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TENSION CONTROLLING APPARATUS

Filed Oct. 7, 1942

2 Sheets-Sheet 1

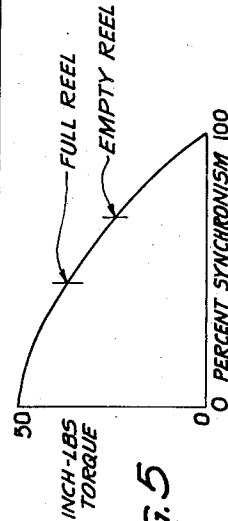
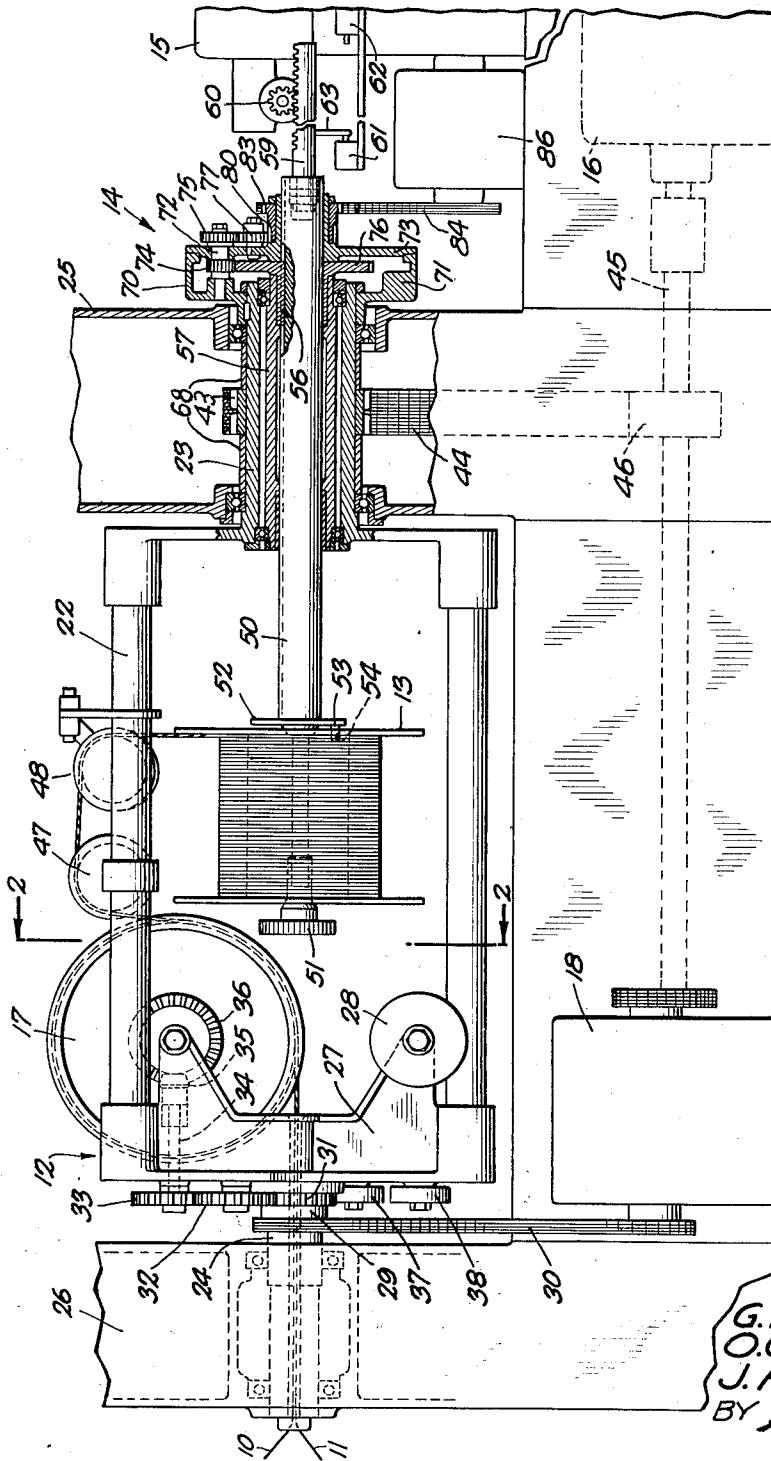


