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Johnson et al.

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[54] **APPARATUS AND METHOD FOR CONTINUOUS SPOOLING**

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[52] **U.S. Cl.** ..... **242/25 A,** 242/75.51

[51] **Int. Cl.** **B65h 54/02,** B65h 54/44

[58] **Field of Search** 242/25, 75.51

[56] **References Cited**

UNITED STATES PATENTS

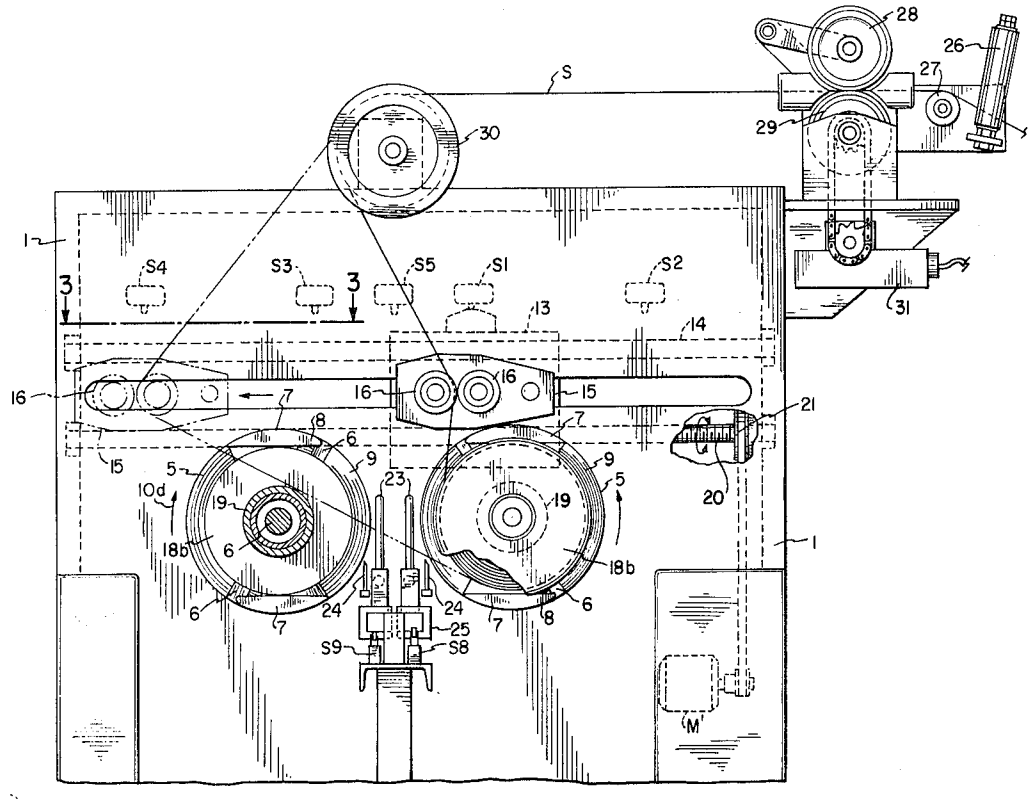
3,223,906	12/1965	Dinger	242/75.51 X
3,324,320	6/1967	Evert	242/75.51 X
3,348,107	10/1967	Hamby	242/75.51 X
3,497,154	2/1970	Lasarev et al.	242/75.51 X
3,535,441	10/1970	Grace	242/75.51 X
3,684,202	8/1972	Otani	242/25 A
3,693,898	9/1972	Otani	242/25 A
3,695,526	10/1972	Otani	242/25 A
3,695,528	10/1972	Taki et al.	242/25 A
3,698,652	10/1972	Morikawa et al.	242/25 A
3,701,491	10/1972	Brown	242/25 A

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[57] **ABSTRACT**

Apparatus and method are disclosed for continuously spooling flexible stock material onto a pair of take-up spools rotatably mounted with their axis in parallel relationship to each other. The stock material is spooled first onto one of the take-up spools and when it is filled the stock material is automatically transferred to the other take-up spool for spooling thereon without interruption of the spooling operation. The apparatus is specially constructed to dependably and reliably insure proper transfer of the stock material from one take-up spool to the other. For applications involving the spooling of insulated stock and the testing of the insulated stock for electrical defects as it is being fed to the take-up spools, the apparatus is provided with means for maintaining the linear rate of feed of the stock material substantially constant as the winding on each of the take-up spools takes place. Means are also provided for grounding the insulated cable to the apparatus.

