May 22, 1962 S. J. HAMLETT 3,035,534

SEWING MACHINE

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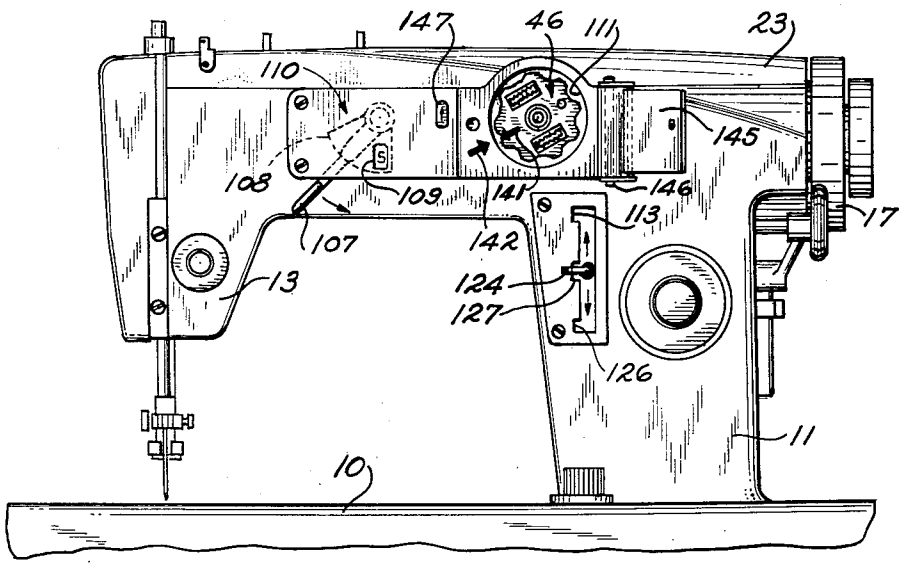

Fig. 1

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SEWING MACHINE

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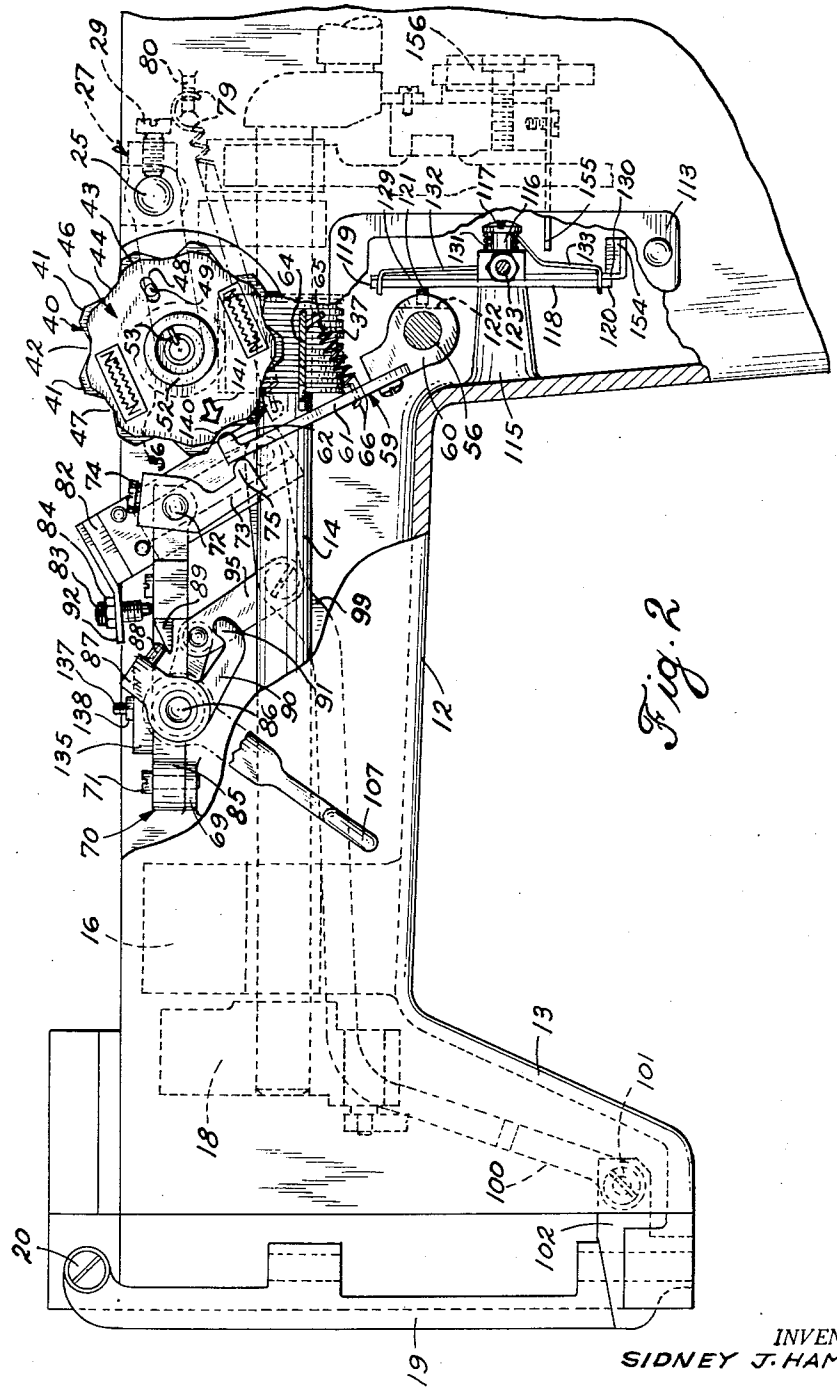

