July 16, 1963 C. P. SMITH ET AL 3,097,815

APPARATUS FOR SPOOLING FILAMENTARY MATERIAL

Filed Nov. 29, 1961 4 Sheets-Sheet 1

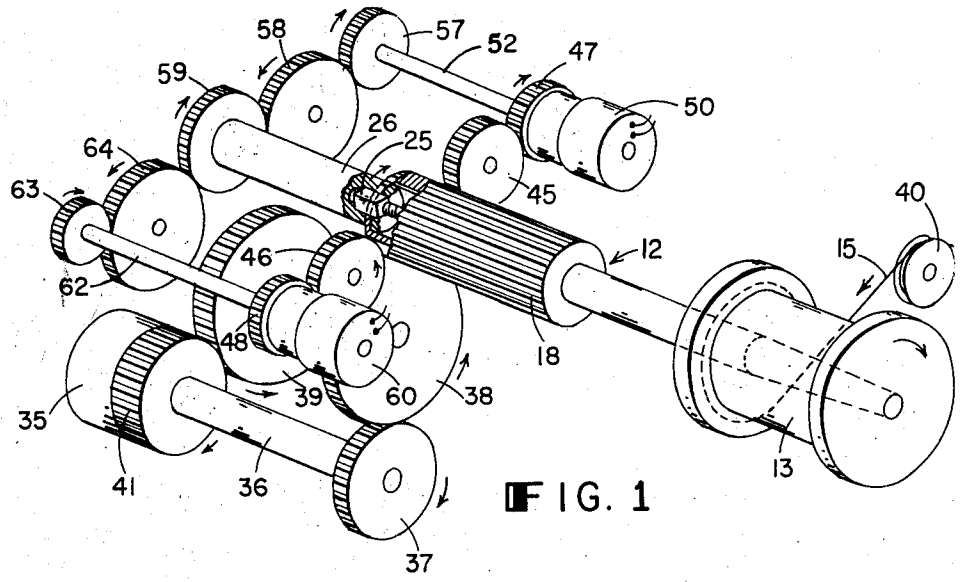


