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THREAD WINDING APPARATUS

Filed Jan. 2, 1952

2 Sheets-Sheet 1

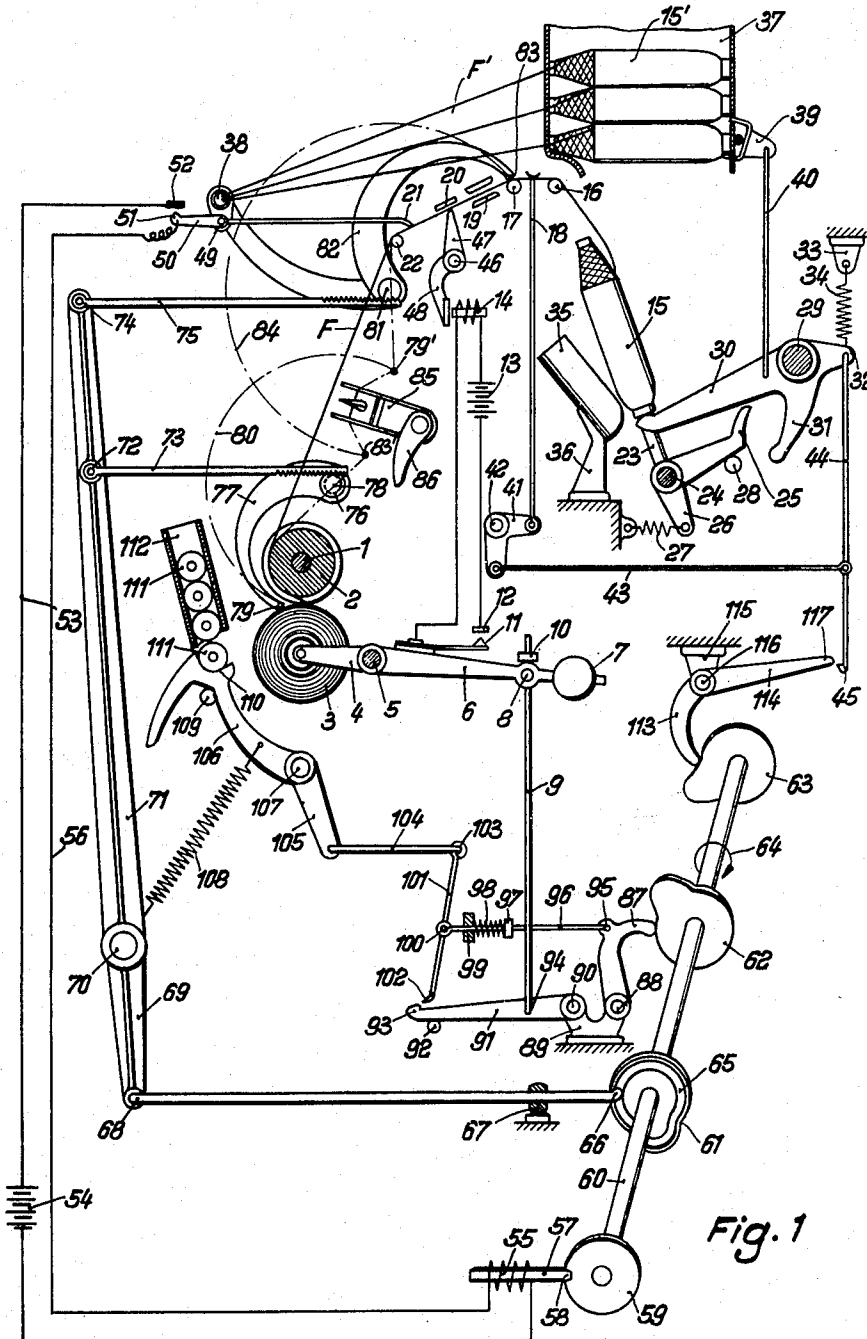


Fig. 1

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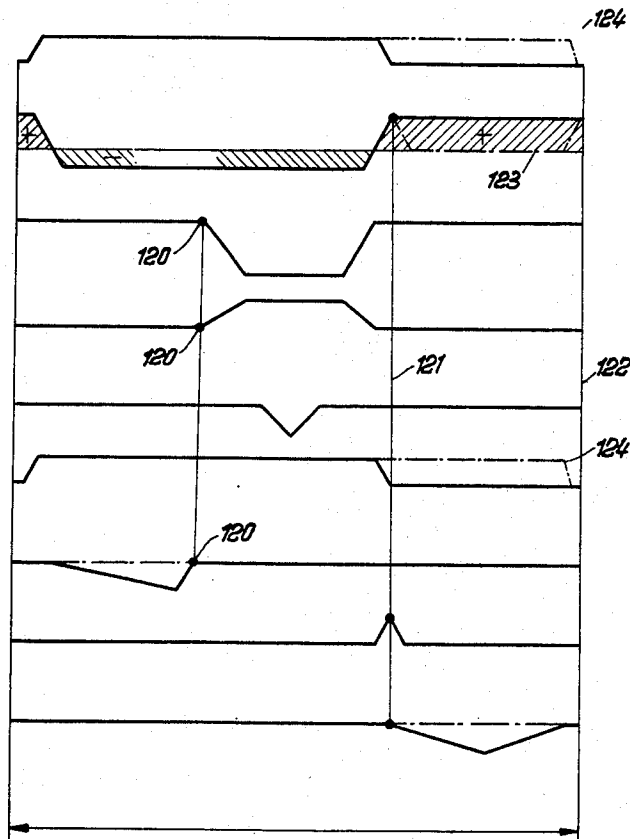


Fig. 2

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THREAD WINDING APPARATUS

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Claims priority, application Germany January 9, 1951

12 Claims. (Cl. 242—35.6)

The present invention relates to a thread winding apparatus.

Such an apparatus is used in the textile industry and normally includes various devices which are adapted, for example, to change an exhausted supply spool, change a full take-up spool, and tie a knot in a broken thread.

More particularly, the present invention relates to control arrangement for controlling automatic devices of the above type.

One of the objects of the present invention is to prevent all conflict in the automatic operation of the above-mentioned various devices of a thread winding apparatus.

Another object of the present invention is to operate one or more of these devices during a predetermined cycle.

Yet another object of the present invention is to provide an apparatus of the above type wherein the devices, such as automatic take-up and supply spool changing devices and an automatic knot tying device, are all completely independent of each other.

An additional object of the present invention is to provide a means for operating these devices in a desired predetermined sequence.

The objects of the present invention also include the provision of a structure capable of accomplishing all of the above objects while at the same time being made of simple, easily obtainable, inexpensive parts which cooperate together in an efficient and reliable manner to produce the desired results.

With the above objects in view, the present invention mainly consists of a thread winding apparatus having a plurality of independent, automatic devices for carrying out different parts of the thread winding operation. A control means is associated with these devices for respectively operating the same in a predetermined sequence during different portions of one of the control means. All but one of the devices are each joined to a releasable connecting means for connecting and disconnecting the same to and from the control means so that the latter may operate only the said one of the devices during the said cycle. This control means preferably takes the form of a cam shaft having a number of cams thereon respectively associated with the different devices, and these cams are in a non-overlapping phase relation with each other so that the various devices are all operated during different portions of a revolution of the cam shaft. All of the various devices each include a lever, such as a feeler lever, for controlling the operation thereof so as to render all these devices independent of each other.