Nov. 9, 1965 L. BONO 3,216,381

BUTTONHOLE SEWING MACHINE

Filed Dec. 27, 1962 6 Sheets-Sheet 1

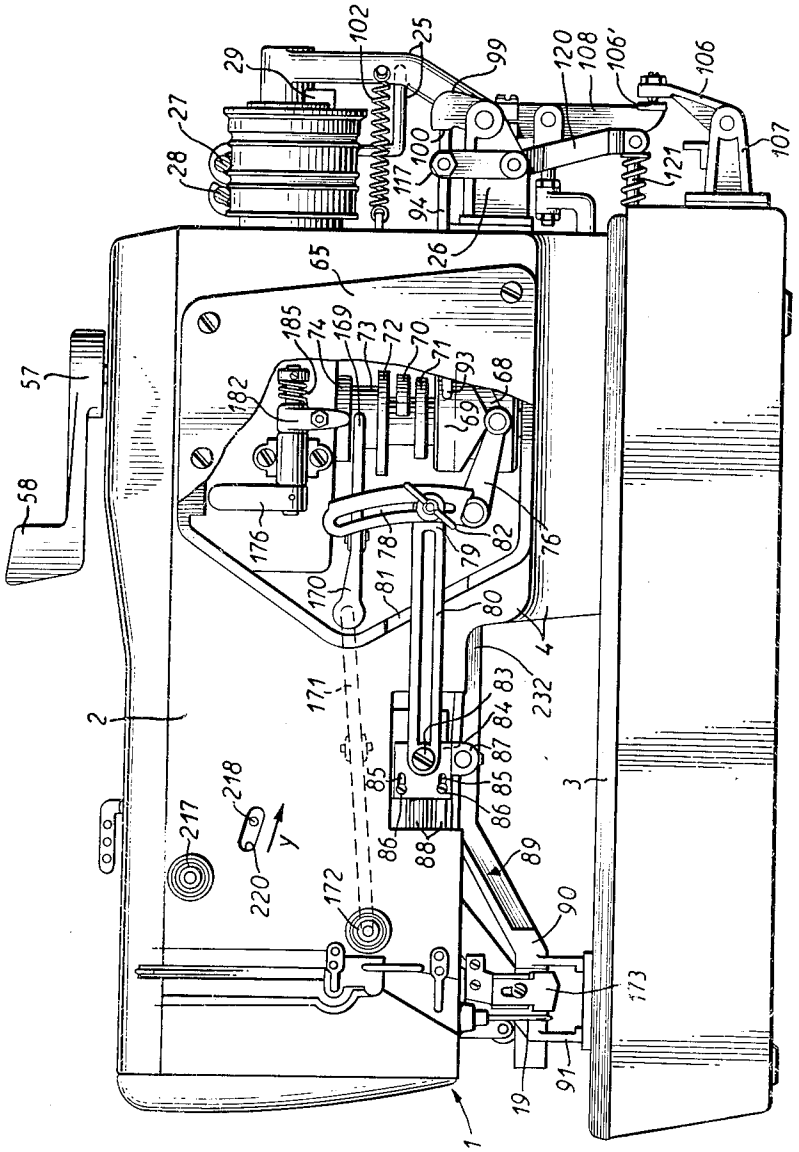

FIG.1

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BUTTONHOLE SEWING MACHINE

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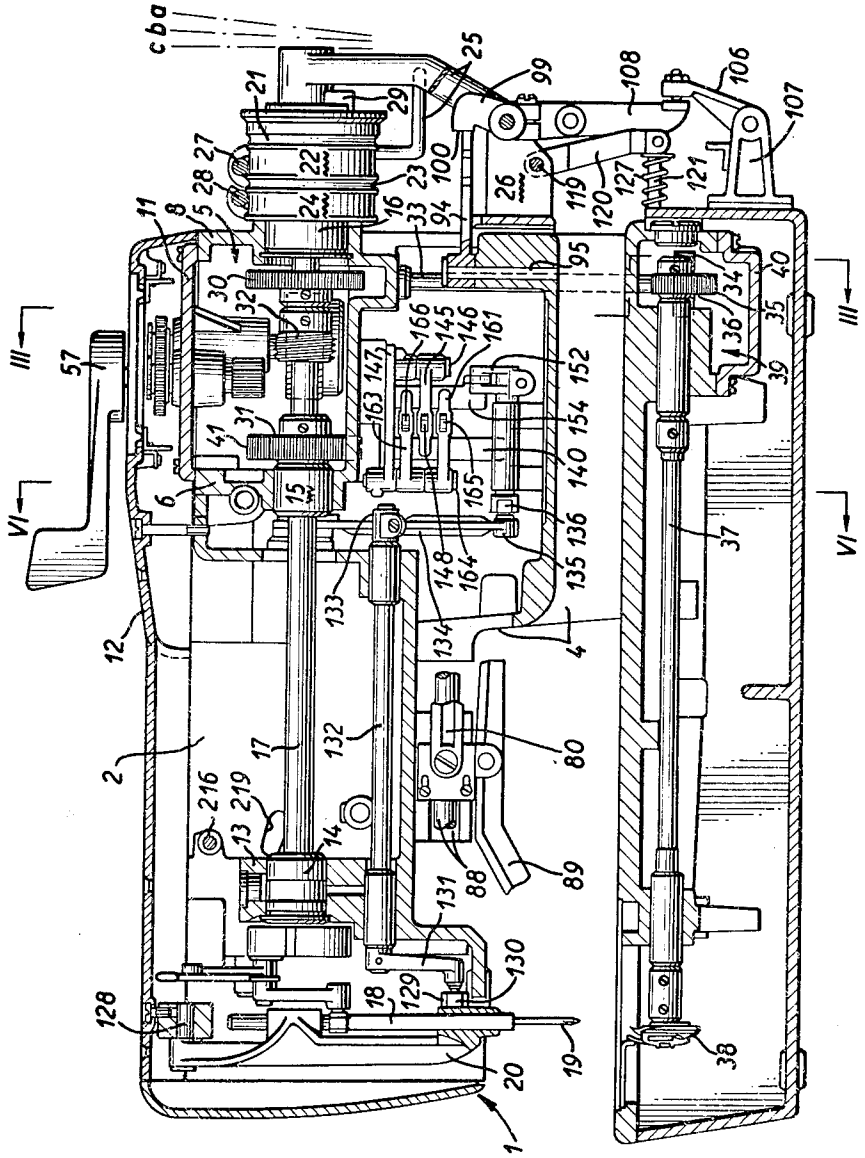

