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(54) **Device and method for automatic opening and closing of doors and gates**

(57) A device for automatic opening and closing of doors and gates comprising an electric motor (1), an electronic control unit (2) arranged to be connected to the electric motor (1) through a supply line (3), at least one position sensor (FC1, FC2, FC3, FC4), and a conversion unit (5), arranged to be set in series on the supply line (3) between the electric motor (1) and the electronic control unit (2), said conversion unit (5) being arranged to receive at input a position signal (S1, S2, S3, S4) coming from said at least one position sensor (FC1, FC2, FC3, FC4) and to interrupt at least temporarily the current in the electric motor (1) in response to the position signal (S1, S2, S3, S4) coming from said at least one position sensor (FC1, FC2, FC3, FC4).

control unit (2), said conversion unit (5) being arranged to receive at input a position signal (S1, S2, S3, S4) coming from said at least one position sensor (FC1, FC2, FC3, FC4) and to interrupt at least temporarily the current in the electric motor (1) in response to the position signal (S1, S2, S3, S4) coming from said at least one position sensor (FC1, FC2, FC3, FC4).

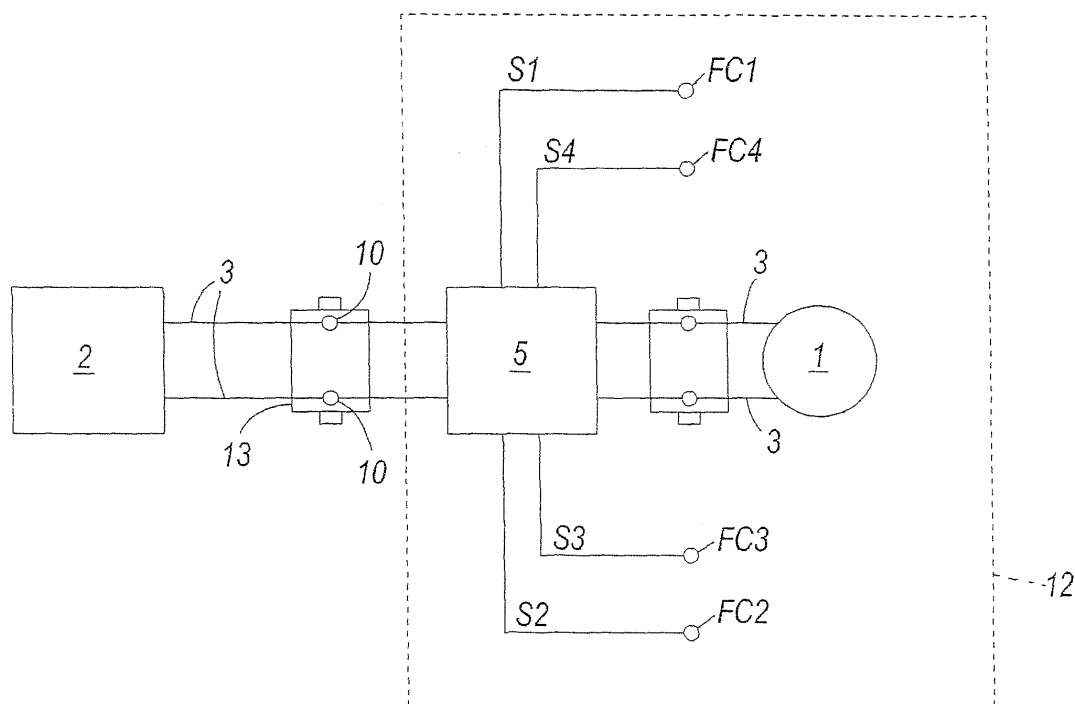


Fig. 1

Description

[0001] The present invention relates to a device and a method for automatic opening and closing of doors and gates according to the preamble of the main claims.

[0002] At the state of the art devices for automatic opening and closing of doors and gates comprise an electric motor for actuating each leaf of the gate and an electronic control unit connected to the electric motor by a supply line. The electronic control unit supplies the electric motor with the supply voltage. To be type approved, the electronic control unit must be able to read the current absorbed by the electric motor and adjust the supply voltage supplied to the electric motor as a function of the current absorbed. If, for example, a person or object were to be located in the middle of the gate when it is closing, the electric current in the motor would increase as the effort made by the motor increases, but the electronic control unit would be able to read said increase of current and suspend the supply to the motor stopping it before it can possibly cause damage. A gate with just one leaf has normally four position sensors: two end-of-travel sensors for the closed and open positions of the gate, which determine arrest of the movement, and two proximity sensors, which detect that the leaf is approaching the end-of-travel position and send a signal which governs a reduction of the rate of movement of the leaf so as to avoid a violent arrest. Said position sensors generate a signal that is processed by the electronic control unit, which is able to stop the motor or decrease its r.p.m.