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

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Fig. 1 shows a schematic view of one possible apparatus for carrying out the present invention; and

Fig. 2 is a graph illustrating the sequence of operation of various parts of the apparatus of Fig. 1.

Referring now to Fig. 1, there is shown therein the shaft 1 upon which the guide roller 2 is mounted for rotation, this guide roller 2 being turned in opposite directions by any suitable drive means (not shown) during different parts of the operation of the structure of Fig. 1. The thread F passes over the guide roller 2 and is wound on a take-up spool 3, the latter being rotated by frictional contact with the guide roller 2. The take-up spool 3 is mounted on a take-up spool support 4, part of which is in the form of a lever 6 mounted for pivotal movement on and about the stationary pivot pin 5 of the apparatus. A weight 7 is fixedly mounted adjacent the outer free end of lever 6 to urge the take-up spool 3 against the roller 2 to be driven thereby. The lever 6 also carries a pivot pin 8 which is mounted for rotation thereon, this pivot pin 8 being bored so as to slidably receive the rod 9 in the bore thereof, this rod 9 being provided with a stop member 10 to engage the lever 6. Also mounted on the lever 6 is a movable electric contact 11, adapted to move with the lever 6, this movable contact being located opposite a stationary contact 12 to contact the same when the diameter of spool 3 reaches a predetermined magnitude. The contacts 11 and 12 are located in a circuit which is supplied with current by the battery 13 and which includes electromagnetic windings located about the core 14.

The thread F is supplied to the take-up spool 3 from a supply spool 15, the thread being drawn from the latter by rotation of the take-up spool 3. The thread issuing from supply spool 15 is guided over thread guide members 16 and 17, between which a feeler lever 18 is located. From the guide 17, the thread F passes between a thread tensioning device 19 and a thread cleaner 20. After passing from the thread cleaner 20, the thread is contacted by a feeler lever 21 and is then guided over the thread guide 22 to the guide roller 2.

