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(54) Benævnelse: **Fremgangsmåde og styresystem til styring af elektriske motorer**

(56) Fremdragne publikationer:
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DESCRIPTION

[0001] The invention relates to a method and control system for controlling electric motors, especially motors carrying relatively strong current. Such motors are widely used for the operation of ship thrusters where it is also particularly important to assure reliable operation.

[0002] Normally, direct-current motors are used, and the current to both the motor rotor or armature and the field coils or field magnets is connected via an operating relay. The operation and the direction of rotation of the motor is controlled by means of a joystick or the like that is connected to a power source such as a battery and via the operating relay provides the desired power supply to the motor.

[0003] One problem that may arise is that the operating relay or the main relay of the motor becomes locked in the on position, usually as a consequence of low voltage and subsequent relay failure and/or strong current, but also for other reasons. The motor will then rotate uncontrollably until the main power switch of the operating system is switched off. This will easily take some second or minutes for an unskilled or inexperienced user or skipper. If the motor operates a thruster which pushes the boat to port or to starboard in narrow stretches or water, the consequence may be personal injury and material damage.

[0004] The object of the invention is to provide a method for controlling electric motors and a control system for electric motors which eliminate the problems of the aforementioned type, and this is achieved by the system as disclosed in claim 1. Document EP0651489 discloses a control system for an electric motor (M), wherein the control system comprises an operating relay having first (C1) and second (C2) relay windings, each with respective normally open and a normally closed relay contacts.

[0005] Advantageous embodiments of the invention are disclosed in the dependent claims.

[0006] The invention will now be described with reference to the drawings, wherein:

Fig. 1 illustrates a standard circuit connection or a control system for an electric motor;

Fig. 2 illustrates a first embodiment of the control system according to the invention;

and

Fig. 3 illustrates a second embodiment of the control system according to the invention.

[0007] Fig. 1 indicates, *inter alia,* an electric motor comprising a rotor or armature 9 and field coils or field magnets M. The motor is a direct-current motor whose rotor 9 and field magnet or magnets M are connected via an operating relay 10, a control means 13, which in the illustrated case consists of a joystick with spring return, wires, a safety fuse 14 and a switch 12, to a power source 11, in the illustrated case a battery. The operating relay 10 is of a type that comprises a first relay winding A1 and a second relay winding B1, each comprising two respective relay contacts A and B respectively. In the drawing, the circuit connection is shown when non-energised or in so-called open position. The centre position or neutral position of the joystick 13 and one of the poles of the armature 9 are connected to the negative terminal of the battery 11. After the battery switch 12 has been switched on, the circuit is ready for operation. When the joystick 13 is moved across to the left of the figure, contact is made between a wire 4 and a wire 1 in the first relay winding A1 so that a circuit is formed through the winding to the wire 3 and via the safety fuse 14 and the switch 12 to the positive terminal of the battery 11, and the relay winding is energised so that one of the relay contacts A is opened or broken and the other is closed or made. For the sake of simplicity, the direction of current is defined as a positive to negative direction. Thus, the current flows through the field coils or field magnets M, then through the closed relay contact B and the armature 9 and back to the negative terminal of the battery 11. If the joystick 13 is shifted to the right in the figure, the current is connected through the relay winding B1 so that the relay contacts are opened and closed respectively via the closed contact to the opposite side of the field coils or field magnets M, according to the sequence described above, through the now closed relay contact A and to the armature 9. Since the field magnets are now excited in the opposite direction, the motor will rotate in the opposite direction.

[0008] It is this standard connection that is particularly vulnerable, as the relay 10 can become locked in the on or energised position as described above, with the problems that this might entail.

[0009] Fig. 2 shows a circuit connection or control system which for the most part is similar to the connection in Fig. 1, but which

has been modified so that a far more reliable operation is provided according to the invention. In one embodiment of the invention there is incorporated a safety function unit 15 which is provided with terminals for connection to the control means 13, the relay windings A1 and B1, optionally a thermoswitch 16 connected to the motor armature 9 or simply arranged internally in the motor and provides controlling current or displacement voltage to the control system, and two terminals S1 and S2 which via indicated broken lines are connected to the open, non-energised relay contacts A and B respectively or another suitable point in the motor which has a varying voltage or current depending on operation or non-operation of the motor.

