ARRANGEMENT FOR DRIVING OF SHUTTLELESS COIL WINDING MACHINES OF CLOSED CORES

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ABSTRACT
Shuttleless coil winding machines for winding of coils on closed cores particularly of miniature cores, require a quick speed reduction in the course of tightening a newly wound-on turn in order to prevent breaking of the conductor. Means controlled by a cam, driven in synchronism with the winding means are provided, which cause a speed reduction of the electric driving motor by counter-current at preselected reduced supply voltage.

6 Claims, 4 Drawing Figures
ARRANGEMENT FOR DRIVING OF SHUTTLELESS COIL WINDING MACHINES OF CLOSED CORES

BACKGROUND OF THE INVENTION

This invention relates to an arrangement for driving shuttleless coil winding machines for winding of coils on closed cores, for instance on miniature ferrite cores of annular or rectangular shape. Coil winding machines of this type are for instance disclosed in the U.S. Pat. No. 2,978,193 and in the British Pat. No. 911,622.

When operating such machines, conductor is dangerously stressed during tightening of each turn and it is therefore necessary to reduce the speed of the machine within the interval of tightening each turn in order to prevent the breaking of the conductor. This reduction of speed is achieved as for instance proposed in the U.S. Pat. No. 3,451,632 by temporary reduction of the supply voltage of a series commutator motor by introducing into the supply circuit a suitable resistor by means of an auxiliary relay or switch controlled by a cam. This method of speed reduction however limits any subsequent substantial increase of the winding speed, particularly for higher operating speeds, due to the inertia of the rotor of the electric motor. Here the switching has to be started rather earlier than the tightening of a turn due to the time loss resulting from the inertia of the rotor. Thus even where higher speeds are used, any increase of the winding speed is limited.

SUMMARY OF THE INVENTION

It is an object of this invention to provide an arrangement which would reduce the driving speed of machines of this type efficiently and quickly.

It is another object of this invention to enable a high acceleration of the machine to full operating speed even after a quick speed reduction.

It is a still further object of this invention to provide an easy adjustment of both speeds in order to enable the use of the most efficient conditions for the kind of conductors used.

Another object is to permit the continuance of the drive at reduced speed for a predetermined time interval.

In accordance with this invention an arrangement is provided where the electric driving motor is operated alternately at high speed and at low speed, the speed reduction being achieved by applying first a countercurrent at reduced supply voltage. For this a centrifugal switch is used, which limits the speed reduction to a predetermined value. Thereafter the motor drive is changed to a movement in the normal direction at reduced supply voltage and reduced speed. The start of the braking and the motion at reduced speed is controlled by cam means operating in synchronism with the winding speed of the coil winding machine.

DESCRIPTION OF THE DRAWINGS

The attached drawings shown in FIGS. 1 and 2 a principal wiring diagram of the speed controlling circuits of a coil winding machine, FIG. 2 b being a continuation of FIG. 1, FIG. 3 a schematic view of the function of the control cam and switch, FIG. 4 is partial circuit diagram showing the operation of the second control switch and its associated relay.