Fig. 2

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SEWING MACHINE

Filed June 14, 1960 6 Sheets-Sheet 3

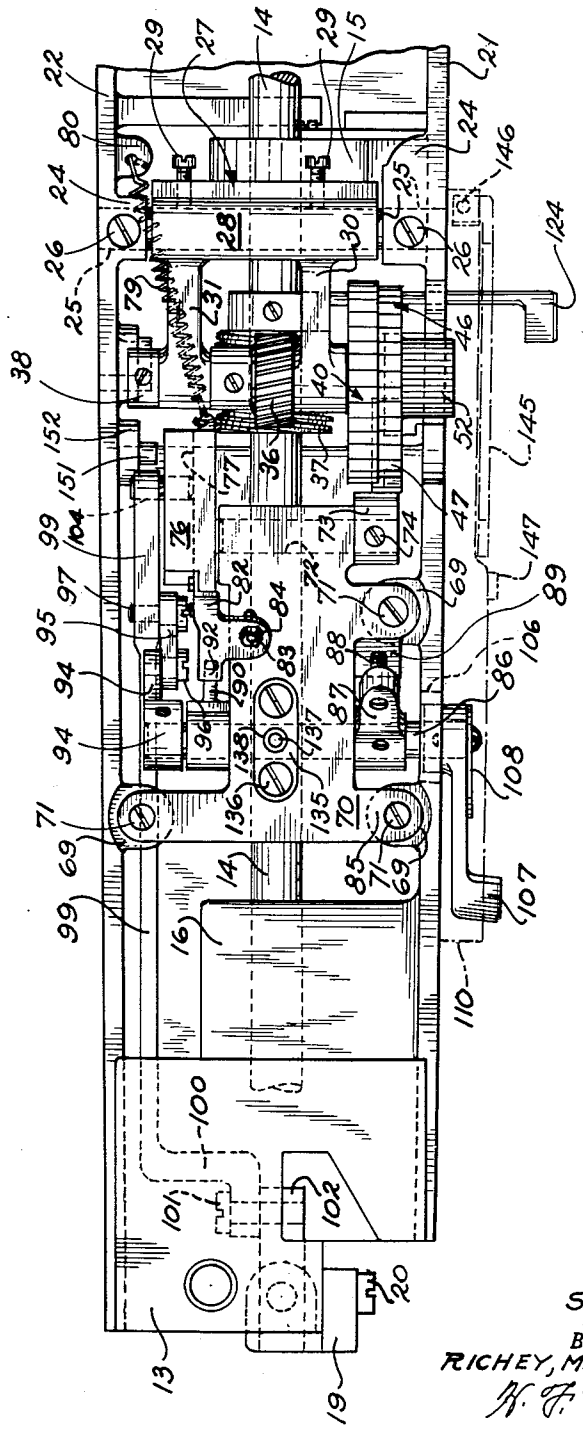

Fig. 3

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SEWING MACHINE

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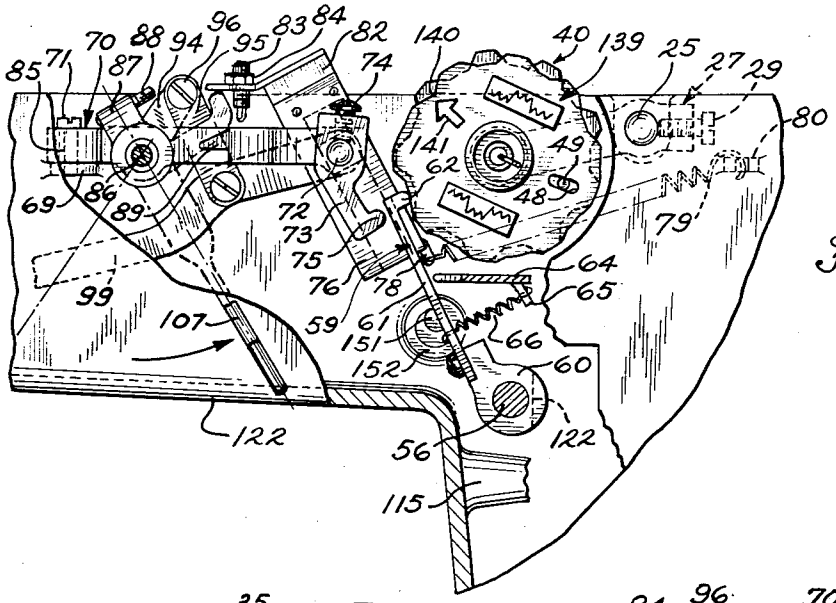

Fig. 4

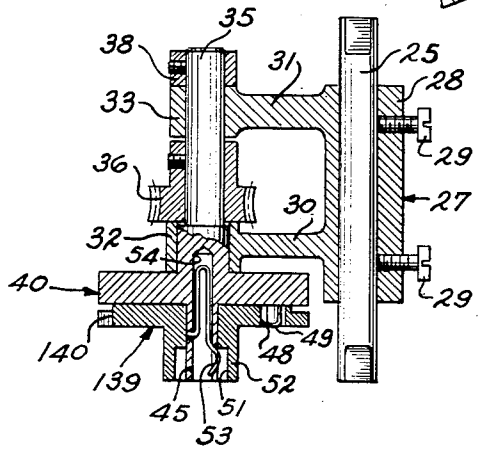

Fig. 5

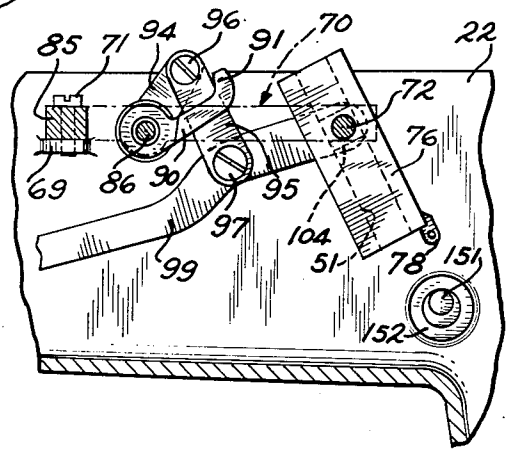

Fig. 6

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SEWING MACHINE

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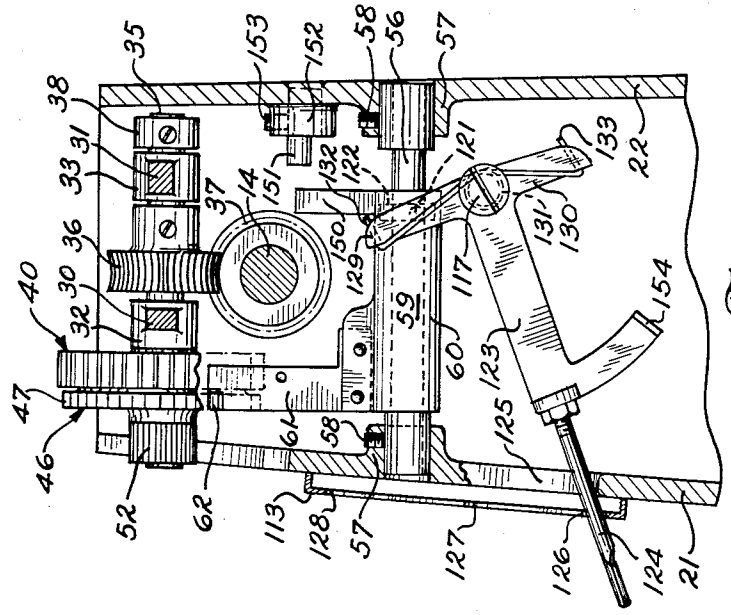

