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H. LOHEST ET AL

3,090,571

WINDING APPARATUS

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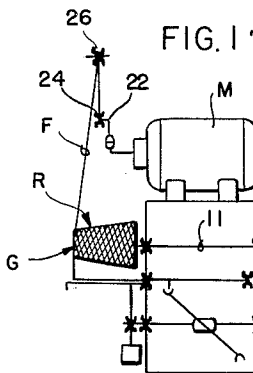


FIG. 1

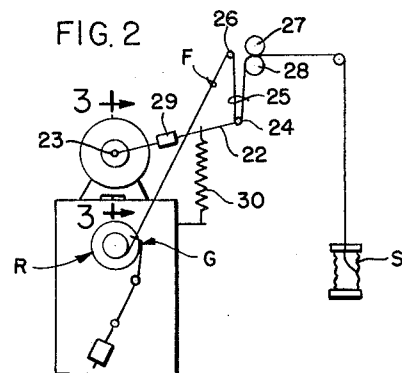


FIG. 2

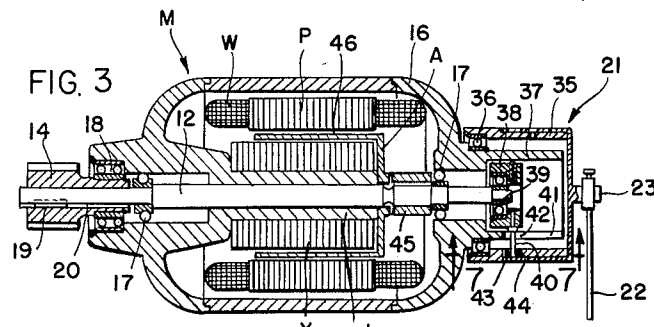


FIG. 3

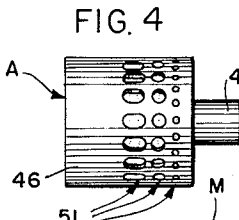


FIG. 4

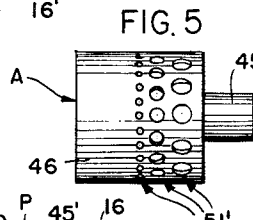


FIG. 5

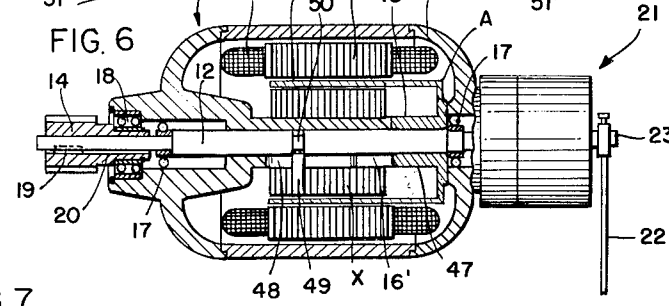


FIG. 6

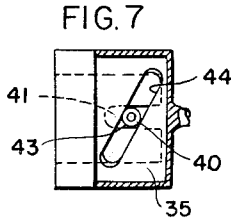


FIG. 7

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1

3,090,571

WINDING APPARATUS

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The present invention relates in general to the winding and reeling of flexible material, and has more particular reference to the winding of thread or similar filamentary material upon receivers, such as bobbins, spools, reels, mandrels, and the like.

An important object of the present invention is to provide for winding filamentary material on a receiver at approximately uniform speed and in accordance with a desired filament tension program; a further object being to provide means for controlling filament winding operations in such fashion as to automatically adjust the driven speed of a winding receiver in accordance with the delivery rate at which filamentary material is supplied thereto, so that the material may be wound upon the receiver under desired tension.

Another important object is to provide filament winding equipment of unusually simple, inexpensive, yet rugged construction, and hence capable of providing trouble free service during the extended service life of the equipment, apparatus of the sort heretofore provided being of complex, somewhat delicate character, highly susceptible to service breakdown, and hence correspondingly expensive to make and maintain in operation.

