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

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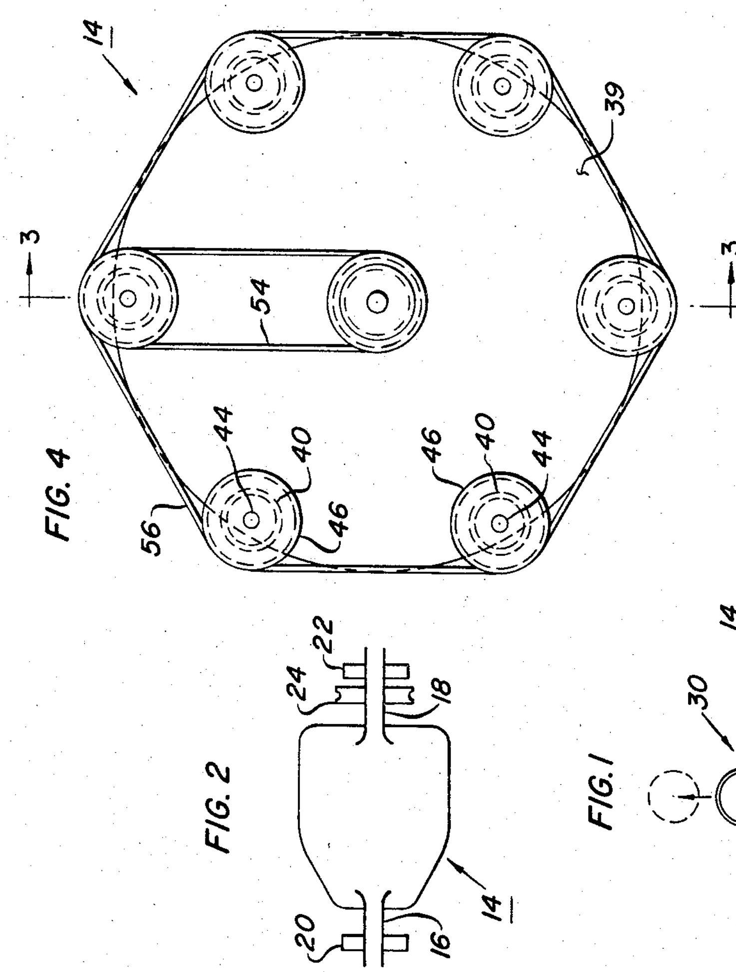

