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(54) METHOD AND APPARATUS FOR DETERMINING THE POSITION OF THE ROTOR OF AN ELEVATOR MOTOR

VERFAHREN UND VORRICHTUNG ZUR BESTIMMUNG DER POSITION DES ROTORS EINES AUFZUGSMOTORS

PROCEDE ET APPAREIL PERMETTANT DE DETERMINER LA POSITION DU ROTOR D'UN MOTEUR D'ASCENSEUR

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Description

[0001] The present invention relates to a method as defined in the preamble of claim 1 and an apparatus as defined in the preamble of claim 5 for determining the position of the rotor of an elevator motor.

[0002] The torque of a synchronous motor is proportional to the angular difference between the rotor magnetic field and the stator magnetic field, i.e. to the rotor angle. The torque is at a maximum when the rotor angle is 90° and it falls according to the sine function as the rotor angle changes. The torque curve of synchronous motors designed for use in an elevator drive is a nearly sinusoidal function of the rotor angle. The function of the control system controlling the elevator motor is to keep the torque at the maximum point.

[0003] Currently used methods for determining the rotor position are not applicable in the case of e.g. flat surface-magnet motors designed for use in elevators without machine room and placed in the elevator shaft, such motors having equal Lq and Ld. Prior-art methods intended for surface magnet motors are based on a comparison of the torque and the angle. When used in an elevator, they cause problems relating to safety and comfort.

[0004] A method for determining the position of the rotor of a synchronous motor disclosed in specification WO-A2-02/065139 allows the absolute angular position of the rotor to be computed while the rotor is stationary by monitoring the saturation of the stator iron. In this method, an alternating current having a certain frequency and phase angle is fed into the stator, samples are taken at given intervals from the current fed in and the voltage obtained, and the stator inductance is calculated from these voltage and current values. After that, the phase angle is increased a certain number of times over the 360-degree cycle and the current feed, sampling and calculation are repeated, thus obtaining a certain number of calculated stator inductances. Next, the position of the d-axis relative to the stator is determined from the minimum of the calculated stator inductance values. This is a relatively complicated method.

[0005] The patent application US2001/0004173 and EP0838669 A2 are further relevant documents of the prior art.

[0006] The object of the present invention is to overcome the drawbacks of prior art and create new type of arrangement that can be used to determine the position of the rotor of an elevator motor without moving the rotor and by using relatively low magnetization.

[0007] The system of the invention is mainly based on the property of an axial motor that it tends to work as a sound reproducer when the rotor and stator are moving on the shaft. In the invention, the angular position of the rotor is detected without releasing the brake by feeding a current of a frequency of about 50...200 Hz into the motor and measuring the vibration of the machine as a function of the rotor angle.

[0008] The details of the features of the method and apparatus of the invention are presented in the claims below.

[0009] The invention increases the areas of application of especially permanent-magnet synchronous motors with no angle feedback used in elevators. In addition, the arrangement of the invention is an advantageous way of finding the rotor angle. Moreover, the invention is safe because the brakes need not be released and the correct angle can be determined more reliably than by prior-art methods. Furthermore, the method of the invention can be relatively easily automated, because the elevator is not moving and therefore fewer monitoring and safeguarding measures are required.

[0010] In the following, the invention will be described in detail with reference to an example and the attached drawing, wherein

[0011] Fig. 1 is a simplified diagrammatic representation of the apparatus of the invention for determining the rotor angle of an elevator motor.

[0012] Fig. 1 presents an apparatus comprising an elevator motor 1, which may be a flat axial motor placed in the elevator shaft and which has a permanent magnet rotor 11 and a stator 12, which is driven by means of a frequency converter 2. The frequency converter is controlled by a control unit 3.

[0013] In the invention, the angular position of the rotor is detected without releasing the brake by feeding a current of a frequency of about 50...200 Hz into the motor and measuring the vibration of the machine as a function of the rotor angle.

[0014] The motion on the shaft is at a maximum when the stator current is in the direction of the d-axis, which means that the stator and rotor have maximum attractive and repelling forces (arrows) but no torque. If the current is in the direction of the q-axis, then the torque is at a maximum while the attractive and repelling forces are at a minimum.