Another important object is to provide winding equipment of the character mentioned in which the filament receiver is driven by an electric motor energized for operation preferably at a substantially constant field excitation level, including means for regulating motor speed by adjusting the magnetic flux field of the motor in accordance with the regulation desired; a further object being to provide an adjustable motor embodying an electrically conductive rotor of sleeve-like character mounted for rotation in an air gap formed between the field component of the motor and an associated magnetic reflux body, including means for regulating motor speed by adjusting the relative position of the rotor and reflux body in the direction of the axis of rotation of the rotor; a further object being to provide for relatively shifting the rotor and reflux body in response to axial adjustment of the motor shaft.

Another important object is to provide an adjustable motor of the character mentioned, wherein axial movement of the motor shaft serves to axially adjust the rotor with respect to the reflux body; a further object being to provide for the shifting of the reflux body, with respect to the rotor, in response to axial movement of the motor shaft.

Another important object is to control motor speed by means of a sensing member preferably in the form of a lever, which feels the filamentary material to be wound, as by suspending the sensing member in a loop formed in the filamentary material along its path of travel from a supply source to the winding receiver, such sensing member being adapted to detect any disparity between the rate at which the filamentary material is delivered from the supply source and the winding speed at which the material is accepted by and applied upon the receiver; a further object being to provide for regulating motor speed in response to any change in length of the filamentary material between a supply source and a receiver on which material, delivered from said source, is wound; a further object being to apply desired tension

2

in filamentary material as the same is applied upon a winding receiver, by forming a bight in the material between the receiver and a supply source of such material, and suspending a tension applying member on the filamentary material at said bight, means being provided for controlling the winding speed of the receiver in order to maintain a substantially uniform bight size.

The foregoing and numerous other important objects, advantages and inherent functions of the invention will become apparent as the same is more fully understood from the following description, which, taken in connection with the accompanying drawings, discloses a preferred embodiment of the invention.

Referring to the drawings:

FIG. 1 is a schematic diagram of filament winding apparatus, including a controllable motor for driving the same, said motor embodying the features of the present invention;

FIG. 2 is a view of the apparatus of FIG. 1 as seen from the left hand side thereof;

FIG. 3 is a sectional view on an enlarged scale taken substantially along the line 3—3 in FIG. 2;

FIG. 4 is a side view of a rotor of the sort which may be employed in the motor shown in FIG. 3;

FIG. 5 is a modified form of rotor which may be employed in place of that shown in FIG. 4;

FIG. 6 is a sectional view similar to FIG. 3, and showing a modified form of motor embodying the present invention; and

FIG. 7 is a sectional view taken substantially along the line 7—7 in FIG. 3.

To illustrate the invention, the drawings show a winding device comprising a winding shaft or spindle 11 adapted to support and to drivingly turn a winding receiver R of any suitable, preferred or convenient sort, such as a bobbin, spool, reel, mandrel or tube, any suitable, preferred or conventional bearing means being employed for supporting the shaft 11 for turning movement.

In accordance with the present invention, filamentary material F, such as thread, may be delivered from a supply source, such as a storage reel S, through a thread guide G, for winding upon the receiver R, as the same is turned on and by the spindle 11. The winding spindle 11 may be drivingly connected with the shaft 12 of a variable speed electric motor M, by any suitable transmission means, such as gears 13 and 14 on the shafts 11 and 12, and drivingly interconnected as by means of a chain 15.

The motor M of the present invention may comprise a main frame 16 formed to provide support for the field component of the motor, embodying field windings W and associated circumferentially spaced pole pieces P forming the field component of the motor, said frame also providing support for a magnetic reflux body X, the same comprising magnetix flux carrying material of preferably laminated character supported within the circumferentially spaced pole pieces P in position forming a magnetic surface therewith, the peripheral surface of the body X being spaced inwardly of the pole pieces P sufficiently to leave an air gap of desired width within the pole pieces and outwardly of the reflux body X.