5 Claims, 6 Drawing Figures



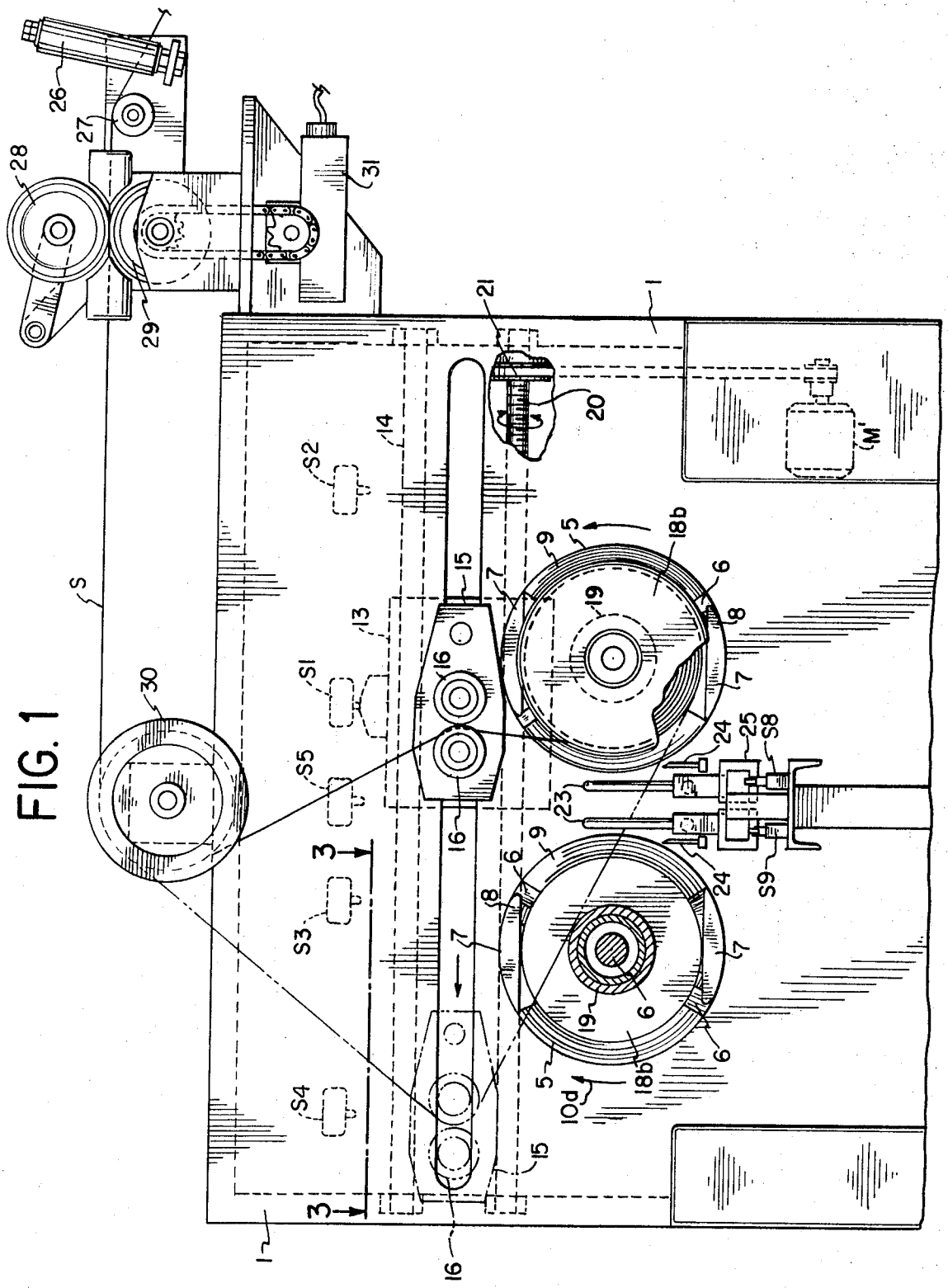

26
27
28
29
31
21
20
1
M'
14
S2
15
7
9
5
18b
6
8
19
13
16
S1
30
S5
24
25
S8
23
S9
3
S3
S4
10d
S
FIG. 1

FIG. 2

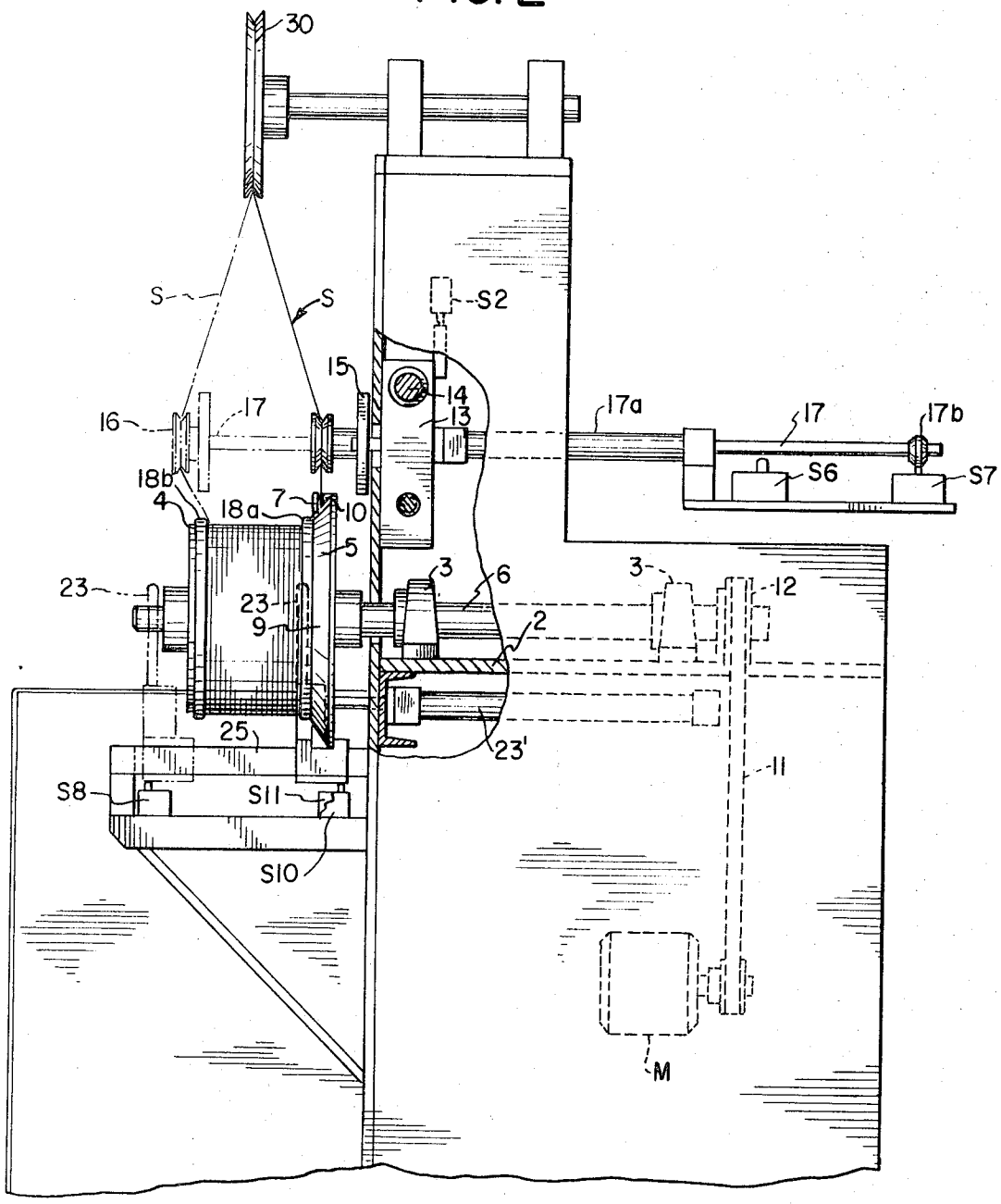

30
S
S
S2
15
14
13
16
17
17a
17
17b
S6
S7
18b
4
18a
7
10
5
23
3
6
3
12
23
9
2
25
23'
11
S8
S11
S10
M

FIG. 3

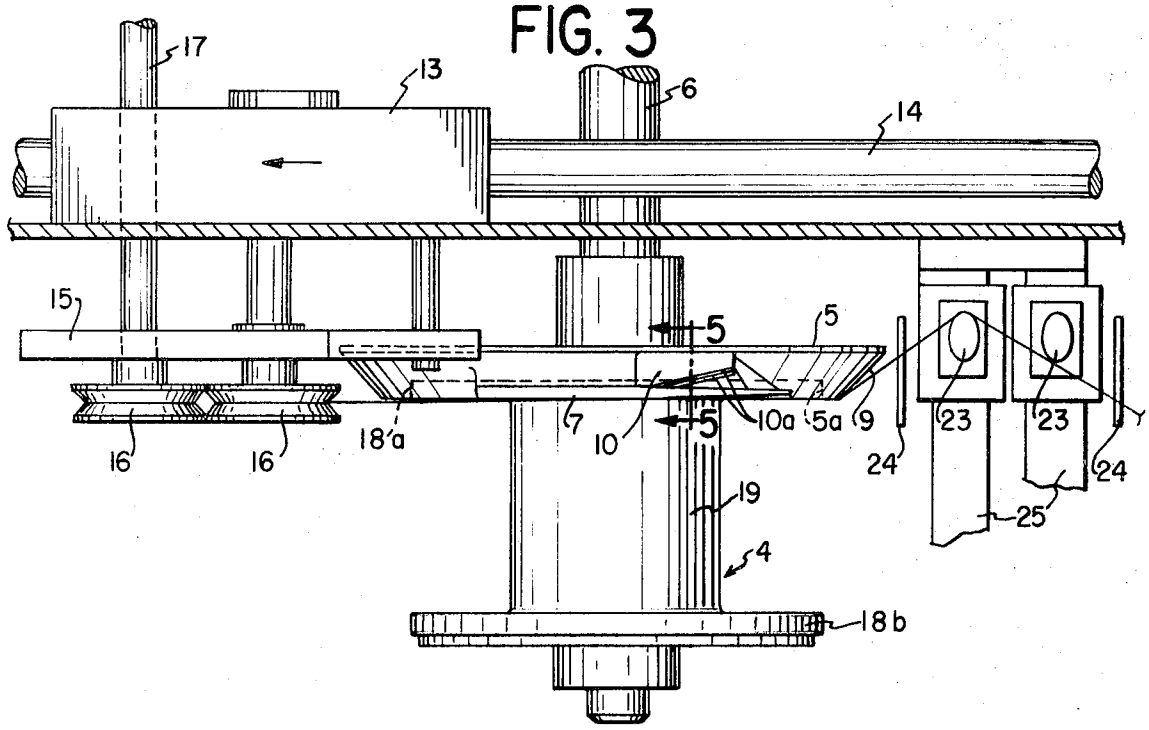

17
13
6
14
15
5
5
5
16
16
18a
7
10
10a
5a
9
24
23
23
24
25
19
4
18b

FIG. 4

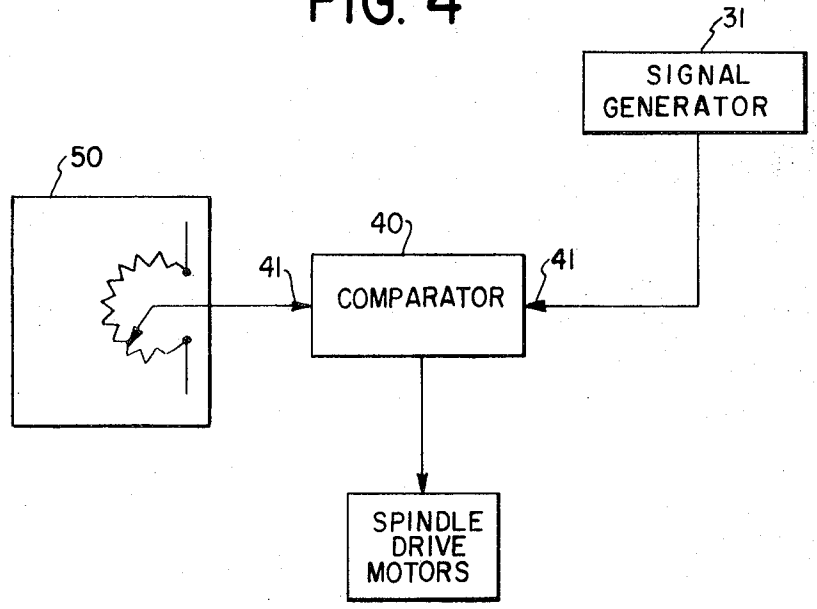

31
SIGNAL GENERATOR
50
40
41
41
COMPARATOR
SPINDLE DRIVE MOTORS

FIG. 5

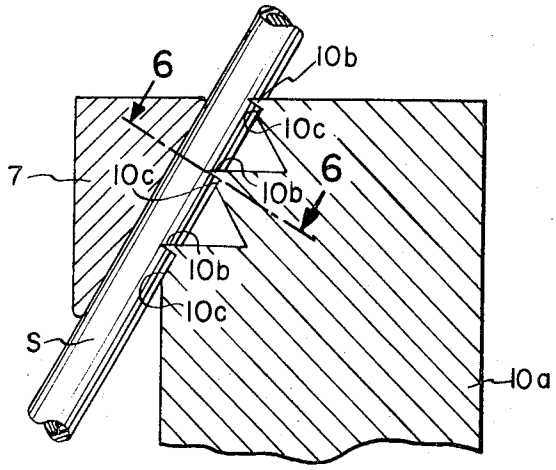
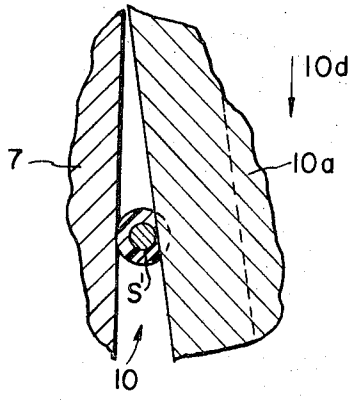


FIG. 6



APPARATUS AND METHOD FOR CONTINUOUS SPOOLING

BACKGROUND OF THE INVENTION

The spooling of a predetermined length of wire or cable onto a take-up spool has, in the past, been a rather slow and tedious process involving the expenditure of considerable time and effort and at considerable expense to the manufacturer or processor of the wire or cable. This is due primarily to the shortage of adequately automated equipment capable of uninterruptedly filling successive take-up spools at the required speed necessary for economical production. Some of the presently in-use machines which purport to provide high speed spooling do not perform to the extent necessary. These machines are generally automated only with respect to the operation of spooling per se and do not provide for automatic transfer of the wire or cable from a filled spool to an empty spool without interrupting the spooling operation. With such machines a fair amount of manual labor is necessary for replacing a filled spool with an empty one during which time the machine must be shut down. In addition, the time consumed in changing spools one at a time and securing the leading end of the cable in position for spooling on the next empty spool adds to the production line cost and generally creates a bottleneck in the manufacturing process.

