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(54) Title: PROCESS FOR CONFIGURATION OF OVERHEAD DOOR END POSITIONS

(57) Abstract: The present invention relates to a process for automatic configuration of end positions of an overhead door leaf, comprising the steps of moving the door leaf towards a first end position, detecting a change in motor shaft power when reaching the first end position, stopping the door leaf at the first end position, storing the first end position as a first end position encoder value, moving the door leaf towards a second end position, detecting a change of motor shaft power when reaching the second end position, stopping the door leaf at the second end position, and storing the second end position as a second end position encoder value.



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PROCESS FOR CONFIGURATION OF OVERHEAD DOOR END POSITIONS

Field of the invention

The present invention relates to a process for automatic configuration of top
5 and bottom end positions of an overhead door leaf.

Background of the invention

Installation and configuration of overhead sectional doors is often time
consuming and complex. The service technician, installing the door, configures the
10 door's top and bottom end positions, i.e. the positions wherein the door is
considered fully open or closed, by simply pressing a button and releasing it when
the door is assumed to have reached a suitable end position.

EP1501181 discloses such a door where the door control unit includes a
wall control switch module provided with learn switches used for setting the end of
15 travel positions during installation. As mentioned, this kind of installation procedure
is time consuming and inconsistent due to the human factor. One further
disadvantage of using such a manual method is that the end positions can be
improperly set or misadjusted.

US6326751 describes a system which generates door profile data during
20 installation and use. The system comprises a potentiometer adapted for detecting
a plurality of speed values of the moving door. If the door slows down past a
factory pre-set threshold speed limit, the door is stopped. In other words, the pre-
set threshold indicates that the door has struck the floor, or is fully open, and can
move no further. Once the door is stopped, the new positional location of the door
25 is stored as the upper or lower end positions of the door. With such a solution,
there is a risk, if the motor is strong, that the speed of the door does not decrease
as it reaches floor level, since the lifting cable could continue to unwind from its
drum of the motor power exceeds the force of the balancing spring(s).

Summary of the invention

It is an object of the present invention to mitigate the above problems, and
to provide an improved way of configuring overhead door end positions. According
to a first aspect of the present invention, these objects are achieved by a process
for automatic configuration of end positions of an overhead door leaf, the door leaf

being operated by means of a motor, a motor shaft, and a control unit, the process comprising the steps of moving the door leaf towards a first end position, detecting a change in motor shaft power when reaching the first end position, stopping the door leaf at the first end position, storing the first end position as a first end

5 position encoder value,

moving the door leaf towards a second end position, detecting a change of motor shaft power when reaching the second end position, stopping the door leaf at the second end position, storing the second end position as a second end position encoder value.

10 A process such as that of the present invention results in a fully automatic installation process which not only is less time consuming, but is also more cost effective and consistent. Further, the installation process will become independent of which service technician installs the door, and his/hers degree of experience.

In one embodiment, the change in motor shaft power is detected by the
15 steps of measuring input to the motor, calculating a present motor shaft power, comparing the calculated present motor shaft power to a further motor shaft power value, and
determining if a change in motor shaft power has occurred. This solution simplifies the installation process significantly.

20 The input may comprise samples of current and voltage, which input is available for all overhead doors and therefore simple to implement for existing overhead doors.

Further, the motor may comprise a three-phase induction motor, in order to facilitate sampling of a varying voltage.

25 In one embodiment, the further motor shaft power value is a predetermined value, assuring that the motor shaft power value never exceeds a pre-set limit value for the motor.

In a further embodiment, the further motor shaft power value is the nominal power of the specific motor.

30 In yet another embodiment, the further motor shaft power is calculated immediately prior to calculating the present motor shaft power, making the time interval between measurements as short as possible, resulting in an end position which is as correct as possible.

The change may comprise an increase in motor shaft power of at least 15 %.

Further, calculating motor shaft power may further comprise compensating for motor power losses, in order to calculate at the best possible end position for
5 the specific overhead door.

In one embodiment, the first end position is a top end position and the second end position is a bottom end position.

In a further embodiment, storing the first and second end positions as first and second end position encoder values, respectively, also comprises the step of
10 offsetting the end position encoder value by a predetermined offset value. This way, the compression of any dampers can be adjusted to a suitable level. The predetermined offset value could be a factory set default value or a value to be adjusted in a menu.