FIG. 1

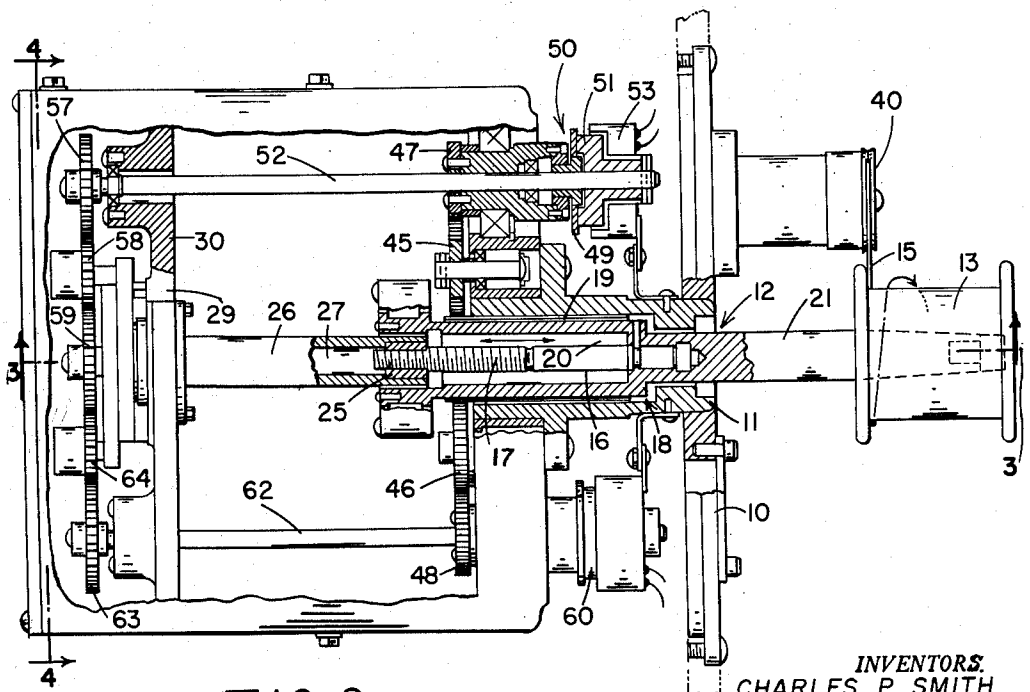


FIG. 2

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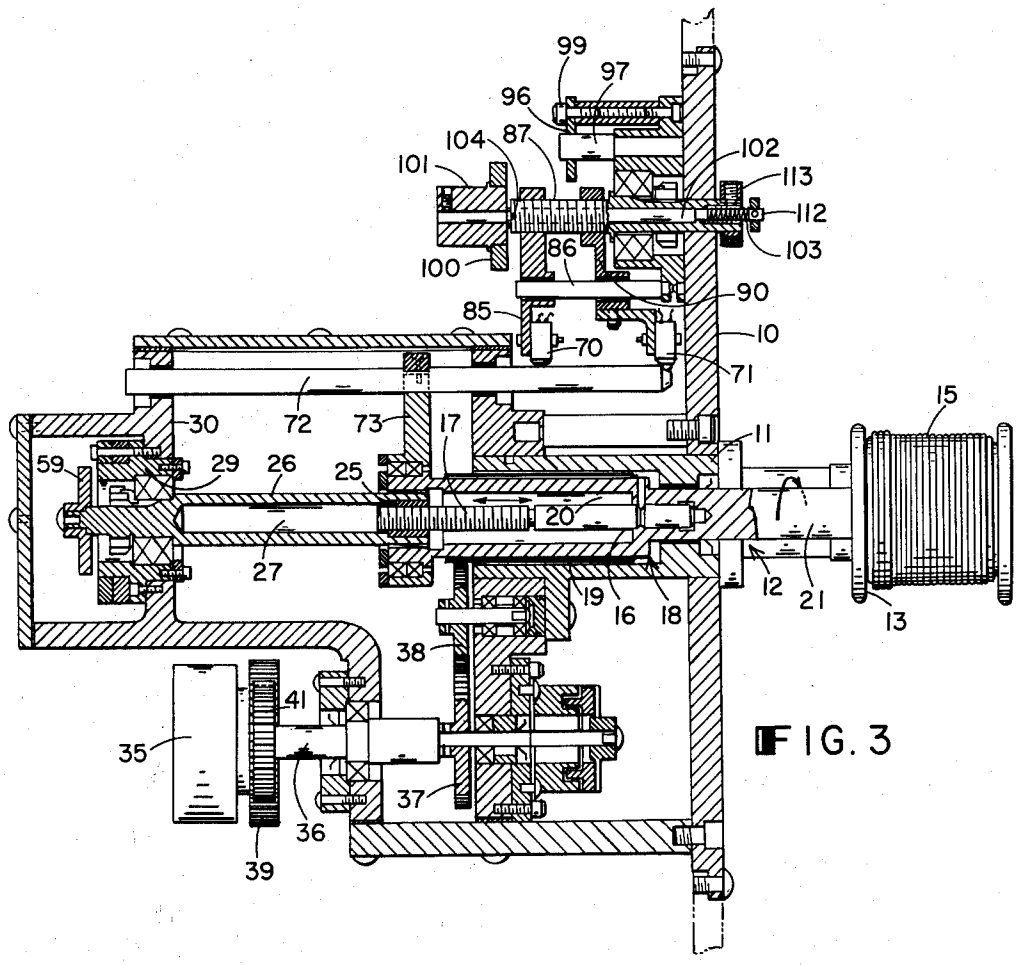