The motor M also comprises a rotary armature or rotor A of electrical conducting material supported on and drivingly connected with the motor shaft 12 which extends concentrically within the field component and reflux body X of the motor, the shaft being suitably journaled for uniform movement in the frame 16. In accordance with the present invention, the motor is adapted to operate in response to excitation of the field windings W, preferably at a substantially constant electrical energy level, means being provided for controlling motor speed by relatively adjusting the reflux body and the armature

components of the motor in the direction of its rotary axis, such relatively axial displacement changing the magnetic flux exerted by the field component upon the armature, thereby controlling the speed of the motor.

Relative axial movement of the armature and reflux body may be accomplished by mounting either the armature or the reflux body for relative axial movement with respect to the frame 16, the armature being thus axially movable in the motor, as shown in FIG. 3, the reflux body being axially movable in the embodiment illustrated in FIG. 6.

Relative axial movement of the armature and the reflux body may be accomplished in response to axial shifting movement of the shaft 12 in the frame 16. To this end, the shaft 12 may be supported in bearings of a sort permitting the shaft to rotate freely with respect to the frame 16, and also to be shifted axially, within limits. In this connection, the gear 14 may be rotatably supported on the frame 16 by means of suitable roller bearings 18, which may serve to turnably support the driving gear 14 and also to hold the same against relative axial movement on the frame 16. The shaft 12 may have an end extending within and drivingly connected with the gear 14, as by means of a spline 19 on the shaft, in position extending in a groove 20 formed in the gear, thereby allowing relative sliding movement of the shaft 12 within and with respect to the driven gear 14.

Operable means 21 may be provided for adjusting the relative axial position of the shaft with respect to the frame 16, in response to fluctuations in the delivery rate of the filamentary material on the winding mechanism, in order to maintain desired tension in the material as it is applied upon the winding receiver. To this end, axial adjustment of the shaft 12, may be effected under the control of a sensing member 22, preferably comprising a lever pivoted for rocking movement about a fulcrum axis 23 and carrying a filament feeling element, such as a roller 24, on the lever remote from the fulcrum axis. The lever 22 may be supported on a bight 25, formed in the filament, as between a roller 26 and a pair of delivery rollers 27 and 28, which are preferably driven at substantially constant speed for drawing filament from the supply source S and delivering the same through the bight 25 and around the rollers 24 and 26, and thence to the filament receiver R.

Suitable means may be provided for biasing the sensing lever in a direction on its fulcrum 23 to apply winding tension in the filament, at the bight 25, by the roller 24. Such biasing means, if desired, may comprise a weight 29 which may be adjusted longitudinally of the lever, between the fulcrum 23 and the roller 24, in order accurately to determine the tension applied to the filament F at the bight; or the lever may be biased by means of a spring 30, if desired. Both a weight 29 and a spring 30, operating in conjunction and simultaneously, may be employed to obtain desired winding tension in the filament. If desired, the weight and spring may be made to act differentially upon the lever 22 in order to obtain a desired biasing effect. Any disparity between the rate at which the filament F is delivered from the storage reel by operation of the rollers 27 and 28, and the winding speed at which the filament is applied upon the receiver R, will result in movement of the lever 22 in one direction or the other about the axis of its fulcrum, as determined by the length of filament contained, from time to time, in the bight 25. The lever 22 is thus capable of sensing such disparity and of correspondingly adjusting the relative axial position of the shaft 12 in order to appropriately alter the speed of the motor M and thereby offset or correct the sensed disparity, by correspondingly changing the driven speed of the filament receiver.

To this end, the arm 22 may be drivingly connected with a cam drum structure 35 journaled on the motor frame 16 for rocking movement about the axis of the shaft 12, as by means of suitable roller bearings 36, said

cam drum structure embracing a sleeve-like extension 37 of the motor frame, which extension is preferably concentric with respect to the shaft 12, and disposed at the end of the motor frame remote from the gear 14. The extension 37 is sized to slidably receive a support member 38 of ring-like configuration, carrying a roller bearing 39, by means of which an end of the shaft 12 may be turnably secured in the support member 38 in fashion preventing relative axial movement of the shaft with respect to said support member.

