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- (54) Benævnelse: **Fremgangsmåde til sikker bremsning af en port og indretning til implementering af fremgangsmåden**
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US-B2- 6 737 823

Description

The invention relates to a method for safe braking of a door.

The invention relates to a method for safe braking of a door in the event of a fault, that is to say in the event of failure of a mechanical component, with the aid of the electrically-powered drive unit of the door.

With electrically-powered doors which are usual nowadays, such as for example roller doors, overhead doors, sectional doors or swing doors, the mechanism of the door is frequently designed such that the electrically-powered drive of the door does not have to drive the full load of the door. To this end, the doors, dependent on their construction and type, are equipped with different devices such as for example spring elements, cables and counterweights which ensure that only part of the energy necessary for movement has to be supplied via the electrically-powered drive, and which can be brought together under the umbrella term "balancing devices".

As soon as such a balancing device fails, for example because a spring breaks or a cable connected to the counterweight snaps, an unintentional, uncontrolled and dangerous downward movement, what is called uncontrolled dropping of a door, may occur.

In other doors which form part of the prior art, the construction and the drive are designed such that a balancing device can be dispensed with. With these doors, frequently an additional electromagnetic braking device ensures that the door is held in the rest position once the drive has been switched off. In the event of a malfunction of the braking device due for example to worn brake linings, uncontrolled dropping of the door may occur with these doors too.

Combinations of balancing device and electromechanical braking devices are also known. In such case, the electromechanical braking device for example has the object of rapidly bringing a moving door to a stop, if for example a holding point is reached, and holding the door securely in this position until a renewed movement command is to be executed.

In the event of a defect of the braking device, a door under certain circumstances may not attain the desired holding position, or the holding position is not held as desired, but the door begins slowly and unintentionally to leave the position.

In order to prevent uncontrolled dropping of the door, diverse mechanical solutions are known from the prior art, as are described for example in DE 37 01 251 C2, DE 38 14 275 C2, DE 41 38 711 C2 or DE 198 55 697 C2 and in which, for example by means of pre-tensioned springs or because of centrifugally activated mechanical devices, additional braking devices are triggered or activated which brake the door to a greater or lesser extent for example in the lateral tracks of the door or which act mechanically on the door shaft in order to stop the uncontrolled movement of the door.

All the technical solutions of the prior art for preventing uncontrolled dropping of a door or for emergency braking have the disadvantage that additional mechanical devices are necessary, the functioning of which in addition in most cases can be checked only with difficulty during a normal life cycle of a door, and in which in the case of intentional or unintentional triggering it can be recognised only with difficulty what has led to the device being triggered. With some devices of the prior art, in addition it cannot be recognised that they are in the triggered state, as a result of which the supposed cause of the fault only becomes recognisable to the user of the door installation after extensive searching.

The electrically-powered drives for doors which are usual nowadays, what are called "door drives", as a rule consist of an electric motor, which in the main is embodied as a reasonably-priced asynchronous three-phase motor, and which in most cases is

connected to a directly flange-connected gear, the gear frequently being embodied as what is called a worm gear.

According to the prior art, it is likewise known to feed door drives via a frequency converter so that the door can be moved at different speeds, and in order to obtain the possibility of gentle starting-up and stopping of the door.

The frequency converter in such case, according to the prior art, is a component of a complex door control which in addition to the frequency converter also has at least one device with which the position of the door can be continuously ascertained. Such door controls with integrated frequency converter and attached position sensor are described in DE 295 13 962 U1 and DE 101 42 431 B4.

A control arrangement for emergency switch-off is known from the prior art (DE 196 45 811 C2). This control arrangement of the prior art has a hoist. In the lifting operation, it is intended to avoid overloading of the lifting mechanism when lifting a load in the event of a fault, for example if the load becomes caught. To this end, a limit violation is detected during the lifting operation. This device of the prior art has the disadvantage that an additional detection device for the mechanical overloading has to be provided: for example, a cable force sensor in the form of a load cell is provided.

