

02 MAR 2000

**DRIVE WITH A CONTROLLER FOR A LIFTING GEAR OF A HOIST, IN
PARTICULAR A COMPACT HOIST**

This application claims the priority of German Patent Application, Serial No.

5 19911429.3-32, filed March 5, 1999, the subject matter of which is incorporated herein by reference.

The present invention relates, in general, to a hoist of a type having a drum for winding and unwinding a load-bearing member connected to a load-receiving
10 member, and more particularly, to a drive with a controller for a lifting gear of a hoist, whereby the lifting speed and lifting direction are controllable by an operator.

European Patent No. EP 647 586 B1 describes a drive system for a lifting gear
15 which uses asynchronous drive motors that exhibit a long life and are wear-resistant. The asynchronous motor drives a drum for winding and unwinding a cable as a load-bearing member. A load-receiving member, for example a hook, for receiving a load is attached to the lower end of the cable. Disadvantageously, however, asynchronous motors of this type are relatively
20 expensive, in particular if used with small inexpensive hoists.

An operator can control the drive by setting the lifting speed and the lifting direction using switches and/or keys as control elements. In this context, reference is made, for example, to German Pat. No. DE 44 12 557 A1 which
25 discloses the use of analog keys which supply a voltage signal which depends on the position of a longitudinally slideable lever and is converted by a frequency converter into a corresponding motor rotation speed. A separate analog key which also transmits to the controller a signal indicating the rotation direction of the asynchronous motor, is thereby provided for each lifting
30 direction. The lifting gear is generally stopped by a mechanical brake.

German Pat. No. DE 42 42 671 C2 proposes a drive for a hoist which has, in particular, a permanently excited DC motor and a gear mechanism. The

rotation speed of the DC motor is controlled by adjusting the DC voltage of the motor power supply, with the polarity determining the rotation direction. It is proposed to brake the drive by implementing the gear mechanism as a worm gear with a reduced efficiency, i.e. the DC motor operates constantly with an
5 engaged "brake."

The publication "Bremsen von elektromotorischen Antrieben (II)" (*Braking of electric motor drives (II)*) in German-language publication "der elektromeister - deutsches elektrohandbuch", volume 17/1983, pp. 1121-1124, describes a
10 braking method for DC motors. A series-wound motor can be electrically braked by commutating the exciter winding at the same time the DC motor is disconnected from the motor power supply and the motor is short-circuited.

The aforescribed drives and the associated controller have the disadvantage
15 of being complex and expensive to manufacture.

It is thus an object of the present invention to provide an improved drive for a lifting gear of a hoist, obviating the afore-stated drawbacks.

20 In particular, it is an object of the present invention to provide an improved lifting gear of an inexpensive compact hoist, in which the drive essentially does not coast after the lifting motion is switched off, to thereby allow a shutdown under load in an emergency situation and a quick reversal of the lifting direction.

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These objects, and others which will become apparent hereinafter, are attained in accordance with the present invention by providing an electric motor in the form of a universal motor with at least one stator winding and one rotor winding having two terminals, with the windings connected in series to an AC power
30 supply, whereby a specified value of the AC output voltage of the AC power supply is associated to each preset lifting speed. Both terminals of the rotor winding can be commutated within the series connection of the windings to

reverse the lifting direction and to stop to the hoist, whereby the hoist can be stopped by disconnecting the series-connected windings additionally from the AC power supply and short-circuiting the windings after the rotor winding terminals are commutated.

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A universal motor which has such an electronic braking circuit for the lifting gear and operates with an AC voltage, provides a very cost-effective solution for small hoists, since the lifting motion can be interrupted quickly at any time and without requiring expensive braking devices, in particular in the event of an
 10 emergency shut-off under load, and also for rapidly reversing the lifting direction. Due to the interaction of the magnetic fields of the stator windings and the rotor winding, this type of brake converts the entire kinetic energy of the universal motor directly to a short-circuit current and thereby to heat. This effect takes advantage of the fact that after the AC power supply is
 15 disconnected, the magnetic field stored in the windings is still present for a short time. The universal motor therefore stops immediately even with an applied nominal load as a consequence of the presence of gears forming part of the hoist.

20 To positively disconnect the universal motor, the windings are shorted via a resistor. The cost of the universal motor can be further reduced by providing the AC power supply with a phase angle control which can be advantageously implemented with triacs which are easy to control.