FIG. 1

FIG. 5

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2 Sheets-Sheet 2

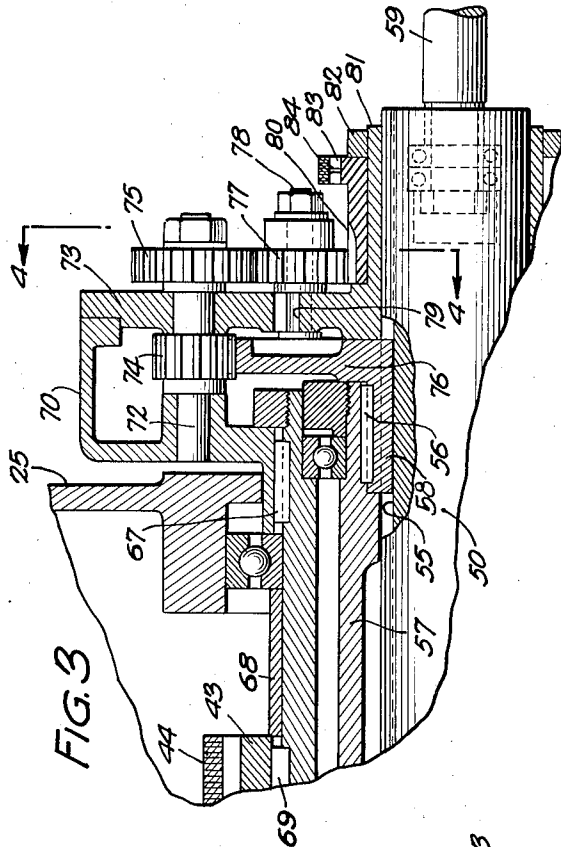


FIG. 3

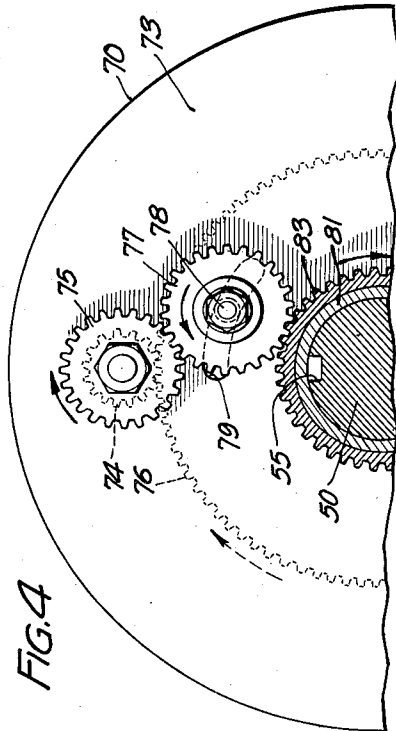


FIG. 4

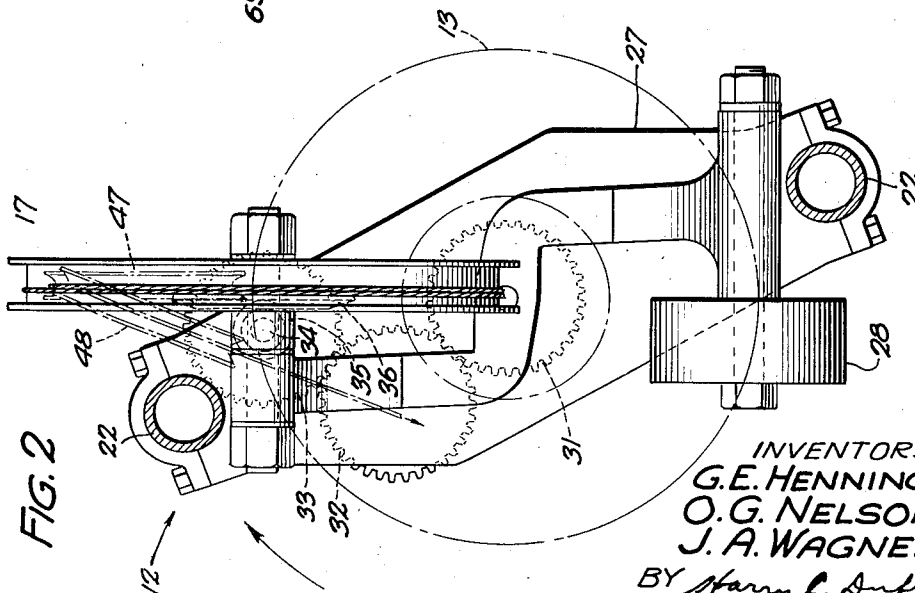


FIG. 2

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TENSION CONTROLLING APPARATUS

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Application October 7, 1942, Serial No. 461,180

10 Claims. (Cl. 57—71)

This invention relates to tension controlling apparatus and more particularly to an apparatus for controlling the tension of strands being wound on a take-up reel.