[0010] The control means 13 may comprise one or more of a number of operating devices such as a joystick, a touch panel, buttons and/or switches, to provide corresponding current control to the motor and the operating relay 10 as described above.

[0011] A signal or signals, sensed by a suitable method if operating relay 10 contacts A and B are in the on position (energised), is or are applied via the terminals S1 and S2 on the unit 15. This applied signal is compared with the voltage at the respective relay windings A1 and B1, i.e., the control signal at the magnet coils of the relay. On position is only accepted by the unit 15 or the control system when the respective relay contact A or B and magnet winding A1 or B1 also have voltage applied thereto.

[0012] What is meant by a suitable method for determining whether the operating relay contacts are in the on position (energised) is, for example, that voltages are measured and compared, the drawing of current is measured, the Hall effect is measured, the rotational speed of the motor is measured, frequencies in cables are measured or the actual mechanical position of the relay contacts is determined using a switch or another sensor etc. All these options and possibly other options for determining whether the operating relay contacts are energised are within the scope of the invention and represent technically obvious options or alternatives.

[0013] If a move is made to cut off the applied voltage, this means that the user or skipper no longer wishes to operate the motor or thruster. In the unit 15 an examination or check is then made to see whether the respective relay contact A or B is also in the open position. If this is not the case, the unit 15 ensures that an operating signal is applied immediately to the opposite side of the relay or magnet winding A1 or B1 or to both sides simultaneously, and this action of the safety function unit 15 causes the electric circuit to be broken and the motor 9 to be stopped, However, it is clear that the monitoring or checking in the unit 15, as mentioned above, should possibly also be carried out continuously during operation, or should only be carried out in a limited period of time after the intended cutting-out of the motor. Both possibilities are within the scope of the invention and represent technically obvious options or alternatives.

[0014] Fig. 3 shows another variant of the control system according to the invention which comprises safety functions for monitoring the voltage to the motor 9. For the sake of clarity, the system in Fig. 3 is shown and described as a separate system, although it could have been incorporated into the system in Fig. 2.
Unlike Fig. 2, Fig. 3 shows the safety function unit 15 equipped with a terminal SV which via a wire indicated in a broken line is connected to the wire 3 between the relay windings.

[0015] The problem on which this variant of the invention is based is that at low supply voltage, the relays A and B could fail with a subsequent risk of burning and uncontrollable operation of the electric motor and thruster. The reason for the burning of the contacts at low voltage is that even at low output voltage (battery voltage), the thruster motor will draw substantial amounts of current. This current will lead to a voltage drop in cables or wires and the battery when the motor is running. If the output voltage is too low, this will cause the relays to fail. When the relays fail, the voltage to the motor will be cut off and the voltage rises again to its starting-up point. This is repeated at a frequency which, because of the arc formation, quickly results in overheating and melting of the contacts on the operating relay of the motor. The relay contacts A or B might then become locked in the on position.

[0016] One solution to this problem may be to ensure that the relay cannot cut in and out as mentioned above at a fairly high frequency. According to the invention, this is ensured in that the control system monitors the voltage applied to the relay coils A1 and B1 and if the voltage is too low, the power supply to the relay windings of the operating relay is cut, whereupon a delay device is activated before the next feed or application of voltage to the same or to the opposite side of the relay windings A1 and B1 once the voltage is above the threshold value again. The operator or the skipper or user will then register that the voltage is too low in that the thruster performs with a distinct low-frequency pulsating output. The contacts of the operating relay are thus not damaged because of the low frequency and the thus limited heating of the contact faces, and necessary measures can be taken before greater damage is done.

[0017] The application of voltage to the operating relay coils will not be fed to a relay winding if the voltage is measured to be below the threshold value.

[0018] The function that the control system in fact provides is to reduce the possibility of damage to the relay contact faces caused by low voltage during operation, and that in the event that the relay is nevertheless in the energised, operational position without the user or skipper having given a signal for this, that the system, on the application of current to one or both of the relay windings A1 and B1, ensures that the relay contacts A and B are put in the same position, i.e., the on position at the same time in order to stop the motor because the circuit is broken when both relay contacts are in the same position.