FIG. 2

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BUTTONHOLE SEWING MACHINE

Filed Dec. 27, 1962 6 Sheets-Sheet 3

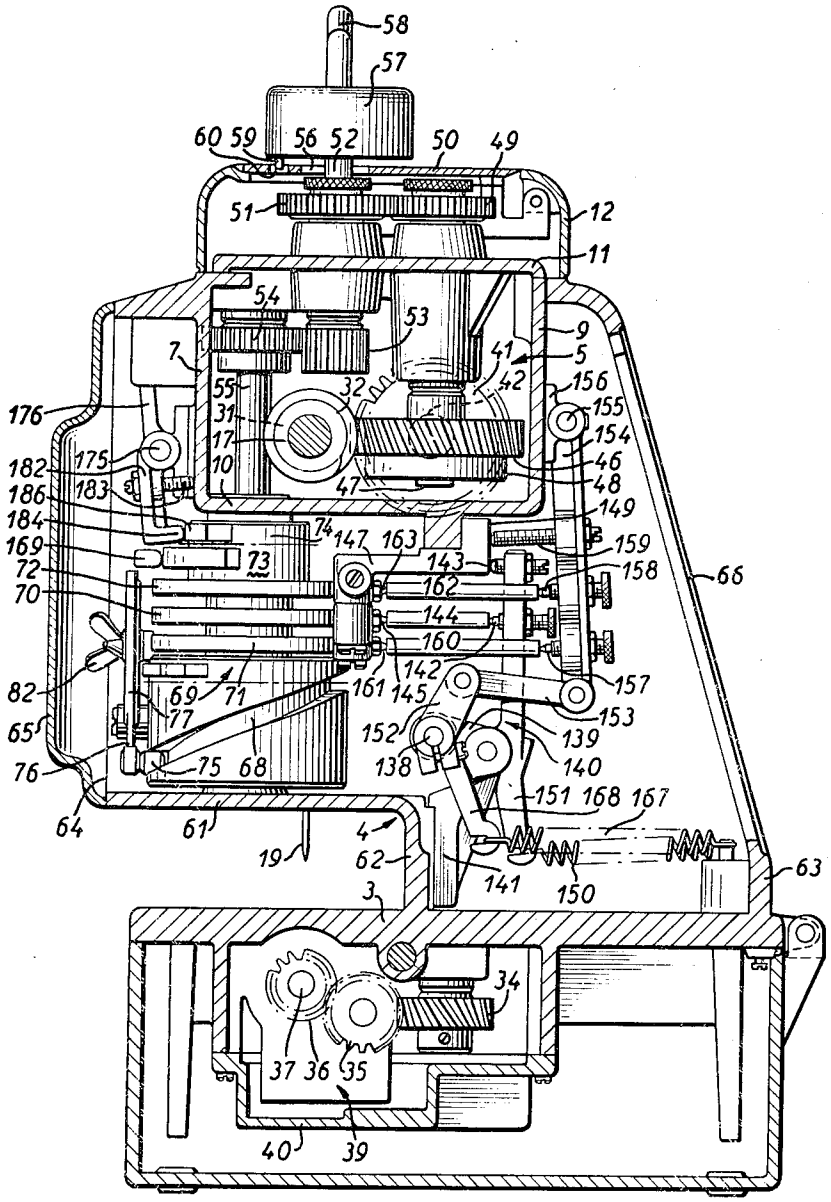

FIG. 3

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BUTTONHOLE SEWING MACHINE

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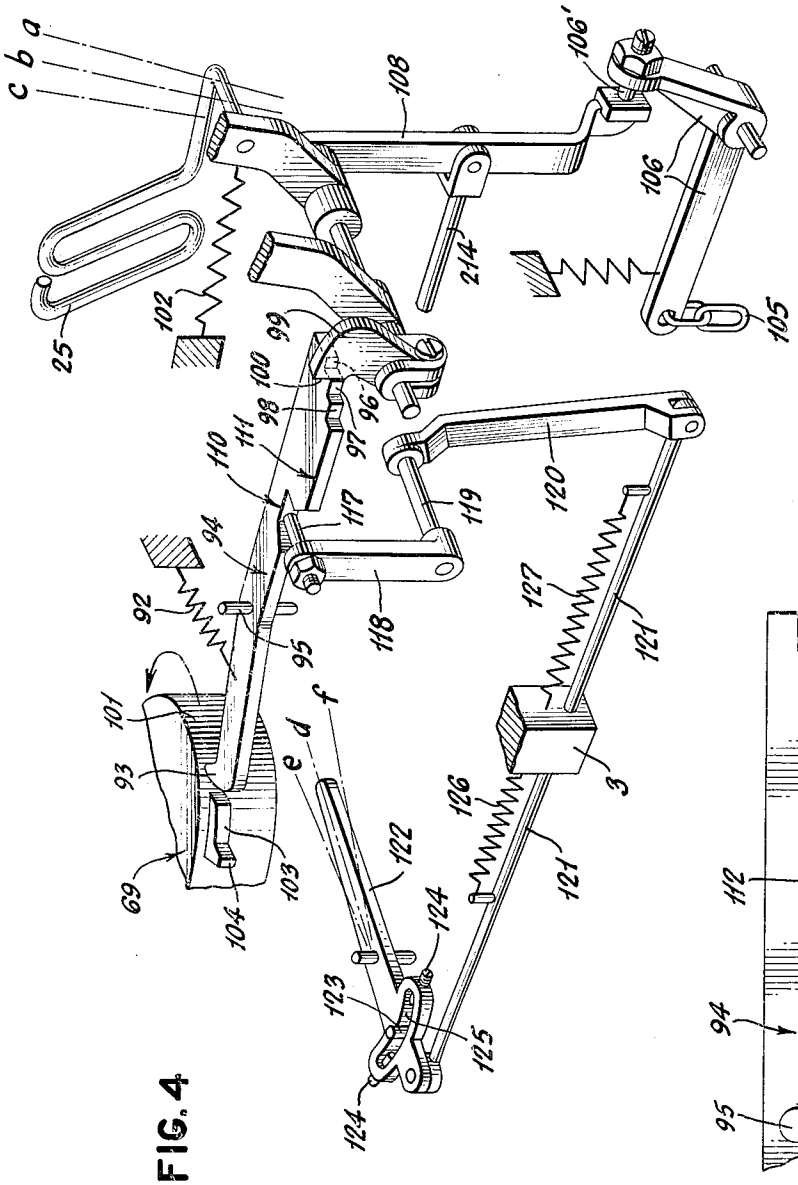

