Nov. 17, 1959 W. BERTHOLD 2,913,190

CONTINUOUS STRAND TAKEUP

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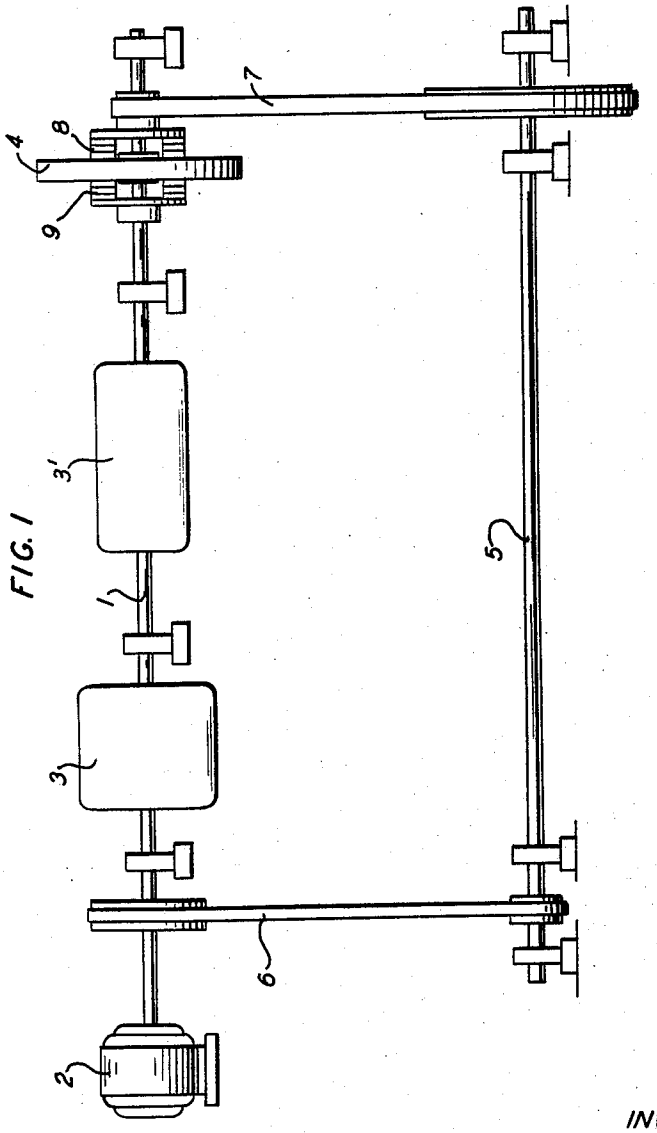