Other machines which do provide for automatic transfer generally include, in construction, two or more spool receiving spindles between which transference of the stock is effected. One such machine, by way of example, includes a pair of spool receiving spindles mounted for rotation in spaced parallel relation to each other. Spooling takes place on one spool at a time. However, when one spool is fully wound the stock is crossed over to the other spool for spooling thereon substantially without interrupting the spooling operation. Such constructions have been found to be somewhat unreliable in operation. Oftentimes, proper transfer is not effected between the filled spool and the next succeeding empty spool thus necessitating shutdown of the machine while the situation is remedied.

In one particular winding application, by way of example, presently available spooling equipment has proved inadequate. This application involves the end phase of the manufacturing process for electrical cable where high speed spooling equipment is needed to package the wire or cable on spools for shipment to a customer. Just prior to the actual spooling operation, it is common to test the insulation of the cable for electrical defects as it is being fed to the spooling equipment. For this purpose the cable is fed through an insulation testing device. The rate of travel through this device must be maintained constant if accurate testing is to be accomplished. Also, since electrical current must be passed through the cable for testing as it moves through the insulation tester the cable must be electrically grounded at all times. Heretofore the achievement of electrical grounding has not been satisfactorily obtained with prior art winding equipment.

SUMMARY OF THE INVENTION

In accordance with teachings of the present invention there is provided automatic spooling apparatus and method of general utility and dependability for continuously filling take-up spools with flexible stock material, such as wire or cable, one after the other in substantially uninterrupted fashion. In construction, the winding apparatus included a frame and a spindle support member mounted on the frame. A pair of spindles are rotatably mounted on the support member with their axes of rotation disposed in spaced parallel relationship. A take-up spool is removably mounted on each spindle to be rotatable therewith. Each spindle is provided with a drive means to rotate the spindle and draw the stock from a guide means on to the corresponding take-up spool which rotates with the spindle.

The guide means includes a carriage which is mounted for lateral movement with respect to both take-up spools between a wind-on position for one of the spools and a cross-over position for the other spool. The guide means further includes a distributor which is mounted for lateral movement with the carriage and for reciprocal movement with respect to the carriage. Reciprocal movement of the distributor takes place in a direction extending axially of the respective take-up spool between the confines of the end flanges thereof. This reciprocal movement of the carrier effects spooling of the stock in uniform layers of successive convolutions about the core of the take-up spool which extends between the end flanges thereof.

The apparatus further includes a specially constructed snagging mechanism which functions to snag, anchor and electrically ground the stock with respect to the corresponding take-up spool during transfer of the stock thereto from the filled spool. The snagging element includes a gripping element which is rotatable with the corresponding spindle and is positioned adjacent to one of the end flanges of the take-up spool mounted on such spindle. Associated with the gripping element is a series of sharpedge teeth which act to pierce the insulation of an electrical cable thus effecting electrical contact with the apparatus acting as a ground.

The construction further includes selectively operable switch means for stopping the reciprocal movement of the distribut or during transfer of the stock between a filled and an empty spool. Selectively operable and cooperatively acting deflection means are provided for each take-up spool to move the stock into a cross-over position and hold it in such position for engagement with the gripping element associated with the empty spool during angular displacement thereof. The switch means and the deflection means cooperate to advantageously position the stock for dependable and reliable engagement with the gripping element.

For applications involving heavy stock, a cutting means positioned alongside the path of angular displacement of each gripping element is provided for severing the stock as it passes by the cutting element under the influence of the gripping element to which it is anchored.

The construction further includes control means for sequentially activating the guide means, switch means, and deflection means in properly timed order. And, for applications which involve the electrical testing of the stock prior to spooling means are provided for maintaining the linear speed of the stock relatively constant during winding.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a front elevation view of the winding apparatus of the present invention;

FIG. 2 is a side elevation view of the winding apparatus of the present invention;

FIG. 3 is a top plan view as viewed along a direction indicated by arrows 3 in FIG. 1;

FIG. 4 is a diagrammatic illustration of the circuitry used to control the linear speed of the stock;

FIG. 5 is a cross-sectional view of the snagging mechanism taken along the lines 5—5 of FIG. 3, and

FIG. 6 is a cross-sectional view of the snagging mechanism taken along the lines 6—6 of FIG. 5.

DETAILED DESCRIPTION OF THE INVENTION

The spooling apparatus of the present invention comprises a main frame 1 which has a support member 2. Mounted on the support member 2 are spool stands 3 which rotatably support cantilever spindles disposed with their axes in spaced parallel relation to each other. Each spindle is adapted to removably receive take-up spools 4 onto which flexible stock such as electrical wire or cable is to be wound.