The prior art (US 6,445,152 B1) includes a control means for a door, in which a "motion control processor" processes signals from a "position encoder" and compares them with desired values for a specified movement profile. If the movement ascertained deviates from the movement profile desired value, the drive is either controlled such that it is accelerated or the drive is braked. The regulation process according to this prior art operates in each case only as long as a command for moving the door applies, namely up to the point "end of stroke". This method of the prior art has the disadvantage that it is not possible to monitor whether for example an electromechanical braking device has a defect and the door is not in a specified stopped position.

The prior art (DE 42 07 705 C2) includes a revolving door which is regulated or controlled by a data processing unit and all of the functions of which including the

control and the microprocessor are themselves monitored internally. In the event of deviations from the normal value, the revolving door stops. A mere stop however is insufficient to minimise the safety risk for doors with vertically moving door curtains.

Furthermore, the prior art (EP 0 429 835 A1) includes a method and a device for reducing the risk of being caught between automatic doors. According to this method, the risk of being caught between automatic doors, in particular in the case of lifts with a regulated door drive, is intended to be reduced. The method of the prior art for this purpose provides for the door, in the event of a disturbing force which acts on the closing door, to be braked until it stops, and reversing, i.e. an opening movement, is initiated.

This method has the disadvantage that in the case of doors with vertically moving door curtains reversing is not possible in each case if a balancing or braking device fails.

The technical problem underlying the invention consists of devising a method with which the uncontrolled dropping of a door can be prevented, without additional devices on the door or on the door drive which can therefore be realised with the devices door drive, door control, frequency converter and position sensor which are already present in the prior art, being necessary for this, and which method at least temporarily can take on the function of a defective electromechanical braking device of the door, and which reliably permits signalling of a defective balancing and/or braking device.

This technical problem is achieved by a method having the features according to Claim 1.

The method according to the invention for safe braking of an electrically-powered door in the event of a fault when the door drops uncontrolledly, in which at least one desired value "direction of rotation" and/or "travelling speed" and/or "door position" is ascertained and compared with an actual value, in which the actual values "direction of rotation", "travelling speed" and/or "door position" are ascertained by at least one position sensor, in which, in the event of a deviation of the actual value from the desired value which lies outside a specified range, a motorised braking operation or a motorised

stopping operation is initiated, is distinguished in that the comparison between the desired value and actual value is carried out permanently, and in that the door after a braking or stopping operation is moved into a safe holding position, and in that it is monitored if an electromechanical braking device has a defect and if the door is not in the specified stopped position, or if a defective balancing device which is intended to hold the door in the respective rest position when stopped is recognised.

The particular advantage of the invention lies in that the actual values "direction of rotation", "travelling speed" and/or "door position" are ascertained on the basis of the data of at least one position sensor. This has the advantage that the position sensor(s) which is/are present anyway transmit the actual values to the control device and thus the actual values are available for comparison with the desired values.

Furthermore, the invention has the advantage that the comparison between desired and actual value is carried out permanently. This means that the comparison is carried out during the movement of the door curtain. Furthermore, however, the at least one actual value is to be ascertained and monitored [sic] with the desired value even when the door is stopped. In this case it can be monitored whether for example an electromechanical braking device has a defect and the door is not in the specified stopped position. However, a defective balancing device which is intended to hold the door in the respective rest position when stopped can also be recognised.

One further advantage of the invention is that in the event of a fault a braking operation or a stopping operation which is carried out predominantly or particularly preferably solely via the motor is initiated.

This means that according to the method according to the invention the aforementioned desired values are detected individually or in combination. These values are compared with the respective actual values. If one or more actual values deviate from the desired values, namely such that the deviations lie outside a specified range, a motorised braking operation or a motorised stopping operation is initiated.

For example, it can be established by means of the speed of the door curtain that for example the cable of the counterweight has snapped. The door curtain in this case moves at a significantly greater speed than would be the case for a normal opening or closing operation. In this case, the actual value "speed" deviates from the desired value, and a motorised braking operation or a motorised stopping operation is initiated.