FIG. 1

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FIG. 2

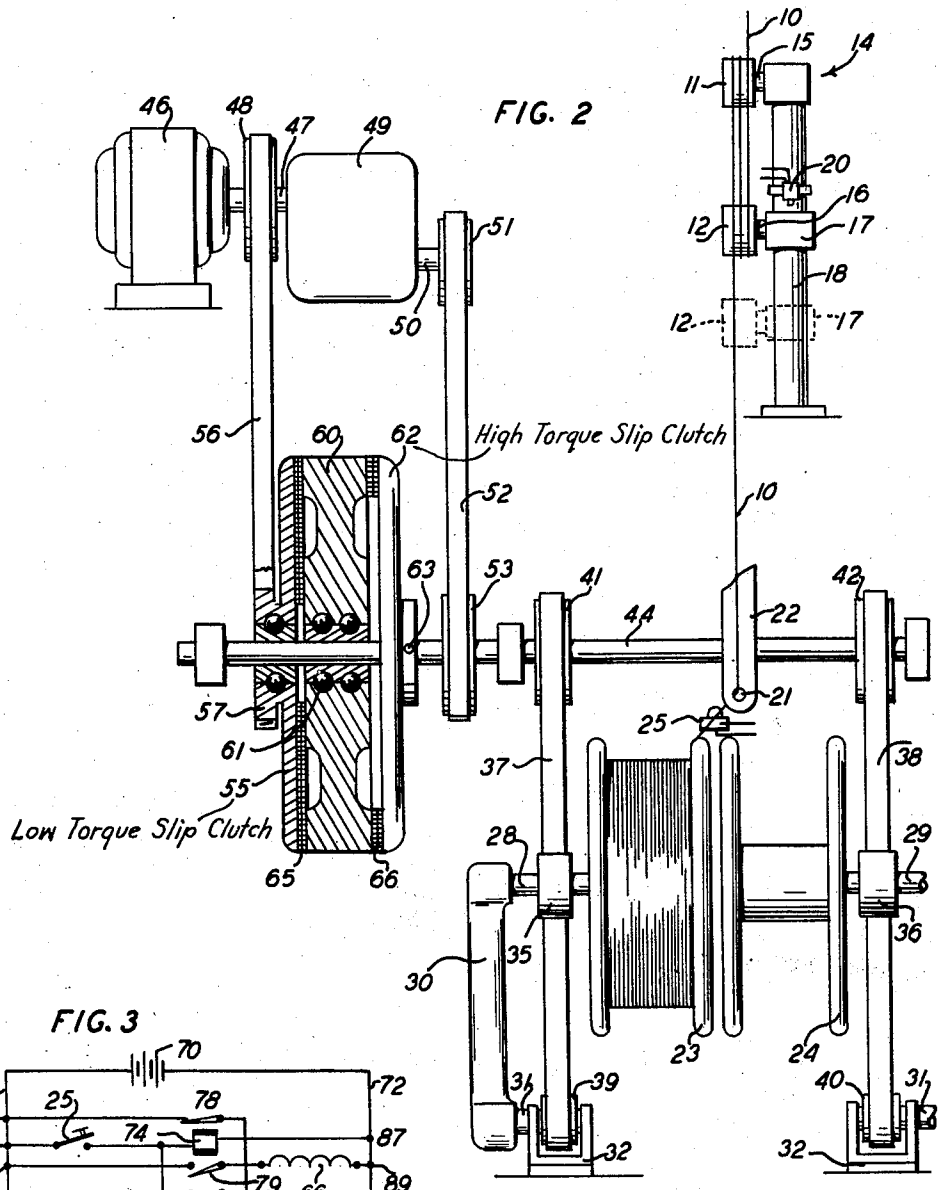
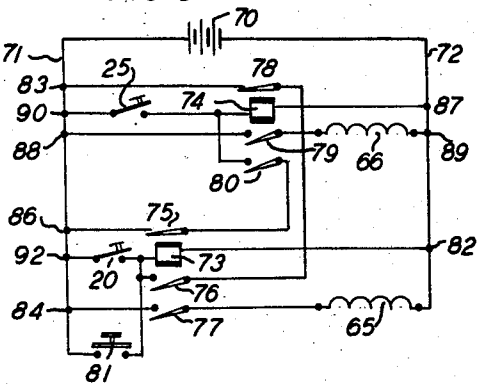


FIG. 3



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CONTINUOUS STRAND TAKEUP

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5 Claims. (Cl. 242—25)

This invention relates to machine drives, particularly those which require rapid acceleration.

Certain manufacturing processes require that drive shafts be accelerated from standstill to full speed, or from a lower speed to a high speed, within an extremely short time. For a given difference of speed, the time to accelerate a machine aggregate is directly proportional to its inertia and inversely proportional to the excess of driving torque over the load torque, the latter consisting of the usual load, friction and windage. It is well known that rapid acceleration of high inertia loads may require driving means vastly more powerful than would be required if the steady load only were to be considered.

One example is found in the takeup end of continuous strand processing equipment such as continuous extruders advancing strands at rapid constant linear speeds where it is necessary, after the transfer of a strand from a full reel to an empty reel, to accelerate the speed of the empty reel to the top speed required to take up the strand.

When processing strands at slow speeds it was possible to operate such a continuous process with only one takeup by inserting between the process and takeup an accumulator or festooning device which would accumulate the strand while the filled takeup reel was stopped and removed from the takeup, a new empty takeup reel put on the takeup, the strand attached to the empty reel and the empty reel brought up to speed. However, takeups for higher speeds are built as dual takeups operated with two takeup reels which are mounted coaxially side by side on two separate arbors. In one machine, the distributor which distributes the strand evenly between the flanges of one reel is mounted on a slide. When the reel is filled the distributor is moved along this slide to the other reel so that the end points of distributor travel will now coincide with the flanges of the empty reel. Usually there are projecting arms or teeth attached to the adjacent flanges of the two reels to insure that the strand is transferred to the empty reel and is taken up thereon. The strand between full and empty reel may not be cut until at least part of the second layer is taken up on the new reel so as to lock the strand to the new reel. Otherwise the strand would slip on the new reel and the process of taking up would stop. At the moment of switchover, the speed of rotation of the takeup reels has to be increased in the ratio of the diameters of the empty to the full reel in order to maintain uniform linear strand speed. To accomplish this theoretically, instantaneous acceleration of the inertia of the reels and associated machine members requires a tremendous accelerating torque in the driving mechanism. Since the theoretically necessary torque can usually not be built into the machine, recourse is taken again to accumulator festooning devices or dancer rolls. At very high speeds these latter devices begin to develop troubles of their own because due to their own inertia they cannot respond fast enough and also because the amount of strand which must be accumulated during reel acceleration becomes too great and unwieldly. The difficulties arising from the accumulator and too slow an acceleration will therefore frequently be the limiting factor of the speed of the machine aggregate even though other parts of it could be operated faster. If the reels could be accelerated at a faster pace the entire machine aggregate could be operated faster.