Fig. 8

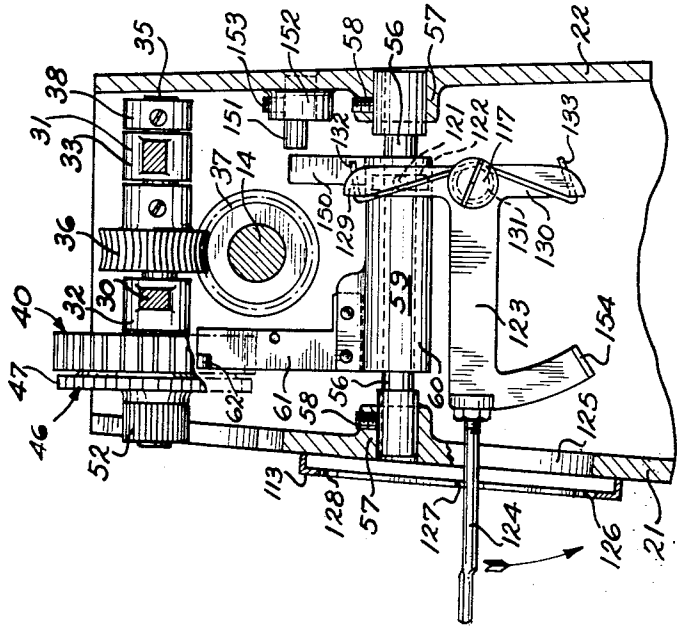

Fig. 7

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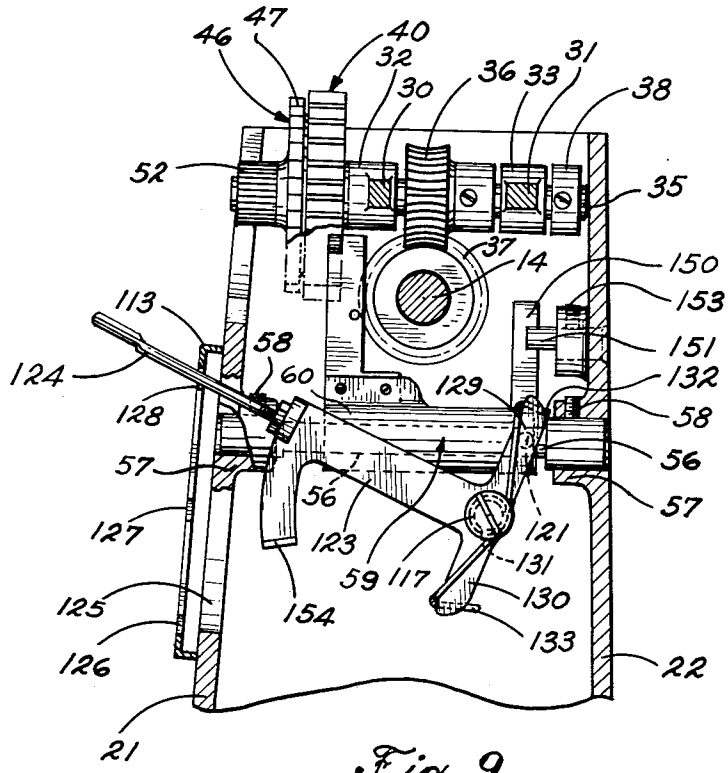

Fig. 9

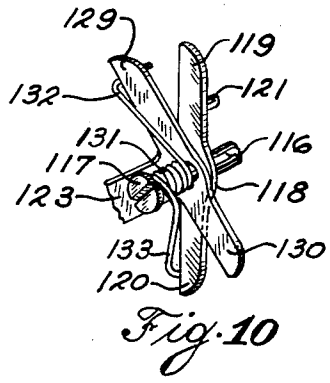

Fig. 10

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United States Patent Office 3,035,534 Patented May 22, 1962

3,035,534
SEWING MACHINE

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Filed June 14, 1960, Ser. No. 35,999
10 Claims. (Cl. 112—158)

This invention relates to household sewing machines in general, and more particularly to zig-zag stitch sewing machines having an oscillating needle bar guide whose motion is controlled by cam discs to sew buttonholes and other decorative stitch patterns.

The principal object of this invention is to simplify the operations and steps involved in the sewing of buttonholes on automatic zig-zag sewing machines by providing a single control lever whose manipulations control the stitch pattern and the cloth feed required for all steps of sewing a buttonhole.

Another object of this invention is a provide a sewing machine for making buttonholes in which all of the motions of the needle bar guide in sewing the buttonhole are controlled by pattern cams, one of which is selected to control the motion of the needle bar guide during each of the various portions of the buttonhole cycle by moving a single cam follower along a stack of cam discs to select the proper cam for actuation of the needle bar guide.

Another object of this invention is to provide a zig-zag type sewing machine adapted to sew buttonholes in which a single cam disc is employed to provide two of the different stitch patterns used in the buttonhole.

Another object of this invention is to provide in a zig-zag type sewing machine a needle bar guide actuating mechanism in which a selectively engageable stop is interposed to limit the motion of a cam follower oscillated by a pattern cam and thereby impart to the needle bar guide a pattern different from that obtained when the stop is disengaged.

Another object of this invention is to provide a zig-zag sewing machine in which a single cam disc is employed to produce two different zig-zag stitch patterns by shifting the cam follower axially from one position along the cam disc into a second position where the cam follower is engageable with a stop to limit the oscillation of the cam follower to an amplitude less than that imparted by the cam disc in the first position.

The above and other and additional objects and advantages of the present invention are accomplished in the preferred embodiment of the invention in which a pair of cam discs are mounted on a cam shaft which is driven by a worm and worm gear from the main drive shaft. One of the cam discs is fixed to the cam shaft and has its periphery formed into a cam surface adapted to oscillate the needle bar guide through a maximum amplitude extending on either side of the center line of the buttonhole. A cam follower is provided which is mounted for both pivotal and axially slidable movement along a pivot shaft by a selector mechanism. The cam follower is spring loaded into contact with the periphery of the cam discs, and the motion of this cam follower is transfererd to a lever arm secured to a rocker shaft and through a variable stroke length mechanism directly to the needle bar guide.

The cam shaft is formed so that interchangeable cam discs can be placed on the cam shaft beside the fixed cam disc for engagement by the cam follower in one position of the selector mechanism. The selector mechanism provides two additional positions for the cam follower axially along the cam shaft and in engagement with the fixed cam disc. In one of these positions, the cam follower is free to follow the periphery of the fixed

cam disc to provide the maximum oscillation of the needle bar guide. In the other position, inward movement of the cam follower is limited by a stop so that the cam follower contacts only the crest portions on the fixed zig-zag cam and is able to ride only half way down into the valleys between the crests before further movement is arrested by the stop.

In making a buttonhole, the selector mechanism is first placed in the middle one of its three positions where the cam follower rides along the full periphery of the zig-zag cam, to sew the bar tack stitches at the beginning end of the buttonhole. After these stitches have been made, the selector mechanism is shifted to the second or lower position so that the cam follower rides on the interchangeable cam disc, which in this case has a pattern with similarly spaced but lower crests than on the fixed cam to form narrower zig-zag stitches on one side of the center line to sew one side of the buttonhole. After this one side has been sewed to the proper length, the selector mechanism is returned to the middle position to sew the bar tack at the other end of the buttonhole.

After these stitches have been made, the selector mechanism is moved to the third or upper position in which the motion of the cam follower is limited by the stop. In this position the selector mechanism also engages the feed reverse of the sewing machine so that the cloth is fed back toward the starting point. Since the motion of the cam follower is now limited by the stop, it oscillates the needle bar guide through a lesser amplitude to form the narrow zig-zag stitch along the other side of the center line of the buttonhole.

Further details and features of the invention are shown in the accompanying drawings of a preferred embodiment of the invention whose construction and operation are described in the following detailed specification.