The support structure for the supply spool 15 comprises a supporting pin 23 upon which the supply spool 15 is located. This pin 23 is fixedly connected to a bell crank lever 25, 26 which is pivotally mounted on the stationary pin 24 of the apparatus. The lever 25, 26 is connected to a spring 27 so as to be urged by the latter in a clockwise direction about the pin 24, as viewed in Fig. 1. The portion 25 of lever 25, 26 is thereby urged against the stationary stop 28 of the machine. On a stationary shaft 29 of the machine there is pivotally mounted the lever 30, 31, 32. Portion 32 of this latter lever is operatively connected to the spring 34 which is connected to the stationary bracket 33 so as to urge lever portion 32 upwardly, as viewed in Fig. 1. Adjacent to the supply spool 15, there is located a trough 35 which is fixedly mounted on the stationary support member 36. A supply chute 37, holding supply spools 15' therein, is located over the trough 35, the supply spools 15' being arranged in chute 37 in a position where they are adapted to successively fall onto the chute 35. The threads F', extending from each of the supply spools 15', extend into a suction tube 38 so as to be thereby held in the position illustrated in Fig. 1. A tiltable release member 39 is mounted on the chute 37 to release only the lowermost spool 15' when the release member 39 is turned in a counterclockwise direction, as viewed in Fig. 1. This member 39 is linked to the upper end of a rod 40 which is linked at its lower end to the lever portion 30 of lever 30, 31, 32, to be actuated thereby.

The feeler lever 18 is pivotally connected at its lower end to the bell crank lever 41 which is mounted for pivotal movement on the stationary pin 42. A rod 43 inter-

connects the bell crank lever 41 with a rod 44, this rod 43 being pivotally connected to the latter two members. The rod 44 is pivotally suspended from the lever portion 32 of lever 30, 31, 32 and is somewhat hook-shaped at its lower end 45.

The thread cleaner 20 cooperates with the lever 47, 48 which is mounted for turning movement on the stationary pivot pin 46 of the apparatus, the portion 47 of this latter lever forming a part of the cleaning device 20. The portion 48 of lever 47, 48 is made of a magnetic material so as to be attracted to the core 14 when the electrical circuit 11, 12, 13 is energized. The feeler lever 21 is mounted for turning movement on a stationary pivot pin 49 of the apparatus and carries on its left end portion 50, as viewed in Fig. 1, a movable contact 51 movable with lever portion 50 and located opposite the stationary contact 52 located in line 53 in which the battery 54 also is located. The line 56 extends from contact 51 to the coil 55 which is connected to the battery 54 so that current flows through coil 55 when contacts 51 and 52 engage each other. A pawl 57 in the form of a solenoid core passes through the coil 55 so as to be moved to the left, as viewed in Fig. 1, when the latter is energized, a spring (not shown) being connected to the pawl 57 to urge the same toward the disc 59. This disc 59 is formed with a notch 58 which is engaged by the right hand end of pawl 57, as viewed in Fig. 1, so that rotation of disc 59 is prevented until coil 55 is energized, after which the disc 59 may turn through one revolution until the pawl 57 again automatically engages the notch 58 under the action of the above-mentioned spring. This disc 59 is fixedly mounted on the cam shaft 60, which is operatively connected to any suitable drive means (not shown) to be rotated thereby in the direction of arrow 64 when disc 59 is released by pawl 57 upon energizing of coil 55. The cam shaft 60 has fixedly mounted thereon the cams 61, 62 and 63.

The cam 61 is formed with a groove 65 in which the bent end of rod 66 is located, this rod 66 extending slidably through the stationary bearing 67 so as to be reciprocated upon turning of cam 61. This rod 66 is pivotally connected at 68 to the lever 69 which is mounted for turning movement on the stationary shaft 70 of the apparatus. At 72 there is pivotally connected to portion 71 of lever 69 a rack 73, and at 74 there is pivotally connected to lever portion 71 a rack 75. The rack 73 has the teeth thereof in engagement with the pinion 76 fixedly connected to the suction tube 77 which is mounted in the apparatus for turning movement about point 78. The open end 79 of suction tube 77, upon movement of rack 73, moves along the dot-dash line 80 to the point 79'. The rack 75, which is maintained in the illustrated position by any suitable support means (not shown) such as a spring, has the teeth thereof in engagement with the pinion 81 fixedly connected to the suction tube 82 which is mounted for turning movement about the axis of pinion 81 so that the open end 83 of suction tube 82 moves along the dot-dash line 84 to the point 83' upon movement of rack 75. A knot tying device 85 is located in the apparatus between the tubes 77 and 82 and includes the turnable lever 86 which is adapted to be moved by the right-hand end of rack 73, as viewed in Fig. 1, to set the knot tying mechanism 85 into operation.

