Dec. 7, 1965 TETSUZO HAYASHI ETAL 3,221,687

AUTOMATIC ORNAMENTAL STITCH SEWING MACHINE

Filed Oct. 21, 1963 7 Sheets-Sheet 1

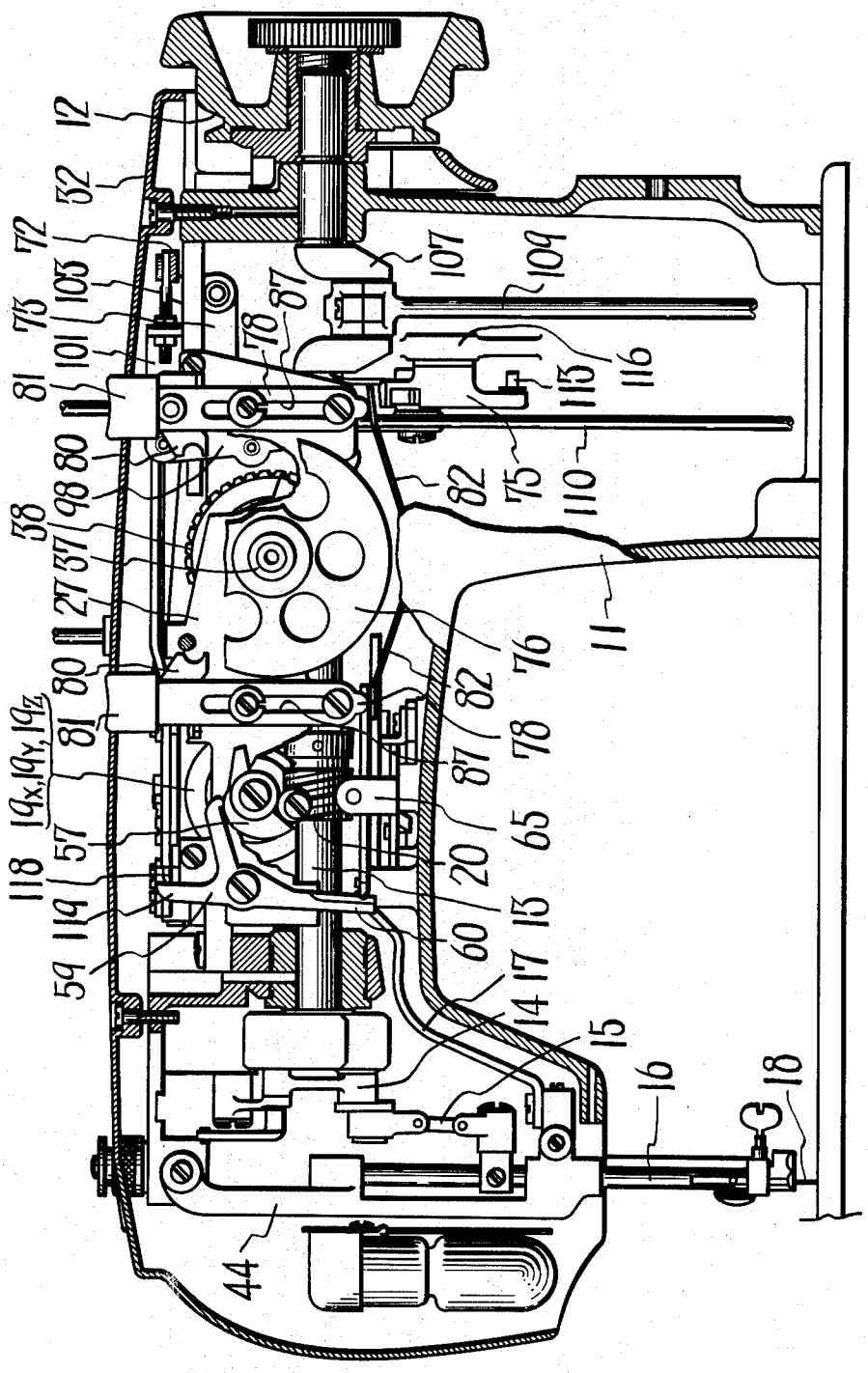


FIG. 1.

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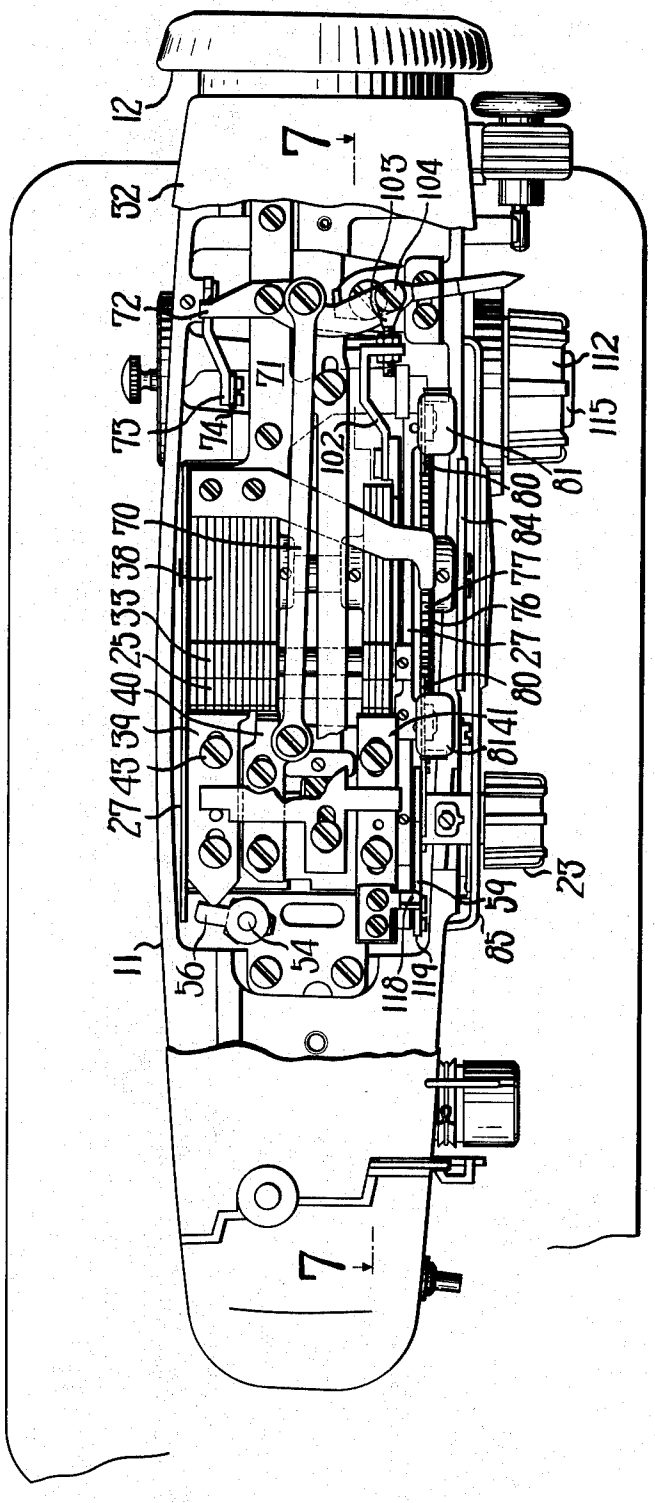


