United States Patent

Sakawa et al.

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[54] CYCLIC SEWING MACHINE

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[52] **U.S. Cl.** **112/67,** 112/70

[51] **Int. Cl.** **D05b 3/04**

[58] **Field of Search** 112/67, 70, 73, 65

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Primary Examiner—H. Hampton Hunter

Attorney—Kemon, Palmer & Estabrook

[57] **ABSTRACT**

A cyclic sewing machine comprising a first cam disk for actuating a motion control mechanism to control the start and stop of a sewing machine and a thread cutting mechanism at the end of a cycle corresponding to a prescribed number of stitches; and a second cam disk for imparting the feed movement to the work clamp mechanism with a number of stitches equal to an integral multiple of said prescribed number of stitches, wherein the motion control mechanism and thread cutting mechanism are brought to an inoperative state until just before the second pattern cam disk imparts a one cycle feed movement to the work clamp mechanism, thereby permitting the very easy change of a number of stitches used in one cycle.

8 Claims, 16 Drawing Figures

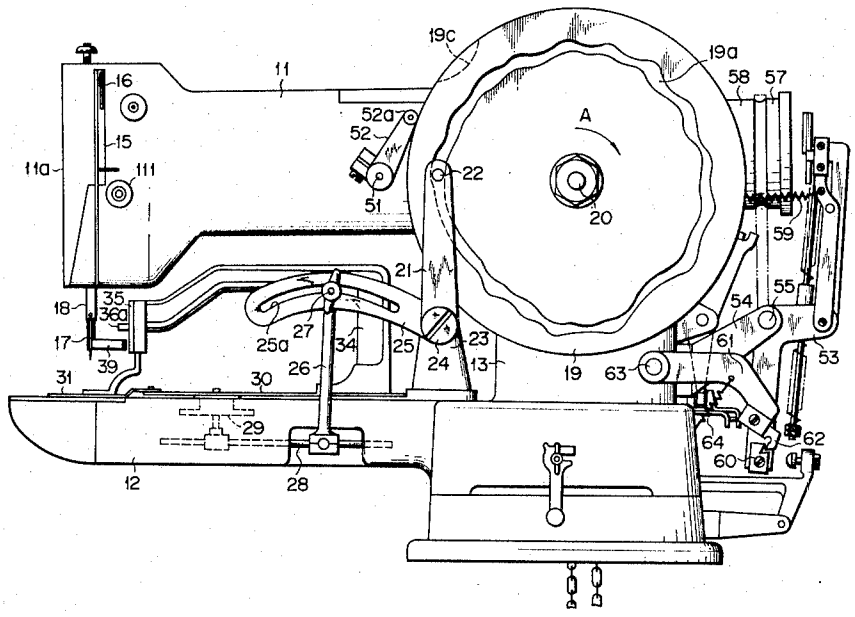
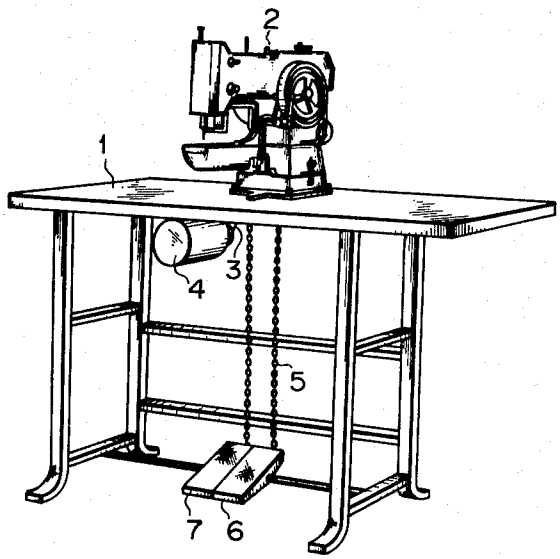
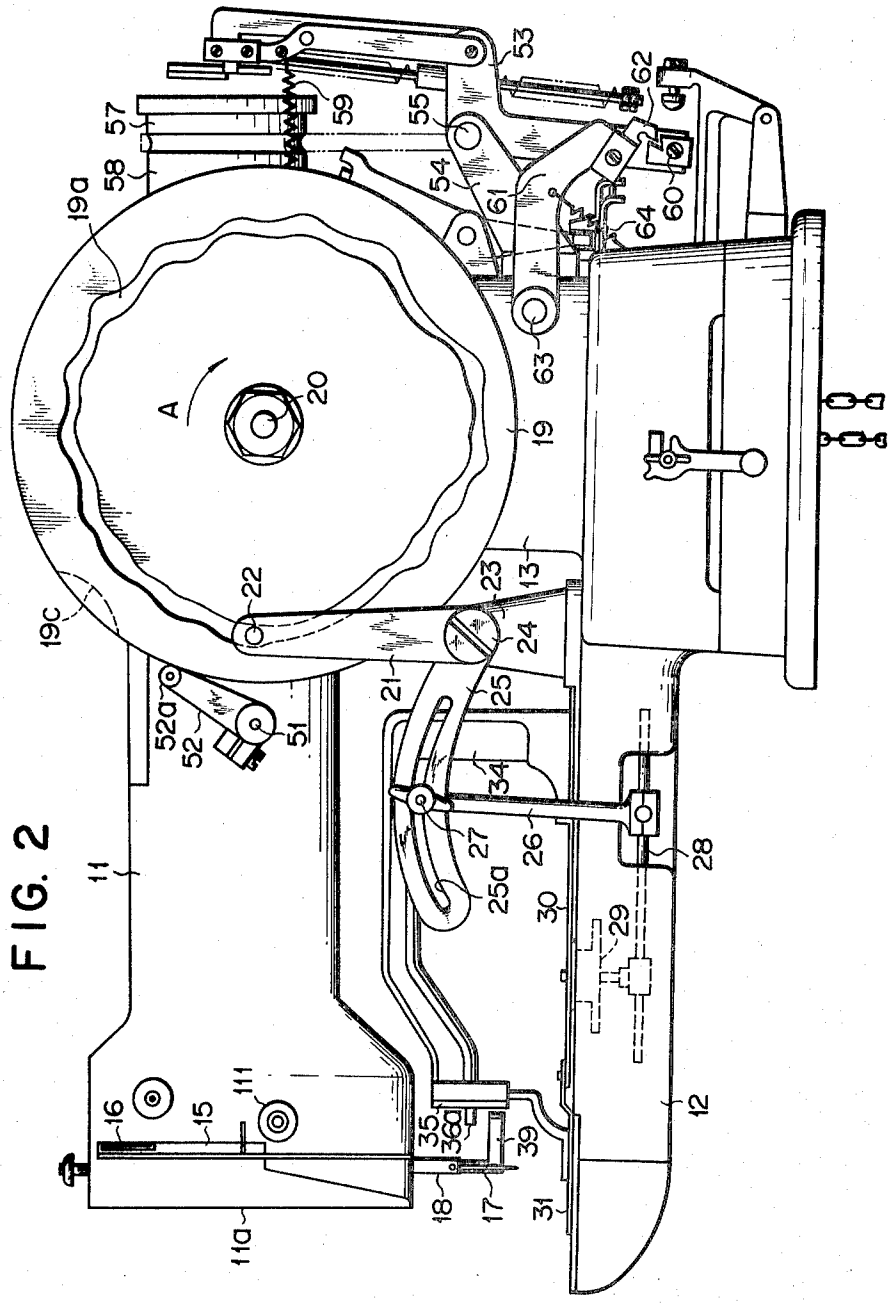


FIG. 1

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28
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36a
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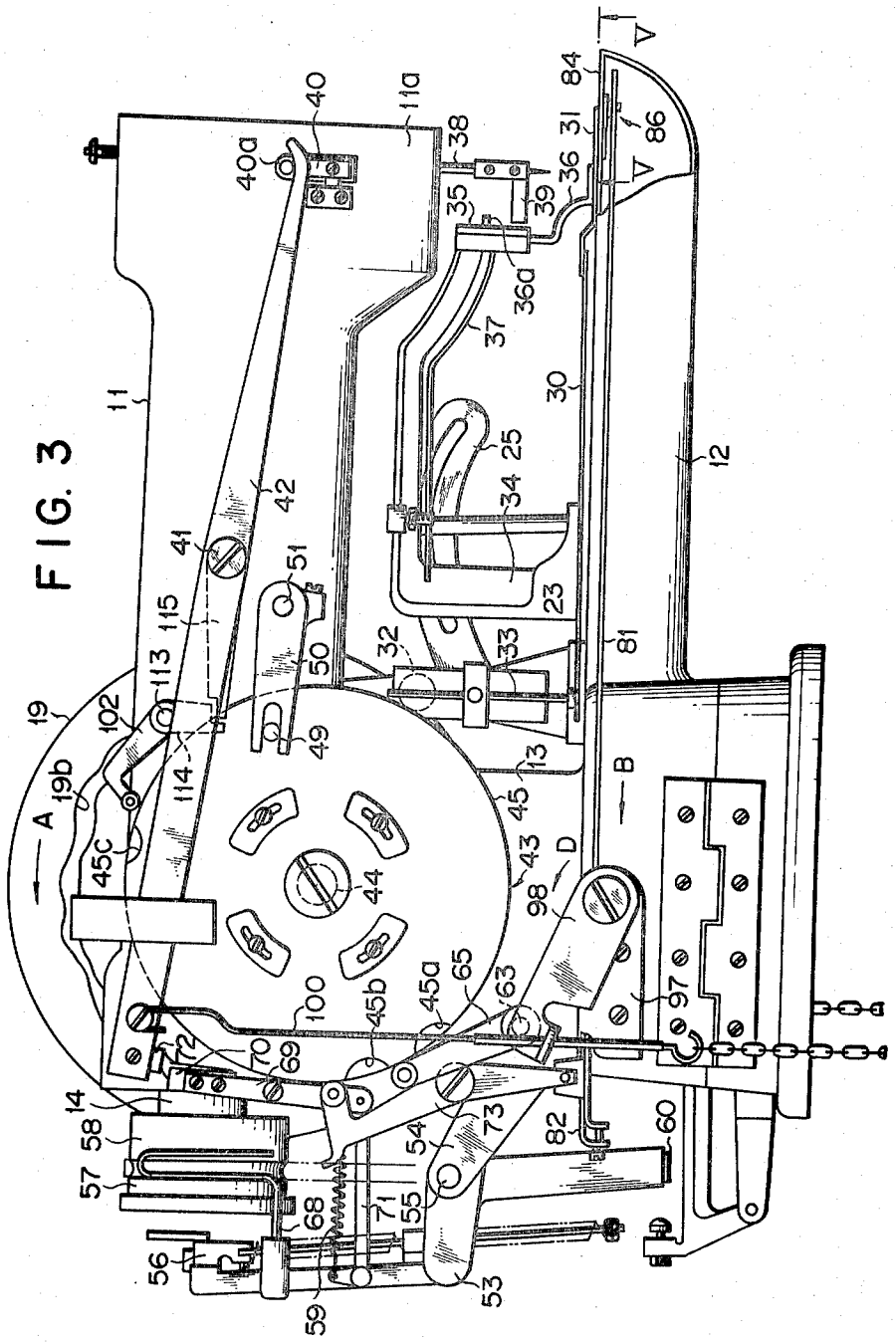
111

FIG. 2

FIG. 3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40a
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44
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45a
45b
45c
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57
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98
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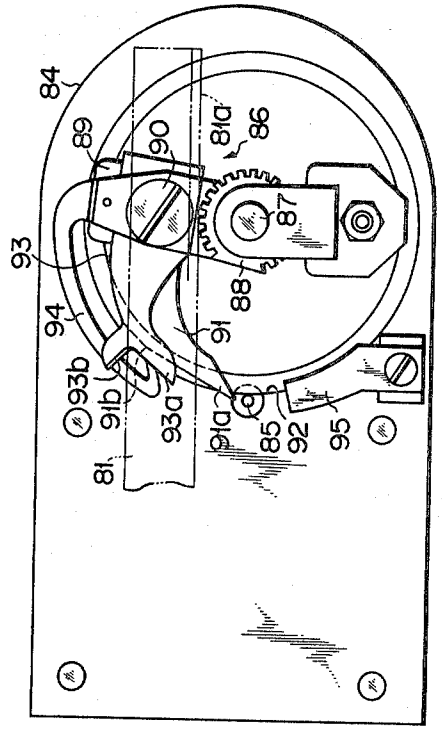
102
113
114
115
A
B
D
V