The cam 62 is located against lever 87 to operate the same, this lever 87 being mounted for turning movement on the stationary pin 88 which is located on the support 89. Also located on this support 89 is a stationary pivot pin 90 which pivotally supports a lever 91 which rests on the stationary stop 92 of the apparatus. The lever 91 is provided with a somewhat hook-shaped end 93 and is pivotally connected at 94 to the lower end of rod 9. The lever 87 is linked at 95 to the rod 96 which carries a fixed collar 97 and a coil spring 98 bearing against this collar. The spring 98 also bears against a fixed guide 99 of the apparatus, the rod 96 extending through guide 99 to be

guided thereby, and the spring 98 in this way urges lever 87 against cam 62. The lever 96 is pivotally connected at 100 to the rod 101 which at its lower end carries a projection 102 adapted to cooperate with end 93 of lever 91 and at its upper end is linked at 103 to the rod 104 which is pivotally connected to lever portion 105 of lever 105, 106. The lever portion 106 is in the form of a transporting device and is pivotally mounted together with lever portion 105 on the stationary pin 107 of the apparatus. A spring 108 is connected to lever portion 106 to urge the same into the illustrated position of rest against the stationary stop 109 of the machine. The upper end of lever portion 106 is formed with a cut out 110 to receive a spool sleeve 111 from the supply chute 112.

The cam 63 operates on the double arm lever 113, 114 which is mounted for turning movement on the stationary pin 116 that is fixedly connected to the stationary support 115. Lever portion 113 is heavier than lever portion 114 so as to remain in engagement with cam 63, and the right-hand end 117 of lever portion 114 is bent to cooperate with the somewhat hook-shaped end 45 of rod 44.

It will be noted that all of the cams 61, 62 and 63 are shaped so that most of the operating parts thereof are located in a circle about the axis of shaft 60, and these parts of the cams therefore will have no effect on the parts operatively connected thereto. Each of the cams is formed with a projecting portion extending from only a small part thereof, and this projecting portion produces the desired operation of the parts during a small part of the revolution of each cam. It will further be noted that the projecting portions of the cams are all located in a non-overlapping phase relationship with each other so that each cam will operate the part connected thereto during a part of a revolution of cam shaft 60 when the other cams are not actuating the parts connected thereto.

The above described apparatus operates in the following manner:

When the thread moving toward the guide roller 2 breaks, the feeler lever 21, which is held in the illustrated position by the thread, turns about point 49 to close the contacts 51 and 52 and thereby energize coil 55. The pawl 57 is thereby withdrawn from notch 58, and the above-mentioned drive means (not shown) then turns the shaft 60 through one revolution in the direction of arrow 64.

During the first part of this revolution the cam 63 actuates the double lever 113, 114 to turn the same in a clockwise direction about the pin 116, as viewed in Fig. 1. However, as long as end 45 of lever 44 is located in the illustrated position beyond the range of end 117 of lever portion 114, the actuation of lever 113, 114 will have no effect on the apparatus. During a further part of the revolution of shaft 60, after the projection of cam 63 has moved beyond lever portion 113, the projection of cam 65 actuates the rod 66 and moves the same to the left, as viewed in Fig. 1, through the guide 67. This results in a turning of the lever 69, 71 in a clockwise direction, as viewed in Fig. 1, about the shaft 70. This turning of lever portion 71 results in a movement of racks 73 and 75 to the right, as viewed in Fig. 1, but before this movement of the racks the rotation of guide roller 2 has been reversed by a known apparatus connected thereto and not illustrated in the drawings, so that this roller 2 now turns in a clockwise direction, as viewed in Fig. 1. The suction tube 77 holds, at its mouth 79, the end of the broken thread attached to the take-up spool 3 and moves this end of the broken thread to the point 79'. The mouth 83 of suction tubes 82 pulls on the other broken end of the thread and moves the same to the point 83', the tubes 77 and 82 being turned simultaneously by the racks 73 and 75, respectively, and being located in different planes so that the movement of one of the suction tubes does not in any way conflict with the movement of the other of the suction tubes. The suction tube 82 pulls thread from the supply spool 15. When the ends of the

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broken thread are located at points 79' and 83', the separate thread portions extend across the knot tying device 85 to be tied thereby in a known manner, this knot tying device 85 being actuated by movement of lever 86 which is moved by the right-hand end of rack 73.

