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2,900,145

VARIABLE SPEED DISTRIBUTOR

Filed Sept. 26, 1957

2 Sheets-Sheet 1

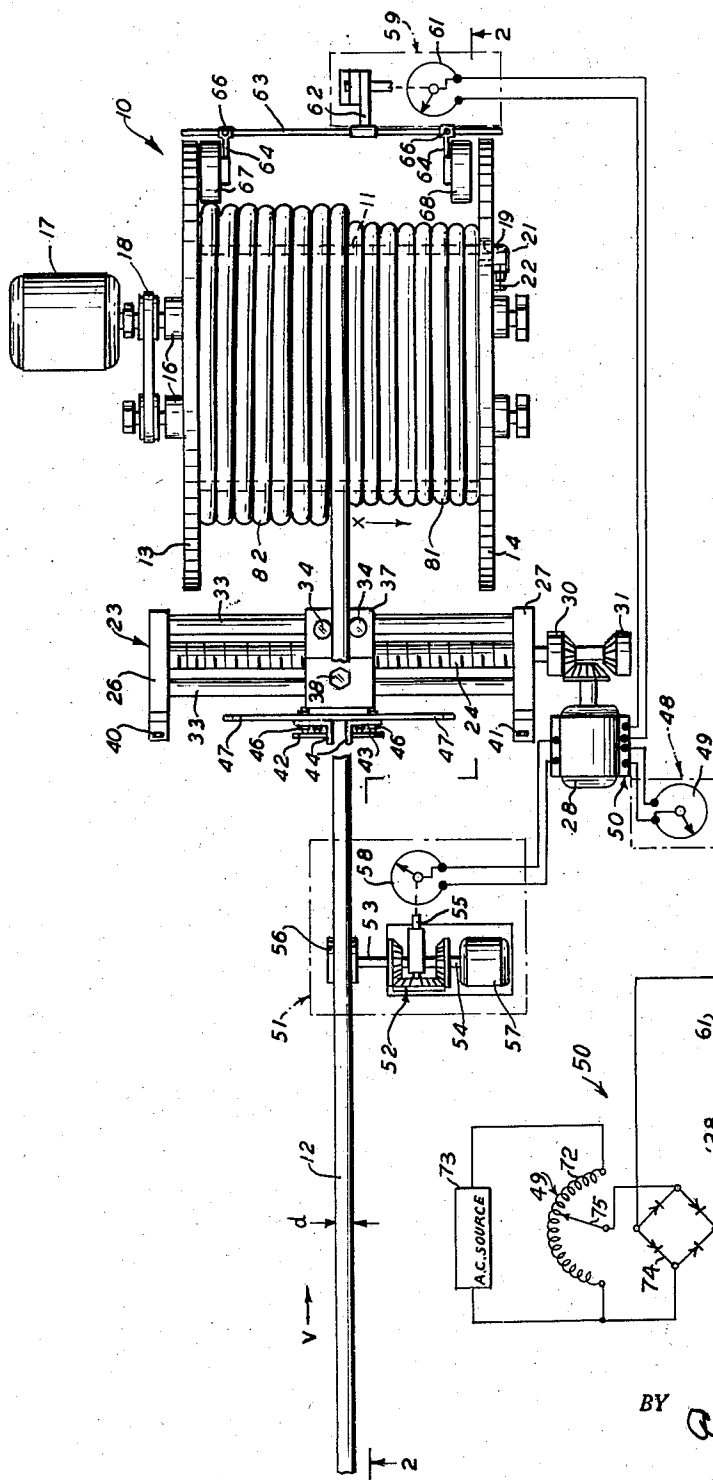


FIG. 1

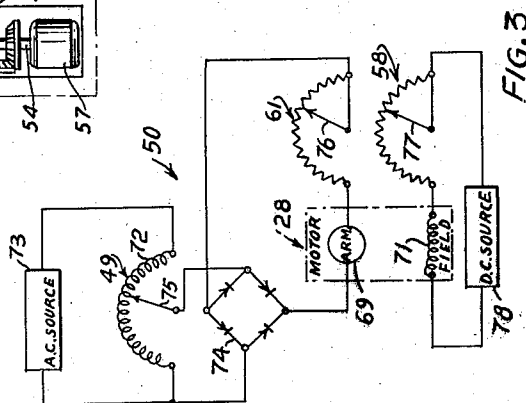


FIG. 3

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2. Sheets-Sheet 2

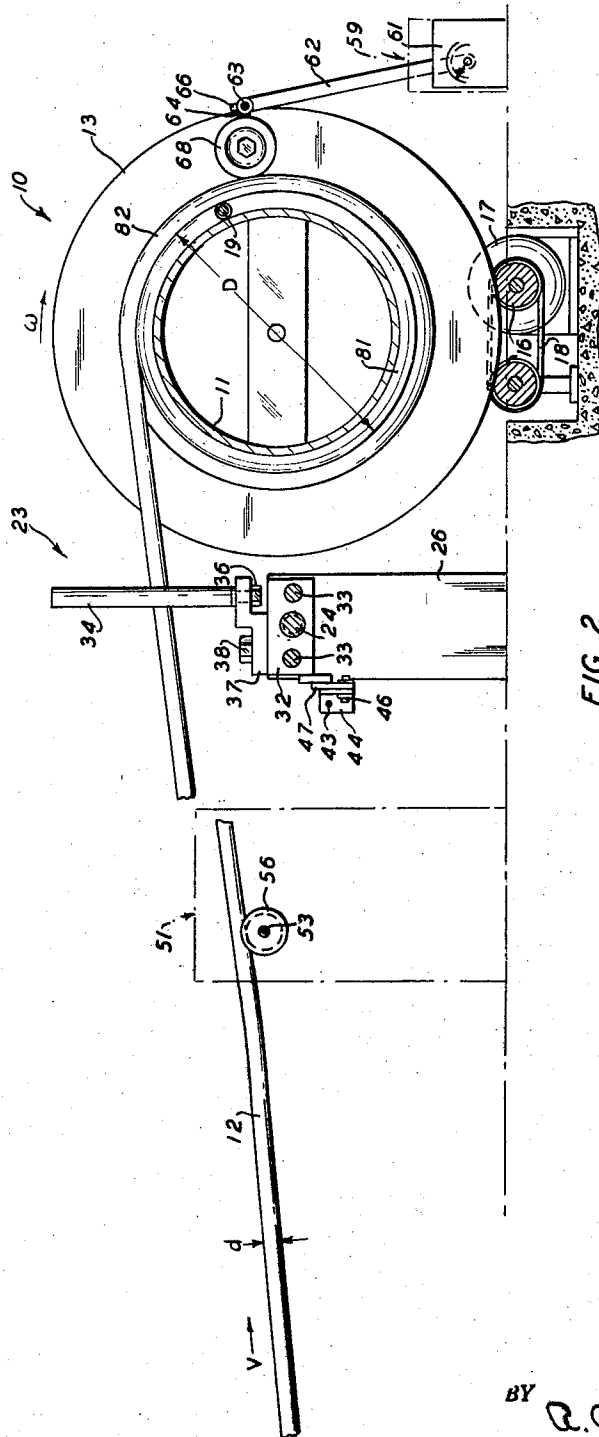


FIG. 2

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VARIABLE SPEED DISTRIBUTOR

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6 Claims. (Cl. 242—158.2)

This invention relates to a variable speed distributor, and more particularly to a variable speed distributor for guiding an advancing strand back and forth along the length of a rotating take-up drum at such a speed that the advancing strand is taken up in a plurality of closely packed helical turns back and forth along the length of the drum.

In the manufacture of communications cable, it is required frequently to take up a strand, advancing continuously from a particular manufacturing process, upon a take-up reel. The strand wound on the take-up reel may be finished cable, or it may be a strand at an intermediate stage in the manufacture of the finished cable, such a reel being unwound subsequently and the strand fed into another process.