Each spindle includes a flange element 5 and a shaft 6 for mounting a take-up spool 4. The flange element is provided with a recessed annular surface 5*a* for receiving the rear flange 18a of take-up spool 4. The flange element 5 has a gripping element 7 secured to its outermost annular rim portion 8 which is defined by a beveled surface 9. As shown most clearly in FIGS. 5 and 6, the gripping element and the beveled surface define a generally V-shaped stock receiving groove 10 which tapers in a direction generally opposite to the direction of rotation of the flange 5 which is indicated by arrows 10*d* in FIGS. 1 and 6. The stock receiving groove 10 functions to snag and anchor the flexible stock in relation to the respective spool by a wedging action. Mounted on the beveled surface 9 opposite the gripping element 7 is an electrical grounding means in the form of a block 10*a* having a series of sharpedged teeth 10*b* each of which is flanked by a flat 10*c*. The teeth extend generally tangetially to the rim of the flange element 5 and generally transverse to the longitudinal axis of the stock engaged by the gripping element. When wedged in the groove 10 the cable is engaged on opposite sides by the gripping element 7 and the flats 10*c* of teeth 10*b* with the teeth piercing the insulation of the stock to make contact with the core S′ of the stock thus providing electrical contact with the spooling apparatus. In addition to their primary function of providing electrical contact as above described, the teeth serve the ancillary function of assisting the gripping element to snag and anchor the stock although the teeth are not necessary for this purpose.

Each spindle is provided with a spindle drive motor M which is operatively connected to the shaft 6 of the spindle via an endless belt 11 directed around pulley 12 fitted to shaft 6. Each spindle drive motor is electrically connected to the output terminals of comparator circuit which operates to maintain the linear travel speed of the stock relatively constant during spooling. The operation of the comparator circuit will be described more fully hereinafter in connection with the operation of the apparatus.

For spooling the stock onto the take-up spools guide means are provided. The guide means is adapted to lead the continuous stock uniformly in successive convolutions onto each of the take-up spools and to shift the stock from a wind-on distribution path for one of the take-up spools to a cross-over distribution path from which path the stock is transferred to the other take-up spool for spooling thereon. In the construction shown, the guide means comprises a carriage member 13 slidably mounted on bar 14 and a distributor 15 mounting a pair of guide rollers 16 between which the stock passes.

For the purpose of distributing the stock uniformly onto the take-up spools the distributor 15 is coupled by piston rod 17 to a hydraulic cylinder 17*a*. When actuated, the hydraulic cylinder operates to reciprocally move the distributor 15 with respect to the carriage 13 axially of the take-up spools between the confines of the front and rear spool flanges 18*a* and 18*b* secured to the ends of the core 19 of the take-up spools. Such movement of the carrier effects spooling of the stock, in layers of uniform turns, about the core 19, between the end flanges 18*a* and 18*b*. A switch actuator 17*b* is mounted on the end of piston rod 17 to actuate reversing switches S6 and S7 which are part of the electrical control circuitry of the apparatus. The switches S6 and S7 are connected to the carriage 13 via cylinder 17*a* and thus move with the carriage 13. Switch S7 has two modes of operation. In its first mode it acts to reverse the direction of rod 17. In its second mode switch S7 acts to stop reciprocal movement of distributor 15 and to actuate air cylinder 23′ the purpose of which will be more fully explained hereinafter. Switch S6 has only a single mode of operation. That is, it acts only to reverse the direction of piston rod 17.

For the purpose of shifting the stock between its windon distribution path and its cross-over distribution path, the carriage 13 is threadedly supported on a drive shaft 20. Shaft 20 is mounted for rotation by bearings 21 and is driven by a reversible motor M′, responsive to the master control circuit. When driven, the drive shaft 20 acts to laterally move the carriage 13 and thus the distributor 15 between a wind-on position for one of the take-up spools and a cross-over position for the other take-up spool. With reference to FIG. 1, the carriage and distributor are shown by solid lines for the windon position for the right-hand take-up spool while the carriage and distributor in their cross-over position for the left-hand take-up spool are shown by phantom lines.

For transferring the stock from the full take-up spool to the empty take-up spool for spooling thereon, means are provided for moving the stock into a cross-over position in which position it is acted upon by the gripping element associated with the empty take-up spool. This means includes a deflector for each take-up spool in the form of an upstanding finger 23. As shown, each finger is slidably mounted on a cantilever track 25. The track 25 extends alongside the adjacent take-up spool across the corridor defined by the various paths of distribution which the stock takes during spooling as a result of the reciprocal movement of the distributor 15 in a direction generally transverse to this corridor. The outer end of the track 25, which defines the extended position of the finger element 23, is located on one side of this corridor while the other end, which defines the retracted position of finger 23, is located on the opposite side of this corridor slightly behind and closely adjacent to the gripping element 7 on the flange element

of the adjacent spool receiving spindle. Each finger is connected by a rod to an air cylinder **23'** which is responsive to the electrical control circuit of the apparatus which in addition to switch S7 includes switches **S8, S10** and **S9, S11** positioned at opposite ends of the respective tracks **25.** The air cylinder provides the driving force for moving the finger on its supporting guide track **25.**

A cutting element **24** is fixedly mounted in a position out of the stock distribution paths corridors and between each finger **23** and the adjacent gripping element **7.** In such position each cutting element cooperates with its respective finger in severing the stock, if necessary, after the stock has been engaged by the gripping element.

Mounted upstream of the rollers **16** on frame **1** are a pair of upright guide rollers **26,** a support roll **27** and a pair of pinch rollers **28, 29** arranged vertically with respect to each other. Downstream of the rollers **28, 29** is a pulley **30,** around which the stock is guided before passing between the rollers **16.** The upper pinch roller **28** is spring loaded to urge the stock passing under it into contact with the lower pinch roller under a constant pressure. With this arrangement slippage between the stock and the lower pinch roller is avoided.