FIG. 5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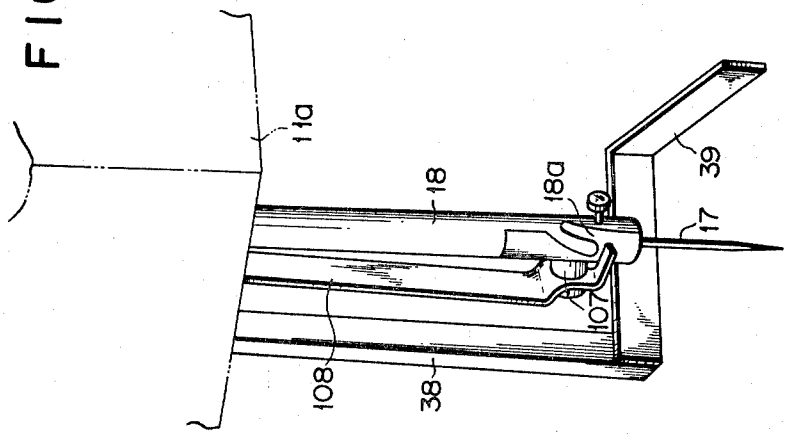
81

FIG. 4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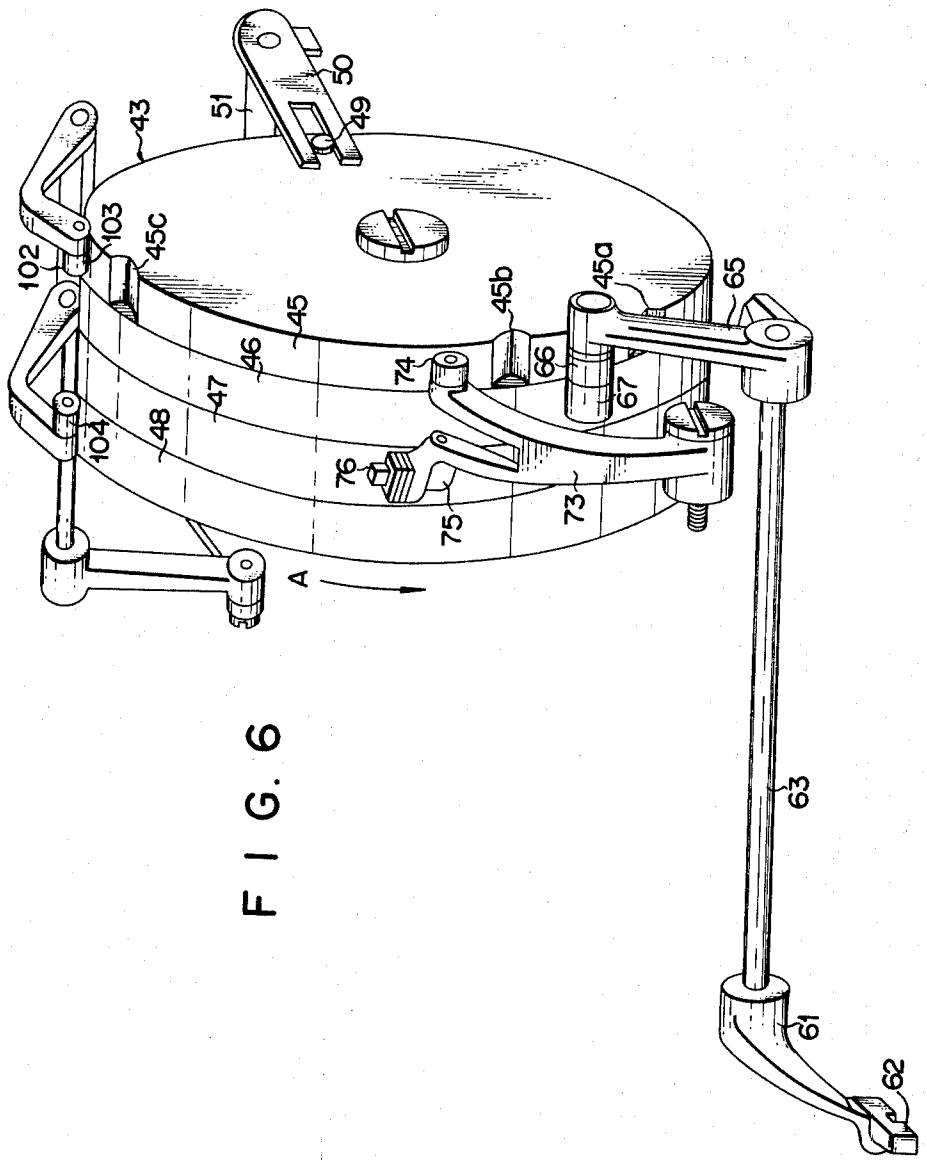
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103
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74
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73
75
A
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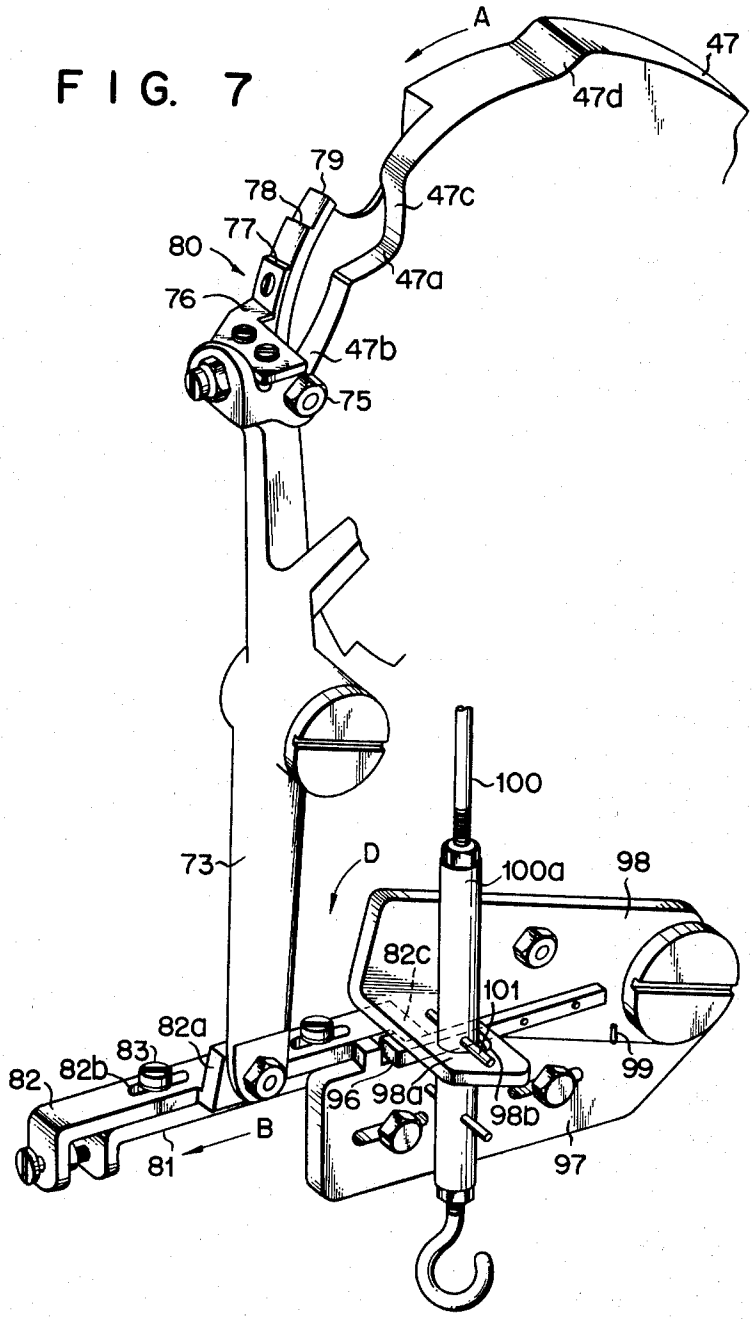
62

FIG. 6

FIG. 7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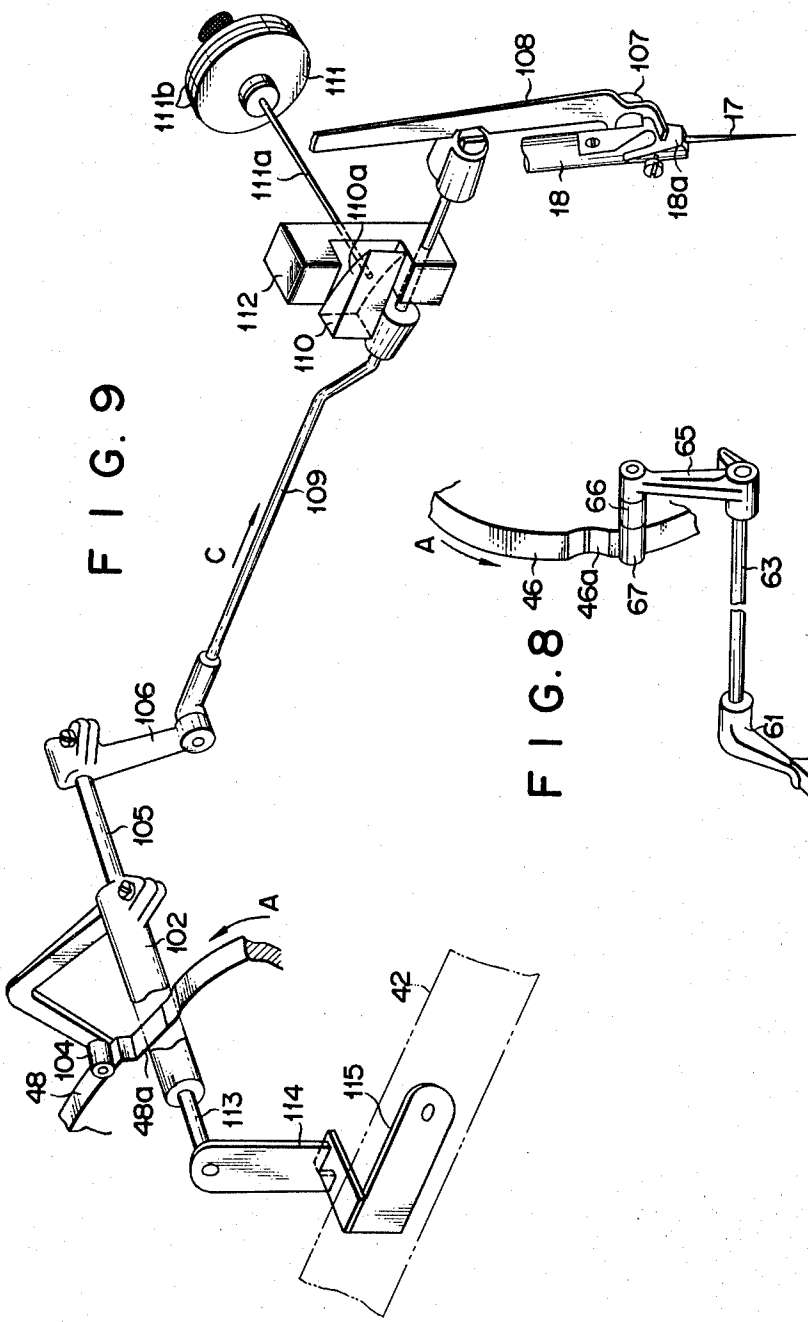
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17
111a
110a
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18a
112
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C
106
105
102
A
42
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48a
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115