A take-up reel for cable commonly consists of a cylindrical drum with a circular flange at either end thereof. A lead end of the cable is secured to the reel, and then the reel is rotated at such speed as to take up the advancing strand upon the periphery of the rotating drum. It is customary to provide a distributor for guiding the advancing strand back and forth along the length of the rotating takeup drum from one flange to the other so that the strand is taken up in a plurality of helical turns back and forth along the length thereof.

It is advantageous to take up the cable in closely packed helical turns, and to accomplish this it is required to provide a variable speed distributor. Such a distributor must be designed for guiding the advancing cable back and forth along the length of the rotating take-up drum at a speed dependent on the cable diameter, the speed of advancement of the cable, and the winding diameter of the drum, which is based on the amount of cable already wound on the drum at any time. The distributor should also have an adjustable traverse in order to permit the winding of cable along the entire drum length of reels having different drum lengths.

An object, therefore, of the invention is to provide an improved variable speed distributor.

Another object of the invention is to provide a variable speed distributor for guiding an advancing strand back and forth along the length of a rotating take-up drum at such a speed that the advancing strand is taken up in a plurality of closely packed helical turns back and forth along the length thereof.

A further object is to provide a novel means for controlling the rate of traverse of a distributor for a moving strand in direct proportion to the speed of the strand.

An apparatus for distributing an advancing strand upon a rotating take-up drum, embodying certain features of the invention, may include a variable speed distributor for guiding the advancing strand back and forth along the length of the rotating take-up drum and the following control means: (1) means for regulating the distributor speed in accordance with the diameter of the strand to be taken up; (2) means for regulating the distributor speed in accordance with the speed of advancement of the strand; and (3) means for adjusting the distributor

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speed in accordance with the effective winding diameter of the drum. With a suitably designed tripartite control system of this type, the advancing strand may be taken up upon the rotating drum in a plurality of closely packed helical turns back and forth along the length thereof.

Other objects and advantages of the invention will appear from the following detailed description of a specific embodiment thereof, when read in conjunction with the appended drawings, in which:

Fig. 1 is a top plan view of an apparatus embodying the invention;

Fig. 2 is a cross-sectional elevation, taken along the line 2—2 of Fig. 1, and

Fig. 3 is a schematic diagram of a suitable control circuit for regulating the distributor speed.

Referring now in detail to the drawings, and in particular to Figs. 1 and 2, a conventional take-up reel, indicated generally by the numeral 10, is provided, having a cylindrical drum 11 upon which an advancing strand, such as a cable 12, may be wound. The reel 10 is provided with a pair of circular flanges 13 and 14, one at each end of the drum 11, which are designed to be supported on and rotated frictionally by a pair of conventional floor rollers 16—16.

The floor rollers 16—16 are rotatably driven by suitable means, such as a motor 17 and a belt 18. As seen in Fig. 2, the floor rollers 16—16 are rotated in a counter-clockwise direction so as to rotate frictionally the flanges 13 and 14 and thus the drum 11, in a clockwise direction in order that the cable 12, advancing from left to right in the figure, may be taken up on the drum 11.

Before starting the take-up operation, the lead end 19 of the cable is attached by suitable means to the cable reel 10. As best seen in Fig. 1, the lead end 19 may extend through an aperture 21 in the flange 14 and may be tied to a projection 22 thereon.

A variable speed distributor, indicated generally by the numeral 23, is provided to guide the advancing cable 12 as it advances toward the rotating take-up drum 11. The distributor 23 is adapted to guide the advancing cable 12 from a position adjacent to the flange 13 to a position adjacent to the flange 14 and back again to distribute the advancing cable back and forth along the entire length of the rotating drum 11 in a plurality of layers of helical turns.