In the drawings:

FIG. 1 is a front elevational view of a sewing machine incorporating the present invention;

FIG. 2 is a front elevational view with parts broken away to show the pattern control mechanism arranged for maximum width;

FIG. 3 is a top plan view of a machine with the cover removed;

FIG. 4 is a fragmentary front elevational view with parts broken away to show the pattern control mechanism arranged for straight stitching;

FIG. 5 is a fragmentary cross-sectional view through the pattern cam shaft and its mounting bracket;

FIG. 6 is a fragmentary cross-sectional view taken on line 6—6 of FIG. 3 to show the width adjustment;

FIG. 7 is a cross-sectional view taken on line 7—7 of FIG. 2 showing the cam follower shifted to the middle position engaging the fixed zig-zag cam;

FIG. 8 is a cross-sectional view similar to FIG. 7 but showing the cam follower shifted to engage the removable pattern cam;

FIG. 9 is a cross-sectional view similar to FIGS. 7 and 8 but showing the cam follower shifted to engage both the zig-zag cam and the stop pin; and

FIG. 10 is a fragmentary perspective view of the lost motion linkage in the selector for shifting the cam follower.

Referring now to the embodiment of the invention shown in the drawings in greater detail, the sewing machine shown generally in FIG. 1 includes a bed plate **10** which incorporates the usual cloth feeding mechanism together with the bobbin and loop forming mechanism. At the one end of bed plate **10** is the upstanding hollow column or standard **11**, to which is connected the horizontally extending hollow arm **12** which terminates in a head portion **13**. As shown more particularly in FIGS.

2 and 3, the machine has a main drive shaft **14** which extends horizontally through the interior of the hollow arm **12** and is journaled in a pair of bearing blocks **15** and **16**. A pulley wheel and clutch mechanism **17** is secured on the one end of drive shaft **14** extending outward of the column **11** to allow the drive shaft **14** to be rotatably driven in the usual manner by belt connection to an electric motor (not shown).

On the opposite end of the drive shaft **14** outboard of the outer bearing block **16** is located the crank mechanism **18** which serves to oscillate the needle bar (not shown) in the manner well known in the art. The needle bar is mounted for reciprocating sliding movement in the usual manner on the needle bar guide **19** which in turn is pivotally mounted at its upper end on head **13** by pivot bolt **20** for oscillating movement about a horizontal axis laterally across the bed plate **10**. It will be understood that by oscillating the needle bar guide **19** in timed relationship with the cyclic operation of the needle bar and the remainder of the stitch-forming mechanism, that various stitch patterns can be obtained. The present invention is concerned with the pattern mechanism for oscillating the needle bar guide, and the remaining portions of the complete sewing machine will not be described in further detail.

In accord with the usual sewing machine construction, the column **11**, transverse arm **12**, and head **13** are preferably formed together as a unit in a casting of a suitable metal such as cast iron or, for purposes of light weight, aluminum. By virtue of this construction, the casting has relatively thick walls which serve both as the frame on which the various portions of the mechanism are mounted as well as a protective cover and shield enclosing the various moving parts. The casting is open at the top and is fitted with a suitable protective cover **23** formed of sheet metal or other suitable material.

The front and rear side walls **21** and **22**, respectively, of the frame casting are each provided with an inwardly extending boss **24**, and these bosses are drilled to receive a horizontally extending support shaft **25** which is secured in place within the bosses by suitable set screws **26**. The support shaft **25** serves as a mounting for the cam shaft bracket **27** which has a tubular section **28** bored to fit on the support shaft **25**. The cam shaft bracket **27** is locked against rotation about support shaft by a pair of set screws **29** which are threaded in the tubular section **28** to lock the bracket securely in position on shaft **25**.

Extending horizontally outward from the tubular section **28** are a pair of arms **30** and **31** which terminate at their outer ends in enlarged bosses **32** and **33**. These bosses **32** and **33** are drilled to provide bearings to journal the cam shaft **35**, as shown in greater detail in FIG. 5. Cam shaft **35** is rotatably driven in timed relationship with the main drive shaft **14**, and to that end is provided with a worm gear **36** which is secured on the cam shaft between the bosses **32** and **33**. Worm gear **36** serves to drive the cam shaft **35** by making driving engagement with a worm **37** secured on the main drive shaft **14** adjacent the inner bearing block **15**. To position cam shaft **35** against axial movement, the worm gear **36** is secured on the cam shaft adjacent the front boss **32**, while a suitable locking collar **38** is secured on the rear end of cam shaft **35** outward of the rear boss **33**.

At its front end, the cam shaft **35** carries an integrally formed radial cam disc **40** whose outer periphery is formed with a series of regularly spaced notches. The disc **40** may be a single cam or a series of fixed cams. The notches are spaced uniformly around the axis of the cam to divide the outer periphery of the cam into crest portions **41** and valley portions **42** spaced apart by sloping connecting surfaces. The number of these crests and valleys is chosen to correspond to the gear ratio between worm **37** and worm gear **36**, so that for each revolution of main drive shaft **14**, and hence one complete reciprocation of the needle, the cam disc **40** is rotated through an angular distance corresponding to the distance between an adjacent crest and valley, and vice versa.

In front of the integral cam disc **40**, the cam shaft has a reduced shaft portion **45** on which the interchangeable cam discs **46** are mounted. These cam discs **46** are made of a suitable material such as hard plastic or metal, and are provided with an outer periphery **47** having a shape corresponding to the desired pattern of movement for the needle bar carrier. The cam disc **46** is rotatably driven by means of a radially extending slot **48** in the web of the disc which fits over a projecting pin **49** on the side of the integral cam disc **40**. In order to hold the interchangeable cam disc **46** in place on the reduced shaft portion **45** adjacent the integral cam disc **40**, the cam disc **46** is provided with an enlarged recess **51** in its hub or shank portion **52** to make engagement with a detent spring **53** fitted within an axially extending bore **54** in reduced shaft portion **45**.

A pivot shaft **56** is mounted on the frame casting below the main drive shaft **14** to extend parallel to the cam shaft **35**. This pivot shaft **56** is mounted at each end within projecting bosses **57** on the front and rear side walls **21** and **22** and is secured in place by set screws **58** in the usual manner. Pivot shank **56** serves as a supporting mount for the cam follower member indicated generally at **59**. Cam follower member **59** has a tubular section **60** provided with an axially extending bore to fit on pivot shaft **56** so that the cam follower member is journaled thereon for both pivotal and axially slidable movement. A cam follower arm **61** is secured at its one end to the front portion of tubular section **60** and extends upward adjacent the cam discs **40** and **46** where it is provided with a contacting tip **62** which projects inwardly toward the cam shaft **35** to make contact with the periphery of the cam discs **40** and **46**.

To limit pivotal movement of the cam follower arm **61** and contacting tip **62** in the direction of cam shaft **35**, a stop plate **64** is secured to the front side wall **21** of the frame casting to extend inwardly and make abutting engagement with the cam follower arm **61** as the latter pivots toward cam shaft **35**. A depending lug **65** is formed on the stop plate **64** and serves as the fixed support for a coil tension spring **66** extending between the lug **65** and the mid-point of cam follower arm **61**. Tension spring **66** provides a spring bias for the cam follower **59** tending to rotate the follower about the pivot shaft **56** so that the arm **61** is normally positioned in contact with the stop plate **64** unless moved outward as a result of contact between the contacting tip **62** and a raised portion on one of the cam discs **40** and **46**.