FIG. 2.

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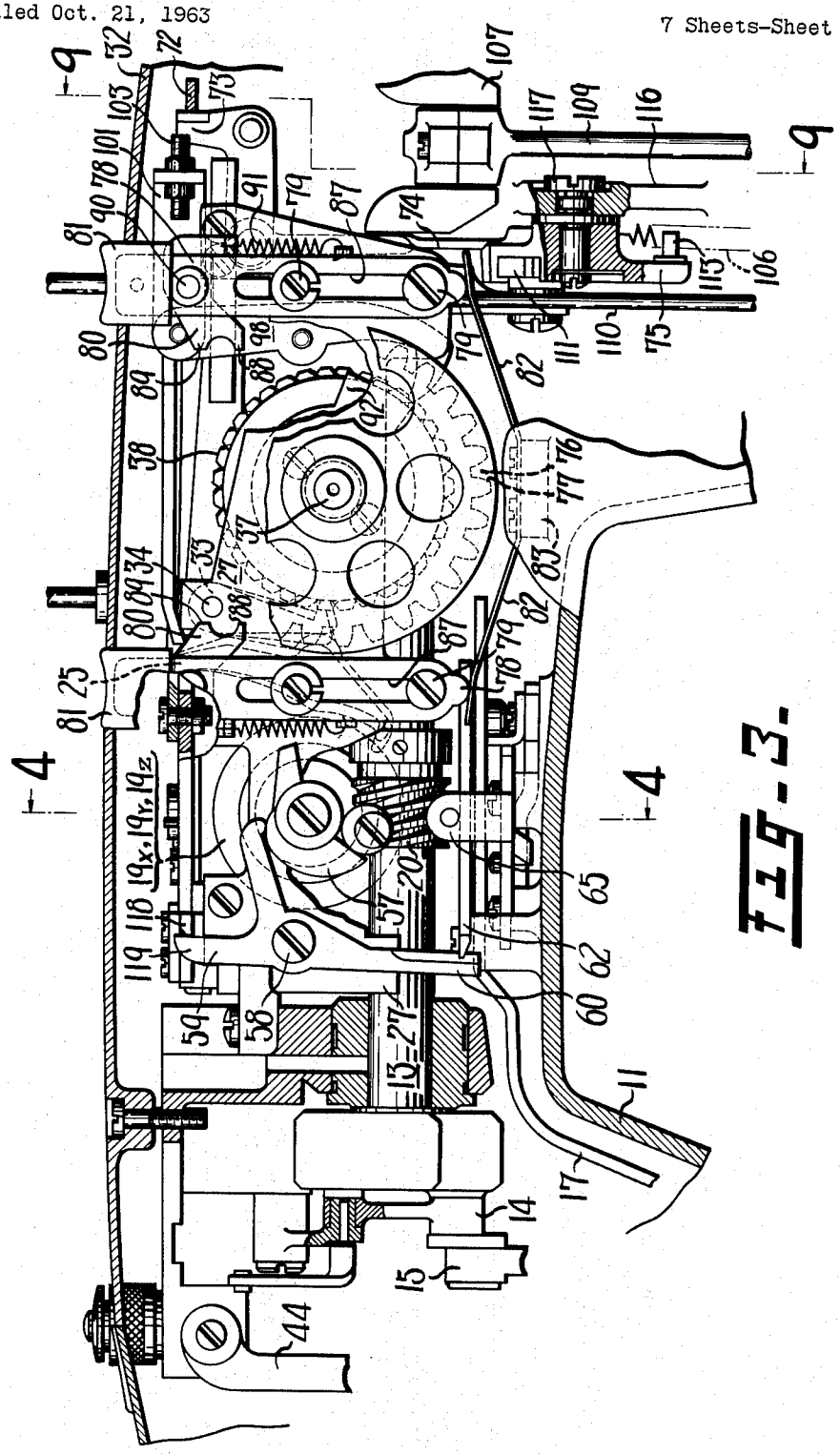


FIG. 3.

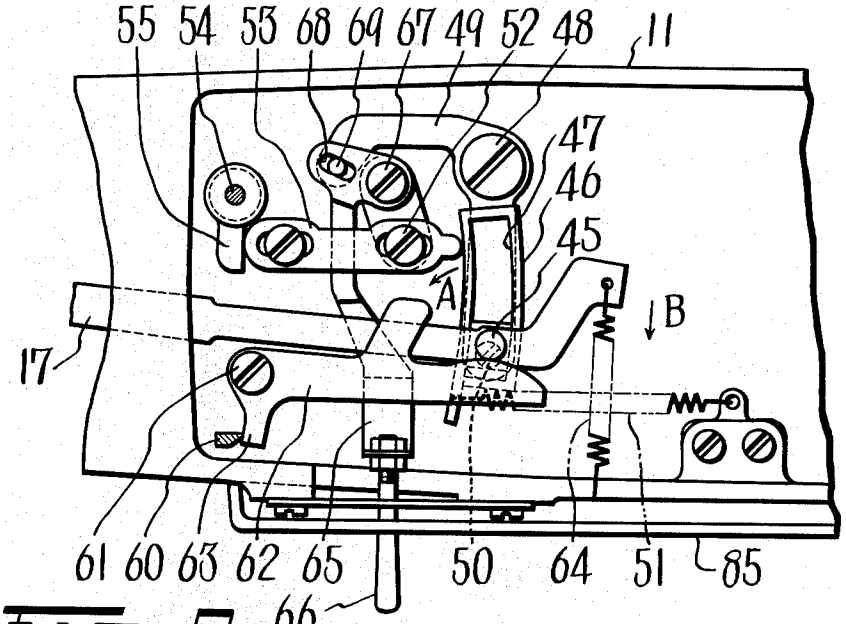


Fig-6.