[0003] The connection between the electronic control unit and the actuation system comprising the motor and four position sensors has at least seven connections: two for the supply line of the motor and five for the signals coming from the four sensors (it is assumed that the neutral is in common). Less sophisticated gates do not have proximity sensors, for slowing down the movement, but only end-of-travel sensors for arrest of the movement. An actuation system with two sensors would hence have five connections for connection to the electronic control unit.

On account of the presence of a large number of connections, installation of a device for automatic opening and closing of doors and gates is rather laborious. It calls for a specialized operator and the time for understanding how to make the connections properly.

[0004] An aim of the present invention is consequently to provide a device and a method that will enable the drawbacks referred to be overcome; in particular, an aim is to provide an automatic device for opening and closing of doors and gates with a reduced number of connections between the electronic control unit and the actuation system.

Another aim is to provide a method for governing a device for automatic opening and closing of doors and gates, which will enable a smaller number of connections.

[0005] The above purposes are achieved by a device and a method the inventive characteristics of which are

highlighted in the claims.

[0006] The invention will be better understood from the ensuing detailed description, provided purely by way of the non-limiting example of an embodiment illustrated in the annexed drawings, wherein:

Figure 1 shows a first diagram of the device according to the invention;

Figure 2 shows an embodiment of the electrical circuit of the conversion unit; and

Figure 3 shows a second diagram of the device according to the invention.

[0007] The device for automatic opening and closing of doors and gates according to a particular embodiment of the invention, shown in Figure 1 and referred to with the overall reference numeral 19, comprises:

- an electric motor 1, such as a d.c. motor;
- a mechanical actuator such as a piston, one or more levers or a worm 15, through which the motor 1 can drive for example a leaf of a gate, moving it from a closed position to an open position and vice versa;
- an electronic control unit 2 connected to the electric motor 1 through a supply line 3; and
- a conversion unit 5 set in series on the supply line 3 between the electric motor 1 and the electronic control unit 2.

The electric motor 1, the mechanical actuator 15, the electronic control unit 2 and the conversion unit 5 can be made as a self-contained and compact supply unit 19 ready for being easily mounted on the door or gate to be driven, and preferably are contained and shielded by a housing or shell 17 which can be made of metal or plastic (Figure 3).

The electronic control unit 2 is arranged, through the supply line 3, to supply the electric motor 1 with a supply voltage, to read the current absorbed by the electric motor 1 during its operation, and to adjust the supply voltage on the supply line 3 supplied to the electric motor 1 as a function of the current absorbed by the electric motor 1. For example, if the leaf moved by the electric motor 1, in its movement, encounters an obstacle that brakes or stops it, the current absorbed by the motor increases, the electronic control unit 2 detects said increase of current and suspends the voltage applied on the supply line 3 so as to stop the motor and not cause accidents or damage.

[0008] In the embodiment of the device according to the invention that is suited to opening the leaf of a gate with slowing-down before reaching end-of-travel (Figure 1), the device comprises four position sensors FC1, FC2, FC3, and FC4, two of which (FC1 and FC2) are used as end-of-travel sensors, when the leaf is to stop, and another two (FC3 and FC4) are used as proximity sensors, when the leaf has not yet terminated its travel but approaches its end-of-travel and hence has to slow down.

[0009] Preferably the position sensors FC1, FC2, FC3, FC4 are mounted on the supply unit 19 so as to directly detect the proximity- and end of travel positions of the worm or other mechanical actuator 15; in particular the position sensors can be enclosed in the housing or shell 17. Alternatively the position sensors FC1, FC2, FC3, FC4 can be mounted out of the supply unit 19, for example directly on the threshold of the door or gate to be driven.

The position sensors FC1, FC2, FC3, and FC4 are arranged to send each a position signal S1, S2, S3, S4 to the conversion unit 5, which is arranged to receive and detect said position signals. The position sensors can basically be switches that are closed or opened by contact when the leaf of the gate is in a pre-set position.

