March 2, 1948. E. P. SPAINE 2,437,052

THREAD-CONTROLLER FOR SEWING MACHINES

Filed May 18, 1946 7 Sheets-Sheet 1

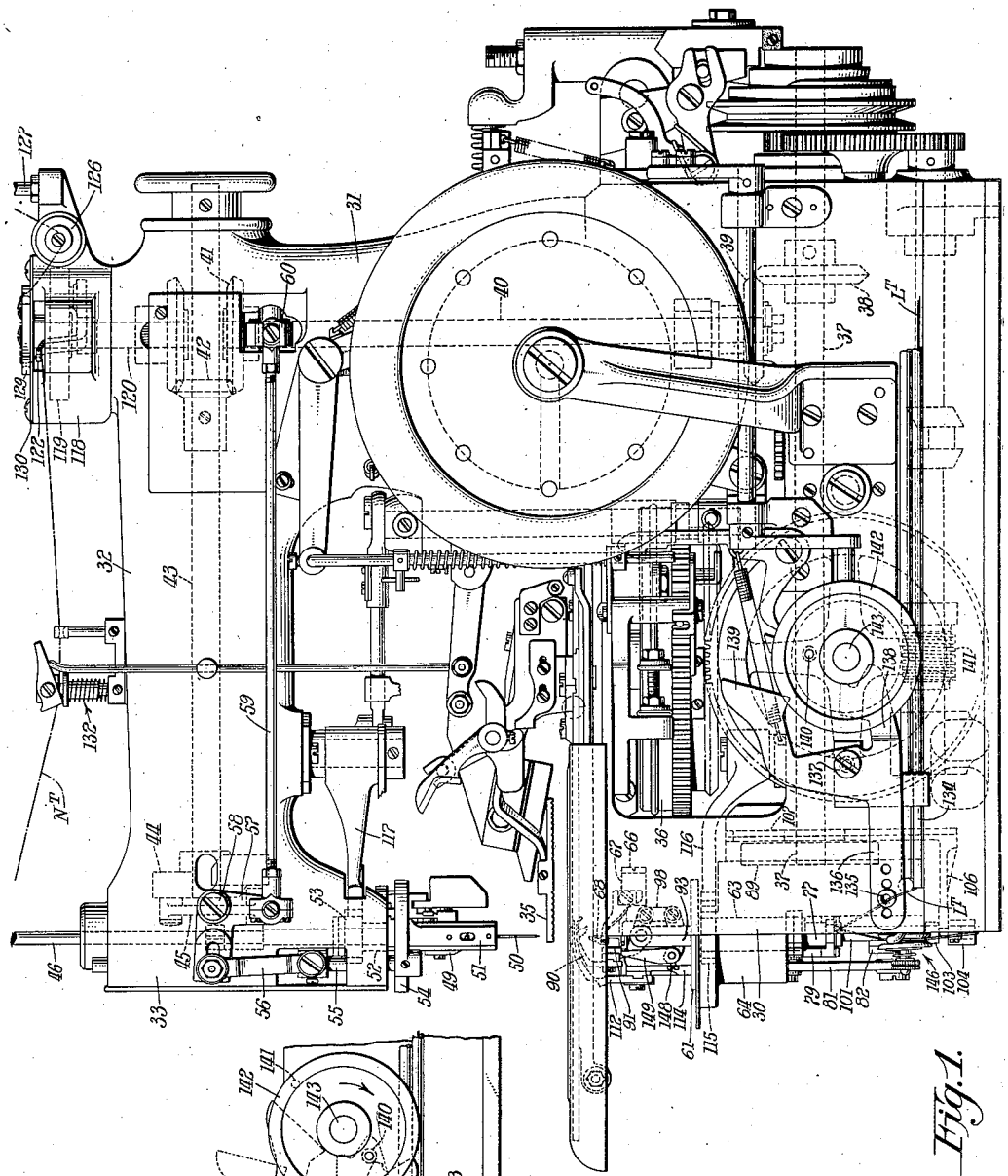

Fig. 1.

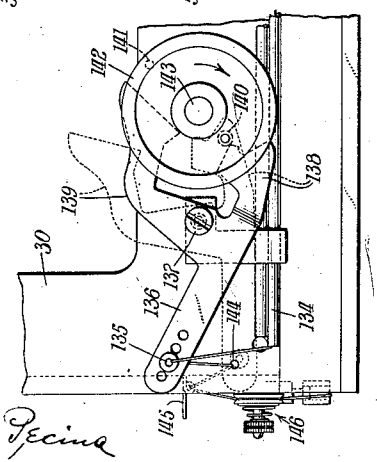

Fig. 2.

Witness:
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March 2, 1948. E. P. SPAINE 2,437,052

THREAD-CONTROLLER FOR SEWING MACHINES

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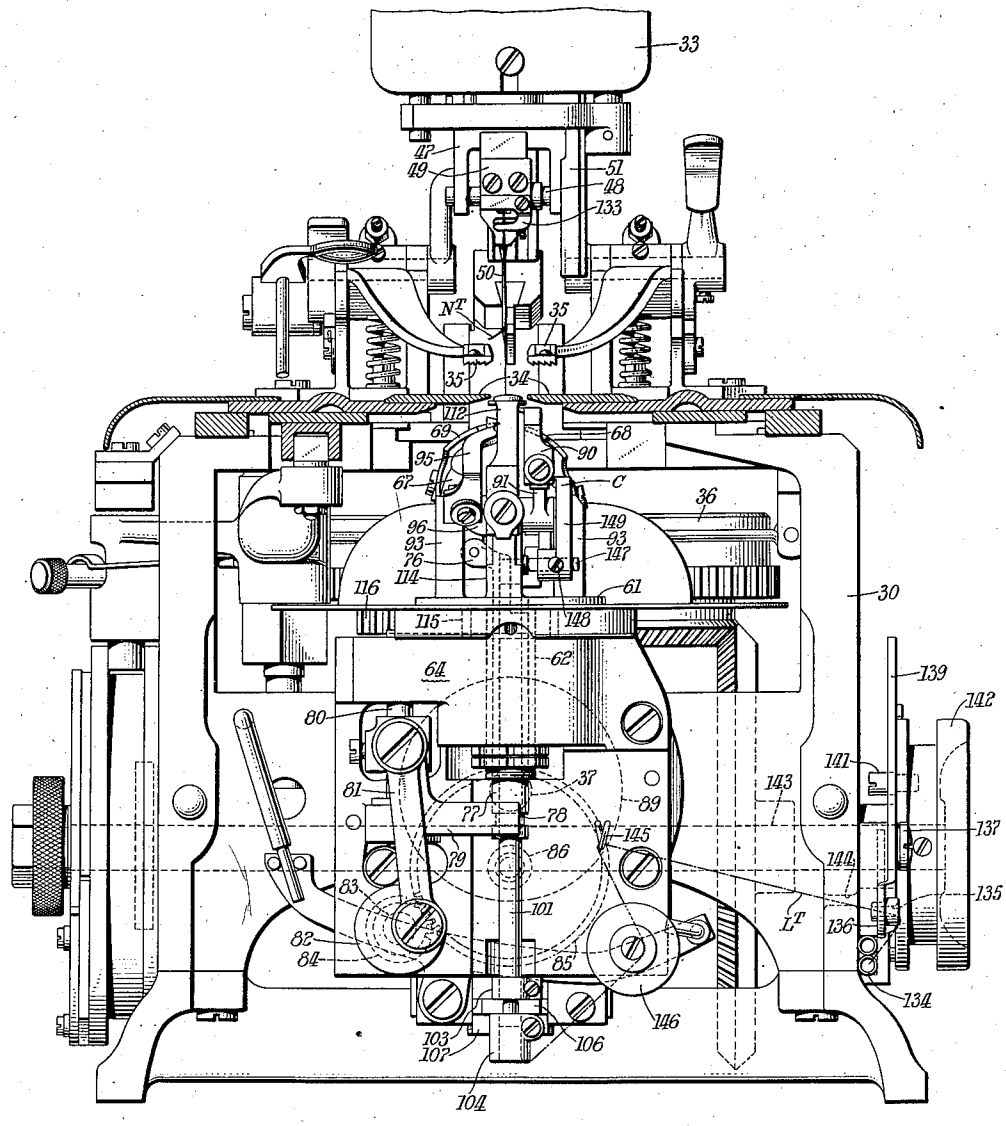

Fig. 3.