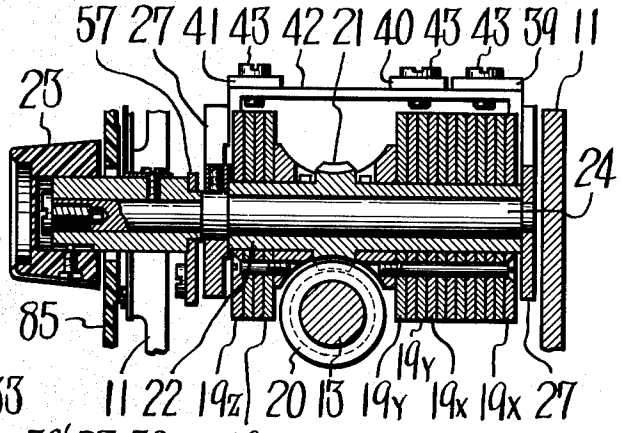


Fig-4.

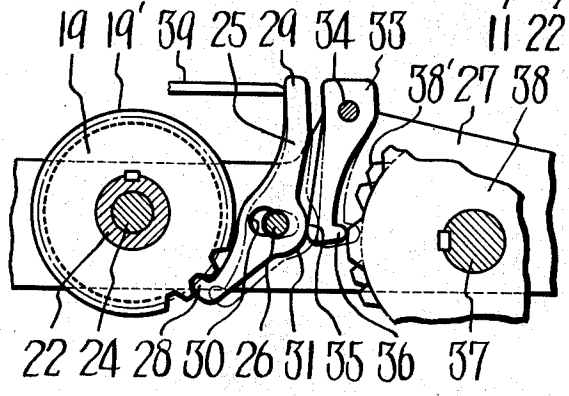


Fig-5.

Fig. 7.

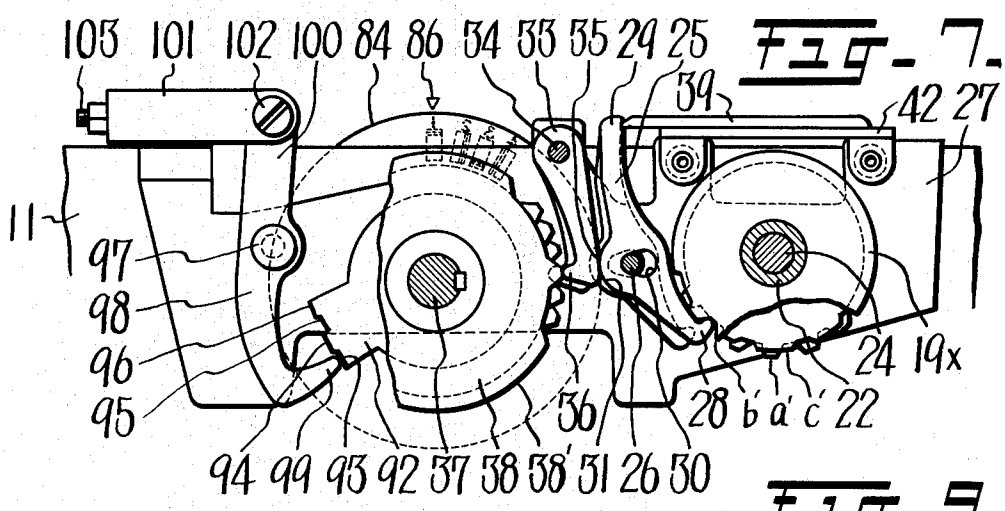
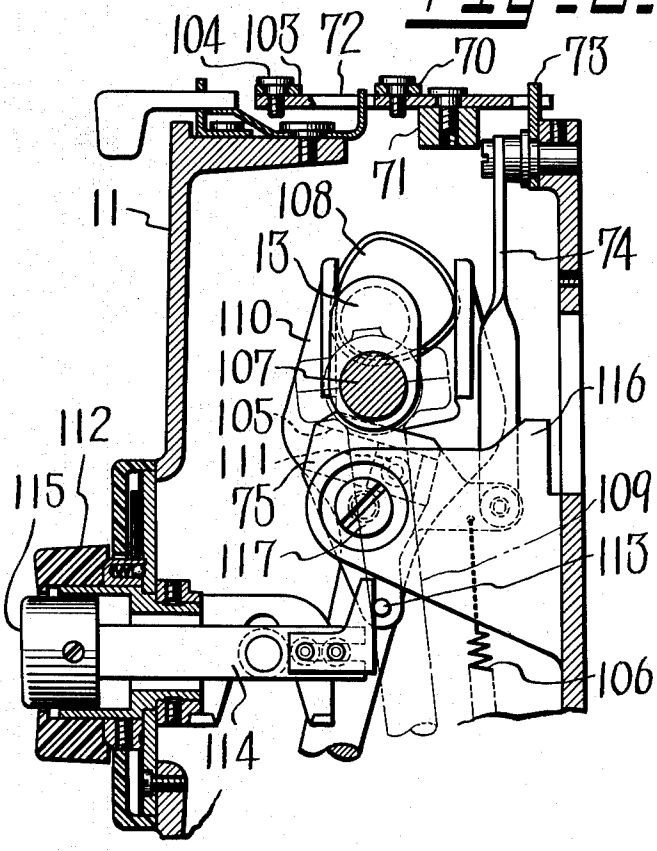


Fig. 9.



