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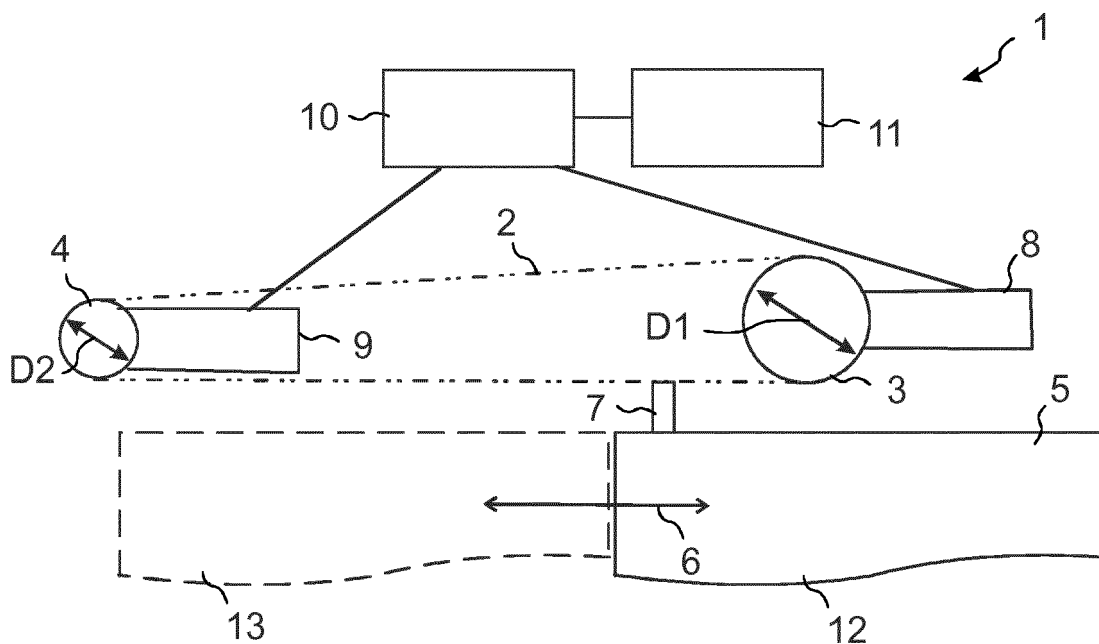
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(54) **A DOOR MECHANISM AND A CONTROL METHOD**

(57) This invention relates to a door mechanism (1) comprising: a drive element (2) which is connected to a door (5) for moving the door. A primary motor (8) rotates the primary pulley (3) and moves the drive element (2). Also a secondary motor (9) rotates a secondary pulley (4) and moves the drive element (2). To obtain a cost efficient and energy efficient door mechanism, the con-

troller (10) controls supply of electricity to the primary motor (8) and the secondary motor (9) independently of each other such that mainly electricity is supplied to the primary motor only, and such that electricity is supplied simultaneously to both to the primary motor (8) and secondary motor (9) only in predetermined situations.



**FIG. 1**

## Description

### BACKGROUND OF THE INVENTION

### FIELD OF THE INVENTION

[0001] This invention relates to a door mechanism and more particularly to a mechanism capable of moving a door and to a control method.

### DESCRIPTION OF PRIOR ART

[0002] Previously there is known a door mechanism including a drive element and two electric motors which are driven together by a controller when the door needs to be moved. The electric motors are driven simultaneously for moving the door.

[0003] In the above mentioned known solution the maximum speed of the door and the maximum torque available is dependent on what the electric motors together can provide. In praxis the maximum torque is needed in predetermined situations which occur for a very short moment, when considering the entire time period during which the door is moved. This maximum torque needs, however, to be taken into consideration when selecting appropriate motors in order to ensure that the motors are dimensioned to be large enough.

[0004] Consequently, in the known solution relatively large motors need to be selected and these motors run together and consume electricity for the time period during which the door moves. This increases the costs of the door mechanism and results in a solution with a poor energy efficiency.

### SUMMARY OF THE INVENTION

[0005] An object of the present invention is to solve the above mentioned drawback and to provide a door mechanism with an improved energy efficiency and lower costs. This object is achieved with the door mechanism according to independent claim 1 and with the control method according to independent claim 11.

[0006] A door mechanism where a controller controls supply of electricity to the primary motor and to the secondary motor independently of each other such that electricity is supplied simultaneously to both the primary and the secondary motor only in predetermined situations, makes it possible to obtain a better energy efficiency and lower costs, as it is no longer necessary to continuously supply energy to both motors.