FIG. 4

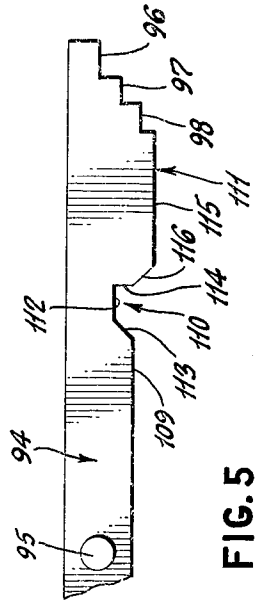

FIG. 5

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BUTTONHOLE SEWING MACHINE

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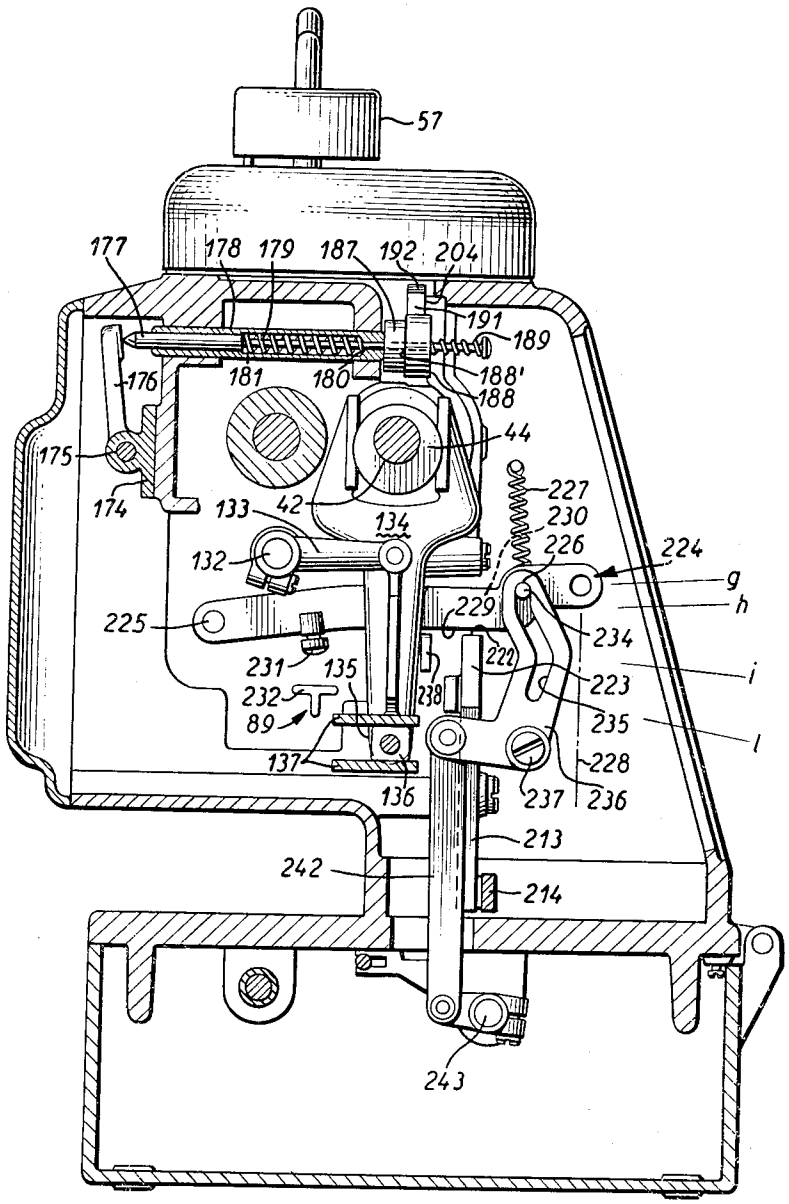

FIG. 6

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BUTTONHOLE SEWING MACHINE

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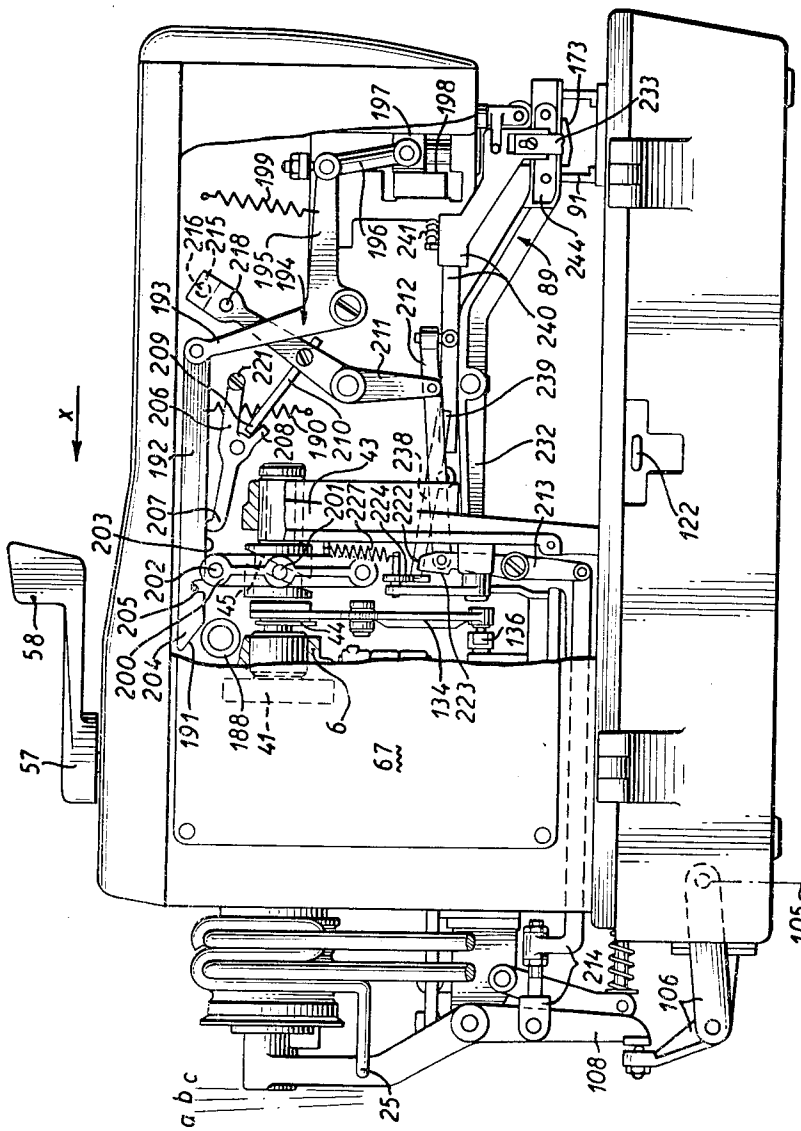

FIG. 7

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United States Patent Office 3,216,381 Patented Nov. 9, 1965

3,216,381 BUTTONHOLE SEWING MACHINE

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Filed Dec. 27, 1962, Ser. No. 247,639
Claims priority, application Italy, Apr. 4, 1962, 672,954
18 Claims. (Cl. 112—67)

This invention relates in general to new and useful improvements in sewing machines, and more particularly to a novel buttonhole sewing machine.

A primary object of this invention is to provide a sewing machine which is specifically designed for sewing buttonholes and which is constructed for automatic operation.

Another object of this invention is to provide a novel sewing machine particularly adapted for the sewing of buttonholes, and which sewing machine is provided with a variable speed drive which is automatically actuated in timed relation to the sewing of a buttonhole.

Still another object of this invention is to provide a novel sewing machine particularly adapted for sewing buttonholes, the sewing machine having a frame which is provided with a re-entrance to permit the necessary moving of fabric during the sewing of the buttonhole.

Another object of this invention is to provide a novel buttonhole sewing machine which includes a fabric presser frame which is movable in a first direction, a needle bar which is reciprocated in the normal manner and which is mounted for oscillatory movement in a direction generally normal to the first direction, and means for automatically actuating the presser frame and the needle bar support.

Another object of this invention is to provide a novel sewing machine particularly adapted for sewing buttonholes which includes means for both automatically effecting the sewing of the buttonhole, and means for automatically cutting the fabric within the confines of the buttonhole at the termination of the sewing operation.

