

The invention relates to a circuit arrangement for the control of motors in accordance with the first part of claim 1.

In motors for precision drives in which, besides the exact adherence to predefined values of rotational speed, there is a requirement for a rapid change of speed and locking onto the changed values of the speed, it is known to connect the inputs of the winding arrangement to current sources by means of a commutating device in order to cause the rotor of the motor to follow a predefined alternating field and to monitor the speed by a feedback action. Owing to the driven mass however, the desired reaction of the rotor is not inertialess but rather, is coupled with a more or less long delay. See for example the patent specification US-A- 3 443 186.

If the rotor is to adopt a higher speed, the delay can be reduced in that, by an appropriate control action, a high positively directed torque is exerted on the rotor and is maintained until such time as the attainment of the desired speed is recognised by the feedback action and then, the control is again reduced to the steady positively directed torque which is necessary for the maintenance of the speed. A change of the speed to a smaller value can be achieved particularly rapidly in that the steady control is turned off, an opposite i.e. negatively directed torque is then applied and, after reaching the reduced speed, there is a return once again to the steady control. However, a problem with this method consists in that the speed reached after the abatement of the negatively directed torque does not always correspond exactly to the sought after actual speed and thus a yet further braking or acceleration process is required. Additionally, the commutation sequence of the connections of the winding arrangement has to be resynchronised with the current rotation of the rotor.

It would be desirable therefore, to maintain the control for the realisation of a positively directed torque, also during the time in which a negatively directed torque is being applied. Thereby, it would be ensured via the feedback action that the commutation sequence of the connections of the winding arrangement also operates synchronously during the braking. Here however, the problem arises, that in their opposed effects on the rotor, the control devices mutually hinder or even destroy one another.

The invention relates to the last mentioned problem. Its object is to produce a circuit arrangement for the control of motors which enables a very precise and rapidly reacting change of the rotational speed both up to higher as well as to lower values of the speed.

This object is achieved in a circuit arrangement in accordance with the first part of the claim 1 by the features specified in the characterising part.

The measures in accordance with the invention permit the same winding arrangement to be used for the acceleration and the braking. Thereby, an undisturbed superimposition of the feed currents is achieved by the construction of the sources undertaking the energy feed in the winding arrangement, as current sources, so that the energy sources do not mutually destroy one another while being simultaneously effective. Instead of a single current source, groups of current sources may also be provided whereby the number of the current sources or partial current sources in each group can be measured in accordance with the number of poles of the motor and also possibly as to whether uni or bipolar control is selected.

Preferably the current sources are constructed such that they are controllable independently of each other. In this way, in the presence of a speed monitor e.g. by means of a tachogenerator and PLL circuit, the speed synchronous commutation can be maintained while an alteration of the speed of the motor is being carried out by means of the other current source. Upon switching off the other current source, the motor can therefore react more quickly and attain the original speed since there is no need to wait until the speed synchronous commutation is re-established in the event of a previously occurring interruption.

The measure in accordance with the invention is useable especially advantageously if the winding arrangement of the motor is bipolar controlled. In this way, due to a better utilisation of copper, a higher torque and thereby, for the same weight, a more rapid reaction to control processes is achieved.

Further developments and advantageous embodiments of the invention are given in the claims, the description and the drawing which illustrates one embodiment of the invention.

The drawing shows in the block circuit diagram, an arrangement of current sources which are connectable via a commutating device to connections of a winding arrangement of the motor as an integral part of a circuit arrangement for the control of motors. Therein, a three phase winding arrangement 1 having connections 2, 3 and 4 is connected via commutating devices 5, 6, 7 and 8 to groups of current sources 9 and 10. The groups of current sources 9 and 10 are comprised of a partial current source 11 and 12 respectively for positively directed currents and of partial current sources 13 and 14 respectively for negatively directed currents. This arrangement thus allows a bipolar control of the motors.