In principle, the method is thus designed such that braking at any time in the event of a fault is possible owing to the constant monitoring of the actual values.

The control device which carries out the comparison between the actual values and the desired values is the control device which is present in the door control anyway. The control device therefore assumes very widely-varying functions. The control device processes the input signals. That is to say that it processes for example open and close commands of the door control. The control device emits output signals, for example emits warning signals. The control device specifies the frequency input for the frequency converter. The control device, according to the invention, processes the signals of the at least one position sensor. The control device can furthermore determine the motor current and/or the motor output. It advantageously has measuring devices for this purpose.

According to a further advantageous embodiment of the invention, a frequency input of 0 Hertz (Hz) is specified to a frequency converter in the braking or stopping operation. This DC voltage is fed to an asynchronous three-phase motor, so that the stopping operation is initiated by electrically-powered braking. It is also possible to set the frequency input in a range of up to 20 Hertz (Hz) in order to move the asynchronous three-phase motor at low speed and to slow the door movement to such an extent that any risk due to the moving door is minimised.

A further advantageous embodiment of the invention provides that upon a braking or stopping operation in parallel to the electrically-powered braking an electromechanical braking device is also controlled if this is present anyway as part of the design. This has the advantage that the door drive and the frequency converter do not have to generate

the full braking power and thus can be designed for a lower output. In addition, this increases the safety of the method.

According to the invention, provision is made for the door after a braking or stopping operation to be moved into a safe holding position. This increases the safety of the entire method.

Advantageously, the door is moved by a frequency input of the control device to the frequency converter. This means that no additional device is required in order to initiate the braking operation.

According to a further advantageous embodiment of the invention, the control device performs signalling during and/or after the initiation of the braking or stopping operation. The signalling may consist for example of an acoustic and/or optical warning signal.

A device for carrying out the method according to the invention may be distinguished in that the device has a control device which is formed as a control device which carries out a comparison of desired and actual value, and which is formed as a control device which transmits a frequency input to a frequency converter.

The control device compares the actual and desired values. If the actual values deviate from the desired values and the deviation lies outside a specified range, the control device sends to a frequency converter a frequency input of for example 0 Hertz (Hz), so that a stopping operation is initiated.

Advantageously, the device additionally has a display module for displaying a fault, so that a fault can be perceived.

According to one possible embodiment, the display module is integrated in the control device.

Advantageously, additionally at least one electromechanical braking device is provided. This advantageously holds the door in an end position and is intended advantageously to exert the braking effect in support of the motor in accordance with the closed circuit principle.

In such case, the present invention also complies with the specifications and technical rules which are in force, according to which a door installation must not give rise to any danger if a single fault occurs.

This aim is achieved by linking the components door drive, door control with frequency converter and position sensor for the continuous detection of position which according to the prior art belong to a door control, the frequency converter not necessarily having to be a component integrated in the door control, but alternatively possibly being embodied as a more or less separate unit, which however can be controlled by the door control.

The present invention in so doing makes use of the fact that with a corresponding design also an alternating voltage with a frequency of 0 Hertz (Hz), i.e. a DC voltage, can be emitted via a frequency converter. The feeding of an asynchronous three-phase motor with a DC voltage results in it remaining at a virtual standstill at a very low speed, which leads to the coupled door being able to be held virtually in its instantaneous position.

In the method according to the invention, which is integrated as software or firmware in the logic sequences of the control device of the door control, continuous monitoring takes place with respect to the instantaneous position of the door and/or whether a movement command for moving the door is to be implemented and at what speed and in what direction the door should move.

If the control device detects a previously defined deviation between the desired speed or desired direction of movement of the door and the actual direction of movement and speed of the door which are ascertained via the position sensor, the terms "desired direction of movement" and "desired speed" also including a standstill, the control

device triggers the forced braking of the door by transmitting a frequency input of 0 Hertz to 20 Hertz (Hz) to the frequency converter, in order to stop or at least drastically reduce the door movement.