FIG. 9

65
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A
63
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46a
67
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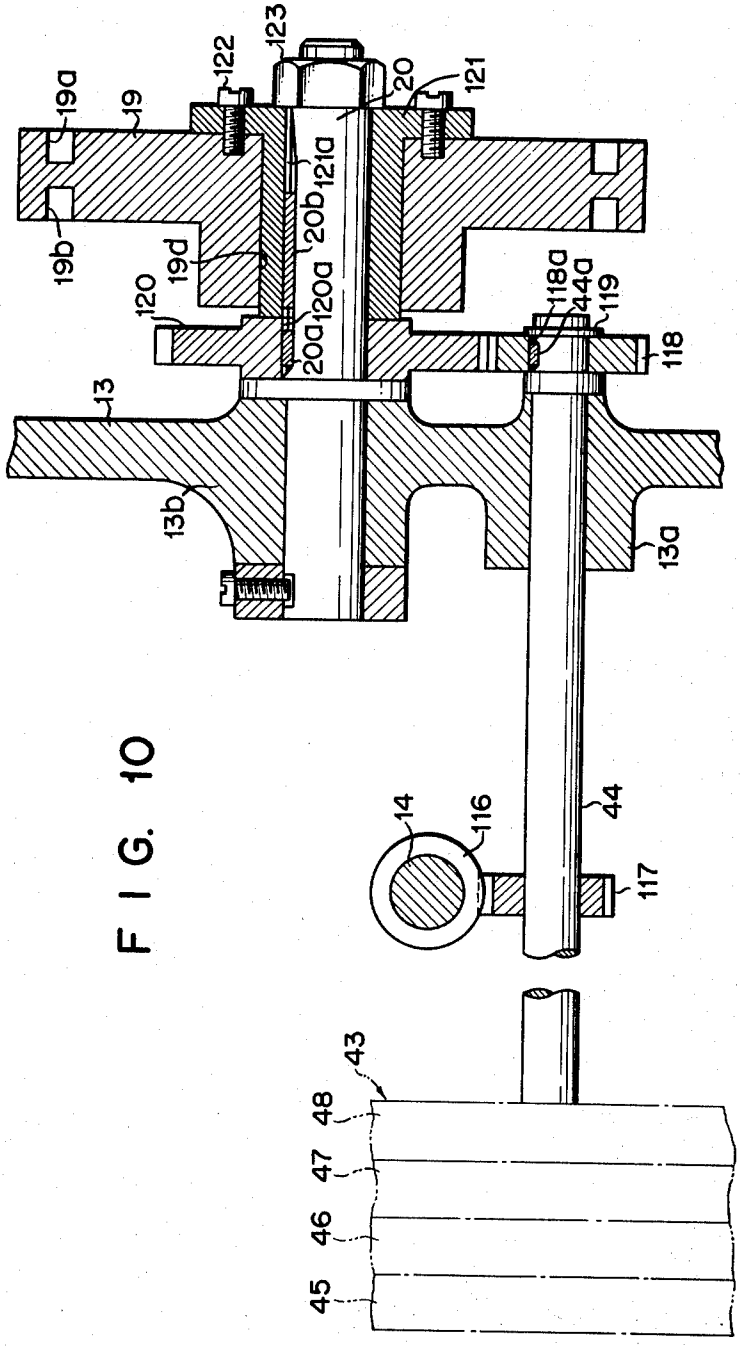
FIG. 8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13b
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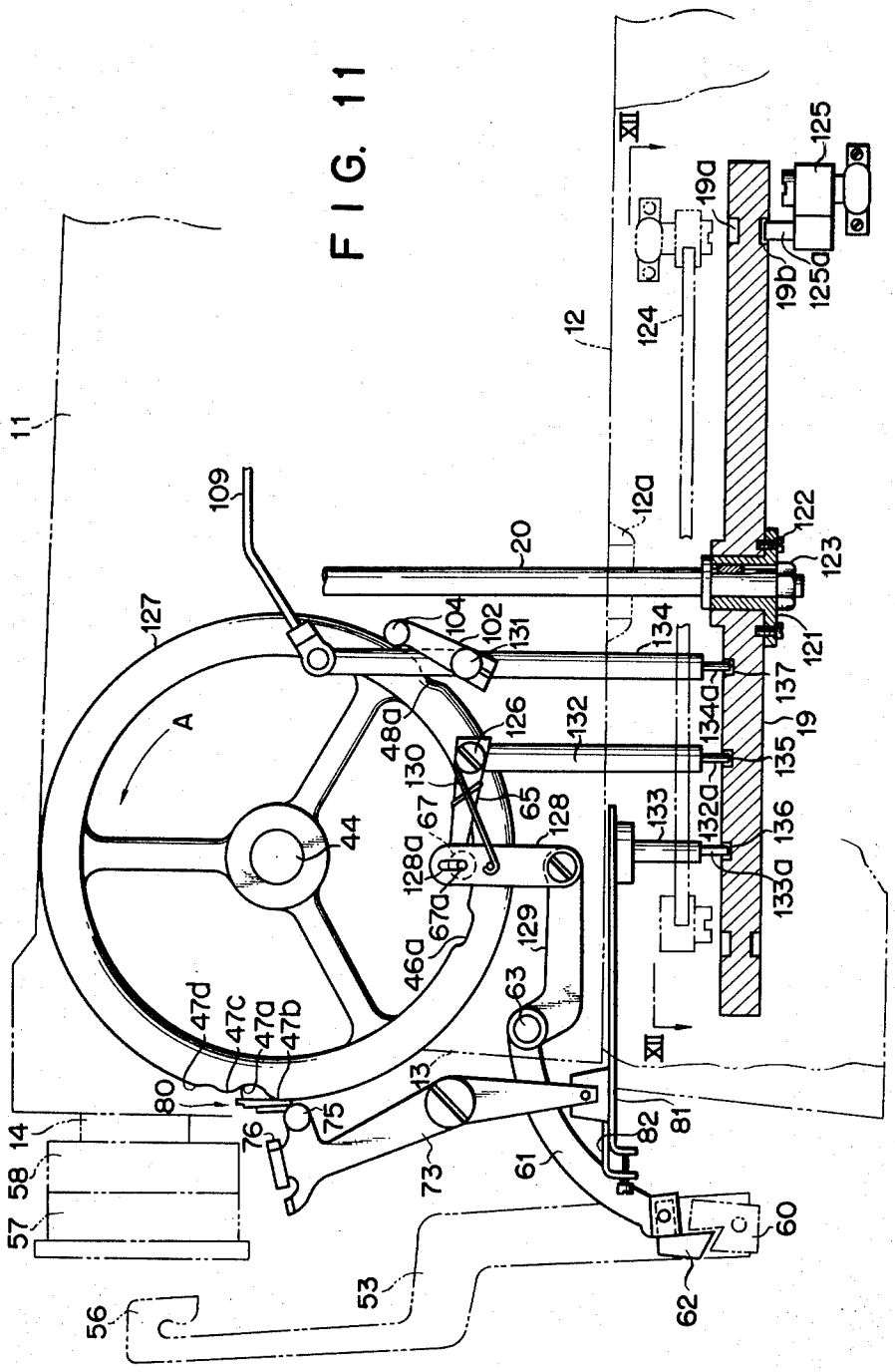
FIG. 10

FIG. 11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125a
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136
137
A
XII
XII

FIG. 12

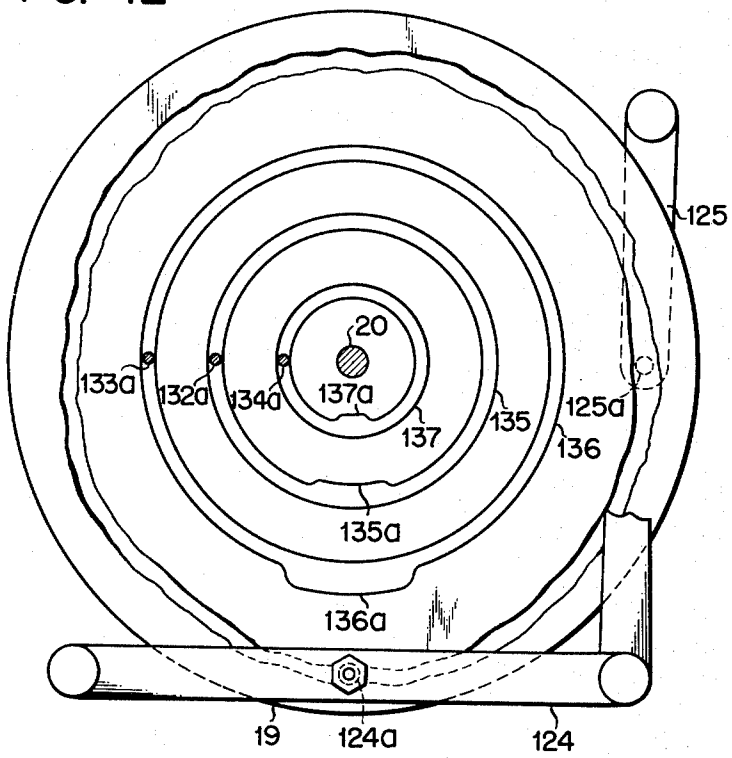


FIG. 15A

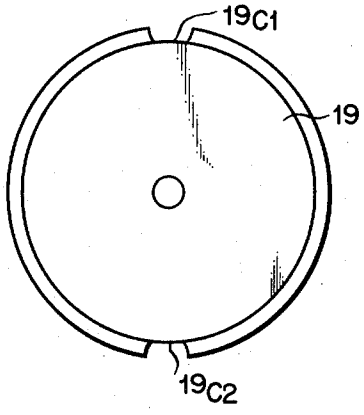
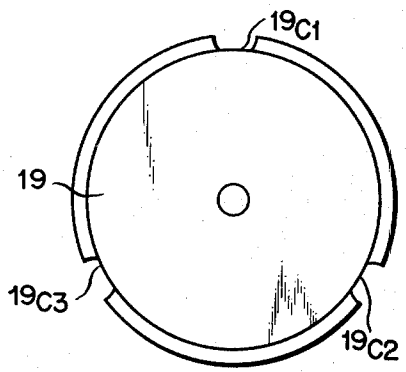
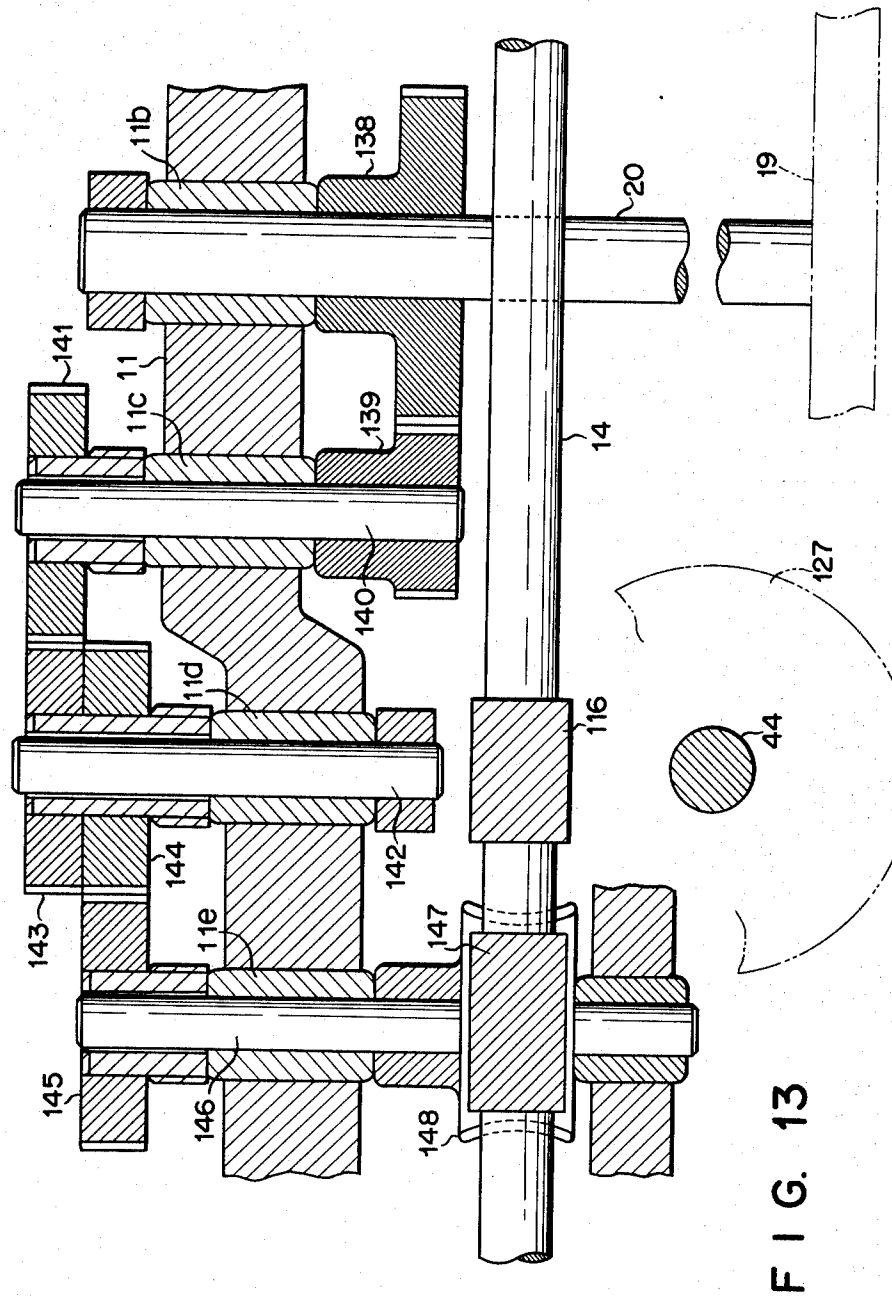


