July 25, 1967 R. DOBNER ETAL 3,332,381

AUTOMATIC UNDERTHREAD WINDING APPARATUS FOR LOCKSTITCH SEWING MACHINES

Filed July 27, 1965 4 Sheets-Sheet 1

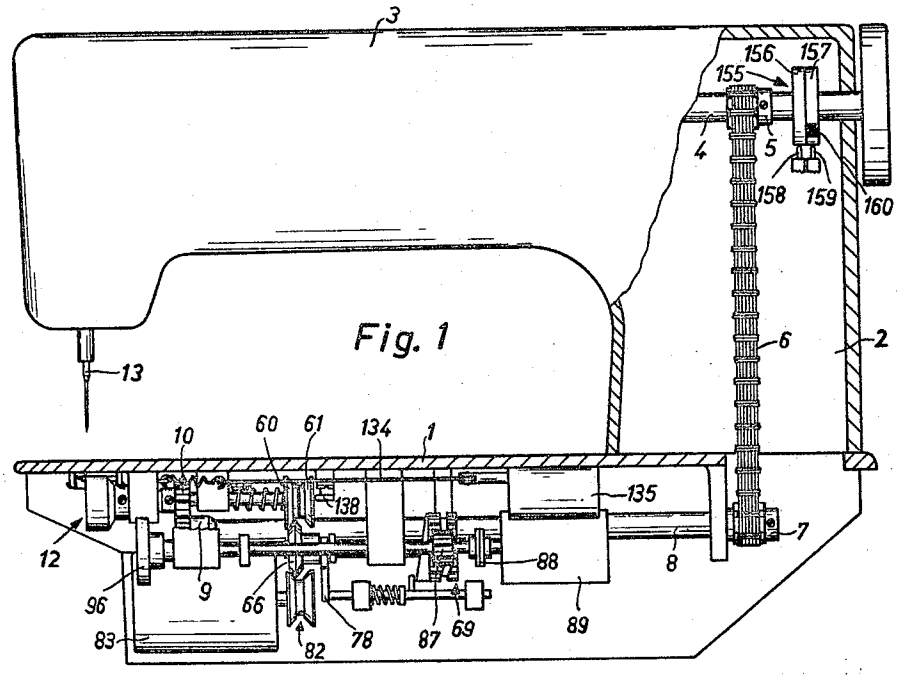
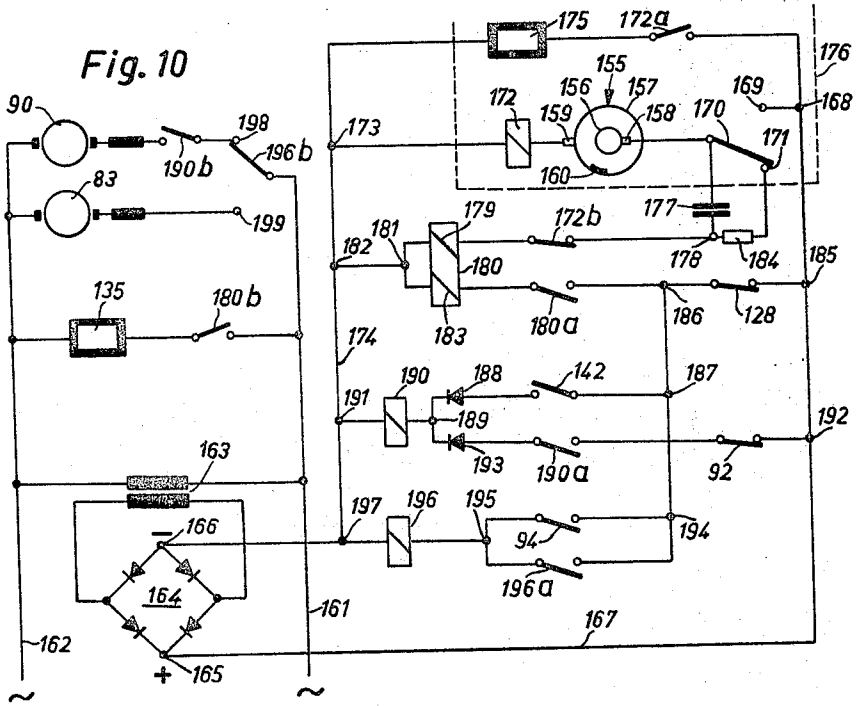


Fig. 1

Fig. 10



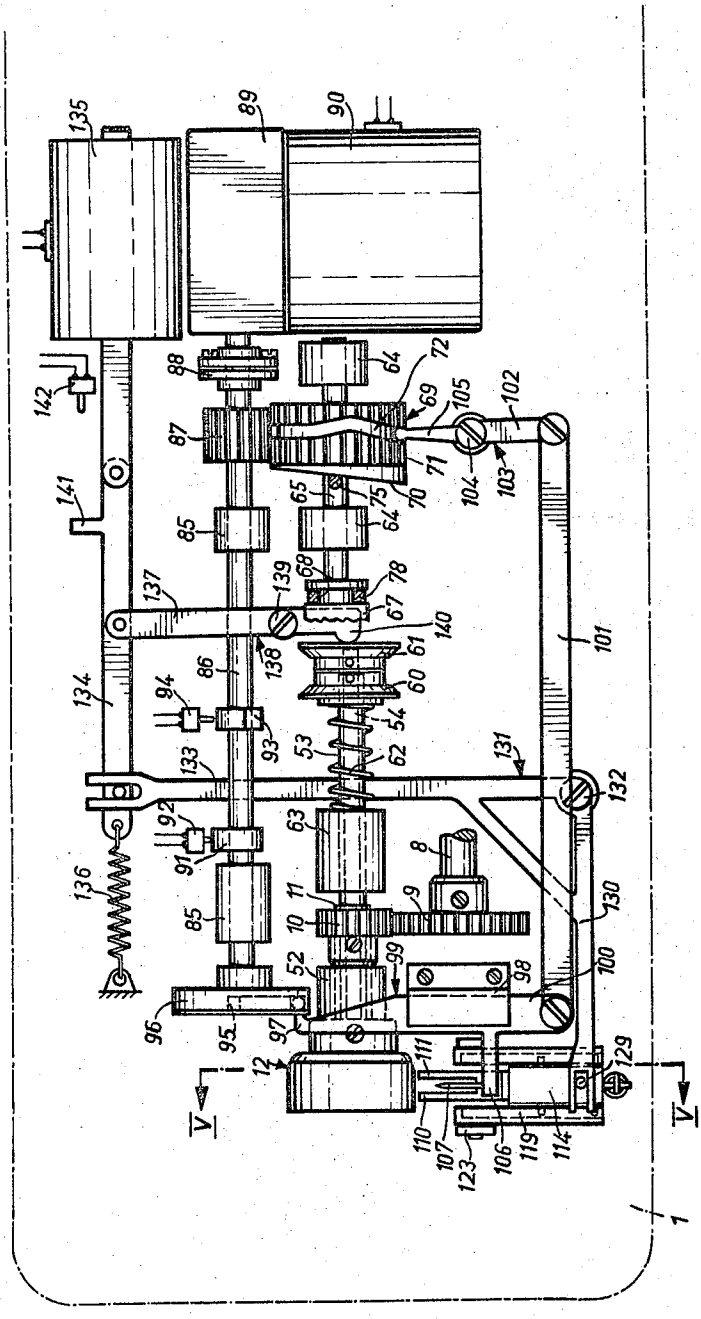
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Fig. 2