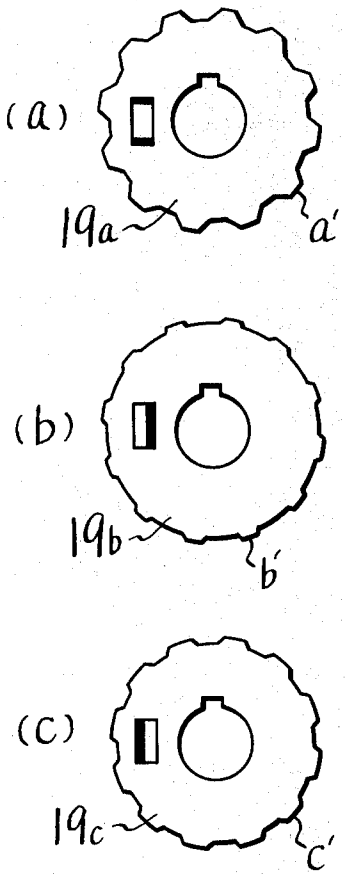


Fig. 8.

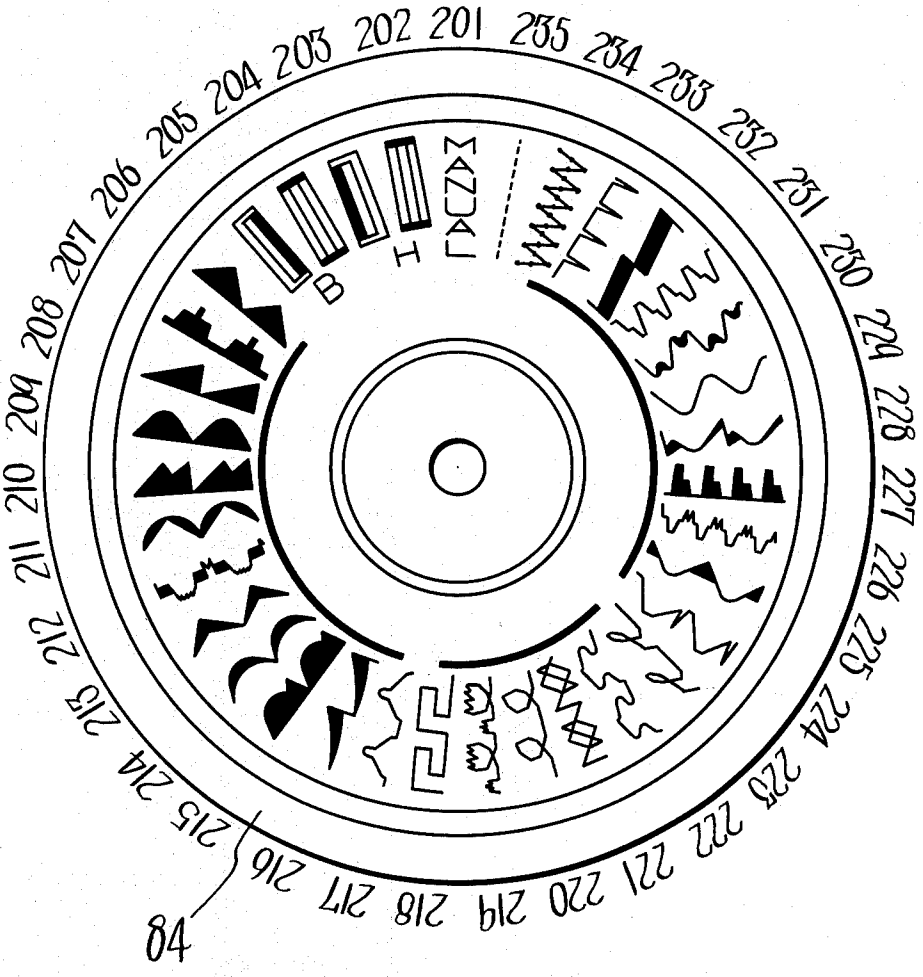

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Fig-10.

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Fig. 11

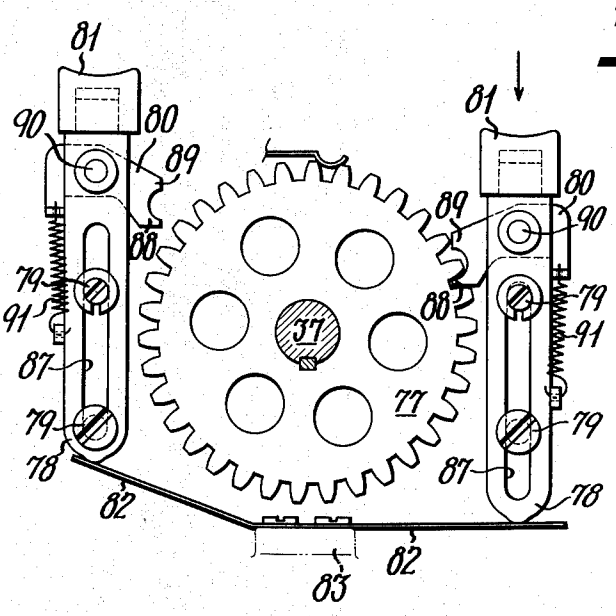


Fig. 12

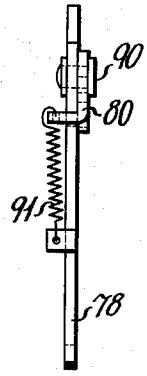
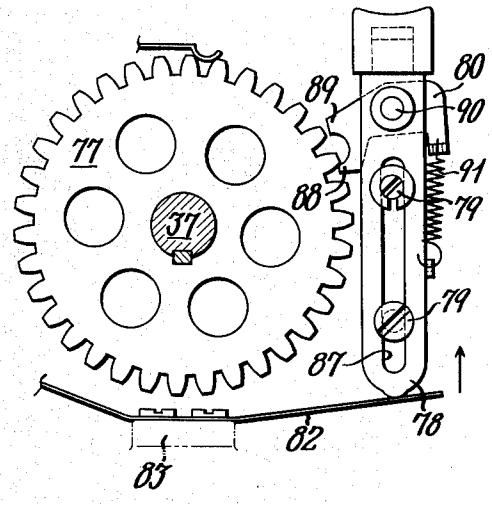


Fig. 13



United States Patent Office

3,221,687

Patented Dec. 7, 1965

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AUTOMATIC ORNAMENTAL STITCH SEWING MACHINE

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Filed Oct. 21, 1963, Ser. No. 317,602
6 Claims. (Cl. 112—158)

The present invention relates to a sewing machine and more particularly to a sewing machine of the kind which, permitted zig-zag stitching by combined reciprocation and transverse oscillation of its needle bar, selectively produces a plurality of different stitch patterns automatically.

