in the inventive door operator, a direct introduction of power for tensioning a spring force accumulator is possible. Therefore, the possibility is given of avoiding unnecessarily stressing the
15 mechanical structural components and of lowering the required operating pressure, because larger effective piston areas are provided. This construction results furthermore in the advantage of having a larger stroke volume, thus improving the operational range for common
20 hydraulic pumps.

As the hydraulic pump of the inventive door operator is in hydraulic connection with a separate pressure compartment, which is associated directly to the spring force accumulator, a direct pressure application and thus a
25 direct introduction of power into the spring force

accumulator is the result, whereby the pre-tensioning of the spring force accumulator is completely or at least partially achieved. By this measure, the disadvantages explained at the beginning are completely eliminated.

- 5 As the output capacity, to be delivered for opening a door, in particular a swing door, with a door operator which is provided with the spring force accumulator for the closing operation and for fire-rated suitability, is divided into two magnitudes of force or torque, it is advantageous with the
10 inventive door operator that, by assigning separate pressure compartments to the drive unit and to the spring force accumulator, a lower oil pressure can be applied to the drive unit, because the torque, required for opening and accelerating the door, is lower at the output shaft of the
15 drive unit than the one for pre-tensioning the spring force accumulator. Experiments conducted during the course of the invention have shown that, depending on the size of the door and the weight of the door, as a rough approximation about 2/3 to 3/4 of the total drive power is
20 required for pre-tensioning the spring force accumulator, whereas only about 1/4 to 1/3 of the total power is required as drive moment for opening the door.

- As, in the inventive door operator, dividing this total output capacity is made possible by providing separate pressure
25 compartments, a direct pressurizing of the spring force accumulator is achieved, and it is thus possible to directly

utilize the major part of the total output capacity, without redirection, for pre-tensioning the spring force accumulator. Therefore, unnecessary stress on structural components, load on bearings, and any loss on account of friction or loss
5 of efficiency are avoided. On account of the separate pressure compartment associated to the spring force accumulator, the effective piston areas for tensioning the spring force accumulator are further increased, and the required system pressure is thus considerably lowered and
10 the stroke volume increased. As a consequence, the control response (during the closing operation) is improved and the overall hydraulic system becomes less sensitive.

Furthermore, on account of the higher volume flow/lower pressure ratio, a small sized hydraulic pump can be used,
15 enabling the pump characteristics to be considerably flatter, making the pump simpler from the technical point of view, and less expensive. Furthermore, it is preferably possible to use pressure control valves or pressure limiting valves in the feeding lines or to use different hydraulic
20 pumps for the respective pressure compartments such that, if required, a division and adaptation of the piston forces of the damping, spring tensioning, and/or opening pistons, is possible.

It can thus be achieved that the torque, required at the
25 output shaft for opening the doors, can be generated by means of a damping piston and a cam arrangement,

whereas the spring tensioning work is generated independently therefrom in the additional separate pressure compartment.

Furthermore, according to the invention, the door operator
5 has associated a motor, preferably in the shape of a direct current or an alternating current motor, and an assembly of pumps, which delivers the necessary oil volume in addition to the required pressure in the one or more operating chambers of the door operator. As already explained
10 above, the spring force accumulator is thus tensioned and, via the drive mechanism, a torque is generated for accelerating the door.

In this case, according to the invention, the hydraulic pump pushes the hydraulic oil leak-free by means of a
15 proportional piston from one compression chamber into the operating chamber or chambers (pressure compartments) of the door operator. The stroke volumes of the compression chamber of the pumps and of the operating chamber or chambers of the door operator are suitably
20 coordinated in this case.

The volume in the operating chamber or chambers, corresponding to the door opening angle, is practically moved out of the compression chamber of the pumps only. Therefore, hold-open and arresting functions are easy to
25 realize. Also the opening speed is very well controllable.

Furthermore, according to the invention, a fire-protection/releasing device is provided such that the inventive door operator can be utilized also for fire-rated doors. The fire-protection/releasing device is provided in order to compensate for the self-locking of the spindle of the hydraulic pump, because otherwise, in the event of power failure, the door would not be able to close on account of the lack of oil flow.

The releasing device is disposed between the operating hydraulic circuit of the door operator and an unpressurized reservoir chamber of the housing of the door operator.

Preferably, the releasing device is formed in the shape of a solenoid valve, which operates according to the closed-circuit principle and is only closed when its electromagnet is energized. If no voltage is applied, a return spring pushes the solenoid valve in an open position.

Interrupting the supply voltage is performed for example by smoke detectors, fire alarm systems, manual push-buttons or only by power failure.

The oil volume in the operating chambers or pressure compartments of the door closer can thus flow into the reservoir chamber and, through the action of the spring force accumulator on the door closer mechanism, in each case the door can be closed automatically.