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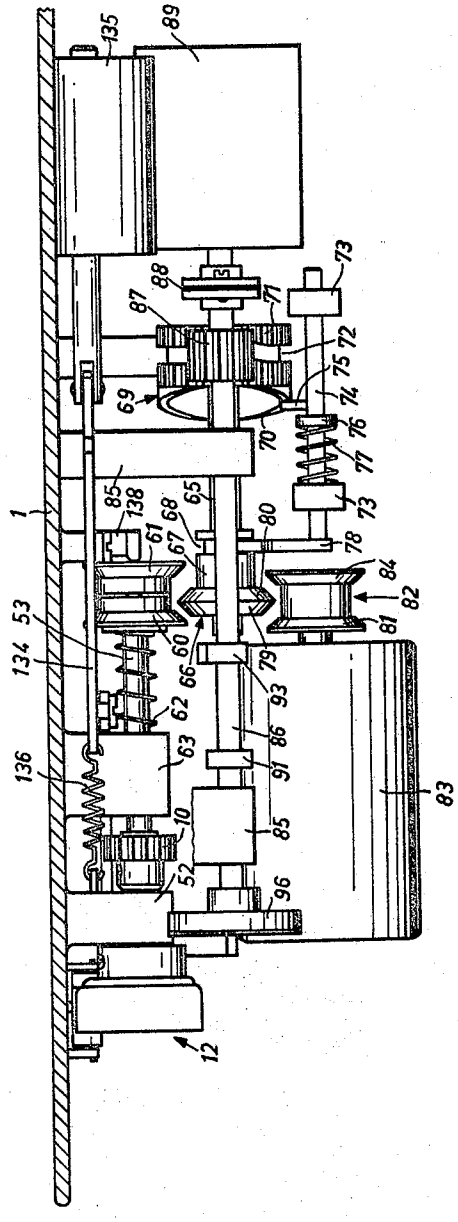
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AUTOMATIC UNDERTHREAD WINDING APPARATUS FOR LOCKSTITCH SEWING MACHINES

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Fig. 3



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AUTOMATIC UNDERTHREAD WINDING APPARATUS FOR LOCKSTITCH SEWING MACHINES

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Fig. 4

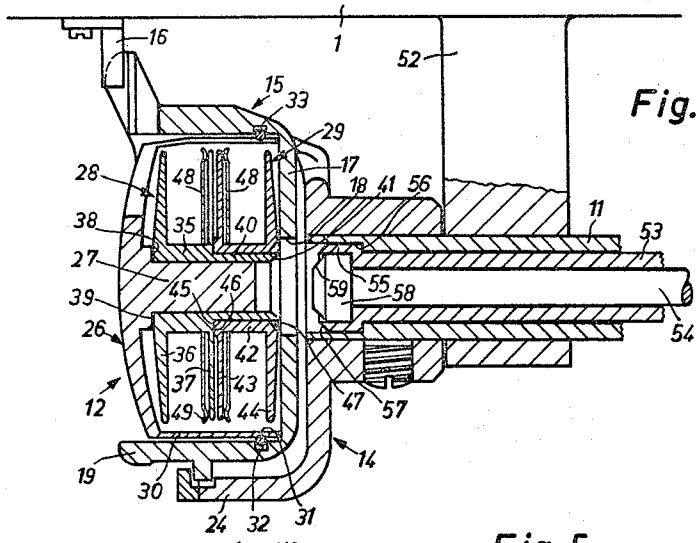


Fig. 5

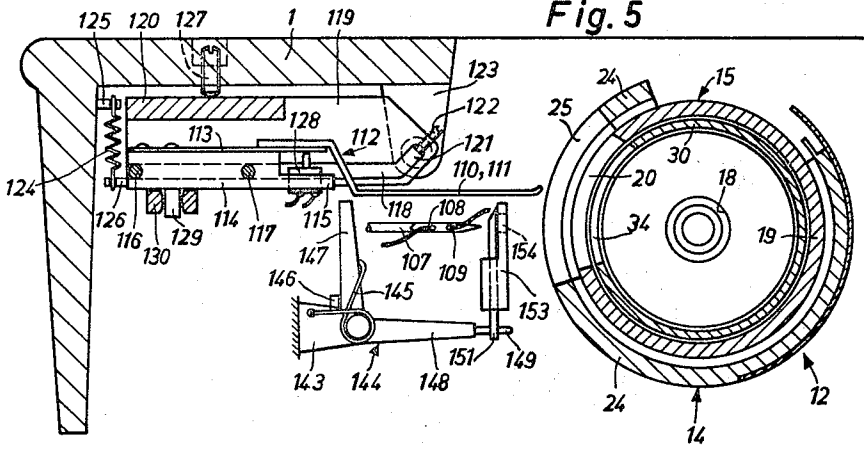


Fig. 6

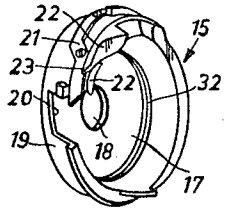


Fig. 7

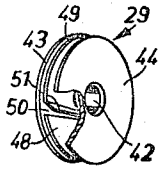


Fig. 8

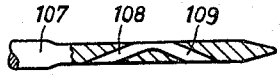
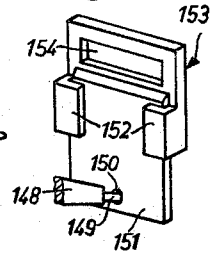


Fig. 9



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3,332,381

AUTOMATIC UNDERTHREAD WINDING APPARATUS FOR LOCKSTITCH SEWING MACHINES

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Filed July 27, 1965, Ser. No. 475,086
Claims priority, application Germany, July 30, 1964, P 34,792
14 Claims. (Cl. 112—186)

The present invention relates to a method of and apparatus for replenishing the loop taker of a lockstitch sewing machine with bobbin- or underthread, and has for its major object the automatic winding of a loop taker bobbin during the normal operation of the machine, or without requiring the removal of the bobbin from the machine or loop taker case.

In the operation of a lockstitch sewing machine it is customary, after the underthread carried by the loop taker bobbin has been exhausted, to arrest the machine and to exchange the empty bobbin by a fully wound bobbin prior to the continuation of the sewing operation. This procedure, aside from consuming substantial time, involves the interruption of the seam being sewn accompanied by faulty stitches, as well as other defects well known. On the other hand, sewing over of the interrupted seam, besides requiring an additional operation, may result in substantially impairment of the appearance of the seam or pattern being sewn.

Accordingly, an important object of the present invention is the provision of improved means or mechanism in conjunction with a rotary hook loop taker type sewing machine, whereby seams of any length may be sewn substantially without interruption and without the requirement of predetermining the length of the underthread for the sewing of a seam or seams of a desired length.

A more specific object of the invention is the provision of improved bobbin thread winding means for lockstitch sewing machines, to maintain the loop taker continuously supplied with bobbin- or underthread by automatically replenishing an empty bobbin upon the underthread supply decreasing below a lower, perferably adjustable, limit.

Another object of the invention is the automatic sensing of the amount of underthread being left in the machine upon each stoppage, or after a limited number of stoppages of the machine, and the replenishing of the loop taker with fresh thread if the supply of the latter has decreased below a predetermined limit, thereby to enable the continuous sewing of seams of any length, substantially without interruption of the sewing operation.

