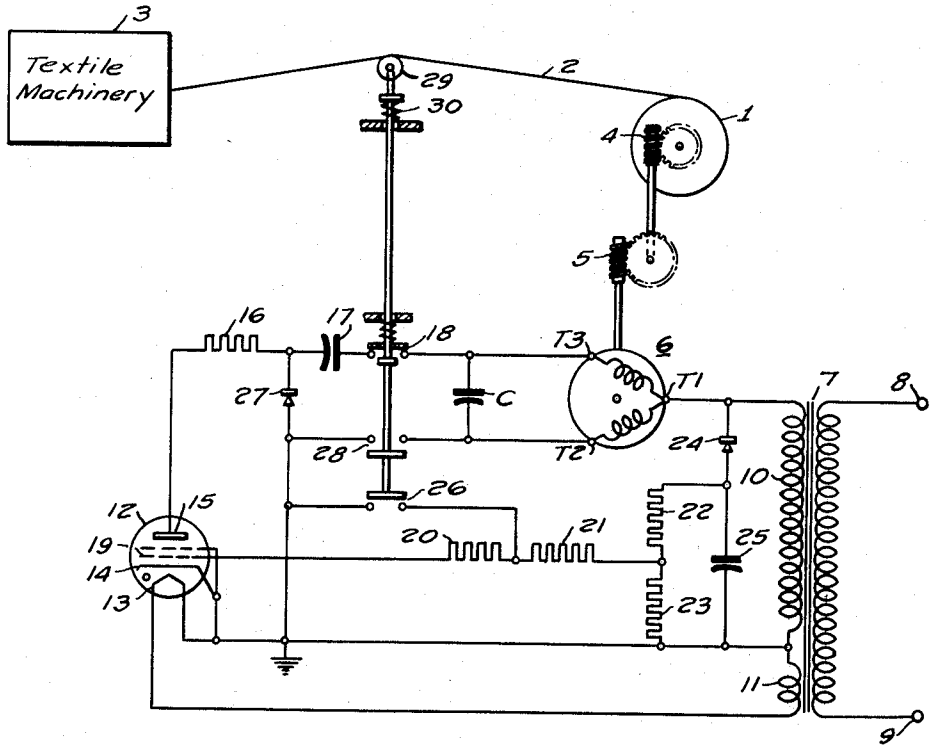
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CONTROL SYSTEM

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CONTROL SYSTEM

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My invention relates to systems for controlling the performance of electric motors and, in one of its more specific aspects, to speed control systems for electric winder drives as used in connection with textile or other strand, web, or yarn fabricating machinery.

It is an object of my invention to provide a system which is capable of controlling or regulating the speed of an electric motor with the aid of control equipment of especially simple and inexpensive design. Another object, subsidiary to the one just mentioned, is the provision of control devices that permit operating an alternating-current motor at controlled average speeds below the synchronous speed of the motor.

Referring to winder drives, for instance for textile machinery, my invention aims also at providing a motor control system which operates to maintain the material to be wound at a substantially constant travelling speed or substantially constant tension and requires a considerably reduced amount of control equipment than heretofore necessary for systems of comparable performance.

Another object, in conjunction with any of those mentioned, is to permit the use of alternating-current motors, including single phase motors, for speed control purposes without requiring the use of variable voltage generators or the like additional equipment.

An object of my invention is further to devise an escapement type let-off control for unwinding yarn, web, or the like material, from a supply or storage reel. In weaving looms, for instance, the unwoven warp is stored on a large beam on which the wound-up material may have a diameter of about five inches when the beam is empty and a diameter of about thirty inches when the beam is full. The loom as it weaves requires that the warp be held under tension and fed at just the correct speed. This means that the unwinding speed of the warp has to vary continuously on the loom warp beam as the diameter of the remaining material on the beam keeps decreasing. In conventional equipment, the warp beam is held from rotating by means of a gear train which is driven from the beam and terminates at an escapement motion similar to a clock mechanism. A dancer roll is placed against the unwound stretch of the warp material. As the loom consumes the warp, the dancer roll is forced down and, after a certain movement, it releases a shoe-type brake that normally keeps the pendulum of the escapement motion from moving. The tension on the travelling stretch of warp material