The pump spindle including the associated proportional piston, which remain in the open position in such a case, will be returned to their initial position by the control of the inventive door operator, once the regular operating
5 conditions are re-established.

Prior to an opening operation, the solenoid valve will be closed by the control of the drive in order to build up pressure in the operating hydraulic circuit of the door operator.

10 This results in the additional advantage that the inventive door operator is suitable for fire-rated doors as well.

Thus, the inventive door operator is characterized by the following advantages. An inexpensive pump can be utilized, because the pump set-up is simple. The pump
15 allows for a leak-free embodiment and has a low-noise operation. Furthermore, a completely variable, controllable opening course and closing course are made possible. The inventive door operator is suitable for the smallest stroke volumes and high pressures and it is optimal for arresting
20 functions and hold-open constructions.

The dependent claims feature advantageous further developments of the invention.

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.

The only Figure of the drawing 1 shows an inventive door operator 1, which in particular may be executed as a swing door operator. The door operator 1 has a drive unit 2, which, via an output shaft 9, can be coupled to a door, not illustrated in the Figure, for example via a lever and a slide channel with a sliding member. The drive unit 2 is disposed in a housing 13.

Furthermore, the door operator 1 has a motor 3 as well as, disposed in the housing 13, a spring force accumulator 4, which is coupled to the motor 3 and to the drive unit 2.

As depicted in the Figure, the motor 3 is in driving connection with a hydraulic pump 5. In the illustrated embodiment, the motor 3 and the pump 5 are flange-mounted to the housing 13. However, the motor 3 and the pump 5 may be disposed separately or they may be integral with the housing. The motor 3, via the hydraulic pump 5 and a first hydraulic line 22, is in hydraulic connection with a pressure compartment 7, which is associated to the spring force accumulator 4. Via a second hydraulic line 23, the motor 3 and the pump 5 are in hydraulic connection with a pressure compartment 6, which is associated to the drive unit 2. This disposition allows to divide the required pressures or forces for opening the door

and for tensioning the spring force accumulator 4, which in the exemplary case has a compression spring 12, resulting in the advantages explained at the beginning.

In the embodiment illustrated in Figure 1, the drive unit 2 is
5 formed as a cam drive. This cam drive has a cam disc 8, which is disposed on the output shaft 9. The cam disc 8 cooperates with two force transmission rollers 10 and 11, which are disposed on both sides of the output shaft 9 and bear on cam paths of the cam disc 8. This structure
10 corresponds in principle to the structure of the overhead door closer of DE 40 38 720 C2, the content thereof being incorporated herein as disclosure content of the present application.

The force transmission roller 11 is disposed at a damping
15 piston 19, which is supported in the housing 13 adjacent the pressure compartment 6.

The force transmission roller 10 is disposed at an opening
piston 18, which is likewise supported in the housing 13 and adjoins a compartment 20, which is separated from the
20 separate pressure compartment 7 via a separating wall 21.

As revealed in Figure 1, a spring tensioning piston 17, which directly introduces the force for tensioning the compression spring 12 into the latter, is disposed in the pressure compartment 7. The spring tensioning piston 17 is
25 connected to the opening piston 18 via a piston rod 24,

which is passes in a sealed manner through the separating wall 21.

Furthermore, Figure 1 shows that one end 14 of the spring 12 bears against a housing wall 15 of the pump 5, whereas
5 its other end 16 bears against the spring tensioning piston 17.

As revealed in Figure 1, this division into pressure compartments first of all results in the option, preferably through suitable hydraulic control means (solenoid valves,
10 throttles, or the like), to realize a division of the required pressures for tensioning the compression spring 12 and for opening the door, and to exploit at the same time the advantages of the cam technology. A further result is the extremely compact design, as explained at the beginning,
15 which allows for a completely concealed installation in door profiles or frame profiles.

As Figure 1 shows furthermore, the pump 5 has a proportional piston 27, which is moved translationally by means of a spindle 26. The spindle 26 may be provided
20 with thread pitches or executed as a recirculating ball screw. The motor 3, with or without upstream gear, drives the spindle 26 itself. Preferably, a gear is utilized, because of the relatively high torque and for reasons of positioning accuracy. Preferably a spindle 26 with self-locking is used
25 for reasons of strength. The proportional piston 27 can be

exactly actuated by means of a monitoring device for the angle of rotation.

For the closing procedure, the motor 3 rotates the spindle 26 back, whereby the proportional piston 27 is moved back
5 as well, which action will enlarge a compression chamber 25, which is disposed adjacent the proportional piston 27. The hydraulic oil from the pressure compartments or operating chambers 6 and 7 of the door operator 1 is pushed back into the pump 5 by means of the pressure
10 building spring force accumulator 4.