The mechanism whereby the motion of the cam follower **59** is transferred to the needle bar guide **19** is shown in FIGS. 2, 3, 4, and 6. As is shown most clearly in FIG. 3, the frame side walls **21** and **22** are provided with another set of lugs or bosses **69** which support a mounting plate **70** which is fastened to the lugs by screws **71**. At its one end adjacent the cam shaft **35**, mounting plate **70** is provided with a suitably transversely extending bore to journal a rocker shaft **72**. On the front end of rocker shaft **72** outward of the mounting plate **70** there is secured a lever arm **73** locked in place on the shaft by means of a set screw **74**. Lever arm **73** extends angularly downward adjacent the outer end of cam follower arm **61** where it terminates in a contacting tip **75** adapted to bear against the follower arm and receive the movement imparted to the cam follower and transfer such motion into oscillatory rotation of rocker shaft **72**. The rear end of rocker shaft **72** is formed into an integral lever arm **76** which forms part of an adjustable, variable length lever arm mechanism. To allow for this length adjustment, lever arm **76** is provided with a rectangular channel **77** cut into its rearwardly facing surface and extending axially along the lever arm with the

axis of the channel intersecting the axis of rocker shaft 72. At the lower end of integral lever arm 76, there is located a small depending lug 78 to which is secured a coil tension spring 79. The other end of tension spring 79 is fastened to a lug 80 formed integrally with the rear side wall 22 and serves to bias the rocker shaft 72 in the rotational direction wherein the contacting tip 75 of the front lever arm 73 is adjacent cam follower arm 61 and the needle bar guide 19 is in the right hand position, as will be explained in greater detail hereinafter.

To limit the rotation of rocker shaft 72 under the biasing action of tension spring 79, a bracket plate 82 is fastened on the upper end of the integral rear lever arm 76 and carries a stop screw 83 threaded in the bracket plate and locked in position by lock nut 84. Stop screw 83 is adjusted to come into abutting contact with the upper surface of mounting plate 70 and thereby prevent further rotation of lever arm 76 under the bias of tension spring 79 to provide a limiting position for the needle bar guide 19 in the direction toward hollow standard 11 when the width control mechanism is set for maximum width, all as will be described in greater detail hereinafter.

At the opposite end of mounting plate 70 from rocker shaft 72, a second transverse bore is provided to journal the control shaft 86. On the front end of control shaft 86 in front of mounting plate 70 there is secured a stop arm 87 which serves to limit the rotation of the control shaft 86 in both directions. When control shaft 86 is rotated in the counterclockwise direction as seen in FIG. 4, the stop arm 87 moves into abutting contact with the adjacent mounting lug 85 of the mounting plates 70 to prevent further rotation of control shaft 86 in that direction. When the control shaft 86 is rotated in the clockwise direcion, a stop screw 88 threadedly engaged on the outer end of stop arm 87 makes abutting contact with the beveled surface of a projecting lug 89 also formed as a part of the mounting plate 70.

Rearwardly of the mounting plate 70, a released arm 90 is secured on the control shaft 86 and carries a contacting tip 91 which is positioned to contact the under side of a projecting tab 92 on bracket plate 82. When the control shaft 86 is rotated in the counterclockwise direction, tip 91 engages the projecting tab 92 to rotate the lever arm 76 and hence rocker shaft 72 to a position where the front lever arm 73 is moved away from the cam follower arm 61. Rearwardly of release arm 90 another lever arm 94 (see FIG. 6) is secured on the end of control shaft 86 and at its outer end is pivotally connected to a connecting link 95 by a suitable pivot screw 96. The lower end of connecting link 95 is pivotally connected to a connecting rod 99 by another pivot screw 97.

The connecting rod 99 serves to transfer the motion of the cam follower 59 and rocker shaft 72 to the needle bar guide 19. As shown in FIGS. 2 and 3, connecting rod 99 extends lengthwise through the hollow transverse arm 12 and into the head 13. Within head 13, the connecting rod 99 has an offset end 100 which is secured by a suitable pivot bolt 101 to a projecting lug or ear 102 on the lower end of needle bar guide 19. At the other end of the connecting rod 99, a pivotally mounted guide block 104 is secured to the connecting rod end and positioned to ride within the rectangular channel 77 on variable length lever arm 76. Since the lower end of the needle bar guide 19 is rigidly connected through connecting rod 99 to lever arm 76 and hence rocker shaft 72, the oscillating movement of the rocker shaft is translated directly into oscillating or vibratory movement of the needle bar guide 19, the amplitude of movement of the latter being determined by the position of guide block 104 along channel 77. Thus, movement of the needle bar guide toward the right as seen from the front of the machine occurs under the action of tension spring 79, while movement to the left results from the movement of the cam follower 59 away from camshaft 35 being transmitted to rocker shaft 72 through the front lever arm 73.

To allow the control shaft 86 to be readily rotated by hand, the control shaft extends toward the front of the machine and passes through an opening 106 in the front side wall 21. On the outer end of control shaft 86 on the front side of wall 21, there is mounted a control lever 107. Control lever 107 is provided with an attached indicia plate 108 on which are printed suitable indicia marks in the form of numbers visible to the operator through a small window 109 formed in the cover 110 which extends over the front of the transverse arm portion of the machine. The marks or numbers on indicia plate 108 serve to indicate to the operator of the machine the relative position of control lever 107 and hence the rotary position of control shaft 86. In order that the control shaft 86 may not rotate too freely and thus move out of the desired position of adjustment as a result of the vibration of the machine, an adjustable drag is provided. A block 135 is secured by screws 136 on mounting plate 70 above the control shaft 86. A screw 137 held in position by locknut 138 is threaded in block 135 and applies downward pressure on a plunger or drag shoe (not shown) within mounting plate 70 which in turn bears against the surface of the control shaft. By adjusting screw 137, this drag may be made great enough to hold the shaft in position, yet allows it to be turned without excessive effort by the operator of the machine.

It will be seen that rotation of control shaft 86, through the motion of lower arm 94 and connecting link 95, will raise and lower the inner end of connecting rod 99 and hence slide the guide block 104 along the axis of rectangular channel 77. When the control lever 107 is moved to the position of FIG. 4, so that stop arm 87 is in contact with mounting lug 85, the pivot axis of the guide block 104 is in alignment with the axis of rocker shaft 72 so that any oscillatory motion imparted to the rocker shaft 72 will not impart any movement to the connecting rod 99 and the needle bar guide 19. In addition, connecting rod 99 is made of such a length that in this position the needle bar guide 19 is positioned at the center of its path of oscillation for straight stitch sewing. As the control lever 107 is rotated in a clockwise direction toward the position of FIG. 2, the guide block 104 is moved down the rectangular channel 77 to provide an increasingly effective length for the variable length lever arm 76. When the control lever 107 is moved into the full clockwise position of FIG. 2, contact between stop screw 88 and beveled surface 89 serves to limit further rotation of the control shaft 86 and hence further movement of guide block 104 within rectangular channel 77 to define the maximum length of lever arm 76 and in turn the maximum possible amplitude for the zig-zag oscillation of the needle bar guide 19.