[0007] Preferred embodiments of the invention are disclosed in the dependent claims.

### BRIEF DESCRIPTION OF DRAWINGS

[0008] In the following the present invention will be described in closer detail by way of example and with reference to the attached drawings, in which

Figure 1 illustrates an embodiment of a door mechanism,

Figure 2 illustrates the torque and speed during movement of the door of Figure 1, and

Figure 3 illustrates electric supply in the door mechanism of Figure 1.

### DESCRIPTION OF AT LEAST ONE EMBODIMENT

[0009] Figure 1 illustrates an embodiment of a door mechanism 1. In the illustrated example it is by way of example assumed that the door mechanism is for a sliding door. However, in praxis the door mechanism may be utilized also for other door types, such as for swing doors, for instance.

[0010] The door mechanism 1 comprises a drive element 2 which is movably arranged to extend between a primary pulley 3 and a secondary pulley 4. The drive element 4, which in praxis may be implemented with an endless belt, such as a toothed belt, is connected by a bracket 7 to a door 5 for moving the door between a closed position 12 and an open position 13, as illustrated by arrow 6.

[0011] A primary motor 8 rotates the primary pulley 3 and moves the drive element 2 and simultaneously also the door 5. A secondary motor 9 rotates the secondary pulley 4 and moves the drive element 2 and simultaneously also the door 5. A controller 10 controls supply of electricity from a power supply 11 to the primary motor 8 and the secondary motor 9.

[0012] The electric supply to the primary motor 8 and the secondary motor 9 is implemented independently from each other. Mainly, electricity is supplied only to the primary motor 8 while the electric supply to the secondary motor is switched off. Typically, the electric supply to the secondary motor 9 is switched off while the door 5 moves with a constant speed or when the door 5 has reached a predetermined position. To maintain a constant speed, for instance, it is sufficient that only the primary motor 8 participates in driving the drive element 2 and in order to obtain a good energy efficiency it is advantageous to switch off electric supply to the secondary motor 9 during these time periods.

[0013] In predetermined situations, such as during acceleration of the drive element 2 and the door 5 for opening or closing the door, the controller 10 controls supply of energy simultaneously to both the primary motor 8 and to the secondary motor 9. In this way, when needed, additional power and torque is available to obtain a fast acceleration of even a heavy door (more than 300 kg, for instance). Once a predetermined speed which is an optimal speed for the door in question has been reached, the controller 10 switches off supply of electricity to the secondary motor 9 and continues supply of electricity to the primary motor 8 only. Alternatively, supply of electricity to the secondary motor 9 can be switched off once the door 5 has reached a predetermined position, for instance.

**[0014]** The motor controller 10 can be implemented with an AC drive output having a triple-H bridge powering 3 phases. The motors driven by the controller can be AC synchronous motors or PMDC synchronous motors (Permanent Magnet DC motors). The controller can drive the primary motor 8 and the secondary motor 9 with a second phase common to both motors. The first and third phases can be connected via motor relays to one of the motors each. In such an implementation the common second phase can be kept at about 50% duty cycle of the PWM (Pulse Width Modulation). The first phase and third phase may be used in combination with the common second phase to drive both motors with active speed and torque control, enabling maximum motor torque. Once the drive element 2 and the door 5 has reached a predefined speed or position, the secondary motor 9 is switched off by disabling the phase (first or third) connected to it alone. The rest of the movement is carried out by the primary motor 8 only by the common phase and the phase (the other one of the first or third) connected to it alone.

**[0015]** Additionally, the motor controller 10 may be provided with a programmable part including a memory, a processor and control circuits, for instance, which facilitate for a user to store parameters and possibly software controlling the supply of electricity for the installation in question. Additionally the controller may handle door commands forwarded to the controller from one or more triggers or sensors arranged such that a user can trigger opening and/or closing of the door.

**[0016]** In the solution according to the illustrated embodiment, advantageously the combination of the secondary pulley 4 and the secondary motor 9 are dimensioned to provide a larger torque than the combination of the primary pulley 3 and the primary motor 8. In this way the primary motor can be used to ensure that a suitable speed range is covered for the door, while the secondary motor can be used to ensure that an appropriate torque range is provided. Such a solution can be achieved by utilizing a secondary pulley 4 having a smaller diameter D2 than the diameter D1 of the primary pulley 3. In this way a larger torque is obtained from the combination of the secondary motor 9 and the secondary pulley 4, even though the properties of the secondary motor 9 would correspond to the properties of the primary motor 8. Naturally, as an alternative to this, it is possible to use a secondary pulley having the same diameter as the primary pulley, and instead obtain a larger torque from the combination of the secondary pulley and secondary motor by selecting a secondary motor which is more powerful than the primary motor.