FIG. 15B

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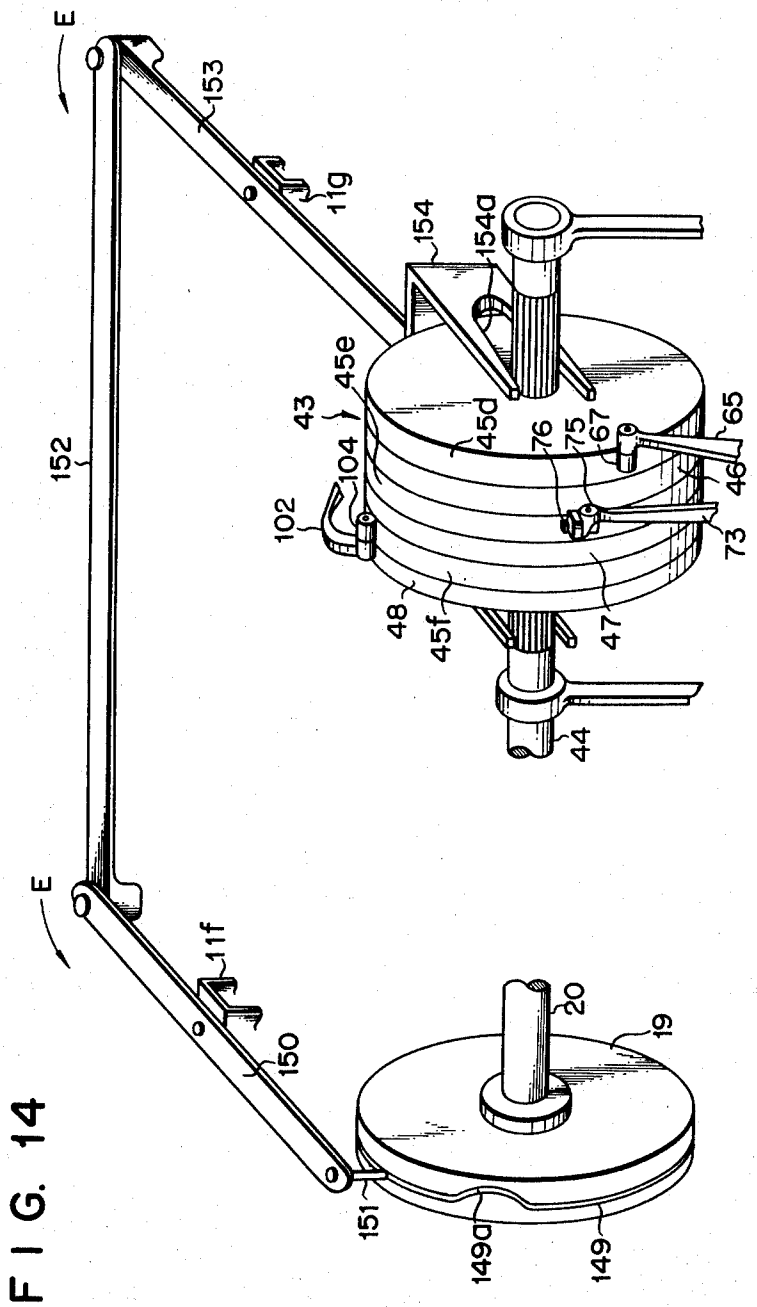
148

FIG. 13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47
44
E
11f
20
19
150
151
149a
149

FIG. 14

CYCLIC SEWING MACHINE

This invention relates to a cyclic sewing machine, and more particularly to a cyclic sewing machine capable of sewing bar tacks, patterns and other forms on a work fabric with a certain number of stitches prescribed for each case.

The prior art cyclic sewing machine is generally so designed that a first cam disk jointly rotating with a main shaft controls a motion control mechanism for stopping a sewing machine upon completion of sewing and a second cam jointly rotating with said main shaft controls the feed movement of a work clamp mechanism.

This type of sewing machine has the drawbacks that where there was to be performed cyclic sewing requiring a different number of stitches from those used in the preceding form of sewing, there should be changed the tooth number ratio of the worms and worm wheels coupling the cam disks with the main shaft, a second cam disk had to be replaced with one corresponding to the resulting changed number of stitches and also a first cam disk had to be exchanged for one capable of imparting proper operation timing to the motion control mechanism and thread cutting mechanism to match the varied number of stitches to be performed by said replaced second cam disk.

Replacement of the first and second cam disks and worms and worm gears to drive them for each such change of the number of stitches not only consumed a great deal of time and work, but also there were presented considerable difficulties in exchanging the worms and worm gears by taking out the main shaft which was designed to control the movement of all movable parts of a sewing machine. This operation was impossible with general nonexpert users of a sewing machine.

There has been developed another type of cyclic sewing machine wherein, instead of replacing the first cam disk, there is adjustably fitted to said cam disk a cam strip for actuating the motion control mechanism and thread cutting mechanism and the operation timing of both mechanisms is adjusted, each time the number of stitches is changed. Either case, however, is accompanied with time-consuming work which is impossible with general users of a sewing machine. Where, therefore, the user desired to perform various types of cyclic sewing, he has to purchase a number of sewing machines with the resulting economic disadvantage. Also where a sewing machine maker manufactures sewing machines performing various numbers of stitches, he is obstructed in mass production due to the necessity of fitting each time different types of first cam disk, worm and worm gear.

It is accordingly an object of this invention to provide a cyclic sewing machine permitting the easy change of a number of stitches.

Another object of the invention is to provide a cyclic sewing machine, which, in changing a number of stitches, eliminates the necessity of replacing a first cam disk for actuating the motion control mechanism and thread cutting mechanism and controlling the operation timing of both mechanisms.

Another object of the invention is to provide a cyclic sewing machine permitting another form of cyclic sewing using a different number of stitches simply by

replacing gear means disposed between the second cam disk and the main shaft.

Still another object of the invention is to provide a cyclic sewing machine permitting another form of cyclic sewing using a different number of stitches simply by machining a second cam disk and replacing it for the previously used one.

A further object of the invention is to provide an inexpensive cyclic sewing machine of extremely simple construction due to a design easily to change a number of stitches.

A still further object of the invention is to provide a cyclic sewing machine which permits mass production for manufacturers and offers handling convenience and saves cost for manufacturers as well as for users.

According to the invention there is provided a cyclic sewing machine comprising a frame including a work supporting bed, drive means, a main shaft journaled in said frame, a reciprocable needle supported on said frame and movably connected to said main shaft, motion control mechanism disposed between said main shaft and said drive means for controlling the start and stop of said main shaft, a thread cutting mechanism mounted on said frame for cutting threads, a work clamp mechanism movably supported on said work supporting bed to move across the reciprocating path of said needle, first cam disk means mounted on said frame and movably connected to said main shaft for controlling the operation of said motion control mechanism and said thread cutting mechanism at the end of each sewing cycle corresponding to a predetermined number of stitches, first cam follower means operatively connecting said first cam disk means with said motion control mechanism, second cam follower means operatively connecting said first cam disk means with said thread cutting mechanism, second cam disk means for imparting feed movement to said work clamp mechanism with a number of stitches equal to an integral multiple of those corresponding to one cycle of said first cam disk means, driving connections provided between said second cam disk means and said main shaft for rotating the second cam disk means to such extent that the ratio of the angular velocity of said second cam disk means to that of said first cam disk means takes a value arrived at by dividing the number of stitches corresponding to said first cam disk means by the number of stitches corresponding to said second cam disk means, third cam follower means operatively connecting said second cam disk means with said work clamp mechanism, and means for rendering said motion control mechanism and thread cutting mechanism inoperable, notwithstanding the rotation of said first cam disk means until just before the rotation for imparting a one cycle feed movement to said work clamp mechanism is completed.

The present invention can be more fully understood from the following detailed description when taken in conjunction with reference to the appended drawings, in which:

FIGS. **1** to **10** show a cyclic sewing machine according to one embodiment of the invention, wherein

FIG. **1** is a schematically perspective view of the machine,

FIGS. **2** and **3** are respectively right and left side views of a machine body,

FIG. 4 is an enlarged perspective view of a jaw portion of the machine,

FIG. 5 is a cross sectional view on line V—V of FIG. 3,

FIG. 6 is a perspective view showing a cam unit and operable levers,

FIGS. 7 to 9 are respectively perspective views of a thread cutting mechanism, stop cam mechanism and thread tightening cam mechanism, and

FIG. 10 illustrates a deceleration mechanism;

FIGS. 11 to 13 show a cyclic sewing machine according to another embodiment of the invention, wherein FIG. 11 is a left side view, partially cut off, of the cyclic sewing machine, FIG. 12 is a cross section on line XII—XII of FIG. 11 and FIG. 13 is a cross sectional view of a deceleration mechanism;

FIG. 14 shows perspectively a modification of a feed cam and cam unit; and

FIGS. 15A and 15B are respectively front views of another modification of a feed cam.

There will now be described a cyclic lock stitch sewing machine according to one embodiment of the invention with reference to FIGS. 1 to 10.

Referring to FIG. 1, on the table 1 there is mounted a machine body or frame 2 while under the table there is provided a motor 4 driving a machine through a belt 3, a starting pedal 6 connected to a chain member 5 and a foot lifting pedal 7.

In FIGS. 2 to 4 a reference numeral 11 indicates a bracket arm portion extended from a standard or leg member 13 having an arm bed 12, and a main shaft 14 is provided in the arm portion 11 and member 13. Said main shaft 14 is adapted to control vertical movements of members such as a thread take up lever 16 extending from an elongated slit 15 formed in the jaw 11*a* of the arm portion 11 and a needle bar 18 provided with a needle 17 on the lower end thereof. 19 denotes a feed cam rotatably mounted on the standard 13 by a rotary shaft 20, which has transverse feed grooves 19*a* in the front surface thereof and forward and backward feed grooves 19*c* in the back surface thereof. There is rotatably contacted with the surfaces of said transverse feed grooves 19*a* a roller 22 mounted on the top end portion of a transverse feed lever 21 of which the base end portion is pivoted by a shaft 24 on a feed bracket 23 erected on said arm bed 12. There is integrally provided a guide member 25 having an elongated guide slit 25a for the base end portion of said lever 21. In the elongated guide slit 25*a* of the guide member 25 there is slidably inserted a spherical shaft 27 mounted on the top end of a transverse feed rod 26. The base end portion of said transverse feed rod 26 is connected to a transverse feed lower shaft 28 supported in said arm bed 12. A feeding link guide 29 is fixed to the lower shaft 28 and connected to a feed bed 30 disposed on the surface of said arm bed 12. A feed plate 31 is connected to the top end of the feed bed 30 so as to be positioned downwardly of said jaw 11*a*.

There is rotatably contacted a roller (not shown) mounted on a forward and backward feed lever 32 supported by said feed bracket 23 in said forward and backward feed grooves 19*b* of said feed cam 19. A forward and backward feed controlling guide shaft 33 is attached to said forward and backward feed lever 32 and is connected to said feed bed 30. 34 shows a pressure arm standed on said feed bed 30, to the top end of which there is vertical-movably attached by a pressure foot guiding plate 35, a pressure foot 36 having a protrusion 36*a*. Normally, biasing force is downwardly applied to said foot 36 by a pressure spring 37, so that the work fabric (not shown) on the surface of said feed plate 31 is held by the pressure foot 36 thereby to constitute a work fabric clamping mechanism. A numeral reference 38 shows a pressure rod mounted on said jaw 11*a* to the lower portion of which there is connected a lever 39 to face from below the protrusion 36*a* of said pressure foot 36, and to the center portion of which there is attached a pressure plate 40 having a protrusion 40*a*. With lower side of the protrusion, there is contacted a top end portion of a pressure arm member 42, the center of which is pivoted on the machine arm portion 11 by a shaft 41. Accordingly, as later described, when the pressure member 42 is, in FIG. 3, swung in a counter-clockwise direction, the pressure rod 38 is moved upwardly and the lever 39 pushes up said pressure foot 36 via said protrusion 36*a*, whereby the foot 36 is upwardly urged against the pressure spring 37.