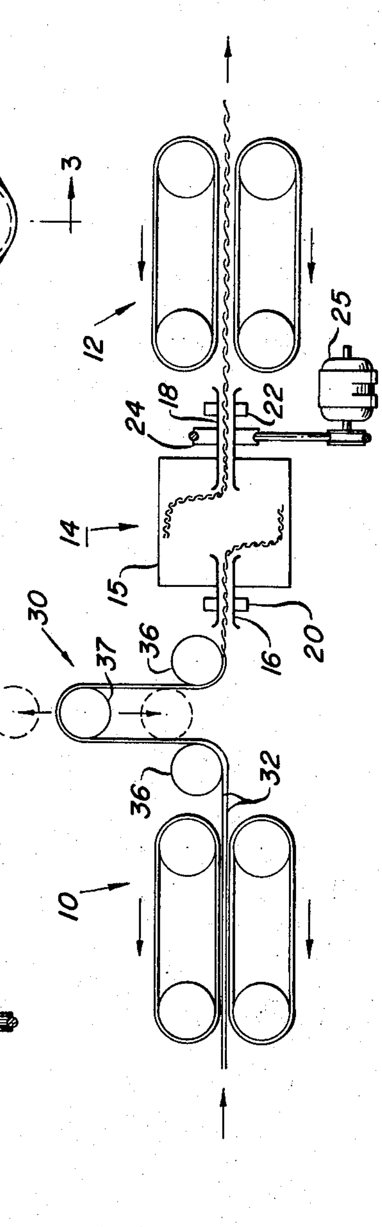

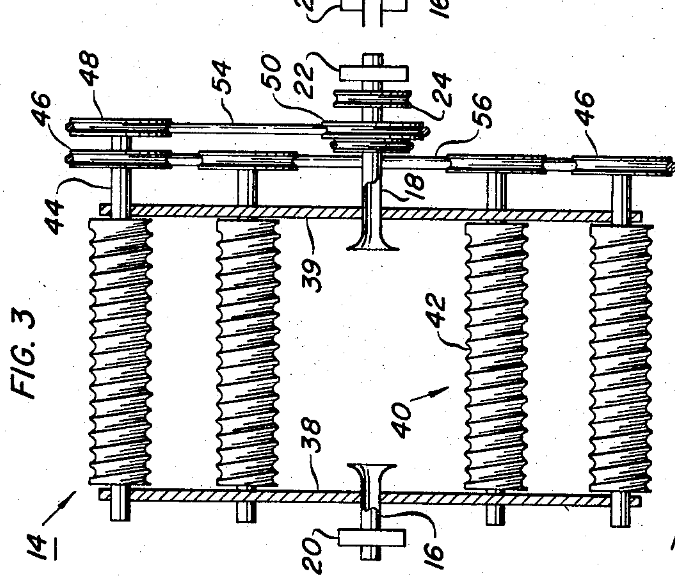

INVENTOR
E. J. SHAW
BY
FLYNN, MARN & JANGARATHIS
ATTORNEY

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1

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

Everett Jesse Shaw, Pennington, N.J., assignor to Western Electric Company, Incorporated, New York, N.Y., a corporation of New York

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ABSTRACT OF THE DISCLOSURE

Imparting alternate-reverse twists to indefinite lengths of strand material, and in particular, to a plurality of electrical conductors. More specifically, a plurality of electrical conductors are fed axially into, and axially out of, a rotating twisting apparatus such as a rotating drum. Axial entry of the conductors into the rotating drum imparts a twist of one direction to the conductors, and, axial discharge of the conductors imparts a twist in the opposite direction. By alternately varying the relative speeds of drum entrance and discharge, alternate-reverse twists are imparted to the conductors.

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 utilizing inertial twisters.

The inertial twister of the present invention employs the inertial twister principle in the same general manner as do the inertial twister embodiments 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, the inertial twister principle upon which the operation of such inertial twisters is based, 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 in 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 twist imparted to 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, 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.

2

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 either the 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 of and apparatus for alternate-reverse twisting of indefinite lengths of strand material utilizing an inertial twister.

The method illustrating certain features of the present invention may include the steps of feeding lengths of strand material axially into and out of a rotating drum and varying alternately the relative speeds of entry and exit of the lengths of strand material into and out of the rotating drum.

Apparatus illustrating certain features of the invention may include rotatable means for receiving and discharging, axially, lengths of strand material, means for feeding the lengths of strand material, axially, into and out of the rotatable means, and means for creating an alternating differential between the entering and exiting speeds of the lengths of strand material into and out of the rotatable means.

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 embodying certain features of the present invention, with the inertial twister shown in cross section;

FIG. 2 is an alternate configuration for the inertial twister, shown in outline form;

FIG. 3 is another alternate configuration for the inertial twister, shown in partial cross section; and

FIG. 4 is an end view of the structure shown in FIG. 3.

Referring now to FIG. 1, there are shown two caterpillar capstans **10** and **12**, of the type well known in the art, which are operated at substantially identical, constant speeds.

The inertial twister, indicated generally by the numerical designation **14**, is of a drum or drum-like configuration defining a chamber **15** and is provided with axially aligned tubular members **16** and **18** leading into and out of the opposite ends of the twister. The inertial twister is mounted for rotation by being suitably journaled within bearings **20** and **22**, in the manner well-known in the art, and rotation is imparted to the twister by a suitable source of power such as a variable speed motor **25**.

An accumulator, indicated generally by the numerical designation **30**, is provided intermediate the capstan **10** and the inertial twister **14**, and includes a pair of rotatable stationary sheaves **36—36** and a rotatable and vertically movable sheave **37**. The accumulator is of the same general type as the accumulator **91** shown in FIG. 1 of U.S. Patent No. 2,971,709, issued February 14, 1961, and the cutover tower **18** shown in FIG. 1 of U.S. Patent No. 2,973,912, issued March 7, 1961; the operation of accumulator **30** being substantially the same as the referred to devices.

A pair of electrical conductors **32**, to which the alternate-reverse twists are to be imparted, is fed forward, from suitable supply reels not shown, by caterpillar capstan **10**, over and around the sheaves **36** and **37**, through tubular-like member **16** into the interior of the inertial twister **14**, out of the inertial twister through tubular member **18**, and further forward by caterpillar capstan **12** onto, for example, a suitable take-up reel, not shown.