One object of the present invention is a drive apparatus which is simple in structure yet is capable of bringing machinery up to speed at higher than conventional rates of acceleration without requiring excessively high powered driving sources.

In one species of the invention, a main shaft of a machine is driven by a motor through a clutch or a variable speed changer and an auxiliary power means including a flywheel is driven faster than the shaft to accelerate the speed of the shaft when connected thereto. Specifically the flywheel which runs considerably faster than the desired drive shaft speed is adapted to be connected to the drive shaft through a clutch capable of transmitting very high torque for a limited period thus imparting part of the kinetic energy of the flywheel to the machine drive shaft in an extremely short time. The rotational speed of the flywheel naturally will decrease during this time but as its top speed is greater than that desired for the main shaft, the top speed of the main shaft will be assured. As soon as the drive shaft has reached the desired speed, the flywheel is declutched from the machine drive shaft and is clutched to the driving end of a low torque clutch which is positively driven from the motor but at a faster speed than the machine drive shaft. The flywheel will now be brought up to its original speed again over a period of time which is long when compared to the rapid acceleration time of the machine drive shaft. In this manner the flywheel draws only a moderate amount of energy from the driving motor. The flywheel in fact accumulates a great amount of kinetic energy from the driving motor at a low rate and releases it to the machine at a very rapid rate.

Other objects and advantages will be apparent from the following detailed description when considered in conjunction with the accompanying drawings, wherein:

Fig. 1 is a schematic front elevational view of one species of the invention;

Fig. 2 is a front elevational view of another species of the apparatus, portions thereof being shown in section, and

Fig. 3 is a schematic wiring diagram of the electrical controls of the apparatus.

The species of the invention shown in Fig. 1 includes a main shaft 1 of a machine connected to a motor 2 through a clutch or variable speed changer of the commercially known type 3. A flywheel 4 is supported for free rotation on the shaft 1 and is operatively connected to the motor 2 by a jack shaft 5 and the belt and pulley connections 6 and 7. A unit 3', serving as the machine to be driven or an inertia load for the main shaft 1, is fixed to the main shaft beyond the unit 3 from the motor 2. A low torque slip clutch 8 is adapted to complete the connection between the flywheel 4 and the driving means 5, 6 and 7 to the motor 2 which is rendered effective during an interval of time while the main shaft is driven to drive the machine to drive the flywheel 4 at a faster rate of speed than the main shaft 1. When desired, the kinetic energy of the flywheel may be imparted to the shaft 1 by disconnecting the clutch 8 and connecting the clutch 9 to connect the flywheel directly to the main shaft. In this manner, the main shaft 1 of the machine is accelerated to a speed higher than the conventional speed by utilizing the driving source initially incorporated in the machine.

The species of the invention shown in Fig. 2 is some-

what schematically illustrated as certain parts thereof are old and well known in the art. A strand **10** is received from conventional strand advancing unit (not shown), such as a driven capstan which receives the strand from any desired processing unit (not shown), such as a continuous extruder for extruding, for example, a plastic sheath on the strand which may be a wire. The strand **10** makes a plurality of turns about a fixed position grooved roll **11** and floating grooved roll **12** of a dancer roll unit **14**. The roll **11** is rotatably supported on a fixed spindle **15** while a spindle **16** for the dancer roll **12** is supported by a sleeve **17** slidably mounted in the conventional manner on a rod **18**. The dancer roll unit **14** functions to store a predetermined maximum length of the strand **10** when slack occurs in the strand. The amount of wire stored in the dancer roll unit depends on the distance the lower roll **12** is allowed to move relative to a given position below the roll **11**. In the present embodiment of the invention, with the apparatus operating at a speed faster than conventional rate to take up a strand which is supplied at a faster linear speed than is possible in conventional continuous takeup apparatus, there is an interval in the operation immediately following the transfer of the strand from a full to an empty reel when the dancer roll unit will not be adapted to absorb all the slack in the strand. Thus the need for an auxiliary power means (the flywheel) adapted to overdrive the empty reel and produce a temporary overspeed which will use up the strand stored in the dancer roll unit **14** and cause operation of a switch **20**.