Generally, all terms used in the claims are to be interpreted according to
15 their ordinary meaning in the technical field, unless explicitly defined otherwise herein. All references to "a/an/the [element, device, component, means, etc.]" are to be interpreted openly as referring to at least one instance of said element, device, component, means, etc., unless explicitly stated otherwise. Further, by the term "comprising" it is meant "comprising but not limited to" throughout the
20 application.

Detailed description

Motorized door operators are used for moving an overhead sectional door, e.g. an industrial door or a garage door, between a top end position and a bottom
25 end position. The absolute bottom end position is defined by the floor upon which the overhead door closes. The absolute top end position is defined by the highest point the door leaf can travel which is limited mainly by the door track system's physical limits and the length of its cables. The top and bottom end positions are employed to prevent door damage or personal injury resulting from the users
30 attempt to move the door past its physical limits.

The overhead sectional door, suitable for use with the present invention, comprises horizontally and vertically extending door frame work, a sectional door leaf, a top damper and a bottom rubber, a control unit including load monitors and an encoder, a motor and a shaft, cables, and balancing springs. The sectional

door leaf is divided into horizontally extending sections such that the door leaf can bend up to 90° when moving from a vertical, closed position, to an essentially horizontal, open position. The top damper usually comprises top compression springs. The bottom rubber usually comprises bottom squeeze protection, and
5 signals from the squeeze protection could be used in combination with the below described process in order to determine the end position of the door leaf as a redundant/secondary signal for reaching the bottom end position. The cables are used for moving the door leaf both upwards and downwards, in combination with the forces generated by the weight of the door leaf and balancing springs provided
10 at the ceiling.

As mentioned, the door leaf comprises of multiple segments and is, in the resting top position, arranged mainly in parallel with the ceiling. As the door leaf moves from the top position to the bottom position, the vertical force, generated by the weight of the door leaf, increases. The torsion in the balancing springs
15 increases in order to compensate for this increase in door leaf weight. The motor pulls, via at least one cable, the door leaf downwards towards the floor, i.e. the balancing spring is a counter force to the force generated by the weight of the door leaf and the motor.

Correspondingly, the door leaf is pulled from the closed position to the
20 open position by means of at least one cable. As a door leaf moves from the bottom position to the top position, the vertical force generated by the weight of the door leaf decreases and the torsion in the balancing springs decreases.

If the overhead sectional door is a vertical lifting door, i.e. the door leaf extends vertically in both the top position and in the bottom position, the vertical
25 force generated by the weight of the door leaf is constant.

The present invention is to be employed in conjunction with a conventional overhead door, and therefore, aspects of the door itself will not be discussed in further detail. In summary, the present invention relates to automatic configuration, during installation, of the top and bottom end positions of a vertically moveable
30 industrial door, a so called overhead door. The power of the motor and motor shaft, driving the door, is monitored, and the end positions of the door leaf are detected due to a rapid change in shaft power which arises as the end positions are reached. The change in shaft power is due to the door leaf's interaction with top dampers, e.g. compression springs, the end of the track which the door leaf

moves in, and/or the balancing springs. The change in power is detected and the position is stored by a control unit as a top position absolute encoder value or a bottom position absolute encoder value. Automatic configuration is activated by, e.g., pressing the up button. The door leaf then moves automatically to the top end position, where load monitors will detect a rapid increase of shaft power when the top compression springs are reached and compressed. The motor is subsequently stopped, and the top end position is stored. Thereafter, the door leaf moves downwards to the bottom end position, where load monitors will detect a rapid increase of shaft power when the torsion increase of the balancing springs is felt by the motor as the weight of the door leaf rests on the floor. The motor is stopped, and the bottom end position is stored. The shaft power is calculated in a microcontroller as a product of current and voltage, and this feature is subsequently referred to as "load monitoring". The calculations may compensate for power losses in the motor.

The process for automatic configuration of end positions of an overhead door leaf comprises several, sequential steps. First, the automatic adjustment of end positions system is activated, e.g. by pressing the up button once. The door leaf will automatically move towards a first end position, e.g. the top end position. The door leaf will come in contact with top dampers. As previously mentioned, the top dampers may be compression springs. However, the present invention allows the compression springs to be replaced by rubber blocks or dampers.

The load monitors will detect a change, a rapid increase, in motor shaft power when the top dampers are reached and compressed.