The invention, both as to the foregoing and ancillary objects and novel aspects, as will hereafter appear, will be better understood from the following detailed description of a preferred practical embodiment thereof, taken in conjunction with the accompanying drawings forming part of this specification and in which:

FIG. 1 is a front elevation of a sewing machine, shown partly in section and embodying automatic underthread winding apparatus constructed according to the principles of the invention;

FIG. 2 is a view of the machine according to FIG. 1 as seen from below the cloth plate;

FIG. 3 is a front view, shown on an enlarged scale, of the control mechanism, mounted below the cloth plate of the machine;

FIG. 4 is a sectional view, on an enlarged scale, of the rotary hook or loop taker of the machine;

FIG. 5 is a section taken on line V—V of FIG. 2;

FIG. 6 is a perspective view of the outer bobbin case of the loop taker;

FIG. 7 is a perspective view of a loop taker bobbin.

FIG. 8 is a section of the underthread feeding needle of the device;

FIG. 9 is a perspective view of the underthread cutting device; and

FIG. 10 is an electric wiring diagram of the device shown in the preceding figures.

Like reference characters denote like parts throughout the different views of the drawings.

With the foregoing objects in view, the invention, according to one of its aspects, involves generally the utilization of a loop taker having a cup-shaped rotary hook fitted with the normal needle thread seizing beak, at least one stationary cylindrical bobbin case rotatively supporting said hook, and a pair of underthread-carrying bobbins having hollow concentric cores and mounted for independent rotation within said case in end to end relation to one another. Each of the bobbins is fitted with thread clamping means, such as in the form of a spring disk adjoining one of the lateral bobbin walls. The adjoining outer end of the bobbins or cores are formed to provide a pair of adjoining friction coupling surfaces for the individual selective rotation, through suitable coupling means, of the bobbins by a bobbin winding motor, to alternately replenish the same with fresh underthread without removal from the loop taker or sewing machine.

The side walls of the hook body and bobbin case are provided with apertures or openings being in alignment with each other in a predetermined position of the sewing machine, such as the UP-position of the needle. For this purpose, the machine may be automatically arrested by means of a known needle-positioning device operative upon the stoppage of the machine.

There is further provided, in accordance with the improvements of the present invention, a reciprocatory underthread sensing or monitoring device having a pair of sensing tongues adapted to pass through said openings in the aligned position and each operable into engagement with the underthread coil carried by said bobbins, and means, operable preferably in response to the operation of the needle-positioning device, to advance said tongues towards the loop taker to a limited fractional distance of its full operating stroke by either of said tongues engaging an underthread coil within said bobbins of a diameter in excess of a lower predetermined limit diameter, on the one hand, and to advance said tongues to the end of said stroke upon the diameter of the bobbin thread coils decreasing below said predetermined diameter, on the other hand. In other words, the thread monitoring device serves to ascertain, preferably after each stoppage of the sewing machine, whether the thread supply of the instantly active bobbin has reached the lower preferably adjustable limit. If this limit has not as yet been reached, the monitoring device returns to its starting position, while in the case of the underthread having been used to an extent below said limit, the automatic control according to the invention acts to initiate the underthread feeding, clamping and winding operations of the empty or standby bobbin.

There is provided for the latter purpose a reciprocatory thread feeding needle disposed substantially parallel to the sensing tongues of the monitoring device and operable, through the aligned openings of the loop taker and bobbin case, from a normal position midway between the bobbins towards and laterally of the loop taker, in such a manner as to lock the end of a supply of underthread carried by and projecting from said needle by the thread clamping means of either of the bobbins upon said

needle engaging and releasing the respective clamping means during its forward and return feed movements. The operation of the thread-feeding needle is advantageously initiated upon the sensing tongues of the monitoring device reaching the end of their full operating stroke, whereby to operate the needle and to clamp the end of the underthread carried thereby upon the empty or standby bobbin, while simultaneously coupling the bobbin winding motor with the frictional coupling surface of the respective bobbin through suitable selective coupling means. The bobbin winding motor is then started, to wind the empty bobbin with fresh underthread, and stopped upon reaching a predetermined diameter by the underthread coil as a result of the auxiliary control means, as shown by the drawing and described in the following.

In other words, the underthread, in the afore-mentioned embodiment of the invention, is carried by two separate bobbins being permanently mounted within the loop taker of the sewing machine. If the thread of a first or active bobbin has been reduced below the predetermined limit or minimum, fresh underthread is automatically wound upon the second empty or standby bobbin, whereupon sewing is continued by use of the remainder of the thread upon the first bobbin followed by the thread of the second or replenished bobbin. If the supply of the latter has, in turn, been reduced below the minimum, new thread is now wound upon the first bobbin in the same manner by the automatic sensing and winding mechanism, and so forth, in such a manner as to enable the continued sewing over any length of time, or without interruption, in a manner as will become more apparent as the description proceeds.

Thread monitoring devices which serve to ascertain the underthread supply of a sewing machine are well known in the art. Their operation is usually based on the provision of a given final length of the thread being wound upon the bobbin in the opposite direction for the remainder of the thread, whereby to reverse the unwinding direction or rotation of the bobbin upon the thread left decreasing below said final length, thereby to, in turn, operate an indicating or monitoring device. On the other hand, the present invention involves the provision and use of an underthread monitoring device embodying a reciprocatory sensing tongue, whereby to enable the thread to be unwound in the same direction.

The thread clamping device of the invention advantageously consists of a spring disk mounted adjoining the inside of the side wall of an underthread bobbin, said disk having a peripheral edge bent to facilitate the insertion of the thread feeding needle therebetween and the adjoining bobbin wall, and said disk being furthermore provided with a radial slot extending substantially tangentially of the inner core of the bobbin, to guide the periphery clamped thread towards said core during the first winding turn, in the manner as will become further apparent from the following detailed description in reference to the drawings.

Referring more particularly to the drawings, FIG. 1, the sewing machine shown, being of conventional general design, comprises a bed or cloth plate **1**, an upright or standard **2** from which extends an overhanging or upper arm **3** terminating in a sewing head and having mounted therein the main drive or arm shaft **4** of the machine. Shaft **4** carries a chain pulley **5** which serves to drive the loop taker drive shaft **8** mounted in the bed **1** by way of a chain belt **6** and a cooperating pulley **7**, while the shaft **4** further serves to operate the reciprocatory needle **13** mounted in the head of the arm **3** through a suitable crank and link mechanism (not shown) which may also serve to operate the usual needle thread take-up lever (not shown) in accordance with conventional sewing machine design and practice The loop taker drive shaft serves to drive the loop taker hook shaft **11** by way of gears **9** and **10**, to rotate the loop taker **12** mounted upon the end of the shaft **11** at a speed being twice the speed of the arm shaft **4** for cooperation with the needle **13** in the formation of lockstitches, in a manner well known.

Mounted within the cup-shaped rotary hook body **14**, FIG. 4, of the loop taker **12** is a satisfactory outer bobbin case **15**, the hook **14** being journalled by its conventional circular raceway engaging an annular rib upon the outside of the case **15**. The latter is restrained against rotation by the provision of a rotation-restraining tongue **16** secured to the bed **1** and engaging a peripheral notch or recess in the case **15**. The bobbin case **15** (see also FIG. 6), while of conventional design, is provided with an axial opening **18** in its bottom **17** and with an aperture or opening **20** in its cylindrical side wall **19**. Secured to the side wall **19** above the aperture **20** is a leaf spring **21** extending into said aperture and serving to control the tension of the lower or bobbin thread. More specifically, the spring **21** engages the lateral flange **22** which serves to protect the needle thread and is interrupted by a guide slot **23**.

The side wall **24**, FIGS. 4 and 5, of the rotary hook body **14** has an opening **25** which is in registry, in the example described, with the aperture **20** of the case **15** in the UP-position of the needle **13** by the action of the automatic needle-positioning device to be described presently.