Whether the door movement in such case can be stopped permanently or merely temporarily or drastically reduced in this case is independent of the method according to the invention, but dependent on the electrical and mechanical capacity of the door drive and of the frequency converter and the electromechanical braking device which is optionally present.

In a further advantageous embodiment, the control device, once a condition described above has been detected, can also transmit a frequency input to the frequency converter, with which the door at low speed can move to a safe holding position such as for example the closed position. With this procedure it is then ensured that no further risk can arise from the supposedly defective door installation, which consists of the door, door drive and door control.

In a further advantageous embodiment, the control device causes the signalling of the recognised fault, so that persons outside are made aware of the fault and rapid fault location and fault correction can be brought about.

Further features and advantages of the invention will become apparent with reference to the associated drawings, in which a plurality of examples of embodiment of a door control according to the invention for safe braking of a door are illustrated only by way of example. In the drawings:

Fig. 1 shows schematically a door installation with a roller door and an electromechanical brake;

Fig. 2 shows schematically a door installation with a balancing device.

Fig. 1 illustrates a door control 1 which contains a frequency converter 3 and a control device 2. In normal operation, the frequency converter 3 receives from the control

device 2 an input for the frequency and direction of rotation to be emitted with which an electrically-powered drive 5 which is connected mechanically to a door shaft 7 via a drive shaft 8 is to be fed and in this way can set a door curtain 9 in motion.

Via a position sensor 4, which may be arranged between the electrically-powered drive 5 and the door shaft 7 or on or at the door shaft 7 or may be integrated in the electrically-powered drive 5 or may be arranged at a different point, and which may be embodied as an absolute value encoder or incremental encoder, the control device 2 can be informed constantly about the actual position and speed of the door drive 5 and the door curtain 9 mechanically coupled thereto.

The control device 2 according to the invention is a component of the door control 1 and is only illustrated schematically, since it is incorporated in the logic sequences as a software module. The control device 2 is contained in the door control 1 anyway and according to the invention merely takes on additional functions.

The control device 2 according to the invention processes the current desired values "direction of rotation" and "travelling speed" which are present internally and compares them with the actual values of the specifications provided by the position sensor 4, from which in addition to the instantaneous door position also the direction of rotation and the momentary speed of the door drive can be ascertained.

If the control device 2 on comparing the desired values with the actual values detects a deviation which lies outside a previously defined range, the control device 2 controls the frequency converter 3 and transmits to the frequency converter 3 a frequency input of 0 Hertz (Hz) in order to reduce the speed of the electrically-powered drive 5 drastically or to bring it to a standstill. At the same time, the control device 2 according to the invention controls a braking device 6, so that the latter supports the braking operation. This braking device 6 is formed as an electromechanical braking device.

In the embodiment of the door installation illustrated in Fig. 1, the method according to the invention can also be used to monitor the operation of the drive 5. In the event that the drive 5, for example because of mechanical wear, cannot move or hold the door

curtain 9 in the required manner, the braking device 6 can be controlled at any time in order to brake the door curtain 9 via the control device 2 according to the invention.

The door installation illustrated in Fig. 2 is a balanced door installation, in which a balancing device 10 is embodied as a counterweight which is suspended from a cable, and the mass of which corresponds approximately to the mass of the door curtain 9. In the event of the balancing device 10 failing for example because of a worn cable, the door curtain 9 would descend more or less unbraked.

If the control device 2 on comparing the desired values with the actual values detects an unintentional movement of the door which lies outside a previously defined range, the control device 2 transmits to the frequency converter 3 a frequency input of 0 Hertz (Hz) in order drastically to reduce the speed of the electrically-powered drive 5 or to bring it to a standstill.

The electrically-powered drive as a rule is not of such dimensions that it can hold the full load of a defective door mechanism. Therefore in one advantageous embodiment provision is made for the control device 2, after detecting a fault, to move the door at low speed into a safe rest position which may be for example the closed position of the door, which is dependent on the type of door, but may also be at a different position.