Referring to FIG. 3, a numeral reference 43 shows a cam unit rotatably supported on the left side frame of said leg member 13 by a rotary shaft 44 which is, as later described in FIG. 6, constituted by a rest cam 45, stop cam 46, a thread cutting cam 47 and a thread tightening cam 48 which are respectively formed with the same diameter. Said rest cam 45 is freely rotatable about the shaft 44 and the remaining cams 46 to 48 are adapted to rotate integrally with the shaft 44. On the side wall of the rest cam 45 there is extended a pin 49 engaged with the forked portion of an operable lever 50. The base portion of said operable lever 50 is attached to one end of a shaft 51 vertically penetrating through said arm bed 12. On the other end of the shaft 51 is fixed a lever 52 having a roller 52*a* rotatably contacting the outer peripheral surface of said feed cam 19. In this case, biasing force is so in advance applied to said lever 52 by, for example, a spring (not shown) as to permit the roller 52*a* to always contact the outer peripheral surface of the feed cam 19. A depression 19*c* is formed in the periphery of the feed cam 19 to have a prescribed area corresponding to four stitches ahead and backward of the stop point of the machine. When said feed cam 19 is, for example, in FIG. 2, rotated in a clockwise direction and then said roller 52*a* is brought down into said depression 19*c* whereby said lever 52 is swung, also in FIG. 2, in a clockwise direction, such rotation is transmitted through the shaft 51 to the operable lever 50, so that said operable lever 50 is adapted to swing the rest cam 45, in FIG. 3, in a counter-clockwise direction through said pin 49.

53 shows a clutch lever rotatably supported by a shaft 55 to a clutch lever bracket 54 extended from said leg member 13, the upper end portion of which is disposed a clutch stopper 56. Said clutch stopper 56 is so arranged as to oppose a movable wheel 57 which is fixed to said main shaft 14 so as to rotate integrally therewith. There is formed on that surface of the movable wheel 57 which faces said clutch stopper 56 a stopper groove (not shown) to be engaged with said stopper 56. 58 shows an idle wheel idly fitted to said machine shaft. Said clutch lever 53 is normally biased

in a counter-clockwise direction in FIG. 2 (in a clockwise direction in FIG. 3) by a clutch lever spring 59 stretched between the lever 53 and said leg member 13. When said lever 53 is swung in a clockwise direction (in FIG. 2) against said spring 59 by manual operation to be brought to an operable position or condition, a clutch lever pawl 60 mounted on the lower end portion of said lever 53 is engaged with a clutch stopping pawl 62 mounted on the top end of a clutch stopping lever 61 whereby said operable condition is maintained. The base end portion o of said clutch lever 61 is fixed to the one end of a shaft 63 transversely penetrating through said standard 13 and biasing force is normally applied thereto in a clockwise direction in FIG. 2 by a spring 64 strected between said lever 61 and the member 13. To the other end of said shaft 63 is fixed a stop lever 65 as shown in FIG. 3. As shown in FIG. 6, to the top end portion of said stop lever 65 there are attached rollers 66 and 67 which slidably move on the peripheral surfaces of said rest cam 45 and stop cam 46, respectively. There is formed in that point of the outer periphery of said stop cam 46 at which the machine operation stops a stop cam groove 46*a* as shown in FIG. 8. When the roller 67 is brought down into said cam groove 46*a* whereby said lever 65 is swung in a clockwise direction in FIG. 3, the clutch stopping lever 61 is swung in a counter-clockwise direction in FIG. 2 through the shaft 63 against the spring 64 and then the clutch stopping pawl 62 is disengaged from the clutch lever pawl 60, so that the clutch lever 53 is swung in a counter-clockwise direction in FIG. 2, i.e. toward the stopping position by the clutch lever spring 59 and then the clutch stopper 56 is engaged with the clutch groove of the movable wheel 57 thereby to stop rotation of the machine shaft 14. 68 is a belt guide attached to said clutch lever 53, which shfts a belt transmitting the rotary force of a motor 4 from either of the movable wheel 57 to the idle wheel 58 to the other in response to the motions of the clutch lever 53, that is, when the clutch lever 53 is moved to the operational position, said belt is shfted from the idle wheel 58 to the movable wheel 57 thereby to rotate the main shaft 14, while when the clutch lever 53 is moved to the stopping position, then the belt is shfted from the movable wheel 57 to the idle wheel 58 to rotate the idle wheel 58, thus preventing drive power from being transmitted to the machine shaft 14, thereby constituting a catch controlling operation stop mechanism.

In FIG. 3, 69 is a pressure stopping lever which is pivoted to said leg member at the intermediate portion. To the upper end of the lever 69 is attached a stopping lever pawl 70 and to the lower end thereof is connected said clutch lever 53 via a connection rod 71. When the clutch lever 53 is placed in the operational position, said lever pawl 70 is opposed from below to the pressure stopping pawl 72 mounted on the end of said member 42 thereby to stop the swing thereof, so that the pressure rod 38 and thus pressure foot 36 are prevented from being raised during operation of the machine. Alternatively, when the clutch lever 53 is moved to the stopping position, the pressure controlling lever 69 is swung in a counter-clockwise direction in FIG. 2 via the connection rod 71, so that the stopping lever pawl 70 becomes unable to oppose the pressure stopping pawl 72, permitting swing of the pressure member 42.

There will now be described a thread cutting mechanism. In FIG. 3, 73 is a thread cutting lever which is pivoted to said leg member 13 at the central portion, the upper portion of which is formed in a forked shape as shown in FIG. 6, the top end of one arm of said forked form being provided with a roller 74 movably contacted with periphery of said rest cam 45 and that of the other arm a roller 75 and pointed body 76. There is, as shown in FIG. 7, fixed to the outer peripheral surface of said thread cutting cam 47 a stepped member 80 which comprises a lower thread catching stepped portion 77, upper thread catching stepped portion 78 and upper and lower thread cutting stepped portion 79. Further, there is formed a depression 47*a* spacingly apart from said stepped member 80 along the rotary shaft of the thread cutting cam 47 and there are formed adjacent said depression 47*a* a first cam face 47*b* for preparing to catch a thread, a second cam face so acting as to permit a thread cutting means hereinafter described to hold a cut upper thread and a third cam face 47*d* for returning the thread cutting means actuated to cut off a thread to the original condition. Said pointed body 76 may be brought down into the lower and upper thread catching stepped portions 77 and 78 of said stepped member 80 just before the machine automatically stops and down into the thread cutting stepped portion 79, when the machine automatically stops, by the action of a spring as later described. Said roller 75 is associated with the thread cutting cam 47 so that the pointed body 76 is not contacted with the periphery of the cam 47 in the normal condition, and at the same time slides in contact therewith, and when the roller 75 is brought down into said depression 47*a*, said pointed body 76 contacts the upper surface of said stepped member 80 in a manner to be brought down into said three stepped portions 77, 78 and 79, whereby provision is so made as to permit the pointed body to be disengaged from the thread cutting cam 47 except when facing the three cam surfaces 47*b*, 47*c* and 47*d* of said depression 47*a*. 81 is a connecting member to be interlockingly operated upon receipt of the swing motion of said thread cutting lever 73 caused by the depression of the pointed body thereof and which is interposed between said lever 73 to actuate the thread cutting means. One end of the connecting member extends to the proximity of the end of said lever 73 and the other end to near the thread cutting means. There is stretched between the leg member 13 and lever 73 a spring (not shown) so acting as to perform the depression of said lever 73. 82 is a connecting piece for the purpose of contacting that end portion of the connecting member 81 which faces said lever 73 with the lever 73 so that the displacement amount of said connecting member 81 may be adjusted in order to secure accurate operation of the thread cutting means, the lower end portion of said lever 73 being associated with a tongue piece 82*a* provided on the connecting piece 82 and the piece 82 being adjustably associated to the connecting member 81 by means of a screw 83 attached to the connecting member 81, penetrating through an elongated groove 82b formed in the connecting piece 82. 84 is a needle plate fitted to the underside of said feed plate 31, which has needle holes 85 through which there is passed the needle 17 vertically reciprocated by said needle bar 18. There is fitted to the undersurface of the needle plate a

thread cut-ting means **86** which catches and cuts off upper and lower threads and then holds the cut upper thread by interlocking with said lever **73**. The thread cutting means **86** comprises, as shown in FIG. **5**, a pivotal shaft **87** fixed to said needle plate **84**, a pinion **88** which is pivoted to the shaft **87** and intermeshed with a rack **81***a* formed in the end portion of said connecting member **81** so as to rotate by desired angles, and a plate member **91** having thread catching pawl **91***a* screwed by a screw **90** to a projective arm **89** formed integrally with said pinion **88** so as to catch the lower thread by passing below said needle holes **85** as the rotation of the pinion **88** and a lower thread cutting blade **91***b* which is disposed backwardly of said pawl **91***a* and fittingly to an angular groove **92** formed coaxially with the rotary center of said pinion **88** on the undersurface of the needle plate **84**. The cutting means further includes an upper thread cutting pawl **93***a* and blade **93***b* disposed therebehind, which are screwed by said screw **90** similarly to said plate **91** and disposed backwardly of the lower thread catching pawl **91***a* of said plate **91** and spaced apart from said pawl **91***a* so as to catch the upper thread by passing below the needle holes **85** as the rotation of said pinion **88**, an upper thread holding member **94** which is screwed by the screw **90** in the same manner as in said both plates **91** and **93** to pass below the needle holes **85** and holds the upper thread by catching that end portion of the cut upper thread which faces the needle **17** and pinching said portion between said holding member and needle plate **84**, and an upper thread cutting stationary blade **95** screwed on the undersurface of said needle plate **84** so as to engage the upper thread cutting blade **93***b* for the purpose of cutting the upper thread by cooperating therewith. Referring to FIG. **7**, **96** is a stopper contacting a projection **82***c* formed in said connecting piece **82** so as to prevent the pointed body **76** of the thread cutting lever **73** from being fallen into the stepped portion **79** against the spring action when said pointed body **76** brought, by the action of the spring, down into said thread catching stepped portions **77** and **78** and then has abutted on the next thread cutting stepped portion **79** by the rotation of the cam **47**. The stopper is disposed in a manner to face the side of the projection **82***c* of said connecting piece **82** and fixed, by, for example, a screw, to a rotary arm **98** rotatably supported at the base end to an auxiliary machine frame **97** screwed to said leg member **13**. **99** is a spring stretched between said auxiliary machine frame **97** and rotary arm **98** to permit the free end of the rotary arm **98** to be upwardly urged.

100 is a connecting rod connected to the foot pedal **7** at the lower end for lifting said pressure foot **36**. The enlarged diameter portion **100***a* of the rod **100** is inserted through a hole **98***b* formed in a bearing arm horizontally extended from the free end of said rotary arm **98** and provided with a pin **101** penetrated through the rod in a manner to swing the arm **98** before the lift-up of the pressure foot so that when the rod is downwardly shifted by the operation of pressure foot the stopper **96** is disengaged from the contacting position with the connecting piece **82** to cause said lever **73** to be brought down into the thread cutting stepped portion **79**. The upper end of said connecting rod **100** is connected to that end portion of said pressure member **42** which faces the side at which is disposed the pressure stopping pawl **72**.