[0010] The conversion unit 5 contains an electrical circuit, which, in response to a position signal S3 or S4 coming from one of the position sensors FC3 and FC4 used for proximity detection, opens the supply line 3 temporarily, for example, by means of a relay, interrupting the current in the electric motor 1. Said suspension of the current to the electric motor 1, of the duration of a few milliseconds, is not sufficient to block the movement of the leaf of the gate, but is sufficient to be detected by the electronic control unit 2 at least as a reduction of the current absorbed by the electric motor 1. Since the electronic control unit 2 is provided for reading the current absorbed by the motor 1, it interprets the reduction of current as a signal, in response to which the electronic control unit 2 reduces the voltage applied on the supply line 3, thus reducing the r.p.m. of the electric motor 1, and slowing down the movement of the leaf of the gate and causing it to reach the end-of-travel position slowly. To this purpose the duration T1 of the reduction or interruption of the current supplied to motor 1 is preferably equal to or shorter than 1,2 seconds, and more preferably equal to or shorter than 0,8 seconds.

The suspension duration T1 has to be such to slow down the movement of the leaf of the door or gate driven by the device but without completely stopping it. Therefore the duration T1 depends on the mass and the rotational inertia of the door or gate to be driven, and on other factors such as the frictions on the door or gate hinges; nevertheless it was observed that a current interruption lasting 0,8 seconds is sufficient for slowing down the most of commonly used doors and gates without substantially stopping them. In this connection optimum values of duration T1 range between 0,2-0,8 seconds, and more preferably between 0,5-0,8 seconds.

[0011] When the leaf of the gate has reached one of the two end-of-travel positions, the position sensors FC1 and FC2 arranged to detect the end-of-travel send a position signal S1, S2 to the conversion unit 5, in response to which the conversion unit 5 opens the supply line 3 and keeps it open, stopping the current of the electric motor 1 and stopping the electric motor 1 in so far as the leaf of the gate has reached the end-of-travel. The conversion unit 5 is then arranged to receive and read the position

signals S1 - S4 sent thereto by the position sensors FC1 - FC4, discriminating whether the position signal received indicates the end-of-travel of the leaf or the proximity and acting accordingly on the line 3 for supply of the motor 1. In the case of position signal indicating proximity (signals S3, S4 sent by the position sensors FC3 and FC4), the conversion unit 5 opens the supply line 3, interrupting the current to the electric motor 1 for a few fractions of a second -that is, for a time T1 lasting as set forth above- and the electronic control unit 2 consequently slows down the rate of the motor 1. In the case of position signal indicating the end-of-travel (signals S1, S2 sent by the position sensors FC1 and FC2), the conversion unit opens the supply line and keeps it open, interrupting the current to the electric motor 1 until the polarity of the voltage on the supply line 3 is reversed by the electronic control unit 2 in order to set the leaf of the gate in motion in the opposite direction.

[0012] It is of course possible for the conversion unit 5, in response to the position signals S1 and S2 that indicate the end-of-travel, to suspend the current to the electric motor 1 for an interval of time different from that for which the current is suspended in response to a position signal S3 or S4 that indicates proximity. The different current absorbed in the two cases by the motor could be read by the electronic control unit 2, which in one case slows down the electric motor 1, whilst in the other case stops it. Arrest of the electric motor 1 could hence be governed by the electronic control unit 2 instead of by the conversion unit 5.

[0013] Once the electric motor 1 is stopped, in so far as the leaf of the gate has reached one of the two end-of-travel positions (leaf completely open or leaf completely closed), it can be set in motion again only in the opposite direction, by reversing the polarity of the supply on the line 3. The conversion unit 5 is arranged to enable closing of the supply line 3 after its permanent opening, that is for instance for a duration equal to or longer than two seconds, only when the electronic control unit 2 reverses the polarity of the voltage on the supply line 3 with respect to the one present on the supply line 3 before opening the supply line 3.

[0014] Figure 2 shows an electrical diagram of one embodiment of the conversion unit according to the invention, where the four position sensors are contact sensors, hence schematically represented by switches. For example, by closing the sensor FC4 that represents a proximity sensor, the current passes through the capacitor C1 and through the resistor R2 and reaches the base of the transistor Q2, which goes into conduction and activates the relay LS3 opening it temporarily. The current to the electric motor 1 is interrupted for a period T1 of a few milliseconds, said duration is determined by the capacitance of the capacitor C1 and by the value of the resistance R4. The electronic control unit 2 detects interruption of current to the motor 1 and slows down the rate of the motor 1 thus reducing the voltage applied on the supply line 3. The gate, proceeding in its movement at a

lower rate, comes, at end-of-travel, to close the sensor FC1. The current in this case bypasses the capacitor C1, arrives to the base of the transistor Q2, keeping it permanently active and opening the relay LS3 and keeping it open. The resistor R2 functions as current limiter so as not to have excessively strong pulses on the transistor Q2. The resistor R4 is a protection and limits the duration of the pulse determined by the capacitor C1. The diode D5 protects the transistor Q2 from overvoltage, whilst the diode D1 protects the transistor Q2 from the reverse current of the relay LS3.