Reference numerals

- 1 door control
- 2 control device
- 3 frequency converter
- 4 position sensor
- 5 electrically-powered drive
- 6 braking device
- 7 door shaft
- 8 drive shaft
- 9 door curtain
- 10 balancing device

PATENTKRAV

1. Fremgangsmåde til sikker bremsning af en elektromotorisk drevet port (9) i en fejlsituation ved et nedfald af porten (9),

- 5 - ved hvilken i det mindste én ønsket værdi "rotationsretning" og/eller "bevægelseshastighed" og/eller "portposition" tilvejebringes og sammenlignes med en faktisk værdi,
- ved hvilken den faktiske værdi "drejeretning", "bevægelseshastighed" og/eller "portposition" tilvejebringes fra i det mindste én positionsføler (4),
- 10 - ved hvilken der, ved en uden for et forudbestemt område liggende afvigelse mellem den faktiske værdi og den ønskede værdi, indledes en motormæssig bremseproces eller en motormæssig standseproces,

kendetegnet ved, at

- at sammenligningen imellem ønsket og faktisk værdi gennemføres permanent,
- 15 således at sammenligningen gennemføres under bevægelse af porten (9) og også ved stilstand for porten (9).
- at porten (9) efter en bremse- eller standseproces køres til en sikker holdeposition,
- at det overvåges, at en elektromekanisk bremseindretning (6) har en defekt og
- 20 at porten (9) ikke befinder sig i den angivne stilstandsposition, eller at en defekt balanceindretning (10) detekteres, som skal fastholde porten (9) i stilstand i den respektive hvileposition.

2. Fremgangsmåde ifølge krav 1, **kendetegnet ved, at** ved bremse- eller standseprocessen tilføres en frekvensomformer (3) en frekvensangivelse på 0 Hertz (Hz), således, at en jævnspænding afgives, og at denne jævnspænding tilføres et elektromotorisk drev (5), som omfatter en asynkron vekselstrømsmotor.

3. Fremgangsmåde ifølge krav 1, **kendetegnet ved, at** ved bremse- eller standseprocessen tilføres en frekvensomformer (3) en frekvensangivelse i et område op til 20 Hertz, med henblik på at bevæge den asynkrone vekselstrømsmotor i langsom bevægelse og mindske portbevægelsen for minimering af en fare ved den sig bevægende port.

35 4. Fremgangsmåde ifølge krav 1, **kendetegnet ved, at** ved bremse- eller standseprocessen aktiveres en elektromekanisk bremseindretning (6).

5. Fremgangsmåde ifølge krav 1, **kendetegnet ved, at** bevægelsen af porten (9) sker ved en frekvensangivelse fra en styreindretning (2) til frekvensomformereren (3).
- 5 6. Fremgangsmåde ifølge ethvert af de foregående krav, **kendetegnet ved, at** styreindretningen (2), under og/eller efter indledning af bremse- eller standseprocessen, gennemfører en signalering.
7. Fremgangsmåde ifølge ethvert af de foregående krav, **kendetegnet ved, at** styreindretningen (2), under en start- og/eller stoprampe, indleder en bremse- eller standseproces.
- 10