The operation of the apparatus of FIG. 1 will now be explained. It will be assumed that the upper sheave **37** of the accumulator **30** is stationary and occupies the solid outlined position shown, that the caterpillar capstan **10** and **12** are operated at substantially constant and identical speeds, and that the inertial twister is being rotated at a uniform rate. The conductors **32** are fed forward, as described above, into the interior of the inertial twister **14**, and due to the inertial twisting principle described above, a twist of one direction will be imparted to the conductors upon the entry of the conductors into the rotating inertial twister. More specifically, if the conductors are entering an inertial twister axially at a linear speed of one foot per second, and the inertial twister is rotating at a rate of one revolution per second, a twist of one turn per foot will be imparted to the conductors.

However, since sheave **37** is stationary, capstan **12** is removing the conductors **32** from the inertial twister at the same linear speed as the conductors are being fed into the twister thus, the twist imparted to the conductors by the inertial twister upon the entry of the conductors into the twister is completely removed, or cancelled out, upon the exiting of the conductors from the inertial twister. Or, viewed differently, the amount of twist imparted to the conductors in one direction by the conductors being fed at a constant linear speed into one end of the uniformly rotating twister, is exactly equal to the twist imparted to the conductors in the opposite direction upon the conductors being removed from the inertial twister at the same constant linear speed.

An alternate-reverse twist may be imparted to the conductors **32** by continuously alternately raising and lowering the upper sheave **37** of the accumulator **30** to the upper and lower dashed outline positions shown in FIG. 1. Such continuous alternate movement of the upper sheave **37** has the effect of creating an alternating differential between the entering and exiting linear speeds of the conductors **32** into and out of the inertial twister.

It will now be assumed that the inertial twister **14** is rotating at a uniform rate and that the upper sheave **37** of the accumulator **30** is moving toward the lower position shown in dashed outline. Accordingly, the length of the conductors between capstan **10** and the inertial twister **14** will be decreased and hence the linear speed of the conductors entering the inertial twister will be increased, relative to the entering linear speed of the conductors at such time the sheave **37** was stationary, and relative to the linear speed of the conductors exiting from the twister. Hence, the number of turns or twists per unit length imparted to the conductors by the inertial twister upon the entry of the conductors into the twister will be decreased. However, the capstan **12** is taking the conductors out of the inertial twister at the same linear speed as before, and since the linear speed of the conductors entering the inertial twister has increased, the capstan **12** relatively speaking, is now removing the conductors from the inertial twister at a slower linear speed than they are entering. Hence, all of the previously imparted twists are removed from the conductors and twists in the opposite direction are imparted to the conductors.

It will now be assumed that the upper sheave **37** of the accumulator **30** is moving toward the upper position shown in dashed outline in FIG. 1, accordingly, the linear speed of the conductors entering the inertial twister will be decreased and, hence, the number of twists per unit length imparted to the conductors by the inertial twister upon the entry of the conductors will be increased. However, the capstan **12** is removing the conductors **32** from the inertial twister **14** at the same linear speed as before, and since the linear speed of the conductors entering the inertial twister has decreased, the capstan **12**, relatively speaking, is removing the conductors from the inertial twister at a greater linear speed than they are entering. Accordingly, not all the twist imparted to the conductors upon their entry into the inertial twister is removed.

Thus, by alternately moving the upper sheave **37** between the upper and lower positions, an alternating differential is created between the speed of the conductors entering and leaving the twister **14**, and an alternate-reverse twist is imparted to the conductors **32**.

It will be appreciated that the alternatnig differential between the speeds of entry and exit of the conductors into and out of the inertial twister **14** could also be accomplished by locating the accumulator **30** intermediate the inertial twister and the capstan **12**.

It will be understood that the alternating differential between entering and existing speeds of the conductors entering and exiting the inertial twister could be achieved without the use of the accumulator **30**, by alternately varying the relative speeds of the capstan **10** and **12** with respect to each other. Of course, the average speed of each capstan would have to remain constant or substantially so, over any given period of time.

It will be further understood that since the number of turns or twists per unit length imparted to the conductors is dependent upon the linear entry or exiting speed of the conductors and the rate of rotation of the inertial twister, a variable number of twists per unit length may be imparted to the conductors by varying the rate of rotation of the inertial twister **14**. This can be accomplished by the use of a variable speed motor (not shown), well known in the art, to rotate the inertial twister **14**.

In order to eliminate the possibility of one or more layers of twisted conductors piling up on top of each other within the inertial twister, an inertial twister **14** may be constructed of the configuration shown in cross section in FIG. 2. Portions of the twister walls near the entrance into the interior of the twister are inclined such that the twisted conductors will advance internally of the twister, toward the rearward portion, by their sum force, i.e., the angle of inclination of the walls is slightly greater than the angle of friction of the conductors on the surface of the inclined walls.