To give further description of a thread tightening mechanism, **102** is a thread tightening lever, which is, as shown in FIG. **6**, constructed by a pair of linearly connected lever to the top end of one of which is attached a roller **103** slidably contacting said rest cam **45** and to that of the other of which is provided a roller **104** slidably contacting said thread tightening cam **48**. There is fixed, as shown in FIG. **9**, to a shaft **105** secured to the thread tightening lever **102** a thread tightening connected lever **106** to which is attached a thread tightening connecting rod **109** connected to a clamping plate **108** which is forwardly guided within said machine arm portion **11** and pivoted to said needle bar **18** by a shaft **107**. There is integrally attached to the middle portion of the thread tightening connecting rod **109** a cam body **110** having the cam surface **110***a* with which is contacted the extended end of the thread loosing guide shaft **111***a* of a main adjuster **111** mounted on the right side of said jaw **11***a* through an auxiliary guide member **112** disposed inside the jaw **11***a*. Further, connected to the thread tightening lever **102** is another shaft **113** fixed to a thread tension adjusting member **114** which is disposed in a manner to be engaged with a stop member **115** so fixed to the side of said pressure member **42** as to swing integrally therewith. There is formed in the outer periphery of said thread tightening cam **48** a cam groove **48***a* corresponding to forward two stitches and backward three or four stitches, so that when said roller **104** slidably moves on the outer peripheral surface of the thread tightening cam **48** to be brought down into the cam groove **48***a*, the thread tightening lever **102** is swung, in FIGS. **3** and **9**, in a counter-clockwise direction, said rotation being transmitted as a forward drive force to the thread tightening connecting rod **109** via the thread tightening connecting lever **106**. In this case, when the roller **104** is brought down into the cam groove **48***a* by substantially one half of the depth thereof, the thread tension adjusting member **114** connected to the shaft **113** is engaged with the stop member **115** fixed to the pressure member **42** thereby to prevent the roller **104** from being any further brought down into said cam groove **48***a*. If the thread tightening connecting rod **109** is forwardly moved by the swing movement of the thread tightening lever **102** resulting from the fall of the roller **104** to half the depth of the cam groove **48***a*, the thread loosing guide shaft **111***a* slidably contacting the cam surface **110***a* of the cam body **110** is moved in its axial direction in FIG. **9** thereby to loose the upper thread pinched by the adjuster disks **111***b* of the main adjuster **111**. Further, when the pressure member **42** is swung (in a counter-clockwise direction in FIG. **9**) via the connecting rod **100** by the operation of the foot pedal for lifting said pressure foot **36**, the thread tension adjusting member **114** is disengaged from the stop member **115** so that the roller **104** is fallen into the deepest portion of the cam groove **48***a*. The thread tightening connecting rod **109** is further forwardly moved by the swing movement of the thread tightening lever **102** resulting from said fall to further loose the thread holded by the main adjuster **111** and by the top end portion thereof the clamping plate **108** is urged to be rotated in a clockwise direction in FIG. **9** and then a

needle thread guide **18***a* mounted on the needle bar **18** is urged to loose the upper thread guided into the needle **17** through said needle thread guide **18***a*. Then, the machine is once again driven and, after three or four stitches are performed, the roller **104** gets out of the cam groove **48***a*, and tightening by the clamping plate **108** of the upper thread is released in reverse motions to those described above and further loosing by the main adjuster **111** of the upper thread is also released.

There will now be described an operation connecting mechanism for driving in a manner to rotate said feed cam **19** and cam unit **43** with reference to FIG. **10**. The rotary shaft **44** of said cam unit **43** transversely penetrates through the leg member **13**, one end of which is supported by the journal bearing **13***a* mounted on the right side wall of the leg member **13** and to the middle portion of which is fixed a worm wheel **117** intermeshed with the worm **116** fixed to said main shaft **14**. To the end portion of said rotary shaft **44** is attached a small gear **118** by intermeshing a key way **118***a* with a key **44***a* formed in the rotary shaft **44**, said small gear being so secured thereto as to integradally rotate with said rotary shaft **44** by means of a stop ring **119**. The rotary shaft **20** of the feed cam **19** is supported by a journal bearing **13b** formed in the right side wall of the leg member **13** and is attached to a large gear **120** intermeshed with said small gear **118** by engaging a key way **120***a* with a key **20***a* formed in said rotary shaft. The key way **121***a* of a cylindrical shaft **121** penetrating through the shaft hole **19***d* of said feed cam **19** is engaged with the key **20***b* of the rotary shaft **20**, and by screws **122** the feed cam **19** is screwed to the cylindrical shaft **121** and simultaneously a nut **123** is screwed into the top end portion of the rotary shaft **20** whereby the large gear **120** and feed cam **19** are so set as to rotate integrally with the rotary shaft **20**. With the above-mentioned construction, if the stop ring **119** is dismounted, the small gear **118** becomes detachable from the rotary shaft **44** and if the nut **123** and screws **122** are dismounted, the large gear **120** and feed cam **19** also become detachable from the rotary shaft **20**. Accordingly, the small and large gears **118** and **120** may consist of a combination of those having arbitrary numbers of teeth, and the feed cam **19** may also be replaced by a cam realizing any desired sewn pattern and stitch numbers.

In the sewing machine, one rotation of the main shaft **14** corresponds to one vertical reciprocating movement of the needle **17**, i.e. one stitch thereof, and accordingly, the number of rotations of the rotary shaft **44** with respect to the main shaft **14**, namely, number of stitches required for one rotation of the cam unit **43** is determined by the ratio of the teeth of the worm **116** to those of the worm wheel **117**. The ratio of the teeth of the worm **116** to those of the worm wheel **117** is so determined as to permit the number of rotations of the main shaft **14** with respect to one rotation of the cam unit **43**, i.e. the number of stitches to become m, and the ratio of the teeth of the small gear **118** to those of the large gear **120** is so selected as to permit the rotary shaft **44**, i.e. cam unit **43** to rotate n times with respect to one rotation of the rotary shaft **20**, i.e. feed cam **19**. Here, it is assumed that said n is an integral multiple of m. Accordingly, the number of stitches corresponding to one rotation of the feed cam **19** is expressed by $m \times n$. There are formed in the outer peripheral surface of the rest cam **45** of said cam unit **43** depressions **45***a*, **45***b* and **45***c* into which, when the rest cam **45** is rotated in FIG. **3** in a clockwise direction via the lever **52**, shaft **51**, operable lever **50** and pin **49** by the fall of the roller **52***a* of the lever **52** slidably contacting the outer peripheral surface of said feed cam **19** into the cam groove **19***c*, there can be brought down the rollers **67**, **74** and **103** of said stop lever **65**, the thread cutting lever **73** and the thread tightening lever **102**.

There will now be described an operation of the apparatus according to the embodiment of the invention constructed as mentioned above.

When the drive motor **4** is rotated and the clutch lever **53** is shifted to the operable position by the manually operable apparatus **6**, said clutch lever **53** is retained in an operable position shown in FIG. **2**, so that the belt travelling from the drive motor is shifted to the movable wheel **57** by the belt guide **58** to rotate the main shaft **14**, thus commencing operation. The feed cam **19** and cam unit **43** are rotated in a direction, for example, indicated by A in response to the rotation of the main shaft **14**. In this case, the rest cam **45** of the cam unit **43** is not rotated and remains in a non-operable condition. When the feed cam **19** is rotated, lateral feed signals supplied by the transverse feed groove **19a** cause the feed bed **30** to conduct lateral feed movements via the feed lever **21**, guide member **25**, lateral feed rod **26**, lateral feed lower shaft **28** and feed link guide **29**. Simultaneously, by the rotation of the cam the forward and backward feed signals supplied from the forward and backward feed groove **19***b* cause the feed bed **30** to conduct forward and backward feed movements through forward and backward feed lever **32** and guide shaft **33**, whereby desired patterns are sewn in the work fabric supported between the feed plate **31** and pressure foot **36** by the cooperation with the needle vertical movement by the rotation of the main shaft **14** when sewing operation is made in this way and accordingly the feed cam **19** makes an approximately $1/n$ rotation, the cam unit **43** makes an approximately one rotation, the roller **67** of the stop lever **65** is brought into a condition that the stop cam **46** is fallen into the cam groove **46***a*, the roller **75** and pointed body **76** of the thread cutting lever **73** respectively fallen into the cam surface **47***b* of the thread cutting cam **47** and the lower thread catching stepped portion **77** of the stepped portion constituting body **80**, and the roller **104** of the thread tightening lever **102** fallen into the cam groove **48a** of the thread tightening cam **48**, so that the operation stopping mechanism, thread cutting mechanism and thread tightening mechanism are respectively brought into a condition capable of being operated. However, as above described, at this time, the feed cam **19** makes only a $1/n$ rotation, i.e. only $1/n$ stitches of the total stitches or one sewing cycle, and accordingly if said respective mechanisms should be operated at such time, smooth sewing operation could not be conducted. However, in the embodiment, the rollers **66**, **74** and **103** of the respective levers **65**, **73** and **102** contact the outer peripheral surface of the rest cam **45** having the same diameter as the respective cams **46**, **47** and **48** and even if, accordingly, said roller **67**, roller **75**, pointed body **76** and roller **104** are brought into a condition capable of being fallen into

the cam groove **46***a*, cam surface **47***b*, lower thread catching stepped portion **77** and cam groove **48***a*, they are prevented from being fallen thereinto by the operation of the rollers **66**, **74** and **103** and rest cam **45**. Accordingly, said movement stopping mechanism, thread cutting mechanism and thread tightening mechanism are not operated, whereby sewing operation is continued. Every time the feed cam **19** rotates $2/n$, $3/n$ . . . times, the cam unit **43** rotates 2, 3 . . . times with the result that the respective mechanisms are, as above described, brought into a condition capable of being operated, but said mechanisms are not operated by the operation of the stop cam **45**, causing the sewing operation to be continued. When in this way, the feed cam **19** enters the stage of $(n\text{-}1)$ n rotations, i.e. the final stage after the $(n - 1)$ rotations and the feed cam **19** is rotated close to the automatic rest position, the roller **52***a* of the lever **52** abuts on the cam groove **19***c* of the feed cam **19** at fourth stitch from the automatic rest position to be brought down thereinto, so that the lever **52** is rotated in FIG. **2** in a clockwise direction. Thus, the operable lever **50** is swung in FIG. **3** in a counter-clockwise direction via the shaft **51**, so that the stop cam **45** of the cam unit **43** is rotated in the same direction via the pin **49** and the rollers **66**, **74** and **103** of the stop lever **63**, thread cutting lever **73** and thread tightening lever **102** are allowed to abut on the depressions **45***a*, **45***b* and **45***c* of the stop cam **45**, whereby the respective levers **65**, **73** and **102** are brought to an operable state capable of being actuated.

The levers **65**, **73** and **102** corresponding to the respective cams **46**, **47** and **48** approximately finishing a group of stitches including one bar tack are in positions shown in FIGS. **7** to **9**, respectively, and as the sewing operation proceeds, the respective cams **46**, **47** and **48** are rotated in a direction indicated by an arrow A to cause the roller **75** of the thread cutting lever **73** to be brought down into the depression **47***a* by sliding along the first cam surface **47***b* and swung and at the same time the pointed body **76** to be contacted with the upper surface of the stepped portion constituting member **80**, so that the connecting member **81** as well as the connecting piece **82** is moved in a direction indicated by an arrow B by the other end of the thread cutting lever **73** thereby to rotate the pinion **88** of the thread cutting means **86** intermeshed with the rack **81***a* of the connecting member **81** and further dispose the lower thread catching pawl **91***a* of the thread cutting means **86** in a position near the needle hole **85** so as to be ready to catch the lower thread. When the respective cams **46** to **48** are further rotated immediately before the machine automatically stops, the pointed body **76** of the thread cutting lever **73** abuts on the lower thread catching stepped portion **77** and is fallen thereinto to cause the thread cutting lever **73** to be swung. Said swing movement is, as above described, transmitted to the thread cutting means **86** so as to cause the lower thread catching pawl **91***a* to be rotated together with the pinion **88** and pass below the needle holes **85** to catch the lower thread. Further, when the respective cams **46** to **48** are rotated, the pointed body **76** of the thread cutting lever **73** abuts on the upper thread catching stepped portion **78** and is fallen thereinto, thereby, the projection **82***c* of the connecting piece **82** being brought into contact with the stopper **96** and at the same time the upper thread being caught by the upper thread catching pawl **93***a* of the thread cutting means **86**. At this time, the roller **104** of the thread tightening lever **102** abuts on and is brought down into the cam groove **48**a of the thread tightening cam **48**, so that when said roller **104** is brought to half the depth of the cam groove **48***a*, the thread tension adjusting member **114** is allowed to contact the stop member **115**. The thread tightening connecting rod **109** is moved, in FIG. **9**, in a direction (ahead the machine) indicated by an arrow C by the swing of the thread tightening lever **102** resulting from the fall of the roller **104** into half the depth of the cam groove **48***a* thereby causing the main adjuster **111** to loose the upper thread via the cam body **110** and thread loosing guide shaft **111***a*, thus permitting the upper thread catching pawl **93***a* to catch the upper thread smoothly.