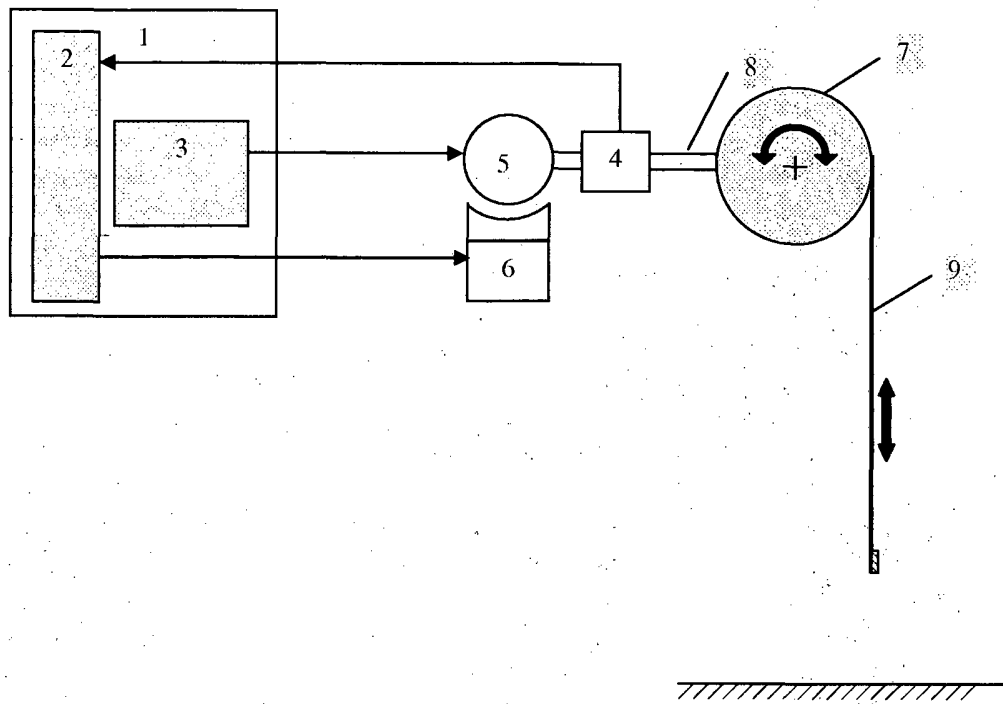


Fig. 1

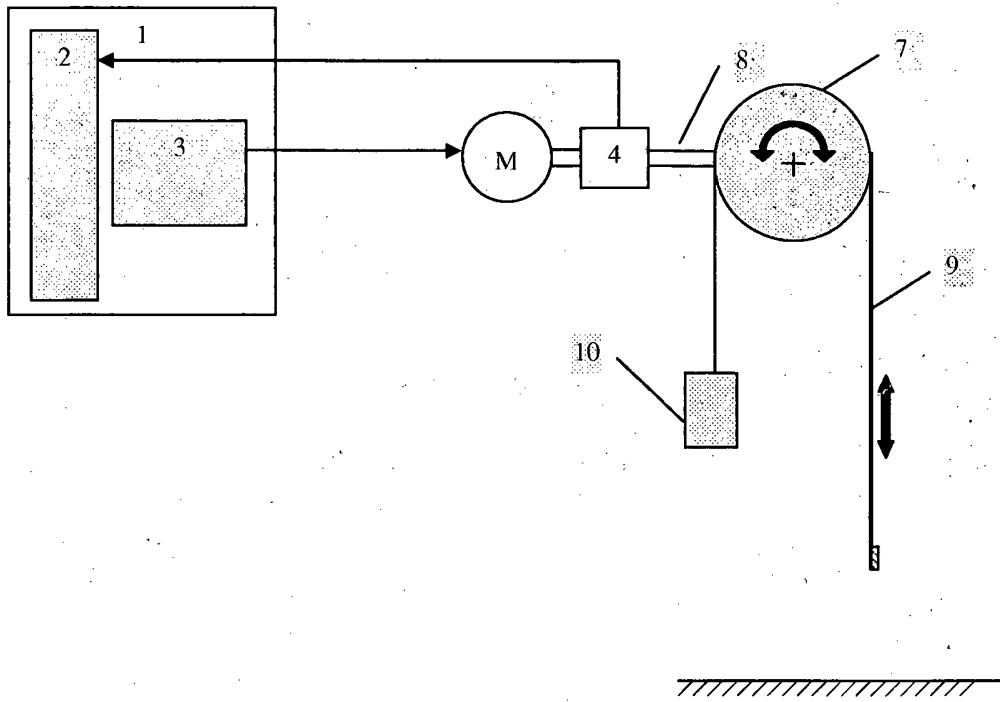


Fig. 2