The lower pinch roller is operatively connected by means of an endless chain and sprocket arrangement to a signal generator indicated generally by reference numeral **31** in FIG. **1.** The signal generator is of the type which generates a signal indicative of the linear speed of the stock through the pinch rollers. In the preferred construction, the signal generator consists of a tachometer which emits a signal indicative of the speed of rotation of the lower pinch roller from which signal the linear speed, in feet per minute, of the stock can be calibrated. The signal emitted by the signal generator, which is herein referred to as the feedback voltage Vf, is fed to the electronic comparator circuit where it is used in conjunction with other signals to maintain the linear speed of the stock relatively constant during winding.

In operation of the apparatus, the flexible stock is fed from a storage roll (not shown), through the upstanding guide rollers **26,** over the support roller **27,** and then through the pinch rollers **28** and **29.** In applications where the electrical insulation of the stock is to be tested before winding on the spools, the stock is fed from the storage roll through an insulation testing device of conventional construction just prior to entering between guide rollers **26.** From pinch rollers **28, 29,** the stock is directed around the pulley **30** through the guide rollers **16** on he distributor **15** onto the spool on which it is to be wound. With the leading end of the stock anchored on the flange element of the right-hand spindle, by wedging it into the V-shaped groove **10,** the apparatus will wind the stock in uniform turns on this spool.

The power to the various drives is turned on whereby the right-hand spindle begins rotating and the carriage begins its reciprocal back and forth movement between the end flanges of the take-up spool. Under this movement, stock is spooled in layers of uniform convolutions about the core or barrel of the right-hand take-up spool. As layers of stock begin to build up on the take-up spool the linear speed of the stock will tend to increase. As mentioned above, this is undesirable in applications where the electrical integrity of the stock is being tested as it is fed to the spooling apparatus. In order to maintain the linear rate of feed substantially constant during winding, he drive motor for each spindle is, as mentioned previously, connected to the output terminals of the comparator circuit, which is shown diagrammatically in FIG. **4** by reference numeral **40.** As shown, the input terminals **41** of the comparator circuit are connected to the signal generator **31** which emits a feedback voltage V_f and to a control voltage source **50** which emits a reference voltage V_r. As mentioned previously, the signal emitted by the signal generator **31** is indicative of the linear speed of the stock at a point of passage through the pinch rollers **28, 29.**

When V_f equals V_r, the rotational speed of the spindle is at its proper value. When V_f becomes greater than V_r due to the build-up of stock on the take-up spool, the comparator circuit acts to restore the equilibrium condition where V_r equals V_f. The comparator circuit thus operates in this manner to automatically maintain the linear speed of stock substantially constant. Of course, it is to be recognized that both spindle drive motors are responsive to the output of the comparator circuit. Thus, the linear speed of stock is maintained substantially constant during winding on either spool.

When the first spool is nearly full, the finger **23** adjacent the left-hand take-up spool is moved from its retracted position to its extended position as shown by phantom lines in FIG. **2** where it is out of the stock distribution corridor. This movement of the finger occurs simultaneously with the starting of the empty (left-hand) spool. On leaving its retracted position, this finger releases switch S11 which initiates circuitry that insures both spools remain running in their proper mode during the cross-over sequence. On reaching its extended position, the finger trips switch S9 which initiates circuitry which starts motor M' thus activating threaded drive screw **20.** In response, the carriage **13** and distributor **15** begin movement to the extreme outside position (cross-over position) opposite the empty left-hand spool. This cross-over position, which is shown by phantom lines in FIG. **1,** is the position where the stock will be crossed over or transferred to the empty take-up spool. In such position it will be seen the path of distribution of the stock to the right-hand or full spool forms a tangent with the barrel or core **19** of the empty or left-hand spool.

As the carriage **13** passes the center of the machine, a position switch S5 is operated. This switch indicates that the carriage is moving to the opposite side of the machine and sets up circuitry, which although not immediately operable, insures proper future sequence of operations.

When the carriage arrives at its cross-over position, a safety switch S4 is tripped which stops the carriage until a manual or automatic signal is received indicating the cross-over operation is to be continued. Upon receipt of such a signal the switch S7 is converted to its second mode of operation. Thus the next time switch S7 is tripped the distributor **15** is brought to rest or stopped along the inner border of the distribution corridor. This inner border is defined by an imaginary line lying in the plane containing the rear spool flange **18***a* which abuts against the recessed surface **5***a* of flange element of the corresponding spindle. The stopped position of the distributor represents its cross-over posi-

tion and is shown by the solid lines in FIG. **2.** Simultaneously with stopping of distributor **15** the previously extended finger **23** is signalled to return to its retracted position where switch **S11** is reclosed signalling the full spool (right-hand spool) to stop.