As described above, when the respective cams **46** to **48** have been rotated, until they finish a bar tack consisting of a group of stitches, the roller **67** of the stop lever **65** abuts on the cam groove **46***a* of the stop cam **46** to be fallen thereinto thereby to cause the stop lever **65** to be swung, in FIG. **3**, in a clockwise direction, so that the clutch stopping lever **61** is swung, in FIG. **2**, in a counter-clockwise direction via the shaft **63**. Accordingly, the clutch stopping pawl **62** is disengaged from the clutch lever pawl **60**, whereby the clutch lever **53** is swung in a direction where it stops by the clutch lever spring **59**, and consequentially the belt is shifted from the movable wheel **57** to the idle wheel **58** by the belt guide **68** to prevent electric power from being transmitted to the main shaft **14** and simultaneously the clutch stopper **56** is engaged with the clutch groove formed in the surface of the movable wheel **57** to stop rotation of the main shaft. Of course, when the rotation of said main shaft **14** is stopped, the needle bar **18**, i.e. needle **17** is adapted to be placed in elevated position.

Under a condition where the above machine automatically stops, the thread cutting cam **47** stops so that the pointed body **76** of the thread cutting lever **73** may be allowed to abut on the thread cutting stepped portion **79** and said stopper **96** contacts the projection **82***a* of the connecting piece **82** of the connecting member **81** so as to prevent said pointed body **76** from being fallen into said stepped portion **79**. Further, the thread tightening cam **48** is also stopped under a condition where the roller **104** of the thread tightening lever **102** abuts on the cam groove **48***a* and is fallen into approximately half the depth thereof, and said roller is prevented from being further fallen into the cam groove by contact of the stop member **115** with the thread tension adjusting member **114**. Under such condition, the loops of the upper and lower threads caught by both catching pawls **91***a* and **93***a* of said thread cutting means **86** are securely enlarged by the enlarging portion of the plate members **91** and **93** following said pawls **91***a* and **93***a*. Further, the stop cam **64** is stopped under a condition where the roller **67** of the stop lever **65** is disengaged from the cam groove **46***a*.

When the connecting rod **100** is downwardly urged by operation of the foot pedal **7** so as to raise the pressure foot **36** to be operated in order to form the succeeding bar tack on the work fabric clamped between the pressure foot **36** and feed plate **84**, since, at this time, the stopping lever pawl **70** is already shifted to a

position where it does not face the pressure adjusting pawl **72** by the shift of the clutch lever **53** to the stop position, so that the connection rod **100** is ready to be downwardly urged and the pressure member **42** to be rotated, the rotatable arm **98** is rotated in a direction indicated by an arrow D in FIGS. **3** and **7** via the pin **101** so that the stopper **96** is disengaged from its contact with the projection **82a** of the connecting piece **82** of said connecting member **81**, whereby the thread cutting lever **73** is permitted to swing to cause the pointed body **76** to be fallen into the thread cutting stepped portion **79** and then the pinion **88** of the thread cutting means **86** is further rotated by the thread cutting lever **73**, thus cutting the upper and lower threads. Then, the pressure member **42** is further swung in a counterclockwise direction in FIG. **3** to raise the pressure rod **38** and lift the pressure foot **36** via the lever **39** and the protrusion **36***a* of the foot **36**. However, the stop member **115** mounted on the pressure member **42** is disengaged from its contact with the thread tension adjusting member **114** by rotation of the member **42** before the pressure foot **36** is lifted. Accordingly, the roller **104** of the thread tightening lever **102** is brought down into the deepest portion of the cam groove **48***a* of the thread tightening cam **48** to swing the lever **102** whereby the thread tightening connecting rod **109** is moved in a direction indicated by an arrow C in FIG. **9** to cause the main adjuster **111** to loose the upper thread and the clamping plate **108** to be rotated so as to urge the needle thread guide **18***a*, to tighten the cut upper thread and thus the upper thread is prevented from escaping from the needle hole of the needle **17**.

When the pressure foot **36** is downwardly urged by releasing operation of the foot pedal **7** and the clutch lever **53** is brought to its operable position by manually operating in order to start a group of the succeeding bar tacks, the main shaft **14** is rotated in a manner mentioned above, so that the feed cam **19** and cam unit **43** are also rotated. When, in this way, the cam unit **43** is rotated, the roller **75** of the thread cutting lever **73** which is fitted into the depression **47***a* of the thread cutting cam **47** abuts on the second cam surface of said depression **47***a* and slides along the same. Consequentially, the thread cutting lever **73** is swung in a reverse direction to that caused by the above mentioned fall to allow the upper thread holding member **94** of the thread cutting means **86** to hold the needle side of the upper thread cut together with the needle plate **84**. When the sewing operation advances to provide several stitches, the roller **75** becomes to abut on the third cam surface **47***d* of the depression **47***a* and slides thereon to cause the thread cutting lever **73** to be further swung in a reverse direction to that described above and then the thread cutting lever **73** and thread cutting means **86** to be returned to their original positions. Substantially at the same time as above, the roller **104** of the thread tightening lever **102** is disengaged from the cam groove **48a** of the thread tightening cam **48** to cause the thread tightening lever **102** to be swung in a reverse direction to that described above and thus the thread tightening connecting rod **109** to be moved in a direction indicated by an arrow C in FIG. **9** thereby to release the tension of the upper thread by the tightening plate **108** and simultaneously the loosening of the upper thread by the main adjuster **111**. When the feed cam **19** is further rotated, for example, corresponding to about four stitches after the stop point as above described, the roller **52***a* of the lever **52** is disengaged from the cam groove **19***c* of the feed cam **19** to swing said lever **52** in a reverse direction to that described above. Accordingly, the operable lever **50** is swung in a counterclockwise direction in FIG. **3** to cause the rest cam **45** of the cam unit **43** to be rotated via the pin **49** in the same direction so that the rollers **66, 74** and **103** of the stop lever **65**, thread cutting lever **73** and thread tightening lever **102** are allowed to contact the outer peripheral surface of the stop cam **45** without being fallen into the depressions **45***a*, **45***b* and **45***c*, whereby the respective levers **65, 73** and **102** are retained in the non-operable position. Resultantly, the stop mechanism, thread cutting mechanism and thread tightening mechanism are not operated freely from the rotation of the cam unit **43** until the feed cam **19** is rotated to come near the automatic stop position.

As above described, according to the embodiment of the invention, the stop mechanism, thread cutting mechanism and thread tightening mechanism may be retained in a non-operable position by the rest cam **45** of the cam unit **43** freely from the rotation thereof until the feed cam **19** is rotated to come near the automatic stop position, and said respective apparatuses are brought, when the cam unit **43** makes final rotation, into a condition capable of being operated by the operational signals produced by the feed cam **19** (by the cam groove **19***c* of the feed cam **19**). Accordingly, if the ratio n of the rotation of the cam unit **43** to that of the feed cam **19** is set to an arbitrary number of integral multiples of the number m of stitches (the number of rotation of the main shaft **14**) corresponding to one rotation of the cam unit **43**, there can be made optional sewing operation having the number $m \times n$ of stitches. There can be changed over the number of stitches without performing the timing of the operation and the adjustment of the position of the stop mechanism, thread cutting mechanism and thread tightening mechanism only by replacing the small gear **118** and large gear **120** providing said ratio n and the feed cam **19** providing the number $m \times n$ of stitches and desired patterns of stitches corresponding thereto.

Referring to FIGS. **11** to **13**, there will now be described another embodiment wherein the same members and parts as those of the preceding embodiment are denoted by the same reference numerals and the detailed description thereof is omitted.

The second cam or feed cam **19** is horizontally disposed in the lower part of the leg member **13** and arm bed **12** and the rotary shaft **20** is supported by a journal bearing **12a** formed in the arm bed **12** in a manner to extend upwardly. A lateral feed lever **124** and forward and backward feed lever **125** having rollers **124***a* and **125***a* respectively fitted into the transverse feed groove **19***a* and forward and backward feed groove **19***b* of said feed cam **19** are allowed to move said feed bed **30** transversely, in a forward or backward direction in response to lateral feed signals and forward and backward feed signals produced by the respective grooves **19***a* and **19***b* to form the desired patterns of stitches, which is as in the preceding embodiment. The stop lever **65** only has the roller **67**, and the thread

cutting lever **73** only has the roller **75** and pointed body **76**, and the thread tightening lever **102** only has the roller **104**. The stop lever **65** is pivoted by a shaft **126** to the leg member **13** and causes the roller **67** to contact the inner peripheral surface of the first cam **127**. The pin shaft **67***a* of the roller **67** is inserted into the elongated slit **128***a* in a guide **128**. The lower end of the guide **128** is pivoted to one end of a link **129** the outer end of which is fixed to said shaft **63**. There is stretched a spring **130** between the rest lever **65** and guide **128**, by which at normal times biasing force is applied to the stop lever **65** in a direction in which the roller **67** contacts the inner peripheral surface of said first cam **127**. The thread cutting lever **73** is constructed and operated in exactly the same manner as in the preceding embodiment, the roller **75** of which is allowed to contact the outer peripheral surface of the first cam **127**. The thread tightening lever **102** is pivoted to the leg member **13** by a shaft **131** and the roller **104** thereof is allowed to contact the outer peripheral surface of said first cam **127**, and biasing force is applied to the lever **102** by a spring not shown in a direction in which the roller **104** is always allowed to contact the outer peripheral surface of said first cam **127**.

Unlike the preceding embodiment, said first cam **127** consists of one cam and in the inner peripheral surface thereof is formed the same cam groove **46***a* as the cam groove formed in said stop cam **46** in the outer peripheral surface thereof are formed the same depression **47***a* as said thread cutting cam **47**, the first to third cam surfaces **47***b* to **47***d*, the stepped portion constituting body **80** and the same cam groove **48**a as said thread tightening cam **48**. The relationship between the position of the respective levers **65**, **73** and **102** and that of the first cam **127** in the vicinity of the automatic stop position of the machine is set as shown in FIG. **11**. Further, there is fitted to said stop lever **65** a lever **132** which can be rotated integrally therewith, to the connecting member **81** connected to said thread cutting lever **73** a lever **133** integrally rotatble therewith, and to the thread tightening lever **102** a lever **134** integrally rotatable therewith. The top end of the lever **134** is connected to said thread tightening connection rod **109** and guide pins **132***a*, **133** *a* and **134***a* attached to the lower end of the respective levers **132**, **133** and **134** are respectively inserted in operation stopping guide grooves **135**, **136** and **137** concentrically formed in the upper face of said feed cam **19**. There are formed in the guide grooves **135** and **137** cam grooves **135***a* and **137***a* directed toward the center of the cam assembly to an extent of about four stitches backward and forward from the atuomatic rest position of the feed cam **19** and there is formed in the guide groove **136** a cam groove **136***a* directed toward the outer periphery of the cam assembly. Under such a condition that the guide pins **132***a*, **133***a* and **134***a* of the levers **132**, **133** and **134** are inserted in the respective guide grooves **135**, **136** and **137**, said levers **132**, **133** and **134** can not be swung, namely, the rollers **67**, **75** and **104** of the stop lever **65**, the thread cutting lever **73** and thread tightening lever **102** are in a position incapable of being fallen into the cam groove **46***a*, depression **47***a* and cam groove **48***a* of the first cam **127** even if said rollers abut thereon, while when the guide pins **132***a*, **133***a* and **134***a* of the levers **132**, **133** and **134** abut on the cam grooves **135***a*, **136***a* and **137***a* of the guide grooves **135**, **136** and **137**, said respective levers **132**, **133** and **134** are brought into a condition capable of being swung. If, under late condition, the rollers **67**, **75** and **104** abut on the cam groove **46***a*, depression **47***a* and cam groove **48***a*, said rollers are brought down thereinto and thus the levers **65**, **73** and **102** are swung in response thereto, whereby, like the preceding embodiment, the stop mechanism, thread cutting mechanism and thread tightening mechanism are operated. The upper end portion of the rotary shaft **20** of the feed cam **19** is supported, as shown in FIG. **13**, by the journal bearing **11***b* formed in the machine arm portion **11** and there is fixed a first gear **138** at a prescribed position of the shaft in the arm portion **11**. The bearing **11***c* formed in the machine arm **11** is made to support an auxiliary rotation shaft **140** to the lower end of which is fixed a second gear **139** intermeshed with said gear **138**, and there is detachably mounted a third gear **141** on that upper end portion of said rotation shaft **140** which projects from said machine arm portion **11**. A fourth gear **143** and a fifth gear **144** are detachably mounted on the upper end portion of an auxiliary rotation shaft **142** supported by a bearing **11***d* formed in the machine arm portion **11** and said fourth gear **143** is intermeshed with said third gear **141**, and a bearing **11**a formed in the machine arm **11** is made to support an auxiliary rotation shaft **146** to the upper end portion of which is detachably attached a sixth gear **145** intermeshed with the fifth gear **144**, and there is fixed to that desired portion of the rotation shaft **146** which is present inside the arm portion **11** a worm wheel **148** intermeshed with a worm **147** set to said main shaft **14**. Further, the rotary shaft **44** of said first cam **127** may be rotated, as in the preceding embodiment, by the main shaft **14** via the worm **116** and worm wheel **117** (not shown).