FIG. 3

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APPARATUS FOR SPOOLING FILAMENTARY MATERIAL

Filed Nov. 29, 1961 4 Sheets-Sheet 3

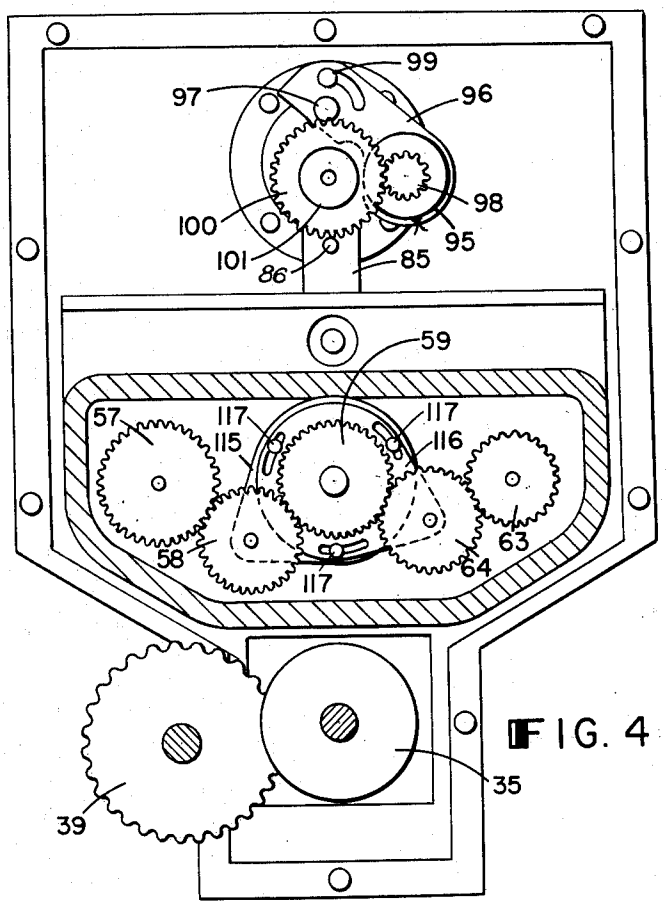


FIG. 4

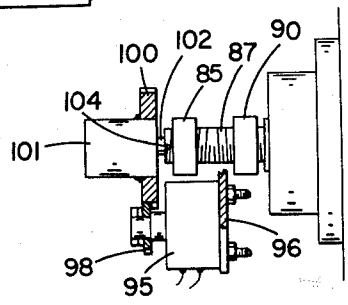


FIG. 5

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APPARATUS FOR SPOOLING FILAMENTARY MATERIAL

Filed Nov. 29, 1961 4 Sheets-Sheet 4

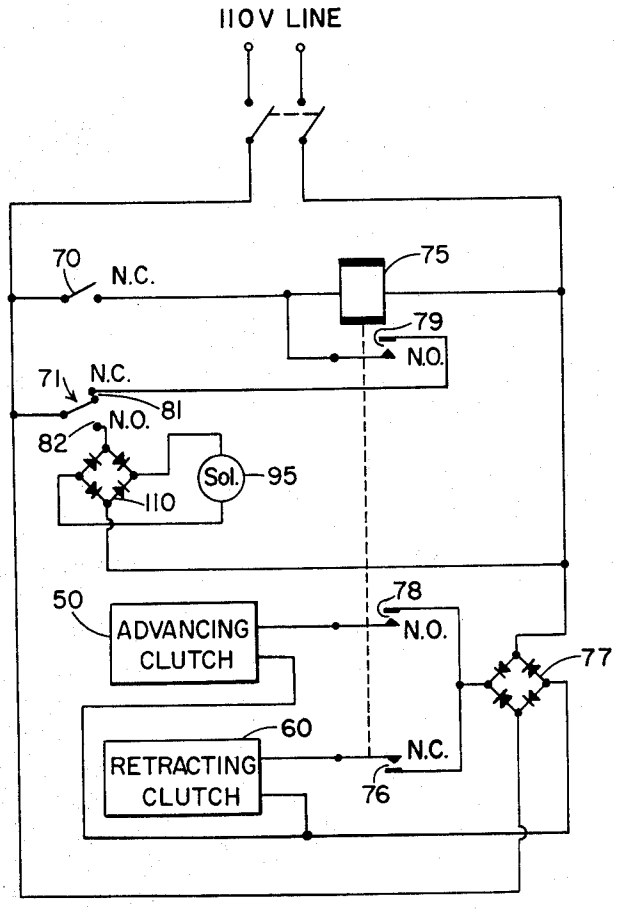


FIG. 6

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United States Patent Office 3,097,815 Patented July 16, 1963

3,097,815
APPARATUS FOR SPOOLING FILAMENTARY MATERIAL

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Filed Nov. 29, 1961, Ser. No. 155,587
4 Claims. (Cl. 242—158.4)

This invention relates to apparatus for spooling filamentary material. More particularly, it is concerned with apparatus for winding fine wire on demountable spools.

Fine wire of the type consumed in the fabrication of electrical and electronic devices is usually supplied wound on spools. The wire is stored on the spools and is unwound as it is used. Wire should be wound on the spools in layers which are even, uniform, and compact in order to avoid piling or sinking of the wire particularly at the flanges of the spool. The wire can then readily be unwound either by hand or by automatic machinery without tangling, sticking, or breaking.

In order for wire to be wound on a spool properly, a traverse mechanism which guides the wire into position along the axis of the spool as it is being wound is provided in the spooling apparatus. This mechanism places each turn of wire closely adjacent the previous turn as a layer of wire is being wound. Upon the completion of a layer, the direction of winding is reversed by the traverse mechanism, and the subsequent layer is laid in the opposite direction.

The traverse mechanism commonly utilizes either one or the other of two principles of operation. A first general type of mechanism employs a wire guide which reciprocates back and forth along the axis of the rotating spool. Another type employs a wire guide which remains stationary while the rotating spool is reciprocated back and forth along its axis.

In spooling extremely fine wire, on the order of one mil or less, particular care is required in order to obtain strain-free winding. The traverse mechanism should subject the wire to a minimum of stress so as not to distort the wire or disrupt the laying of compact, uniform layers. Piling or sinking of the turns of wire and consequent jamming between turns and against the flanges of the spool are troublesome and difficult to avoid with fine, fragile wire. Abrupt changes in the direction of movement of the parts of the apparatus particularly in the traverse mechanism also tend to subject the wire to stress and introduce discontinuities in the smooth continuous spooling of wire.

It is an object of the present invention, therefore, to provide improved apparatus for spooling filamentary material.