In accordance with known practice, sewing machines of such a kind will generally be classified into two: one is the disc cam type and the other is the triangle cam type, both of which are applied widely to industrial and home uses. In the former type, the needle bar is oscillated, and the amplitude of oscillation is controlled, by the same one disc cam. This type, therefore, has the advantages that it automatically stitches various fancy patterns with only one cam, thereby saving costs substantially, and that it varies the stitch amplitude freely, but it has the disadvantages that its does not vary the stitch pattern itself but only the relative location of the stitch pattern of the basic stitch line in response to a shift of the basic stitch line, and that it is not applicable to the sewing machines of the oscillation-type shuttle race as the cam follower is put into contact with the disc cam by a spring means for oscillating the needle bar. Meanwhile, in the latter type, the needle bar is oscillated by a triangle cam, while the amplitude of oscillation is determined by another disc cam in co-operation with the triangle cam. This type, therefore, has the advantages that it varies the stitch pattern itself in response to a shift of the basic stitch line, and that it is applicable to the sewing machines of the oscillation-type shuttle race as a positive motion cam system is employed for oscillating the needle bar, but it has the disadvantages that it does not stitch various fancy patterns automatically with only one cam but with two cams for controlling the oscillatory amplitude of the needle bar and the basic stitch line, thereby not saving cost substantially and that it does not vary the stitch amplitude freely, unless provided with a special equipment for this purpose, as the amplitude of oscillation is given by the profile of the disc cam. Indeed, the advantage of one type is the disadvantage of the other type, and various difficulties, both economical and mechanical, arises to make a sewing machine which has the advantages of both the types, but which is free from their disadvantages.

A major object of the invention is to provide a zig-zag ornamental stitch sewing machine which has a cam follower assembly of such a simple structure as to permit of enclosing all the important mechanism, such as cam members and their co-operative devices for oscillation of the needle bar, control of oscillatory amplitude, and regulation of cloth-feed, into a minimum possible space of the machine frame.

Another important object of the invention is to provide such an ornamental zig-zag sewing machine as performs the functions of both the above-described conventional two types, that is, the disc cam type and the triangle cam type, for stitching various patterns automatically.

Yet another object of the invention is to provide a zig-zag ornamental stitch sewing machine which performs the functions of both the above-described conventional two types in such a manner as to stitch a large number of patterns automatically with a relatively small number of cam members.

A further object of the invention is to provide a zig-zag sewing machine which has a selector assembly to be manipulated simply by push button for automatically selecting various ornamental stitch patterns in co-operation with a convenient stitch pattern indicator.

A still further object of the invention is to provide a zig-zag ornamental stitch sewing machine by which buttonhole stitch patterns are obtainable as well as various other ornamental stitch patterns simply by manipulating a push button in co-operation with a stitch pattern indicator.

Other objects and many of the attendant advantages of the invention will be readily appreciated as the same becomes better understood by reference to the following detailed description and the accompanying drawings:

FIG. 1 is a longitudinal section of the upper part of a sewing machine made according to an embodiment of the invention.

FIG. 2 is a top view of the mechanism shown in FIG. 1, with a top cover omitted.

FIG. 3 is a partly enlarged sectional view of FIG. 1.

FIG. 4 is an enlarged transverse section taken along the 4—4 line of FIG. 3, showing the stitch cam mechanism in accordance with the invention.

FIG. 5 fragmentarily shows the arrangement of the stitching cam and selector cam in accordance with the invention.

FIG. 6 is a fragmentary plan view of the device which oscillates the needle bar, shown in co-operation with the device for hand-controlling of the oscillatory amplitude in accordance with the invention.

FIG. 7 is a fragmentary back-view of an enlarged longitudinal section taken along the 7—7 line of FIG. 2, showing the cams in co-operation with each other in accordance with the invention.

FIG. 8 shows the front views of cam members for buttonhole stitching.

FIG. 9 is a sectional side view taken along the 9—9 line of FIG. 3, showing the cloth-feed regulating device.

FIG. 10 is a front view of a stitch pattern indicator.

FIGURE 11 is a diagrammatic fragmentary view of the toothed ring and actuating rod assembly forming part of the mechanism for positioning the selector cams illustrating one of the actuating rods at the lower limit of its stroke.

FIGURE 12 is a side elevation view of one of the actuating rods, viewed from the right hand side of FIGURE 11.

FIGURE 13 is a view similar to FIGURE 11 illustrating only one of the actuating rods at a position occupied at an intermediate point in its return stroke.

In the embodiment shown in FIGS. 1 to 3, the reference numeral **11** designates the frame of a sewing machine. In this frame, the main drive shaft **3** is supported horizontally, this shaft being movable by a pulley **12** from a conventional driving means (not shown). The drive is transmitted to the needle bar **16** by an eccentric crank **14** and a link **15** so as to impart thereto reciprocating up-and-down motion. The needle bar **16**, which carries the sewing needle **18**, is movably guided,

according to known practice, in a swingable needle guide which receives its oscillatory motion by a curved link **17** from the devices for producing the oscillation of the needle bar and for controlling the oscillatory amplitude of the needle bar. By this oscillatory motion of the needle guide, the needle bar **16** receives in known manner transverse motion necessary for producing a zig-zag seam.

The sewing machine in accordance with the invention is provided with a combination of a number of laminated cam members for various stitch patterns and the corresponding number of laminated cam followers for selecting one or more of the cam members.