A suitable distributor 23, according to the invention may include a lead screw 24 journaled for rotation between supports 26 and 27 and driven rotatably by a variable speed motor 28. A pair of electromagnetic clutches 30 and 31 are provided for alternately reversing the direction of rotation of the lead screw 24. A nut 32 is received threadedly on the lead screw 24 and is adapted to reciprocate back and forth along the length thereof as the lead screw 24 reverses its direction of rotation. The travelling nut 32 is supported for sliding movement by a pair of guide bars 33—33, which are secured fixedly to the supports 26 and 27.

The advancing cable 12 passes between a pair of up-standing guide fingers 34—34 secured to the travelling nut 32 for reciprocating movement therewith, the cable 12 being guided thereby as it advances into take-up position adjacent to the drum 11. The spacing between the guide fingers 34—34 may be adjusted to accommodate cable of various diameters by means of a pair of adjusting bolts 36—36, which secure the guide fingers 34—34 to a support member 37, which is in turn mounted by means of a bolt 38 to the travelling nut 32.

Secured to the supports 26 and 27 are a pair of micro-switches 40 and 41 which are designed upon actuation to reverse the connection of the electromagnetic clutches 30 and 31 to reverse the direction of rotation of the lead

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screw 24 and, thus, the direction of travel of the distributor 23.

A pair of adjustable tripping bars 42 and 43 are secured to the travelling nut 32 for reciprocation therewith and are adapted to alternately actuate the microswitches 40 and 41 respectively, to reverse the direction of travel of the nut 32. The tripping bars 42 and 43 are secured to a pair of bracket members 44—44, which are secured by a plurality of bolts 46—46 to an elongated bar 47, which is in turn secured to the travelling nut 32.

In order to distribute the cable 12 from a position adjacent to the flange 13 to a position adjacent to the flange 14 for any desired drum length, the distance between the ends of the tripping bars 42 and 43 may be preset in accordance with the drum length by loosening the bolts 46—46, sliding the bracket members 44—44 with respect to the bar 47, and then tightening the bolts 46—46.

In order that successive turns of cable 12 may be taken up in a closely packed helix, it is necessary that the distributor 23 guide the advancing cable 12 along the length of the drum 11 at a speed of one cable diameter for each revolution of the take-up drum 11. This relationship may be expressed by the equation $X = \omega d$, where ω is the rotational speed of the drum 12 in r.p.m., d is the wire diameter in inches and X is the desired distributor speed in inches per minute. The rotational speed of the drum 11 is approximated by the equation

$$\omega = \frac{V}{\pi D}$$

where V is the linear speed of the advancing cable 12 in feet per minute, D is the effective winding diameter of the drum in feet and ω is the rotational speed in r.p.m. The effective winding diameter (D) is initially that of the bare drum 11 and increases, as each layer of cable 12 is wound, by an amount approximately equal to twice the cable diameter (d).

Eliminating ω from the above two equalations, it is seen that the desired distributor speed is approximated by the equation

$$X = \frac{Vd}{\pi D}$$

In order to wind the cable 12 in a plurality of closely packed helical turns back and forth along the length of the drum 11, control means are provided to: (1) regulate the distributor speed in direct proportion to the diameter (d) of the cable to be taken up; (2) regulate the distributor speed in direct proportion to the speed of advancement (V) of the cable; and (3) regulate the distributor speed in inverse proportion to the winding diameter of the drum, which increases as successive layers of cable are wound thereon.

First control means are provided, designated generally by the numeral 48, for regulating the speed (X) of the distributor 23 in accordance with the diameter (d) of the advancing cable 12. Other factors being constant, the speed of the distributor 23 is designed to be a direct function of the cable diameter (d).

Since the diameter of the cable 12 does not normally vary appreciably during the winding of any one reel, suitable means for accomplishing this control may include a manually-controlled variable electrical component 49, disposed in and forming a first part of a control circuit 50 for the variable speed motor 28. An example of a suitable control circuit 50 is shown in Fig. 3 and will be described fully hereinafter.