It is a more specific object of the invention to provide improved automatic apparatus for winding wire on demountable spools which permits the winding to be accomplished without jamming wire against the spool flanges and which operates smoothly and continuously in order to obtain layers which are evenly, uniformly, and compactly wound.

Briefly, in accordance with the foregoing objects, spooling apparatus according to the invention includes a lead screw on which a spool is mounted. A nut engages the lead screw. The lead screw is rotated in one direction of rotation by a driving means. The nut is rotated in the same direction of rotation by either a first nut driving means or a second nut driving means. The nut is rotated at a speed less than the speed of rotation of the lead screw by the first nut driving means and is rotated at a speed greater than the speed of rotation of the lead screw by the second nut driving means. The lead screw and spool

mounted thereon may thus be reciprocated along the axis of the lead screw by alternate activation of the two nut driving means.

It is a feature of the invention to provide means for changing the period of activation of the first and second nut driving means thereby changing the distance the lead screw moves axially in each direction. The period of activation is shortened upon completion of each cycle of back and forth axial movement of the lead screw so that the layers of wire being wound are built up on the spool in trapezoidal fashion thereby eliminating reliance on the spool flanges for holding the wire on the spool.

Additional features, objects, and advantages of spooling apparatus according to the invention will be apparent from the following detailed discussion and the accompanying drawings wherein:

FIG. 1 is a diagrammatic representation in perspective of various elements of the apparatus,

FIG. 2 is a plan view of the apparatus according to the invention with portions broken away,

FIG. 3 is a cross-sectional view in elevation of the apparatus of FIG. 2 taken generally along the line 3—3 of FIG. 2,

FIG. 4 is a side view of the apparatus of FIG. 2 taken in cross-section along the line 4—4 of FIG. 2,

FIG. 5 is a detailed view from above showing portions of the apparatus, and

FIG. 6 is a schematic diagram of the electrical circuit for controlling the operation of the apparatus.

GENERAL DESCRIPTION

The various parts of the spooling apparatus are shown in detail in FIGS. 2 through 5 while an understanding of their operation may best be had by reference to FIG. 1. The housing of the apparatus includes a mounting plate **10** fixed to a support **11** in which a lead screw assembly **12** is journaled so as to permit both rotational and axial movement of the assembly. A removable spool or reel **13** on which wire **15** is wound is removably mounted on one end of the lead screw assembly. The lead screw assembly includes a lead screw **16** having a threaded portion **17** with a right hand thread. A traverse gear **18** having gear teeth **19** extending along a portion of its length encircles the lead screw so as to provide a cavity **20** intermediate the lead screw and the internal surface of the traverse gear. An arm **21** of the traverse gear adapted to receive a demountable spool or reel **13** on which wire **15** is wound extends beyond the mounting plate.

A nut **25** which engages the threaded portion of the lead screw is securely mounted at one end of a spindle **26**. The spindle has an axial cavity **27** of diameter larger than the outside diameter of the lead screw. The outside diameter of the spindle is less than the inside diameter of the traverse gear **18**. The spindle is mounted for rotation in a bearing housing **29** whic his secured to a portion of the body **30** of the apparatus.

The lead screw assembly **12** is rotated by a slip clutch **35** having a shaft **36** on which is mounted a gear **37** meshing with an idler gear **38** engaging the traverse gear **18** of the lead screw assembly. The clutch gear **41** through which the slip clutch is driven is rotated by an idler gear **39** which is engaged by the capstan drive mechanism (not show). Wire **15** is led from the capstan (not shown), which may be pulling the wire from another spool through, for example, a cleaning bath, over a guiding sheave **40** rotatably mounted on the mounting plate **10** to the spool **13**. The sizes of the gears in the gear train from the capstan through the slip clutch to the spool are such as to rotate the spool at a speed which is capable of taking up the wire faster than it is delivered by the capstan. The slip clutch **35** is of a well-known type which permits slipping of the driven member

with respect to the continuously rotating driving member so as not to place more than a minimum stress on the wire and at the same time maintain the wire taut while it is being wound.

The traverse gear **18** of the lead screw assembly **12** also drives two idler gears **45** and **46** which in turn drive gears **47** and **48** respectively. The first of these gears **47** rotates the driving member or armature **49** of a first electro-magnetic clutch **50**. The driven member or rotor **51** of the clutch is secured to one end of a first clutch shaft **52** supported for rotation in the body of the apparatus. A portion of the rotor **51** is encircled by the stationary field winding **53** of the clutch. The clutch is activated by the flow of electrical current through the field which magnetizes the rotor causing the armature **49** and the rotor **51** to be clamped together.

At the other end of the shaft **52** a first shaft gear **57**, which is removable, is mounted for rotation with the shaft. The gear engages an idler gear **58** which in turn drives a gear **59** secured at the end of the spindle **26**.