When leaving the dancer roll unit **14**, the strand **10** travels through an aperture **21** in a conventional distributor arm **22** which is reciprocated alternately between pairs of limits for reels **23** and **24**. Reciprocation continues at one position until that reel is substantially filled or until the predetermined length of the strand has been wound thereon, after which the distributor **22** will be moved to the next position over an empty reel to transfer the strand from one reel to the other and to continue its operation distributing the strand on the second reel.

In continuous takeup apparatus, additional means are employed to catch and hold the strand as it passes from one reel to another while other means severs the strand between the reels, thereby fastening the trailing end of the severed strand to the filled reel and securing the leading end of the strand to the empty reel to assure winding of the strand thereon. These means are well known in the art and it is not believed necessary to disclose them to illustrate the present invention. There is a switch **25** positioned in the path of the distributor or distributor arm **22** to be actuated into closed position thereby as it travels from one distributing position to another to transfer the strand from a filled reel to an empty reel.

The reels **23** and **24** are removably supported by their respective spindles **28** and **29** rotatably carried by arms **30** (only one of which is shown). The arms **30** are pivotally supported on rods **31** carried by rigidly mounted brackets **32**. Pulleys **35** and **36** fixedly mounted on spindles **28** and **29** are adapted to engage belts **37** and **38**. The belts **37** and **38** extend around fixed position pulleys **39** and **40**, rotatably supported in the brackets **32**, and around pulleys **41** and **42** fixedly mounted on a drive or main shaft **44**. The pulleys **41** and **42** on the drive shaft **44** are positioned out of vertical alignment with the pulleys **39** and **40** so as to effectively tilt the belts **37** and **38** at like angles to permit the pulleys **35** and **36**, when moved with their spindles **28** and **29** and their respective reels **23** and **24** beyond vertical alignment with the pulleys **39** and **40**, to rest upon the belts **37** and **38** sufficiently to be driven thereby. The supporting structures for the reels permit movement of a filled reel out of driving position away from its belt **37—38** and into a loading position where the filled reel may be removed and an empty reel mounted on the spindle.

In this embodiment of the invention there is a single power means, illustrated as an electric motor **46**, having a shaft **47** which drives a pulley **48** and the conventional variable speed unit **49**. The unit **49** includes the conventional variable belt drive wherein the belt, extending around (what may be called) the input shaft **47** and an output shaft **50**, travels over companion pairs of the conventional truncated cone-shaped pulley members adjustable toward and away from each other in the usual manner so that a constant speed drive from the power means **46** to the input shaft **47** may produce a highly variable output speed for the shaft **50**. The inner structure of the unit **47** and the means for controlling it are well known in the art and for that reason, it is not believed necessary that these features be disclosed to illustrate the present invention. A pulley **51** mounted on the output shaft **50** is connected directly to the drive shaft **44** through a belt **52** and a pulley **53**. The pulley **48** is connected to a low torque slip clutch member **55** through a belt **56** and a pulley **57**, the pulley being mounted for free rotation on the shaft **44**. A flywheel **60** is supported by a bearing **61** for free rotation on the drive shaft **44**. A high torque slip clutch **62** is fixedly mounted at **63** on the drive shaft **44**. A coil **65** for the low torque slip clutch is shown schematically in Figs. 2 and 3 while a coil **66** for the high torque slip clutch is also shown in these figures.

