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(73) Patenthaver: **dormakaba Deutschland GmbH, Dorma Platz 1, 58256 Ennepetal, Tyskland**

(72) Opfinder: **SALUTZKI, Thomas, Zu den Tannen 9, 58456 Witten, Tyskland**
**SEMELKA, Wolfgang, Vormholzer Ring 91, 58456 Witten, Tyskland**
**BÖSE, Felix, Friedensstraße 3, 58256 Ennepetal, Tyskland**

(74) Fuldmægtig i Danmark: **Inspicos P/S, Kogle Alle 2, 2970 Hørsholm, Danmark**

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# SERVO DOOR CLOSER

The present invention relates to a servo door closer to assist an opening or closure operation of a door.

Door closers are known from the prior art, comprising an output shaft drivable by a drive mechanism. The output shaft is for example connected to a door leaf via a scissor type linkage or a sliding rail arrangement. Moreover, a closer spring acts on the drive mechanism. The output shaft is set into rotation by manually opening the door leaf. The closer spring is tensioned via the drive mechanism and therefore stores the energy for the closure operation. The closure operation of the door leaf takes place without manual actuation by the user. In this case, the energy of the closer spring acts via the drive mechanism on the output shaft and, as a result, on the door leaf. In particular in the case of very heavy and large door leaves, assistance is needed to tension the closer spring during the opening operation and/or to dampen the door in the end position. In order that the door leaf securely engages in the lock latch, a sufficient closure torque is required in the region of the zero position of the door. A servo door closer according to the preamble of claim 1 is known from US 2006/244271 A1.

The object of the present invention is to indicate a servo door closer which enables a secure and user-friendly assistance of the opening and/or closure operation of the door and is cost-effective to manufacture, install and maintain.

The object is achieved by the features of claim 1. The dependent claims have advantageous configurations of the invention as their subject matter.

Therefore, the invention is achieved by a servo door closer, comprising an output shaft. The output shaft is formed to transfer force to a linkage or directly transfer force to a door leaf. A scissor type linkage or a sliding rail arrangement for example serve as the linkage. If the servo door closer is fastened directly to the door leaf, then the force is transferred via the output shaft and the linkage to a fixed point, for example a wall or a casing. If the servo door closer is fastened to the wall or casing, then the force is transferred via the output shaft and the linkage to the door leaf. Alternatively, the servo door closer, for example as a bottom door closer, can transfer the force directly from the output shaft to the pivot axis of the door leaf. Moreover, the servo door closer according to the invention comprises a drive mechanism operatively connected to the output shaft and a mechanical energy accumulator acting on the drive mechanism for storing

closing energy for the door leaf. This mechanical energy accumulator is charged or tensioned during the manual opening operation of the door leaf and is discharged to close the door leaf. Moreover, the servo door closer comprises a motor/generator unit operatively connected to the output shaft and an electrical energy accumulator electrically connected to the motor/generator unit for storing assisting energy for the door leaf. Simultaneously to the opening and the closure operation of the door leaf, the output shaft always rotates and, as a result, also the anchor shaft of the motor/generator unit operatively connected to the output shaft. The motor/generator unit now serves, depending on how it is actuated, to charge the electrical energy accumulator or for assisted driving of the output shaft. In particular, the motor/generator unit is mechanically operatively connected or coupled to the output shaft in a bidirectional manner. This means that when the output shaft rotates, i.e. during the opening and closure operation of the door, the anchor shaft of the motor/generator unit also always rotates.

According to the invention, it is provided that the motor/generator unit is used to reduce the opening torque at the beginning of the opening operation of the door leaf. Depending on the configuration of the drive mechanism and the linkage used, the required opening torque can be very high at low door angles. Particularly in this range, assistance with the opening operation by means of the motor/generator unit is recommended. To this end, it is provided according to the invention that the motor/generator unit is formed to assist a manual opening of the door leaf only in the angle range of 0° to 45°, in particular only from 0° to 30°, in particular only from 0° to 25°. It is knowingly provided that only a partial range of the opening operation is assisted such that the motor/generator unit and the electrical energy accumulator do not have to be dimensioned too large and sufficient electrical energy is always available.

During the closure operation, it is desirable for the mechanical closing to be assisted at low angle ranges such that the door engages securely in the latch. To this end, it is provided according to the invention that the motor/generator unit is formed to assist a closure of the door leaf only in the angle range of 0° to 45°, in particular only from 0° to 30°, in particular only from 0° to 25°.