Second control means are provided, designated generally by the numeral 51, responsive to the speed of advancement (V) of the cable 12, for adjusting the speed (X) of the distributor 23 in accordance therewith. Other factors being constant, the speed of the distributor 23 is designed to be a direct function of the speed of advancement (V).

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Suitable means 51 for accomplishing this control may include a differential gear unit, designated generally by the numeral 52, having two rotatable input shafts 53 and 54 and an output shaft 55, responsive to any difference between the speeds of rotation of the two input shafts 53 and 54. A grooved roller 56 is mounted on the first input shaft 53 and is positioned so as to engage the cable 12 as it advances toward the guide fingers 34—34. The roller 56 and thus its shaft 53 are rotated by the advancing cable at a speed proportional to the speed of advancement thereof.

The second input shaft 54 of the differential gear unit 52 is driven by a pilot motor 57 at a constant speed preselected in accordance with the expected speed of advancement of the cable 12. A variable electrical component 58 is disposed in and forms a second part of the control circuit 50 for the variable speed motor 28. The output shaft 55 is designed to regulate the setting of the variable electrical component 58 in accordance with the magnitude and sense of any variation in the cable speed from the expected value as determined by a difference in the speeds of rotation of the two input shafts 53 and 54.

Third control means are provided, designated generally by the numeral 59, responsive to the effective winding diameter (D) of the drum 11, for adjusting the speed (X) of the distributor 23 in accordance therewith. Other factors being constant, the speed of the distributor 23 is designed to be an inverse function of the effective winding diameter (D).

One means 59 for accomplishing this control may include a variable electrical component 61, disposed in and forming a third part of the operating circuit 50 for the variable speed motor 28. The component 61 is adapted to vary in such a manner as to decrease the speed of the motor 28 as the winding diameter of the drum 11 increases. The setting on the component 61 is controlled by a pivotable arm 62 having a transverse bar 63 connected to one end thereof. A pair of support members 64—64 are secured adjustably by a pair of set screws 66—66 to opposite ends of the transverse bar 63 and are adapted to support rotatably a pair of rollers 67 and 68.

The rollers 67 and 68 are adapted to ride upon the winding surface of the drum 11 in positions adjacent to the flanges 13 and 14, respectively. As the winding diameter increases, the rollers 67 and 68 are pushed away alternately from the drum 11 to pivot the arm 62 in a clockwise direction, as viewed in Fig. 2, changing the setting of the variable component 61 to compensate for the increased winding diameter of the drum 11. It will be apparent that this control might be achieved by one roller extending the length of the drum 11, and that approximate control would result if only one relatively thin roller were utilized.

A suitable control circuit for varying the speed of the motor 28 in accordance with the settings of the three variable components 49, 58 and 61 is shown in Fig. 3. The motor 28 may be a separately-excited, shunt-wound direct current motor having an armature 69 and a field 71 energized separately by suitable direct current sources. The speed of such a motor will vary substantially directly with the armature current and substantially inversely with the field current.

The variable component 49 comprises a variable transformer 72 connected across an alternating current source 73. The output from the variable transformer 72 is impressed across a rectifier 74 and the rectified output is impressed across a series circuit including the armature 69 and the variable component 61. If the diameter of the cable to be wound is doubled, a pick off arm 75 of the transformer 72 is moved manually in a clockwise direction, as seen in Fig. 3. This acts to double the output of the transformer 72 and, thus, to double the armature current and, accordingly, to double the motor speed.

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The variable component 61 comprises a rheostat having a pick off arm 76, which moves automatically in a clockwise direction, as seen in Fig. 3, as the winding diameter doubles. This increases the resistance, connected in series with the armature 69, by the amount required to halve the armature current and, thus, to halve the motor speed. It should be noted that the rheostat is not linearly wound, rather the resistance of the armature 69 is taken into account and the rheostat is wound so that the resistance increases by an amount sufficient to double the total resistance of the rheostat plus that of the armature 69, in order to halve the armature current. With this control, the motor speed will vary inversely with the winding diameter irrespective of what voltage is being supplied by the transformer 72.