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THREAD-CONTROLLER FOR SEWING MACHINES

Filed May 18, 1946 7 Sheets-Sheet 3

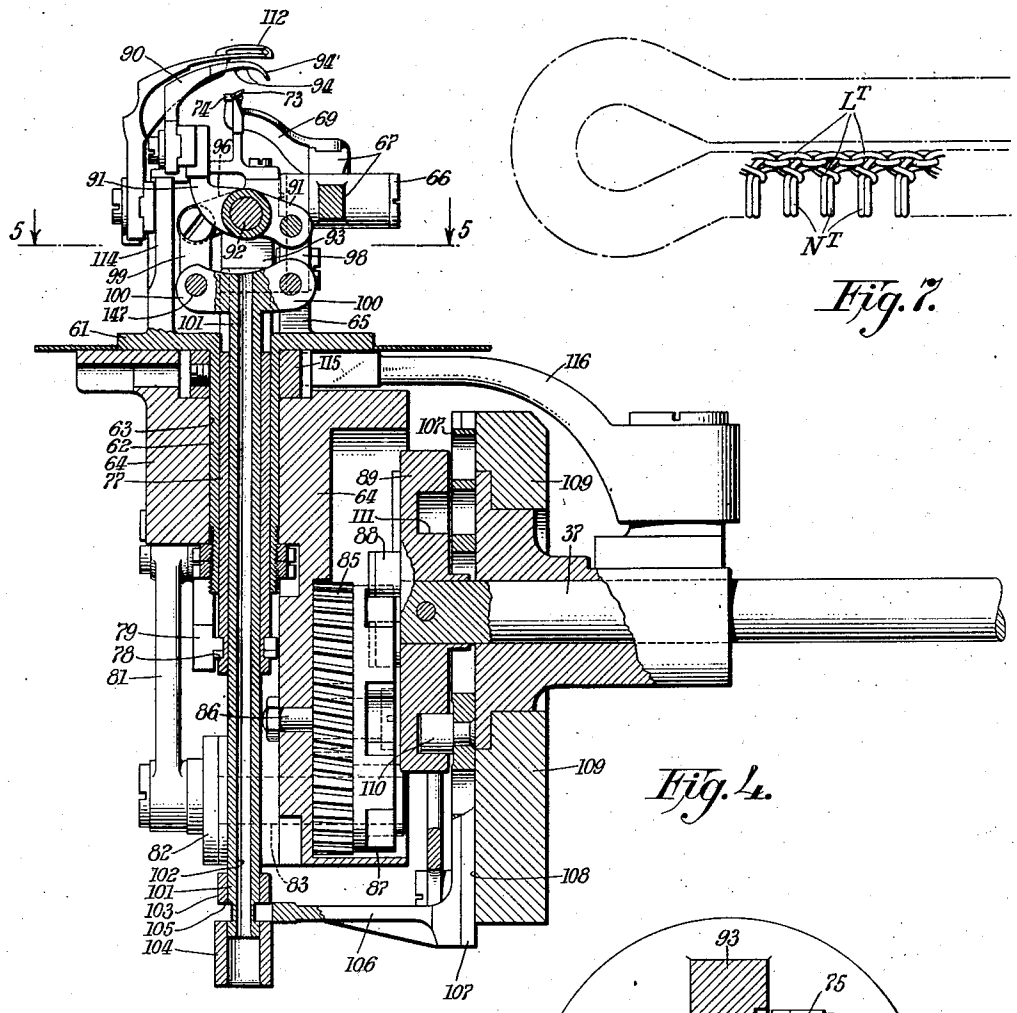

Fig. 4.

Fig. 7.

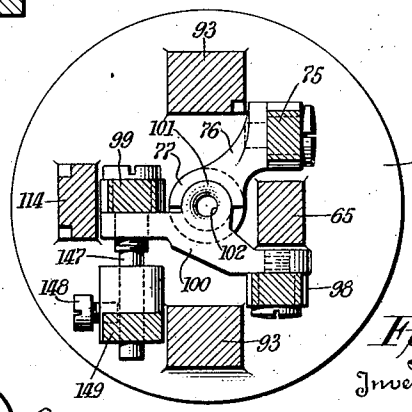

Fig. 5.

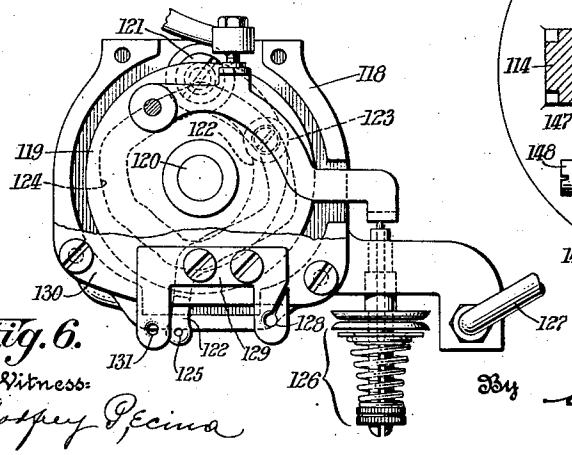

Fig. 6.

Witness:
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March 2, 1948. E. P. SPAINE 2,437,052

THREAD-CONTROLLER FOR SEWING MACHINES

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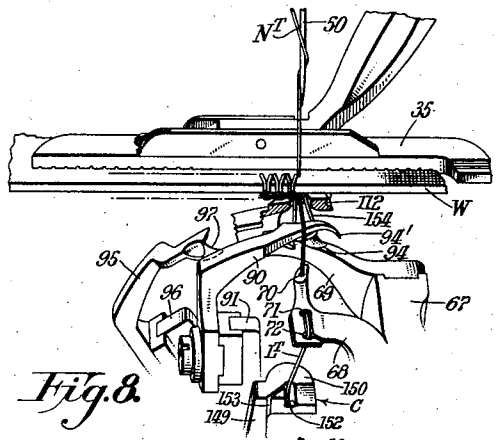


Fig. 8.

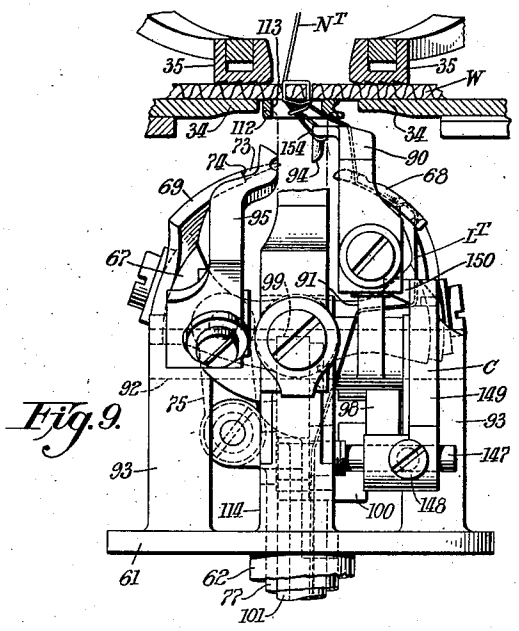


Fig. 9.

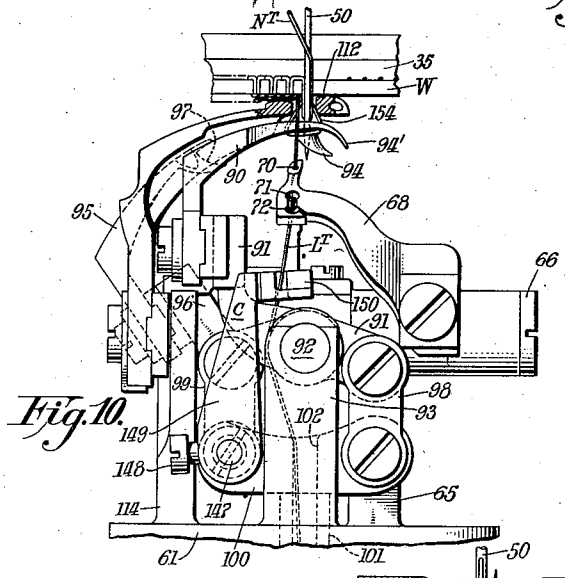


Fig. 10.

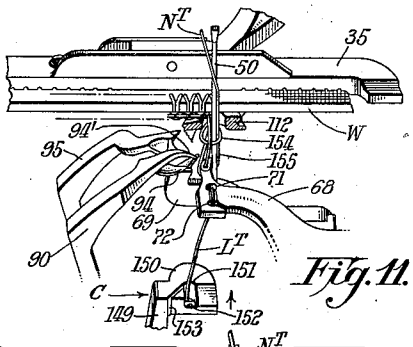


Fig. 11.