The above-described operation is based on the assumption that there is thread still remaining on the supply spool 15. If, when the feeler lever 21 moves as described above in the case of a thread break, there is a downward movement of feeler lever 18. This indicates that the supply spool 15 is exhausted and that there is no thread between the supply spool 15 and thread tensioner 19. In this case, the downward movement of feeler 18 causes the bell crank lever 41 to turn about pivot 42 in a clockwise direction, as viewed in Fig. 1, and this causes the rod 44 to swing to the left, as viewed in Fig. 1, so that the end 45 thereof is located beneath the end 117 of lever portion 114. Therefore, when the lever 113, 114 is actuated by cam 63, as described above, the clockwise turning of lever portion 114 produces a downward movement of rod 44 and a clockwise turning of lever 30, 31, 32 about pivot 29. The clockwise turning of lever portion 30 causes the empty spool sleeve of supply spool 15 to be moved off from the support pin 23. The further turning of lever 30, 31, 32 causes the lever portion 31 to engage lever portion 23 and turn the same in a counterclockwise direction about pivot 24 against the action of spring 27. At the same time the rod 40 moves upwardly to turn the release member 39 in a counterclockwise direction, as viewed in Fig. 1, so that a fresh supply spool 15' falls out of chute 37. This supply spool 15' falls onto the trough 35 and is guided thereby to slide onto the pin 23 which has been turned by the turning of lever 25, 26 to a position to receive the new supply spool 15' which falls onto the chute 35. The further turning of cam 63 permits the springs 27 and 34 to return the supply spool changing mechanism to its position to rest illustrated in Fig. 1, so that a new supply spool is located in an operative position in the apparatus and the thread F' thereof is now located in the region where it comes under the influence of the mouth 83 of the suction tube 82. The movement of thread F' by the suction force of tube mouth 83 causes the same to move beneath the upper end of feeler lever 18 which has been returned to the illustrated position by spring 34; any suitable guide means (not shown) being provided to guide the upward and downward movement of feeler lever 18. In the above described manner the changing of the supply spool takes place only when the lever 18 moves downwardly due to a lack of thread issuing from the supply spool. The duration of time required for the changing of the supply spool is controlled by the cam 63 which enables the entire supply spool operation to take place before the projecting portion of cam 61 actuates the rod 66.

During the winding of thread onto the take-up spool 3, the lever 6 is turned in a counterclockwise direction about pivot 5 so as to raise the rod 9 and the lever 91 therewith. When the diameter of take-up spool 3 has reached a predetermined magnitude, the end 93 of lever 91 will be located across the path of movement of end 102 of rod 101. Therefore, when the cam 62 is turned with the lever 91 in the latter position where end 93 thereof extends across the end 102 of lever 101, the end 93 of lever 91 will engage end 102 of lever 101 and cause the latter to turn in a counterclockwise direction, as viewed in Fig. 1, about its end 102. In this way the cam 62 will actuate the lever 105, 106 to move a fresh take-up spool sleeve 111 to the take-up spool support 4, the extension at the upper end of lever portion 106 preventing successive sleeves 111 in supply chute 112 from falling out of the same. A known means (not shown) is provided in the machine to release the full take-up spool 3 from the support 4, to mount the new sleeve 111 on the latter, and to join the thread to the empty sleeve 111 on support 4 so as to be wound on this sleeve 111.

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The above described take-up spool changing mechanism is adapted to be independently actuated through the medium of movable contact 11 on lever 6. When the take-up spool is full, the contact 11 will have moved into engagement with the contact 12 to energize the core 14 which thereby attracts the lever portion 43 so as to turn the lever portion 47 of thread cleaner 20 in a counterclockwise direction, as viewed in Fig. 1. This movement of lever portion 47 causes the thread F to be torn by the thread cleaner so as to actuate the apparatus in the above-described manner.

The above-described structure of Fig. 1 is only illustrative of one type of apparatus to which the invention may be applied. The invention is generally applicable to all types of machines which include several devices for automatically carrying out parts of the thread winding operation. For example, the above apparatus obviously is equally applicable to a machine where the supply spool is changed before it is completely empty and where a feeler means is provided to initiate the changing of the supply spool when a predetermined amount of thread remains thereon.

The operation of the above-described structure of Fig. 1 is graphically illustrated in Fig. 2 where the horizontal distance between the extreme left-hand ordinate and ordinate 122 corresponds to one revolution of the cam shaft 60. The changing of the supply spool takes place only between the left-hand ordinate and the ordinate 120. The knot tying operation takes place only between ordinates 120 and 121, and the take-up spool changing operation takes place only between ordinates 121 and 122. The topmost line extending across the graph of Fig. 2 indicates the operation of feeler lever 21 which moves out of its position of rest during the changing of the empty spool and knot tying operation and back into its position of rest during the third part of the revolution of cam shaft 60 in the event that a supply spool is not changed during this third part of the revolution. The dot-dash portion of the movement of feeler lever 21 indicates its position when a supply spool is being changed, the feeler lever 21 swinging back into its operative position at point 124 of this dot-dash portion.