It is an object of the present invention to provide an automatic apparatus for accurately maintaining constant the tension in material being handled.

In accordance with one embodiment of the invention, an apparatus is provided for controlling the tension in a pair of strands as they are taken up on the take-up reel of a twisting machine. In the twisting machine, a flyer is provided for imparting a twist to the pair of strands and the take-up reel is mounted within the flyer and concentric with its axis of rotation. The tension in the strands is maintained constant by providing a differential gear mechanism receiving power from the flyer driving motor and also from an induction type torque motor and delivering the power to drive the take-up reel. Since, if the applied voltage is constant, the torque output of this type of motor varies at a known rate as the speed of the motor varies, this characteristic of the torque motor is utilized to maintain the tension constant as the winding diameter of the reel increases.

A clear understanding of the invention may be had by reference to the following detailed description, when considered in conjunction with the accompanying drawings, wherein

Fig. 1 is a side elevational view of a strand twisting machine, parts being broken away to more clearly illustrate the details of construction;

Fig. 2 is a vertical sectional view taken on the line 2—2 of Fig. 1 in the direction of the arrows;

Fig. 3 is an enlarged fragmentary sectional view showing, on a relatively large scale, details of construction of the drive for the takeup reel;

Fig. 4 is a vertical sectional view taken substantially along the line 4—4 of Fig. 3 in the direction of the arrows, and

Fig. 5 is a diagram of a torque-speed curve of a torque motor suitable for use in practicing the invention, showing the portion of the torque-speed curve which is utilized in maintaining constant tension in the strands being taken up in accordance with the present invention.

Referring to the drawings, it will be noted, by reference to Fig. 1, that a pair of strands 10 and 11 are being fed into the apparatus and twisted by a flyer 12, which then directs them to a take-up reel 13 driven by an arrangement of gears 14 and reciprocated by a distributor drive 15 to lay

the twisted strands 10 and 11 evenly upon the reel 13. Power for driving the flyer 12 is supplied by a main drive motor 16, which is directly coupled to the flyer and, through the arrangement of gears 14, to the take-up reel 13. The strands 10 and 11 are drawn into the twister by a capstan 17 mounted in the flyer and driven through a change gear mechanism 18 from the main drive motor 16.

The flyer 12 comprises a balanced framework 22 provided with hollow trunnions 23 and 24, which are freely rotatable in standards 25 and 26, respectively. The strands 10 and 11 are fed through the trunnion 24 to the capstan 17, which is mounted on an end block 27 of the framework 22 and which is counterbalanced by a weight 28 mounted on the end block 27. Encircling the trunnion 24 is a sprocket 29, adapted to be driven about the trunnion 24 by a chain belt 30, which is, in turn, driven by the change gear mechanism 18 at a selected speed to drive the capstan at the desired rate. The sprocket 29 is secured to a gear 31 in mesh with an idler gear 32 freely rotatable on the end block 27 and transmitting driving motion from the gear 31 to a pinion 33. The pinion 33 is fixed to a shaft 34, carrying at its right end (Fig. 1) a small bevel pinion 35, which meshes with a bevel gear 36, suitably fixed to the capstan 17. In this manner, the capstan 17 is driven at a rate directly proportional to the rate of speed of the driving motor 16. The mechanism for driving the capstan 17 is counterbalanced by the counterweight 28 and a pair of counterweights 37 and 38, which are mounted on the end block 27 of the flyer 12 and which will compensate for the weight of the idler 32 and the pinion 33.

The trunnion 23 is provided with a sprocket 43 extending around its periphery and in mesh with a chain belt 44. The sprocket 43 is keyed to the trunnion 23 by a key member 69 and is held against movement axially of the trunnion by spacers 68—68. The chain belt 44 is driven by the main drive motor 16 through the shaft 45 and gear 46, the shaft 45 extending over to and driving the change gear mechanism 18. Thus, the capstan 17 and flyer 12 are positively geared one to another and driven by the main drive motor 16 at a constant rate of speed to draw the strands 10 and 11 into the flyer 12 to impart a definite amount of twist to each unit of length drawn into the flyer.