As a consequence, the motor is stopped and the door leaf is stopped at the top end position. An absolute encoder value for the top end position is stored automatically. The stored, absolute top end position encoder value is preferably automatically compensated for with a number of encoder pulses in order to get a suitable top damper compression.

Thereafter, the door leaf automatically starts to move downwards towards a second end position, e.g. the bottom, floor position. When the floor is reached, the load monitors will detect a change, a rapid increase, in motor shaft power and stop the motor, as the torsion increase of the balancing springs is felt by the motor when the weight of the door leaf rests on the floor.

In one embodiment, squeeze protection such as an optical safety edge or pneumatic protection could be used together with the above described process, in order to even more clearly detect that the bottom end position has been reached.

As a consequence, the motor is stopped and the door leaf is stopped at the
5 bottom end position. An absolute encoder value for the bottom end position is stored automatically. The stored, absolute bottom end position encoder value is preferably automatically compensated for with a number of encoder pulses in order to get a suitable bottom rubber compression. Finally, the control unit indicates that installation has been completed by means of a display message, a
10 light, sound, or similar.

As previously mentioned, the door leaf is pulled both upwards and downwards by at least one cable. The door is provided with balancing springs, mounted at the ceiling, in order to keep the door leaf balanced during the opening and closing cycle, independent of the position of the door. This means that the
15 power, which the motor experiences during the opening and closing cycles, is approximately constant if the balancing is ideal.

As the door leaf moves from an upper position (e.g. the top end position) to the bottom end position, the tension in the balancing springs increases in order to compensate for the increase in door leaf weight. The motor pulls, via the cable, the
20 door leaf downwards towards the floor, i.e. the balancing spring generates a counter force to the forces generated by the weight of the door leaf and the motor. When the door leaf eventually hits the floor, there is no longer any force applied onto the cable by the weight of the door leaf. As a result, the motor will experience a rapid increase in power since now only the counter force from the balancing
25 springs remain. In other words, a change in motor shaft power, i.e. the power used by the motor, is detected through the cable since the motor is connected to its load via this cable.

Correspondingly, the door leaf is pulled from a lower position (e.g. the bottom end position) to the top end position by means of the same cable. The
30 force generated by the weight of the door leaf is a counter force to the forces generated by the balancing spring and the motor. The ceiling is provided with top dampers, which will interact with the top edge of the door leaf at the top end position. When the door leaf hits the top dampers, there will be additional force applied onto the cable in addition to the force generated by the weight of the door

leaf. As a result, the motor will experience an increase in power. When the top dampers are fully compressed and the end stop of the track is reached, the increase in power will be very high.

Hence, in both cases, the motor experiences an increase in load.

5 The change in motor shaft power is detected by the steps of measuring input to the motor, calculating a present motor shaft power from the input, comparing the calculated present motor shaft power to a further motor shaft power value, and determining if a change in motor shaft power has occurred. The input to the motor is preferably measured through sampling of current and voltage used by
10 the motor, or through sampling of current and the phase angle between voltage and current used by the motor. The motor is a three-phase induction motor.

The further motor shaft power value may be a factory pre-set threshold motor shaft power value, or a value set through an installation menu. For example, the motor shaft power value for regular use is approximately 350-400 W, and the
15 threshold value may be set at 550 W. When the motor shaft power exceeds 550 W over a time period of e.g. 500ms, an end position has been reached.

Another way of comparing the calculated present motor shaft power to a further motor shaft power value is to compare the calculated present motor shaft power to a percentage of the nominal power of the specific motor. For example, if
20 the nominal power of the motor is 700 W, the further motor shaft power value could be set to 60% of the nominal power. When the motor shaft power exceeds 420 W, an end position has been reached.

Also, the further motor shaft power value may be calculated, in the same way as the present motor shaft power, immediately prior to calculating the present
25 motor shaft power. In this case, the change in motor shaft power is, as previously mentioned, an increase in motor shaft power. The change is preferably a power increase of at least 15%, compared to the power value during regular use, and the change is executed rapidly, e.g. over a time period of 60- 500 ms. By regular use is meant when the door leaf travels through the air, not yet having reached an end
30 position.

Calculation of the motor shaft power is done by discrete sampling of current and voltage, and indirectly phase angle, by means of A/D converters in the microprocessor. The motor shaft power is calculated from this input.