The selector mechanism for shifting the cam follower 59 axially along pivot shaft 56 to choose between operation by the integral cam disc 40, or a particular part thereof, or one of the interchangeable cam discs 46, is best shown in FIGS. 2, 7, 8, and 9. A boss 115 projects outwardly from the portion of the inner wall of column 11 which is beneath the transverse arm portion 12. This boss is drilled axially to receive the threaded end of a pivot shaft or bolt 116 having an enlarged slotted head 117 at its other end. An elongated actuating lever 118 having an upper end 119 and a lower end 120 is pivotally mounted at its midpoint on pivot shaft 116 adjacent the end of the boss 115. Upper end 119 carries a projecting pin 121 to make engagement within a vertical slot 122 cut in the end of tubular section 60 of the cam follower member 59. It will be seen therefore that pivotal movement of the actuating lever 118 about pivot shaft 116 will cause pin 121 to move the tubular section 60 axially along the pivot shaft 56 to shift the contacting tip 62 of the cam follower between the integral cam 40 and the interchangeable cam disc 46.

A selector lever 123 is also pivotally mounted on the pivot shaft 116 between actuating lever 118 and the slotted

head 117. To allow manipulation of the selector lever 123, the lever is provided with a handle 124 which projects outwardly toward the front of the machine through opening 125 formed in the wall of the hollow column 11. A slotted cover plate 113 fits over opening 125 to receive and guide the movement of handle 124. Three detent notches 126, 127 and 128 are provided at the bottom, middle and top, respectively of the slot in cover plate 113 to receive the handle 124 and hold selector lever 123 and cam follower 59 in the three operating positions, as described in detail hereinafter.

The selector lever 123 is provided with upper and lower arms 129 and 130, respectively, to extend outwardly from pivot shaft 116 adjacent the upper and lower arms 119 and 120 of actuating lever 118. A coil torsion spring 131 has its body portion wound about the pivot shaft 116 between slotted head 117 and selector lever 123. Torsion spring 131 is also provided with projecting upper and lower ends 132 and 133, respectively, which extend outward and are formed into hooks extending over the front edges of the arms of both the actuating lever 118 and selector lever 123. Thus upper end 132 of the torsion spring is hooked over the front edge of arms 119 and 129, while the lower end 133 of the torsion spring is hooked over the lower arms 120 and 130.

It will be seen therefore that the actuating lever 118, the selector lever 123, and torsion spring 131 serve to form a resilient lost motion linkage to allow the selector handle 124 to be shifted positively between the detent notches 126, 127 and 128 while providing only a resiliently limited force upon the cam follower 59 urging it to slide axially toward its corresponding position. For example, if it is desired to move the selector handle 124 from its position in detent notch 127 as shown in FIG. 7 to a position in detent notch 126, as shown in FIG. 8, to shift the cam follower from engagement with the front portion integral cam disc 40 into engagement with the interchangeable cam disc 46, the shape of the cam surfaces on the two cam discs may be such as to interfere with motion of the cam follower in that direction. If the interchangeable cam disc has a profile such as that of cam disc 139 shown in FIG. 4, there will occur rotary positions of the cam shaft in which the adjacent section of the interchangeable cam disc has a greater radius than the portion of the integral cam disc 40 in which the contacting tip 62 is in engagement. Under these conditions, axial force applied to the cam follower to move toward the front of the machine will cause the contacting tip 62 to move into abutting engagement with the end surface of cam disc 46, and if sufficient force is applied to the cam follower the interchangeable cam disc will be forced off the end of cam shaft 35.

However, the use of the selector linkage just described results in the axial force applied to the cam follower 59 being limited to that of the tension within the coil torsion spring 131. As the selector lever 123 is rotated in a counterclockwise direction as seen in FIG. 7, if the cam follower 59 encounters a sufficiently great resistance against further axial movement, the actuating lever 118 will remain fixed, and the lower end 133 of the spring will remain in contact with the lower actuating lever arm 120. However, further rotation of the selector lever 123 as shown in FIG. 10 will cause its upper arm 129 to rotate the upper end 132 of the torsion spring away from upper actuating lever arm 119 and thereby further compress the spring. Whenever the cam discs are rotated into an aligned position so that the contacting tip 62 can slide axially without resistance, the force of torsion spring 131 acting through its lower end 133 on the lower actuating lever arm 120 will bias the actuating lever 118 in a counterclockwise direction and slide tubular section 60 toward the front of the machine until the actuating lever 118 and selector lever 123 are again in alignment. If the selector lever is moved in the clockwise direction to shift the cam follower 59 toward the rear of the machine and interference occurs, the linkage will perform in exactly the reverse manner, so that only the force of the torsion spring 131 is actually applied to slide the cam follower 59 in either direction. As a result of this lost motion linkage, the operator of the machine need not be concerned about the relative positions of the cam discs or possible interference between them, inasmuch as the selector lever can be moved at any time and the actual shifting of the cam follower will take place only when there is no interference against axial movement between the cams.

The three positions of the selector lever handle 124 in the detents 126, 127, and 128 are employed in the sewing of buttonholes. Utilizing this arrangement, the complete buttonhole can be made simply by moving the selector handle 124 without adjustment of the width control as determined by the position of control lever 107. When the selector lever handle 124 is in the middle detent 127, the cam follower contacting tip 62 rides on the front portion of the integral cam disc 40 to oscillate the needle bar guide 19 through the full amplitude of oscillation as determined by the position of control lever 107. The selector lever handle 124 is placed in this position to make the bar tack stitches at each end of the buttonhole.

After the initial bar tack has been made, the operator shifts the selector lever handle 124 down to engage the lower detent 126, in which case the cam follower contacting tip 62 is shifted by the selector linkage to engage the interchangeable buttonhole cam disc 46. This cam disc is arranged to have crest portions 43 and valley portions 44 in corresponding position with the crests and valleys on the integral cam disc 40, except that the crest portions 43 are of a lesser radius than the crest portions 41 on the integral cam disc 40. As a result of these lower crest portions, the needle bar guide 19 oscillates with a lesser amplitude extending from the right-hand side to the center of the range of movement for the bar tack stitches, thereby sewing the right-hand side of the buttonhole.

After the buttonhole has been sewed to the proper length along the right-hand side, the selector lever handle 124 is shifted back into the middle detent 127 to make the bar tack stitches at the other end of the buttonhole. To complete the buttonhole, the selector lever handle 124 is shifted into the upper detent 128. In this position, the contacting tip 62 is shifted rearwardly to engage the rear portion of the integral cam disc 40, and the entire cam follower assembly 59 is shifted to a position rearwardly of its middle position as determined by detent 127. In this position, an upwardly extending blade 150 secured at the rearward end of tubular section 60 is positioned to swing into abutting engagement with a stop pin 151. This stop pin 151 is mounted horizontally in a projecting boss 152 on the rear side wall 22 and held in position by a suitable set screw 153. Stop pin 151 is so positioned that as the cam follower contacting tip 62 rides off the crest portion 41 of cam disc 40, the cam follower is allowed to pivot inwardly only a limited distance before blade 150 contacts stop pin 151 and prevents further inward movement of contacting tip 62. Thus, the cam follower oscillates between the high position of crest portion 41 and a mid-position intermediate crest portion 41 and valley portion 42, these positions corresponding to the zigzag stitches along the left-hand side of the buttonhole.