25 The circuit can be simplified by providing at least one switching relay for disconnecting the electric motor from the AC power supply, for commutating the terminals of the rotor winding and for short-circuiting the windings. This switching relay is advantageously actuated by a single switch. The switching relay, which can be energized and de-energized to make or break a
 30 connection, closes or opens the switches required for braking the universal motor in the required temporal sequence. Even large currents can be reliably switched. The brake circuit can be simplified further by having the switching

relay sequentially switch an interrupt switch which disconnects the AC power supply, a changeover switch which reverses the lifting direction, and a short-circuit switch which shorts the windings.

- 5 An emergency shut-off in the event of an AC power supply failure can be realized by energizing the switching relay from the AC power supply. If the AC power supply fails, then the switching relay is de-energized and actuates the switch in the aforescribed sequence to provide an emergency stop for the universal motor, thereby preventing the load from dropping at a high rate.

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The above and other objects, features and advantages of the present invention will be more readily apparent upon reading the following description of a preferred exemplified embodiment of the invention with reference to the accompanying drawing, in which:

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FIG. 1 is a schematic control circuit for a universal motor forming a drive motor of a lifting gear of a hoist, in accordance with the present invention; and

FIG. 2 is a schematic overall drive circuit diagram for the lifting gear of

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FIG. 1.

Throughout all the Figures, same or corresponding elements are generally indicated by same reference numerals.

- 25 Turning now to the drawing, and in particular to FIG. 1, there is shown an electric control circuit for a universal motor which is used as a drive motor of a lifting gear of a hoist (not shown). The hoist typically includes a drum for winding and unwinding a load-bearing member (not shown) which is connected to a load-receiving member (not shown). The drive motor of the drum is an
- 30 AC-operated universal motor, generally designated by reference numeral 1.

The universal motor 1 is connected to an AC power supply 2 and includes a rotor winding 3a which is arranged on a rotatably supported rotor shaft (not shown) and has two terminals 5a, 5b. Disposed on either side of the rotor winding 3a are two stator windings 3b and 3c in relative parallel relationship, whereby the rotor winding 3a and the stator windings 3b, 3c are connected in series. The two terminals 5a, 5b of the rotor winding 3a can be commutated within the series connection by means of a changeover switch 4 which includes four individual switches 4a, 4b, 4c, 4d. A brake switch 6 is used to allow disconnection of the universal motor 1 from the AC power supply 2 using a brake switch 6.

Also illustrated in FIG. 1 is a switching relay 7 shown in an energized switching state. The four individual switches 4a, 4b, 4c, 4d of the changeover switch 4 can be alternately switched by the switching relay 7. In addition, the switching relay 7 also switches a short-circuit switch 8 which is open when the switching relay 7 is energized; as indicated in FIG. 1. The switching relay 7 is so designed as to open and close the switches 4, 8 almost simultaneously, i.e. switches the switches 4, 8 over into their respective other switching state. Persons skilled in the art will understand, however, that is certainly also feasible to switch the switches 4, 8 in accordance with a predetermined temporal sequence.

When the universal motor is to be stopped, the brake switch 6 is opened, causing the switching relay 7 to be de-energized. At approximately the same time or at a slight time delay, the changeover switch 4 is actuated by the switching relay 7, commutating the terminals 5a, 5b of the rotor winding 3a within the series-connected windings 3a, 3b, 3c. After actuation of the changeover switch 4, a de-energizing of the switching relay 7 is accompanied by a closing of the switch 8 which short-circuits the three windings 3a, 3b, 3c.

A switch-over of the individual switches 4a, 4b, 4c, 4d and a subsequent closing of the short-circuit switch 8 results in a mutual interaction of the still existing magnetic fields of the two stator windings 3b, 3c and of the rotor

winding 3a, thereby inducing in the shorted circuit a large short-circuit current and thus converting the entire magnetic field energy into heat. The induced short-circuit current inhibits the movement of the rotor by producing a large braking torque which brakes the rotor. Thus, the briefly existing magnetic field of the rotor winding 3a, and the stator windings 3b, 3c is used to generate the braking torque. Practice has shown that this braking torque is large enough to stop the universal motor 1 immediately after the switch 6 is closed.

FIG. 2 shows an overall drive circuit diagram of the lifting gear of FIG. 1. The universal motor 1 is here connected to a phase angle controller 10 which is implemented by electrically controllable triacs. The phase angle controller 10 is connected to a 220 VAC power mains, with the AC output voltage connected to the series-connected windings 3a, 3b, 3c of the universal motor 1. The phase angle controller 10 has a control input to which a control voltage can be applied. The magnitude of the control voltage is determined by the frequency of the AC output voltage. The frequency of the AC output voltage in turn determines the rotation speed of the universal motor 1.