The relative sizes of the traverse gear **18**, the clutch gear **47**, the shaft gear **57**, and the spindle gear **59** are such that when the first clutch **50** is activated and the spindle and nut **25** are rotated through this gear train, the nut rotates at a speed faster than the speed of rotation of the lead screw assembly **12**. Thus the lead screw assembly and the attached spool are advanced from the left to the right as viewed in the figures. The shaft gear **57** may be replaced with a gear of different size in a manner to be explained hereinafter in order to change the relative speeds of rotation of the nut and the lead screw.

The second idler gear **46** which is driven by the traverse gear **18** engages a gear **48** fastened to the driving member of a second electro-magnetic clutch **60** similar to the first clutch. The driven member of the clutch is secured to a second clutch shaft **62** which is rotatably supported in the body of the apparatus and has a shaft gear **63** removably mounted at its end. This gear which is smaller than the first shaft gear **57** drives an idler gear **64** which in turn engages the spindle gear **59**.

When the second clutch **60** is enerigzed, the relative sizes of the traverse gear **18**, the clutch gear **48**, the shaft gear **63**, and the spindle gear **59** in the gear train between the lead screw assembly and the spindle are such as to rotate the spindle and nut **25** at a speed less than the speed of rotation of the lead screw assembly. The rotating lead screw and spool are thus retracted from the right toward the left as viewed in the figures. The second shaft gear may also be replaced with a gear of different size in order to change the relative speeds of rotation of the nut and the lead screw.

Operation

Operation of the elements of the apparatus described to this point can best be understood by reference to the perspective representation of FIG. 1. The lead screw assembly **12** is rotated in a clockwise direction, as viewed from the spool, through the slip clutch **35**, gear **37**, and the idler gear **38** which engages the traverse gear **18** of the lead screw assembly. The traverse gear rotates the clutch gears **47** and **48** in a clockwise direction through the idler gears **45** and **46**, respectively. When the first or advancing clutch **50** is energized and the second or retracting clutch **60** is de-energized, the first shaft **52** is rotated through the advancing clutch and the first shaft gear **57** drives the spindle **26** and nut **25** in the clockwise direction through the idler gear **58** and spindle gear **59**.

The first or advancing shaft gear **57** is selected to be of appropriate size relative to the other gears in the advancing gear train so that the spindle and nut are rotated at a speed sufficiently greater than the speed of rotation of the lead screw to advance the lead screw assembly and spool toward the right a predetermined distance, typically approximately one and one-half times the diameter of the wire, during each revolution of the spool. The wire guiding sheave **40** positions the wire so that it aiways feeds to the spool along a plane which is perpendicular to the axis of the lead screw. Thus, a layer of wire is wound on the spool as the spool advances at the proper rate of speed.

While the advancing clutch **50** is engaged and the lead screw assembly and spool advance toward the right, the spindle gear **59** engages the other idler gear **64** which in turn rotates the smaller second shaft gear **63** and its shaft **62** in a clockwise direction. The retracting clutch **60** is not engaged while the spool is advancing, and therefore the second shaft **62** rotates independently of the retracting clutch gear **48**. The retracting clutch gear is also rotating in a clockwise direction, but at a speed slower than the shaft.

When the lead screw assembly and spool have completed their advance from left to right and a layer of wire has been wound on the spool, the direction of movement of the lead screw assembly and spool is reversed for laying of the subsequent layer of wire. The advancing clutch **50** is de-energized and the retracting clutch **60** is energized, thereby rotating the spindle **26** and nut **25** through the retracting gear train including the traverse gear **18**, the second clutch gear **48**, the second shaft gear **63**, and the spindle gear **59**. As explained hereinabove the relative sizes of the gears in the retracting gear train are such as to cause the spindle and nut to rotate in a clockwise direction at a speed slower than the speed of rotation of the lead screw assembly. The lead screw assembly and spool are therefore retracted toward the left and during each revolution the spool moves axially a predetermined distance, again typically, one and one-half times the diameter of the wire being wound.

While the spindle and nut are being driven through the retracting gear train, the spindle gear **59** rotates the idler gear **58**, advancing shaft gear **57**, and the advancing shaft **52**. The shaft rotates in the clockwise direction freely of the advancing clutch gear **47** since the advancing clutch **50** is not energized. The advancing clutch gear **47** is also being driven in a clockwise direction but at a speed greater than the shaft. Upon completion of the retraction movement of the spool, the retracting clutch **60** is de-energized and the advancing clutch **50** is energized in order to again reverse the action of the apparatus and cause the spool to advance from left to right while continuing its clockwise rotation.