It is particularly preferably provided that the mechanical energy accumulator comprises a closer spring. This closer spring is in particular a coil spring. The drive mechanism preferably comprises a toothed rod which engages with a toothed wheel on the output shaft. Alternatively to this, a cam disc can be

arranged on the output shaft. The drive mechanism then comprises a pressure roller which rolls on this cam disc. The closer spring acts either on the toothed rod or on this pressure roller such that by rotating the output shaft either via the toothed rod or via the pressure roller, a linear movement is generated on the closer spring.

Moreover, it is preferably provided that the electrical energy accumulator comprises at least one accumulator and/or at least one capacitor. The servo door closer has in particular no connection to a mains power supply. Only the energy from the electrical energy accumulator is used to assist with the opening and/or closure operation of the door.

It is provided that the motor/generator unit is formed to assist a manual opening of the door leaf and a simultaneous tensioning of the mechanical energy accumulator. Moreover, it is provided that a closure of the door leaf carried out by discharging the mechanical energy accumulator is assisted by the motor/generator unit. During the opening operation, the mechanical energy accumulator is tensioned. To this end, a certain effort is required by the user of the door. In order to reduce this effort, the opening operation is assisted by the motor/generator unit and by the energy stored in the electrical energy accumulator. The door is closed by discharging the mechanical energy accumulator. The motor/generator unit and the energy stored in the electrical energy accumulator can be utilized here to boost the mechanical energy accumulator by releasing electrical energy and also to dampen the door closure by absorbing electrical energy.

The motor/generator unit is preferably formed to act as a generator to charge the electrical energy accumulator when opening and/or closing the door leaf.

A part of the mechanical energy from the mechanical energy accumulator can be converted via the motor/generator unit into electrical energy in particular in part during the closure operation. In this case, the motor/generator unit acts simultaneously as a generator to charge the electrical energy accumulator and to dampen the closure operation of the doors.

During the manual opening of the door leaf, in particular heavy door leaves have to be dampened in the end region such that for example an impact of the door leaf on the wall or an overloading of the hinges is avoided. To this end, it is preferably provided that the motor/generator unit is formed, acting as a generator,

to dampen a manual opening of the door leaf in the door angle range of up to 30° before the door end position, in particular of up to 20° before the door end position, in particular of up to 15° before the door end position.

The assistance with the opening or closure operation by means of the motor/generator unit always takes place by releasing electrical energy from the electrical energy accumulator.

Moreover, a control unit actuating the motor/generator unit is provided. The control unit can act in a controlling and regulating manner on the motor/generator. A position sensor is preferably attached to the motor/generator unit which detects the angle of rotation directly at the motor/generator unit, in particular directly at the anchor shaft. Alternatively, the position sensor can also be arranged on the output shaft. Furthermore, the control unit is formed to detect the direction of rotation of the door leaf based on the current and/or the voltage at the motor/generator unit. Based on the angle of rotation data of the position sensor and the direction of rotation, the motor/generator unit is actuated, as required, and therefore the door leaf movement is assisted or dampened.

The invention will now be described in more detail on the basis of an exemplary embodiment. It is shown here:

Figure 1 the schematic design of a servo door closer according to the invention in accordance with one exemplary embodiment,

Figure 2 a course of the opening torque when the servo door closer according to the invention is used in accordance with the exemplary embodiment,

Figure 3 a course of the closure torque when the servo door closer according to the invention is used in accordance with the exemplary embodiment, and

Figure 4 a schematic design of a control unit of the servo door closer according to the invention in accordance with the exemplary embodiment.

Figure 1 shows the schematic design of the servo door closure 1. The servo door closure 1 comprises an output shaft 2, a drive mechanism 3, a mechanical energy accumulator 4, formed as a closure spring, a motor/generator unit 5, a control unit 7 and an electrical energy accumulator 6, formed as an accumulator or capacitor.

The output shaft 2 is set into rotation via the drive mechanism 3. The door

or a scissor type linkage or a sliding rail linkage is for example installed directly on this output shaft 2. The drive mechanism 3 translates the rotational movement of the output shaft 2 into a linear movement. This linear movement is used to transfer force to the closer spring 4. During the closure operation of the door, the closer spring 4 is released. In this case, the output mechanism 3 transfers the linear movement of the closer spring 4 into a rotating movement of the output shaft 2.

