March 19, 1968 J. M. SYMONDS 3,373,550

METHODS OF AND APPARATUS FOR ALTERNATE-REVERSE TWISTING OF INDEFINITE LENGTHS OF STRAND MATERIAL

Filed June 10, 1965

FIG. 1

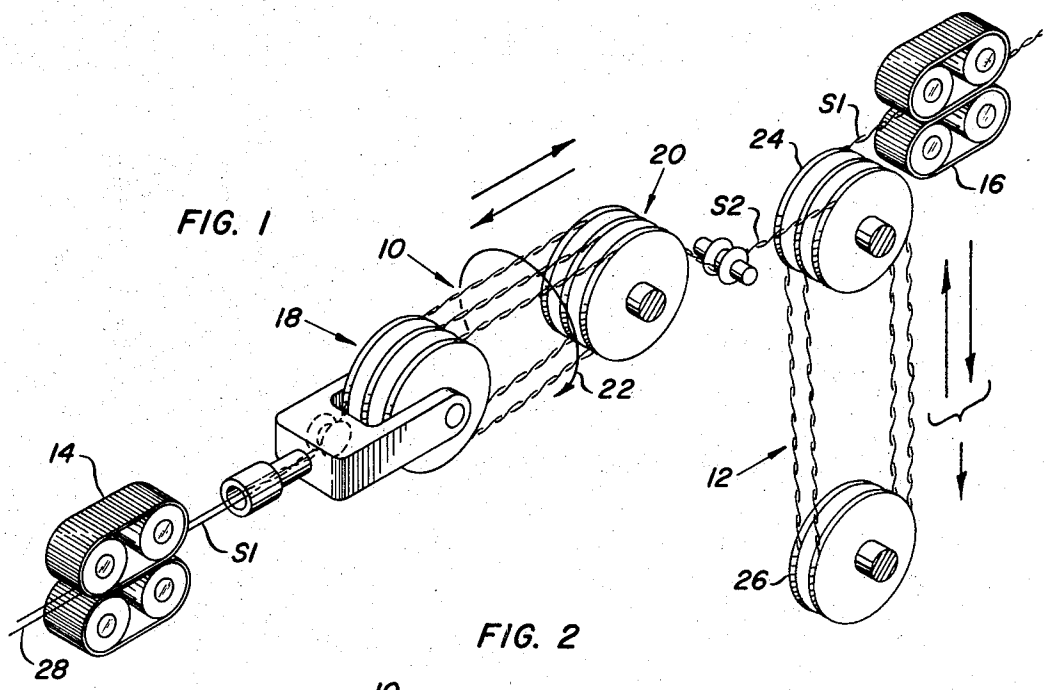


FIG. 2

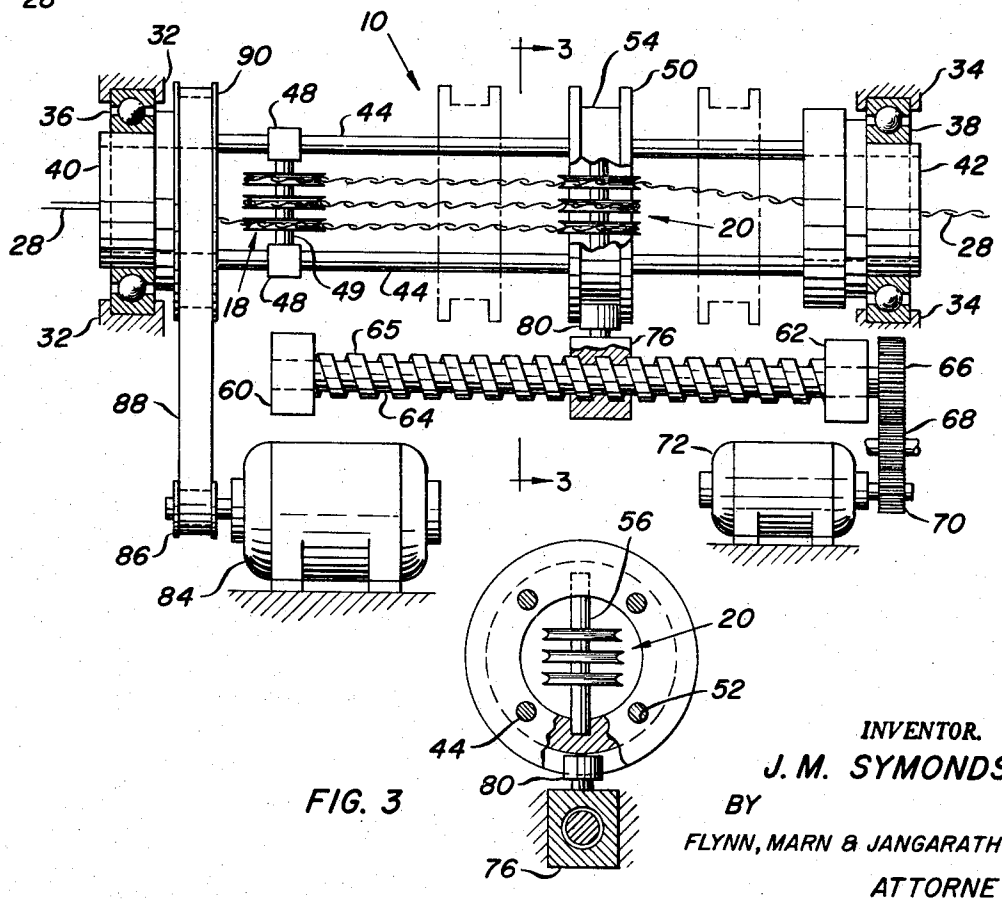


FIG. 3

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United States Patent Office 3,373,550
Patented Mar. 19, 1968

3,373,550

METHODS OF AND APPARATUS FOR ALTERNATE-REVERSE TWISTING OF INDEFINITE LENGTHS OF STRAND MATERIAL

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Filed June 10, 1965, Ser. No. 462,858
6 Claims. (Cl. 57—34)

ABSTRACT OF THE DISCLOSURE

Imparting alternate-reverse twists to indefinite lengths of strand material, in particular a plurality of electrical conductors, by feeding the strand material axially into and out of a rotating accumulator which cooperates with a non-rotating accumulator which creates an alternating differential between the entrance and exit speeds of the strand material into and out of the rotating accumulator. By making the entrance speed of the strand material into the rotating accumulator alternately greater and less than the exit speed from the rotating accumulator, a net alternate-reverse twist is imparted to the strand material.

This invention relates to methods of and apparatus for alternate-reverse twisting of indefinite lengths of strand material, and more particularly, to methods of and apparatus for alternate-reverse twisting of a plurality of electrical conductors.

The principle of operation of the present invention is related to the internal twister principle employed by the inertial twister embodiments for twisting wire-like members disclosed in U.S. Patent No. 3,096,610, issued July 9, 1963, to the Western Electric Company, Inc., as assignee of Tillman T. Bunch. Briefly stated, such inertial twister principle is that if lengths of strand material are fed axially into one end of a rotating drum, or drum-like structure, the material will be thrown outwardly by centrifugal force against the walls of the drum and a twist of one direction will be imparted to the material.