Switching Arrangement

The direction of the axial movement of the lead screw assembly and spool is controlled by a switching arrangement, shown in the circuit diagram of FIG. 6, which activates and inactivates the electro-magnetic clutches in alternation in response to the triggering action of two switches **70** and **71**. The switches are actuated by a switching rod **72** which is slidably mounted in the body of the apparatus. The rod is fixed to an arm **73** which is fastened to the lead screw assembly so as to permit the lead screw assembly to rotate freely with respect to the arm. Axial movement of the lead screw carries the arm and rod, which together serve as a trigger means, along a path parallel to the axis of the lead screw assembly. The switches are mounted on the apparatus along the path of movement of the switching rod in position to be triggered by the rod.

The switches are connected in the switching arrangement which controls the electro-magnetic clutches as illustrated schematically in FIG. 6. For purposes of explanation let it be assumed that the retracting clutch **60** is energized and the advancing clutch **50** is de-energized so that the lead screw assembly and spool are being retracted axially from right to left as viewed in FIGS. 2 and 3. As the switching rod **72** clears the first switch **70** which has been open, the switch assumes its normally-

closed condition. Current flows through the switch and an A.C. relay **75** opening the first set of relay contacts **76** which are normally closed. Current which was flowing through the full-wave rectifier **77** and the field of the retracting clutch **60** is interrupted, thereby inactivating the retracting clutch. The second set of relay contacts **78** which are normally open are closed completing the circuit through the full-wave rectifier **77** and the field of the advancing clutch **50**. The advancing clutch is thus activated and the direction of axial movement of the lead screw is reversed.

Current flow through the relay also closes the third set of relay contacts **79** which are normally open. Since the armature of the second switch **71** is in its normal position with the normally-closed contacts closed, current flows through the normally-closed contacts **81** of the second switch, the third set of relay contacts **79**, and the relay **75**. Thus, although the advancing lead screw assembly and the switching rod move toward the right and the switching rod actuates the normally-closed first switch **70** and opens the switch contacts, current continues to flow through the relay **75** maintaining the three sets of relay contacts in their energized positions.

The advancing clutch **50** remains in its active condition and the retracting clutch **60** remains in its inactive condition until the switching rod **72** actuates the second switch **71** opening the normally-closed switch contacts **81**. Actuation of the second switch **71** also closes the normally-open switch contacts **82** for a purpose which will be explained hereinafter. Current through the relay is interrupted by the opening of the normally-closed switch contacts **81**, and the relay contacts all revert to their normal positions. The second set of relay contacts **78** open, thus inactivating the advancing clutch **50** and stopping the advance of the lead screw assembly and spool. The first set of relay contacts **76** close, thus activating the retracting clutch **60** and starting the retraction movement of the lead screw assembly, the spool, and the switching rod. The third set of relay contacts **79** open so that as the switching rod **72** retracts clear of the second switch and the normally-closed contacts of the second switch reclose, the relay **75** remains de-energized and the conditions of the clutches are not changed.

Switch Stepping Mechanism

In order that the length of the period during which each clutch is activated may be shortened so that the layers of wire are formed on the spool in pyramidal or trapezoidal fashion, the switches are mounted so as to permit movement with respect to the mounting plate **10**. The first switch **70** is carried by a bracket **85** which is slidably mounted on a shaft **86**. The shaft is fixed to the mounting plate **10** and lies along a line parallel to the axis of the lead screw assembly. An opening at one end of the bracket is threaded with a right hand thread to receive a threaded portion of a shaft **87** which is mounted in a bearing so as to be rotatable with respect to the mounting plate.

The second switch **71** is similarly mounted on a bracket **90** which is slidable along the shaft **86** and which has a left hand threaded opening for engaging a portion of the threaded shaft **87**. Since the two threaded portions of the threaded shaft **87** and the mating internal threads of the two brackets are of opposite pitch, rotation of the shaft **87** in a clockwise direction, as viewed from the spool end of the apparatus, moves the two switches toward each other.

As can be seen from FIGS. 3, 4, and 5, each of which shows portions of the mechanism, a rotary solenoid **95** is attached to a plate **96** which in turn is pivotally mounted on a pin **97** attached to the mounting plate **10**. A gear **98** is mounted on the shaft of the solenoid and the solenoid mounting plate is pivoted into position and clamped by a nut **99** so that the solenoid gear **98** engages a gear **100** which is the driving member of an over-running clutch **101**. The driven member of the clutch is a shaft **102** which passes coaxially through the threaded shaft **87**. When the clutch gear rotates in one direction, the clutch drives the clutch shaft with it. When the clutch gear rotates in the opposite direction, the clutch slips with respect to the clutch shaft and the shaft does not move. A compression spring **103** which biases the clutch shaft toward the right forces a pin **104** fitted through the shaft into engagement with notches at the end of the threaded shaft **87** thereby keying the two shafts together.