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thus releases the pendulum to oscillate, thereby allowing a little amount of warp to be released from the beam, until the dancer roll moves up and again applies the brake to the escapement pendulum. Such a mechanical escapement motion is rather critical, considerable trouble is experienced with its proper maintenance, and the tension of the warp material is usually varying to a larger extent than desirable. The last-mentioned object of my invention therefore aims at providing a let-off control for spools of material to be unwound, which avoids the intricacy of the known mechanical escapement devices and affords a higher degree of accuracy in performance.

According to one of the features of my invention, I provide the motor of an electric drive with a power supply circuit which contains control means for effecting an intermittent one-and-off control of the power supply, so that the motor is rapidly energized and deenergized during intervals of varying ratio, with the result that the average motor speed is determined by this ratio. Referring to winder drives for textile machinery and the like, yarn, strand, or web fabricating equipment, I provide the control system with a dancer roll, or other condition responsive device, which cooperates with the material so as to perform an oscillatory movement which in turn controls the above-mentioned on-and-off control means of the power supply circuit.

According to another feature of my invention, an alternating-current motor, for instance of the single phase type, is connected with a transformer or other alternating-current supply means through two rectifying devices which are connected in parallel and inverse relation to each other, so that the motor is energized by alternating current when both rectifying devices are in conductive condition. One of the rectifying devices is of the controllable type. It may consist of a grid controlled gaseous discharge tube of the type known as thyratron. The above-mentioned condition responsive control device is connected with the control or grid circuit of the controllable rectifying device, in order to render it intermittently conductive and non-conductive, thereby causing the motor to receive measured impulses of alternating-current energization.

These and further objects and features of my invention will be apparent from the following description of the embodiment shown in the drawing which illustrates diagrammatically a let-off winder drive for textile machinery in conjunction with control equipment designed and

operative in accordance with the principles of my invention.

In the drawing, a roll of yarn material is denoted by 1. The material 2 withdrawn from the roll 1 travels into a loom, or other fabricating machinery shown schematically at 3. The beam or shaft carrying the roll 1 of material is provided with two series-arranged worm gears 4 and 5, of which the latter is connected to an electric drive motor 6. The worm gearing between the beam and the motor 6 represents a reduction gear of a high reduction ratio and is of the self-locking type. That is, unless the motor 6 is driven, the worm gearing will prevent the roll from paying out material. The motor 6 consists preferably of a single phase capacitor motor. The motor terminals are denoted by T1, T2 and T3, and the appertaining capacitor by C. A transformer 7 with primary terminals 8 and 9 and two secondary windings 10 and 11 provides the necessary power supply. The terminal T1 of motor 6 is directly connected to one terminal of the secondary winding 10. A thyratron 12 has the heater 13 for its cathode 14 energized from the transformer secondary 11. The anode 15 of tube 12 is connected to motor terminal T3 through an auxiliary resistor 16, a capacitor 17 and a switch contact 18. The contact 18 is normally closed. The tube 12 operates as a controllable rectifier. Its control grid 19 is connected through resistors 20 and 21, to a voltage dividing arrangement of resistors 22 and 23 which is series connected with a rectifier 24 across the secondary winding 10 of transformer 7. The rectifier 24 may consist of a dry junction type unit for half-wave rectification. A capacitor 25 connected across the series connected resistors 22 and 23 serves to smooth the current rectified by the unit 24. Consequently, the voltage dividing resistors 22 and 23 are traversed by a substantially continuous direct current when the transformer 7 is energized. As a result, a potential is normally imposed on the tube control grid 19 which is sufficiently negative with respect to the tube cathode 14 to maintain the tube in non-conductive condition. A point between resistors 20 and 21 is connected through a normally open control contact 26 with the cathode 14 of the tube. Consequently, when contact 26 is closed, the negative potential on grid 19 is reduced to nearly that of the cathode 14 in order to fire the tube 12.

A second half-wave rectifier 27 is connected in parallel and inverse relation to the tube 12. This second rectifier may consist of a dry junction type unit, although an electronic tube may be employed instead.