It has been discovered that if the lengths of strand material are removed or discharged axially out of the opposite end of the rotating drum, or equivalent structure, a twist in the opposite direction is imparted to the strand material.

If the drum, or equivalent structure, is rotating at a uniform rate, and if the entrance and exit speeds of the strand material into and out of the drum are the same, the net effect on the strand material is zero, i.e., the number of twists of one direction imparted to the strand material upon its entrance into the rotating drum is exactly equal to the twist in the opposite direction imparted to the strand material upon its exit from the drum.

It has been further discovered that if an alternating differential is created between the entrance and exit speeds of the strand material into and out of the rotating drum or equivalent structure, an alternate-reverse twist is imparted to the strand material. More specifically, if the speed of the strand material exiting the rotating drum is less than the speed at which the strand material is entering the drum, all of the twists imparted to the material upon its entry into the rotating drum will be removed and a twist in the opposite direction will be imparted to the strand material. When the speed of the strand material leaving the rotating drum is greater than the speed of the strand material entering the drum, not all of the twists imparted to the strand material upon its entry into the drum will be removed, and a portion of such initially imparted twist will remain in the strand material. This discovery is included in a copending patent application

Ser. No. 462,857 filed June 10, 1965 in the name of Everett J. Shaw as assignor to the Western Electric Company, Incorporated.

The use of an alternate-reverse twist, for example, in pairs of electrical conductors, rather than a continuous actual twist, provides a major manufacturing advantage, namely, the need for rotating a conductor supply or take-up device, both in general being quite massive, is eliminated.

Accordingly, it is an object of the present invention to provide new and improved methods of and apparatus for alternate-reverse twisting of indefinite lengths of strand material.