Whenever one of the two groups of current sources 9 or 10 are in operation, then the partial current sources 11 and 13, or 12 and 14 pertaining to these groups are always connected up simultaneously. The groups of current sources 9 serve for the acceleration while the groups of current sources 10 serve for the deceleration. By means of the commutating circuits 5 and 7, the partial current sources 11 and 13 are respectively connected to those connections 2, 3 and 4 of the winding arrangement 1 of the motor with which, taking into account the position of the rotor which is to be driven, a field is generated which will give rise to an acceleration. For the braking, this applies in a corresponding manner to the groups of current sources 10 in which the partial current sources 12 and 14 are similarly connectable to the connections 2, 3 and 4 of the winding arrangement 1 by means of the commutating circuits 6 and 8. Thereby, the case can also arise that two current sources are connected simultaneously to the same connections, thus for example the partial current source 11 and the partial current source 14 to the connection 4. Due to the construction of the energy sources as current sources however, here, there is only a simple superimposition of the currents without any endangering of the current sources themselves. The commutating circuits 5, 6, 7 and 8 as well as the groups of current sources 9 and 10 have control inputs 15, 16, 17, 18, 19, 20, 21, 22 which are connected to a control circuit 23. The control circuit 23 is thereby phase dependent, as is indicated by a feedback 24. It is thus achieved that the rotating fields generated in the winding arrangement 1 by the current sources 11, 12, 13, 14 are exactly matched to the rotational movement of the motor.

In this way, a superimposition of the rotating fields is possible which can, in the desired manner, lead to an acceleration or a braking without a control loop having to be interrupted. One phase from the commutated control, in which current from the group 9 of current sources 11, 13 serving for

the acceleration as well as current from the group 10 of current sources 12, 14 serving for the braking is supplied to the winding arrangement 1, is illustrated in the drawing.

In this phase, the partial current source 11 is connected to the connection 4, the partial current source 13 to the connection 2, the partial current source 14 to the connection 4 and the partial current source 12 to the connection 3. There then flows in the winding arrangement 1, a current $-i_{13}$ via the connection 2, a current $+i_{12}$ via the connection 3 and a current $+i_{11}-i_{14}$ via the connection 4. The indices here refer to the references of the current sources delivering the current.



Claims

1. Circuit arrangement for the control of an electronically commutatable motor in which the connections (2, 3, 4) of a winding arrangement (1) are connectable to current sources (11, 12, 13, 14) by means of a certain number of electronically controllable commutating devices (5, 6, 7, 8), characterised in that,

a) there is provided a first controllable current source (9) which is connectable to the winding arrangement (1) or group (9) of controllable current sources (11, 13) which is connectable to the winding arrangement (1), for the production of a rotating field effecting the acceleration of the motor,

b) there is provided a second controllable current source (10) which is connectable to the winding arrangement (1) or group (10) of controllable current sources (12, 14) which is connectable to the winding arrangement (1), for the production of a rotating field effecting the braking of the motor,

c) control inputs (15, 16, 17, 18) of the current sources (9, 10) or groups (9, 10) of current sources (11, 13; 12, 14) and control inputs (19, 20, 21, 22) of the commutating devices (5, 6, 7, 8) are connected to a control circuit (23) which is dependent on the motor speed and phase,

d) for the purpose of rapid acceleration or braking of the motor, the current sources (9, 10) or groups (9, 10) of current sources (11, 13; 12, 14) are so controlled by the control circuit (23) via the commutating devices (5, 6, 7, 8) that the rotating field effecting the braking is superimposed on the rotating field effecting the acceleration, without thereby, a control loop for the current source (9) or group (9) of current sources (11, 13) serving for the acceleration having to be interrupted .

2. Circuit arrangement in accordance with claim 1, characterised in that, the current sources (9, 10) or groups (9, 10) of current sources (11, 12; 13, 14) connectable to the connections (2, 3, 4) of the winding arrangement (1) are controllable independently of each other.



3. Circuit arrangement in accordance with claim 1 and/or claim 2, characterised in that, the current sources (9, 10) or groups (9, 10) of current sources (11, 12; 13, 14) are connectable to the connections (2, 3, 4) of the winding arrangement (1) via a commutating device comprising electronically controlled switches (5, 6, 7, 8).

4. Circuit arrangement in accordance with one or more of claims 1 to 3, characterised in that, the groups (9, 10) of current sources (11, 13; 12, 14) comprise complementary oppositely poled partial current sources (11; 13; 12; 14) simultaneously connectable to different connections (2, 3, 4).

5. Circuit arrangement in accordance with claim 4, characterised in that, the complementary partial current sources (11; 13; 12; 14) are controllable by means of a current mirror circuit whose control inputs are connected to the motor speed and phase dependent control circuit (23).

6. Circuit arrangement in accordance with one or more of claims 1 to 5, characterised in that, the current sources (11, 13) serving for the acceleration are continuously controlled and the current sources (12, 14) serving for the braking are controlled as required.