As can be seen from the circuit diagram of FIG. 6, each time the switching rod **72** actuates the second switch **71** closing the normally-open contacts **82**, current flows through the full-wave rectifier **110** and the rotary solenoid **95**. The solenoid is energized rotating the solenoid shaft and gear **98** through a particular angle. The clutch gear **100** is thus rotated through a predetermined angle which is dependent on the relative sizes of the solenoid gear and clutch gear. As the clutch gear rotates, the clutch shaft and the threaded shaft are driven by the clutch through the same predetermined angle. Rotation of the threaded shaft **87** through the predetermined angle causes the switches **70** and **71** to be advanced a predetermined distance toward each other. When the switching rod reverses its direction of movement and permits the normally-open contacts of the second switch **71** to reopen, the rotary solenoid is de-energized and the solenoid gear **98** and clutch gear **100** return to their original positions. During this action, the over-running clutch **101** causes the clutch gear **100** to slip with respect to the clutch shaft **102** and the threaded shaft **87** remains in its new position. Thus, the switches remain in their newly established positions after the electrical pulse causing their movement has ceased.

At any time, as when resetting the apparatus after completing the winding of a spool, the switches **70** and **71** can be returned to their starting positions by rotation of the threaded shaft **87** in a counter-clockwise direction independently of the clutch shaft **102**. The clutch shaft pin **104** is disengaged from the notch in the threaded shaft **87** by pressing the end **112** of the clutch shaft **102** against the action of the compression spring **103**. The threaded shaft **87** may then be freely rotated by turning the knob **113** until the switches are set in the desired starting position.

The ratio of the size of the solenoid gear **98** to the size of the clutch gear **100** is set by selection of the proper solenoid gear, which gear is changeable in a manner to be described hereinafter, so that each actuation of the rotary solenoid **95** moves the switches **70** and **71** an amount to provide the desired build-up of successive layers of wound wire. When the switch stepping mechanism is set to move each switch toward the other in predetermined increments, usually of the order of one and one-half times the distance between successive turns, a trapezoidal or pyramidal build-up of the layers of wire is achieved. The wound wire is thus independent of the spool flanges and binding or excessive pile-up of the wire at the ends of the coil being wound is avoided.

Interchangeable Gears

In order to provide for winding wire of various thicknesses the shaft gears **57** and **63** and the solenoid gear **98** can be removed and replaced with gears of different sizes. As can best be seen in FIG. 4 the idler gears **58** and **64** which engage the spindle gear and the shaft gears **57** and **63** respectively are rotatably mounted on plates **115** and **116**. These plates are pivoted about the center of rotation of the spindle gear and are held in fixed position by clamping nuts **117**. The idler gears may thus be pivoted out of engagement with the shaft gears so that the shaft gears may be removed and replaced as desired. The plates **115** and **116** are then pivoted into position and clamped so that the idler gears engage the respective shaft gears. The shaft gears are chosen so as to permit the

speed of rotation of the nut 25 with respect to the lead screw 12 to be such that the lead screw assembly and spool are advanced or retracted a predetermined axial distance.

In order to change the width of successive layers of wire being wound on the spool, the angle through which the threaded shaft 87 is rotated upon each actuation of the rotary solenoid 95 is changed. This change is accomplished by replacing the solenoid gear 98 with a gear of different size. The solenoid mounting plate 96 is pivoted to move the solenoid gear out of engagement with the clutch gear 100. The solenoid gear is then replaced, and the mounting plate pivoted to place the gears in engagement. Then the clamping nut 99 is tightened to hold the gear in position. Generally, the solenoid gear is chosen so that the switches 70 and 71 are each advanced a distance equal to about one and one-half times the distance between the center of the wire in successive turns. However, the solenoid gear can be selected so as to provide a different build-up of layers if desired.

Apparatus as described hereinabove has proven particularly useful in the spooling of extremely fine wire in even, uniform, compact layers. The build-up of the layers in a trapezoidal pattern as illustrated in FIG. 3 avoids using the spool flanges to confine the wire to the spool. Binding and pile-ups which cause stressing and breaking of the wire as it is unwound are thereby eliminated. The reciprocating action of the spool along its axis permits the wire to be guided perpendicularly to the axis of the spool and no sidewise stress is placed on the wire. The combination of the rotating lead screw assembly and the rotating nut for obtaining axial movement of the lead screw provides smooth continuous rotation of all parts. Sudden stopping and reversing of the direction of rotation is avoided. Only the direction of axial movement is changed. As an example of the smoothness of operation that may be achieved in apparatus according to the invention, a spooling machine with a spindle gear having eighty teeth employed an advancing shaft gear having eighty-one teeth and a retracting shaft gear having seventy-nine teeth in order to properly wind wire of .0005 inch diameter. Thus, upon each reversal of the direction of axial movement of the spool, the changes in the speeds of rotation of the rotating elements of the apparatus were relatively very small.