In FIG. 4, three laminations of the disc cam members **19***x*, **19***y*, **19***z* are mounted on a cylindrical shaft **22** which is provided transversely to the main drive shaft **13** in the frame **11**. The drive is transmitted from the drive shaft **13** to the shaft **22** by means of the worm **20** and the worm gear **21**. The axis **24** of the dial **23** for hand-controlling the oscillatory amplitude of the needle bar supports the cylindrical shaft **22** in such an inserted relation as to be free from the rotation of the shaft **22**. The axis **24** is held by the supporting member **27**.

The disc cam members **19***x*, **19***y*, **19***z* are positioned face to face with the corresponding cam followers **25**, **25**, **25** swingably mounted on the shaft **26** which is held fixedly by the supporting member **27**. The numeral **19** in FIG. 5 designates one of the cam members **19***x*, **19***y*, **19***z*. One of the cam followers **25**, **25**, **25** corresponds to the cam member **19** in such a manner as to be put into, or out of, contact with the curved periphery **19'** of the cam member **19**. One end of the cam follower **25** forms the engaging portion **28** to follow the periphery **19'** of the cam member **19**, and the other end forms the actuating portion **29**, while the middle of it has the slot **30** for the shaft **26** and forms the projecting portion **31** on the side opposite the disc cam **19**. The three grouped cam laminations **19***x*, **19***y*, **19***z* are put into co-operation with the needle bar operating plate **39**, the cloth-feed regulating plate **40** and the oscillatory amplitude controlling plate **41** respectively by means of the actuating portions **29** of the cam followers **25**, **25**, **25**. And each cam member in lamination is paired with a cam follower in such a manner as to impart its own motion, independently of the other cam members by way of the corresponding cam follower to the needle bar operating plate **39**, the cloth-feed regulating plate **40**, or the oscillatory amplitude controlling plate **41**. All the cam followers **25** are the same in shape and size and are supported on the shaft **26** in such a manner as to be individually shiftable on the shaft **26** in the longitudinal direction of the slot **30** provided on each of them.

All the cam followers **25** are paired with the corresponding number of selector cam followers **33** in such a manner that the projecting portion **31** of each cam follower **25** is in an engageable relation with the pushing portion **35** formed at the lower end of the corresponding cam follower **33**. All the cam followers **33** are the same in shape and size, and they are supported on the shaft **34** in an individually rotatable relation. The shaft **34** is fixedly held by the supporting member **27**. Each cam follower **33** is paired with the selector cam member **38** in such a manner that the engaging portion **36** formed on the opposite side of the pushing portion **35** may always follow the periphery **38'** of the selector cam member **38**. And all the selector cam members **38** are fixed on the shaft **37**. The slot **30** is made wider than the diameter of the shaft **26** in the portion nearer to the cam **19**, and is made almost as wide as the diameter of the shaft **26** in the portion nearer the selector cam **33**, so as to facilitate the shifting movement of the cam follower **25** along the longitudinal direction of the slot **30**.

It will, therefore, be seen that the sewing machine in accordance with the invention is provided with the same number of stitch cam members **19**, cam followers **25**, selector cam followers **33** and selector cam members **38**, which are held on the shafts **22**, **26**, **34**, **37** respectively in a transverse relation to the main drive shaft **13**. And the four shafts **22**, **26**, **34**, **37** are all held by the supporting member **27**. It will also be all right to let the projecting portion **31** of the cam follower **25** follow the periphery **38'** of the selector cam member **38** without the intermediary of the selector cam follower **33**.

With the above-described cam arrangement of the sewing machine in accordance with the invention, a desired stitch pattern is obtained as the cam member **19** and the corresponding cam follower **25** are selected to work in combination. More particularly, the selector cam member **38** is initially rotated for a desired stitch pattern by a dial known structure or a similar means (described later), and then a higher portion or the periphery **38'** of the selector cam member **38** meets the engaging portion **36** of the selector cam follower **33** which is rotatable on the shaft **34**, and, accordingly, the cam follower **25** is put in the position shown in true line in FIG. 5 where it is supported on the shaft **26** in the narrow portion of the slot **30**, and its engaging portion **28** is put into contact with the periphery **19'** of the stitching cam **19**, as the projecting portion **31** of the cam follower **25** is shifted towards the cam **19** by the pushing portion **35** of the selector cam follower **33**. In this case, the cam follower **25** is held between the shaft **26** and the pushing portion **35** of the selector cam follower **33** in a relation to permit of rocking motion, which is imparted to the plate **39**, **40** or **41** by means of the actuating portion **29** of the cam follower **25**, as the engaging portion **28** of the cam follower **25** follows the periphery **19'** of the stitching cam **19**.

From the above-described actuating position, the selector cam member **38** is further rotated, and then a low portion on the periphery **38'** of the selector cam member **38** meets the engaging portion **36** of the selector cam follower **33**, and, accordingly, the cam follower **25** is put in the position shown in dotted line in FIG. 5 where it is supported on the shaft **26** in the wide portion of the slot **30**, and its engaging portion **28** is put out of contact with the periphery **19'** of the stitching cam **19**, as the cam follower **25** is shifted towards the selector cam member **38** in response to the releasing of the selector cam follower **33** from the projecting portion **31** of the cam follower **25** and the pushing towards the selector cam member **38** of the cam follower **25** by the plates **39**, **40** or **41**. Therefore, the rotation of the selector cam member **38** gives a desired stitch pattern by selectively actuating the cam follower **25** to follow the periphery **19'** of the corresponding stitching cam member **19**.

The three groups of cam followers **25** are connected to the needle bar operating plate **39**, the cloth-feed regulating plate **40**, and the oscillatory amplitude controlling plate **41**. Accordingly, the three cam members **19***x*, **19***y*, **19***z* are linked by means of the actuating portions **29** of the corresponding cam followers **25** to the needle bar operating plate **39**, the cloth-feed regulating plate **40**, and the oscillatory amplitude regulating plate **41** respectively (these three plate members are represented by the numeral **39** in FIG. 4). The plate **39** operates the needle bar **16** in its transverse oscillation for fundamental stitch patterns. In the present invention, the plate **39** works in co-operation with nine stitching cam members **19***x* of different profiles by means of nine cam followers **25**. The plate **40** regulates the ratio and direction of cloth-feed. In the present invention, the plate **40** works in co-operation with three stitching cam members **19***y* of different profiles by means of three cam followers **25**. The plate **41** controls the oscillatory amplitude of the needle bar **16**. In the present invention, the plate **41** works in co-operation with four stitching cam members **19***z* of different profiles by means of four cam followers **25**. All the plates **39**, **40**, **41** are mounted on the ceiling **42** of the supporting member **27** by means of the screw **43** in such a manner as to go back and forth horizontally in response to the rocking motion of cam followers **25**.