The motor field 71 is energized by a separate direct current source 78, the variable component 58 being connected in series with the motor field 71. The variable component 58 comprises a rheostat having a pickoff arm 77, which moves automatically in a clockwise direction, as seen in Fig. 3, as the wire speed doubles. This increases the resistance connected in series with the field 71 by the amount required to halve the field current and, thus, to double the motor speed. This winding is also nonlinear, the resistance of the field being taken into account.

Operation

In operation, an empty reel 10 of any desired drum diameter and drum length is positioned on the floor rollers 16—16. As best seen in Fig. 1, the cable 12 to be taken up is passed over the roller 56, between the guide fingers 34—34, and over the drum 11. The lead end 19 of the cable is then secured to the reel 10 by passing it through the aperture 21 in the flange 14 and tying it to the projection 22 thereon.

The guide fingers 34—34 are adjusted by means of the bolts 36—36 so that the distance between them is approximately equal to the diameter (d) of the cable 12 to be wound. The tripping bars 42 and 43 are adjusted by means of the bolts 46—46 so that the ends thereof will trip the microswitches 40 and 41 respectively, when the cable has been wound approximately as far as the flanges 13 and 14 respectively, of the reel 10. This adjustment is dependent on the particular length of the drum 11 employed and enables the winding of different length drums from one flange to the other.

The positions of the supports 64—64 with respect to the transverse bar 63 is adjusted by means of the set screws 66—66 so that the rollers 67 and 68 will ride on the drum 11 adjacent to the flanges 13 and 14, respectively. The variable component 49 is set manually in accordance with the diameter (d) of the cable 12 to be taken up.

The cable advancing means, which may be a capstan of known design (not shown), is actuated to advance the cable 12 to the take-up reel 11. The motor 17 is then started, driving the floor rollers 16—16 to rotate frictionally the flanges 13 and 14 of the reel 10 to permit taking up of cable 12 upon the drum 11. The variable speed motor 28 is also started which, through engagement of the front electromagnetic clutch 31, causes the distributor 23 to start travelling from front to rear, as seen in Fig. 1, to guide the advancing cable into windup position.

The pilot motor 57 is also started at a speed preselected in accordance with the expected cable speed, which provides an initial setting of the variable component 58. Assuming that the speed (V) of advancement of the cable 12 is approximately equal to the expected speed thereof, there will be no output from the differential gear unit 52 and the setting of the variable component 58 will remain constant.

The cable 12 will start to be taken up on the rotating drum 11, and, as the first turn is wound, the front roller

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68 will be pushed away from the drum 11 and will ride on the newly wound cable to provide an initial setting for the variable component 61, based on the diameter of the bare drum 11.

The distributor 23 will advance from front to rear, as seen in Fig. 1, at a speed equal to $Vd/\pi D$, as determined by the combination of the settings on the variable components 49, 58 and 61 disposed in the control circuit 50 of the motor 28. A first layer 81 of closely packed helical turns will thus be wound upon the rotating take-up drum 11, starting with the lead end 19 of the cable 12 adjacent to the front flange 14.

When the first complete layer 81 of cable has been wound upon the drum 11 with the guide fingers 34—34 being positioned so as to supply the cable adjacent to the rear flange 13, the rear tripping bar 42 will trip the rear microswitch 40 to reverse the connection of the electromagnetic clutches 30 and 31. The rear electromagnetic clutch 30 will now rotate the lead screw 24 in the opposite direction to cause the nut 32 to travel from rear to front in order to wind a second layer 82 of cable upon the first layer 81.