A further object of this invention is to provide in a sewing machine particularly adapted for sewing buttonholes a drive mechanism which includes uni-directional drive connections wherein a handle projecting from the frame of a sewing machine may be moved, as necessary, to position the drive mechanism of the sewing machine at the termination of a buttonhole sewing operation without the handle being otherwise driven during the operation of the sewing machine.

Yet another object of this invention is to provide a novel sewing machine particularly adapted for sewing buttonholes, the sewing machine including means for simultaneously moving the fabric to be sewn in one direction while oscillating a reciprocating needle in a transverse direction, and means for varying the effective speed of the sewing machine during different portions of the cycle of operation thereof.

A still further object of this invention is to provide a novel sewing machine which is particularly adapted for sewing buttonholes and which sewing machine is automatic in operation to form a complete buttonhole and sever the fabric within the confines thereof, the sewing machine being provided with a plurality of cams which are operable during the operation of the sewing machine to automatically effect the movement of the various components thereof to provide the necessary automation.

Still another object of this invention is to provide a novel sewing machine for automatically forming buttonholes in fabric, the sewing machine including means for automatically effecting the sewing of the buttonhole, then automatically severing the fabric within the confines of the sewing and for severing the threads at the termination of the sewing operation.

Still another object of this invention is to provide in a sewing machine a novel speed change mechanism which includes a plurality of pulleys of which certain of the pulleys are idler pulleys, and at least two drive belts driven at different speeds, the drive belts having associated therewith shifting mechanism for shifting the drive belts from one pulley to the next whereby the drive belts are selectively independently operable and totally ineffective.

A further object of the invention is to provide a novel drive mechanism in accordance with the foregoing wherein the sewing machine includes automatic mechanism for effecting the shifting of the drive belts.

With the above and other objects in view that will hereinafter appear, the nature of the invention will be more clearly understood by reference to the following detailed description, the appended claims and the several views illustrated in the accompanying drawing.

In the drawing:

FIGURE 1 is a front view of the sewing machine of this invention with a portion thereof broken away in order to illustrate the internal working details thereof.

FIGURE 2 is a longitudinal vertical sectional view taken through the machine of FIGURE 1.

FIGURE 3 is a transverse vertical sectional view taken along the line III—III of FIGURE 2 and shows more specifically other features of the internal mechanism of the sewing machine.

FIGURE 4 is an enlarged fragmentary and partially schematic perspective view showing specifically linkage of the sewing machine.

FIGURE 5 is an enlarged plan view of a toothed lever of the sewing machine and part of the linkage illustrated in FIGURE 4.

FIGURE 6 is a transverse vertical sectional view taken along the line VI—VI of FIGURE 2 and shows the constructional details of other features of the sewing machine.

FIGURE 7 is a rear view of the sewing machine with portions broken away to illustrate the internal working components of the sewing machine.

Referring now to the drawings in detail, reference is first made to FIGURE 1 wherein it is shown that the sewing machine of this invention, which is of the buttonhole type, basically includes a frame **1** which comprises an arm **2** and a base **3** connected to each other by an upright **4**. In the upright **4**, there is provided a chamber **5** containing lubricating oil, the chamber **5**, as is best shown in FIGURES 2 and 3, being defined by vertical walls **6**, **7**, **8** and **9**, and by a horizontal bottom wall **10**. The top of the chamber **5** is closed by a plate **11** and access to the plate **11** is obtained through an opening in the arm **2** which is closed by a removable upper cover **12**.

The arm **2** has an internal rib **13** (FIGURE 2) which carries a horizontally disposed bearing **14**. The bearing **14** is aligned with a bearing **15** mounted in the front wall **6** of the chamber **5** and a bearing **16** mounted in the opposite wall **8** of the chamber **5**. A main shaft **17** of the sewing machine is journaled in the bearings **14**, **15** and **16** and is connected in a conventional manner to a customary needle bar **18**, which carries a needle **19**, for effecting reciprocating movements thereof along a support **20** for the needle bar **18**.

The main shaft **17** carries pulleys **21**, **22**, **23** and **24**. The pulleys **21** and **23**, each of which has a narrow groove, are rigidly connected to the main shaft **17**. The pulleys **22** and **24**, each of which has a relatively wide groove, are rotatably journaled relative to the main shaft **17**. A belt shifting lever **25** of a conventional type is suitably pivoted on a support **26** fastened to the outside

of the upright 4. The belt shifting lever 25 is adapted to displace along the pulleys 21, 22, 23 and 24 two belts 27 and 28 which receive their motion from a motor, not shown. The belt 27 is driven at a greater linear speed than the belt 28.

Referring now to FIGURE 2 in particular, it will be seen that in a first position *a* of the belt shifting lever 25, the belt 27 is entrained over the pulley 21 and the belt 28 is entrained over the pulley 22 so that the shaft 17 is driven at a high speed. In a second position of the belt shifting lever 25, identified by the letter *b* in FIGURE 2, the belt 27 is entrained over the pulley 22 and the belt 28 is entrained over the pulley 23 so that the shaft 17 is driven at a lower speed. In a third possible position *c* of the belt shifting lever 25, the belt 27 is entrained over the pulley 22 and the belt 28 is shifted so as to be entrained over the pulley 24 so that the shaft 17 idles with respect to the drive motor. Simultaneously with the displacement of the belt shifting lever 25 from position *b* to position *c*, a mechanical locking system 29 of a conventional type and merely indicated in FIGURE 2 enters into action and locks the shaft 17 in a predetermined angular position at which the needle 19 remains in its upper position outside of the fabric being sewn.

The main shaft 17 has connected thereto for rotation therewith and in fixed positions longitudinally of the shaft, three gears 30, 31 and 32 which are disposed within the chamber 5. The gear 30 engages with a gear, not shown in the drawings, which is rigidly fastened in a conventional manner to a vertical shaft journaled in a bottom wall 10 of the chamber 5 and in the base 3. This shaft, shaft 33, carries a gear 34 disposed below the base 3. The gear 34, by means of gears 35 and 36, transmits the motion of the vertical shaft 33 to a horizontal shaft 37 which is journaled below the base 3 parallel to the main shaft 17. The shaft 37 is provided at the opposite end thereof with a conventional hook 38 which, in cooperation with the needle 19, effects the formation of the required sewing stitches. The gears 34, 35 and 36 rotate in an oil bath within a chamber 39 formed below and within the general confines of the base 3. The chamber 39 is closed at its bottom by a plate 40.

The gear 31 is meshed with a gear 41 which is carried by a horizontal shaft 42 disposed parallel to the main shaft 17, as is shown in FIGURE 3. The shaft 42 is journaled in the front wall 6 of the chamber 5 and a rib 43 of the upright 4, as is shown in FIGURE 7, and carries an eccentric 44 and a grooved cutter control cam 45 which are disposed between the wall 6 and the rib 43.