The inertial twister embodiment shown in FIG. 2, in the same manner as the inertial twister embodiment of FIG. 1, is provided with axially aligned tubular members **16** and **18**, through which conductors **32** to be twisted would enter and exit, and is mounted for rotation by being suitably journaled within bearings **20** and **22**. Rotary motion is imparted to the inertial twister by means of the pulley **24** fixedly secured to the tubular member **18**.

Another manner of assuring that the twisted conductors advance properly internally of the inertial twister, involves utilization of the inertial twister structure shown in FIGS. 3 and 4. Such structure includes axially aligned tubular members **16** and **18**, through which conductors **32** to be twisted would enter and exit, and to which tubular members are secured fixedly end plates **38** and **39**. A plurality of rollers **40**, provided with external helical corrugations indicated generally by numerical designation **42**, are mounted around the periphery of the inertial twister **14**, as shown in FIGS. 3 and 4, for rotation with individually associated rods **44** extending between and through the end plates **38** and **39** and mounted for rotation therein. Each rod **44** is provided with a pulley **46**, and the rod **44**, shown in the top portion of FIG. 3, is provided with an additional pulley **48** by the means of which rotative power is imparted to the rod by a belt **54** in engagement with a double pulley **50**. Pulley **50** is mounted rotatably on the tubular member **18**, for independent rotation about the tubular member, and rotative power is supplied to the pulley **50** by a suitable source, such as the variable speed motor **25** of FIG. 1. A belt **56** engages all the pulleys **46** and imparts rotative motion to such pulleys, and hence to their associated rods **44** and rollers **40**, upon rotation of the double pulley **50**.

In substantially the same manner as the inertial twister embodiments **14** of FIGS. 1 and 2, the inertial twister **14** of FIGS. 3 and 4 is mounted for rotation by being suitably journaled within bearings **20** and **22**. Rotation is imparted to the inertial twister by means of the pulley **24** which is secured fixedly to the tubular member **18** and which would be, in actual operation, connected by a belt to a suitable source of rotative power, such as the motor **25** of FIG. 1.

Accordingly, the rollers **40** are mounted for simultaneous rotation with their individually associated rods **44** about the periphery of the inertial twister **14** at the same time that the entire inertial twister is rotating within journals **20** and **22**. As the rollers **40** are rotated simultaneously, twisted conductors residing internally of the inertial twister will be progressively and orderly advanced internally of the twister for removal therefrom by a capstan, such as capstan **12**.

It will be understood that the expression "indefinite lengths of strand material," as used herein and in the appended claims, is intended to include not only the specific example shown and described, viz, electrical conductors, but also solid wires, stranded wires, tubing, tapes, 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 alternate-reverse twists, which comprises the steps of:
  feeding said lengths of strand material axially into and out of a rotating drum, and
  varying alternately the relative speeds of entry and exit of said lengths of strand material into and out of said drum so as to impart said alternate-reverse twists to said strand material.

2. The method of providing indefinite lengths of strand material with alternate-reverse twists, which comprises the steps of:
  feeding lengths of strand material into one end of a rotating drum to impart a twist of one direction to said lengths of strand material and feeding said strand material out of the opposite end of said drum to impart a twist to said strand material in a direction opposite to said one direction, and
  varying alternately the entry speed of said strand material into said drum above and below the exiting speed of said strand material out of said drum so as to impart said alternate-reverse twists to said strand material.

3. The method of providing indefinite lengths of strand material with alternate-reverse twists, which comprises the steps of:
  feeding said lengths of strand material into one end of a rotating drum to impart a twist to said lengths of strand material of one direction; and
  removing, alternately, said lengths of strand material from said drum: (i) at a linear speed relatively greater than the entrance speed of said strand material into said drum so as not to remove all of said imparted twist, and (ii) at a linear speed relatively less than said entrance speed so as to remove all of said imparted twist and to impart a twist to said lengths of strand material in a direction opposite to said one direction.

4. The method of providing indefinite lengths of strand material with alternate-reverse twists of a variable number of twists per unit length, which comprises the steps of:
  feeding said lengths of strand material into one end of a rotating drum at a variable linear speed to impart a twist to said lengths of strand material of one direction;
  removing, alternately, said lengths of strand material from said drum: (i) at a linear speed relatively greater than the entrance speed of said strand material into said drum so as not to remove all of said imparted twist, and (ii) at a linear speed relatively less than said entrance speed so as to remove all of said imparted twist and to impart a twist to said lengths of strand material in a direction opposite to said one direction; and
  varying the speed of rotation of said rotating drum to vary the number of alternate-reverse twists per unit length imparted to said lengths of strand material.