What is claimed is:

1. Apparatus for spooling filamentary material including a lead screw for supporting a spool, a nut engaging the lead screw, a lead screw driving means for rotating said lead screw in one direction, a first nut driving means adapted to be operated by said lead screw driving means and to rotate said nut in said one direction at a speed less than the speed said lead screw is rotated by the lead screw driving means whereby the lead screw is moved along its axis in one direction relative to said nut, a second nut driving means adapted to be operated by said lead screw driving means and to rotate said nut in said one direction at a speed greater than the speed said lead screw is rotated by the lead screw driving means whereby the lead screw is moved along its axis in the opposite direction relative to said nut said first nut driving means including a first clutch means for placing said first nut driving means in engagement with said lead screw driving means, said second nut driving means including a second clutch means for placing said second nut driving means in engagement with said lead screw driving means, a first switching means adapted to inactivate said first clutch means and activate said second clutch means when said lead screw is moved along its axis in said one direction with respect to the nut to a first predetermined point, and a second switching means adapted to inactivate said second clutch means and activate said first clutch means when said lead screw is moved along its axis in said opposite direction with respect to the nut to a second predetermined point.

2. Apparatus for spooling filamentary material as in claim 1 including means for automatically changing the position of said first and second predetermined points in responsive to axial movement of the lead screw.

3. A wire spooling machine including in combination a lead screw for supporting a spool, said lead screw having a threaded portion, a support in which said lead screw is journaled so as to permit rotational and axial movement of the lead screw, a nut engaging the threaded portion of the lead screw and mounted with respect to the support so as to permit rotational movement and prevent axial movement of the nut, driving means for rotating said lead screw in one direction, a speed reducing means engaging said nut and adapted to be placed in engagement with the driving means for rotating the nut in the one direction at a speed less than the speed the lead screw is rotated by the driving means whereby the lead screw is moved along its axis in one direction relative to said support, a speed increasing means engaging said nut and adapted to be placed in engagement with the driving means for rotating the nut in the one direction at a speed greater than the speed the lead screw is rotated by the driving means whereby the lead screw is moved along its axis in the opposite direction relative to said support, said speed reducing means including a first clutch for placing the driving means in engagement with the speed reducing means, said speed increasing means including a second clutch for placing the driving means in engagement with the speed increasing means, a first switching means for activating the first clutch and inactivating the second clutch, a second switching means for activating the second clutch and inactivating the first clutch, trigger means carried by said lead screw and moveable therewith along a line parallel to the direction of axial movement of the lead screw and adapted to actuate said second switching means when said lead screw is moved axially in one direction to a first predetermined position with respect to said support and for actuating the first switching means when said lead screw is moved axially in the opposite direction to a second predetermined position with respect to said support, and switch adjusting means responsive to actuation of one of said switching means for changing the location of portions of said switching means with respect to the support whereby said first and second predetermined positions are change for each cycle of axial movement of the lead screw in both directions.

4. A wire spooling machine including in combination a lead screw for supporting a spool, said lead screw having a threaded portion, a support in which said lead screw is journaled so as to permit rotational and axial movement of the lead screw, wire guiding means mounted on said support for maintaining wire being spooled at a constant distance from the support in the direction of the axis of the lead screw, a nut engaging the threaded portion of the lead screw, means mounting the nut with respect to the support so as to permit rotational movement and prevent axial movement of the nut with respect to the support, driving means for rotating said lead screw in one direction, a speed reducing means engaging said nut and adapted to be placed in engagement with the driving means for rotating the nut in the one direction at a speed less than the speed the lead screw is rotated by the driving means whereby the lead screw is moved along its axis in one direction relative to said support, a speed increasing means engaging said nut and adapted to be placed in engagement with the driving means for rotating the nut in the one direction at a speed greater than the speed the lead screw is rotated by the driving means whereby the lead screw is moved along its axis in the opposite direction relative to said support, said speed reducing means including a first clutch for placing the lead screw in engagement with the speed reducing means, said speed increasing means including a second clutch for placing the lead screw in engagement with the speed increasing means, a first switching means for activating the first

clutch and inactivating the second clutch, a second switching means for activating the second clutch and inactivating the first clutch, a first clutch for triggering the operation of the first switching means, a second switch for triggering the operation of the second switching means, switch support means on which said first and second switches are mounted so as to be moveable along a line parallel to the direction of axial movement of the lead screw, switch triggering means carried by said lead screw and moveable therewith along a path parallel to the direction of axial movement of the lead screw and into engagement with said switches whereby the switch triggering means actuates said second switch to trigger operation of said second switching means as said switch triggering means is carried in the one direction, and whereby the switch triggering means actuates said first switch to trigger operation of said first switching means as said switch triggering means is carried in the opposite direction, and switch adjusting means responsive to actuation of one of said switches by the switch triggering means for moving each of said switches a predetermined distance toward each other along said line whereby the distance of movement of the lead screw and the switch triggering means carried by the lead screw in each direction is reduced.

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