**[0017]** Figure 2 illustrates the torque and speed during movement of the door 5 of Figure 1.

**[0018]** In Figure 2 line 14 illustrates the speed V of the door 5 at different moments of time  $t_0 - t_{10}$  while the door moves between a closed position 12 and an open position 13, or vice versa. Line 15 illustrates the available torque T to drive the drive element and the door at different moments of time.

**[0019]** From Figure 2 it can be seen, that during the acceleration phase between moments  $t_0$  and  $t_1$  both the primary motor 8 and the secondary motor 9 are supplied with electricity, and the torque T accelerating the drive element and the door is consequently very high as both motors participate in generating this torque.

**[0020]** At moment  $t_1$  a predetermined speed V has been reached. Alternatively the door may have reached a position from where further acceleration is unnecessary, or if needed, further acceleration can be achieved by means of the primary motor only. At that moment the controller 10 switches off supply of electricity to the secondary motor 9, which can be seen in Figure 2 as a substantial reduction of the torque T illustrated by line 15. From that moment the primary motor 8 alone is provided with electricity which is sufficient, as line 14 indicates that the speed still slightly increases after moment  $t_1$ , and after that, the speed remains constant until reduction of speed occurs at the end of the movement of the door.

**[0021]** Figure 3 illustrates electric supply in the door mechanism of Figure 1. Figure 3 shows connection of two PMDC motors on a AC H-bridge, which together with two motor relays 16 and 17 may be integrated into the controller 10.

**[0022]** A first phase X and a second phase Y supply electricity to the primary motor 8. The second phase Y and the third phase Z supply electricity to the secondary motor 9.

**[0023]** Two first motor relay 16 controls supply of the first phase X and of the second phase Y. The second motor relay 17 controls supply of the third phase Z. In this way, by appropriately controlling the first and second motor relays 16 and 17, the controller 10 may select to supply both motors 8 and 9 with electricity, or alternatively, only the primary motor 8 with electricity.

**[0024]** It is to be understood that the above description and the accompanying figures are only intended to illustrate the present invention. It will be obvious to a person skilled in the art that the invention can be varied and modified without departing from the scope of the invention.

## Claims

### 1. A door mechanism (1) comprising:

a drive element (2) which movably extends between a primary pulley (3) and a secondary pulley (4) and which is connected to a door (5) for moving the door,  
a primary motor (8) for rotating the primary pulley (3) and moving the drive element (2),  
a secondary motor (9) for rotating the secondary pulley (4) and moving the drive element (2), and  
a controller (10) controlling supply of electricity to the primary motor (8) and to the secondary motor (9), **characterized in that**

- the controller (10) controls supply of electricity to the primary motor (8) and the secondary motor (9) independently of each other such that mainly electricity is supplied to the primary motor only, and such that electricity is supplied simultaneously to both to the primary motor (8) and secondary motor (9) only in predetermined situations.
2. The door mechanism according to claim 1, wherein the controller (10) controls supply of electricity such that electricity is supplied to both the primary motor (8) and to the secondary motor (9) simultaneously during acceleration of the drive element (2).
  3. The door mechanism according to claim 1 or 2, wherein the controller (10) controls supply of electricity by switching off supply of electricity to the secondary motor (9) and by continuing supply of electricity to the primary motor (8) when drive element has reached a predetermined speed or the door (5) has reached a predetermined position.
  4. The door mechanism according to one of claims 1 to 3, wherein the combination of the secondary pulley (4) and secondary motor (9) are dimensioned to provide a larger torque than the combination of the primary pulley (3) and the primary motor (8).
  5. The door mechanism according to one of claims 1 to 4, wherein the primary motor (8) and the secondary motor (9) provide an equal torque, and the diameter (D2) of the secondary pulley (4) is smaller than the diameter (D1) of the primary pulley (3).
  6. The door mechanism according to one of claims 1 to 5, wherein the drive element (2) is an endless belt.
  7. The door mechanism according to one of claims 1 to 6, wherein the door mechanism (1) is a mechanism for a slide door or for a swing door.
  8. The door mechanism according to one of claims 1 to 7, wherein the primary motor (8) is supplied with electricity by a first (X) and a second phase (Y), the secondary motor (9) is supplied with electricity by the second phase (Y) and a third phase (Z), and the controller (10) controls supply of electricity to the secondary motor (9) via the third phase (Z) only in said predetermined situations.
  9. The door mechanism according to claim 8, wherein the door mechanism comprises a first relay (16) and second relay (17) controlling supply of the first, second and third phase to the primary motor (8) and secondary motor (9).
  10. The door mechanism according to claim 9, wherein the door mechanism (1) comprises a triple H-bridge providing the first (X), second (Y) and third (Y) phase to the primary motor (8) and the secondary motor (9).
  11. A method for controlling a primary motor (8) and a secondary motor (9) of a door mechanism, **characterized in that** the method comprises:
    - supplying electricity independently to the primary motor (8) and to the secondary motor (9), by supplying electricity mainly only to the primary motor (9), and
    - supplying electricity simultaneously to both the primary motor (8) and to the secondary motor (9) only in predetermined situations.
  12. The method according to claim 11, wherein electricity is supplied to both the primary motor (8) and to the secondary motor (9) simultaneously during acceleration of a door operated by the door (5) mechanism.
  13. The method according to claim 11 or 12, wherein supply of electricity to the secondary motor (9) is switched off and supply of electricity to the primary motor (8) only is continued when a door (5) operated by the door mechanism has reached a predetermined speed or the door (5) has reached a predetermined position.