[0015] The diodes D3 and D4 activate alternatively the two parts A and B into which the circuit is divided. Part B of the circuit is identical to part A and functions like part A interrupting temporarily or permanently the current to the electric motor 1 through the relay LS4 according to closing of the sensors FC3 and FC2. Once the current to the electric motor 1 has been interrupted permanently on account of closing of the position sensor FC1, the electric motor 1 can be set again in motion only in the opposite direction, when the electronic control unit 2 reverses the polarity of the voltage applied on the supply line 3. In this case the gate, moving in the opposite direction, first closes the position sensor FC3, which determines a temporary suspension of current T1 to the electric motor 1, detected by the electronic control unit 2, which reduces the supply voltage and the rate of the motor 1, and then closes the position sensor FC2, which determines a permanent stop of the current to the motor 1 until the electronic control unit again reverses the polarity of the voltage applied to the supply line.

It is of course possible that the functions of the conversion unit 5 may be obtained by an electrical circuit built in a different way or by a CPU programmed in an appropriate way.

[0016] The actuation system 12 comprises the electric motor 1, the conversion unit 5, and one or more position sensors FC1- FC4. The actuation system 12 produced in the factory has only two connections 10 to the electronic control unit 2 combined in one connector 13. The connection between the actuation system 12 and the electronic control unit 2 is thus extremely simple and suitable also for an installer with little experience.

[0017] The aim of the present patent is also to protect a method for governing a device for automatic opening and closing of doors and gates comprising an electric motor 1 and an electronic control unit 2 connected to the electric motor 1 by means of a supply line 3, said electronic control unit 2 being arranged to supply the electric motor 1 with a supply voltage, to read the current absorbed by the electric motor 1 and to adjust the supply voltage to the electric motor 1 as a function of the current absorbed by said electric motor 1, and at least one position sensor FC3, FC4 used as proximity sensor, the method comprising the following actions:

- the door or the gate in its movement of opening or closing reaches a pre-set position whereby the po-

sition sensor FC3 or FC4 sends a signal S3 or S4;

- in response to said position signal S3 or S4 the current in the supply line 3 is temporarily interrupted for a time interval T1, causing a temporary reduction of the average current absorbed by the electric motor 1; and
- the electronic control unit 2 reads the temporary reduction of current absorbed by the electric motor 1 and responds by reducing the supply voltage supplied to the electric motor 1 through the supply line 3 so as to reduce the r.p.m. of the electric motor 1.

[0018] The temporary suspension of the current to the electric motor 1 is of a few milliseconds, as previously explained, it does not serve to stop the motor but serves to send a signal to the electronic control unit 2, which can read the reduction of current on average absorbed by the motor or also a pulse for interruption of current.

Thanks to the fact that the proximity signal S4 results in a pulse for interruption of current to the electric motor 1, the electronic control unit 2 can read said signal in the form of reduction of current to the electric motor 1 and reduce accordingly the voltage and the speed of rotation of the electric motor 1 -or however of the driven door or gate- without any need for direct connections to each individual position sensor used, but with a simple connector 13 having two connections to the supply line 3.

[0019] The connections of the actuation system 12 are all produced in the factory so that the assembly and connection of the actuation system 12 to the electronic control unit 2 is particularly simple and fast, requiring only coupling of the male-female parts of the connector 13, which contains the connection 10.

[0020] The embodiments previously described can be modified in different ways without departing from the scope of the invention. For example a device for automatic opening and closing of doors and gates according to the invention can be provided with a number of position sensors different from four, for example comprising even only one position sensor FC1 used as end of travel sensor, when the door or gate leaf needs to be stopped, and only another position sensor FC3 used as proximity sensor.

The previous examples and lists of possible variations in this application are to be understood as non exhaustive lists.