The motor/generator unit 5 is connected to the output shaft 2 via the mechanical operative connection 8. This mechanical operative connection 8 or coupling is bidirectional such that when the output shaft 2 rotates, the anchor shaft of the motor/generator unit 5 always rotates and vice versa. The motor/generator unit 5 is electrically connected to the electrical energy accumulator 6 via a control unit 7 (see Figure 4). As a result, the electrical energy accumulator 6 can be charged by means of the motor/generator unit 5 or the motor/generator unit 5 can be operated by means of the electrical energy accumulator 6 as a motor. To this end, electrical connections 9 are provided between motor/generator unit 5, control unit 7 and electrical energy accumulator 6.

Figure 2 shows the course of an opening torque at the output shaft 2 during the opening operation of a door leaf. The door leaf opening angle is represented on the X axis 10. The opening torque is represented on the Y axis 11. The continuous line shows an opening torque 12 without assistance by the motor/generator unit 5. The dashed line shows an opening assistance 13 by the motor/generator unit 5 in the range of low door angles, i.e. in the range of the initial opening of the doors. According to the invention, a relatively weak drive mechanism 3 can be used, and by also using the motor/generator unit 5 and the electrical energy accumulator 6, the opening torque can be reduced to preferably 47 Nm. This opening torque of 47 Nm is specified by DIN standard 18040 for a barrier-free access of certain doors.

Figure 3 shows the course of a closure torque at the output shaft 2. The door angle is in turn represented on the X axis 10 here. The Y axis 11 shows the closure torque. The continuous line shows a closure torque 14 without assistance by the motor/generator unit 5. The dashed line shows a closure assistance 15 by means of the motor/generator unit. A relatively weak closure mechanism is assisted here according to the invention by the motor/generator unit 5 and the

electrical energy accumulator 6 in such manner that the closure torque can be raised to 37 Nm. This 37 Nm closure torque is necessary for certain doors for fire protection reasons and specified by DIN standard 1154.

In addition to reducing the opening torque according to Figure 2 or increasing the closure torque according to Figure 3, it is also possible to increase for example the opening torque in the range of larger door angles with the motor/generator unit 5 such that an opening end position dampening is implemented. Similarly, during the closure operation, the motor/generator unit 5 can be operated as a generator and therefore provide a closure damping.

Figure 4 shows a schematic representation of the control unit 7 of the servo door closer 1 according to the exemplary embodiment. The control unit 7 is connected to the motor/generator unit 5. A position sensor 16, which is also connected to the control unit 7, is located on the motor/generator unit 5. The control unit 7 is also connected to the energy accumulator 6.

The control unit 7 comprises a rectifier 17 connected to the motor/generator unit 5. This rectifier 17 is in turn connected to the energy accumulator 6. Moreover, the control unit 7 comprises a voltage regulator 19 for supplying the control unit 7, in particular a processor 22 with energy from the energy accumulator 6. The processor 22 of the control unit 7 receives data from the position sensor 16 about the current angle of rotation of the door leaf. An angle of rotation detection unit 21 determines, based on current or voltage at the motor/generator unit 5, the angle of rotation of the motor/generator unit 5 and also provides this data to the processor 22. Other input data for the processor 22 is the desired closure behaviour 23, the desired opening behaviour 26, the door weight 24 and data about the linkage 27 used and an algorithm for active learning 18. The processor 22 controls the motor/generator unit 5 via an actuation/brake circuit unit 20. Moreover, an optical display 25 is provided on the control unit 7 to display different operating states of the servo door closer 1.

It is possible by means of this control unit 7 to actuate the motor/generator unit 5 as a function of the direction of rotation of the door leaf and as a function of the door angle in such manner that it acts either as a generator or as a motor.