As is best shown in FIGURE 3, the gear 32 is meshed with a gear 46 which is coaxial with a vertical shaft 47. The gear 46 is connected to the shaft 47 by a conventional unidirectional drive mechanism 48 which will not be described in detail. The shaft 47 is journaled in the plate 11 and is provided above the plate 11 with means (not shown) for engagement with an interchangeable gear 49 which is arranged below a door 50 of the cover 12. The interchangeable gear 49 is meshed with another interchangeable gear 51 which is carried by a vertical shaft 52 disposed alongside the vertical shaft 47. The shaft 52 is journaled in the plate 11 and is provided at the lower end thereof with a gear 53 disposed within the chamber 5 and meshing with a gear 54 of a vertically disposed cam shaft 55.

The shaft 52 protrudes above the door 50 through a hole 56 therein. On the shaft 52 there is connected a unidirectional drive mechanism 57 of a conventional type, which carries a handle 58 disposed in an exposed position, as is clearly shown in FIGURES 1 and 3. The handle 58 has rigidly connected thereto a pin or key 59 which is engageable in a slot 60 of the door 50, which slot is disposed concentric with the hole 56. Due to the operation of the uni-directional drive mechanism 57 and the key 59, the handle 58 remains stationary during the normal operation of the sewing machine.

The slot 60 is of an extent greater than that of the key 59 so as to permit the handle 58 to swing alternatively through a predetermined angle. In this way, when the sewing machine is stopped, it is possible to rotate the cam shaft 55 in opposite directions while the main shaft 17 remains stationary due to the uni-directional drive mechanism 48.

Referring once again to FIGURE 3, it will be seen that the cam shaft 55 is journaled in a vertical position in the bottom wall 10 of the chamber 5 and in a lower horizontal wall 61 of the upright 4. The horizontal wall 61 is connected with a front vertical wall 62 arranged at the base of the upright 4. The wall 62 is disposed substantially parallel to a plane passing through the axes of the shafts 17 and 37 and is displaced with respect to that plane towards a rear wall 63 of the upright 4. In this manner, the base of the upright is shifted with respect to the axis of the main shaft 17 so that the frame 1 has a re-entrance of a nature so as to permit the fabric arranged in position corresponding to the needle 19 to shift freely in the direction of the axis of the shaft 17.

The upright 4 is provided with a wide vertical window 64 disposed above the lower horizontal wall 61. The window 64 is closed by a removable cover 65. Similarly, the rear wall 63 of the upright 4 has a large window 66 which is closed by a removable cover 67.

The cam shaft 55 has keyed thereonto cams 68 through 74, inclusive. The cam 68, which is disposed lowermost, is a grooved cam and has a follower roller 75 engaged in the groove thereof. The follower roller 75 is carried by a lever 76 which is pivoted on the upright 4. The lever 76 has an arm 77 in which is formed an arcuate groove 78, as is best shown in FIGURE 1. The groove 78 permits the adjustable mounting of an end 79 of a link rod 80 which passes through a slot 81 in the upright 4. The end 79 of the rod 80 is maintained in a fixed position relative to the arm 77 by means of a wing nut type fastener 82 which is accessible after the cover 65 has been removed. The other end of the rod 80 is pivoted on a pin 83 of a small plate 84 in which there are formed two parallel elongated slots 85 which receive screws 86 to adjustably fasten the plate 84 to a block 87. The block 87 is mounted for sliding movement along a guide 88 fastened to the arm 2 parallel to the main shaft 17. A lever 89 is pivoted on the block 87 and an end 90 of the lever 89 has interchangeably fastened thereto a presser frame 91 which is of a toothed bottom construction and which, by elastic means not shown, presses against the fabric being sewn at the location of the needle 19. During the use of the sewing machine, the fabric moves with the displacements of the presser frame 91 in the direction of the axis of the main shaft 17. The distance between the presser frame 91 and the axis of the pin 83 can be adjusted by rotating the small plate 84 180° with respect to the block 87, or by utilizing the play between the small plate 84 and the block 87 provided by the elongated slots 85.

Referring now to FIGURES 4 and 5, it will be seen that a spring 92 urges a follower 93 against the cam 69. The follower 93 consists of one end of a lever 94 which is pivoted on a vertical pin 95 carried by the upright 4. The other end of the lever 94 has steps 96, 97 and 98. A small lever 99, which is rigidly secured to a shaft 99' carried by the support 26 and on which the belt shifting lever 25 is secured for its pivotal movement has a tooth 100 which is adapted to engage with one of the steps 96, 97 and 98.

At the start of the production of a buttonhole, the follower 93 is on a cylindrical surface 101 of the cam 69 and a spring 102, which extends between the upright 4 and the belt shifting lever 25, resiliently effects the engagement of the tooth 100 of the lever 99 against the step 96 of the lever 94. The belt shifting lever 25 is at this time in position *a* and the main shaft 17 is driven at a high speed.

Towards the end of the production of the buttonhole, the follower 93 is engaged by a high portion 103 of the cam 69 and effects the displacement of the lever 94 in such a manner that the tooth 100 of the lever 99 engages in the step 97. The belt shifting lever 25 is then pulled into position *b* corresponding to the rotation of the main shaft 17 at a low speed.

Finally, the follower 93 is engaged by a raised portion 104 of the cam 69 and effects the shifting of the lever 94 in such a manner that the tooth 100 of the lever 99 engages the step 98. The belt shifting lever 25 is then moved to the position *c* and the shaft 17 is stopped in the predetermined angular position. In the meantime, the cam 69 has rotated so as to again present the cylindrical surface 101 thereof to the follower 93.

In order to start another buttonhole, it is merely necessary to depress a foot pedal, not shown, which is connected to a chain 105. The chain 105 is connected to a lever 106 pivoted on a support 107 of the base 3. The lever 106 carries an adjustable stop 106′ which bears against an end of a lever 108 which is secured on the rod 99′ for swinging movement with the belt shifting lever 25 and the lever 99. When the foot pedal is depressed, the adjustable stop 106′ presses against the lever 108 and brings the belt shifting lever 25 back into its original position *a*. At the same time, the tooth 100 is disengaged from the step 98 and is brought back into contact with the step 96 while the spring 92 brings the follower 93 into contact with the cylindrical surface 101 of the cam 69.

The sewing machine of this invention also has means adapted to make it possible to produce the entire buttonhole at a low speed or instantaneously stop the operation of the machine at any moment.

A wall 109 of the lever 94, as is best shown in FIGURE 5, is interrupted by a re-entrance 110 which has adjacent thereto a projection 111. A bottom wall 112 of the re-entrance 110 is connected to the wall 109 by an inclined wall 113. Towards the projection 111, the re-entrance is defined, however, by a wall 114 which is disposed perpendicular to the bottom wall 112. This wall 114, in its turn, is connected to a head wall 115 of the projection 111 by an inclined wall 116.

A camming element 117 is provided for contact with the walls of the re-entrance 110. The camming element 117 is carried by a lever 118 which is rigidly connected to a pin 119 for pivotal movement. The pin 119 is pivotally carried by a portion of the support 26 in a manner not shown. The pin 119 also has rigidly connected thereto a second lever 120 which, by means of a rod 121 arranged below the base 3, is connected to an operating lever 122 which can be actuated from outside of the base and is pivoted below the base. A pin 123 fastened in the base 3 is mounted for movement within an elongated arcuate slot 125 formed in the lever 122 and is engageable with regulating screws 124 which project into the opposite ends of the slot 125 so as to limit the relative movement of the pin 123 with respect to the lever 122.