The terminal T2 of the capacitor motor 6 is connected to the cathode 14 of tube 12 under control by a normally open switch contact 28. The contacts 18, 26 and 28 are controlled by a tension responsive device which has a dancer roll 29 biased by a spring 30 so as to be held against the travelling stretch 2 of the material fed from the roll 1 into the textile machinery 3. The contacts 18 and 28 form together a reversing switch for the motor 6. Small oscillatory movements of the dancer roll 29, sufficient to close and open the control contact 26, do not affect the contact condition of switch contacts 18 and 28. However, when the material 2 slackens or reduces its tension to such an extent that the dancer roll 29 moves upwardly beyond a given maximum limit, the switch contact 18 is opened and the contact 28 closed. The motor terminals T1 and T2 are

then directly connected across the transformer secondary 10 so that the motor is caused to run in opposition to its normal direction of operation. As a result, the material 2 is wound back onto the roll 1, until the slack is reduced and the dancer roll 29 forced to reestablish the illustrated normal condition of switch contacts 18 and 28.

The operation of the control system as a whole is as follows.

When the textile machinery 3 is running and the transformer 7 energized with the dancer roll and contacts in the position shown in the drawing, the tube 12 is non-conductive, while the non-controllable rectifier 27 is in condition to conduct current, this current charges the capacitor 17. As soon as the charge reaches full capacity, the further flow of current is stopped so that the motor 6 remains at rest. The self-locking worm gearing will then prevent the roll 1 from delivering material. Consequently, the slack portion of material contacted by the dancer roll 29 is gradually reduced by the fabricating machinery, and the dancer roll is forced against the biasing force of spring 30 to close the contact 26. At the closing moment, the grid potential of tube 12 is changed and causes the tube to fire. Now, both rectifying devices 12 and 27 are in operation, so that the motor 6 is supplied with almost full alternating-current voltage with one rectifier conducting during half of each cycle and the other rectifier during the other half of the cycle. The capacitor 17 does not offer an appreciable impedance to the flow of alternating current. Consequently, the motor will now rotate in the direction required to release material from the roll 1. As soon as a slight amount of material is released, the dancer roll 29 is lifted and the contact 26 opened, with the result of stopping the flow of current through the tube 12. Consequently, the motor is again stopped. The contact 26 is of such design that a movement of the dancer roll of a few thousandths of an inch will suffice to start and stop the motor. The contact 26 may consist of an open metallic contact which does not have to be kept clean because the tube will fire with a resistance up to the order of 100,000 ohms across the control contact 26. Under such conditions, the dancer roll 29 oscillates up and down many times per second so that the motor is intermittently energized and deenergized in rapid succession. Consequently, the motor operates virtually at a controlled average speed just sufficient to unwind the correct amount of material. If, for some reason, the tension of the material becomes excessively low, for instance when the material is permitted to slacken extensively during adjustments of the machine, the reversing switch contacts 18 and 28 become operative, as explained previously, and adjust the slackness or tension of the material 2 between the proper operating limits of the control contact 26.

The capacitor 17 may be of the electrolytic type, a rating of about 500 Mfd. being, as a rule, sufficient for single phase capacitor motors of up to about 1 hp. to operate under a secondary transformer voltage of about 110 to about 220 volts. When using an electrolytic capacitor, the voltage drop through the tube 12 should be slightly larger than the drop through the parallel connected rectifier 27, in order to insure that the capacitor 17 will remain slightly charged at all times in the proper direction. To this end, some circuits may require the insertion of a resistor, such as the one denoted by 16, in series with the anode of the tube.

If desired, a separate electromagnetic contactor may be used instead of the reversing switch contactors 18 and 28, and the coil of the separate reversing contactor may then be controlled by a single auxiliary contact of the dancer roll device.