A needle bar operating device is provided under the supporting member **27** in the frame **11** as shown in FIG. 6 for oscillating the needle bar **16** in response to the back-and-forth movement of the needle bar operation plate **39**. The left end of the curved link **17** is connected with the needle bar guide **44**, as shown in FIG. 1, whose top end is swingably held by the frame **11**, while the right end of the curved link **17** is provided with the roller **45**. The bell crank **49** is supported on the frame **11** by the shaft **48** in a rotatable relation for regulating the direction of the basic stitch line as described later in detail. The rocker case **46** receives the roller **45** in its curved groove **47** in a guidable relation. The rocker case **46** is swingably mounted on the bell crank **49** by means of the screw **50** fixed almost at the end of the bell crank **49**. One end of the rocker case **46** is connected with the spring **51** in such a manner that it is always inclined to rotate in the direction marked "A" in FIG. 6. The other end of the rocker case **46** is in contact with one end of the rocker piece **53** in such a manner as to push it in the direction contrary to the spring **51**. The rocker piece **53** is supported on the frame **11** by means of the screw **52** in such a manner as to go back and forth in an axial direction with its one end in contact with the rocker case **46**. The other end of the rocker piece **53** is in contact with the lower rocker piece **55** fixed to the foot of the vertical shaft **54**. The upper rocker piece **56** is fixed to the top of the vertical shaft **54** which is in contact with the needle bar operating plate **39** as shown in FIG. 2. The vertical shaft **54** is supported by the ceiling **42** of the supporting member **27** and the bottom of the frame **11** rotatably.

Therefore, in the above-described structure, the spring **51** forces the needle bar operating plate **39** to the actuating portion **29** of the cam followers **25** by way of the rocker case **46**, rocker piece **53**, lower rocker piece **55**, vertical shaft **54**, and upper rocker piece **56**. In other words, the rocking motion, which the cam follower **25** causes as it follows the periphery **19'** of the stitching cam member **19***x*, oscillates the needle bar **16** by way of the plate **39**, upper rocker piece **56**, vertical shaft **54**, lower rocker piece **55**, rocker piece **53**, rocker case **46**, roller **45**, and curved link **17** as the rocker case **46** makes rocking motion on the screw **50** serving as the rocking center.

In FIG. 6, the curved link **17** oscillates with a very slight amplitude in response to the rocking motion of the rocker case **46** because the roller **45** of the curved link **17** is quite near to the rocking center **50** of the rocker case **46**. Therefore, the relative location of the roller **45** to the screw **50** determines the oscillatory amplitude of the needle bar ranging from the straight stitch line to the maximum width of the zig-zag stitch line.

The dial **23** is provided for adjusting the location of the roller **45** in the rocker case **46** so as to control the amplitude of needle bar oscillation. The amplitude controlling cam **57** manipulated by the dial **23** is followed on its periphery by the arm **59** which is rotatably supported on the supporting member **27** by means of the screw **58** as shown in FIGS. 1, 2, 3, and 4. The lower end **60** of the arm **59** is in contact with one end **63** of the bell-crank-like member **62** which is supported rotatably on the frame **11** by means of the screw **61**. The roller **45** of the curved link **17** is in contact with the other end of the bell-crank-like member **62** by means of the spring **64** which pulls the link **17** in the direction marked "B" in FIG. 6. In other words, the spring **64** always forces the arm **58** to the periphery of the cam **57** by means of the bell-crank-like member **62** and the link **17**.

With the above-mentioned structure, a desired oscillatory amplitude of the needle bar is obtained by handling the dial **23**, whose rotation will shift the roller **45**, that is, the oscillatory center of the curved link **17**, along the curved groove **47** of the rocker case **46** in response to the profile of the cam **57** by way of the arm **59** rotating on the screw **58** and the bell-crank-like member **62** rotating on the screw **61**. As the roller **45** shifts itself in the rocker case **46**, the curved link **17** changes its amplitude of oscillation, thereby changing that of the needle bar **16**.

In the sewing machine in accordance with the present invention, the basic stitch line is shifted by rotating the lever **65** as shown in FIG. 6. One end of the lever **65** is provided with the handle **66** projecting outside the frame **11**, and the other end of it is supported rotatably on the frame **11** by means of the screw **67**, near which the lever **65** is provided with the slot **68** to receive the pin **69** provided at the end of the bell crank **49**.

The rotation of the handle **66** will rotate the bell crank **49** on the shaft **48**, and then the rocker case **46** will be shifted with its rocking center **50**, and accordingly the basic stitch line is shifted by means of the curved link **17**.

As shown in FIGS. 1, 2 and 3, the cloth-feed regulating plate **40**, which is operated by the cam followers **25** in response to the profile of the stitching cam **19***y*, is connected to the cloth-feed regulating device **75** of known structure by way of the link **70** fixed on the plate **40**, the lever **72** mounted on the supporting member **71**, another lever **73**, and the link **74** in such a manner that the device **75** may take different postures in response to the motion of the cloth-feed regulating plate **40**. Therefore, the plate **40** will regulate the ratio and direction of cloth-feeding to give various stitch patterns in co-operation with the needle bar operating plate **39**.

As shown in FIGS. 1 to 4, the oscillatory amplitude controlling plate **41** is provided with the contact piece **118** at its left end in a shiftably mounted relation. The piece **118** is in contact with the upper offset **119** of the arm **59**, so that the link **17** may be shifted relatively to the rocker case **46** by means of the roller **45** by the motion of the plate **41** which the cam followers **25** cause in response to the profiles of the stitching cam members **19***z* as already described in detail in reference to the hand operation with the dial **23**.