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- EP0651489A [0004]

Patentkrav

1. Styresystem til en elektrisk motor, hvilken motor omfatter et motoranker (9) og en feltspole (M), hvori styresystemet omfatter et betjeningsrelæ (10) med første og andre relævindinger (A1, B1), hver med respektive normalt åbne og normalt lukkede relækontakter (A, B), en styreenhed (13), hvori en første terminal af de normalt åbne og normalt lukkede relækontakter (A, B) styret af de første relævindinger (A1) er tilsluttet en første side af feltspolen (M), og en første terminal af de normalt åbne og normalt lukkede relækontakter (A, B) styret af de andre relævindinger (B1) er tilsluttet en anden side af feltspolen (M), og en anden terminal af de normalt åbne og normalt lukkede relækontakter (A, B) styret af de første relævindinger (A1) er serieforbundet med en strømkilde (11), motorankeret (9) og en anden terminal af de normalt åbne og normalt lukkede relækontakter (A, B) styret af de andre relævindinger (B1), hvori systemet yderligere omfatter en sikkerhedsfunktionsenhed (15) omfattende følemidler arrangeret til at føle spændingen over de første og andre relævindinger (A1, B1) og yderligere arrangeret til at føle en spænding på mindst en af de normalt åbne og normalt lukkede relækontakter (A, B), hvori sikkerhedsfunktionen (15) er arrangeret sådan, at når der ikke er noget styresignal til de første og andre relævindinger (A1, B1), når en af de normalt åbne relækontakter (A, B) er lukkede, aktiverer sikkerhedsfunktionsenheden (15) både de første og de andre relævindinger (A1, B1) til at åbne de normalt lukkede relækontakter (A, B), sådan at motoren standser.

2. Styresystem ifølge krav 1, hvori sikkerhedsfunktionsenheden (15) er forsynet med terminaler (S1, S2), som via ledninger er tilsluttet styreenheden (13), hvori ledningerne (1, 2) er tilsluttet en side af de respektive relævindinger (A1, B1), sådan at spændingen ved vindingerne (A1, B1) kan føles og gives som et signal til de tilsluttede terminaler på enheden (15), hvis modstående sider er tilsluttet via ledning (3) til strømkilden (11), og terminaler (S1, S2) er tilsluttet de i relæets (10) åbne stilling ikke-aktiverede relækontakter (A, B), sådan at det kan føles, om relækontakterne (A, B) er i en aktiveret stilling, hvori den følte værdi sammenlignes med en referenceværdi, og den følte stilling gives som et signal til terminalerne (S1, S2), og signalerne fra de respektive relækontakter (A, B) og sikkerhedsfunktionsenheden (15) er arrangeret til at sammenligne relævindingernes (A1, B1) stilling, hvori sikkerhedsfunktionsenheden (15) omfatter en indretning, som i tilfælde af en uoverensstemmelse mellem de pågældende sammenlignede signaler er indrettet til umiddelbart at påtrykke et betjeningssignal på den mod-

satte side af den relevante relævinding (A1, B1), sådan at det elektriske kredsløb brydes og motoren standser.

3. System ifølge krav 2, hvori enheden (15) yderligere omfatter en terminal (SV), som via en ledning er forbundet med en ledning (3) tilsluttet en forbindelse mellem to relævindinger (A1, B1) eller indgangsspændingen til motoren eller styresystemet, sådan at spændingen på dette punkt kan føles og gives som et signal til terminalen (SV), og i enheden (15) er der tilvejebragt en indretning, som bestemmer, om den følte spænding er for lav i forhold til en forudbestemt tærskelværdi, ved hvilken relæerne ikke svigter, men er nær ved at gøre det, og en egnet forsinkelsesindretning, som aktiveres forud for hver påtrykning af spænding på den modsatte side af den relevante relævinding (A1, B1), sådan at påtrykning af spænding i tilfælde af relæsvigt vil ske ved en lavere frekvens end uden forsinkelsesindretningen.

4. Styresystem ifølge krav 1, hvori sikkerhedsfunktionsenheden (15) er udstyret med terminaler, som via ledninger er tilsluttet styreenheden (13) og en terminal (SV), som via en ledning er forbundet med en leder eller ledning (3) tilsluttet en forbindelse mellem to modstående relævindinger (A1, B1), sådan at spændingen på dette punkt kan føles og gives som et signal til terminalen (SV), og i enheden (15) er der tilvejebragt en indretning, som bestemmer, om den følte spænding er for lav i forhold til en forudbestemt tærskelværdi, og en egnet forsinkelsesindretning, som aktiveres forud for hver påtrykning af spænding på den modsatte side af den relevante relævinding (A1, B1), sådan at påtrykning af spænding i tilfælde af relæsvigt vil ske ved en lavere frekvens end uden forsinkelsesindretningen.