Claims

1. A device for automatic opening and closing of doors and gates (19) comprising an electric motor (1), an electronic control unit (2) arranged to be connected to the electric motor (1) through a supply line (3), said electronic control unit (2) being arranged, through the supply line (3), to supply the electric motor (1) with a supply voltage, to read the current absorbed by the electric motor (1) and to adjust the

- supply voltage supplied to the electric motor (1) as a function of the current absorbed by the electric motor (1), and at least one position sensor (FC1, FC2, FC3, FC4), said device (19) being **characterized by** comprising a conversion unit (5), arranged to be set in series on the supply line (3) between the electric motor (1) and the electronic control unit (2), said conversion unit (5) being arranged to receive at input a position signal (S1, S2, S3, S4) coming from said at least one position sensor (FC1, FC2, FC3, FC4) and to reduce and/or interrupt at least temporarily the current in the electric motor (1) in response to the position signal (S1, S2, S3, S4) coming from said at least one position sensor (FC1, FC2, FC3, FC4).
2. The device for automatic opening and closing of doors and gates according to Claim 1, **characterized by** comprising a first position sensor (FC1) and optionally a second position sensor (FC2), for detection of the end-of-travel, the conversion unit (5) being arranged to receive at input the position signals (S1, S2) generated by said first and optionally second position sensors (FC1, FC2) and to open the supply line (3) to stop the current in the electric motor (1) in response to the position signals (S1, S2) coming from said first and optionally second position sensors (FC1, FC2).
 3. The device for automatic opening and closing of doors and gates according to Claim 2, **characterized by** comprising a third position sensor (FC3) and optionally a fourth position sensor (FC4), the conversion unit (5) being arranged to receive at input the position signals (S3, S4), generated by said third and optionally fourth position sensors (FC3, FC4), and to open temporarily the supply line (3) to stop the current in the electric motor (1) temporarily in response to the position signals (S3, S4) coming from said third and optionally fourth position sensors (FC3, FC4).
 4. The device for automatic opening and closing doors and gates according to Claim 3, **characterized in that** the conversion unit (5) is arranged for opening temporarily the supply line (3) for a time interval T1 equal to or shorter than 1,2 seconds, for switching off or reducing temporarily the current in the electric motor (1) in response to the position signals (S3, S4) coming from said third and optional fourth position sensor (FC3, FC4).
 5. The device for automatic opening and closing doors and gates according to claim 3, **characterized in that** the electronic control unit (2) is arranged to adjust the supply voltage supplied to the electric motor (1) reducing the rate thereof, as a consequence of a reduction of the current absorbed by the electric motor (1) on account of the temporary interruption of the current to the electric motor (1) by the conversion unit (5).
 6. The device for automatic opening and closing of doors and gates according to Claim 2, **characterized in that** the conversion unit (5) is arranged to enable closing of the supply line (3) after its opening, only if the voltage on the supply line (3) has a polarity reversed with respect to the one present on the supply line (3) before opening of the supply line (3).
 7. The device for automatic opening and closing of doors and gates according to Claim 1, **characterized in that** the electric motor (1), the conversion unit (5), and said at least one sensor (FC1, FC2, FC3, FC4) are comprised in an actuation system (12), which has only two connections (10) for connection to the electronic control unit (2).
 8. The device for automatic opening and closing of doors and gates according to Claim 1, **characterized in that** at least one of said position sensors (FC1, FC2, FC3, FC4) comprises a contact switch.
 9. The device for automatic opening and closing of doors and gates according to Claim 3, **characterized in that** said conversion unit comprises at least one capacitor (C1, C2) for generation of a pulse that controls temporary opening of the supply line (3).
 10. The device for automatic opening and closing of doors and gates according to Claim 1, **characterized by** comprising a housing (17) which during the normal operation contains and shields:
 - the electric motor (1);
 - the electronic control unit (2);
 - at least one first position sensor (FC1, FC2) arranged for detecting a proximity position in which the door or gate draws near to the opening or closing position;
 - at least one second position sensor (FC3, FC4) arranged for detecting when the door or gate is substantially closed or open;
 - the conversion unit (5).
 11. A method for governing a device for automatic opening and closing of doors and gates, said device comprising an electric motor (1), an electronic control unit (2) connected to the electric motor (1) by means of a supply line (3), said electronic control unit (2) being arranged to supply the electric motor (1) with a supply voltage, to read the current absorbed by the electric motor (1), and to adjust the supply voltage supplied to the electric motor (1) as a function of the current absorbed by the electric motor (1), and at least one position sensor (FC4), said method being **characterized by** comprising the step of interrupting

and/or reducing temporarily, for example by a time interval T1 equal to or shorter than 1,2 seconds, the current in the supply line (3) in response to a position signal (S4) coming from the position sensor (FC4), causing a temporary reduction of the current absorbed by the electric motor (1). 5