Figure 1 reveals furthermore, that the inventive door operator 1 is provided with a fire-protection/releasing device 28, which in the exemplary case is formed as a solenoid valve. In the exemplary case, the releasing device
15 28 is disposed in the second hydraulic line 23 between the pressure compartment 6 and a reservoir chamber 29, which is unpressurized and in which the drive unit 2 is disposed in the illustrated embodiment. However, any other unpressurized reservoir chamber of the housing 13 of the
20 door operator 1 is suitable.

List of References

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|----|----|---|
| | 1 | door operator |
| | 2 | drive unit |
| | 3 | motor |
| 5 | 4 | spring force accumulator |
| | 5 | hydraulic pump |
| | 6 | pressure compartment (drive unit) |
| | 7 | pressure compartment (spring force accumulator) |
| | 8 | cam disc |
| 10 | 9 | output shaft |
| | 10 | force transmission rollers |
| | 11 | force transmission rollers |
| | 12 | compression spring |
| | 13 | housing |
| 15 | 14 | end |
| | 15 | housing wall |
| | 16 | end |
| | 17 | spring tensioning piston |
| | 18 | opening piston |
| 20 | 19 | damping piston |
| | 20 | compartment |
| | 21 | separating wall |
| | 22 | first hydraulic line |
| | 23 | second hydraulic line |
| 25 | 24 | piston rod |
| | 25 | compression chamber |
| | 26 | spindle |
| | 27 | proportional piston |
| | 28 | releasing device |
| 30 | 29 | reservoir chamber |

Patent claims

1. A door operator (1), in particular a swing door operator,

5 - with a drive unit (2), which can be coupled to a door via an output shaft (9) and is disposed in a housing (13);

- with a motor (3) being in driving connection with the drive unit (2), and

10 - with a spring force accumulator (4), which is disposed in the housing (13) and is coupled to the motor (3) and the drive unit (2);

characterized in that

15 - a hydraulic pump (5) in the shape of a proportional piston pump is provided, which is in driving connection with the motor (3) and is in hydraulic connection with a first pressure compartment (6), associated to the drive unit (2), and with a separate at least second pressure compartment (7), associated to the spring force accumulator (4), as well as

20 characterized

- by a fire-protection/releasing device (28), which is disposed between an operating

hydraulic circuit (25, 22, 7, 23, 6) and an unpressurized reservoir chamber (29).

2. A door operator according to claim 1, characterized in that the drive unit (2) is formed as a cam drive, which has a cam disc (8) disposed on the output shaft (9) and two force transmission rollers (10, 11), which are disposed on both sides of the output shaft (9) and bear on cam paths of the cam disc (8).
3. A door operator according to claim 1 or 2, characterized in that the spring force accumulator (4) has a compression spring (12), which with one end (14) bears against a housing wall (15) and with the other end (16) against a spring tensioning piston (17).
4. A door operator according to any of the preceding claims 1 to 3, characterized in that the pressure compartment (7) associated to the spring force accumulator (4) is disposed adjacent the spring tensioning piston (17).
5. A door operator according to any of the preceding claims 1 to 4, characterized in that the spring tensioning piston (17) is connected via a connecting part (24) to an opening piston (18) of the drive unit (2), the opening piston (18) carrying

one force transmission roller (10) of the force transmission rollers (10, 11).

- 5 6. A door operator according to any of the preceding claims 1 to 5, characterized in that the pressure compartment (6) associated to the drive unit (2) is disposed adjacent a damping piston (19), which carries the other force transmission roller (11) of the force transmission rollers (10, 11).
- 10 7. A door operator according to any of the preceding claims 1 to 6, characterized in that the pressure compartment (7) is separated from a compartment (20) of the housing (13), accommodating the drive unit (2), by means of a fluid-tight separating wall (21).
- 15 8. A door operator according to any of the preceding claims 1 to 7, characterized in that the motor (3) is formed as an alternating current or direct current micro-motor.
- 20 9. A door operator according to any of the claims 1 to 8, characterized in that the hydraulic pump (5) has a translationally movable proportional piston (27), which cooperates with a spindle (26) which is rotatably driven by the motor (3).

10. A door operator according to any of the claims 1 to 9, characterized in that the proportional piston (27) is disposed adjacent a compression chamber (25), which is in hydraulic connection through a first hydraulic line (22) and a second hydraulic line (23) with the pressure compartment (7) associated to the spring force accumulator (4), and with the pressure compartment (6) associated to the drive unit (2).
- 10 11. A door operator according to any of the claims 1 to 10, characterized in that the releasing device (28) is formed as a solenoid valve.
12. A door operator according to any of the claims 1 to 11, characterized in that a hydraulic damping device is provided, which is disposed between a compartment (20) for the drive unit (2) and an intermediate compartment of the housing (13) adjacent the second pressure compartment (7).
- 15 13. A door operator according to any of the preceding claims, characterized in that several pressure compartments corresponding to the pressure compartments (7) including the associated separating wall (21) can be connected in series.
- 20