A cup-shaped inner bobbin case **26** disposed in snug-fitting and slidable relation within the outer case **15**, with the bottom of one case disposed on the side opposite to the bottom of the other case, has an axial spindle **27** for the mounting thereon of a pair of bobbins or underthread carrying spools **28** and **29**. The inner case **26** has its cylindrical side wall **30** provided with an inner circular groove **31** parallel to the free edge of the case, said groove adapted to engage with a snap action an annular wire or spring **32** disposed in a groove of the outer case **15**, to firmly lock the inner case **26** in the inserted position in the outer case **15**. The side wall **30** of the inner case also has an aperture or opening **34** being in registry with the openings **20** and **25** of the hook body **14** and outer case **15** in the UP-position of the needle **13**.

The first underthread bobbin **28** has a tubular core **35** and a pair of lateral disks or side walls **36** and **37**. The core **35** is rotatively mounted upon the spindle **27** of the inner case **26** with the disk **36** engaging by its annular surface **38** a ring-shaped offset or shoulder **39** of the spindle **27**. The core **35** is extended beyond the disk **37**, as shown at **40**, and terminates in an inwardly chamfered edge or friction coupling surface **41**. Rotatively mounted upon the extension **40** of the core **35** is the second underthread bobbin **29** having a tubular core **42** and a pair of side walls or disks **43** and **44**. The adjoining disks **37** and **43** of the bobbins **28** and **29** are slightly offset in the center, to cause the disks to engage over a limited annular surface only. The end of the core **42** of the bobbin **29** adjoining the bottom **17** of the outer bobbin case **15** is formed with a further chamfered or bevelled edge or friction coupling surface **47**, for the purpose as will become further apparent as the description proceeds.

Secured, by rivetting or the like, to the inner faces of the disks **37** and **43** of the bobbins **28** and **29** is a spring disk **48** (see also FIG. 7) the outer edge of which is slightly beaded or bent towards the adjoining bobbin walls. The disks **48** are furthermore provided with a radial slot **50** extending inwardly from the periphery **49** and tangentially of the cores **35** and **42** of the bobbins **28** and **29**, respectively. The slot **50** is slightly inclined in the direction opposite to the winding direction or rotation of the bobbins **28** and **29** and its leading edge **51** in respect to said direction is slightly bent inwardly, in the manner shown in FIG. 7.

The loop taker or hook shaft **11**, being journalled in a bracket **52**, FIG. 4, supported by the cloth plate **1**, is of hollow construction to, in turn, support, in the order named, a further hollow shaft **53** and a normal drive shaft **54**. Shaft **53** is fitted at its end disposed within the hub

of the hook body 14 with a cylindrical extension 55 mounted within a corresponding recess 56 of the loop taker shaft 11 and having its front edge 57 chamfered to correspond with the chamfer 47 of the bobbin 29, in such a manner as to establish frictional driving connection between the shaft 53 and the bobbin 29 upon axially displacing said shaft in the manner described in greater detail hereafter. The extension 55 has an inner bore adapted to receive the head 58 of the drive shaft 54, said head being, in turn, formed with a chamfered surface 59 conforming to the chamfer 41 of the core bobbin 28. Again, axial displacement of the shaft 54 will result in the frictional engagement of the surfaces 41 and 59, to establish driving connection between the shaft 54 and the bobbin 28.

Mounted upon the shaft 53 is a coupling disk or member 60, FIGS. 2 and 3, adjoining which is a further coupling member 61 fast on shaft 54. A compression spring 62 having one end engaging a stationary bearing 63 of the shaft 53 and having its opposite end engaging the member 60 serves to normally urge both the members 60 and 61 and, in turn, their drive shafts 53 and 42 towards the right or inoperative position, as shown in FIG. 4.

A further drive shaft 65 disposed below the shaft 53 and supported by stationary bearings 64, FIGS. 2 and 3, carries a displaceable coupling sleeve 67 connected to a coupling disk 66, said sleeve having an annular groove 68. Further mounted upon the shaft 65 is a cam or control disk 69 fitted upon its front with a cam surface 70 and having peripheral teeth 71 interrupted by a cam grove 72. Secured to a rod 74, displaceable axially within bearings 73, is a radial pin 75 which is resiliently urged against the cam surface 70 by the action of a compression spring 77 having one end arranged to engage one of the bearings 73 and having its opposite end engaging a disk being fast upon the rod 74. Secured to the end of the rod 74 is a fork 78 operably engaging the groove 68 of the coupling sleeve 67.

The coupling disk 66 has two opposed coupling surfaces 79 and 80, whereby axial displacement of the sleeve 67 towards the left will result in the engagement of the surface 79 with the coupling member 60, on the one hand, and with the coupling surface 81 of a further coupling disk 82 driven by a fast-running bobbin winding motor 83 mounted below the bed 1, while axial displacement of the sleeve 67 towards the right will result in the engagement of the surface 80 with both the coupling member 61 and a further coupling surface 84 of the disk 82, on the other hand.

A further drive shaft 86 being parallel to the shaft 65 and supported by bearings 85 carries a gear 87 which meshes with the teeth 71 of the cam disk 69, the number of teeth of gear 87 being equal to one half of the number of teeth 71 of the cam disk 69.

Shaft 86 is rigidly coupled, by way of a coupling 88, with the speed reduction gearing 89 of an auxiliary operating motor 90 and carries a first control cam 91 adapted to cooperate with a limit switch 92 for the control of the bobbin winding motor 83. Besides, shaft 86 carries a second saw-tooth-shaped control cam 93 adapted to cooperate with a limit switch 94 for the connection and disconnection of the operating motor 90.

Secured to the free end of the shaft 86 is a further disk 96 provided with a cam groove 95 in which is pivoted or rotatively mounted the bent end of an arm 97 of a control lever 99 being longitudinally displaceably mounted in a stationary guide 98, the opposite arm 100 of said lever being connected, by way of a link 101, with the arm 102 of a double-arm lever 103. The latter is fulcrumed by a pivot screw 104 rotatively mounted upon the underside of the cloth plate 1. The end of the opposite arm 105 of the lever 103 engages the groove 72 of the cam disk 69.

Extending from and at right angle to the arms 97 and 100 of the lever 99 is an arm 106 carrying an underthread feeding needle 107 (see also FIG. 8). The feeding needle 107 has its free end, being normally positioned opposite to the apertures 25, 20 and 34 of the loop taker 12 in the up-position of the stitching needle 13, pointed or flattened, to facilitate its entering or insertion between the disks 37 or 43 of the bobbins 28 and 29 and the respective spring or clamping disks 48, the needle 107 being provided a pair of thread feeding or guide channels 107 and 108 which form an obtuse angle with one another, as shown by FIG. 8.

Disposed above and substantially parallel to the needle 107, FIG. 5, and opposite to the loop taker apertures 20 and 34 are a pair of spaced sensing tongues 110 and 111 of an underthread sensing or monitoring device 112. The latter has one of its ends secured to a leaf spring 113 which is, in turn, secured to a sliding member 114, the latter being provided at its end adjoining the device 112 with an offset or shoulder 115 and fitted with pairs of lateral guide pins 116 and 117. The latter engage grooves 118 in the side walls 119 of a carrier member 120. The mainly horizonal grooves 118 extend upwardly at an angle as at 121 adjoining the loop taker 12 and are fitted with a limiting screw 122 projecting into the end of one the grooves and being mounted in one of the side walls 119, to control or limit the effective length of the bent portions of the grooves, for the purpose as will become further apparent as the description proceeds.