While I have illustrated and specifically described the application of my invention to a winder drive, it will be understood that the speed control embodied in the example may also be used for electric drives serving purposes other than the one exemplified. For many applications, the reversing switch feature may be wholly omitted. If desired, the intermittent on-and-off control of the power supply to the motor may be effected by means other than a tension or slackness responsive device. It will further be understood by those skilled in the art that the invention is likewise applicable to electric motors other than capacitor type motors, although I consider it an advantage that, by virtue of the invention, a capacitor motor or other type of single-phase motor can be made to operate at a controllable subsynchronous speed with the aid of extremely simple control devices. Such and other modifications and alterations based on the above-disclosed characteristics of my invention are intended to be included in the essential features of the invention set forth in the claims attached hereto.

I claim as my invention:

1. A control system, comprising an alternating-current motor, means for supplying alternating current, two half-wave rectifiers connected in parallel relation and opposing polarities to each other between said current supply means and said motor so that said motor is energized by alternating current when both rectifiers are in operation, a capacitor series-connected with said motor for preventing the flow of current when only one of said rectifiers is in operation, and intermittently operable control means connected with one of said rectifiers for controlling its operation to thereby control the speed of said motor.

2. A control system, comprising an alternating-current motor, means for supplying alternating current, two half-wave rectifiers connected in parallel relation and opposing polarities to each other between said current supply means and said motor so that said motor is energized by alternating current when both rectifiers are in operation, at least one of said rectifiers consisting of a controllable electronic discharge device and having a control circuit, and condition-responsive oscillatory control means connected with said grid circuit for on-and-off control of said device, whereby the speed of said motor is controlled in dependence upon the condition responded to by said control means.

3. A control system, comprising an alternating-current motor, means for supplying alternating current, a grid controlled discharge tube disposed between said current supply means and said motor for half-wave rectification of the current, another half-wave rectifier connected in parallel and opposing pole relation to said tube so that said motor is energized by alternating current when said tube is conductive, a capacitor series-connected with said motor for preventing the flow of current through said motor when only said other rectifier is conductive, said tube having a grid circuit for rendering it non-conductive, and condition responsive control means connected with said grid circuit for intermittently causing the latter to impose an on-and-off control on said tube.

4. A control system, comprising a transformer,

a single phase motor having two terminals of which one is connected to said transformer, two half-wave rectifiers connected in parallel and inverse relation to each other between said other motor terminal and said transformer so that said motor is energized by alternating current when both rectifiers are conductive, a capacitor series connected between said motor and said transformer for blocking the flow of current when only one of said rectifiers is conductive, and intermittently operating control means connected with one of said rectifiers for causing it to become intermittently non-conductive to thereby control the speed of said motor in accordance with the variations in the intervals of conductivity of said latter rectifier.

5. A control system, comprising means for supplying alternating current, a capacitor motor connected to said current supply means, a controllable half-wave rectifier and a non-controllable half-wave rectifier connected in parallel and inverse relation to each other between said motor and said current supply means so that said motor is energized by alternating current when both rectifiers are conductive, a capacitor series connected between said motor and said transformer for blocking the flow of current when only one of said rectifiers is conductive, and oscillatory contact means connected with said controllable rectifier for rendering it intermittently conductive and non-conductive during variable intervals of time to thereby control the speed of of said motor.

6. A let-off control for unwinding material from a roll, comprising a roll shaft, a self-locking gear connected with said shaft for locking the roll, an alternating-current induction motor in driving connection with said gear for causing it to rotate the roll in the unwinding direction, alternating-current supply means connected to said motor for supplying power thereto and having oscillatory on-and-off control means for controlling the power supply, and condition responsive means for intermittently actuating said control means in response to a condition of the material so as to control said motor to run at subsynchronous speed for maintaining said condition substantially within given limits.

7. A let-off control for unwinding material from a roll, comprising a self-locking gear disposed for connection to the roll, a single-phase motor in driving connection with said gear, mean for supplying alternating current connected to said motor, two half-wave rectifiers connected in parallel and inverse relation to each other between said motor and said current supply means so that said motor is energized by alternating current when both rectifiers are conductive, one of said rectifiers being controllable and having a control circuit for on-and-off operation, condition-responsive control means cooperative with the material and connected with said control circuit for causing it to intermittently render said one rectifier conductive and non-conductive in response to a condition of the material in order to control said motor so as to maintain said condition substantially within given limits.