When the selector lever handle 124 is moved upward into upward detent 128, a projecting arm 154 on selector lever 123 engages and lifts a projecting arm 155 on the reverse mechanism indicated generally at 156. Reverse mechanism 156 may be of any design well known in the art, and will not be described in greater detail. By virtue of this engagement, the feeding mechanism of the cloth is reversed in direction so that as the sewing positions of the needle bar guide 19 are shifted to make the left-hand side of the buttonhole, the feed is auto-

matically reversed to return the stitches to the initial bar tack and complete the buttonhole.

The ease with which the interchangeable cam discs can be removed and replaced at any time will be more readily appreciated when viewed in conjunction with the feature shown most clearly in FIGS. 1, 2, and 4. As shown in FIG. 2, each of the interchangeable cam discs, such as cam disc **46**, is provided on its periphery with a notch **140** where the periphery of the cam has a lesser radius than the remaining portion. When this notch is aligned with the contacting tip **62** of the cam follower, the arm **61** will pivot about pivot shaft **56** into engagement with the stop plate **64** under the action of tension spring **66** while remaining out of contact with the surface of notch **140**. Thus the presence of notch **140** allows the cam disc to be moved axially onto the reduced shaft portion **45** without interference from the cam follower contacting tip **62**. It will be noted that all of the interchangeable cam discs having various different profiles, such as cam disc **139** shown in FIG. 4, are arranged to have a notch **140** at some position on their peripheries. In order to obtain engagement with the projecting pin **49** on the fixed cam disc **40** to provide the driving connection to the interchangeable cam disc **46**, after the cam disc has been placed on reduced shaft portion **45** with the notch **140** in alignment with contacting tip **62**, it is necessary only to rotate the cam disc in either direction until the pin **49** is aligned with slot **48**, whereupon additional inward axial movement will perfect the locking action of detent spring **53** to hold the cam disc firmly in position.

In order that the operator need not search either visually or by touch to locate the position of contacting tip **62**, the cam discs are each provided with an index arrow **141** which is radially aligned with the notch **40**. In like manner, another index arrow **142** is provided on the cover **110** also in radial alignment with the contacting tip **62**. Therefore, it is necessary only to align the index arrows **141** and **142** when the cam disc is being placed in position and then push the cam inward until movement is stopped by contact between the pin **49** and the face of the cam disc **46**. Thereafter, the cam disc is rotated by turning the shank portion **52** until the pin **49** engages slot **48** in the aforedescribed manner.

While in the above-described method of installing the interchangeable cam discs it has been assumed that the machine is stopped so that cam shaft **35** is not rotating, the cam disc may also be installed while the machine is running. In this case, the operator will simply place the cam disc **46** in position on reduced shaft portion **45** with the index arrows **141** and **142** in alignment. If the cam disc **46** is then held in that position while the machine continues to run, further rotation of cam shaft **35** and fixed cam disc **40** will bring the pin **49** into alignment with slot **48**, whereupon the cam disc **46** will be shifted axially by detent spring **53** the short distance necessary to make engagement.

Inasmuch as the cam follower contacting tip **62** makes engagement only with the peripheral surface of the cam disc, it will be seen that if sufficient outward axial force is applied to the cam disc to overcome the holding action of the detent spring **53**, the cam disc can be removed at any time regardless of the rotational position of the cam disc and regardless of whether or not the cam discs are rotating.

For purposes of safety and appearance, the cover plate **110** is provided with a door **145** shown in the open position in FIG. 1. Door **145** is pivoted on a hinge pin **146** and held closed by a suitable catch mechanism actuated by button **147**. Thus the door **145** normally covers opening **111** in cover plate **110** when the machine is running and need be opened only when it is desirable to change one of the pattern cam discs.

While one embodiment of the invention has been shown in the drawings and described in detail in the foregoing specification, the invention is not limited to any particular form, and various arrangements and modifications may be resorted to by those skilled in the art without departing from the scope of the invention which is defined in the appended claims.

What is claimed is:

1. A sewing machine comprising a frame, a drive shaft rotatably journaled in said frame, a needle bar guide pivotally mounted on said frame for lateral swinging movement, a cam shaft on said frame rotatably driven in timed relationship with said drive shaft, a radial cam on said cam shaft, said cam having a high portion on its periphery, said cam having a low portion on its periphery, a cam follower mounted on said frame for radial movement to and from said cam and for shiftable movement between first and second positions axially of said cam shaft, means biasing said cam follower into contact with said cam, linkage means interconnecting said needle bar guide and said cam follower to oscillate said needle bar guide synchronously with the movement of said cam follower, stop means on said frame, said stop means being engageable by said cam follower in one of said positions to limit motion of said cam follower towards said cam and thereby reduce the amplitude of oscillation of said needle bar guide.

2. A sewing machine comprising a frame, a drive shaft rotatably journaled in said frame, a needle bar guide pivotally mounted on said frame for lateral swinging movement, a cam shaft on said frame rotatably driven in timed relationship with said drive shaft, a radial cam on said cam shaft, said cam having crest portions spaced about its periphery, said crest portions being interspaced by valley portions, a cam follower mounted on said frame for radial movement to and from said cam, and for shiftable movement between first and second positions axially of said cam shaft, selector means to shift said cam follower between said first and second positions, means biasing said cam follower into contact with said cam, linkage means interconnecting said needle bar guide and said cam follower to oscillate said needle bar guide synchronously with the movement of said cam follower, stop means on said frame, said stop means being engageable by said cam follower in one of said positions to limit motion of said cam follower towards said cam and thereby reduce the amplitude of oscillation of said needle bar guide.

3. A sewing machine comprising a frame, a drive shaft rotatably journaled in said frame, a needle bar guide pivotally mounted in said frame for lateral swinging movement, a cam shaft on said frame rotatably driven in timed relationship with said drive shaft, a radial cam on said cam shaft, said cam having crest portions spaced about its periphery, said crest portions being interspaced by valley portions, a cam follower pivotally and slidably mounted on said frame for swinging movement radially to and from said cam and for slidable movement axially of said cam shaft between first and second positions, means biasing said cam follower into contact with said cam, linkage means interconnecting said needle bar guide and said cam follower to oscillate said needle bar guide synchronously with the movement of said cam follower, stop means on said frame, said stop means being engageable by said cam follower in one of said positions to limit motion of said cam follower toward said cam and thereby reduce the amplitude of oscillation of said needle bar guide.

4. A sewing machine comprising a frame, a drive shaft rotatably journaled in said frame, a needle bar guide pivotally mounted in said frame for lateral swinging movement, a cam shaft on said frame rotatably driven in timed relationship with said drive shaft, a radial cam on said cam shaft, said cam having crest portions spaced about its periphery, said crest portions being interspaced by valley portions, a cam follower pivotally and slidably mounted on said frame for swinging movement radially to and from said cam and for slidable movement axially of said cam shaft between first and second positions,

means resiliently biasing said cam follower into contact with said cam, linkage means interconnecting said needle bar guide and said cam follower to oscillate said needle bar guide synchronously with the movement of said cam follower, a fixed stop secured to a side wall on said frame a projecting arm on said cam follower, said stop projecting outward from said side walls toward said cam follower arm, said stop projecting into the path of said cam follower arm when said cam follower is shifted into said second slidable position to limit motion of said cam follower toward said cam and thereby reduce the amplitude of oscillation of said needle bar guide.

