AUTOMATIC UNDERTHREAD WINDING
APPARATUS FOR LOCKSTITCH SEWING MACHINES

Reinhold Dobner and Heinrich Berg, both of Kaiserslautern, Pfalz, Germany, assignors to G. M. Pfaff A.G., Kaiserslautern, Pfalz, Germany, a corporation of Germany

Filed July 27, 1965, Ser. No. 475,886
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 underthread 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 substantial 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 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, preferably 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, 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
3,332,381

The needle engaging and releasing the respective clamping means during its forward and return feed movements and 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 underside carried thereby upon the empty or standby bobbin, while simultaneously engaging 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 underneath, and stopped upon reaching a predetermined diameter by the underneath control or the auxiliary control means, as shown by the drawing and described in the following.

In other words, the underneath, 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 underneath 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 underneath 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 underneath monitoring device embodying a reciprocating 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 underneath bobbin, said disk having a peripheral edge bent to facilitate the insertion of the thread feeding needle (not shown) and engaging 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 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 reciprocating needle 13 mountable on the head of the arm 3 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 hook shaft 11 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 journaled 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 base 17 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 to 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 underneath carrier spoons 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 underneath bobbin 28 has a tubular core 35 and a pair of lateral disks or side walls 36 and 37. The core 35 is rotatably 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 underneath bobbin 29 having a tubular core 42 and a pair of side walls or disks 43 and 44. The adjoining disks 43 and 45 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 beveled edge or friction coupling surface 47, for the purpose as will become further apparent as the description proceeds. Secured, by riveting 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 case 15 through a suitable 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 journaled in a bracket 52, FIG. 4, is supported by the plate 1, is of hollow construction and, 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 conform to the chamfer 41 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.

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 groove 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 60 on the other hand and the 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 displaced in a stationary guide 98, the opposite arm 100 of said lever being connected, by way of a link 101, with the arm 130 of the lever 103. The latter is fulcrummed 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 under-thread feeding needle 107 (see also FIG. 8). The feeding needle 107 has its own cam disk 108 and is positioned opposite to the apertures 25, 29 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 48 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 main horizontal 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 of 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 eyeflet 125 secured to the plate 1 and having its opposite end engaging an eyeflet 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 fulcrummed 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 paragraphs.

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 double lever 131 and are fitted with the other lever arm 148 extends through a bore in an under-thread cutter or knife blade 151, FIG. 9. The latter is supported in guides 152 of a cooperating cutter element.
chime 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 taking foot 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 of the primary of which is connected to 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 172a and a closed-circuit contact 172b. The contact 172a 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, and the rectifier supply line 166 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 172b, 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 180a and 180b. 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 180a, winding 183 of relay 180 and junctions 181 and 182, while a branch circuit leads from the junction 185 to a weiter junction way of a junction 187, limit switch 142, a rectifier 188, junction 189 and relay 190, the latter having two open-circuit contacts 190a and 190b.

Further leading from a junction 192 upon line 167 to junction 189 is a circuit including the limit switch 92, contact 190a 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 196a, connected in parallel to the series circuit between the junctions 194, 195, and a switch-over contact in 196b, 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 196b, switch contact 198, relay contact 190b and operating motor 90. A further circuit extends from the contact 199 of switch 1960 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 (shift 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 supply, through supply line 167, junction 168, and the rectifier 164, 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 172a to be closed and the contact 172b to be opened before the relay 180 in series therewith has sufficient time to become energized. Closing of contact 172b, 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 172a 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 172b is re-closed, whereby to get up a charging current pulse through line 167, junction 168, contact 169, switch arm 170, capacitor 177, junction 178, contact 172a, 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 180a and 180b. Closing of contact 180a results in a current flow from line 167 to line 174 by way of junction 185, switch 128, junction 186, contact 180a, winding 180 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 166 and 167 and having a current source is energized by the closed contact 180b, 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 in a foregoing section, the end 111 of the thread monitoring device 112 are allowed to enter into the loop tanker 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 tanker 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 distance away 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 180a and 180b and to de-energize the solenoid 135. This, in turn, causes the monitoring device 112 to recede from the loop tanker 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 amount 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 be appreciated from FIG. 1.

Simultaneously with the operation of the monitoring device 112 into the loop tanker 12, the double-arm lever 136, FIG. 2, is deflected to a limit position by the link 134, whereby its arm 140 engages the outside of the coupling member 60, to displace the latter and with it the coupling member 66 in a direction towards the loop tanker 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 member 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 190a, and rectifier 193.

Besides, there is established a current flow between the lines 161 and 162 of the alternator current source by way of the switch-over contact 196, contact 198, contact 190b of relay 190, and the operating motor 69, 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 tanker 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 tanker 12, the needle during this operation first passing through the aperture 154 in the cutter member 153 and thereafter through the registering loop tanker 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 channnels 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 tanker 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 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 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 196a, to maintain the same in energized condition. At the same time, the switch-over contact 196c is operated into engagement with contact 199, to arrest the operating 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 rotating 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 190a.

De-energization of relays 180 and 196, in turn, causes the opening of contacts 196a and 196c, whereby, with the microswitch 128 being released, the monitoring device, renewed operation of the relays 180 and 196 is prevented. Besides, contact 180b 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 112, 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 cam 151 and, returned by the action of the spring 145, into engagement with the stop 146. During this operation, the arm 143 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 155.

During release of the relay 196, the change-over contact 196c 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 196. Contacts 196a and 196c 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 described 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 196, 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 switch 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 thread winding 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 wound thread makes it possible to positively prevent sewing interruptions, as required in accordance with customary practice, as pointed out hereinafter.

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 196a and 196c by 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,
3,332,381

(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 of any 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 bobbins,

(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 tangential 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 removable mounted within said outer case with the bottom of said 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 journaled 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 journaled 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 vertical 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 tongues, 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 oppositely 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
3,012,539 12/1961 Ketterer et al. 112—181
3,103,189 9/1963 Ketterer 112—184
3,106,176 10/1963 Doerner 112—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
3,129,689 4/1964 Doerner 242—22 X
3,303,802 2/1967 Crawford 112—186

FOREIGN PATENTS

376,858 7/1932 Great Britain.

JORDAN FRANKLIN, Primary Examiner.

H. F. ROSS, Examiner.