As finger **23** is moved to its retracted position the stock is caused to be deflected into the position shown in FIG. **3** where it will be seen the stock is directed along a path running across the rear flange **18a** of the take-up spool, back across and closely adjacent to the beveled surface **9** of the flange **5,** around behind finger **23** adjacent the empty (left-hand) take-up spool and in front of the finger **23** adjacent the full (right-hand) take-up spool. As shown, the adjacent finger **23** advantageously acts to keep the stock out of the path of movement of the gripping element mounted on flange **5** associated with the full take-up spool so that the stock is not inadvertently resnagged to the full spool. During the short time period in which the stock is held in this position, the flange element associated with the empty spool moves through a partial revolution and the V-shaped stock receiving groove **10** on its outer rim engages the stock thereby causing it to become anchored and grounded (if the stock is electrical cable) to the spindle flange by a wedging action previously described. Upon continued angular displacement of the spindle flange the anchored stock is brought sharply to bear against the knife edge of the associated cutting element **24** thereby severing the stock. For light weight stock the cutting element **24** is not necessary since the continued rotation of the gripping element after the stock has been snagged will apply sufficient tension to the stock to result in breakage thereof at some point between the gripping element and the full spool.

Reclosing of switch **S11** also signals resumption of the normal reciprocal movement of the distributor **15** and movement of the carriage to its wind-on position with respect to the left-hand take-up spool where switch **S3** is tripped stopping carriage **13.** The wind-on position for the left-hand spool is slightly to the right of the left-hand take-up spool. When the second spool is nearly full, the operation will be repeated as above described in the opposite direction as determined by the position of center switch **S5** previously mentioned. When transferring the stock from the left-hand spool to the right-hand spool the switches **S1, S2, S8** and **S10** perform the same functions as switches **S3, S4, S9** and **S11,** respectively, previously mentioned. With the construction shown, filled take-up spools are manually removed from the corresponding spindle and an empty spool is manually replaced thereon for subsequent filling.

We claim:

1. In a machine for continuously spooling insulated electrical stock material having an electrically conductive core and an outer non-conductive insulation, said machine having a pair of rotatable spindles disposed in spaced apart, parallel relationship for mounting take-up spools, each of said spools having a flange at one end, a snagging means comprising a gripping element mounted on the flange of each spindle and defining with said flange a generally tapered stock-receiving groove operable to receive an anchor stock by a wedging action, a carriage mounted for movement laterally of the take-up spools between a wind-on position for one take-up spool and a cross-over position for the other take-up spool at which latter position the stock is transferred to the other take-up spool for spooling thereon, a distributor member mounted for reciprocal movement axially of the take-up spools between the inner and outer end flanges thereof to apply the stock in uniform layers of successive convolutions about the take-up spools, and spindle drive means for rotating each spindle to spool the stock from the distributor onto the corresponding take-up spool, the improvement which comprises:

a. a series of teeth defining one side of said stock-receiving groove, said teeth having sharp edges extending in the direction of the taper of said groove and transversely to the axis of the insulated electrical stock material wedged in said groove for slicing through the outer insulation on the stock material and into contact with the electrically coductive core as the stock material is wedged into said groove.

2. The improvement according to claim **1** wherein:

a. said teeth are disposed on the flange of the spool opposite the gripping element of said snagging means.

3. The improvement according to claim **2** wherein:

a. each of said teeth is generally V-shaped in cross-section with the sharp edge thereof defined by the apex of the V; and

b. each of said teeth is provided with a flat facing the sharp edge and spaced therefrom for engaging with and gripping one side of the outer insulation of the stock material as the latter is wedged into the stock-receiving groove and engaged and gripped on its opposite side by the gripping element of the snagger.

4. In a method for continuously spooling insulated electrical stock material onto take-up spools mounted on a pair of rotatable spindles disposed and spaced in parallel relationship to each other, said stock materially having an electrically conductive core and an outer non-conductive insulation and each spindle having snagger means mounted for movement therewith and defining therewith a generally tapered stock-receiving groove operable to receive and anchor the stock by a wedging action for transferring the stock to the corresponding take-up spool from the other spool without stopping the rotation of the corresponding spindle, said method including the steps of directing the stock along a wind-on distributing path for one of said take-up spools for spooling thereon, moving the stock reciprocally in an axial direction with respect to said one take-up spool in order to apply the stock uniformly in layers of successive convolutions onto said one take-up spool, directing the stock along a cross-over path for the other of said take-up spools as the one take-up spool becomes full, and snagging the stock onto the other take-up spool at a predetermined point along its length as it is completing its winding on the one take-up spool for transferring the stock to the other take-up spool for spooling thereon when said one take-up spool is full, the improvement which comprises the step of:

a. piercing the insulation of the stock material at said point along its length where it is snagged and simultaneously with the snagging thereof, said piercing being effected by means carried by said spindle to place said means in electrical contact with the conductive core of said stock material.

5. The improvement according to claim **1** wherein:

a. said piercing is effected by the step of slicing through the insulation on the stock material, said slicing being in a direction generally transverse to the longitudinal axis of said stock material and parallel to the direction of movement of the stock material into said stock receiving groove.

* * * * *