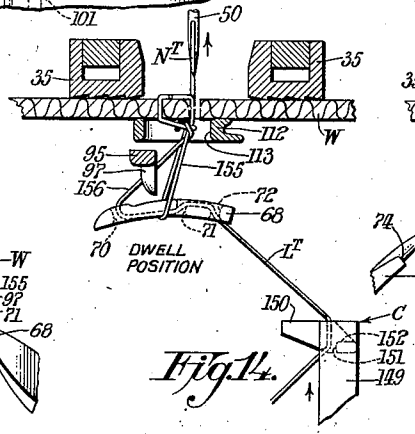


Fig. 14.

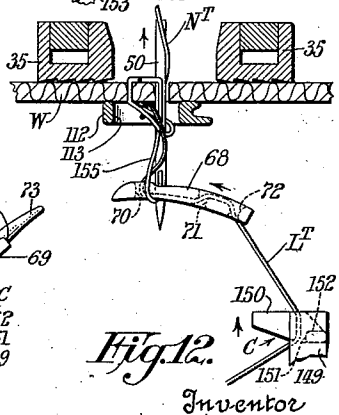
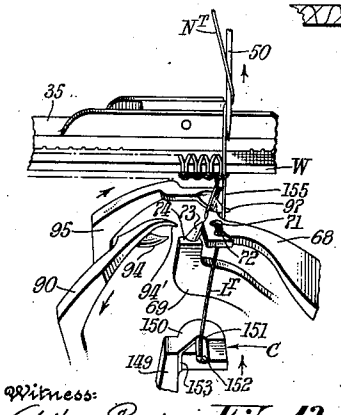


Fig. 12.



Witness:
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Fig. 13.

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March 2, 1948. E. P. SPAINE 2,437,052

THREAD-CONTROLLER FOR SEWING MACHINES

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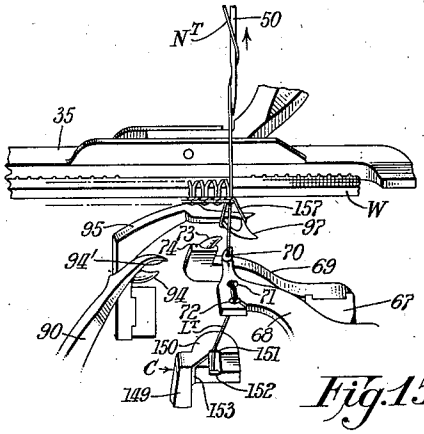

Fig. 15.

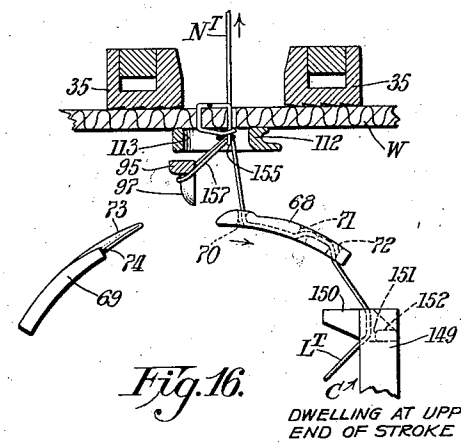

Fig. 16.

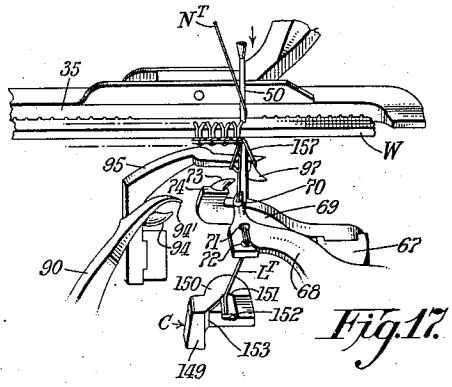

Fig. 17.

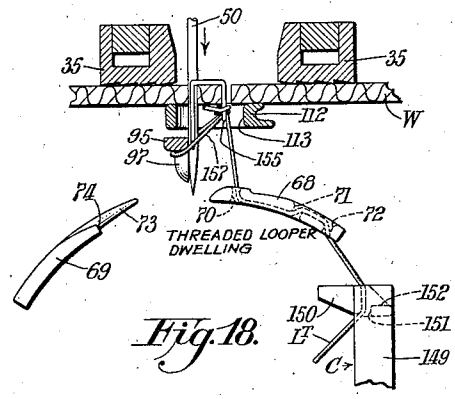

Fig. 18.

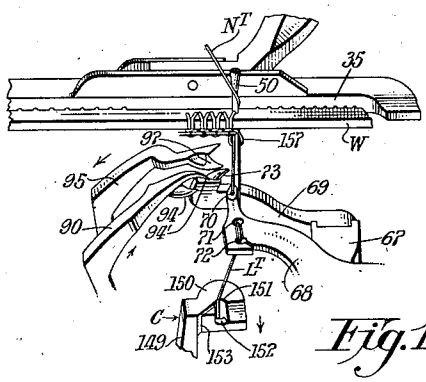

Fig. 19.

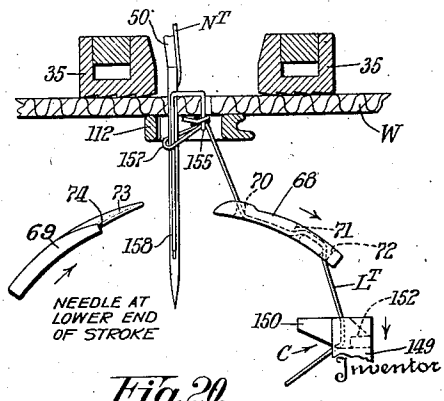

Fig. 20.

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THREAD-CONTROLLER FOR SEWING MACHINES

Filed May 18, 1946 7 Sheets-Sheet 6

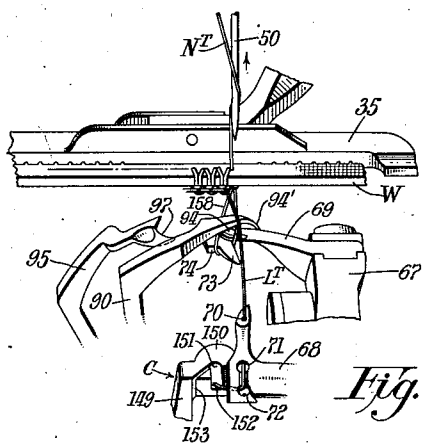

Fig. 21.

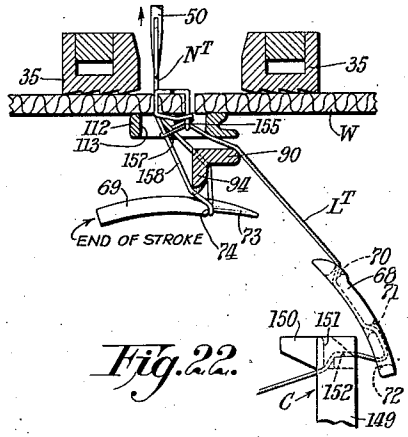

Fig. 22.

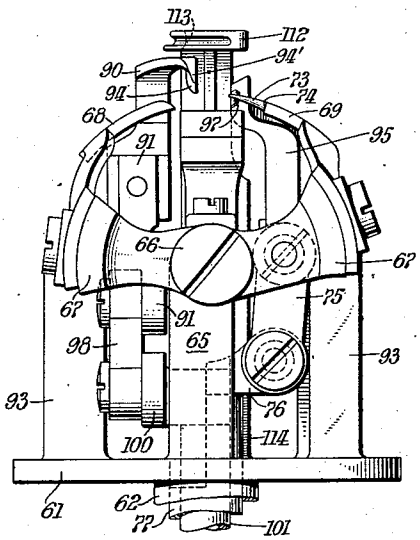

Fig. 23.