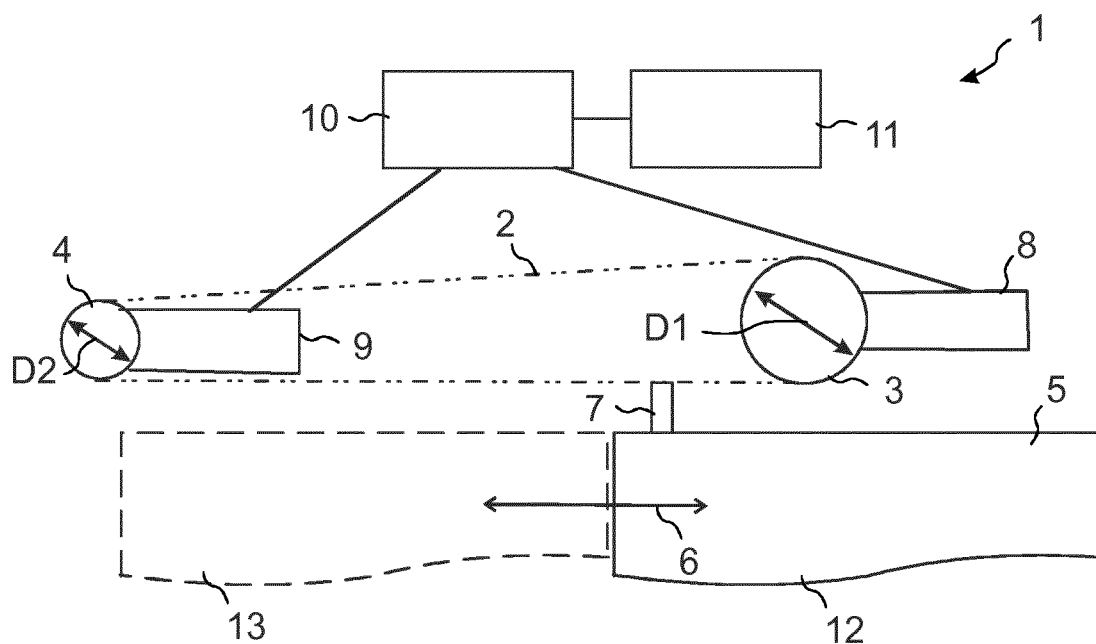


FIG. 1

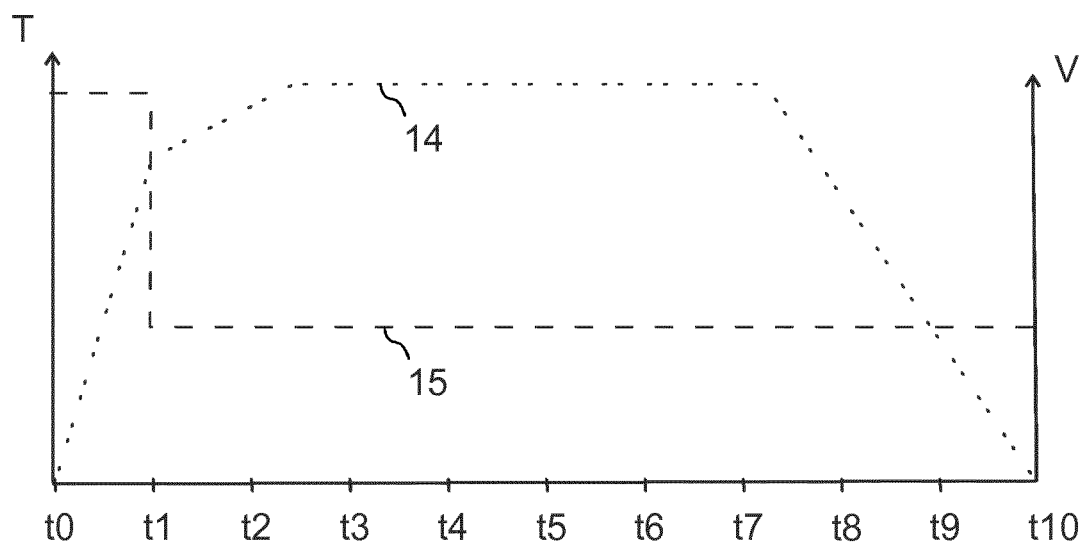


FIG. 2

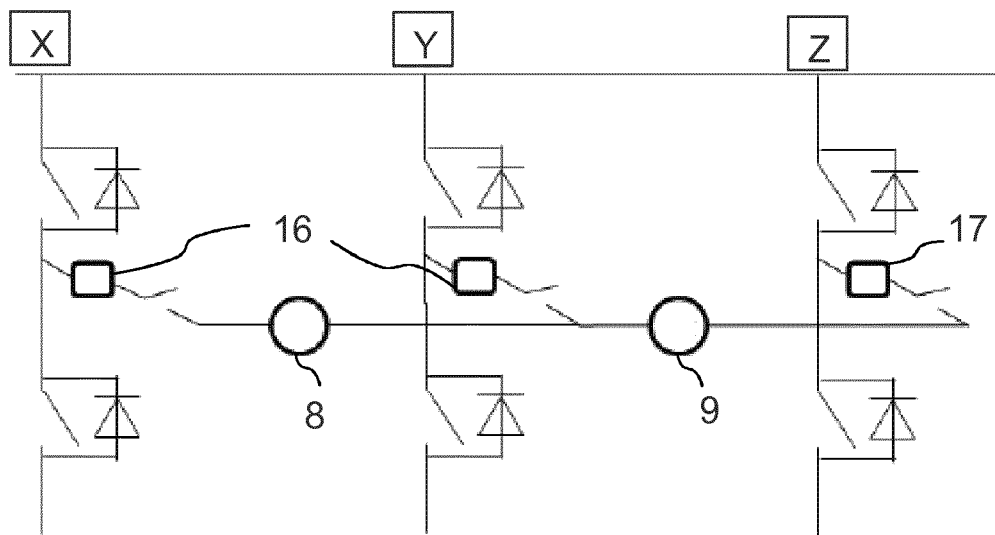


FIG. 3



## EUROPEAN SEARCH REPORT

Application Number  
EP 17 19 2032

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| DOCUMENTS CONSIDERED TO BE RELEVANT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                      |                                                             |                                         |
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| Category                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Citation of document with indication, where appropriate, of relevant passages                                                                        | Relevant to claim                                           | CLASSIFICATION OF THE APPLICATION (IPC) |
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| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | * column 3, lines 50-67 *<br>* column 4, lines 17-58 *<br>* figures *                                                                                | 4,5                                                         |                                         |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | -----<br>EP 0 947 658 A2 (GEZE GMBH [DE]; GEZE GMBH & CO [DE]) 6 October 1999 (1999-10-06)<br>* paragraphs [0024], [0025] *<br>* figure 3 *<br>----- | 1-13                                                        |                                         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                      |                                                             | TECHNICAL FIELDS SEARCHED (IPC)         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                      |                                                             | E05F                                    |
| The present search report has been drawn up for all claims                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                      |                                                             |                                         |
| Place of search<br><b>The Hague</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                      | Date of completion of the search<br><b>23 February 2018</b> | Examiner<br><b>Mund, André</b>          |
| CATEGORY OF CITED DOCUMENTS<br>X : particularly relevant if taken alone<br>Y : particularly relevant if combined with another document of the same category<br>A : technological background<br>O : non-written disclosure<br>P : intermediate document<br>T : theory or principle underlying the invention<br>E : earlier patent document, but published on, or after the filing date<br>D : document cited in the application<br>L : document cited for other reasons<br>& : member of the same patent family, corresponding document |                                                                                                                                                      |                                                             |                                         |

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