8. A left-off control for unwinding material from a roll, comprising a self-locking gear disposed for connection to the roll, a single-phase motor in driving connection with said gear, means for supplying alternating current connected to said motor, two half-wave rectifiers connected in parallel and inverse relation to each

other between said motor and said current supply means so that said motor is energized by alternating current when both rectifiers are conductive, a capacitor series connected with said motor to prevent the flow of current when only one of said rectifiers is conductive, one of said rectifiers having a control circuit and being on-and-off controllable thereby, tension-responsive control means connected with said control circuit to intermittently control said latter rectifier in response to variations in the tension of the material in order to control the speed of said motor so as to maintain said tension substantially within given limits.

9. A system for controlling the winding performance of a roll of material, comprising a reversible electric motor, means for supplying power to said motor, reversing switch means disposed between said power supply means and said motor so as to connect said motor normally for operation in a given running direction, on-and-off control means disposed between said power supply means and said motor for controlling the supply of power when said motor is connected by said switch means to run in said given direction, a tension-responsive device arranged to engage the material so as to perform oscillatory movements in dependence of variation in slackness of the material, said device being connected with said control means for causing the latter to control the speed of said motor so as to maintain the slackness normally within given limits, and said device being also connected with said switch means for temporarily reversing said motor when the slackness exceeds a given value.

10. A system for controlling the winding performance of a roll of material, comprising a reversible electric motor, means for supplying power to said motor, reversing switch means disposed between said power supply means and said motor so as to connect said motor normally for operation in a given running direction, a discharge tube disposed between said current supply means and said motor so as to control the power supply to said motor when said motor is connected by said switch means for running in said given direction, said tube having a control circuit having a movable control contact for rendering said tube conductive and non-conductive depending upon the position of said contact, a tension-responsive device having a movable member disposed for engaging the material so as to perform oscillatory movements in dependence upon the tension in the material being wound, said member being connected with said contact for causing it to control said tube so as to vary the speed of said motor for maintaining said tension normally within given limit values, and said member being also connected with said switch means for causing the latter to temporarily reverse said motor when said tension drops below a given value.

11. A control system, comprising alternating current apparatus to be controlled, means for supplying alternating current, two half-wave rectifiers connected in parallel relation and opposing polarities to each other between said current supply means and said apparatus so that said apparatus is energized by alternating current when both rectifiers are in operation, a capacitor series-connected with said apparatus for preventing the flow of current when only one of said rectifiers is in operation, and control means connected with one of said rectifiers for controlling its operation to thereby control the energization of said apparatus.

12. A system for controlling the winding performance of a reel of material comprising an electric reel drive motor of the induction type, alternating-current supply means connected to said motor, an electronic discharge tube interposed between said motor and said supply means and having a discharge control circuit for controlling the power supply to said motor, said control circuit having oscillatory contact means movable between on and off positions for controlling the conductance of said tube to vary said power supply dependent upon the position of said contact means, and tension-responsive means engageable by the let-off material and connected with said contact means for moving said contact means in response to variations in tension of the material.

13. A let-off control for unwinding a reel of material, comprising a reel shaft, an induction motor connected with said shaft for turning said shaft in the let-off direction when said motor is energized, alternating-current supply means for said motor, a gaseous discharge tube connected between said power supply means and said motor for energizing said motor when said tube is conductive, said tube having a control circuit, oscillatory on-and-off contact means connected in said control circuit for controlling said tube to be conductive and non-conductive respectively depending upon the position of said contact means, and a tension-responsive device engaging the let-off material and connected with said contact means for moving said contact means so as to cause said tube to intermittently energize said motor.

14. In a reel let-off control for connection to oscillatory tension feeler means, the combination of a single-phase induction motor, alternating-current supply means connected with said motor to provide energization therefore, an electronic tube having a plate circuit connected with said supply means for controlling said energization and having a grid circuit, said grid circuit having bias voltage means attachable to the feeler means and having a cut-off voltage value and a firing voltage value, respectively, depending upon the condition of the feeler means.

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