[0015] When an alternating current of a frequency of 50...200 Hz is used, the motor noise varies very much depending on the position of the rotor. If the frequency is near the resonant frequency, the amplitude of the noise may vary by tens of dB.

[0016] It is possible to increase acoustic feedback or acceleration feedback e.g. by using a resolver. By adding a very simple microphone (sound reproducer) 4 or an acceleration sensor attached to the motor body, the adjustments can be automated by finding the minimum signal. The magnetization current may be small, even only a few hundred mA, and the brake of the motor can be kept closed.

[0017] By using the invention, the maximum torque angle can be found but its direction can not be detected unambiguously. To achieve this, it is possible to release the brake and check the torque direction in connection with the start of motion.

[0018] It is obvious to the person skilled in the art that different embodiments of the invention are not limited to the example described above, but that they may be varied

within the scope of the claims presented below. Instead of a current signal, it is possible to use a voltage signal, and the direction of the current is estimated by utilizing the motor parameters (resistance, inductance).

Claims

1. A method for determining the position of the rotor (11) of a synchronous motor (1) used as an elevator motor, in which method: an alternating current or voltage of a certain frequency is fed into the stator of the motor, and a quantity produced by the alternating current or voltage is measured and used to determine the position of the rotor; **characterized in that**, in the method, the vibration of the machine is measured as a function of the rotor angle, and the position of the rotor (11) is determined by utilizing the said vibration.

2. A method according to claim 1, **characterized in that** the vibration is measured by means of a microphone or acceleration sensor attached to the motor body and utilized to provide feedback.

3. A method according to claim 1, **characterized in that**, in the method, a minimum signal is found, whereupon it is possible e.g. to detect the maximum torque angle.

4. A method according to claim 1, **characterized in that**, in the method, a maximum signal is found, whereupon it is possible e.g. to detect the minimum torque angle and the maximum torque can be obtained with a 90° phase shift.

5. An apparatus for determining the position of the rotor (11) of a synchronous motor (1) used as an elevator motor, comprising: supply means used to feed an alternating current or voltage of a certain frequency into the motor, and a unit used to measure a quantity produced by the alternating current or voltage fed in, **characterized in that** the apparatus comprises elements used to measure the vibration of the machine as a function of the rotor angle, the said vibration being utilized to determine the position of the rotor (11).

6. An apparatus according to claim 5, **characterized in that** the apparatus comprises a microphone (4) or an acceleration sensor fitted to the motor body and used to produce feedback.

Patentansprüche

1. Verfahren zur Bestimmung der Position des Rotors (11) eines Synchronmotors (1), der als Aufzugsmotor verwendet wird, bei welchem Verfahren dem Stator des Motors ein Wechselstrom oder eine Spannung bestimmter Frequenz zugeführt wird, und eine Grö-ße, die durch den Wechselstrom oder die Wechselspannung generiert wurde, gemessen und verwendet wird, um die Position des Rotors zu bestimmen, **dadurch gekennzeichnet, dass** in dem Verfahren die Vibration der Maschine als Funktion des Rotorwinkels gemessen wird, und die Position des Rotors (11) bestimmt wird durch Verwendung dieser Vibration.

2. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, dass** die Vibration gemessen wird mittels eines Mikrophons oder Beschleunigungssensors, der an dem Motorkörper angebracht ist und verwendet wird, um ein Feedbacksignal bereitzustellen.

3. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, dass** in dem Verfahren ein Signalminimum gefunden wird, woraufhin es möglich ist, z.B. den Winkel des maximalen Drehmoments zu bestimmen.

4. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, dass** in dem Verfahren ein Signalmaximum gefunden wird, woraufhin es möglich ist, z.B. den Winkel des minimalen Drehmoments zu bestimmen, und das maximale Drehmoment über eine 90°-Phasenverschiebung erhalten werden kann.

5. Vorrichtung zur Bestimmung der Position des Rotors (11) eines Synchronmotors (1), der als Aufzugsmotor verwendet wird, umfassend: Speiseeinrichtungen zur Zuführung eines Wechselstroms oder einer Wechselspannung bestimmter Frequenz zu dem Motor, und eine Einheit zum Messen einer Größe, die durch den/die zugeführten Wechselstrom oder Wechselspannung hervorgerufen wurde, **dadurch gekennzeichnet, dass** die Vorrichtung Elemente umfasst, die verwendet werden, um die Vibration der Maschine als Funktion des Rotorwinkels zu messen, wobei die Vibration verwendet wird, um die Position des Rotors (11) zu bestimmen.