Before considering the operation of this species of the invention, attention is directed to Fig. 3, where the electrical control means is shown schematically. The source of electrical energy is represented by a battery **70** disposed between two main circuit lines **71** and **72**. There are two relays **73** and **74**, the relay **73** having a normally closed contact **75** and normally open contacts **76** and **77** while the relay **74** has a normally closed contact **78** and normally open contacts **79** and **80**. A switch **81** may be actuated manually momentarily when the apparatus begins its operation to complete a circuit from line **71** through switch **81**, relay **73** to line **72** at connection **82**. Energization of the relay **73** will open contact **75** and close contacts **76** and **77**. When contact **76** is closed, a locking circuit for the relay **73** will be completed from line **71** at connection **83** through normally closed contact **78**, closed contact **76**, relay **73** to line **72** at connection **82**. In this manner, the relay **73** will be held operated until contact **78** is opened. Closing of contact **77** will complete a circuit from line **71** at connection **84**, through closed contact **77**, winding **65** of clutch **55** to line **72**. In this manner, the driving means including the belt **56** and its pulleys **48** and **57** for the flywheel **60** is connected to the power means **46** to cause driving of the flywheel at a speed faster than the speed of rotation of the shaft **44**. This driving connection between the motor **46** and the flywheel will continue until the distributor **22** transfers the strand **10** from the substantially filled reel **23** to the empty reel **24**. During this movement the distributor switch **25** will be actuated momentarily into closed position to energize relay **74**, operating its contact **78** into open position and its contacts **79** and **80** into closed positions. Opening of contact **78** will de-energize relay **73** allowing contact **75** to close and contacts **76** and **77** to open. Opening of contact **76** opens the circuit to relay **73** while opening of contact **77** opens the circuit to winding **65** for the clutch **55**. Closing of contact **75** and operating of contact **80** into closed position completes a locking circuit for the relay **74** from line **71** at connection **86**, through contacts **75** and **80**, relay **74** to line **72** at connection **87**. This circuit will be held closed to hold the relay **74** operated until contact **75** is opened. Closing of contacts **79** will complete a circuit from line **71** at connection **88**, through contact **79** and winding **66** of clutch **62**, at connection **89** of line **72**. When switch **25** is closed, a circuit is completed initially from line **71**

at connection 90 through switch 25, relay 74, through line 72 at connection 87.

The switch 20 of the dancer roll unit 14 functions during subsequent operations of the apparatus after the driving force of the flywheel, in each instance, has been utilized to accelerate the speed of rotation of the shaft 44 and the empty reel 24 to take up the excess slack in the strand or wire accumulated in the dancer roll unit 14 and move the lower roll 12 up to a position where the switch 20 will be operated into closed position. When the switch 20 is closed, a circuit is completed from line 71 at connection 92 through switch 20 and relay 73 to line 72 at connection 82. When this takes place, the cycle is repeated in that the clutch 62 is disconnected from the flywheel by de-energizing the winding 66 through de-energization of the relay 74 and at the same time the winding 65 of clutch 55 is energized to connect the flywheel to its drive means to be driven thereby at a faster rate of speed than the shaft 44 for the next transfer of the strand from the reel 24 when filled to an empty reel 23. The schematic wiring diagram does not show a controlling connection with the motor circuit which is necessary to render the controls in Fig. 2 unoperable until the motor 46 is energized.

In preparing this species of the invention for operation, the strand 10 from the extruder or other processing apparatus is threaded through its advancing means around the rolls 11 and 12 of the dancer roll unit 14 through the guiding aperture 21 of the distributor 22 where the leading end of the strand is secured in a conventional manner to (empty) reel 23. Motor 46 is then energized and switch 81 (Fig. 3) is momentarily closed. The variable driving means or unit 49 driven by the motor and operatively connected to the shaft 44 causes driving of the shaft to drive the belts 37 and 38 at a variable rate of speed while the distributor reciprocates between the limits adjacent reel 23 to uniformly distribute the strand on the reel until it is substantially filled (as shown in Fig. 2). During this interval, the power means or motor 46 has caused the flywheel 60 to rotate in the direction of the shaft 44 and at a faster rate of speed. When the strand 10 is transferred from the substantially filled reel 23 to the empty reel 24, switch 25 will be operated into closed position to cause disengagement of clutch 55 with the flywheel 60 and engagement of the clutch 62 with the flywheel to connect the flywheel to the shaft whereby the flywheel will accelerate the speed of rotation of the shaft and thereby the empty reel 24. Acceleration of the main shaft 44 to bring the empty reel 24 to the desired starting speed will also cause acceleration of the variation of the variable unit 49 to drive the main shaft at the starting speed. When this has been accomplished the flywheel is disconnected. As soon as the strand has been transferred from the filled reel 23 to the empty reel 24 and severed between the reels, the filled reel may be moved away from its driving means, removed from its spindle 28 and an empty reel mounted in its place on the spindle. When the rotating force of the flywheel has been utilized to accelerate the speed of the empty reel 24 to that desired to continue taking up the strand at the constant linear speed, the excess strand absorbed by the dancer roll unit 14 will be removed to move the roll 12 upwardly until the sleeve 17 actuates the switch 20 into closed position to energize relay 73, cause de-energization of relay 74 and resulting in disengagement of clutch 62 with the flywheel and engagement of clutch 55 therewith.