**List of reference numerals**

1 Servo door closer
2 Output shaft
3 Drive mechanism

4 Mechanical energy accumulator
5 Motor/generator unit
6 Electrical energy accumulator
7 Control unit
8 Mechanical operative connection
9 Electrical connection
10 X axis
11 Y axis
12 Opening torque
13 Opening assistance
14 Closure torque
15 Closure assistance
16 Position sensor
17 Rectifier
18 Active learning unit
19 Voltage regulator
20 Actuation/brake circuit unit
21 Angle of rotation detection unit
22 Processor
23 Closure behaviour
24 Door weight
25 Optical display
26 Opening behaviour
27 Data about the linkage used

PATENTKRAV

1. Servodørlukker (1), der omfatter
- en udgangsaksel (2)
- en drivmekanik (3), der er forbundet virksomt med udgangsakslen (2),
- en mekanisk energilagringsenhed, der indvirker på drivmekanikken (3), til lagring af en lukkeenergi til dørfløjen,
- en motor-/generatorenhed (5), der er forbundet virksomt med udgangsakslen (2), og
- en elektrisk energilagringsenhed (6), der er forbundet elektrisk med motor-/generatorenheden (5), til lagring af en supplerende energi til dørfløjen,
kendetegnet ved, at
motor-/generatorenheden (5) er udformet til at understøtte en manuel åbning af dørfløjen alene inden for et dørvinkelområde fra 0° til 45°, særligt alene fra 0° til 30°, særligt alene fra 0° til 25°,
og motor-/generatorenheden (5) er udformet til at understøtte en lukning af dørfløjen alene inden for et dørvinkelområde fra 0° til 45°, særligt alene fra 0° til 30°, særligt alene fra 0° til 25°.

2. Servodørlukker ifølge krav 1, kendetegnet ved, at den mekaniske energilagringsenhed (4) omfatter en lukkerfjeder.

3. Servodørlukker ifølge et af de foregående krav, kendetegnet ved, at den elektriske energilagringsenhed (6) omfatter en akkumulator og/eller en kondensator.

4. Servodørlukker ifølge et af de foregående krav, kendetegnet ved, at motor-/generatorenheden (5) er udformet til at understøtte en manuel åbning af dørfløjen og en samtidig spænding af den mekaniske energilagringsenhed (4), at understøtte en lukning af dørfløjen, der udføres ved en afladning af den mekaniske energilagringsenhed (4), og optionelt også at dæmpe denne.

5. Servodørlukker ifølge et af de foregående krav, kendetegnet ved, at motor-/generatorenheden (5) er udformet til i forbindelse med åbningen og/eller lukningen af dørfløjen at virke som generator til opladning af den elektriske energilagringsenhed (6).

6. Servodørlukker ifølge et af de foregående krav, kendetegnet ved, at motor-/generatorenheden (5) er udformet til at virke som generator med henblik på at dæmpe en manuel åbning af dørfløjen inden for et dørvinkelområde op til 30° inden dørens endeposition, særligt op til 20° inden dørens endeposition, særligt op til 15° inden dørens endeposition.

7. Servodørlukker ifølge et af de foregående krav, kendetegnet ved en positionssensor (16) til registrering af drejevinklen direkte på motor-/generatorenheden (5).

8. Servodørlukker ifølge et af de foregående krav, kendetegnet ved en styreenhed (7), som aktiverer motor-/generatorenheden (5), og som er udformet til baseret på strømmen og/eller spændingen ved motor-/generatorenheden (5) at registrere dørfløjens drejeretning.