The ring-like support member 38 may carry a cam engaging pin 40 extending radially outwardly thereof through a slot 41 formed in the extension sleeve 37 and extending in a direction parallel to the axis of the shaft 12. The cam pin 40 may be and preferably is fitted with a roller 42 adapted for rolling engagement in the slot 41. The pin 40 may also carry a roller 43 adapted to extend within and to drivingly engage a helically inclined slot 44 formed in the drum structure 35. As a consequence of the foregoing arrangement, the shaft 12 may be adjusted in the frame 16, in either direction axially of the shaft, in response to rocking movement of the drum structure 35 about the axis of the shaft, in one direction or the other, such rocking movement being caused by the action of the lever 22 in response to the combined action thereon of the filament, at the bight 25, and the biasing means comprising the weight 29, or the spring 30, or both.

As shown in both FIGS. 3 and 6, the frame 16 may include a sleeve-like portion 16' extending coaxially in the motor structure, from one end thereof toward the other, the inner end of said sleeve-like portion being spaced inwardly of the facing end of the frame 16, said sleeve-like portion 16' serving to support the reflux body X coaxially thereon. In the embodiment shown in FIG. 3 of the drawings, the reflux body X is secured firmly and immovably upon the sleeve-like frame portion 16', while the rotary armature A is formed with a collar 45 sized to snugly embrace the shaft 12 outwardly of the inner end of the sleeve portion 16', said armature having a cylindrical portion 46 of electrical conducting material carried by said sleeve portion 16', in position embracing the reflux body X and extending in the space outwardly of said body and within the pole pieces P of the field component of the motor. The collar 45 may be pinned or otherwise secured on the shaft 12 for axial and rotary movement in unison with the shaft. When in the relative position shown in FIG. 3, with the rotor portions 46 entirely within the space defined between the reflux body X and the pole pieces P, the armature A and its carrying shaft 12 will be driven at maximum speed. By moving the shaft axially toward the right, from the position shown in FIG. 3, the cylindrical armature portions 46 may be drawn endwise from the space between the reflux body and the pole pieces P, and thus be progressively withdrawn from the influence of the motor field components, thereby reducing the speed of rotation at which the rotor is turned by the action of the field windings of the motor.

In the embodiment shown in FIG. 6, the armature may comprise cylindrical portions 46', similar to the rotor portions 46 of the FIG. 3 embodiment, such portions 46' being adapted to extend within the space defined between the reflux body X and the pole pieces P. The rotary armature of the FIG. 6 embodiment may be provided with a sleeve portion 45' adapted to slidably embrace the shaft 12 between the inner end of the sleeve-like portion 16' and the facing end of the frame 16, said sleeve portion 45' being held against relative axial movement in the frame 16 by and between the inner end of the sleeve portion 16' and the facing end of the frame 16. The sleeve portion 45', however, is connected with the shaft 12, as by means of a spline or feather 47, so that the rotary armature A is drivingly connected, at all times, with the shaft.

The reflux body X of the FIG. 6 embodiment, however, is mounted for axial sliding movement upon the sleeve-like portion 16' in unison with axial movement of the shaft 12. To this end, the sleeve-like frame portion 16' may be provided with a slot 48 extending in the axial direction of the shaft 12, the reflux body X being provided with an inwardly extending pin 49, which passes through the slot 48, said pin having an inner end extending in a groove 50 formed in the shaft. Accordingly, as the shaft 12 of the FIG. 6 embodiment is moved axially, the reflux body X will be shifted within and with respect to the field component of the motor, comprising the windings W and pole pieces P and, consequently, will alter the amount of motor driving flux that is applied upon the armature A.

It is within the contemplation of the present invention to arrange the motor structure so that both the rotary armature A and the magnetic reflux body X may be adjustably shifted on the frame 16 in the axial direction of the motor shaft. In such case, it will be possible and convenient to utilize the displacement of one component for regulating motor speed in coarse fashion, and to employ the displacement of the other component in order to obtain precise adjustment of motor speed, as in the manner described in the copending application of Wolfgang Weber and Hans Lohest, Serial No. 576,970, filed April 9, 1956, now Patent No. 2,915,254.