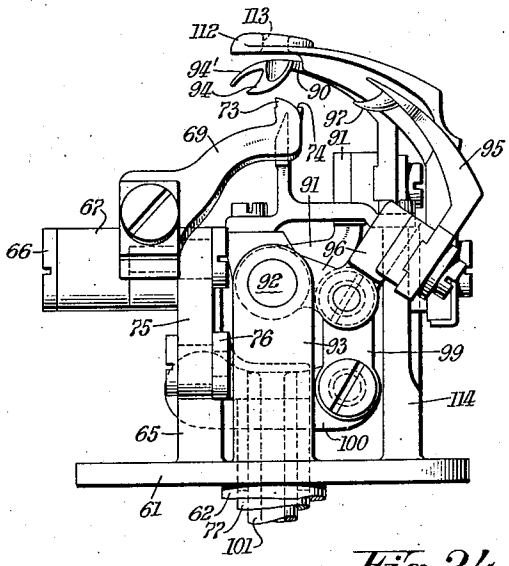

Fig. 24.

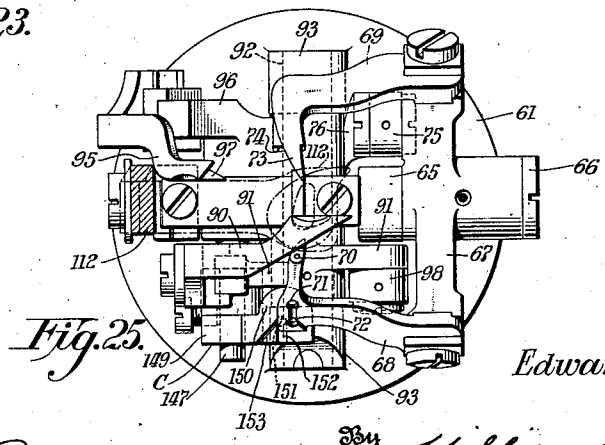

Fig. 25.

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THREAD-CONTROLLER FOR SEWING MACHINES

Filed May 18, 1946 7 Sheets-Sheet 7

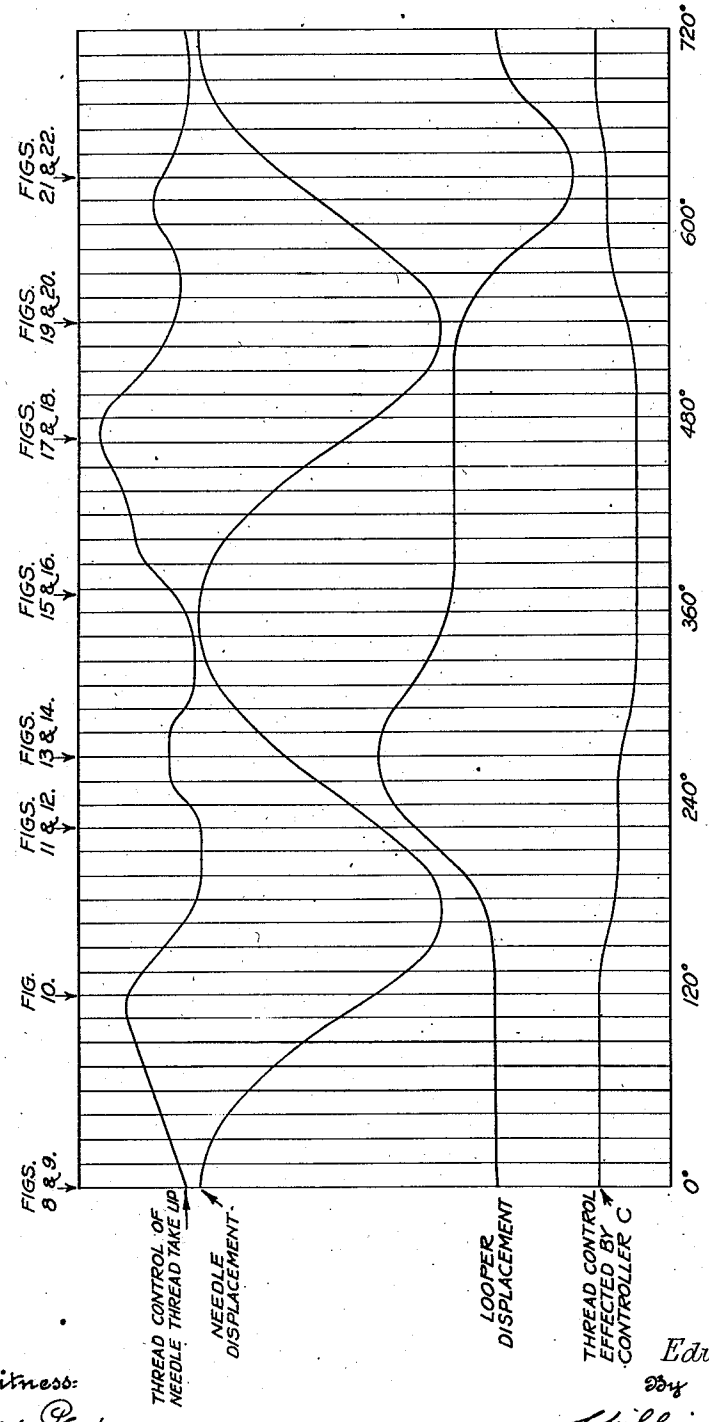

Fig. 26.

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Patented Mar. 2, 1948

2,437,052

UNITED STATES PATENT OFFICE

2,437,052

THREAD-CONTROLLER FOR SEWING MACHINES

Edward P. Spaine, Bridgeport, Conn., assignor to The Singer Manufacturing Company, Elizabeth, N. J., a corporation of New Jersey

Application May 18, 1946, Serial No. 670,801

9 Claims. (Cl. 112—241)

1

This invention relates to sewing machines and particularly to the means for manipulating and controlling the under thread of a two-thread sewing machine during the stitch-forming cycle in order that the under thread will not be subjected to excessive strains during its actual concatenation with the needle thread.

In buttonhole sewing machines it is desirable that the under or looper thread be accurately controlled to the extent of having a very light but sufficient tension applied thereto during the entire stitch-forming cycle so that, first, the usual purl can be accurately positioned relatively to the buttonhole slit, second, a better thread-luster on the finished buttonhole can be assured due to the absence of excessive thread-tension during the critical periods of stitch-formation, third, poorer grades of cotton needle threads can be used because of the fact that the various loops of one of the sewing threads formed about the other sewing thread during the concatenation of the threads are not prematurely closed and consequently do not effect a "choking" action on the thread and, fourth, a very heavy looper thread can be employed because of the ready and proper yielding of the accurately controlled and lightly tensioned looper thread, which heavy looper thread can be used to good advantage in the production of so-called imitation hand buttonholes.

I accomplish this object by providing a thread-controlling means properly located and timed with respect to the movable thread-carrying looper as to differentially modify the action of the looper on the thread to the extent that, during the entire stitch-forming cycle, the looper thread is subjected to a uniform light tension or control essential to the successful high speed operation of a two-thread chain-stitch buttonhole sewing machine.

In buttonhole sewing machines of the type herein illustrated, the under or looper thread mechanism is usually supported on a rotary turret situated beneath the work, the under thread mechanism including an oscillatory thread-carrying looper and complemental loop-retainers which are actuated by a reciprocatory hollow driving bar. The looper thread, in its passage from its source of supply to the looper, travels through the hollow loop-retainer driving bar and then to the heel of the thread-carrying looper. The hollow reciprocatory loop-retainer driving bar and the oscillatory looper effect a varying take-up action or control on the looper thread during each stitch-forming cycle. This control

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is inadequate for successful operation of the stitch-forming devices.

In the present embodiment of my invention I have shown a preferred construction in which an additional thread-controlling element is fastened to the reciprocatory loop-retainer driving bar; said thread-controlling element being disposed to engage the looper thread between the thread-delivery end of the loop-retainer driving bar and the heel of the oscillatory looper. The position of the additional thread-controlling element relative to the loop-retainer driving bar and the heel of the looper is such as to combine its take-up action with that of the loop-retainer driving bar and the looper additively during a portion of a stitch-forming cycle and subtractively during another portion of the cycle. As a net result, the three movable elements insure the desired yielding of the looper thread at the required times and the desired take-up action on the thread in completing a stitch at the right times, without leaving any uncontrolled slack in the thread at any time.

For the practical operation of a two-thread sewing machine, it is necessary also that an accurate control of the needle-thread be exercised. To that end, the machine illustrated is equipped with a cam-actuated take-up constructed substantially in accordance with the disclosure in my U. S. Patent No. 2,165,016, dated July 4, 1939.

In order to give a complete understanding of the present invention I have illustrated in the drawings a selected embodiment thereof which will now be described after which the novel features will be pointed out in the appended claims.

Fig. 1 is a right side elevational view of a buttonhole machine embodying the invention.