Also in this embodiment, in the case where the ratio which the teeth numbers of the gears **138**, **139**, **141**, **143**, **144** and **145** and worm **147** and worm wheel **148** bear to each other is so designed as to permit the first cam **127** to make *n* rotations during one rotation of the feed cam **19** (also in this case, *n* is an integral multiple of the number *m* of stitches corresponding to one rotation of the first cam **127**), even if the feed cam **19** makes $1/n$, $2/n$ . . . rotation and thus the first cam **127** makes 1, 2 . . . rotations, the stop mechanism, the thread cutting mechanism and thread tightening mechanism are not actuated by the operation of the guide grooves **135** to **137** formed in the feed cam **19**, and if the feed cam **19** makes $(n\text{-}1)/n$ rotation to come near the automatic rest position of the machine, said respective mechanisms are brought into a condition capable of being actuated by the cam grooves **135***a* to **137***a* of said guide grooves **135** to **137**. Accordingly, in this embodiment said *n* is set at the arbitrary value corresponding to an integral multiple of *m* by optional combinations of the third, fourth, fifth and sixth gears **141**, **143**, **144** and **145** detachably attached and the feed cam **19** can be replaced and the feed cam **19** can be replaced with a cam capable of sewing an $m \times n$ number of stitches and patterns, thus presenting the same effects as in the preceding embodiment.

FIG. **14** shows another embodiment of this invention, in which there is generally shown a mechanism wherein said stop mechanism, thread cutting mechanism and

thread tightening mechanism are held in a non-operating state. In FIG. **14**, the same members and parts as those of the preceding embodiments are denoted by the same reference numerals and the detailed description thereof is omitted. In FIG. **14**, the cam unit **43** consists of, as in the preceding embodiments, the stop cam **46**, thread cutting cam **47**, thread tightening cam **48** and the rest cam **45**, the cam **45** consisting of three cams **45***d*, **45***e* and **45***f* alternately disposed with said cams **46**, **47** and **48** having no cam grooves in the outer peripheral surfaces. The rotary shaft **44** of said cam unit **43** is formed into a spline shaft, and the shaft hole of said cams **46** to **48** and **45**d to **45***f* is formed into a spline hub so as for the cam unit **43** to be rotated together with the rotary shaft **44** and movable along the axis thereof. The rollers **67**, **75** and **104** of the stop lever **65**, thread cutting lever **73** and thread tightening lever **102** are allowed, at normal times, to contact the stop cams **45***d*, **45***e* and **45***f*, respectively. A guide groove **149** is formed in the outer peripheral surface of the feed cam **19**, which has a cam groove formed toward said cam unit **43** to an extent of about four stitches backward and forward from the automatic rest position of the feed cam **19**. There is fitted in the guide groove **149** of said feed cam **19** a guide pin **151** extended from one end portion of a link **150** which is pivoted by the desired portion **11**f of the machine arm **11** at the intermediary portion. The other end of the link is connected to one end of link bar **152**. **153** is a link which is swingably supported by the prescribed portion **11***g* of the machine arm **11** at the intermediary portion and whose one end portion is pivoted to the other end of said link bar **152**. To the other end of said link **153**, there is connected one end of a guide member **154**, the other end portion of which is separated into two arms to interpose the cam unit **43** therebetween. In the end portion of the arm there is formed a cutting portion **154***a* through which the rotary shaft **44** is loosely inserted.

With such construction, since, at normal times, the rollers **67**, **75** and **104** of the respective levers **65**, **73** and **102** are allowed to contact the stop cams **45***d*, **45***e* and **45***f*, the stop mechanism, thread cutting mechanism and thread tightening mechanism are not operated even if the feed cam **19** makes $1/n$, $2/n$ . . . rotation and thus the cam unit **43** makes 1, 2 . . . rotations. When the feed cam **19** is rotated $(n\text{-}1)/n$ times to come near the automatic rest position, the guide pin **151** provided to the link **150** abuts on the cam groove **149***a* of the guide groove **149** of the feed cam **19**, so that the link **150** is swung in a direction indicated by an arrow E in FIG. **14**. Since the swing of said link **150** is transmitted to the link **153** via the link bar **152**, the link **153** is also swung in a direction indicated by the arrow E, whereby the cam unit **43** is moved by the guide member **154** in the right direction in FIG. **14**. Accordingly, the rollers **67**, **75** and **104** of the respective levers **65**, **73** and **102** are brought into contact with the stop cam **46**, thread cutting cam **47** and thread tightening cam **48**, whereby, like the aforementioned embodiments, the stop mechanism, thread cutting mechanism and thread tightening mechanism are brought into a condition capable of being operated. Therefore, also in this embodiment, there can be obtained the same effects as in the preceding embodiments.

In the aforesaid respective embodiments, although there is performed one cycle of desired bar tack stitches by one rotation of the feed cam **19**, the same cam grooves **19***c*$_1$ and **19***c*$_2$ as said cam groove **19***c* may be formed at every peripheral angle of 180° in the outer peripheral surface of the feed cam **19** so as for two sewing cycles to be carried out, by one rotation of the feed cam **19**, as shown in FIG. **15**A and further the same cam grooves **19***c*$_1$, **19***c*$_2$ and **19***c*$_3$ as the cam groove **19***c* may be formed at every peripheral angle of 120° in the outer peripheral surface of the feed cam **19** so as for three sewing cycles to be performed by one rotation of the feed cam **19**, as shown in FIG. **15**B. In these cases, in the feed cam **19** shown in FIG. **15**A, the number of stitches corresponding to one sewing cycle accounts for $m \times n/2$ and in the feed cam **19** shown in FIG. **14**B the number of stitches corresponding to one sewing cycle accounts for $m \times n/3$. Similarly, 4, 5 . . . sewing cycles may be performed by one rotation of the feed cam **19** and in this case the number of stitches stands at $m \times n/4$, $m \times n/5$ . . . . However, the numbers $m \times n/2$, $m \times n/3$, $m \times n/4$, $m \times n/5$ . . . of stitches are respectively required to be set at a value equal to an integral multiple of the number m of stitches corresponding to one rotation of the first cam (cam unit).

For example, suppose that the number m of stitches corresponding to one rotation of the first cam (cam unit) is set at **8**, sewing cycle T corresponding to one rotation of the second cam (feed cam) is set at **1**, **2** and **4**, and the number n (e.g. the ratio of the teeth of the small gear **118** to those of the large gear **120** in the first embodiment) of rotations of the first cam with respect to one rotation of the second cam is set at **12**, **14**, **16**, **18** and **20**, then the changeable number of stitches is as shown in the following table.

Number of stitches	T 1	T 2	T 3
n	$m \times n$	$m \times n/2$	$m \times n/4$
12	96	48	24
14	112	56	
16	128	64	32
18	144	72	
20	160	80	40

That is to say, if a combination of the large gear **120** and small gear **118** is made to rotate an n number of times (set at **12**), the number of stitches can be changed in three ways of **96**, **48** and **24** only by replacing the second cam. As the result, n can be changed in five ways and the number of stitches can be changed in 13 ways by replcacement of the second cam. Of course, m, n and T are not limited only to those shown in the above table and can be optionally determined.

Further, in the aftoresaid respective embodiments, a value of n is determined by employing the gear mechanism but there may be employed other members such as ratched or unidirectional clutch and the point is that there should be provided a replaceable operation connecting mechanism causing the second cam to rotate a number of times equal to an integral fraction of that of the first cam.

The aforesaid embodiment relates to the case where this invention was applied to a lock stitch sewing machine adapted for bar tack stitches. But the invention is applicable to any type of sewing machine which

can sew small attachments such as patterns, names or labels.

As mentioned above, this invention provides a sewing machine in which the number of stitches can be changed only by replacing one or both of the second cam as the feed cam and operation connecting mechanism and which makes unnecessary the timing of the operation and the adjustment of the position of the operation stopping mechanism, thread cutting mechanism and the first cam for controlling these and permits extremely simple operation and realizes high productivity.

What we claim is:

1. Cyclic sewing machine comprising a frame including a work supporting bed, drive means, a main shaft journaled in said frame, a reciprocable needle supported on said frame and movably connected to said main shaft, motion control mechanism disposed between said main shaft and said drive means for controlling the start and stop of said main shaft, a thread cutting mechanism mounted on said frame for cutting threads, a work clamp mechanism movably supported on said work supporting bed to move across the reciprocating path of said needle, first cam disk means mounted on said frame and movably connected to said main shaft for controlling the operation of said motion control mechanism and said thread cutting mechanism at the end of each sewing cycle corresponding to a predetermined number of stitches, first cam follower means operatively connecting said first cam disk means with said motion control mechanism, second cam follower means operatively connecting said first cam disk means with said thread cutting mechanism, second cam disk means for imparting feed movement to said work clamp mechanism with a number of stitches equal to an integral multiple of those corresponding to one cycle of said first cam disk means, driving connections provided between said second cam disk means and said main shaft for rotating the second cam disk means to such extent that the ratio of the angular velocity of said second can disk means to that of said first cam disk means takes a value arrived at by dividing the number of stitches corresponding to said first cam disk means by the number of stitches corresponding to said second cam disk means, third cam follower means operatively connecting said second cam disk means with said work clamp mechanism, and means for rendering said motion control mechanism and thread cutting mechanism inoperable, notwithstanding the rotation of said first cam disk means until just before the rotation for imparting a one cycle feed movement to said work clamp mechanism is completed.

2. A cyclic sewing machine according to claim 1, wherein said second cam disk means is adapted to be exchanged for another cam disk means for imparting different feed movement to said work clamp mechanism, and said driving connections include selectively exchangeable gear means.

3. A cyclic sewing machine according to claim 1, wherein the means for rendering the motion control and thread cutting mechanisms includes at least two cam portions formed on the circumference of said second cam disk means to permit the operation of said motion control mechanism and said thread cutting mechanism by the rotation of said second cam disk means and said cam portions are formed at an equal interval and along the periphery of said second cam disk means at an equal interval corresponding to a number of stitches equal to an integral multiple of a number of stitches corresponding to one cycle of said first cam disk means.

4. A cyclic sewing machine according to claim 1, wherein said motion control mechanism and thread cutting mechanism are rendered inoperative by releasing engagement between said first cam disk means and both cam follower means.

5. A cyclic sewing machine according to claim 4, wherein the last mentioned means further includes a cam surface formed on said second cam disk means, and a cam following mechanism operatively connecting said cam surface with said both follower means or said first cam disk means.

6. A cyclic sewing machine according to claim 1, wherein the last mentioned means includes a control disk arranged adjacent to said first cam disk means for releasing said first and second cam follower means from the first cam disk means.

7. A cyclic sewing machine according to claim 6, wherein said first cam disk means includes a pair of cam elements for controlling said first and second cam follower means respectively and said control disk includes a pair of control elements, each of said cam elements and said control elements being arranged alternately on an axis, and said first cam disk being moved along said axis for releasing said first and second cam follower means from the related cam element.

8. A cyclic sewing machine according to claim 1, wherein the last mentioned means includes a cam surface formed on said second cam disk means, and a cam following mechanism operatively engaged with said cam face and control disk operatively connected with said cam following mechanism.

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