The control voltage is produced by a control element 11 which may be implemented as a resistive potentiometer. Alternatively, the control element 11 can also be a longitudinally moveable plunger-type switch which supplies a control voltage of a magnitude in dependence on the position of the plunger. In particular advantageous is the provision of two longitudinally moveable plunger-type switches 12, 13, as shown in FIG. 2, with switch 12 being used for raising the load, while the other switch 13 is used for lowering the load, whereby only one of the two switches 12, 13 can be actuated at one time. When not actuated by an operator, the two switches 12, 13 are in their respective rest positions.

When either one of the switches 12, 13 is actuated, the respectively actuated one of the switches 12, 13 closes along its path first the brake switch 6, thereby energizing the switching relay 7. Subsequently, the respectively actuated one of

the switches 12, 13 actuates a rotation direction switch 12a or 13a, respectively, which switches the changeover switch 4 to the position which corresponds to the predetermined rotation direction. The rotational speed of the universal motor 1 is then adjusted with the switch 12 or 13 to the desired
5 value.

When the actuated one of the switches 12, 13 is returned to its rest position, for example by means of a return spring force, the brake switch 6 is opened again, so that the switching relay 7 is de-energized and the universal motor 1 stops in
10 a manner described above.

Subsequent actuation of the other one of the switches 12, 13 results again in a closing of the brake switch 6, and the universal motor 1 is thereafter operated in the opposite rotation direction.

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While the invention has been illustrated and described as embodied in a drive with a controller for a lifting gear of a hoist, in particular a compact hoist, it is not intended to be limited to the details shown since various modifications and structural changes may be made without departing in any way from the spirit of
20 the present invention.

**CLAIMS**

1. A drive for a lifting gear of a hoist, in particular a compact hoist, of a type having
5 a drum for winding and unwinding a load-bearing member connected to a load-receiving member, comprising:
 - an electric motor for driving the drum, said electric motor being a universal motor having at least one stator winding and one rotor winding;
 - 10 - an AC power supply, said stator winding and said rotor winding being connected in series to the AC power supply, with the rotor winding having two terminals which are capable of being commutable within the series connection; and
 - a control unit, operated by a user, for presetting a lifting speed
15 and a lifting direction;
 - wherein each preset lifting speed is associated with a value of an AC output voltage of the AC power supply, and
 - wherein the series-connected windings are disconnected from the AC power supply and thereafter capable of being short-circuited
20 after the two terminals of the rotor winding are commutated.
2. The drive as defined in claim 1, and further comprising a resistor, said stator winding and said rotor winding being short-circuited via a resistor.
- 25 3. The drive as defined in claim 1, wherein the AC power supply includes a phase angle controller.
4. The drive as defined in claim 3, wherein the phase angle controller includes triacs.
- 30 5. The drive as defined in claim 1, and further comprising a switching relay for disconnecting the universal motor from the power supply, for



commutating the terminals of the rotor winding and for short-circuiting the series-connected stator and rotor windings.

- 5 6. The drive as defined in claim 5, and further comprising a brake switch for actuating the switching relay.
7. The drive as defined in claim 5, wherein the switching relay is energized by the AC power supply.
- 10 8. The drive as defined in claim 6, wherein the switching relay actuates in succession the brake switch for interrupting the AC power supply, a short-circuit switch for shorting the series-connected stator and rotor windings, and a changeover switch which commutates the terminals of the rotor winding.
- 15 9. A control device for arresting an electric universal motor driving a lifting gear, with the electric motor including at least one stator winding and one rotor winding, with the stator and rotor windings connected in series to an AC power supply, said control device comprising:
- 20 - a changeover switch for commutating a rotor winding with respect to at least one stator winding of the electric motor, and
- a brake switch for disconnecting the series-connected stator and rotor windings from the AC power supply and shorting the stator and rotor windings, after the rotor winding is commutated.
- 25 10. The control device as defined in claim 9, and further comprising a resistor, said stator winding and said rotor winding being short-circuited via a resistor.
- 30 11. The control device as defined in claim 9, wherein the AC power supply includes a phase angle controller.



12. The control device as defined in claim 11, wherein the phase angle controller includes triacs.
- 5 13. The control device as defined in claim 9, and further comprising a switching relay for disconnecting the universal motor from the power supply, for commutating the terminals of the rotor winding and for short-circuiting the series-connected stator and rotor windings.
- 10 14. The control device as defined in claim 13, and further comprising a brake switch for actuating the switching relay.
15. The control device as defined in claim 13, wherein the switching relay is energized by the AC power supply.
- 15 16. The drive as defined in claim 14, wherein the switching relay actuates in succession the brake switch for interrupting the AC power supply, a short-circuit switch for shorting the series-connected stator and rotor windings, and a changeover switch which commutates the terminals of the rotor winding.