DESCRIPTION OF PREFERRED EMBODIMENT

The individual elements which are contained in the wiring diagram are shown at rest conditions. The arrangement comprises a supply transformer TR, a rectifier U₁, for feeding the motor ROT of a commutator driving motor, a manually operated change-over switch P₁ for selection of the winding speed for the quick winding period, a manually operated change-over switch P₂ for selection of the speed of the slow winding period in the course of tightening of the conductor turn on the core. Also provided is a relay M of an electromagnetic counter of turns which is provided with a cut-out contactₘ for stopping the drive after the chosen number of turns has been wound. A cam V₁ determining the period of reduced speed, the position of which is adjustable, a coil C of a relay closing the motor circuit by means of contacts C₂ and C₃ in the normal direction, and a coil B of a relay closing the braking countercurrent by means of contacts B₂ and B₃ is also included an auxiliary relay A, enabling a push-button contact by contacts A₁ and A₂ is provided as is a centrifugal change-over switch OSP fixed on the shaft of the motor ROT of driving motor, a rectifier U₂ for feeding the stator STAT of the driving motor, a rectifier U₃ for feeding the auxiliary relays E and D, a master switch SP, a cut-out fuse PO. The part of the wiring diagram beyond the section within the dot-and-dash line is suitable for microcoil winding machines without electromagnetic control for the reversal of feeding, for instance for microtoroid winding machines with one way rotary feeding of the toroid core, whereas the whole wiring diagram including the part within the dot-and-dash line is suitable for winding machines with electromagnetic control of feed reversal. Feed reversal is employed in winding microtransformer coils of rectangular shape having a plurality of overlaying windings. Reversal changes the direction of the coil shift in for instance for microwinding machines provided with a clamping head with a straight line feeding and with reversal in the extreme positions. In this case an additional rectifier U₃ is used for feeding the electromagnet ELM controlling the feed reversal for instance by shifting clutch means, through the electromagnet ELM with a relay H controlling by way of limit switches K₁ and K₂ and stops N₁ and N₂ this electromagnet by the relay contacts H₁ and H₂. Signal glow discharge tubes Z₁ and Z₂ indicating the adjusted or just proceeding feed direction by contacts H₁ and H₂ is provided enabling the adjustment of the width in the course of adjustment of the stops N₁ and N₂. The push button T₁ is adapted to start the normal continuous operation by way of contacts A₁ and A₂, which is possible only in the position of the change-over switch P₁ indicated in the drawing. In the opposite position of the change-over switch P₁ only a limited travel is possible by actuating the push button T₂, which is required for instance for adjustment purposes, as the electric motor is running only as long as the push button T₁ is pressed. The push button T₃ serves for stoppage of the machine in case of a continuous drive, causing the opening of contacts A₁ and A₂. This results in quick stoppage after disconnection, the machine is braked by countercurrent equally as after a limited travel controlled by the push-button T₃. The braking by countercurrent is introduced by the centrifugal change-over switch OSP which bridges the contacts 6 and 12 after starting the motor, and preparing.
the circuit of relay B which for a closed motor circuit is disconnect by the contact e. When the relay C is disconnect for instance by the push button $S_4$ or by the contact $C_3$, the relay B is preselected in the course of operation by means of the centrifugal switch OSP is automatically energized and countercurrent is supplied to the rotor of the motor. The braking proceeds until the revolutions drop close to zero, where the centrifugal switch disconnects the contacts 6, 12.

The function of the cam $V_1$ relative to the switch $K_3$ is shown in FIG. 3 in the phase of the winding cycle at the moment of tightening of the turns on the toroid of the winding machine. The toroid 3 is shown in section and there is seen how the beam of the wound wire 4 is arranged beforehand in the space between the pulleys 1, 2. The loop 5 of the wound wire is tightened by the rotary movement of the pulley 2 in the direction of the arrow. A subsequent turn is produced on the toroid 3 by this tightening. The phase of winding is shown in FIG. 3 in the moment, when the stop on the cam $V_1$ is so long that the switch $K_3$ would remain closed for the whole period of tightening of the loop 5. he shaft 6 of the cam $V_1$ is geared with respect to the mechanism of the winding machine in the way that one turn is taken in the period of winding i.e. for the period of winding one turn. The cam $V_1$, the number of revolutions of which are coincident with the winding cycle of the machine, connects in the course of the winding cycle, where the turn is tightened, to the relay $F$ by way of the contact $C_3$, which relay $F$ reduces the voltage by way of contacts $F_2$ and $F_3$ from $P_2$ to $P_3$. In addition it energizes the relay $E$ by way of contact $F_4$, but for a moment only, as the relay $E$ energizes in turn the auxiliary relay $D$ by its contact $e_2$. The relay $D$ remains permanently closed by its contact $d_1$ for the whole time that the relay $F$ is energized, but relay $D$ in turn disconnects, by its contact $d_2$, the relay $E$. This instantaneous closing of the relay $E$ causes a momentary disconnection of the circuit of the relay $C$ by the contact $e_1$, which is not only sufficient for disconnecting the relay $C$, but is also sufficient for connecting the relay $B$ by the contact $c_1$.