Fig. 2 is an elevational view of the looper thread stitch-by-stitch pull-off mechanism employed for drawing from the looper thread supply a length of thread sufficient to complete each stitch, the thread arm being shown in full lines in its maximum pull-off position and in dotted lines in its retracted position.

Fig. 3 is a front end elevational view of the machine shown partly in section.

Fig. 4 is a longitudinal vertical sectional view of the looper thread mechanism, showing the details of the actuating connections therefor.

Fig. 5 is an enlarged horizontal sectional view taken substantially along the line 5—5, Fig. 4.

Fig. 6 is a top plan view of the needle thread take-up device, with the top cover plate broken

away to more clearly show the development of the actuating cam.

Fig. 7 is a fragmentary view of a portion of a buttonhole, illustrating the way in which the purl-concatenations are uniformly and tightly set close to the buttonhole slit.

Fig. 8 is a view, partly in section, of the stitch-forming mechanism, showing several stitches completely formed in a fragment of work held in the work-clamp and the components of the stitch-forming mechanism and the sewing threads in position to begin the formation of the next stitch.

Fig. 9 is a front elevation of the turret with the work-clamp and needle-throat member in section, showing the stitch-forming mechanism components and sewing threads in position at the commencement of a stitch-forming cycle.

Fig. 10 is a right side elevation of the turret with the needle-throat member in section, showing the first step in the stitch-forming cycle in which the needle has descended to begin the slit-stitch and entered the spread loop of needle thread detained by the right hand loop-retainer.

Fig. 11 illustrates the stitch-forming devices in their next position of stitch-formation, the detained needle-thread-loop having been released by the right hand loop-retainer and the thread-carrying looper having advanced and entered the next needle-thread-loop cast out by the ascending needle.

Fig. 12 is a front elevation, partly in section, of the parts shown in Fig. 11.

Fig. 13 shows the next position of stitch-formation in which the thread-carrying looper has traveled to the end of its needle-thread-loop-seizing stroke and in so doing has positioned a limb of its own thread for seizure by the advancing left hand loop-retainer.

Fig. 14 is a front elevation, partly in section, of the parts shown in Fig. 13.

Fig. 15 shows the position of the stitch-forming devices at substantially the completion of the slit-stitch, in which position the looper-thread-loop is detained on the left hand loop-retainer.

Fig. 16 is a front elevation, partly in section, of the parts shown in Fig. 15.

Fig. 17 shows the next position of stitch-formation in which the needle has penetrated the work to form the depth-stitch and has entered the looper-thread-loop held spread by the left hand loop-retainer.

Fig. 18 is a front elevation, partly in section, of the parts shown in Fig. 17.

Fig. 19 shows the needle at the bottom of its depth-stitch stroke, the looper-thread-loop having been released by the left hand loop-retainer and the loop being taken up by the retracting thread-carrying looper and my improved thread-controller.

Fig. 20 is a front elevation, partly in section, of the parts shown in Fig. 19.

Fig. 21 illustrates the parts in the position after the non-threaded looper has seized the needle-thread-loop cast out by the needle and presented said seized loop for engagement by the advancing right hand loop-retainer.

Fig. 22 is a front elevation, partly in section, of the parts shown in Fig. 21.

Fig. 23 is a rear elevational view of the turret, showing the details of the looper oscillating connections.

Fig. 24 is a left side elevational view of the turret.

Fig. 25 is a top plan view of the turret, with the shank of the needle-throat-member in section and the remainder of the needle-throat-member shown in dotted lines.

Fig. 26 is a development showing the action of the needle, needle-thread take-up, thread-carrying looper and my thread controller on the two sewing threads during the complete stitch-forming cycle covering 720 degrees rotation of the arm-shaft of the sewing machine.

Referring in detail to the accompanying drawings, the invention is shown as embodied in a machine of the buttonhole type having, in general, constructive features which are substantially in accordance with the disclosure of the U. S. patent to Allen, No. 15,324, reissued April 4, 1922. The machine-frame is formed with a hollow box-like bed 30 from the rear end of which rises a standard 31 of an overhanging bracket-arm 32 terminating in a head 33. Supported on the bed 30 is the usual traveling work-holder comprising the lower work-supporting plates 34 and the upper clamping members 35, to which work-holder longitudinal feeding and sidewise shifting movements are imparted for spacing the stitches of a buttonhole. The work-holder is moved relative to the stitch-forming mechanism during the sewing period as well as prior and subsequent to the sewing period by the usual connections with the feed-wheel 36, as disclosed in said Allen reissued Patent No. 15,324.

The stitch-forming mechanism is constructed substantially in accordance with the disclosure of the Allen et al. Patent No. 1,372,473, dated Mar. 22, 1921. It is driven by means including a main sewing shaft 37, Fig. 1, journaled within and lengthwise of the bed 30, which main shaft 37, through one-to-one bevel gears 38, 39, drives a vertical shaft 40 journaled within the standard 31. The shaft 40 has a one-to-two speed-multiplying bevel-gear driving connection 41, 42 with an upper or needle-bar-reciprocating shaft 43 which is journaled within and extends lengthwise of the bracket-arm 32 and has the usual crank 44 and link-connection 45 with a vertically reciprocatory hollow needle-bar 46 mounted in the head 33.

The hollow needle-bar 46, Figs. 1 and 3, has fixed to its lower end a yoke 47 carrying a cross-pin 48 on which is slidably mounted a needle-clamp-block 49 and embracing at its upper end the horizontal portion of the yoke 47. The block 49 carries an eye-pointed thread-carrying needle 50. During its reciprocation, the yoke 47 is steadied by a vertical guide-member 51 depending from the lower end of a needle-bar bearing bushing 52 journaled in the head 33 and having a pinion 53 fixed to its upper end, whereby turning movements may be imparted to it, as in stitching around the eyelet-end of a buttonhole. As fully explained in the Allen et al. Patent No. 1,372,473, the needl-clamp-block 49 is adapted to be laterally vibrated on the cross-pin 49 through suitable connections with an internally grooved ring-member 54 fixed to the lower end of a vertical slide-rod 55, Fig. 1, journaled in the head 33. The slide-rod 55 is reciprocated by means of a link 56 adjustably and pivotally secured to the slotted limb of a bell-crank lever 57 fulcrumed at 58 on the head 33. The other limb of the bell-crank lever 57 is connected by a link 59 to an arm 60 fulcrumed at its rear end on the bracket-arm 32 and actuated by an eccentric fast on the vertical shaft 40, in a manner fully disclosed in the above mentioned Allen et al. Patent No. 1,372,473.

Cooperating with the endwise reciprocatory and laterally shiftable needle 50, in the formation of stitches, are under thread-handling implements supported in the usual manner on a rotary turret 61 having a tubular shank 62 journaled in a vertical bearing aperture 63, Fig. 4, in a frame-block 64 detachably secured to the machine-bed 30. Extending upwardly from the turret 61 is a post 65 into the upper extremity of which is threaded a horizontal pivot-screw 66 on which is fulcrumed a looper-carrier 67 formed with oppositely extending arms to which are rigidly secured the threaded and non-threaded loopers 68 and 69. The threaded looper 68 is provided adjacent its point or beak with a thread-eye 70 and in its heel with a pair of thread-eyes 71 and 72. The non-threaded looper 69 is formed with a loop-seizing beak 73 at the opposite sides of the base of which are formed loop-arresting shoulders 74.

The actuating connections for the loopers 68 and 69 comprise a link 75 secured at its upper end to one arm of the looper-carrier 67, Figs. 23 and 24, and at its lower end to the offset head 76 formed on the upper end of a tubular rod 77, Fig. 4, fitted to slide within the tubular shank 62 of the turret 61. At its lower end the tubular rod 77 is formed with a circumferential groove 78 which is entered by the forked extremity of an arm 79, Fig. 3, clamped on a guide-rod 80 journaled to slide vertically in bearing lugs provided on the frame-block 64. The arm 79 is thus adapted to lift and lower the tubular rod 77 and thereby rock the looper-carrier 67 about its fulcrum-stud 66. The means for raising and lowering the arm 79 preferably includes a link 81, Figs. 3 and 4, connected at its lower end to a crank 82 carried on the forward end of a short shaft 83 journaled in the frame-block 64. At its inner end, the shaft 83 carries a pinion 84 meshing with a gear 85 of triple its size supported by a stud 86 carried by the frame-block 64. Secured to the rear face of the gear 85 is a star-wheel 87 which has imparted to it step-by-step turning movements by means of a pair of driving pins 88 arranged diametrically of a driving disk 89 secured to the main sewing shaft 37. As fully explained in the above mentioned U. S. Patent No. 1,372,473, the teeth of the star-wheel 87 are shaped such wise as to produce periods of appreciable dwell between the periods of motion of the star-wheel. During these periods of dwell the crank 82 is held stationary at one or the other of its positions midway between its extreme up and down positions, thus arresting the motion of the loopers midway between the extremes of their strokes to avoid interference with the loop-retainers now to be described.