The second line from the top, in the graph of Fig. 2, indicates the direction of rotation of the guiding roller 2, the plus areas indicating counterclockwise turning of roller 2, as viewed in Fig. 1, and the minus area indicating clockwise turning of roller 2, as viewed in Fig. 1. It will be seen that during the changing of the supply spool, the roller 2 starts turning in a clockwise direction and continues to turn in a clockwise direction until the knot tying operation is almost complete when it again turns in a counterclockwise direction unless a take-up spool is being changed. If the latter operation takes place, the roller 2 remains stationary during most of this operation, as shown by the dot-dash line 123 of Fig. 2.

The next three lines below the roller 2 line of the graph of Fig. 2 respectively indicate the movement of the suction tube 77, the suction tube 82, and the knot tying mechanism 85. As is clearly shown in Fig. 2, these parts of the apparatus operate only during the intermediate knot tying portion of the rotation of cam shaft 60, the tubes 77 and 82 operating both before and after the operation of knot tying mechanism 85.

The next line down indicates the operation of the feeler lever 18 which, as shown, is located out of its position of rest during the changing of a supply spool and during the knot tying operation, this feeler lever 18 being again located in its position of rest during the third part of the revolution of cam shaft 60 in the event that a take-up spool is not being changed. If a take-up spool is being changed, the feeler lever 18 remains out of its position of rest, as shown by the dot-dash line, and returns to its position of rest at point 124.

The next line down on the graph illustrates the movement of lever portion 30 which, as shown, moves only

during the first part of the revolution of cam shaft 60, in the event that a supply spool is changed. If a supply spool is not changed the lever portion 30 remains stationary during this first part of the revolution of cam shaft 60, as shown by the dot-dash line, and the same is true of lever 18.

The next-to-last line from the bottom of the graph of Fig. 2 illustrates the operation of the parts 93-102 which are operated by the increasing diameter of the take-up spool.

The bottom line of the graph of Fig. 2 illustrates the operation of lever 106, of the take-up spool changing mechanism, which, as shown, moves only during the last third of a revolution of the cam shaft 60.

It will be noted that with the above described structure, each of the independent mechanisms of the apparatus necessarily operates at separate times so that no special structure is required to prevent conflicting movements of the parts of the apparatus. Such structure would be required if two or more of the mechanisms could operate simultaneously.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of thread winding apparatus differing from the types described above.

While the invention has been illustrated and described as embodied in a thread winding apparatus having a means for operating various parts thereof in a predetermined sequence, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. Thread winding apparatus having a supply spool and take-up spool and comprising in combination, an automatic supply spool changing device, an automatic take-up spool changing device, and an automatic knot tying device, said devices being independent of each other; control means engaging said devices for respectively operating the same in a predetermined sequence during different portions of one cycle of said control means; and a plurality of automatic, releasable connecting means respectively joined to all but one of said devices for connecting and disconnecting the same from said control means so that the latter may operate only said one of said devices during said cycle.

2. Thread winding apparatus having a supply spool and take-up spool and comprising in combination, an automatic supply spool changing device, an automatic take-up spool changing device, and an automatic knot tying device, said devices being independent of each other; control means engaging said devices for respectively operating the same in a predetermined sequence during different portions of one cycle of said control means; and a pair of automatic, releasable connecting means respectively joined to said supply and take-up spool changing devices for connecting and disconnecting the same from said control means so that the latter may operate only said knot tying device during said cycle.

3. In a thread winding apparatus, in combination, a plurality of independent, automatic, independently operable devices for carrying out different parts of the thread winding operation; a cam shaft having a plurality of cams thereon respectively engaging said devices for permanently operating one of said devices and for

operating the other devices in a predetermined sequence with said one device when at least one of said other devices operates during one revolution of said cam shaft, said cams all being out of phase with each other to respectively operate said devices during different portions of said cycle; and a plurality of automatic releasable connecting means respectively joined to said other devices for connecting and disconnecting the same from said cams whenever required so that said cams may operate only said one of said devices during said revolution.

4. Thread winding apparatus having a supply spool and take-up spool and comprising, in combination, an automatic supply spool changing device, an automatic take-up spool changing device, and an automatic knot tying device, said devices being independent of each other; a cam shaft carrying three cams which are in a non-overlapping phase relation with each other and which are respectively in engagement with said devices for respectively operating the same in a predetermined sequence during different portions of one revolution of said cam shaft; and a pair of automatic, releasable connecting means respectively joined to said supply and take-up spool changing devices for connecting and disconnecting the same from the two cams in engagement therewith so that only said knot tying device will be operated during said revolution.