The carrier 120 is rotatively supported by a pair of arms or brackets 123 secured to the underside of the cloth plate 1 and is resiliently urged against a set screw 127 also mounted in said plate by the action of a tension spring 124 having one end arranged to engage an eyelet 125 secured to the plate 1 and having its opposite end engaging an eyelet 126 secured to the carrier 120.

Supported by the offset 115 of the sliding member 114 is an electric microswitch 128 which is normally engaged, via the spring 113, by the thread monitoring device 112.

Engaging a bolt 129 secured to the underside of the sliding member 114 is the bifurcated arm 130, FIG. 2, of an angular or bellcrank lever 131 rotatively mounted below the cloth plate 1 by means of a pivot screw 132, the remaining arm 133 of said lever being operably connected, by way of a link 134, with an electromagnetic control device or solenoid 135 also mounted below the plate 1. A tension spring 136 having one end engaging the end of the link 134 and having its opposite end engaging the plate 1 serves to normally urge the plunger or armature of the solenoid and with it the link 134 toward the left or inoperative position, as shown in the drawing.

Rotatively connected to the link 134 is the arm 137 of a double arm lever 138 fulcrumed upon the underside of the plate 1 by means of a pivot screw 139, the remaining arm 140 of said lever engaging the left hand surface of the coupling disk or member 61. The link 134 has a nose or projection 141 which upon energization of the solenoid 135 and operation of its plunger to the end of its full operating stroke, serves to actuate the limit switch 142 for the initiation of a bobbin threading and winding operations, as described in the following.

Further disposed below the plate 1, FIG. 5, is a stationary bracket 143 which supports an angular or bellcrank lever 144 normally being urged, by the action of a torsion spring 145, against a stop 146 upon said bracket, corresponding to the position as shown in FIG. 5. One arm 147 of the lever 144 extends into the path of the arm 130 of the lever 131, while a pin 149 secured to the other lever arm 148 extends through a bore in an underthread cutter or knife blade 151, FIG. 9. The latter is supported in guides 152 of a cooperating cutter element 153 secured below the cloth plate 1 of the sewing ma-

chine and having an aperture **154**, to enable free passage of the thread feeding needle **107**.

The sewing machine being equipped with a conventional automatic needle positioning device is designed to stop the needle in a predetermined, such as the UP-position, upon release of the usual foot pedal or the like control member, whereby to result in the stoppage of the loop taker with the aperture **25** thereof being in alignment with the apertures **20** and **34** in the outer and inner bobbin cases, in the manner described.

In order to effect a stoppage of the sewing machine in the UP-position of the needle **13**, the arm shaft **4**, FIG. 1, may be fitted in a known manner with a synchronizing disk **155** having a pair of peripheral contact paths **156** and **157** each being engaged by a sliding contact **158** and **159**, respectively, the contact **157** having, in the example shown, an insulating section or interruption **160**, corresponding to the UP-position of the needle and resulting in the automatic positioning of the loop taker hook, as shown in FIG. 5 in the manner as will become further apparent during the description of the operation of the invention.

Referring now to the wiring diagram of FIG. 10, the supply lines **161** and **162** of an alternating current source or network feed the primary winding of a transformer **163** to the secondary of which is connected a bridge rectifier **164** for the energization of the control circuit, said rectifier having a pair of direct current output terminals **165** and **166**. Starting from the terminal **165** a supply line **167** leads, by way of junction **168**, to the contact **169** of a main control switch **170** which may be operated by the foot pedal or the like control member of the sewing machine and which has a cooperating contact **171**. More specifically, the contact arm **170** is operated by the foot pedal or the like in such a manner that in the raised or rest position of the pedal the contact **169** is closed by the arm **171** (OFF-position of the sewing machine), while depression of the pedal to operate the machine will result in the closing of the contact **171** (ON-position of the machine), the latter position being shown in the drawing. Switch arm **170** is connected, by way of sliding contact **158**, contact paths **156** and **157**, sliding contact **159**, a relay **172**, junction **173** and line **174**, to the remaining terminal **166** of the rectifier **164**.

The relay **172** has an open-circuit contact **172***a* and a closed-circuit contact **172***b*. The contact **172***a* is connected in series with a magnetic coupling winding **175**, forming part of the auxiliary (low speed) drive of the needle positioning device, between the junctions **168** and **173** of the rectifier supply lines **167** and **174**, respectively. The elements **155–160**, **170**, **172** and **175** are part of the needle positioning device indicated by the dashed-line rectangle in the drawing and well known to those skilled in the art.

The switch arm **170** is furthermore connected to the line **174** by way of a capacitor **177**, junction **178**, contact **172***b*, winding **179** of a relay **180**, and junctions **181** and **182**. Relay **180** has two separate windings **179** and **183** and a pair of open-circuit contacts **180***a* and **180***b*. Connected between switch contact **171** and junction **178** is a discharge resistor **182**.

A further junction **185** upon the line **167** is connected with the line **174** through the microswitch **128** of the underthread monitoring device **112**, the open-circuit contact **180***a*, winding **183** of relay **180** and junctions **181** and **182**, while a branch circuit leads from the junction **186** to a junction **191** upon the line **174** by way of a junction **187**, limit switch **142**, a rectifier **188**, junction **189** and relay **190**, the latter having two open-circuit contacts **190***a* and **190***b*.

Further leading from a junction **192** upon line **167** to junction **189** is a circuit including the limit switch **92**, contact **190***a* and a further rectifier **193**. Finally, junction **187** is connected to a junction **197** upon the line **174** by way of a junction **194**, limit switch **94**, junction **195** and a relay **196**, the latter having an open-circuit contact **196***a*, connected in parallel to the switch **94** or between the junctions **194**, **195**, and a switch-over contact arm **196***b* cooperating with two contacts **198** and **199**.

Extending from line **161** to line **162** of the alternating current source is a further circuit including the switch-over contact **196***b*, switch contact **198**, relay contact **190***b* and operating motor **90**. A further circuit extends from the contact **199** of switch **196***b* to line **162** through the bobbin winding motor **83**, while a final branch circuit between lines **161** and **162** contains the winding of the solenoid **135** and contact **180** of the relay **180**.

The function and operation of the invention as illustrated by the drawings will now be described in detail in the following.

The main drive of the sewing machine (shaft **4**) is arrested in the ordinary manner at the end of a sewing operation or completion of a seam, such as by the release or raising of a foot pedal, whereby to result in the operation of the contact arm **170**, FIG. 10, from engagement with contact **171** (ON-position of the sewing machine) to its engagement with contact **169** (OFF-position of the sewing machine). As a consequence, a direct current is started to flow from the plus terminal **165** to the minus terminal **166** of the rectifier **164** through supply line **167**, junction **168**, contact **169**, switch arm **170**, sliding contact **158**, contact paths **156** and **157**, sliding contact **159**, relay **172**, junction **173**, and supply line **174**. The relay **172** is energized, whereby to cause the contact **172***a* to be closed and the contact **172***b* to be opened before the relay **180** in series therewith has sufficient time to become energized. Closing of contact **172***a*, in turn, results in the energization of the coupling magnet or solenoid **175** controlling the auxiliary drive of the sewing machine by establishing a current path between junctions **168** and **173** and, in turn, the supply lines **167** and **174** of the rectifier **164**. As a consequence, the sewing machine is driven at a reduced speed by the auxiliary drive (not shown) started by the solenoid **175** until the insulating section **160** is engaged by the sliding contact **159**, at which instant the needle **13** is out of the work or in the UP-position and the opening **25** of the hook body **14** is in register with the openings **20** and **34** of the outer and inner bobbin cases **15** and **26**, respectively, as shown in FIG. 5.