A further object of the present invention is to provide new and improved methods and apparatus for alternate-reverse twisting of indefinite lengths of strand material utilizing a rotatable accumulator.

A further object of the present invention is to provide new and improved methods and apparatus for alternate-reverse twisting of indefinite lengths of strand material utilizing a pair of accumulators one of which is rotatable.

The present invention utilizes two accumulators to provide an alternate-reverse twist in indefinite lengths of strand material. The accumulators are of the same general type as the accumulator **91** shown in FIG. 1 of U.S. Patent No. 2,971,709, issued Feb. 14, 1961, and the cutover tower **18** shown in FIG. 1 of U.S. Patent No. 2,973,912, issued Mar. 7, 1961. The operation of the accumulators of the present invention insofar as the storing of the strand material is concerned, is substantially the same as the above-referred to devices.

One of the accumulators of the present invention, however, is mounted for rotation and the other accumulator is mounted for operation in the usual manner of accumulator take-up operation. The length of the rotatable accumulator is alternately increased and decreased to provide an alternating differential between the speed of the strand material leaving the rotatable accumulator and the speed of the strand material entering the rotatable accumulator. This alternating speed differential provides, as described above, an alternate-reverse twist in the strand material. The length of the other accumulator is alternately decreased and increased to provide take-up for the material as the length of the rotatable accumulator is being alternately increased and decreased.

A more complete understanding of the present invention may be obtained from the following detailed description when read in conjunction with the appended drawings, in which:

FIG. 1 is a diagrammatical representation of apparatus for providing indefinite lengths of strand material with alternate-reverse twists in accordance with the teachings of the present invention; and

FIG. 2 is a plan view of a portion of specific structure which may be utilized to practice the present invention; and

FIG. 3 is a sectional view taken substantially along the line 3—3 in FIG. 2.

Referring now to the drawings, and in particular FIG. 1, there are shown diagrammatically a rotatable accumulator, indicated generally by the numerical designation **10**, a take-up accumulator, indicated generally by the numerical designation **12**, and a pair of constant speed tractor type capstans **14** and **16**, of the type well known in the capstan art.

The accumulator **10** includes two sets of sheaves **18** and **20**. The sets of sheaves are rotatable, as indicated by the arrow **22**, and sheaves **20** are movable longitudinally of the axis of rotation of accumulator **10**, and more significantly, with respect to sheaves **18**.

The accumulator **12** includes two sets of sheaves **24**

and 26. Sheaves 26 are mounted for movement upwardly and downwardly with respect to sheaves 24.

A pair of electrical conductors 28, to be provided with alternate-reverse twists, is fed forward from a supply, not shown, by the capstan 14 into the accumulator 10. The conductors 28 are fed over and around the sheaves 18 and 20 of accumulator 10 and then forward over and around the sheaves 24 and 26 of the accumulator 12. The capstan 16 then feeds the conductors 28 forward and onto a suitable take-up reel, not shown.

It will now be assumed that the capstans 14 and 16 are operating at substantially constant and identical speeds, that the conductors 28 occupy the positions shown in FIG. 1 as described above, and that accumulator 10 is rotating at a uniform rate in the direction indicated by the arrow 22.

As the conductors 28 are fed forward by the capstans 14 and 16 at a linear speed S1, and are received by the rotating accumulator 10, a twist of one direction will be imparted to the conductors. As the conductors are fed further forward, or discharged from, the rotating accumulator 10 at a linear speed S2, and onto the accumulator 12, a twist will be imparted to the conductors in the opposite direction. At such times that sheaves 20 are not being moved longitudinally with respect to sheaves 18, the linear speed S1 of the conductors entering the rotating accumulator 10 will be equal to the linear speed S2 of the conductors leaving, or being discharged from, the rotating accumulator and no resulting twist will be imparted to the conductors.

When the sheaves 20 are moving toward the sheaves 18, the linear speed S2 of the conductors 28 leaving the rotating accumulator 10 will be greater than the linear speed S1 of the conductors entering the rotating accumulator. At such time S2 is greater than S1, not all of the twists imparted by the rotating accumulator 10 upon the entry of the conductors into the accumulator will be removed, and the twisted conductors will be fed forward onto the take-up accumulator 12.

At such time the sheaves 20 are moving toward the sheaves 18 of the rotating accumulator 10, the sheaves 26 of take-up accumulator 12 are moving downwardly from sheaves 24 so as to take up and store a sufficient quantity of the conductors 28 to permit the linear speed S1 of the conductors leaving the take-up accumulator to remain constant.