Upon the winding of the first turn of the second layer 82, the roller 67 will be pushed outwardly to ride thereon, thereby moving the connected pivot arm 62 in a clockwise direction, as seen in Fig. 2, to change the setting on the variable component 61 by an amount predetermined in accordance with the increased winding diameter. This will operate to slow down the variable speed motor 28, and thus the speed of the distributor 23, by a calculated amount. It can be seen that each additional layer of cable wound upon the drum 11 will alternately move the rollers 67 and 68 to cause the arm 62 to move an additional step to further slow down the distributor 23.

If, at any time, the speed (V) of the advancing cable 12 varies above or below the expected speed, the differential gear unit 52 will be actuated to adjust by a proportionate amount the setting on the variable component 58 to speed up or slow down, respectively, the distributor 23 in accordance with the new cable speed.

Thus it can be seen that, by using the tripartite control system herein described, any diameter of cable may be taken up upon a drum of any diameter and length in closely packed helical turns back and forth along the length thereof, variations in the speed of advancement of the cable and changes in the winding diameter of the drum being automatically compensated for.

If it were desired to always utilize the distributor 23 with one particular diameter of cable, it would be possible to use only the control 51, responsive to the speed of advancement of the cable, and the control 59, responsive to the winding diameter. In this case, the control 48, responsive to the diameter of the cable is dispensed with, the driving apparatus for the distributor being designed to include implicitly the setting for the particular diameter of cable involved.

It will be manifest that this invention is not limited to the specific details described in connection with the above embodiment of the invention and that various modifications may be made without departing from the spirit and scope thereof.

What is claimed is:

1. Apparatus for distributing an advancing strand upon a rotating take-up drum, which comprises a distributor for guiding the advancing strand back and forth along the length of the rotating take-up drum, a variable speed electric motor for driving said distributor, a control circuit for varying the speed of said electric motor, a first variable electrical component disposed in said control circuit, means for varying said first variable electrical component so that the distributor speed is in direct proportion to the diameter of the strand to be taken up, a second variable electrical component disposed in said control circuit, means for varying said second variable electrical component so that the distributor speed is in direct pro-

portion to the speed of advancement of the strand, a third variable electrical component disposed in said control circuit, and means for varying said third variable electrical component so that the distributor speed is in inverse proportion to the winding diameter of the drum, whereby the advancing strand is taken up upon the rotating drum in a plurality of closely packed helical turns back and forth along the length thereof.

2. Apparatus for distributing an advancing strand upon a rotating take-up drum, which comprises a distributor for guiding the advancing strand back and forth along the length of the rotating take-up drum, a variable speed electric motor for driving said distributor; a control circuit for varying the speed of said electric motor, a first variable electrical component disposed in said control circuit, the setting of said first variable electrical component being regulated manually in accordance with the diameter of the strand to be taken up so that the distributor speed is in direct proportion thereto, a second variable electrical component disposed in said control circuit, means responsive to the speed of advancement of the strand for regulating automatically the setting of said second variable electrical component so that the distributor speed is in direct proportion to the speed of advancement of the strand, a third variable electrical component disposed in said control circuit, and means responsive to the winding diameter of the drum for regulating automatically the setting of said third variable electrical component so that the distributor speed is in inverse proportion to the winding diameter of the drum, said three variable electrical components being so constructed and so disposed in said control circuit that the speed of the distributor is at all times substantially equal to

$$\frac{dV}{\pi D}$$

wherein d is the diameter of the strand, V is the speed of advancement thereof, and D is the winding diameter of the drum.