12. The method according to claim 11, **characterized in that** the electronic control unit (2) reads the temporary reduction of current absorbed by the electric motor (1) and responds by reducing the supply voltage supplied to the electric motor (1) through the supply line (3) so as to reduce the speed of rotation of the electric motor (1). 10

13. The method according to claim 11, wherein the device for automatic opening and closing of doors and gates comprises at least one first position sensor (FC1, FC2) and at least one second position sensor (FC3, FC4), and the method is **characterised by** 20 comprising the following steps:

- detecting a predetermined proximity position by means of the at least one second position sensor (FC3, FC4), wherein in said proximity position the door or gate draws near the closing or opening position; 25
- detecting a predetermined end of stroke position by means of the at least one first position sensor (FC1, FC2), wherein by said end of stroke position the door or gate is substantially closed or open; 30
- reducing or interrupting temporarily the supply current to the electric motor (1) for a time interval T1 optionally equal to or shorter than 1,2 seconds in response to the detection of the predetermined proximity position by the at least one second position sensor (FC3, FC4); 35
- subsequently restore the supply current to the electric motor (1); 40
- subsequently stop the electric motor (1) when the door or gate reaches the predetermined end of stroke position, for example by interrupting the supply current to the electric motor (1). 45

14. Method according to claim 13, comprising the step of restarting the electric motor (1) reversing the rotation direction after the electrical motor (1) has reached the predetermined end of stroke position. 50

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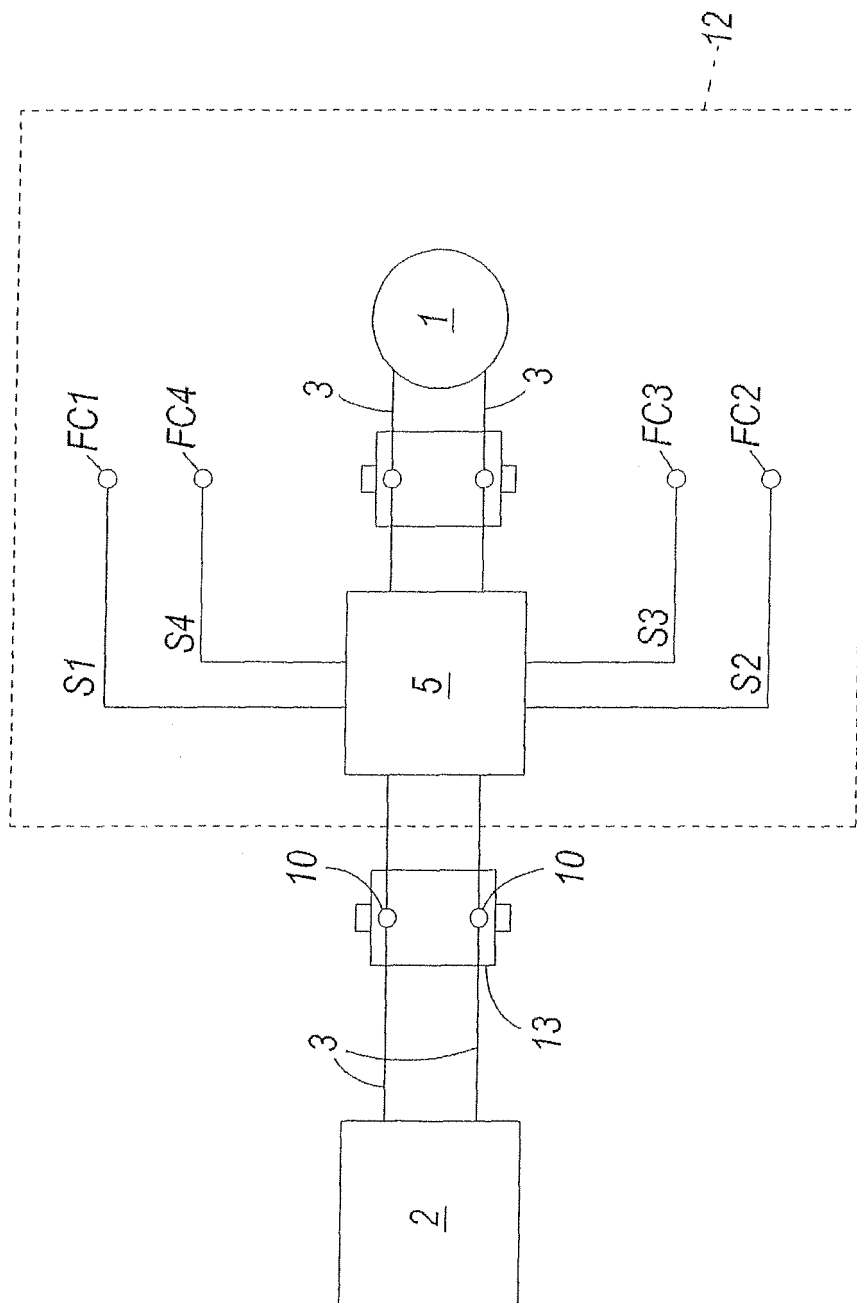