When the sheaves 20 are moving away from the sheaves 18, the linear speed S2 of the conductors exiting the rotating accumulator 10 will be less than the linear speed S1 of the conductors entering the rotating accumulator, and all of the twist imparted to the conductors upon their receipt by the rotating accumulator 10 will be removed and twist in the opposite direction will be imparted to the conductors.

At such time sheaves 20 are moving away from the sheaves 18 of the rotatable accumulator 10, the sheaves 26 of take-up accumulator 12 are moving upwardly toward the sheaves 24 so as to give up a portion of the conductors accumulated or stored on the accumulator 12, which in turn permits the linear speed S1 of the conductors leaving the take-up accumulator to remain constant.

By moving alternately the sheaves 20 toward and away from the sheaves 18, an alternating differential is created between the linear speeds S1 and S2 of the conductors 28, and an alternate-reverse twist imparted to the conductors.

Since one set of sheaves in each accumulator has the ability to move with respect to the associated set of sheaves, the accumulators may be said to be elongatable.

An actual embodiment of a rotatable and elongatable accumulator 10, which may be used to practice the present invention, is shown in FIG. 2. The accumulator 10 includes pairs of stationary support members 32 and 34 which support fixedly the outer races of bearings 36 and 38, respectively.

A pair of generally annular shaped members 40 and 42, are mounted for rotation by being suitably secured, such as by a press fit, to the inner races of the bearings 36 and 38, respectively.

Extending between the rotatable annular members 40 and 42, are a plurality of rods 44. The ends of the rods are secured fixedly, such as by welding, to the members 40 and 42 and, thus, the rods are mounted for rotation with the annular members 40 and 42.

A pair of block members 48 are secured fixedly, such as by welding, to the rods 44 and support a shaft 49 which extends between the block members. The shaft 49 supports the set of sheaves 18 for rotation about its own axis and also supports the sheaves 18 for rotation with the annular members 40 and 42.

Secured slidably along the rods 44 is an annular member 50 which is provided with slightly oversized apertures 52 through which extend the rods 44. A groove 54 is provided around the periphery of the annular member 50 and a shaft 56 extends across the center aperture of the annular member.

The shaft 56 supports the set of sheaves 20 for rotation about the shaft, for rotation with the rods 44 and annular rings 40 and 42, and for reciprocating longitudinal movement with respect to the set of sheaves 18.

Support blocks 60 and 62 support rotatably a helical lead screw 64 which includes the helix 65. A gear 66 is secured fixedly to one end of the screw and the gear through intermediate gear 68, is in engagement with a pinion 70 provided on the drive shaft of a reversible motor 72.

Traveling block 76 encircles the helical lead screw 64, in engagement with the helix 65 formed thereon, and is provided with a cylindrically shaped pin 80 which resides within the peripheral groove 54 of annular member 50.

As reversible rotational motion, provided by the reversible motor 72, is transmitted to the helical lead screw by the afore-mentioned gearing, reciprocating translational motion is imparted to the traveling block 76 by the helix 65 of the helical lead screw. This motion is transmitted to the annular member 50 by the pin 80 of the traveling block and reciprocating longitudinal motion is imparted to the annular member 50 and the set of sheaves 20.

Rotational motion is imparted to the accumulator 10 by a unidirectional, variable-speed motor 84. The motor shaft is provided with a pulley 86 which is engaged by a belt 88 which belt is also in engagement with a pulley 90 secured fixedly to the annular member 40. Thus, when rotative power supplied by the motor 84 is transmitted to the pulley 40, the annular members 40 and 42, the rods 44 and the sheaves 18 and 20 and annular ring 50 supported, thereby, are rotated.

The cooperative engagement between the peripheral groove 50 and the cylindrical pin 80, permits the aforementioned reciprocating longitudinal movement to be imparted to the annular member 50 and set of sheaves 20 while the sheaves and annular member are being rotated.

Accordingly, it will be appreciated that sets of sheaves 18 and 20 are mounted for rotational movement and that set of sheaves 20 is also mounted for reciprocating longitudinal movement toward and away from set of sheaves 18.

In the practice of the present invention utilizing the structure of FIG. 2, the pairs of electrical conductors 28 are fed forward by the capstans 14 and 16, axially into the rotatable accumulator 10, over and around sets of sheaves 18 and 20, and axially out of the accumulator 10 onto a take-up accumulator 12 such as is shown diagrammatically in FIG. 1 and such as is shown and described in the patents referred to above. The conductors 28 are passed over and around the sheaves 24 and 26 of the take-up accumulator 12 and are then fed further forward by the capstans onto a suitable take-up reel, not shown.