3. Apparatus for distributing an advancing strand upon a rotating take-up drum, which comprises a distributor for guiding the advancing strand back and forth along the length of the rotating take-up drum, a variable speed electric motor for driving said distributor, a control circuit for varying the speed of said electric motor, a first variable electrical component disposed in said control circuit, the setting of said first variable electrical component being regulated manually in accordance with the diameter of the strand to be taken up so that the distributor speed is in direct proportion thereto, a second variable electrical component disposed in said control circuit, a differential gear unit having two rotatable input shafts and an output shaft responsive to any difference between the speeds of rotation of the two input shafts, a grooved roller mounted on the first input shaft of said differential gear unit and over which the advancing strand passes to cause rotation of the first input shaft at a speed proportional to the speed of advancement of the strand, a pilot motor for driving the second input shaft of said differential gear unit at a constant speed preselected in accordance with the expected speed of advancement of the strand, the output shaft of said differential gear unit automatically regulating the setting of said second variable electrical component so that the distributor speed is in direct proportion to the speed of advancement of the strand, a third variable electrical component disposed in said control circuit, a control arm for varying the setting of said third variable electrical component, and a roller secured to said control arm and designed to ride upon the winding surface of the drum for regulating automatically the setting of said third variable electrical component so that the distributor speed is in inverse proportion to the winding diameter of the drum, said three variable electrical components being so constructed and so disposed in said con-

trol circuit that the speed of the distributor is at all times substantially equal to

$$\frac{dV}{\pi D}$$

wherein d is the diameter of the strand, V is the speed of advancement thereof, and D is the winding diameter of the drum.

4. Apparatus for distributing an advancing strand of constant diameter upon a rotating take-up drum, which comprises a distributor for guiding the advancing strand back and forth along the length of the rotating take-up drum, a variable speed electric motor for driving said distributor, a control circuit for varying the speed of said electric motor, a first variable electrical component disposed in said control circuit, means for varying said first variable electrical component so that the distributor speed is in direct proportion to the speed of advancement of the strand, a second variable electrical component disposed in said control circuit, and means for varying said second variable electrical component so that the distributor speed is in inverse proportion to the winding diameter of the drum, whereby the advancing strand is taken up upon a rotating drum in a plurality of closely packed helical turns back and forth along the length thereof.

5. Apparatus for distributing an advancing strand of constant diameter upon a rotating take-up drum, which comprises a distributor for guiding the advancing strand back and forth along the length of the rotating take-up drum, a variable speed electric motor for driving said distributor, a control circuit for varying the speed of said electric motor, a first variable electrical component disposed in said control circuit, a differential gear unit having two rotatable input shafts and an output shaft responsive to any difference between the speeds of rotation of the two input shafts, a grooved roller mounted on the first input shaft of said differential gear unit and over which the advancing strand passes to cause rotation of the first input shaft at a speed proportional to the speed of advancement of the strand, a pilot motor for driving the second input shaft of said differential gear unit at a constant speed preselected in accordance with the expected speed of advancement of the strand, the output shaft of said differential gear unit regulating automatically the setting of said first variable electrical component so that the distributor speed is in direct proportion to the speed of advancement of the strand, a second variable electrical component disposed in said control circuit, a control arm for varying the setting of said second variable electrical component, and a roller secured to said control arm and designed to ride upon the winding surface of the drum for regulating automatically the setting of said second variable electrical component so that the distributor speed is in inverse proportion to the winding diameter of the drum, said two variable electrical components being so constructed and so disposed in said control circuit that the speed of the distributor is at all times substantially equal to

$$\frac{dV}{\pi D}$$

wherein d is a constant equal to the diameter of the strand, V is the speed of advancement thereof, and D is the winding diameter of the drum.

6. Apparatus for controlling the rate of traverse of a distributor for a moving strand, which comprises a variable speed motor for causing traverse of the distributor, a control circuit for said variable speed motor, a differential gear unit having two rotatable input shafts and an output shaft responsive to any difference between the speeds of rotation of the two input shafts, a grooved roller mounted on the first input shaft of said differential gear unit and over which the moving strand passes to cause rotation of the first input shaft at a speed proportional to the speed of the moving strand, a pilot motor for driving the second input shaft of said differential gear

unit at a constant speed preselected in accordance with the expected speed of the moving strand, and a variable electrical component disposed in the control circuit for said variable speed motor and regulated by the output shaft of said differential gear unit, whereby the rate of traverse of the distributor is substantially in direct proportion to the speed of the moving strand.

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