6. Vorrichtung nach Anspruch 5, **dadurch gekennzeichnet, dass** die Vorrichtung ein Mikrophon (4) oder einen Beschleunigungssensor umfasst, der an dem Motorkörper angebracht ist und verwendet wird, um ein Feedbacksignal zu generieren.

Revendications

1. Procédé permettant de déterminer la position du rotor (11) d'un moteur synchrone (1) utilisé en tant que moteur d'ascenseur, dans lequel procédé : un courant ou une tension alternatifs d'une certaine fré-

quence sont introduits dans le moteur, et une quantité produite par le courant ou la tension alternatifs introduits est mesurée et utilisée pour déterminer la position du rotor ;
caractérisé par le fait que, dans ce procédé, la vibration de la machine est mesurée en tant que fonction de l'angle de rotor, et la position du rotor (11) est déterminée en utilisant ladite vibration.

2. Procédé selon la revendication 1,
caractérisé par le fait que la vibration est mesurée au moyen d'un microphone ou d'un capteur d'accélération reliés au corps du moteur et utilisée pour fournir un retour.

3. Procédé selon la revendication 1,
caractérisé par le fait que, dans ce procédé, un signal minimum est trouvé, après quoi il est possible par ex. de détecter l'angle de couple maximum.

4. Procédé selon la revendication 1,
caractérisé par le fait que, dans ce procédé, un signal maximal est trouvé, après quoi il est possible par ex. de détecter l'angle de couple minimum et le couple maximum peut être obtenu avec un déphaseur 90°.

5. Appareil permettant de déterminer la position du rotor (11) d'un moteur synchrone (1) utilisé en tant que moteur d'ascenseur, comportant : un moyen d'alimentation servant à introduire un courant ou une tension alternatifs d'une certaine fréquence dans le moteur, et une unité servant à mesurer une quantité produite par le courant ou la tension alternatifs introduits,
caractérisé par le fait que l'appareil comporte des éléments servant à mesurer la vibration de la machine en tant que fonction de l'angle de rotor, ladite vibration étant utilisée pour déterminer la position du rotor (11).

6. Appareil selon la revendication 5,
caractérisé par le fait que l'appareil comporte un microphone (4) ou un capteur d'accélération montés sur le corps du moteur et servant à produire un retour.

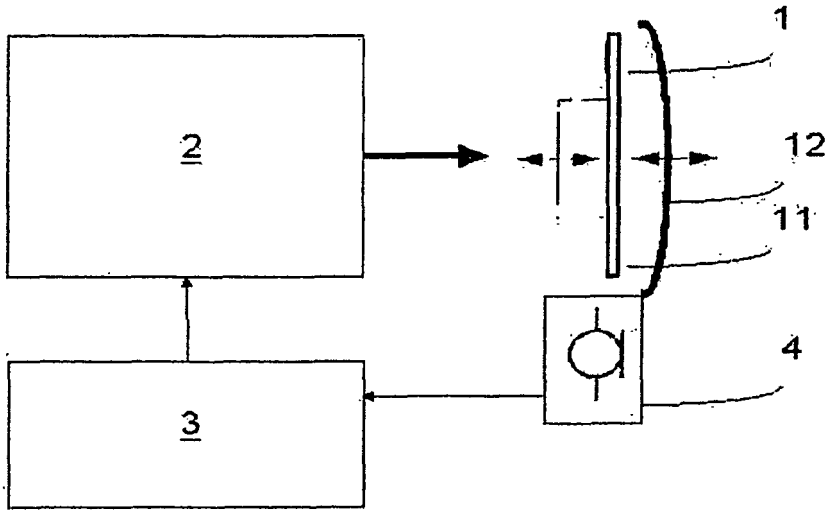


FIG. 1

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO 02065139 A2 **[0004]**
- US 20010004173 A **[0005]**
- EP 0838669 A2 **[0005]**