Elastic means 126 and 127 act on opposite sides of the rod 121 to maintain the lever 122 in a position *d* intermediate the outer positions *e* and *f* shown in FIGURE 4 so that the follower 117 is at the re-entrance 110 of the lever 93.

When the sewing machine operates at a high speed, that is, when the tooth 100 of the lever 99 is engaged in the step 96 of the lever 94, the camming element 117 is in contact with the bottom wall of the re-entrance 110. Under these conditions, the operating lever 122 cannot be shifted into the position *f* since the follower 117 will strike against the wall 114. The lever 122 can, however, be shifted into the position *e* since the follower 117 can slide along the inclined wall 113.

The camming element 117, upon sliding on the inclined wall 113, causes the lever 94 to rotate so that the tooth 100 can engage the step 97 and the operating speed of the sewing machine is thus reduced. Upon releasing the

operating lever 122, the follower 117 is brought again into the re-entrance 110 in the lever 94, but is spaced away from the bottom wall 112 of the re-entrance so that it can slide on the inclined wall 116 as soon as the operating lever 122 is shifted towards the position *f*. When the operating lever 122 reaches the position *f*, the lever 94 is rotated in such a manner that the tooth 100 engages the step 98 so that the shaft 17 is stopped. By carrying out the displacement of the operating lever 122 rapidly from the position *d* to the position *e* and from the position *e* to the position *f*, there is obtained the instantaneous stopping of the machine at any point during the sewing cycle. If the sole displacement of the operating lever 122 is, however, from position *d* to position *e*, sewing will be effected at a reduced speed and the stopping of the sewing machine will be effected at the end of the sewing cycle in the customary manner by the cam 69.

The cams 70, 71 and 72 and the eccentric 44 cooperate with each other to control the amplitude of the oscillations and the position of the field of oscillation of the needle 19 in a direction transverse to the axis of the main shaft 17. In FIGURE 2, it is shown that the support 20 of the needle bar 19 is pivoted on a pin 128 carried by the arm 2. The support 20 also carries a guide 129 in which there is engaged a part 130 carried by an arm 131 of an oscillatory shaft 132. The shaft 132 runs parallel to the main shaft 17 and carries a second arm 133 on which there is pivoted a forked lever 134 which surrounds the eccentric 44 in the manner shown in FIGURE 6. On a foot 135 of the forked lever 134 there is pivoted a part 136 which is slidable in an oscillatory link member 137. As is shown in FIGURE 3, the link 137 is rigidly connected with a pin 138 disposed parallel to the main shaft 17 and which is pivotally carried by an arm 139 of a lever 140. The lever 140 in its turn is pivoted, parallel to the main shaft 17, on a support 141 which is fastened on the front wall 62 of the upright 4 within the upright.

The lever 140 carries two adjustable stops 142 and 143. The stop 142 presses against a rod 144 which, in its turn, presses against a lever 145. Although it is not shown in the drawings, it is preferred that a spring act on the levers 140 and 145. The lever 145 is pivoted on a vertical pin 146 of a support 147 which is fastened to the lower wall 10 of the chamber 5 and carries a follower 148 (FIGURE 2) which rides on the cam 70. The stop 143, in its turn, is arranged opposite a vertical wall 149 of the support 147. Depending upon the radius of the cam 70, a spring 150, which is fastened to an arm 151 of the lever 140 and to the upright 4, either causes the follower 148 to press against the cam 70 or causes the stop 143 to press against the vertical wall 149 of the support 147. Corresponding to this, the position of the field of oscillation of the needle 19 is shifted towards the right or towards the left.

The pin 138 rigidly connected to the link 137 is also rigidly connected to a lever 152 which by means of a tie rod 153 is connected to a lever 154. The lever 154 is pivoted on a pin 155 fastened to a rib 156 of the rear wall 9 of the chamber 5 parallel to the main shaft 17.

The lever 154, as is clearly shown in FIGURE 3, carries three adjustable stops 157, 158 and 159. The stop 157 presses against a rod 160 which, in its turn, presses against a lever 161 by means of a spring (not shown) fastened to the levers 154 and 161. The stop 158, in its turn, presses against a rod 162 which, in its turn, presses against a lever 163 due to the function of the spring (not shown) fastened to the levers 154 and 163. The levers 161 and 163 are pivoted on a vertical pin 164 fastened to the support 147 and carry followers 165 and 166, respectively (FIGURE 2), of the cams 71 and 72. The stop 159 is arranged opposite the vertical wall 149 of the support 147.

Depending upon the radii of the cams 71 and 72 and their angular phasings, a spring 167, which is fastened to the upright 4 and to an arm 168 rigidly connected to the

pin 138 of the lever 152, either causes the follower 165 to press against the cam 71 or causes the follower 166 to press against the cam 72 or causes the stop 159 to press against the wall 149. Corresponding to these several positions, the amplitude of the oscillations of the needle 19 will be maximum, medium or zero in the stated order.

The cam 73 is engaged by a follower 169 of a lever 170 which is pivoted in the arm 2 and is adjacent another lever 171 which upon the completion of a buttonhole controls in a conventional manner the opening of tension disks 172, all best shown in FIGURE 1.

The cam 74 cooperates with the grooved cam 45 of the shaft 42 to control the operation of a knife 173 adapted to cut the buttonhole at the end of the sewing cycle. Referring now to FIGURE 6, it will be seen that there is a support 174 fastened on the frame and there is pivoted in the support 174 a pin 175 to which there is rigidly connected an arm 176. Against the arm 176, there presses a rod 177 which is slidable in a horizontal guide 178 fastened to the outside of front wall 6 of the chamber 5. Pressure exerted by the rod 177 against the arm 176 is assured by a spring 179 which is disposed coaxial to the rod and acts between a shoulder 180 of the guide 178 and a shoulder 181 of the rod 177. On the pin 175, there is pivoted a lever 182, as is shown in FIGURE 3. The lever 182, which carries a stop 183, adapted to press against the front wall 7 of the chamber 5, and a follower 184, arranged opposite the cam 74, is connected to the pin 175 and the arm 176 by means of a spring 185 best shown in FIGURE 1. The spring 185 is more rigid than the spring 179. Accordingly, it follows from the foregoing that when towards the end of the sewing cycle the cam 74 presents its raised portion 186 to the follower 184, the arm 176 follows the rotation of the lever 182 and displaces the rod 177 axially against the action of a spring 179. If, however, due to an improper operation the rod 177 is prevented from movement axially, the spring 185 will permit the lever 182 to rotate with respect to the arm 176 and thus avoid the breaking of the associated machine parts.