Fig. 1

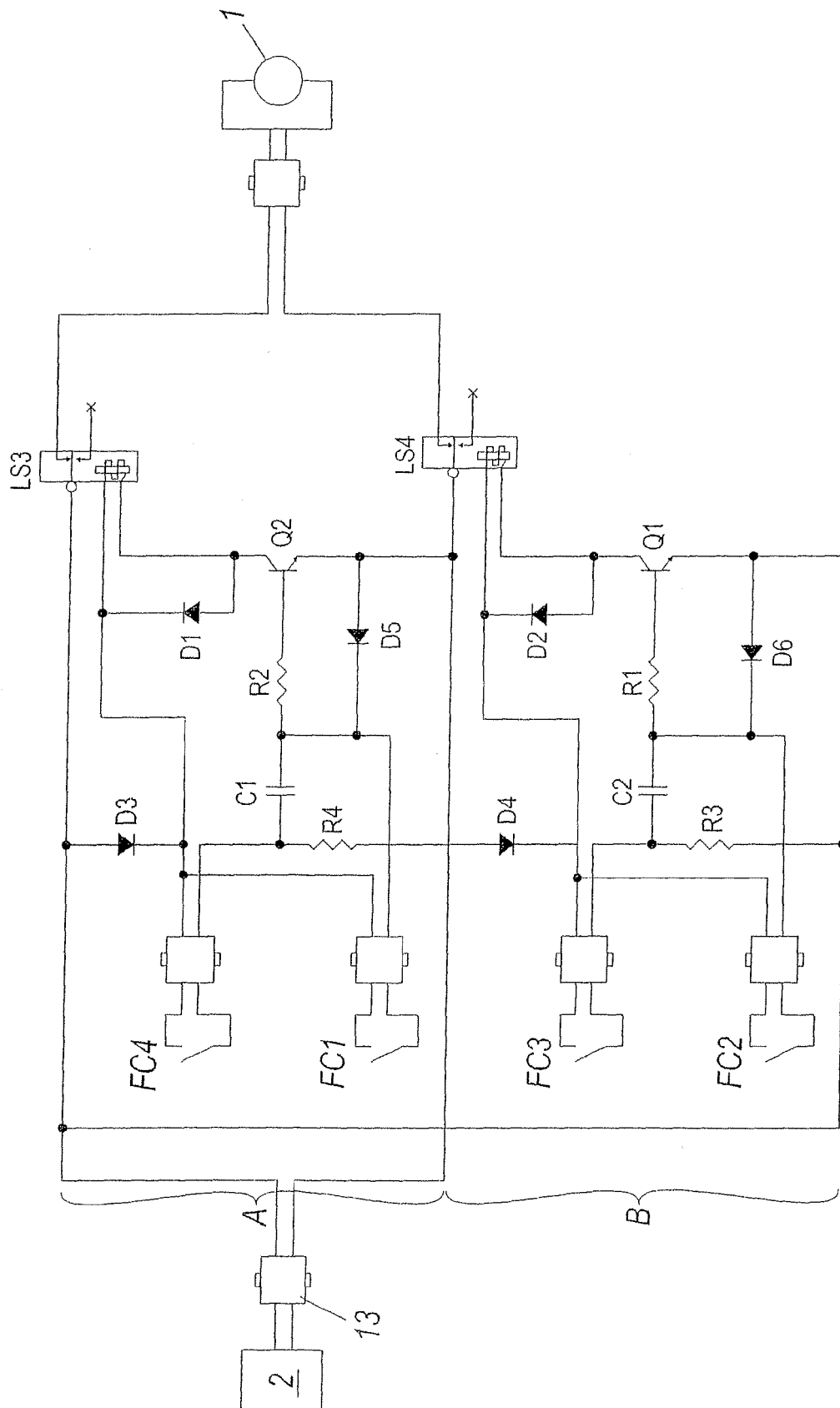


Fig. 2

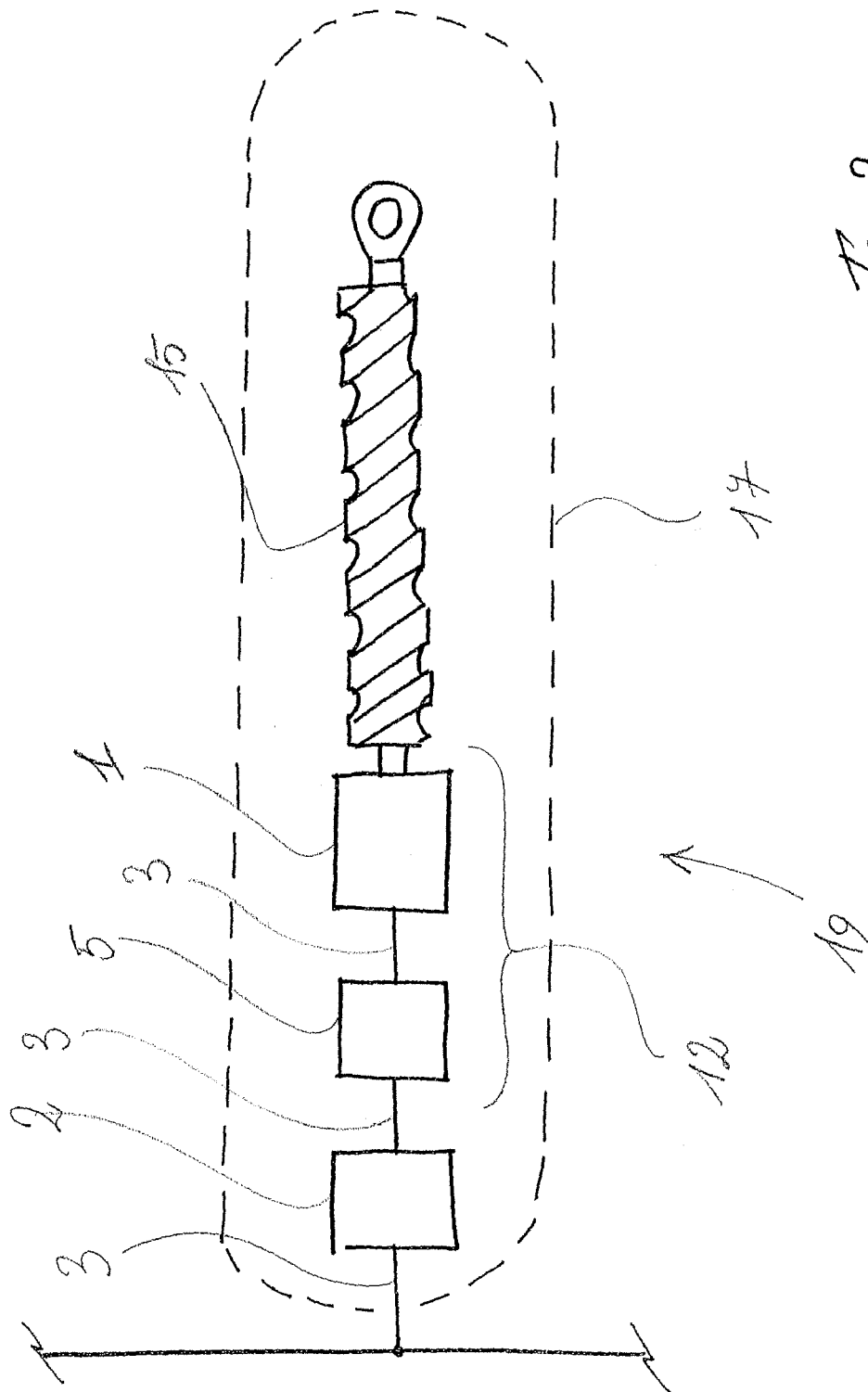


Fig. 3



EUROPEAN SEARCH REPORT

Application Number
EP 09 17 6721

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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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The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (IPC)
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Place of search		Date of completion of the search	Examiner
Munich		24 February 2010	Balice, Marco
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 09 17 6721

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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