The relay B has been previously preselected in the course of running of the motor by the centrifugal switch OSP by bridging contacts 6 and 12. The relay B now causes a braking of the motor by countercurrent at a lower voltage and in addition maintains by its blocking contact $b_1$ the disconnection of relay C during the course of the whole braking time. After braking to nearly zero revolutions the contacts 6 and 12 are disconnected by the centrifugal change-over switch OSP and the relay B becomes deenergized, closing thus by its contact $b_1$ the circuit of the relay C. As the braking by countercurrent is very effective and lasts for a very short time (i.e. in the order of $10^{-3}$ seconds) the relay C remains still energized even after finishing braking the hump of the cam $V_1$ is in action, that is, what the supply voltage is still connected by the contact $F_3$ to a lower voltage. The motor finishes its running slowly according to the voltage selected by $P_3$ and the tightening of the turn proceeds smoothly. When the hump of the cam $V_1$ has passed, the relay $F$ once again provides the rotor a a higher supply voltage, selected by the change-over switch $P_3$ and the motor continues to operate again at maximum speed, which can be applied in the remaining part of the winding cycle. In order to secure a disconnection of relay C by the contact $e_1$ of sufficient duration for energizing the relay B over contacts $c_1$, the disconnecting period of relay E is extended feeding to it rectified voltage for instance from the rectifier $U_3$. A larger capacitor, for instance an electrolytic capacitor of a capacity of 8 to 16 microfarad is connected in parallel to the relay coil so that the relay $E$ after being disconnected by the contact $d_1$ is released with a time lag due to the charge of the capacitor. The electrolytic capacitor connected in parallel to the coil of relay D serves in the described case only for smoothing the current in the event the one way rectifier $U_3$ is used. An extinguishing circuit is used in the circuit of the contacts $F_2$ and $F_3$ to reduce sparking of contacts, the capacitor connected in parallel and the resistor connected in series in the circuit of the rectified rotor voltage products the rectifier $U_3$ against voltage surges at frequent change-over. A counter $M$ registers the number of turns wound on and is actuated by a contact $e_5$ of the fifth relay $E$. After the predetermined number of turns has been wound, a contact $m$ in the circuit of the first relay A is disconnected, stopping the whole winding machine.

The arrangement operates as follows:

After closing the master switch $SP$ the whole arrangement is prepared for operation. Prior to starting, the elevated supply voltage for feeding the rotor winding of the electric motor is manually adjusted by means of the change-over switch $P_2$ (FIG. 2) and the reduced supply voltage by means of the change-over switch $P_3$. The proper operation is started by pressing the push-button $T_1$ acting the first relay A which closes the circuit of the third relay C, closing contacts for feeding the rotor ROT in one direction so that the electric motor starts to move, as its stator coils $STAT$ have already received the current at a chosen voltage from the transformer TR via the rectifier $U_3$. As the rotor ROT gains speed, the centrifugal switch OSP bridges contacts 6 and 12 and prepares the circuit of the second relay B for braking with counter-current. When the cam $V_1$ actuates the contact $K_3$, the circuit of the sixth relay F is closed. This causes a change-over of the supply voltage of the rotor RDT, a reduced voltage over the change-over switch $P_3$ and closing also the circuit of the fifth relay. This together with the fourth relay an interruption of the circuit of the third relay C and the establishment of the circuit of the second relay B. The switching of relay B changes by its contacts $b_1$, $b_2$ the direction of the rotor current and instigating braking of the motor with counter-current at reduced supply voltage. This braking proceeds as long as the centrifugal switch OSP remains closed. As soon as the speed is lowered to a predetermined value, the contacts 6 and 12 of the centrifugal switch are opened, the second relay B is deenergized and the circuit of the third relay C again established, causing a further driving of the rotor at reduced voltage, until the cam $V_1$ releases the contact $K_3$ and the supply of the rotor ROT at elevated voltage is again established. Thus the driving speed of the coil winding machine is automatically and quickly reduced and again elevated at exactly predetermined time intervals, so that a smooth tightening of the just wound on turn on the core is enabled, while maintaining for the remaining time of the winding cycle an elevated speed.