Further, the calculation of motor shaft power may comprise compensating for motor power losses. The three-phase induction motor, driving the door leaf, experiences power losses. This may be compensated for by subtracting a constant*actual measured current from the sampled input, i.e. $P_{\text{shaftpower}} = P_{\text{inputpower}} - (k * \text{actual measured current})$. The constant k is derived from the actual motor used by means of measurements or theoretical approximation.

The top and bottom end positions are stored, as previously mentioned, by means of an absolute encoder. After storage, it is easy to use encoder offset such that neither the top dampers nor the bottom rubber are fully compressed. The door leaf should stop prior to the absolute end position, i.e. each end position is offset by a number of encoder pulses. In one embodiment, these offset values are pre-set default values which usually remain constant, but can be adjusted when needed.

After completion of the installation process, the next step may comprise a test run of the door leaf in order to verify installation. The door leaf should then open to the top end position (i.e., the absolute top end position minus offset), i.e. to a position where the top dampers are suitably compressed.

After manually checking that the top end position is correct, the same step is executed for the bottom end position such that the bottom rubber is suitably compressed.

As previously mentioned, the top damper need no longer comprise of spring dampers, but could be replaced by cheaper, more silent, and more durable rubber blocks. Rubber blocks are not as sensitive to wear and do not break as easily as spring dampers.

Further, the bottom rubber compression could be mechanically controlled by using, e.g., rubber spacers to assure that the bottom rubber is compressed to the exact same degree in every door movement down. This means that the bottom rubber does not have to become completely compressed when the door is closed, increasing the lifetime of the bottom rubber.

The person skilled in the art realizes that the present invention by no means is limited to the preferred embodiments described above. On the contrary, many modifications and variations are possible within the scope of the appended claims. For example, only one of the top and bottom end positions may be detected using

the process. Further, the process may calculate the momentum instead of the shaft power.

CLAIMS

1. A process for automatic configuration of end positions of an overhead door leaf, said door leaf being operated by means of a motor, a motor shaft, and a control unit, the process
- 5 comprising the steps of:
- moving said door leaf towards a first end position,
 - detecting a change in motor shaft power when reaching said first end position,
 - stopping said door leaf at said first end position,

10 -storing said first end position as a first end position encoder value,

 - moving said door leaf towards a second end position,
 - detecting a change of motor shaft power when reaching said second end position,
 - stopping said door leaf at said second end position,

15 -storing said second end position as a second end position encoder value.
2. A process according to claim 1, wherein said change in motor shaft power is detected by the steps of:
- measuring input to said motor,

20 -calculating a present motor shaft power,

 - comparing said calculated present motor shaft power to a further motor shaft power value, and
 - determining if a change in motor shaft power has occurred.
- 25 3. A process according to claim 2, wherein said input comprises samples of motor current and voltage.
4. A process according to claim 3, wherein said motor comprises a three-phase induction motor.
- 30 5. A process according to any of claims 2-4, wherein said further motor shaft power was calculated immediately prior to calculating said present motor shaft power.

6. A process according to any of claims 2-5, wherein said change comprises an increase in motor shaft power of at least 15 %.
- 5 7. Process according to any of claims 2-6, wherein calculating said motor shaft power further comprises compensating for motor power losses.
8. A process according to any of the previous claims, wherein said first end position is a top end position and said second end position is a bottom end position.
- 10 9. Process according to any of the previous claims, wherein storing said first and second end positions as first and second end position encoder values, respectively, comprises the step of offsetting said end position encoder value by a predetermined offset value.
- 15

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2017/065725

A. CLASSIFICATION OF SUBJECT MATTER
INV. E05F15/668
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
E05F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y A	DE 43 39 565 A1 (HOERMANN KG VERKAUFSGES [DE]) 24 May 1995 (1995-05-24) column 1, lines 3-10 column 3, lines 20-32 column 3, line 58 - column 4, line 20 column 5, lines 5-58 figure 1 column 2, line 44 - line 62 -----	1-4,6,8, 9 7 5
X A	US 4 831 509 A (JONES RICHARD E [AU] ET AL) 16 May 1989 (1989-05-16) column 1, lines 5-9 column 5, lines 26-36,43-57 ----- -/-	1,8,9 2-7



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2017/065725

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

Information on patent family members

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