5. System ifølge et af krav 1-4, hvori styreenheden (13) omfatter en eller flere af joystick, touchpanel, knapper, radiosignalmodtager, automatisk styring med passende intelligens og/eller omskifterkontakter.

6. System ifølge et af krav 1-4, hvori følerne eller føleindretningerne omfatter mikroswitches og/eller andre egnede måleindretninger eller detektorer.

7. System ifølge et af krav 1-6, hvori der er tilvejebragt en termoomskifterkontakt (16) tilsluttet mellem motorankeret og sikkerhedsfunktionsenheden (15).

DRAWINGS

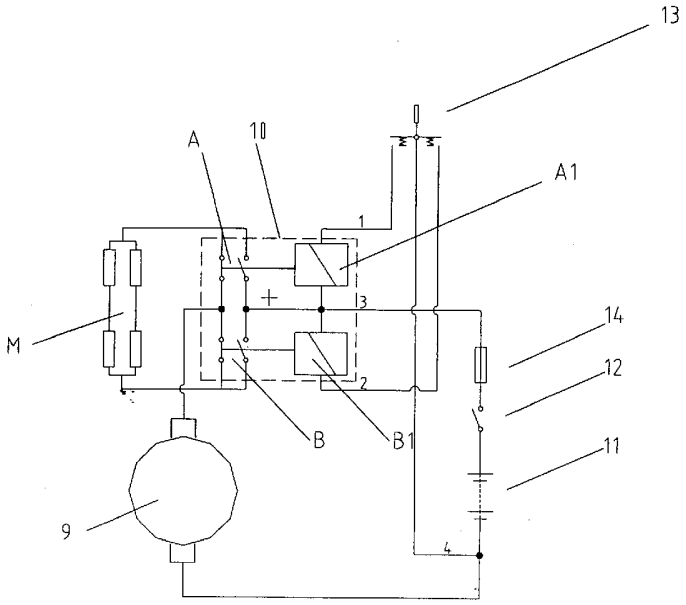


Fig. 1

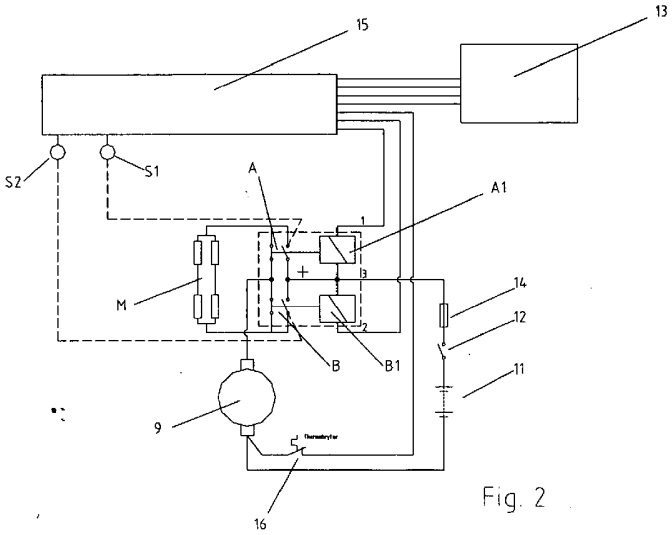


Fig. 2

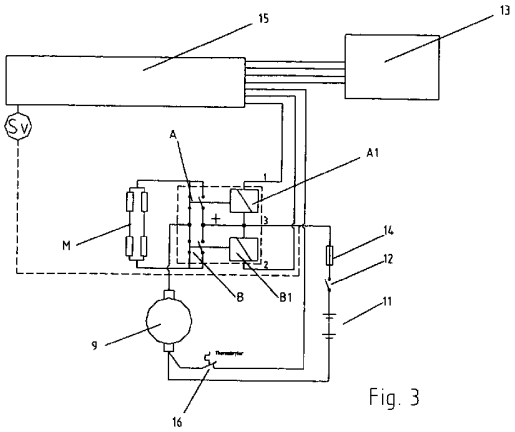


Fig. 3