5. 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 to impart alternate reverse twist thereto, and
  creating an alternating differential between the speed of the material entering the accumulator and the speed of the material leaving the accumulator so as to impart to the strand material a net alternate-reverse twist.

6. The method of providing indefinite lengths of strand material with an alternate-reverse twist, which comprises the steps of:
  feeding said material axially into a rotating accumulator to impart a twist of one direction to the material,
  removing said material axially from said accumulator at a speed greater than the speed at which said material was fed into said accumulator so as not to remove all of said imparted twist of said one direction, and
  removing said material axially from said accumulator at a speed less than the speed at which said material was fed into 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.

7. The method of providing indefinite lengths of strand material with an alternate-reverse twist of a varying number of twists per unit length, which comprises the steps of:
  feeding said material axially at a predetermined speed onto a rotating accumulator to impart a twist of one direction to the material,
  removing said material axially from said accumulator at a speed greater than said predetermined speed so as not to remove all of said imparted twist of said one direction,
  removing said material axially from said accumulator at a speed less than said predetermined speed 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
  varying the speed of rotation of said accumulator with respect to the linear speed of said material to vary the number of alternate-reverse twists per unit length imparted to said material.

8. Apparatus for imparting an alternate-reverse twist to indefinite lengths of strand material, which comprises:
  rotatable means for receiving and discharging, axially, said lengths of strand materials;
  means for feeding said lengths of strand material axially into and out of said rotatable means; and
  means for creating an alternating differential between the entering and exiting speeds of said lengths of strand material into and out of the rotatable means so as to impart said alternate-reverse twists to said strand material.

9. Apparatus for imparting alternate-reverse twists to indefinite lengths of strand material, which comprises:
  rotatable means for receiving said lengths of strand material and for imparting a twist of one direction thereto upon the axial receipt thereof and for im-

parting a twist thereto in the opposite direction upon the axial exiting therefrom,

means for feeding axially said lengths of strand material into and out of said first mentioned means, and

means for creating an alternating differential between the entering and exiting linear speeds of said lengths of strand material into and out of said rotatable means so as to impart said alternate-reverse twist to said strand material.

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

rotatable means provided with a chamber and axially aligned means for permitting the axial entry and axial exit of said lengths of strand material into and out of said chamber,

means for feeding said lengths of strand material through said axially aligned means into and out of said chamber, and

means for creating an alternating differential between the relative linear speeds of said lengths of strand material entering and exiting said rotatable means so as to impart said alternate-reverse twist to said strand material.

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

an inertial twister including a chamber for receiving axially and imparting a twist of one direction to said lengths of strand material upon the receipt thereof, and for imparting a twist to said lengths of strand material in the opposite direction upon said lengths of strand material being removed axially therefrom;

a pair of capstans for feeding said lengths of strand material into and out of said chamber; and

an accumulator located intermediate one of said capstans and said inertial twister and for making alternately the linear speed of said lengths of strand material entering said chamber relatively slower or greater than the linear speed of said lengths of strand material leaving said chamber whereby alternately: (i) not all of said imparted twist of said one direction is removed from said lengths of strand material, and (ii) all of said imparted twist of said one direction is removed from said lengths of strand material and a twist is imparted thereto in a direction opposite to said one direction.

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

an inertial twister comprised of a rotatable drum provided with axially aligned tubular members for per-

mitting the axial entry and exit of said material into and out of said rotatable drum, and also provided with means for advancing said twisted material axially internally of said drum;

a pair of capstans operating at substantially the same speed for feeding axially said material through said tubular members into and out of said rotatable drum; and

an accumulator located intermediate one of said capstans and said inertial twister and for engaging said material and making, alternately, the linear speed of said material exiting said drum relatively greater and less than the linear speed of said material entering said drum whereby alternately (i) not all of said imparted twist is removed from said conductors and (ii) all of said imparted twist is removed from said material and a twist is imparted to said material in a direction opposite to said one direction.

13. Apparatus according to claim **11** including variable speed means for rotating said rotatable drum whereby the twist per unit length imparted to said lengths of strand material can be varied.

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

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

means for creating and alternating differential between the speed of the material received and discharged by said accumulator to cause an alternate-reverse twist to remain in said material.

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FRANK J. COHEN, *Primary Examiner.*

WERNER SCHROEDER, *Assistant Examiner.*