As a result of the interruption of the needle positioning circuit by the section **160** of the contact path **157**, relay **172** is de-energized, whereby to open the contact **172***a* and to stop the sewing machine in the predetermined needle position. The machine is now ready for the underthread monitoring and replenishing operations described in the following. At the same time, the contact **172***b* is reclosed, whereby to get up a charging current pulse through line **167**, junction **168**, contact **169**, switch arm **170**, capacitor **177**, junction **178**, contact **172***b*, winding **179** of the relay **180**, the junctions **181** and **182**, and line **174**. The relay **180** is energized briefly during the charging period of the capacitor **177**, whereby to close the contacts **180***a* and **180***b*. Closing of contact **180***a* results in a current flow from line **167** to line **174** by way of junction **185**, switch **128**, junction **186**, contact **180***a*, winding **183** of relay **180** and junctions **181** and **182**. As a consequence, the relay **180** is maintained in energized condition, while the winding **179** is de-energized upon charging of the capacitor **177** to the full operating voltage of the source **164**.

At the same time, the solenoid **135** connected between the lines **161**, and **162** of the alternating current source is energized by the closed contact **180***b*, whereby to displace both the angular lever **131** and the double-lever **138**, FIG. 2, by way of the link **134**.

Displacement of the lever **131**, in turn, results in the operation of the sliding member **114**, FIG. 5, towards the loop taker **12**, member **114** being initially displaced in a straight line as a result of the horizontal portion of the

guide grooves 118. Since, with the needle in the UP-position, the openings 20, 25 and 34 of the inner and outer bobbin cases and of the hook are in alignment in the manner described, the sensing tongues 110 and 111 of the thread monitoring device 112 are allowed to enter into the loop taker during the forward displacement of the member 114. The horizontal movement of the device 112 is arrested as soon as the ends of guide pins 117 closest to the loop taker reach the end of the horizontal portion of the grooves 118. At this instant, the free ends of the tongues 110 and 111 have moved to a position closely above the cores 35 and 42 of the bobbins 28 and 29, whereby to sense or monitor the underthread in said bobbins, in the manner further understood from the following.

In order to set a desired lower limit of the underthread supply at which the device 112 will respond in starting a thread replenishing operation, the carrier 120 is rotated about its pivot within the arms 123 by adjustment of the set screw 127 against the action of the tension spring 124. This will result in a change of the angular position of the grooves 118 and, in turn, of the distance between the tongues 110 and 111 and the cores 35 and 42 in the sensing position of the device 112.

If there is still sufficient underthread left upon either of the bobbins 28 and 29, the corresponding tongue 110 or 111, upon engaging an underthread coil in said bobbins, and with it the entire device 112, will be lifted by flexing or upward bending of the leaf spring 113. This, in turn, causes the actuation of the microswitch 128, whereby to interrupt the current flow between leads 167 and 174 via the winding 183 of the relay 180. As a consequence, relay 180 is de-energized, whereby to open its contacts 180*a* and 180*b* and to de-energize the solenoid 135. This, in turn, causes the monitoring device 112 to receed from the loop taker and to return to its starting position, as shown in FIG. 2, by the action of spring 136.

In other words, the monitoring device 112 acts to ascertain the amount of underthread left at the end of each sewing operation or stoppage of the sewing machine, returning to its starting position if the thread supply exceeds a predetermined minimum and initiating an automatic thread replenishing operation if said minimum has been reached, in the manner described in greater detail in the following.

If the underthread supply has decreased below the minimum, set by means of the adjusting screw 127, the monitoring device 112 is not lifted above the cores 35 and 42 during the forward displacement of the tongues 110 and 111, whereby to prevent actuation of the microswitch 128 as described and to allow the electromagnet 135 to carry out its full operating stroke, to displace the member 114 to the end or limit position determined by the grooves 118. During the latter operation, the guide pins 117 move in an upward direction as a result of the incline or bent of the ends of the grooves 118, in such a manner as to cause the member 114, together with the entire monitoring device, to assume an inclined position with the tongues 110 and 111 being deflected, by a predetermined distance, away from the cores 35 and 42 of the bobbins 28 and 29.

The distance between the cores 35 and 42 from the tongues 110 and 111, which may be adjusted by means of the set screw 122, determines the amount or extent of filling of the bobbins in the fully wound condition, as will become further apparent as the description proceeds.

Simultaneously with the operation of the monitoring device 112 into the loop taker 12, the double-arm lever 138, FIG. 2, is deflected to a limit position by the link 134, whereby its arm 140 engages the outside of the coupling member 61, to displace the latter and with it the coupling member 60 in a direction towards the loop taker 12 against the action of the spring 62. Displacement of the coupling members 60 and 61, in turn, results in an equal axial displacement of the drive shafts 53 and 54, in such a manner as to cause the coupling surfaces 57 and 59 of the extension 55 and head 58 to engage the coupling surfaces 47 and 41 of the bobbin cores 42 and 35, respectively.

Shortly before reaching the end of its operating stroke, the angular lever 131 by its arm 130 engages the arm 147 of the angular lever 144, whereby to pull the knife 151 in the downward direction and to free the aperture 154, as shown in FIGS. 5 and 9.

Upon reaching the end of its operating stroke by the electromagnet 135, FIG. 2, the nose 141 of the link 134 actuates the switch 142. As a consequence, a further current flow is established between the supply lines 167 and 174, FIG. 10, by way of junction 185, microswitch 128, junctions 186 and 187, switch 142, uni-directional conductor or rectifier 188, junction 189, relay 190 and junction 191. Relay 190 remains in energized condition by a further current flow between line 167 and junction 192, switch 92, holding contact 190*a*, and rectifier 193.

Besides, there is established a current flow between the lines 161 and 162 of the alternating current source by way of the switch-over contact 196*b*, contact 198, contact 190*b* of relay 190, and the operating motor 90, whereby to start the latter to drive the cam disk 69 (through gear 87) and 96 at reduced speed by virtue of the reduction gearing 89 and coupling 88.

Rotation of the cam disk 96 causes the control lever 99 to move in a direction at right angles to the axis of the loop taker 12 by virtue of the design of the cam groove 95, while the cam groove 72 of the disk 69 acts to effect, by way of lever 103 and link 101, a deflection of the lever 99 about its pivot formed by arm 97 engaging the groove 95. The resultant composite movement of the lever 99, determined by the grooves 72 and 95, in turn, results in the displacement of the thread feeding needle 107 from its normal position midway between the bobbins 28 and 29 in the direction towards the loop taker 12, the needle during this operation first passing through the aperture 154 in the cutter member 153 and thereafter through the registering loop taker openings 25, 20 and 34. More specifically, assuming, by way of example, that the bobbin 28 has been wound during the preceding replenishing operation, the needle 107 will be displaced laterally during its advance feed movement, in such a manner as to enter the space between the disks 43 and 44 of the bobbin 29, the needle, together with the underthread being forced between the disk 43 and spring disk 48 by virtue of its pointed or flattened end. As a consequence, the underthread guided by the channels 108 and 109 of the needle 107 is firmly clamped between the disks 43 and 48, whereupon the needle is retracted to its starting position outside of the loop taker 12 and slightly shifted laterally by virtue of the design of the cam groove 72. In other words, the underthread is guided or positioned between the disks 43 and 44 symmetrically to the bobbin 29.