The motor 84, as described above, imparts rotational motion to the sets of sheaves 18 and 20 and the reversible motor 72, as described above, imparts reciprocating longitudinal motion to the set of sheaves 20.

As the conductors 28 are received axially by the rotating accumulator 10, a twist of one direction will be imparted to the conductors.

During the movement of the set of sheaves 20 toward the set of sheaves 18, i.e., toward the leftward dashed outline position shown for sheaves 20 in FIG. 2, the linear speed S2 of the conductors leaving or being discharged from the rotating accumulator will be greater than the linear speed S1 of the conductors entering the rotating accumulator.

During the movement of the set of sheaves 20 away from the set of sheaves 18, i.e., toward the rightward dashed outline position shown in FIG. 2, the linear speed S2 of the conductors leaving the rotating accumulator will be less than the linear speed S1 of the conductors entering the rotating accumulator.

The alternating differential between the speeds S1 and S2, as described above, provides the conductors 28 with an alternate-reverse twist.

The number of alternate-reverse twists imparted per unit length of the conductors is dependent upon the rate of rotation of the rotatable accumulator relative to the linear speed of the conductors, and, of course, the rate of recipriocating translational movement of the traveling block 76. Accordingly, the number of twists per unit length can be varied by varying the speed of the motors 72 and 84 with respect to each other. This could be accomplished by varying solely the speed of either motor, or by varying the speeds of both motors as long as a different differential in motor speeds is established.

Although the present invention has been presented with reference to providing indefinite lengths of strand material, viz., a pair of electrical conductors, with an alternate-reverse twist, it will be understood that the expression "indefinite lengths of strand material" is intended to include solid wires, stranded wires, tubing, ribbons and all types of members of relatively small cross section and of relatively indefinite length.

It is manifest that many alterations and modifications can be made in the present invention without departing from the spirit and scope of the invention.

What is claimed is:

1. The method of providing indefinite lengths of strand material with an alternate-reverse twist, which comprises the steps of:

feeding said material axially into and out of a rotating accumulator, and

varying the length of the accumulator to create an alternating differential between the speed of the material entering the accumulator and the speed of the material leaving the accumulator.

2. Apparatus for imparting an alternate-reverse twist to indefinite lengths of strand material, which comprises:

a rotatable and elongatable accumulator for receiving and imparting a twist of one direction to said material and for discharging and imparting a twist in the opposite direction to said material, and

means for varying the length of said accumulator to make the speed of the material discharged from said accumulator alternately faster and slower than the speed of the material received by the accumulator.

3. Apparatus for imparting an alternate-reverse twist to indefinite lengths of strand material, which comprises:

a rotatable accumulator, including two sets of sheaves for axially receiving and discharging said material;

one of said set of sheaves being mounted for reciprocating movement longitudinally of the axis of rotation of said accumulator;

means for imparting reciprocating movement to said one set of sheaves to create an alternating differential between the speed of the material received by the accumulator and the speed of the material discharged from the accumulator; and

a second accumulator for receiving the material discharged from said rotatable accumulator and for providing take-up of said material as said one set of sheaves is reciprocated.

4. Apparatus according to claim 3 for providing a variation in the number of alternate-reverse twists per unit length, which comprises:

means for varying the speed of rotation of said rotatable accumulator.

5. Apparatus for imparting an alternate-reverse twist to indefinite lengths of strand material, which comprises:

a rotatable accumulator, including two sets of sheaves, for axially receiving and imparting a twist of one direction to said material and for discharging axially and imparting a twist to said material in a direction opposite to said one direction;

one of said set of sheaves being mounted for reciprocating movement longitudinally of the axis of rotation of said accumulator;

means for imparting reciprocating movement to said one set of sheaves to make the linear speed of the material discharged by said accumulator alternately: (i) greater than the linear speed of the material received by said accumulator so as not to remove all of said imparted twist of said one direction, and (ii) less than the linear speed of the material received by said accumulator so as to remove all of said imparted twist of said one direction and to impart a twist to said material in a direction opposite to said one direction; and

an elongatable accumulator including two sets of sheaves, one of which set is movable with respect to the other set, and for providing take-up for said material during said reciprocation of said one set of sheaves.

6. Apparatus according to claim 5 for providing a variation in the number of alternate-reverse twists imparted per unit length, which comprises:

a variable speed motor for rotating said rotatable accumulator.

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