The rod 177 controls a well-known cutter control linkage device for permitting the operation of the knife 173 by means of the grooved cam 45. An example of such a device is shown in FIGURE 6 and consists of a collar 187 rigidly fastened to the rod 177 and of a ring 188 of slightly larger diameter which is slidable along the rod 177 and which is pressed against the collar 187 by a light spring 189. Against the ring 188, there is pressed by a spring 190 an inclined plane 191 (FIGURE 7) of a lever 192 which is pivoted on the arm 193 of an L-shaped lever 194. The L-shaped lever 194 is pivoted on the arm 2 and is connected by an arm 195 thereof through a connecting rod 196 to a small block 197 which is slidable in a vertical guide 198 of the arm 2. To the block 197 there is rigidly connected a cutter 173 which, when at rest, is held in the rest position by a spring 199.

The actuation of the knife 173 is controlled by an oscillating follower lever 200 which is pivoted in the upright 4 and which carries a follower 201 engaged in the grooved cam 45. The lever 200 carries a horizontal pin 202 which is opposite a lower face 203 of the lever 192.

When the cam 74 is rotated to bring its raised portion 186 into engagement with the follower 184, the rod 177 is moved in opposition to the spring 179 so that the collar 187 is moved below the inclined plane 191 of the lever 192. Under these conditions, a face 188' of the ring 188 comes into contact with a vertical face 204 of the lever 192. It follows that as soon as the rotations of the cam 74 have caused the follower 184 to pass beyond the raised portion 186, the rod 177 returns to its initial position but is not followed by the ring 188. Due to the action of the spring 190, the lever 192 is then free to wedge itself between the collar 187 and the ring 188 and descends in such a manner that the pin 202 of the oscillating lever 200, by moving in the direction indicated by the arrow x in FIGURE 7, slides on its lower face 203 and at the end of the stroke engages a niche 205 provided on the lower face 203. Thereupon, moving in an opposite direction, the pin 202 carries the lever 192 along with it so as to cause the lowering of the knife 173. At the same time, the inclined plane 191 of the lever 192 moves away from the ring 188 so that the spring 189 again brings the ring 188 into contact with the collar 187. During the subsequent oscillation in the direction indicated by the arrow x, the pin 202 again drives the lever 192 along with it so that the latter, sliding by means of the inclined plane 191 on the ring 188, is again brought into the initial rest position.

It is contemplated that the knife 173 can there act to cut the buttonhole until the buttonhole machine rotates at a maximum speed. This driving of the machine is guaranteed by the phasing of the cam 74 with respect to the cam 69. There is also provided a safety device such that the knife 173 cannot enter into action as the result of an improper operation when the belt shifting lever 25 is in position c. This safety device is best shown in FIGURE 7 and consists of a lever 206 which is pivoted on the arm 2 and an arm 207 which is adjacent the lower surface 203 of the lever 192. Another arm 208 of the lever 206 is adjacent and end 209 of an iron 210 which is rigidly connected with a lever 211, the lever 211 also being pivoted on the arm 2. The lever 211 is connected by means of a strut 212 to still another lever 213 which is pivoted within the upright 4. The lever 213 is finally connected by means of a strut 214 with the lever 108 which is rigidly connected with the belt shifting lever 25.

When the belt shifting lever 25 is in its position c, the end 209 of the iron 210 presses against the arm 208 of the lever 206; the arm 207 of the lever 206 then presses against the lower surface 203 of the lever 192 in such a manner that the inclined plane 191 of the lever 192 is maintained slightly spaced from the ring 188 and prevents the actuation of the cutter or knife 173 by means of the lever 200. The lever 211 of the safety device has at its upper end an inclined plane 215 which is arranged opposite a small rod 216 which is slidably journaled in the arm 2, as is best shown in FIGURE 7. When the belt shifting lever 25 is shifted into its position c, the small rod 216 controls the positioning of an aperture of a tensioning disk 217 best shown in FIGURE 1. The lever 211 is also rigidly connected with another small rod 218 (FIGURE 1) which is engaged in slots 219 and 220 of the arm 2 and which upon moving in the direction of the arrow y pulls back thread from the tension disk 217 before the tension device 172 is opened.

Referring once again to FIGURE 7, it will be seen that a handle 221 of the lever 206 protrudes through a slot, which is not shown in the drawings, in the frame and makes it possible, when desired, to act manually on the lever 206 even during the normal buttonhole production cycle, so as to avoid the cutter acting at the end of the cycle.

The lever 213 of the safety device prevents the presser frame 91 from being raised when the machine is in motion and, conversely, the machine from being placed in operation when the presser frame 91 is raised.

The lever 213 has a horizontal face 222 and a vertical face 223 opposite a lever 224 which is pivoted on a horizontal pin 225 of the upright 4 (FIGURE 6), and is held in a position g against a stop 226 by a spring 227. The lever 224 is connected to an operating pedal (not shown) by a chain 228. When the belt shifting lever 25 is in its position a or its position b corresponding to the operation of the sewing machine, the horizontal face 222 of the lever 213 is in contact with a lower wall 229 of the lever 224 and prevents it from rotating downwardly against the action of the spring 227. When the belt shifting lever 25, however, is in position c, the lever 213 is displaced so as to permit the lever 224 to rotate downwardly. Under these conditions, a vertical wall 230 of

the lever 224 slides on the vertical face 223 of the lever 213 and then, as long as the lever 224 is rotated downwardly, prevents the belt shifting lever 25 from returning into its position *a* or its position *b*.

The lever 224 carries a stop 231 which is directed towards an arm 232 of the lever 89 to which the presser frame 91 is fastened, and by moving downwardly the lever 224 controls the raising of the presser frame 91. The contact between the stop 231 and the arm 232 of the lever is formed, however, only after the lever 224 has been rotated so as to bring about, in order, the action of a conventional type of knife 233 which cuts and holds the upper thread of the sewing machine and another conventional type of knife (not shown) which cuts and holds the lower thread.

The lever 224 carries a pin 234 which is engaged in a profiled groove 235 of a lever 236 which is pivoted on a pin 237 of the upright 4. The profiled groove 235 is developed in such a manner that the lever 224, upon rotating from its position *g* to its position *h* (FIGURE 6), does not shift the lever 236. However, upon rotating from the position *h* to the position *i*, the lever 224 rotates the lever 236 around the pin 237, and upon rotating from position *i* to position *l*, it does not shift the lever 236. There also presses against the lever 224, as a result of the action of a spring which is not illustrated, a lever 238 which is pivoted on the arm 2 of the sewing machine.

The lever 224 rotates from position *g* to position *h*, the lever 238 rotates so as to free its own end 239 from a conventional buttonhole type sewing machine lever 240 which is articulated on the strut 212 (FIGURE 7) and the lever 240, under the action of a spring 241, can control in a conventional manner the knife 233 of the upper thread. When the lever 224 rotates from position *h* to position *i*, the lever 236 rotates around its own pin 237 and by means of a connecting rod 242, it causes the rotation of a shaft 243 which is arranged below the base 3 and which in a known manner drives the unillustrated conventional thread cutter of the lower thread.

Finally, when the lever 224 rotates from position *i* to position *l*, its stop 231 presses against the arm 232 of the lever 189 and brings about the raising of the presser frame 91.

The above indicated order in which the action of the thread cutting knives is controlled makes it possible to see that the lower thread, before it is cut, pulls back towards the lower face of the fabric the end of the upper thread of the buttonhole which has already been cut, so that the buttonhole is of impeccable appearance.