Cooperating with the threaded looper 68 is a loop-retainer 90 hereinafter referred to as the right hand loop-retainer. As shown in Figs. 4, 10, 23 and 25, the right hand loop-retainer 90 is mounted on a carrier-lever 91 fulcrumed to oscillate about a horizontal pin 92 supported at its opposite ends by the spaced vertical posts 93 extending upwardly from the turret 61. At its free end the right hand loop-retainer 90 is formed with a curved and pointed loop-seizing horn 94 which, as will be explained later, functions to enter and retain control of a needle-thread-loop presented to the loop-retainer by the non-threaded looper 69. Overlying the horn 94 is a curved pilot 94' which functions to deflect the looper thread above the horn 94 when the loop-retainer 90 is advancing to enter the needle-thread-loop.

Adjacent the right hand loop-retainer 90 is a second or left hand loop-retainer 95, Fig. 24, mounted on a carrier-lever 96 also fulcrumed on the horizontal pin 92. Like the first loop-retainer 90, the second loop-retainer 95 is formed at its free end with a curved and pointed loop-seizing horn 97. The two loop-retainers 90 and 95 are oscillated on their common fulcrum-pin 92 by means including two links 98 and 99, Fig. 4, connected at their upper ends to the carrier-levers 91 and 96 and at their lower ends to the opposite ends of a cross-head 100. The cross-head 100 is preferably integral with the upper end of a rod 101 bored longitudinally to provide a looper-thread passageway 102. The rod 101 is slidingly fitted within the tubular rod 77 and has clamped to its lower end two collars 103 and 104 spaced to provide a circumferential groove 105 adapted to receive the forked extremity of an actuator arm 106 projecting forwardly from a slide-plate 107 fitted to a slideway 108 in the transverse bed-partition 109. The slide-plate is caused to reciprocate in the slideway 108 by a roller 110 carried by the slide-plate and tracking a suitable cam-groove 111 cut in the rear face of the driving disk 89. Through the connections just described it will be understood that rotation of the main sewing shaft 37 causes the driving disk 89, through the star-wheel 87, to impart to the threaded and non-threaded loopers 68 and 69 a variable motion and at the same time, through the cam-groove 111, to actuate the right and left hand loop-retainers 90 and 95 in proper sequence to effect stitch-formation.

To properly support the work W at the stitching point, there is provided the usual needle-throat-member or button 112 apertured at its upper free end, as at 113, to provide needle-clearance, and adjustably supported at its lower end on a vertical post 114 integral with the turret 61. The needle-throat-member 112, when correctly mounted, lies directly above and very close to the path of movement of the retainer-horns 94 and 97 which, it will be seen, operate at an elevation between the loopers 68 and 69 and the throat-member 112.

The mechanism for turning the stitch-forming mechanism in stitching around the eyelet-end of a buttonhole is constructed substantially in accordance with the disclosure in the E. B. Allen Patent No. 1,162,207, Nov. 30, 1915. Suffice it to say that the needle-bar mechanism carries a gear 53, Figs. 1 and 4, and the turret carries a similar gear 115, these gears having in mesh therewith two gear-segments 116 and 117 connected together by mechanism deriving its actuation from the feed-wheel 36.

To control the needle thread N^T, the present machine has mounted on top of the bracket-arm 32 a common form of thread take-up mechanism disclosed, for instance, in my U. S. Patent No. 2,165,016, July 4, 1939. The take-up mechanism includes a housing 118, Figs. 1 and 6, enclosing a take-up cam 119 which is mounted on a shaft 120 gear-driven by the needle-bar reciprocating shaft 43. Pivotally mounted at 121, Fig. 6, in the housing 118 is a take-up lever 122 carrying intermediate its ends a follower roll 123 which enters the take-up cam-groove 124. The take-up lever 122 has at its free end a thread-eye 125 which acts upon the needle thread N^T between a conventional tension device 126 and the hollow needle-bar 46 through which the needle thread runs to the needle 50. As shown in Figs. 1 and 6, the needle thread N^T travels from a source of

supply through a guide hole (not shown) in a post 127, thence between the disks of the tension device 126, thence up through a fixed thread-eye 128 in one limb of a U-shaped plate 129 fast on the housing cover-plate 130 and then down through a fixed thread-eye 131 in the other limb of the plate 129 and through the take-up thread-eye 125, thence forwardly through the open thread-nipper 132 and down through the hollow needle-bar 46 into the thread-retainer 133, Fig. 3, and then to the needle 50. It will be appreciated that for perfect stitch-formation an accurate control of the needle thread must be maintained and that the control exercised must bear a definite relation to that applied to the looper thread. Such a control of needle thread is accomplished with the aid of the take-up cam-groove 124 which is preferably cut to operate the take-up lever 122 so that its thread requirements are as indicated in Fig. 26.

The course of travel of the looper thread L^T is best shown in Figs. 1, 2 and 3. From a supply, the looper thread passes through a guide-tube 134, thence through a thread-eye 135 provided in the free end-portion of a thread pull-off lever 136 frictionally fulcrumed at 137 on the bed 30. The thread pull-off lever 136 is oscillated about its fulcrum 137 from the dotted line position to the full line position, Fig 2, by the alternate engagement of the spaced arms 138 and 139 by the two pins 140 and 141 carried on a disk 142 fast on a cross-shaft 143, in a manner fully shown in U. S. Patent No. 2,210,638, Aug. 6, 1940. One complete stroke is imparted to the thread pull-off lever 136 during the complete buttonholing cycle, the length of slack looper thread thus provided being sufficient to complete the stitching cycle. From the thread-eye 135, the looper thread runs through a guide-hole 144, Figs. 2 and 3, in the bed 30, thence through a "self-threading" wire thread-guide 145 to and through the regular tension device 146, and then up through the bore 102 of the loop-retainer actuating rod 101. In prior machines it has been customary to lead the looper thread L^T directly from the upper end of the hollow rod 101 to and through the thread-eyes in the threaded looper 68. The thread-controlling action obtained by the reciprocatory loop-retainer driving bar 101 and the oscillatory looper 68 only approximated that required and, to satisfactorily handle the looper thread, resilient check-springs and other similar devices had to be employed. These devices improved the thread-handling to some extent, but were not entirely satisfactory.

The present invention contemplates the use of a thread-controller, indicated generally as C, disposed to operate on the looper thread as it passes from the upper end of the loop-retainer driving bar 101 to the heel of the thread-carrying looper 68. The improved thread-controller is adapted to be carried by the loop-retainer driving bar 101 and therefore partakes of the vertical reciprocation thereof. The resultant movement of the controller working in conjunction with the oscillatory thread-carrying looper 68 and with other of the movable elements of the under thread handling mechanism forms a bight in the looper thread which varies in size. The effect of this varying bight is a control of the looper thread L^T such that the thread is devoid of excessive strains at the critical points in the stitch-forming cycle. Referring to Figs. 3, 9 and 10, the pivot-stud, which secures the loop-retainer carrier-lever link 99 to the cross-head 100, is formed with an extension 147 on which is adjustably clamped by means of a screw 148 the lower end of the shank 149 of my improved looper-thread-controller. At the upper end, the shank 149 terminates in an offset head 150 formed with a vertically disposed aperture 151, Fig. 13, intersected by a slot 152 cut in the top face of the offset head 150, the aperture and slot providing a thread-eye through which the looper thread travels. To facilitate threading the aperture 151, there is provided a threading-slot 153 through which the looper thread can be laterally introduced into the aperture. It will be understood that the extension 147 is sufficiently long to permit sidewise adjustment of the thread-controller in a direction parallel to the plane of vibration of said needle 50, which adjustment is provided to compensate for extreme variations in the lateral vibration or bight of the needle. The illustrated form of thread-controller mounting also provides for allowing a small degree of circular adjustment of the controller-element about the axis of the extension 147.