5. A sewing machine comprising a frame, a drive shaft rotatably journaled in said frame, a needle bar guide pivotally mounted in said frame for lateral swinging movement between first, second, third and fourth laterally sequential positions, zig zag cam means on said frame rotatably driven in timed relationship with said drive shaft, said cam means having alternating crests and valleys on its periphery, spring means biasing said needle bar guide toward said first position, motion transmitting linkage movable synchronously with said needle bar guide including a cam follower and means for transmitting motion from said cam follower to said needle bar guide, control means on said frame operably connected to said linkage and movable to first, second and third control positions, said control means in said first control position shifting said linkage to a first position whereby cyclic operation of said zig-zag cam means oscillates said needle bar guide between said first and second positions, said control means in said second and third control positions shifting said linkage whereby cyclic operation of said cam means is operable to oscillate said needle bar guide between said first and fourth positions, and stop means engageable by said motion transmitting linkage in said third control position of said control means to limit oscillation of said needle bar guide to movement between said third and fourth positions in proportion to only the radially outer portions of the crests of said cams.

6. A sewing machine comprising a frame, a drive shaft rotatably journaled in said frame, a needle bar guide pivotally mounted in said frame for lateral swinging movement between first, second, third and fourth laterally sequential positions, zig zag cam means on said frame rotatably driven in timed relationship with said drive shaft, said cam means having alternating crests and valleys on its periphery, spring means biasing said needle bar guide toward said first position, a cam follower engageable with said cam means, linkage means connected to said needle bar guide, cam follower means shiftable between first and second positions interconnecting said cam follower and said linkage means and movable synchronously with said needle bar guide, control means on said frame operably connected to said cam follower means and movable to first, second and third control positions, said control means in said first control position shifting said cam follower means to said first position whereby cyclic operation of said zig zag cam means oscillates said needle bar guide between said first and second positions, said control means in said second and third control positions shifting said cam follower means whereby cyclic operation of said cam means is operable to oscillate said needle bar guide between said first and fourth positions, and stop means engageable by said cam follower means in said third control position of said control means to limit oscillation of said needle bar guide to movement between said third and fourth positions in proportion to only the radially outer portions of the crests of said cams.

7. A sewing machine comprising a frame, a drive shaft rotatably journaled in said frame, a needle bar guide pivotally mounted in said frame for lateral swinging movement between first, second, third and fourth laterally sequential positions, first and second zig zag cam discs rotatably journaled on said frame and driven in timed relationship with said drive shaft, said cam discs having alternating crests and valleys on their peripheries, spring means biasing said needle bar guide toward said first position, cam follower means mounted on said frame for radial movement to and from said cam discs synchronously with movement of said needle bar guide and for shiftable movement between first, second and third control positions axially of said cam discs, linkage means interconnecting said cam follower means and said needle bar guide, control means adapted to shift said cam follower means between said first, second and third control positions, said cam follower means in said first control position engaging said first cam disc whereby cyclic rotation of said first cam disc oscillates said cam follower means to oscillate said needle bar guide between said first and second positions, said cam follower means in said second and third control positions engaging said second cam disc whereby cyclic rotation of said second cam disc is normally operable to oscillate said needle bar guide between said first and fourth positions, said cam follower means in said third position engaging stop means on said frame to limit oscillation of said needle bar guide to movement between said third and fourth positions in proportion to only the radially outer portions of the crests of said second cam.

8. A sewing machine comprising a frame, a drive shaft rotatably journaled in said frame, a needle bar guide pivotally mounted in said frame for lateral swinging movement between first, second, third and fourth laterally sequential positions, first and second zig zag cam discs rotatably journaled on said frame and driven in timed relationship with said drive shaft, said cam discs having alternating crests and valleys on their peripheries, spring means biasing said needle bar guide toward said first position, cam follower means pivotally and slidably mounted on said frame for swinging movement radially to and from said cam discs synchronously with movement of said needle bar guide and for slidable movement axially between first, second and third control positions along said cam discs, linkage means interconnecting said cam follower means and said needle bar guide, control means adapted to shift said cam follower means between said first, second and third control positions, said cam follower means in said first control position engaging said first cam disc whereby cyclic rotation of said first cam disc oscillates said cam follower means to oscillate said needle bar guide between said first and second positions, said cam follower means in said second and third control positions engaging said second cam disc whereby cyclic rotation of said second cam disc is normally operable to oscillate said needle bar guide between said first and fourth positions, said cam follower means in said third position engaging stop means on said frame to limit oscillation of said needle bar guide to movement between said third and fourth positions in proportion to only the radially outer portions of the crests of said second cam.

9. A sewing machine comprising a frame, a drive shaft rotatably journaled in said frame, a needle bar guide pivotally mounted in said frame for lateral swinging movement between first, second, third and fourth laterally sequential positions, a cam shaft rotatably journaled on said frame and driven in timed relationship with said drive shaft, first and second zig zag cam discs on said cam shaft, said cam discs having alternating crests and valleys on their peripheries, spring means biasing said needle bar guide toward said first position, a pivot shaft on said frame parallel to said cam shaft and spaced therefrom, cam follower means pivotally and slidably mounted on said pivot shaft for swinging movement radially to and from said cam discs synchronously with movement of said needle bar guide and for slidable movement axially between first, second and third control positions along said pivot shaft, linkage means interconnecting said cam follower means and said needle bar guide, control means on said frame adapted to shift said cam follower means between said first, second and third control positions, said

cam follower means in said first control position engaging said first cam disc whereby cyclic rotation of said first cam disc oscillates said cam follower means to oscillate said needle bar guide between said first and second positions, said cam follower means in said second and third control positions engaging said second cam disc whereby cyclic rotation of said second cam disc is normally operable to oscillate said needle bar guide between said first and fourth positions, said cam follower means in said third position engaging stop means on said frame to limit rotation of said cam follower means toward said second cam disc and limit oscillation of said needle bar guide to movement between said third and fourth positions in proportion to only the radially outer portions of the crests of said second cam.

10. A sewing machine comprising a hollow frame, a drive shaft journaled for rotation within said hollow frame, a needle bar guide mounted on said frame for lateral movement, buttonhole stitch mechanism including a zig zag cam in said frame rotatably driven in timed relation to said drive shaft, said cam having alternating crests and valleys on its periphery, motion transmitting linkage movable synchronously with said needle bar guide including a cam follower and means for transmitting motion from said cam follower to said needle bar guide, a spring acting in a direction to urge said cam follower toward the periphery of said cam, a manual control member accessible from the outside of the frame operably connected to said linkage and movable to a position

for bar tack stitches of a buttonhole, and to other positions for left hand and right hand side stitches of a buttonhole, said linkage when said manual control member is in position for bar tack stitches oscillating said needle bar guide laterally in proportion to substantially the full radial extent of the crests above the valleys of said cam, and stop means engageable by said motion transmitting linkage when said manual control member is moved to another position to limit movement of said linkage under the influence of said spring in a direction to move said cam follower into engagement with the valleys of said cam, whereby said needle bar guide oscillates laterally in proportion to only the radially outer portions of the crests of said cam.

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