By returning the lever 224 to the position *g*, the presser frame 91 is lowered again onto the fabric and the thread cutter knife of the lower thread returns from the initial rest position. The subsequent return of the belt shifting lever 25 into either position *a* or position *b*, shifts the strut 212 in such a manner that the lever 240 of the thread cutter knife 233, sliding in a conventional manner on a cam 244 rigidly connected to the presser frame 91, is again engaged by the end 239 of the lever 238. The cam 244 permits in a conventional manner the spring 241 to rotate the lever so as to actuate the thread cutter knife 233 only when the presser frame 91 is in the position corresponding to the end of the production of a buttonhole.

Although only a preferred embodiment of the invention has been illustrated and specifically described herein, it is to be understood that minor modifications may be made in the invention within the spirit and scope of the appended claims.

I claim:

1. A buttonhole sewing machine comprising a rotatable main shaft drivingly connected to a needle bar for effecting reciprocatory vertical movement of said bar along a needle bar support, a drive means for driving said main shaft, drive actuating means operable to effect respectively either one of various drive relationships between said main shaft and said drive means, a first of said relationships comprising said main shaft being driven at high speed, a second of said relationships comprising said shaft being driven at low speed, and a third of said relationships comprising said drive means being disconnected from driving relationship with said shaft, gear means drivingly connected to said main shaft, said gear means being drivingly connected to a cam shaft which rotatively drives a plurality of cams, a one of said cams being associated with said drive actuating means whereby the rotative position of said one cam acts through said actuating means to determine the aforementioned drive relationships between said main shaft and said drive means, a hand operated means associated with said drive actuating means and adapted to act therethrough to determine the aforementioned drive relationship independently of said one cam.

2. The sewing machine of claim 1, wherein said one cam is so phased relative to said drive actuating means whereby rotation of said one cam causes said drive actuating means to successively position said drive means in said first, second, and third drive relationships relative to said main shaft.

3. The sewing machine of claim 2, wherein said hand operated means is so associated with said drive actuating means as to be able to position said drive means in said third drive relationship only when said drive means is in said second drive relationship.

4. The sewing machine of claim 2, wherein said drive actuating means comprises a pivoted actuating lever one end of which engages said one cam and the other end of which comprises three stepped surfaces, a pivoted locking lever acting upon said drive means and engageable with respective ones of stepped surfaces whereby such engagement corresponds respectively to said three drive relationships, said one cam successively causing said actuating lever to pivot and thereby causing said locking lever to successively engage said stepped surfaces.

5. The sewing machine of claim 4, wherein said hand operated means comprises a pivoted hand lever operatively connected to a camming element, said camming element extending into a recess in said actuating lever and being movable in opposite directions in said recess in correspondence to said hand lever being pivoted in opposite directions, said hand lever being biased to an intermediate position whereby said camming element has no effect upon said actuating lever, said recess being configured so that pivotal movement of said hand lever causes said camming element to slide against the surface of said actuating lever, thereby pivoting said actuating lever, such pivotal movement of said actuating lever causing said locking lever to engage a different one of said stepped surfaces.

6. The sewing machine of claim 5 wherein pivotal movement of said hand lever in a first direction will move said camming element in a direction which places said actuating lever in a position corresponding to said second drive relationship, while pivotal movement of said hand lever in an opposite direction will move said camming element in a direction which places said actuating lever in a position corresponding to said third drive relationship.

7. The sewing machine of claim 6, wherein said recess is so configured that, with said actuating lever in a position corresponding to said first drive relationship, said camming element can be moved by said hand lever only in a direction corresponding to said second drive relationship, said camming element then being movable in an opposite direction to a position corresponding to said third drive relationship.

8. The sewing machine of claim 1, wherein a second of said cams is operatively connected to a presser frame, said presser frame being mounted for reciprocatory movement parallel to the axis of said main shaft.

9. The sewing machine of claim 8, wherein said second cam comprises a grooved cam surface, a generally L-

shaped lever pivotally mounted on a stationary pivot, a follower attached to one leg of said L-shaped lever and riding in the groove of said grooved surface, the other leg of said L-shaped lever comprising an elongated slot, a link member adjustably connected at one end thereof within said slot and pivotally connected at the opposite end thereof to a block which is mounted for sliding movement parallel to the axis of said main shaft, a presser frame lever pivotally mounted at one end to said block, the other end of said presser frame lever having said presser frame attached thereto.

10. The sewing machine of claim **9**, wherein said presser frame is detachably mounted on said presser frame lever.

11. The sewing machine of claim **1**, wherein said needle bar support is mounted for oscillatory pivotal movement in a plane transverse to the rotative axis of said main shaft, said gear means being drivingly connected to an eccentric for rotative motion thereof, a fork embracing said eccentric and being driven thereby, said fork being connected to an oscillatory shaft so as to impart oscillatory rotative motion thereto, said oscillatory shaft being connected to said needle bar support so as to pivot said support in response to oscillatory movement of said oscillatory shaft, said fork engaging an oscillatory link member, a third one of said cams being drivingly connected to said link member and oscillating said link member in response to rotation of said third cam, said link member imparting oscillatory motion to said fork which in turn imparts same to said oscillatory shaft.

12. The sewing machine of claim **11**, wherein said link member is mounted for oscillatory motion about a first, fixed pivot axis, said link member also being rotatable about a second axis, fourth and fifth ones of said cams being drivingly connected to said link member and successively acting thereon to determine the rotative position of said link member about said second axis, said rotative position of said link member being determinative of the amplitude of the oscillatory motion which is imparted from said link member to said fork.

13. The sewing machine of claim **12**, wherein said fourth and fifth cams are phased to act upon said link member successively, said amplitude of oscillatory motion being a maximum when said fourth cam is acting upon said link member, and being less when said fifth cam is acting upon said link member, there being an interval in the rotation of said fourth and fifth cams during which neither of them acts upon said link member and whereby there is no oscillatory motion transmitted from said link member to said fork.

14. The sewing machine of claim **1**, wherein said gear means is drivingly connected to a cutter control cam which has a groove running axially along the circumference of said cutter cam, an oscillating follower lever having a follower engaged in said cutter cam groove, said follower lever being operatively connected to a cutter knife whereby rotation of said cutter control cam acts through said follower lever to cause successive raising and lowering of said knife.

15. The sewing machine of claim **14**, wherein said follower lever is disengageably associated with said knife through a cutter control linkage device, said linkage device being operatively associated with a sixth one of said cams, said sixth cam acting upon said linkage device to engage or disengage said device from said follower lever.

16. The sewing machine of claim **1**, wherein said gear means is drivingly connected to said cam shaft through a unidirectional drive means, a hand operable means connected to said cam shaft whereby said cam shaft can be rotated by said hand operable means without said gear means and said main shaft being affected.

17. The sewing machine of claim **16**, wherein said hand operable means is connected to said cam shaft through a unidirectional drive means.

18. The sewing machine of claim **1**, wherein said gear means is drivingly connected to a hook shaft extending parallel to said main shaft and below said needle bar, said hook shaft comprising a hook device aligned below said needle bar and adapted to cooperate with a needle carried by said needle bar.

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