From the capstan 17, the twisted strands 10 and 11 are directed over a pair of guide rollers 47 and 48 angularly disposed with respect one to another

and mounted on the balanced framework 22 of the flyer for guiding the twisted strands to the take-up reel 13. The take-up reel 13 is removably fixed to the left end (Fig. 1) of a shaft 50 by means of a retainer 51, which is adapted to hold the take-up reel 13 on the shaft 50. In addition to the retainer member 51, the shaft 50 has a disc 52 fixed thereto and carrying a locking stud 53 in position to engage in an aperture 54 in reel 13 to lock the reel on the shaft 50 for rotation with it. By reference to Figs. 3 and 4, it will be noted that the shaft 50 has a keyway 55 formed therein for receiving a spline 58 formed on a gear 76 described more fully hereinafter. The gear 76 is keyed to a sleeve 57 by means of a key 56. This construction permits the shaft 50 to be reciprocated along its axis with respect to the sleeve 57 and at the same time to be rotated with the sleeve 57 which is journaled in the hollow trunnion 23.

A reciprocable driving rack 59 is attached to the right hand end of shaft 50, as seen in Fig. 1, in such manner that the shaft 50 is free to rotate but may be reciprocated by the driving rack 59. The driving rack 59 meshes with a pinion 60 which may be rotated by the distributor drive 15 to reciprocate the shaft 50. A pair of switches 61 and 62 are provided for reversing the current supply to the motor driving the distributor drive 15 under control of a switch actuating pin 63 attached to the underside of the rack 59.

Fixed to the trunnion 23, by means of a key 67, is a rotatable housing 70, having in its lower end, as viewed in Fig. 1, a counterweight 71 for counterbalancing the housing 70. In the upper part of the housing 70, as viewed in Figs. 1 and 3, there is journaled a stud shaft 72, which extends out through a housing cover plate 73 and carries a pair of gears 74 and 75 fixed thereto. The gear 74 meshes with a gear 76 upon which is formed integrally the spline 58. The gear 75 meshes with an idler gear 77 mounted upon a stud 78, which may be locked in various positions in an arcuate slot 79 (Fig. 4). The gear 75 may be replaced with various sized gears and the idler gear 77 may be adjusted to compensate for the various sizes of the gear 75 which may be used in the gear train. The idler 77 is adjustable about the axis of the shaft 50, always being maintained in mesh with a sleeve gear 80, which is mounted for rotation on a sleeve 81 extending from and concentric with the cover plate 73, the sleeve gear 80 being locked in place on the sleeve 81 by an annular collar 82 fixed to the sleeve 81. The sleeve gear 80 has teeth 83 formed on its periphery for engagement by a chain belt 84, which is driven by an induction type torque motor 86.

From the foregoing, it is believed to be apparent that the gears 83, 77, 75, 74 and 76 comprise a differential mechanism of the sun and planet type, whereby power from the main drive motor 16 and torque motor 86 will be supplied differentially to drive the take-up reel 13 at a speed depending upon the speed of the rotation of the flyer 12, which is driven directly by the motor 16, and the speed of the motor 86. Since the rate of feed of the twisted strands 10 and 11 is constant, the take-up reel 13 must be caused to rotate at a gradually increasing speed from an empty reel to a full reel and the amount of torque applied to the reel 13 should also gradually increase as the reel fills up with the strands.

Because the torque of an induction type torque motor decreases gradually from 100% torque to zero torque as its speed increases from 0% of

synchronous speed to 100% of synchronous speed, providing the proper resistance is wound in the secondary of the torque motor and the applied voltage is constant, this characteristic of this type of motor may be utilized to apply the proper tension to the strands being wound on the take-up reel. A torque motor should be chosen having such resistance in its secondary circuit that the torque-speed curve thereof will correspond substantially to the curve shown in Fig. 5. The various member of the apparatus are so designed that the portion of this curve falling between the vertical lines marked "full reel" and "empty reel" on Fig. 5 will be utilized. As a result, as the reel 13 fills up gradually, the proper torque to maintain the desired tension on the strands 10 and 11 will be applied to the reel until the reel is filled.

In the operation of the apparatus, the housing 70 which is driven with the flyer 12 will tend to drive the shaft 50 (and the reel 13) through the gears 74 and 76 at the same speed as the flyer if the gear 74 is prevented from rotating. However, the gear 74 is not prevented from rotating, but is driven by the torque motor 86 in the direction indicated by the arrow thereon, which tends to retard the rotation of the reel 13 so that the reel will rotate at a speed different from that of the flyer. With respect to the flyer 12 the reel rotates in a direction opposite to the direction of rotation of the flyer, while with respect to the whole apparatus the reel rotates in the same direction as the flyer but at a slower speed. When the reel is empty and is rotating at its slowest speed, the torque motor 86 must rotate at its highest speed and when the reel is full and is rotating at its highest speed, the motor 86 must rotate at its lowest speed. A torque motor may be provided with such a resistance in its secondary circuit that it will have a substantially constant power output for a given range of speed, i. e., as its speed decreases, its torque will increase proportionately. Referring to the torque-speed curve of such a motor (Fig. 5), it will be seen that when the reel is empty, the motor speed will be high and a low retarding torque will be applied to the reel and when the reel is full, the motor speed will be proportionately lower and a higher retarding torque will be applied to the reel. Thus, the speed of rotation of the reel 13 will approach the speed of rotation of the flyer 12 as the reel fills up and the tension on the twisted strands being wound upon the reel 13 will be constant throughout the reeling operation.