It is to be understood that the above described arrangements are simply illustrative of the application of the principles of the invention. Numerous other arrangements may be readily devised by those skilled in the art which will embody the principles of the invention and fall within the spirit and scope thereof.

What is claimed is:

1. A continuous strand takeup apparatus, in combination with a distributor actuable to distribute given lengths of a strand, advanced longitudinally at a constant linear speed, on takeup reels and intermittently transfer the strand from each reel when substantially filled to an empty reel, of a single motor energized continuously during operation of the apparatus, variable means driven continuously by the motor to cause driving of the reels at decreasing rates of speed with increasing lengths of turns of the strand on one of the reels, a flywheel, means operatively connecting the flywheel to the motor during each takeup interval to drive the flywheel at a speed faster than the speed of the reels during taking up the strand on one of the reels, and an element actuable by the distributor to cause disconnection of the flywheel from its drive means and cause connection of the flywheel with the drive means for the reels when the strand is transferred to the empty reel, so that the flywheel will accelerate the speed of the empty reel.

2. A continuous strand takeup apparatus, in combination with a distributor actuable to distribute given lengths of a strand, advanced longitudinally at a constant linear speed, on takeup reels and intermittently transfer the strand from each reel when substantially filled to an empty reel, of a single motor energized continuously during operation of the apparatus, a variable unit driven by the motor to cause driving of the reels at decreasing rates of speed from a starting speed with increasing lengths of turns of the strand on one of the reels, a flywheel, means driven by the motor and adapted for operative connection with the flywheel during taking up the strand on one of the reels, an element operable by the distributor when transferring the strand from the substantially filled reel to the empty reel to cause disconnection of the flywheel from its drive means and cause connection of the flywheel to the drive means for the reels so that the flywheel will accelerate the speed of the empty reel and accelerate the variable unit to drive the empty reel at the starting speed.

3. A continuous strand takeup apparatus, in combination with a distributor actuable to distribute given lengths of a strand, advanced longitudinally at a constant linear speed, on takeup reels and intermittently transfer the strand from each reel when substantially filled to an empty reel, of a single motor energized continuously during operation of the apparatus, a variable speed unit driven by the motor to cause driving of the reels at decreasing rates of speed from a starting speed with increasing lengths of turns of the strand on one of the reels, a flywheel, drive means for the flywheel operatively connected to the motor, a first clutch operable to connect the flywheel to its drive means to cause driving of the flywheel at a speed at least equal to the starting speed of the reels during taking up the strand on one of the reels, a second clutch interposed between the flywheel and the variable speed unit, and an element actuable by the distributor transferring the strand from the substantially filled reel to the empty reel to cause disconnection of the first clutch and connection of the second clutch so that the rotating force of the flywheel added to the drive means for the reel will accelerate the speed of the empty reel to the starting speed.

4. A continuous strand takeup apparatus, in combination with a distributor actuable to distribute given lengths of a strand, advanced longitudinally at a constant linear speed, on one of two initially empty takeup reels removably mounted on individual aligned spindles, and intermittently transfer the strand from one of the reels when substantially filled with the given length of the strand to the other empty reel, a single motor, a main shaft supported for rotation, means driven by the main shaft to drive the spindles, a variable speed unit driven by the motor to drive the main shaft at decreasing speeds from its maximum speed to cause driving of the reels

at decreasing rates of speed with increasing lengths of turns of the strand on the reel being filled, a flywheel supported free to rotate on the main shaft, means driven by the motor to drive the flywheel at a speed faster than the main shaft, and means operable to connect the flywheel to the main shaft to accelerate the speed of the main shaft and the empty reel when the strand is transferred by the distributor thereto.

5. A continuous strand takeup apparatus, in combination with a distributor actuable to distribute given lengths of a strand, advanced longitudinally at a constant linear speed, on one of two initially empty takeup reels removably mounted on individual aligned spindles, and intermittently transfer the strand from one of the reels when substantially filled with the given length of the strand to the other empty reel, a single motor, a main shaft supported for rotation, means driven by the main shaft to drive the spindles, a variable speed unit driven by the motor to drive the main shaft at decreasing speeds from its maximum speed to cause driving of the reels at decreasing rates of speed with increasing lengths of

turns of the strand on the reel being filled, a flywheel supported free to rotate on the main shaft, means driven by the motor to drive the flywheel at a speed faster than the main shaft, and an element actuated by the distributor when transferring the strand from the filled reel to the empty reel to cause disconnection of the flywheel from the motor and connect the flywheel to the main shaft to cause acceleration of the main shaft and the empty reel.

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