The switch $P_2$ serves just for adjustment purposes. If its position is changed to the right, the circuit of the first relay A is interrupted and the circuit of the third relay C connected to the supply mains via a push-but
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	on T₂, so that the whole drive can be closed only, so far the push button T₂ is actuated.

For winding of coils on toroidal cores, the driving motor in addition to actuating a pick-up device which deposits a new turn on the core, has the task to slowly turn the toroidal core around its axis in order to deposit the subsequent turn to close to the preceding.

This movement is generally accomplished by a ratchet wheel with two pawls as indicated in the co-pending patent application Ser. No. 23,409 filed on even date herewith and now U.S. Pat. No. 3,618,868 issued Nov. 9, 1971.

If a rectangular closed core is to be wound, the direction of the drive of the core has to be reversed. This is accomplished for instance by means of a reverse clutch, operated electromagnetically as indicated in the aforementioned co-pending patent. In this case the additional circuits contained within the dash and dot lines are brought into operation. A seventh relay H is alternately energized and deenergized by the action of limit switches K₁ and K₂ actuated by stops N₁ and N₂, energizing alternately the electromagnet ELM which actuates the clutch. The glow discharge lamps Z₁ and Z₂ indicate the just proceeding direction of operation.

After the required number of turns has been wound, the counter M causes an interruption of the circuit of the first relay A by the contact m₁ and the whole drive is stopped.

I claim:

1. An arrangement for driving of shuttleless coil winding machines of closed cores, particularly of miniature ferrite cores of circular, toroidal and rectangular shape comprising an electric driving motor with 9 stator and rotor, means for supplying the rotor of this motor alternately at adjustable elevated and reduced voltage, a centrifugal switch actuated by the electric motor, cam means driven by the electric motor in synchronism with the winding speed of the coil winding machine, a system of relays and switching contacts, said cam means introducing within a cycle of winding of a turn of the coil first a reduction of the supply voltage of the rotor of the electric motor, reversing subsequently the current direction in the rotor for braking with counter-current at reduced supply voltage, said centrifugal switch interrupting after speed reduction to a predetermined value the further supply of counter current, continuing a supply of the rotor current in the normal direction at reduced supply voltage until said cam means cause again feeding of the rotor at elevated supply voltage.

2. An arrangement as claimed in claim 1 comprising a first relay circuit for starting the motor drive with closing and interrupting means, closed contacts of which first relay preparing the circuit of a third relay for feeding the rotor in one direction, contacts of this relay closed in its operative position included in a rotor supply circuit for one direction of movement, a circuit of a second relay for feeding the rotor in the opposite direction, said circuit comprising a contact of said centrifugal switch closed when the rotor speed exceeds a predetermined value and a contact of the third relay, closed in its inoperative position, contacts of this second relay, closed in its operative position included in the rotor supply circuit for movement of the rotor in the opposite direction, a sixth relay circuit comprising switching means actuated by said cam means, contacts of which sixth relay closed in its inoperative position included in the rotor supply circuit at elevated voltage, contacts of which, closed in its operative position included in the rotor supply circuit at reduced voltage and in the circuit of a fifth relay, operating with a time delay, its contact closed in the inoperative position included in the circuit of the third relay for supply of the rotor current at elevated voltage, and with its contact closed in the operative position included in the circuit of a fourth relay, one contact of which closed in the inoperative position included in the circuit of the fifth relay, a second contact closed in its operating position being a self-holding contact of this fourth relay.

3. An arrangement as claimed in claim 2 comprising a counter, counting the number of wound-on turns on the core, actuating switching means disconnecting the drive after winding a predetermined number of turns.

4. An arrangement as claimed in claim 2 comprising means for adjustment of the elevated and reduced voltage.

5. An arrangement as claimed in claim 2, comprising a circuit of a seventh relay for changing the direction of feeding of a wound on rectangular core, said circuit comprising limit switches for both directions of movement, contacts of which seventh relay actuating means for reversing the feed of the wound on core.

6. An arrangement as claimed in claim 2 comprising a change-over switch for disconnecting the circuit of the first and third relay and connecting the relay to the supply mains by way of an additional switch, closing thus the feeding circuit of the driving motor only for the time this switch is maintained closed.

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