At the same time, the cam surface 70, FIG. 3, of the disk 69 acts to displace the pin 75 and with it the rod 74, fork 78 and coupling sleeve 67 towards the left, in such a manner as to cause the surface 79 of the coupling member 66 to engage both the surface 81 of the coupling member 82 and the coupling member 60.

The saw-tooth cam 93 closes, upon continued rotation of the shaft 86, the switch 94, FIGS. 2 and 10, whereby to establish a current flow through a further circuit path between the junctions 185 and 197 of the lines 167 and 174, said path including the microswitch 128, junctions 186, 187 and 194, switch 94, junction 195 and relay 196. As a consequence, relay 196 is energized whereby to close the holding contact 196*a*, to maintain the same in energized condition. At the same time, the switch-over contact 196*b* is operated into engagement with contact 199, to arrest the operating motor 90 and to start the bobbin winding motor 83 by energizing the same by the alternating current source through lines 161 and 162.

The bobbin winding motor 83, FIG. 3, drives, by way of the coupling disks 82 and 66, the coupling member 60 which, in turn, rotates the bobbin 29 by way of the drive shaft 53 and extension 55. As a consequence, the underthread is led, by way of slot 50 of the disk 48, from its peripheral clamping point between the disks 43 and 48 to the center of the bobbin to be wound upon the core 42. During this operation, the other bobbin 28 is prevented from rotation by the bobbin 29 by its drive shaft 54 being at rest. By the proper design and use of suitable materials, the friction between the surfaces 41, 59 and the surfaces 47 and 57 may be substantially greater than the friction between the surfaces 38, 39, and the surfaces 45, 46, to prevent rotation of one of the bobbins 28 and 29 by and during rotation of the other bobbin.

As soon as the underthread wound upon the bobbin 29 exceeds the amount set in the manner described set screw 122, the tongue 111 and with it the monitoring device 112 is lifted by said tongue engaging the outer layer of the thread wound upon the bobbin, whereby to open the microswitch 128 and, in turn, to de-energize the relays 180 and 196, while leaving relay 190 energized by way of the switch 92 and contact 190*a*.

De-energization of relays 180 and 196, in turn, causes the opening of contacts 180*a* and 196*a*, whereby, with the microswitch 128 being released during the retraction of the monitoring device, renewed operation of the relays 180 and 196 is prevented. Besides, contact 180*b* is opened and the magnet 135 de-energized, whereby its armature returns to the starting position, FIG. 2, by the action of the spring 136. As a consequence, the angular lever 131 releases the monitoring device and the lever 138 releases the coupling members 60 and 61. The latter are displaced towards the right by the action of the spring 62, whereby to disengage the bobbins 28 and 29 from their drive shafts 53 and 54. At the same time the switch 142 is opened.

Simultaneously, the lever 144, FIG. 5, is released to actuate the cutter 151, and returned by the action of the spring 145, into engagement with the stop 146. During this operation, the arm 148 of the lever 144 operates the cutter 151 in the upward direction, to sever the underthread in cooperation with the upper edge of the aperture 154.

During release of the relay 196, the change-over contact 196*b* engages the contact 198, whereby to arrest the winding motor 83 and to re-start the operating motor 9A. The latter again causes the shaft 65 to rotate until the switch 92 is opened by the cam 91, resulting in the de-energization of the relay 190. Contacts 190*a* and 190*b* are then opened and the motor 90 arrested finally.

The sewing machine is now ready for the commencement of the next sewing operation to be initiated by the depression of the foot pedal in the ordinary manner or change from the OFF to the ON-position of the machine, whereupon the machine uses up the remainder of the thread upon the bobbin 28 followed by the new thread wound upon the bobbin 29, the end of the new thread being in known manner seized, during the first stitch formation, by the needle thread and drawn through the stitching hole in the cloth plate 1, the thread during this operation being guided by the slot 23 below the leaf spring 15 and the protective flange 22, FIG. 6.

At the same time, the switch arm 170 is operated to engage its contact 171, whereby to discharge the capacitor 177 by way of the switch 170, contact 171, resistor 184 and junction 178, to thereby return the system to a condition for effecting a new underthread monitoring and/or replenishing operation, in the manner described and understood for the foregoing. As soon as the thread supply in the bobbin 29 decreases below the minimum, the bobbin 28 will be automatically replenished with new underthread in the manner described. During the latter operation, the lateral movement of the monitoring device is in the opposite direction and the bobbin 28 is coupled with the drive shaft 54 as a result of the proper design of the cams 70, 72 and 95.

In order to prevent the machine from operation as a result of an inadvertent depression of the foot pedal during thread monitoring and/or replenishing operation, the coupling magnet of the main drive (not shown) may be connected in series with a closed-circuit contact of either of the relays 180 and 190, to disable the main drive during the monitoring and thread winding periods.

According to a modified arrangement of the invention, means may be provided to prevent the thread monitoring device from operating after each stoppage of the sewing machine. Depending upon the kind and nature of the sewing operation involved or the length of the seams to be sewn, the initiation of monitoring and/or thread winding operation may be blocked during any desired periods, such as by the use of timing devices stitch counters or arrangement for metering the length of the needle thread used. Finally the initiation of the thread monitoring operation may be controlled by an automatic thread cutter of known design operative upon the completion of a seam or sewing operation.

According to a further feature of the invention, means may be provided, especially in connection with the sewing of very long seams, to arrest the machine, by the use of suitable stitch counter or timing devices, after a predetermined sewing period, to replenish the loop taker with a desired supply of underthread sufficient for the completion of a subsequent seam or sewing operation. The fact that the remaining thread supply is used together with the newly wounded thread makes it possible to positively prevent sewing interruptions, as required in accordance with customary practice, as pointed out hereinbefore.

While a fully automatic system and method of alternately replenishing a pair of permanently mounted underthread bobbins has been described in the foregoing and shown by the drawings for illustration, it is to be understood that the improved bobbin winding mechanism of the invention may be used independently, such as for manually or semi-manually controlling bobbin winding operation, either with a single bobbin or a pair of bobbins as shown by the drawings. Such operation may be effected without having to remove the bobbin or bobbins from the sewing machine. This use of the invention may be in conjunction with any bobbin thread monitoring device, including the improved device according to the present invention. Alternatively, a bobbin may be simply rewound upon the exhaustion of the underthread either manually or semi-manually by the operation of an underthread feeding and winding mechanism described by the invention, whereupon the sewing may be continued without ever removing the bobbin from the sewing machine.

In the foregoing the invention has been described in reference to a preferred illustrative device or underthread winding system. It will be understood, however, that modifications and variations, as well as the substitution of equivalent parts or elements for those shown herein for illustration, may be made without departing from the broader scope and spirit of the invention as set forth in the appended claims. The specification and drawings are accordingly to be regarded in an illustrative rather than in a restrictive sense.