To aid in describing a cycle of operations of the stitch-forming mechanism, attention is directed to Figs. 8 through 22, inclusive. Let it be understood that in the present case a complete stitch-forming cycle includes two complete reciprocations of the needle, the cycle beginning with the needle in raised position preparatory to descending to form the so-called slit-stitch. Since two reciprocations of the needle are included in the complete stitch-forming cycle, the arm-shaft 43 rotates through 720 degrees. With this in mind, assume now that the machine has produced several stitches and that the parts are in the position shown in Figs. 8 and 9, with a loop 154 of needle thread detained and held spread on the horn 94 of the right hand loop-retainer 90, and with the thread-carrying looper 68 in a position of dwell awaiting the descent of the needle 50 to begin the slit-stitch. With the parts in these positions, the thread-controller C is also in a state of dwell since it is mounted on the loop-retainer driving rod 101 which, as mentioned above, is stationary at this time. Continuing with the cycle, the needle 50 now descends through the work W and enters the needle-thread-loop 154 detained by the horn 94 of the right hand loop-retainer 90 (Fig. 10). During the descent of the needle 50 toward the work W, the needle thread take-up lever 122 is actuated in a direction to absorb the slack in the needle thread produced by the descending needle-bar. When the needle-point penetrates the work, the needle thread take-up lever 122 is quickly moved in the opposite direction, thereby yielding thread, first, to insure against excessive needle thread strain as the needle-eye passes through the work and, second, to relieve the needle thread of tension so as to facilitate the shedding of the needle-thread-loop 154 held by the horn 94 of the right hand loop-retainer 90 after the needle 50 has entered the detained needle-thread-loop 154, Fig. 10. The slackness of the needle thread is maintained until the needle reaches the bottom of its stroke and begins to ascend to cast out its thread-loop 155, Fig. 11. After the needle 50 has entered the detained needle-thread-loop 154, Fig. 10, the right hand retainer 90 is retracted, leaving the needle-thread-loop 154 about the needle 50, as shown in Fig. 11. The needle 50 then travels to the bottom of its stroke, after which it begins to ascend, casting out the needle-thread-loop 155 which is entered by the advancing thread-carry-

ing looper 68, as shown in Figs. 11 and 12. As the looper 68 passes the needle 50 in its loop-seizing stroke, the needle thread take-up lever 122 is operated to take up a slight amount of thread to partially close the cast-out needle-thread-loop 155, thereby preventing said loop 155 from twisting in a direction away from the beak of the looper 68 and also to provide a purchase on the needle-thread enabling the needle-bar better to work in drawing up the preceding needle-thread-loop 154 to the inside edge of the purl formation. After the looper 68 enters the cast out needle-thread-loop 155, the needle 50 is withdrawn from the work and the looper 68 continues in its advance until it reaches the end of its loop-seizing stroke, Figs. 13 and 14.

During the movement of the parts from the positions shown in Fig. 11 to the positions shown in Fig. 14, the thread-controller C moves upwardly to assist in giving some slack looper thread to the advancing thread-carrying looper 68. But, near the end of the advancing stroke of the looper 68, a sufficient bight is formed in the looper thread (Fig. 14) to effect a control action on the looper thread. This control action results in a straightening of the limb 156 of looper thread extending from the thread-eye 70 in the looper 68 to the previous stitch in the work (Fig. 14), thus positioning the limb 156 across the path of movement of the loop-retainer 95 so that the horn 97 of the loop-retainer unerringly seizes said thread-limb 156. After seizure of the looper-thread-limb 156 by the left hand loop-retainer 95 (Figs. 13 and 14), the continued upward movement of the thread-controller C and the bodily upward movement of the loop-retainer driving bar 101 provide slack looper thread for the formation of the looper-thread-loop 157 (Figs. 15 and 16) which is detained by the horn 97 of the left hand loop-retainer 95 after the thread-carrying looper 68 has retracted far enough to release the needle-thread-loop 155. Continued retraction of the thread-carrying looper 68 provides additional slack looper thread, which slack thread is augmented slightly by the continued upward movement of the thread-controller C so that sufficient tension-free looper thread is furnished to permit the needle-thread-loop 155, cast off by the looper 68, to be pulled up in response to the needle thread take-up action, to the purl-forming position at the under side of the work, as shown in Fig. 16. As the needle-thread-loop 155 is pulled up to its purl-forming position, it carries with it the looper thread forming the thread-loop 157 (Fig. 16). The amount of looper thread made available by the thread-controller and the thread-carrying looper 68 is sufficient so that when the needle-thread loop 155 is pulled up to purl-forming position, the looper-thread-loop 157 on the horn 97 of the left hand loop-retainer 95 is caused to slide up the horn into the throat thereof (Fig. 15), thus opening or spreading the looper-thread-loop 157 for positive entrance by the descending needle 50 on its next work-penetrating stroke, as shown in Figs. 17 and 18. It is desirable that the looper thread be properly controlled at this critical time in the cycle, for if the looper thread is under-controlled and there is too much slack looper thread the thread-loop 157 on the loop-retainer horn 97 will not be drawn up into the throat of the horn. Consequently, the thread-loop 157 will not be spread sufficiently to insure the unerring entrance thereof by the needle. Further, if the looper thread is over-controlled at this time, the thread will be excessively tensioned and therefore the thread-loop 157 will not cast free of the loop-retainer horn 97 at the correct instant, but will hang on the horn causing either a stealing of looper thread from the supply or a pulling down of the previous needle-thread-loop 155 from its purl-forming position. This pulled down or displaced needle-thread-loop 155 must be reset. This resetting however cannot always be accomplished and particularly when the pull on the thread, resulting in the displacement of the previous needle-thread-loop 155, has closed or tightened any of the previous unset thread-loops. Later in the stitch forming cycle, the failure in resetting the needle-thread-loop 155 into its normal purl-forming position up against the under side of the work (Figs. 21 and 22) will result in lowering the lead of that portion of the looper thread L^T, extending from the needle-thread-loop 155 to the looper-thread-eye 70, to a position below the level of the point of the pilot 94' on the advancing right hand loop-retainer 90. Should this occur, the looper thread will be engaged by the advancing loop-retainer 90 and pushed to an abnormal position, i. e. from one side to the other side of the needle 50. This causes an abnormal concatenation of the sewing threads and results in a malformed or rough purl.

When the needle-thread-loop 155 has been properly pulled up to purl-forming position and the looper-thread-loop 157 is detained on the horn 97 of the left hand loop-retainer 95 (Fig. 16), the thread-controller C is positioned at the top of its stroke. The needle 50 now descends to start the depth or bight stitch, penetrating the work W and entering the looper-thread-loop 157, as shown in Figs. 17 and 18. After the needle 50 has entered the looper-thread-loop 157, the left hand loop-retainer 95 is retracted, causing the horn 97 thereof to shed the loop 157 on the needle 50. The needle then continues to the bottom of its stroke and begins its ascent to cast out a needle-thread-loop 158. The non-threaded looper 69 now advances in the direction indicated by the arrow in Fig. 20, to seize the needle-thread-loop 158 cast out by the needle. After seizure of the thread-loop 158 by the beak 73 of the non-threaded looper 69, the needle 50 is withdrawn from the work W and the non-threaded looper 69 carries the needle-thread-loop 158 to the right as shown in Fig. 22, thereby to position it for entrance by the horn 94 of the right hand loop-retainer 90. During the movement of the parts from the position shown in Fig. 18 to the position shown in Fig. 22, the looper-thread-controller C moves downwardly and augments the take-up action of the threaded looper 68 and the loop-retainer driving bar 101 to the extent of, first, properly reducing the looper-thread-loop 157 about the needle and, second, of taking up the slack looper thread created by the retraction of the threaded-looper 68, whereby the lead of the looper-thread extending from the needle-thread-loop 155 to the looper-thread-eye 70 (Fig. 22) will be above the advancing point of the pilot 94' on the loop-retainer 90. By maintaining the lead of the looper thread above the point of the advancing pilot 94', the looper thread will be directed over the top of the loop-retainer 90 during each stitch-forming cycle, thus insuring a uniform positioning of the looper thread to the left of the needle as viewed in Fig. 10. This constant relative disposition of looper thread with respect to the needle insures a uniform concatenation of the threads forming the purl.

After the right hand loop-retainer 90 has entered and seized the needle-thread-loop 158 presented by the non-threaded looper 69, the latter is retracted from its advanced position shown in Fig. 22 to an intermediate dwell position shown in Fig. 9. The thread-carrying looper 68 has advanced to its intermediate dwell position in readiness for the descent of the needle to start the next slit-stitch. The complete stitch-forming cycle has now been performed.