5. Thread winding apparatus having a supply spool and take-up spool and comprising in combination, an automatic supply spool changing device, an automatic take-up spool changing device, and an automatic knot tying device, said devices being independent of each other and each comprising a feeler means to independently set each of said devices into operation; a cam shaft carrying three cams which are in a non-overlapping phase relation with each other and which are respectively in engagement with said devices for respectively operating the same in a predetermined sequence during different portions of one revolution of said cam shaft; and a pair of automatic, releasable connecting means respectively joined to said supply and take-up spool changing devices for connecting and disconnecting the same from the two cams in engagement therewith so that only said knot tying device will be operated during said revolution.

6. Thread winding apparatus having a supply spool and take-up spool and comprising in combination, an automatic supply spool changing device, an automatic take-up spool changing device, and an automatic knot tying device, said devices being independent of each other; a cam shaft carrying three cams which are in a non-overlapping phase relation with each other and which are respectively in engagement with said devices for respectively operating the same in a predetermined sequence during different portions of one revolution of said cam shaft; and a pair of automatic, releasable connecting means respectively joined to said supply and take-up spool changing devices for connecting and disconnecting the same from the two cams in engagement therewith so that only said knot tying device will be operated during said revolution, the cam in engagement with said take-up spool changing device having a projection which operates the latter toward the end of said revolution so that said supply spool changing and knot tying devices are operated before said take-up spool changing device.

7. Thread winding apparatus having a supply spool and take-up spool and comprising in combination, an automatic supply spool changing device, an automatic take-up spool changing device, and an automatic knot tying device, said devices being independent of each other; a cam shaft carrying three cams which are in a non-overlapping phase relation with each other and which are respectively in engagement with said devices for respectively operating the same in a predetermined

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sequence during different portions of one revolution of said cam shaft; and a pair of automatic, releasable connecting means respectively joined to said supply and take-up spool changing devices for connecting and disconnecting the same from the two cams in engagement therewith so that only said knot tying device will be operated during said revolution, the cam in engagement with said take-up spool changing device having a projection which operates the latter toward the end of said revolution so that said supply spool changing and knot tying devices are operated before said take-up spool changing device and the cam in engagement with said supply spool changing device being located on said cam shaft to operate during the first part of said revolution so that said knot tying device is operated after said supply spool changing device and before said take-up spool changing device.

8. Thread winding apparatus, comprising in combination, a supply spool support; a take-up spool support spaced from said supply spool support; guide means located between said supply and take-up spool supports for guiding thread from a supply spool to a take-up spool to be wound thereon; a feeler lever pivotally mounted on the apparatus and having an end portion movable transversely through the space between said supports so as to contact the thread moving between the spools; a movable electrical contact mounted on said feeler lever for movement therewith during an interruption in the thread between the spools; an electrical circuit including a stationary contact located opposite said movable contact to be contacted thereby upon movement of said feeler lever so as to close said electrical circuit at said interruption; a knot tying mechanism located on the apparatus between said supports; a cam shaft having a first cam thereon operatively connected to said knot tying mechanism to operate the same upon rotation of said cam shaft; pawl means operatively connected to said cam shaft to prevent operation thereof and being located in said electrical circuit to be moved upon closing of the latter into an inoperative position to permit rotation of said cam shaft; a supply spool changing mechanism mounted on the apparatus adjacent to said supply spool support; a second cam mounted on said cam shaft and being in engagement with said supply spool changing mechanism to operate the latter upon rotation of said cam shaft; a take-up spool changing mechanism located adjacent to said take-up spool support; a third cam mounted on said cam shaft and being in engagement with said take-up spool changing mechanism to operate the latter upon rotation of said cam shaft; first connecting means joined to said supply spool changing mechanism for operatively connecting the same to said second cam only when a supply spool is exhausted; and second connecting means joined to said take-up spool changing mechanism to connect the same to said third cam only when a take-up spool is full, said first, second and third cams being in a non-overlapping phase relation with each other so that said mechanisms are independently operated during different portions of a revolution of said cam shaft.

9. Thread winding apparatus, comprising in combination, a supply spool support; a take-up spool support spaced from said supply spool support; guide means located between said supply and take-up spool supports for guiding thread from a supply spool to a take-up spool to be wound thereon; a first feeler lever pivotally mounted on the apparatus and having an end portion movable transversely through the space between said supports so as to contact the thread moving between the spools; a movable electrical contact mounted on said first feeler lever for movement therewith during an interruption in the thread between the spools; an electrical circuit including a stationary contact located opposite said movable contact to be contacted thereby upon movement of said first feeler lever so as to close said electrical circuit at