We claim:

1. Underthread winding apparatus for a lockstitch sewing machine including a reciprocatory sewing needle and a rotary loop taker cooperating therewith, to produce lockstitches in the work being operated on, said apparatus comprising in combination:

(1) positioning means operative upon the stoppage of the machine to arrest said needle and loop taker in a predetermined position,

(2) said loop taker including

(a) a cup-shaped rotary hook body,

(b) a stationary cylindrical bobbin case supported in said hook body,

(c) a pair of underthread bobbins having concentric cores and mounted for independent rotation within said case in end to end relation to one another, and

(d) resilient thread clamping means carried by each of said bobbins,

(e) the adjoining edges of said cores providing a pair of friction coupling surfaces for said bobbins,

(3) said hook body and bobbin case having apertures in the side walls thereof and being in alignment in said predetermined loop taker position,

(4) a reciprocatory underthread monitoring device having a pair of parallel sensing tongues adapted to pass through said apertures in the aligned position and each operable into engagement with an underthread coil carried by one of said bobbins,

(5) means responsive to the operation of said positioning means to advance said device towards said loop taker and to arrest the same, prior to the reaching the end of its full operating stroke, upon either of said tongues engaging an underthread coil within said bobbins of a diameter in excess of a lower predetermined limit diameter, while allowing said device to advance to the end of said full stroke upon the diameter of the underthread coils decreasing below said predetermined diameter,

(6) a reciprocatory thread feeding needle disposed substantially parallel to said sensing tongues and operable, through said aligned apertures, from a normal position between said bobbins towards and away from as well as laterally of said loop taker to lock the end of a supply of underthread carried by and protruding from said feeding needle by the thread clamping means of either of said bobbins upon said needle engaging and releasing the respective clamping means during its forward and return feed movements,

(7) a bobbin winding motor and coupling means therefor operable to selectively establish driving connection with the coupling surfaces of either of said bobbin cores,

(8) operating means controlled by and operative upon said monitoring device upon reaching the end of its full operating stroke, to operate said feeding needle and to clamp the end of the underthread carried thereby upon the empty bobbin of said loop taker and to simultaneously couple said motor with the core of the respective bobbin by said coupling means, and

(9) means operable in response to the operation of said last means to start rotation of said winding motor.

2. In underthread winding apparatus as claimed in claim **1**, said clamping means consisting of a spring disk mounted adjoining the inside of a side wall of said bobbins, said disk having a peripheral edge bent to facilitate insertion of said feeding needle therebetween and the adjoining bobbin wall, said disk furthermore being provided with a radial slot extending substantially tangentially of the respective bobbin core.

3. In underthread winding apparatus as claimed in claim **1**, said stationary bobbin case comprising an outer cup-shaped bobbin case and a cup shaped inner bobbin case carrying said bobbins and being removably mounted within said outer case with the bottom of one case located on the side away from the bottom of the other case.

4. In underthread winding apparatus as claimed in claim **3**, one of said bobbins having a hollow core journalled upon a coaxial spindle of said inner case and having an extension and said last bobbin arranged with said friction coupling surfaces located at a point adjoining a concentric opening in the bottom of said outer case.

5. In underthread winding apparatus as claimed in claim **3**, one of said bobbins having a hollow core journalled upon a coaxial spindle of said inner case and having an extension rotatively supporting the hollow core of the other bobbin, both said extension and said last bobbin arranged with said friction coupling surfaces located at a point adjoining a concentric opening in the bottom of said outer case, a hollow hook drive shaft rotatively supported by the frame of the sewing machine, a first concentric hollow bobbin drive shaft rotatively mounted within said hook shaft, a second concentric bobbin drive shaft rotatively mounted within said first drive shaft, and means to axially displace said bobbin drive shafts into coupling connection of the edge surfaces of said shafts with said bobbin friction coupling surfaces.

6. In underthread winding apparatus as claimed in claim **1**, said monitoring device having a first substantially straight horizontal guide path extending to a point with the ends of said tongues adjoining the cores of said bobbins, and a second guide path inclined at an upward angle and following said first guide path, to deflect said tongues from said cores by a predetermined angle.

7. In underthread winding apparatus as claimed in claim **6**, including means to vary the effective length of said inclined guide path of said monitoring device.

8. In underthread winding apparatus as claimed in claim **6**, including means to vary the position of said guide paths within a predetermined vertical angle.

9. In underthread winding apparatus as claimed in claim **6**, including further control means responsive upon engagement with the outer diameter of the underthread coil wound by said motor upon said bobbins reaching a diameter to engage the respective deflected sensing tongue, to arrest said motor and to return the monitoring device and feeding needle to their starting position.

10. In underthread winding apparatus as claimed in claim **9**, including thread cutting means operative upon the actuation of said last control means, to cut the end of the wound underthread at a predetermined point from said loop taker.

11. In underthread winding apparatus for a lockstitch sewing machine comprising in combination,

(1) a reciprocating sewing needle and a rotary loop taker operating in synchronism therewith to produce lockstitches in the work being operated on,

(2) said loop taker including

(a) a cup-shaped rotary hook body,

(b) a stationary cylindrical bobbin case supported in said hook body,

(c) at least one underthread bobbin having a core rotatively mounted within said case, and

(d) resilient thread clamping means carried by said bobbin,

(e) the edge of said bobbin providing a friction coupling surface therefor,

(3) said hook body and loop taker case having apertures in the side walls thereof and being in alignment at a predetermined needle position,

(4) a reciprocatory thread feeding needle disposed opposite to said apertures in the aligned position and operable towards and away from said loop taker to lock the end of a supply of underthread guided by and protruding from said feeding needle by said clamping means upon said feeding needle engaging and releasing the same during its forward and return feed movements, and

(5) a bobbin winding motor and coupling means therefor operable to establish driving connection with said coupling surface.

12. In underthread winding apparatus as claimed in claim **11**, said clamping means consisting of a spring disk

mounted adjoining the inside of a side wall of said bobbin, said disk having a peripheral edge bent to facilitate insertion of said feeding needle therebetween and the adjoining wall of said bobbin, and said disk being provided with a radial slot extending substantially tangentially of the core of said bobbin.

13. In underthread winding apparatus for a lockstitch sewing machine including a reciprocatory needle and a rotary loop taker cooperating therewith, to form lockstitches in the work being operated on,

(1) said loop taker including
  (a) a cup-shaped rotary hook body,
  (b) a stationary cylindrical bobbin case supported in said hook body,
  (c) a pair of underthread bobbins having concentric cores mounted in said case for independent rotation in end to end relation, and
  (d) resilient thread clamping means upon each of said bobbins,
  (e) the adjoining edges of said cores providing a pair of friction coupling surfaces for said bobbins,

(2) said hook body and case having apertures in the side walls thereof and being in alignment at a predetermined needle position,

(3) a reciprocatory thread feeding needle passing through the aligned apertures of said hook body and case operable from a normal position midway between said bobbins toward and laterally of said loop taker to lock the end of a supply of underthread carried by and protruding from said feeding needle by the thread clamping means of either of said bobbins upon said feeding needle engaging and releasing the respective clamping means during its forward and return movement, and

(4) a bobbin winding motor and coupling means therefor operable to selectively establish driving connection with the coupling surfaces of either of said bobbins.

14. In underthread winding apparatus as claimed in claim **13**, said clamping means consisting of a spring disk mounted adjoining the inside of a side wall of said bobbins, said disk having a peripheral edge bent to facilitate insertion of said feeding needle therebetween and the adjoining bobbin wall, and said disk being provided with a radial slot extending substantially tangentially of the respective bobbin core.

References Cited

UNITED STATES PATENTS

877,108	1/1908	Murphy	112—186 X
1,794,255	2/1931	Stephenson	112—186 X
2,632,604	3/1953	Ayers	242—22
3,012,530	12/1961	Ketterer et al.	112—181
3,103,189	9/1963	Ketterer	112—184
3,106,176	10/1963	Doerner	121—181 X
3,115,110	12/1963	Ketterer	112—186 X
3,115,855	12/1963	Ketterer	112—184
3,125,973	3/1964	Bernerus et al.	112—186
3,129,680	4/1964	Doerner	242—22 X
3,303,802	2/1967	Crawford	112—186

FOREIGN PATENTS

376,858	7/1932	Great Britain.

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