While I have not described in detail the action on the needle thread of the take-up lever 122, it will be understood that accurate control of the needle thread is essential. This control is illustrated in Fig. 26, which discloses a diagram or dvelopment of the displacement of the needle 50 and looper 68, the thread-control of the needle thread take-up and the control produced by the thread-controller C. The positions lengthwise of the diagram indicated by the vertically disposed arrows and numerals 8 to 22, inclusive, correspond respectively, with the periods of the stitch-forming cycle shown in Figs. 8 to 22, inclusive.

From the above description, it will be evident that the exacting thread-control made possible by my improved controller renders the machine capable of producing buttonholes of highest quality. One of the factors contributing to this is the uniform formation of the purl close to and paralleling the slit of the buttonhole. While a uniform formation and location of the purl has been heretofore attained in buttonhole machines, this was accomplished by using hard finished cords of good size in combination with a strong tension, causing the purl to roll toward the slit. This method proved successful on material of a firm weave, but not so successful on material of a flimsy nature, such as cottons having a basket or diagonal weave. The present improvement has adapted the machine for sewing equally well on firm or flimsy weave materials. It is further desirable that the maximum degree of lustre be preserved on the sewing threads in the finished buttonhole. It is well known that the thread lustre is reduced when the thread is excessively tensioned. In prior machines the thread-control was at best an approximation and as a result thereof the loops of thread during stitch-formation were unavoidably prematurely closed. This "choking" of the thread-loops had to be overcome by excessively tensioning the threads, causing not only a reduction in the lustre of the completed buttonhole but minimizing the ability of the machine to handle successfully the poorer grades of cotton threads. The present thread-control is such that the loops of thread in the stitch are not prematurely set but are left open slightly, thereby enabling the stitch to be completed with a minimum of tension on the sewing threads. This light tension permits the use of heavy looper threads to the end that imitation hand buttonholes may be readily produced. Another advantage gained by the use of the present looper-thread-control is the elimination of all check-springs as an aid in the control of the thread.

Having thus set forth the nature of the invention, what I claim herein is:

1. A two-thread sewing machine having work-holding means and stitch-forming mechanism which are relatively movable to space stitches, said stitch-forming mechanism including an endwise reciprocatory and laterally vibratory thread-carrying needle, a threaded looper and a non-threaded looper adapted alternately to enter thread-loops presented by said needle, loop-retainers for seizing thread-loops from said loopers and presenting them for entrance by said needle, means for actuating said stitch-forming mechanism including a driving bar operatively connected to said loop-retainers, thread-guiding means carried by said driving bar for directing thread to said threaded looper, and a thread-controller adapted to engage the thread between said thread-guiding means and said threaded looper.

2. A two-thread sewing machine having work-holding means and stitch-forming mechanism which are relatively movable to space stitches, said stitch-forming mechanism including an endwise reciprocatory and laterally vibratory thread-carrying needle, a threaded looper and a non-threaded looper adapted alternately to enter thread-loops presented by said needle, loop-retainers for seizing thread-loops from said loopers and presenting them for entrance by said needle, means for actuating said stitch-forming mechanism including a reciprocatory driving bar operatively connected to said loop-retainers, thread-guiding means carried by said driving bar for directing thread to said threaded looper, and a thread-controller movable in a right line parallel to the axis of said driving bar and disposed to engage the thread between said thread-guiding means and said threaded looper.

3. A two-thread sewing machine having work-holding means and stitch-forming mechanism which are relatively movable to space stitches, said stitch-forming mechanism including an endwise reciprocatory and laterally vibratory thread-carrying needle, a threaded looper and a non-threaded looper adapted alternately to enter thread-loops presented by said needle, loop-retainers for seizing thread-loops from said loopers and presenting them for entrance by said needle, means for actuating said stitch-forming mechanism including a driving bar operatively connected to said loop-retainers, thread-guiding means carried by said driving bar for directing thread to said threaded looper, and a thread-controller mounted on said driving bar and adapted to engage the thread between said thread-guiding means and said threaded looper.

4. A two-thread sewing machine having work-holding means and stitch-forming mechanism which are relatively movable to space stitches, said stitch-forming mechanism including an endwise reciprocatory and laterally vibratory thread-carrying needle, a threaded looper and a non-threaded looper adapted alternately to enter thread-loops presented by said needle, loop-retainers for seizing thread-loops from said loopers and presenting them for entrance by said needle, means for actuating said stitch-forming mechanism including an endwise reciprocatory driving bar operatively connected to said loop-retainers and having a looper thread guiding bore terminating at the end of said bar adjacent said loop-retainers, and a thread-controller mounted on said driving bar and adapted to engage the thread between said thread-guiding bore and said threaded looper.

5. A two-thread sewing machine having work-holding means and stitch-forming mechanism which are relatively movable to space stitches, said stitch forming mechanism including an endwise reciprocatory and laterally vibratory thread-carrying needle, means for varying the amplitude of vibration of said needle, threaded and non-

threaded loopers adapted alternately to enter thread-loops presented by said needle, loop-retainers for seizing thread-loops from said loopers and presenting them for entrance by said needle, means for actuating said stitch-forming mechanism including a driving bar operatively connected to said loop-retainers, thread-guiding means carried by said driving bar for directing thread to said threaded looper, a thread-controller adapted to engage the thread between said thread-guiding means and said threaded looper, and means supporting said thread-controller for varying the operative location thereof in accordance with the selected amplitude of vibration of said needle.

6. A two-thread sewing machine having work-holding means and stitch-forming mechanism which are relatively movable to space stitches, said stitch forming mechanism including an endwise reciprocatory and laterally vibratory thread-carrying needle, means for varying the amplitude of vibration of said needle, threaded and non-threaded loopers adapted alternately to enter thread-loops presented by said needle, loop-retainers for seizing thread-loops from said loopers and presenting them for entrance by said needle, means for actuating said stitch-forming mechanism including a driving bar operatively connected to said loop-retainers, thread-guiding means carried by said driving bar for directing thread to said threaded looper, a thread-controller adapted to engage the thread between said thread-guiding means and said threaded looper, and means supporting said thread-controller and permitting adjustment of the operative location thereof in a direction parallel to the plane of vibration of said needle in accordance with the selected amplitude of vibration of said needle.

7. A two-thread sewing machine having work-holding means and stitch-forming mechanism which are relatively movable to space stitches, said stitch-forming mechanism including an endwise reciprocatory and laterally vibratory thread-carrying needle, oscillatory threaded and non-threaded loopers adapted alternately to enter thread-loops presented by said needle, loop-retainers for seizing thread-loops from said loopers and presenting them for entrance by said needle, means for actuating said stitch-forming

mechanism including a member having a variable reciprocatory motion operatively connected to said loop-retainers, thread-guiding means carried by said member for directing thread to said threaded looper, and a thread-controller adapted to act on the thread between said guiding means and said threaded looper and movable in a path parallel to the line of reciprocation of and in synchronism with said member.

8. A two-thread sewing machine having work-holding means and stitch-forming mechanism which are relatively movable to space stitches, said stitch-forming mechanism including an endwise reciprocatory and laterally vibratory thread-carrying needle, oscillatory threaded and non-threaded loopers adapted alternately to enter thread-loops presented by said needle, loop-retainers for seizing thread-loops from said loopers and presenting them for entrance by said needle, means for actuating said stitch-forming mechanism including a reciprocatory driving bar operatively connected at one end to said loop-retainers and having a thread-guiding bore extending from one end to the other for directing thread to said threaded looper, and a thread-controller secured to said driving bar and having a thread-engaging free end disposed to act on the thread between the mouth of said thread-guiding bore and said threaded looper.

9. A sewing machine having, in combination, an endwise reciprocatory and laterally jogging thread-acrrying needle, oscillatory threaded and non-threaded loopers cooperating with said needle in entering thread-loops presented by said needle, a plurality of loop-detainers for seizing thread-loops from said loopers, means for actuating said loop-detainers including a driving member operable in a right line, thread-guiding means carried by said driving member for directing thread to said threaded looper, and a thread-controller operable in a right line and disposed to act on the looper thread between said thread-guiding means and said oscillatory threaded looper, said thread-guiding means, oscillatory threaded looper and thread-controller summarily effecting a differential control on the looper thread such that the latter is devoid of excessive strains during the entire stitch-forming cycle.

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