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said interruption; a knot tying mechanism located on the apparatus between said supports; a cam shaft having a first cam thereon operatively connected to said knot tying mechanism to operate the same upon rotation of said cam shaft; pawl means operatively connected to said cam shaft to prevent operation thereof and being located in said electrical circuit to be moved upon closing of the latter into an inoperative position to permit rotation of said cam shaft; a supply spool changing mechanism mounted on the apparatus adjacent to said supply spool support; a second cam mounted on said cam shaft and being in engagement with said supply spool changing mechanism to operate the latter upon rotation of said cam shaft; a take-up spool changing mechanism located adjacent to said take-up spool support; a third cam mounted on said cam shaft and being in engagement with said take-up spool changing mechanism to operate the latter upon rotation of said cam shaft; first connecting means joined to said supply spool changing mechanism for operatively connecting the same to said second cam only when a supply spool is exhausted, said first connecting means comprising a second feeler lever adapted to contact thread between said supports so as to be moved when thread no longer issues from a supply spool to place said first connecting means in the connecting position thereof; and second connecting means joined to said take-up spool changing mechanism to connect the same to said third cam only when a take-up spool is full, said first, second and third cams being in a non-overlapping phase relation with each other so that said mechanisms are independently operated during different portions of a revolution of said cam shaft, said second connecting means comprising a third lever forming part of said take-up spool support and being pivotally mounted on the apparatus for turning movement during winding of thread on a take-up spool, said third lever, upon reaching a predetermined position, placing said second connecting mechanism in the connecting position thereof.

10. Thread winding apparatus, comprising in combination, a supply spool support; a take-up spool support spaced from said supply spool support; guide means located between said supply and take-up spool supports for guiding thread from a supply spool to a take-up spool to be wound thereon; a first feeler lever pivotally mounted on the apparatus and having an end portion movable transversely through the space between said supports so as to contact the thread moving between the spools; a movable electrical contact mounted on said first feeler lever for movement therewith during an interruption in the thread between the spools; an electrical circuit including a stationary contact located opposite said movable contact to be contacted thereby upon movement of said first feeler lever so as to close said electrical circuit at said interruption; a knot tying mechanism located on the apparatus between said supports; a cam shaft having a first cam thereon operatively connected to said knot tying mechanism to operate the same upon rotation of said cam shaft; pawl means operatively connected to said cam shaft to prevent operation thereof and being located in said electrical circuit to be moved upon closing of the latter into an inoperative position to permit rotation of said cam shaft; a supply spool changing mechanism mounted on the apparatus adjacent to said supply spool support; a second cam mounted on said cam shaft and being in engagement with said supply spool changing mechanism to operate the latter upon rotation of said cam shaft; a take-up spool changing mechanism located adjacent to said take-up spool support; a third cam mounted on said cam shaft and being in engagement with said take-up spool changing mechanism to operate the latter upon rotation of said cam shaft; first connecting means joined to said supply spool changing mechanism for operatively connecting the same to said second cam only when a supply spool is exhausted, said first connecting means comprising a second feeler lever adapted to con-

tact thread between said supports so as to be moved when thread no longer issues from a supply spool to place said first connecting means in the connecting position thereof; second connecting means joined to said take-up spool changing mechanism to connect the same to said third cam only when a take-up spool is full, said first, second and third cams being in a non-overlapping phase relation with each other so that said mechanisms are independently operated during different portions of a revolution of said cam shaft, said second connecting means comprising a third lever forming part of said take-up spool support and being pivotally mounted on the apparatus for turning movement during winding of thread on a take-up spool, said third lever, upon reaching a predetermined position, placing said second connecting mechanism in the connecting position thereof; and thread breaking means operatively connected to said third lever to be operated thereby when said third lever reaches said predetermined position, whereby the break in the thread by said thread breaking means initiates the rotation of said cam shaft to bring about the replacement of a full take-up spool.

11. In a thread winding apparatus having a supply spool and a take-up spool, in combination, an automatic supply spool changing device, and automatic take-up spool changing device, and an automatic knot tying device, said devices being independent of each other and independently operable during subsequent cycles of operation; and control means engaging said devices for operating during each of said cycles of operation only of said

knot tying device or operating said knot tying device and at least one of the other of said devices in a predetermined sequence during different portions of one cycle of operation.

12. Thread winding apparatus having a supply spool and a take-up spool and comprising, in combination, an automatic supply spool changing device, an automatic take-up spool changing device, and an automatic knot tying device, said devices being independent of each other; and control means engaging said devices for respectively operating the same in a predetermined sequence during different portions of one cycle of said control means, said control means including a shaft which turns through one revolution during said cycle and said different portions of said cycle each taking place during a third of a revolution of said shaft, so that one of said devices is operated during one third of a revolution of said shaft, another of said devices is operated during a second third of said revolution of said shaft, and the third of said devices is operated during the remaining third of said revolution of said shaft.

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