When it is desirable to change the lay of the twist given to the strands 10 and 11 as they are twisted together by the flyer 12, the change gear mechanism 18 is adjusted accordingly to change the speed of rotation of the capstan 17. This will also change the linear speed at which the twisted wires are fed to the take-up reel 13. Consequently, the gear 75 must be replaced by another gear of suitable size to cause the reel 13 to rotate at the speed necessary to take up the twisted wires as fast as they are fed thereto. When the gear 75 is replaced, the stud 78 is adjusted in the arcuate slot 79 so as to cause the gear 77 carried thereby to mesh with the gear that replaces the gear 75.

It will be seen that in this apparatus the tension control mechanism is mounted outside of the flyer, thereby simplifying the problem of balancing the flyer to avoid vibration when operating at high speeds. This construction also makes the control mechanism readily accessible for

maintenance and permits the gear 75 to be readily replaced.

What is claimed is:

1. A tensioning apparatus comprising a rotatable member for engaging a supply of material to be tensioned, driving means operable at a fixed rate of speed, driving means operable at a variable rate of speed, and means operable jointly by said driving means for rotating said rotatable member to apply a predetermined tension to said material.

2. A tensioning apparatus comprising a rotatable member for engaging a supply of material to be tensioned, a differential gear system for said member, driving means operable at a fixed speed for driving said gear system, and a second driving means operable at variable speed for driving said gear system to apply a predetermined tension to said material.

3. A tensioning apparatus comprising a rotatable take-up member for strand material, a differential gear for actuating said member, said differential gear having two power inputs, a constant speed source of power connected to one of said power inputs, and a motor having a substantially constant power at a variable speed connected to the other power input.

4. An apparatus for maintaining constant the tension in strands being delivered at a fixed rate to a take-up reel, comprising a constant speed drive for delivering said strands, and means for driving the take-up reel comprising a differential gear mechanism having two inputs and one output, means connecting said output to the take-up reel, means connecting one of said inputs positively to the drive for delivering the strands, a torque motor, and means connecting the torque motor positively to the other input of the differential gear mechanism to increase the torque applied to the take-up reel as its speed of rotation increases.

5. An apparatus for maintaining constant the tension in strands being twisted by a flyer and delivered to a take-up reel, comprising driving means for driving the reel concentrically with the flyer, a differential mechanism for transmitting power to said driving means, a power source for applying power to the flyer and differential mechanism, and means for controlling the torque output of the differential mechanism comprising

a torque motor connected directly to the differential mechanism.

6. A tensioning apparatus comprising a rotatable member for engaging a supply of material to be tensioned, driving means operable at a fixed rate of speed, driving means operable at a variable rate of speed, and differential gear mechanism operable jointly by said driving means for rotating said rotatable member to apply a predetermined tension to said material.

7. A tensioning apparatus comprising a rotatable member for engaging a supply of material to be tensioned, driving means operable at a fixed rate of speed, driving means operable at a variable rate of speed, and differential gear mechanism positively connected to both of said driving means for rotating said rotatable member to apply a predetermined tension to said material.

8. A tensioning apparatus comprising a rotatable member for engaging a supply of material to be tensioned, driving means operable at a fixed rate of speed, a torque motor operable at a variable rate of speed, and means operable jointly by said driving means and said torque motor for rotating said rotatable member to apply a predetermined tension to said material.

9. A tensioning apparatus comprising a rotatable member for engaging a supply of material to be tensioned, driving means operable at a fixed rate of speed, a torque motor operable at a variable rate of speed, and gear mechanism operable jointly by said driving means and said torque motor for rotating said rotatable member to apply a predetermined tension to said material.

10. A tensioning apparatus for controlling the take-up reel of a flyer type strand twisting apparatus, comprising a shaft for supporting the reel coaxially of the flyer, a differential gear mechanism for driving said shaft having its output gear connected to said shaft, means for driving the flyer and one of the input gears of the differential gear mechanism, and a torque motor for driving the other input gear of the differential gear mechanism.

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