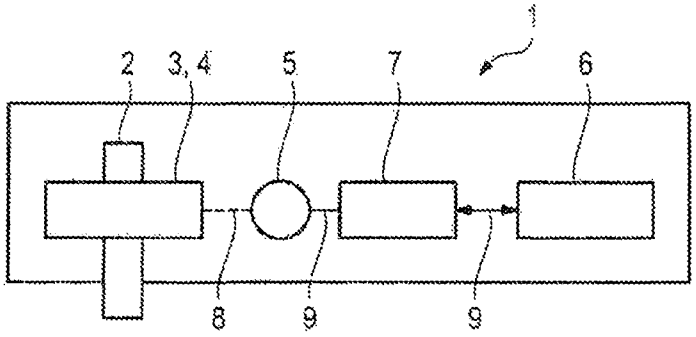


Fig. 1

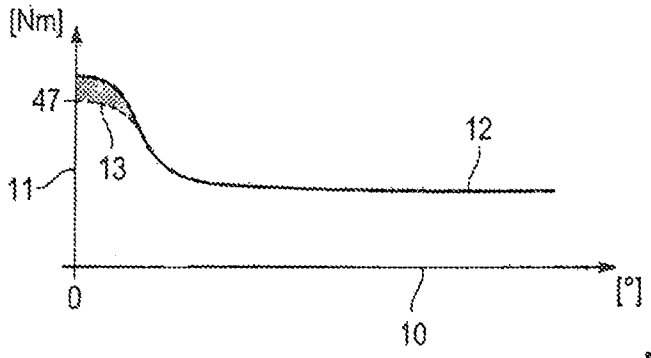


Fig. 2

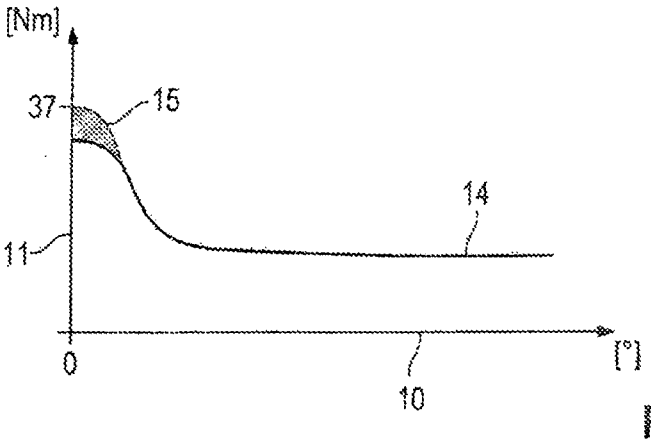


Fig. 3

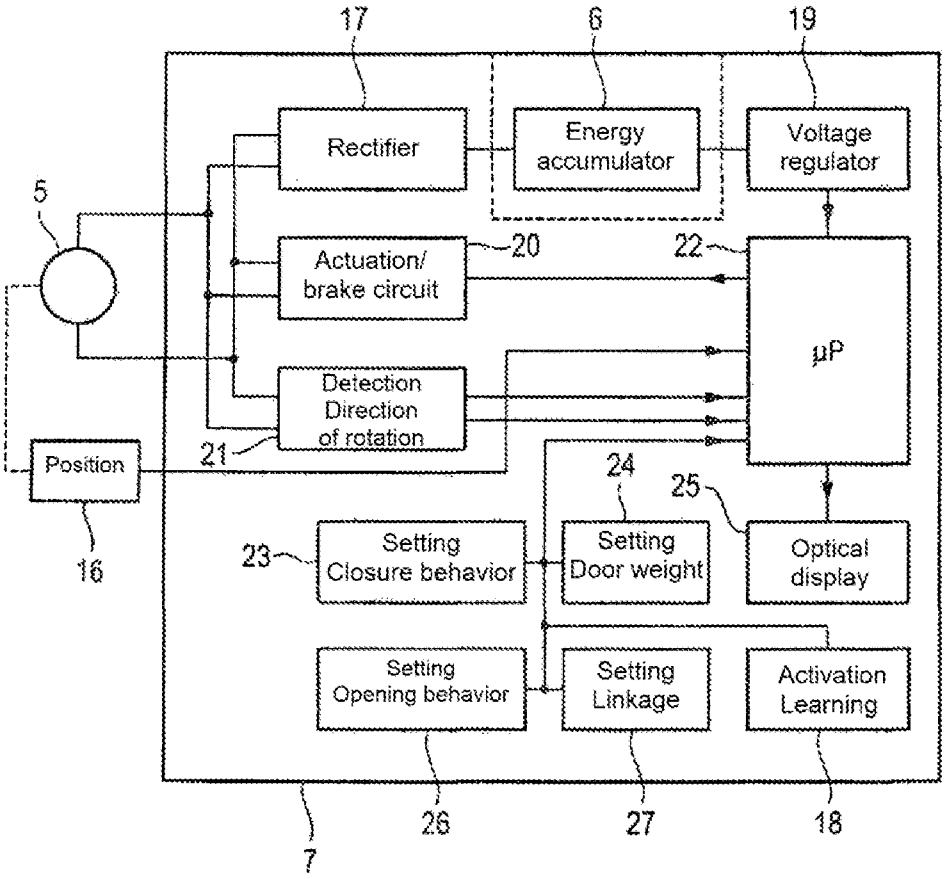
17
6
19
Rectifier
Energy accumulator
Voltage regulator
5
Actuation/ brake circuit
20
22
µP
Detection Direction of rotation
Position
21
24
25
16
23
Setting Closure behavior
Setting Door weight
Optical display
Setting Opening behavior
Setting Linkage
Activation Learning
7
26
27
18

Fig. 4