The cylindrical body portion of the rotary armature A, as shown in FIGS. 4 and 5, may be formed with openings 51, 51' of size and arrangement to produce desired resistance characteristics in the rotor, in its axial direction, in order to obtain required and desired motor speed regulation. The regulation obtained through the arrangement of the openings 51 as illustrated in FIG. 4, for example, comprises an initial rapid change in speed, in response to axial shaft movement, whereas speed change accomplished by the arrangement of the openings 51' shown in FIG. 5 initially occurs more slowly. The perforations 51, 51', as shown, may be of unlike size, which may be selected in order to attain desired speed regulation characteristics. If desired, in place of perforations, or in conjunction therewith, the rotor may be made of materials having unlike electrical resistance characteristics in the axial direction of the rotor, and the rotor may be made with unlike wall thicknesses in order to attain the desired regulation affecting resistance characteristics therein.

The filament feeler arm 22 always adapts itself to the length of filamentary material that is disposed between the feed rollers 27, 28 and the winding receiver R, so that the filamentary material may be delivered under such tension as is applied thereto by the action of the biased lever upon the filamentary material at the bight 25. Any change in the differential between the rate of supply of filamentary material, by the feed rollers 27 and 28, and the rate at which the receiver accepts the filamentary material, will be sensed by the arm 22 and immediately applied, through the drum 35, to alter the speed of the receiver driving motor, and thus adjust for the so sensed speed variation, in order to maintain a desired tension in the filament.

It is thought that the invention and its numerous attendant advantages will be fully understood from the foregoing description, and it is obvious that numerous changes may be made in the form, construction and arrangement of the several parts without departing from the spirit and scope of the invention, or sacrificing any of its attendant advantages, the forms herein disclosed being a preferred embodiment for the purpose of illustrating the invention.

The invention is hereby claimed as follows:

1. A variable speed motor comprising means forming a magnetic field system including circumferentially spaced

field poles and a cooperating magnetic reflux body defining air gaps with said poles, an eddy current armature having a sleeve portion of electrical conducting material disposed in said air gaps in position exposed to magnetic fields extending between said body and said poles, said armature and field system being mounted for relative turning movement about a rotary axis, said sleeve portion of said armature comprising an electrical conductor having variant conductivity in the axial direction of said sleeve, and means operable to adjust the relative axial relationship of said eddy current armature with respect to the reflux body in order to vary the operating speed of said motor.

2. A variable speed motor comprising a frame, a field system including circumferentially spaced pole pieces mounted on said frame, and a magnetic reflux body supported on said frame concentrically with respect to said pole pieces and in position forming air gaps therewith, a shaft mounted on said frame, an eddy current armature having a sleeve portion of electrical conducting material supported on said shaft for turning movement about the axis thereof, with said sleeve portion disposed in said air gaps, the cross sectional area of said sleeve portion varying in its axial direction, and means to relatively shift said armature and reflux body in the direction of the axis of rotation of said armature.

3. A variable speed motor comprising means forming a magnetic field system including circumferentially spaced field poles and a cooperating magnetic reflux body defining air gaps with said poles, an eddy current armature having a sleeve portion of electrical conducting material disposed in said air gaps in position exposed to magnetic fields extending between said body and said poles, the conductivity of said sleeve varying axially thereof and the armature and field system being mounted for relative turning movement about a rotary axis, said sleeve portion of the armature comprising a shell formed circumferentially with spaced openings to determine the electrical conductivity thereof in the direction of its axis, and means operable to adjust the relative axial relationship of said eddy current armature with respect to said reflux body in order to vary the operating speed of said motor.

4. A filament winding device comprising a shaft for turning a filament receiver, a motor drivably connected with said shaft, said motor comprising means forming a magnetic field system including circumferentially spaced field poles and a cooperating magnetic reflux body defining air gaps at said poles, an armature having an eddy current sleeve portion of electrical conducting material disposed in said air gaps in position exposed to magnetic fields extending between said body and said poles, said armature and field system being mounted for relative turning movement about a rotary axis, said sleeve portion of said armature comprising an electrical conductor having variant conductivity in the axial direction of said sleeve, and operable means to adjust the relative axial relationship of said armature and reflux body to vary the operating speed of said motor, said operable means including a control member actuated by the filament as the same is delivered to the receiver from a supply source.

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