With the stitching cam members **19***z* connected to the arm **59** by means of the plate **41**, the oscillatory amplitude of the needle bar is controlled in a fully automatic manner, as the oscillatory amplitude controlling plate **41** is operatable simultaneously with the needle bar operating plate **39**.

Therefore, the sewing machine in accordance with the present invention is provided with even better advantages than both the conventional types, that is, the disc cam type and the triable cam type. In case only the needle bar operating plate **39** is in operation in response to the stitching cam **19***x* with the oscillatory amplitude controlling plate **41** not in operation in response to the stitching cam **19***z*, the needle bar does zig-zag stitching in response to the rocking motion of the rocker case **46** with the possibility that the stitch pattern itself is not varied, but the relative location of the stitch pattern to the basic stitch line is varied in response to a shift of the basic stitch line caused by rotation of the lever **65** with the handle **66**. In other words, in this case, the sewing machine in accordance with the invention will work just like the conventional disc cam type. And the sewing machine in accordance with the invention will stitch fancier and finer patterns than the two conventional types, because it stitches with the oscillatory amplitude of the needle bar varied as the result of simultaneous co-operation with the needle bar operating cam **19***x* and the oscillatory amplitude controlling cam **19***z*. In addition, the sewing machine in accordance with the invention can reverse the stitch patterns by the rotation of the lever **65** just as the conventional triangle type does. The stitch pattern reversing process will be understood without description by any specialist, because it is quite the same as the conventional one.

FIG. 10 shows the face of a stitch pattern indicator **84** illustrating some of the stitch patterns made available by single or combined operation of the plates **39**, **40**, **41** in response to the stitching cams **19***x*, **19***y*, **19***z* in accordance with the present invention. The seventeen patterns **201** to **205** and **224** to **235** are stitched by the single opera-

tion of the plate **39** in response to the profile of the cam **19***x*. The twelve patterns **206** to **217** are stitched by the combined operation of the plates **39** and **41** in response to the profiles of the cams **19***x* and **19***z*. The six patterns **218** to **223** are stitched by the combined operation of the plates **39** and **40** in response to the profiles of the cams **19***x* and **19***y*.

A device for selecting one or more of the stitching cam members **19***x*, **19***y*, **19***z* in accordance with the invention will be shown in detail in FIGS. 3, 7 and 11–13. The cam arrangement shown in FIG. 7 is held by the supporting member **27** in the frame **11**. The disc **76** fixed to the shaft **37** forms the toothed ring **77** on the back side. A pair of actuating rods **78**, **78** are mounted in the front portion of the supporting member **27** in a vertically slidable relation by means of the screws **79**, **79**. The disc **76** is located between the two actuating rods **78**, **78**. A pair of clicks **80** are provided in the upper portion of the actuating rods **78** in such a manner that they project towards the shaft **38** so as to engage with the toothed ring **77**. The top of each actuating rod **78** is provided with the push button **81** which projects outside the frame **11**. The lower end of each actuating rod **78** is pushed upwards by the spring **82** held on the frame **11** by means of the anchor member **83**. The selector cam members **38** rotate simultaneously with the toothed ring **77** in such a manner as to come into contact with one or more of the selector cam followers **33** selectively. The stitch pattern indicator **84** is provided on the shaft **37** in front of the disc **76** for facilitating the selection of stitch patterns in co-operation with an index marked on the transparent plate **85** shown in FIG. 2. The indicator **84** bears various stitch patterns **201** to **235** marked radially with an equal angle as it is shown in FIG. 10.

The actuating rod **78** goes down against the spring **82** when the push button **81** is actuated, and it goes up to the original level by means of the spring **82** when the push button **81** is released. In the present invention, the actuating rod **78** is provided with the vertical slot **87** for the screws **79** which guide the vertical movement of the rod **78** as well as provide an upper limit to it. As the actuating rod **78** goes down, the toothed ring **77** is rotated by one tooth, together with the disc **76**, because one of its teeth is pushed down by the lower engaging end **88** of the click **80**. And as the toothed ring **77** rotates further at a given angle, the upper engaging end **89** of the click **80** stops the rotation of the toothed ring **77** by engaging with the following tooth of the ring **77**. When the push button **81** is released, the actuating rod **78** goes up while releasing the click **80** from the toothed ring **77** without moving the ring **77** of the disc **76**. The click **80** is pivotally mounted on the rod **78** by means of the pin **90** and is retained in the normal position as shown in FIG. 3 by means of the spring **91** provided on the opposite side of the engaging ends **88**, **89** of the click **80**. After it rotates the toothed ring **77** with its engaging ends **88**, **89** at a given angle, the click **80** is easily pivoted back to its normal position by means of the spring **91** while it is carried on the actuating rod **78** as it goes back up to the original level.

The sewing machine in accordance with the invention will give various stitch patterns selectively only by pushing either of the buttons **81**, **81**. A push on the button **81** will rotate the disc **76** by one tooth of the ring **77** to rotate the stitch pattern indicator **85** by a given radial angle of one stitch pattern, and simultaneously the selector cam **38** by the corresponding radial angle, so that one or more of the cam members **38** are selected to meet the corresponding selector cam follower or followers **33** in the high portion or portions of the periphery **38'**, while the other selector cam members **38** remain to meet the corresponding selector cam followers **33** in the low portions of the periphery **38'**. Accordingly, one or more of the cam followers **25** are selectively pushed into contact with the corresponding stitching cam member(s) **19***x*, **19***y*, **19***z*, while the other stitching cam members **19** remain free from their corresponding cam followers **25**. Thus, the selected stitching cam member(s) **19** will give a desired stitch pattern in response to their profiles.

The sewing machine in accordance with the invention makes it possible to carry out buttonhole stitching as easily as other ornamental stitchings. The stitching cam members *a*, *b*, *c* shown in FIG. 8, which have such profiles as correspond to the four processes of buttonhole stitching, are added to the cam members **19***x* mounted on the shaft **24** for co-operation with the needle bar operating plate **39**. The cam members *a*, *b*, *c* are related with the three selector cam members **38**, **38**, **38** by means of the corresponding cam followers **25**, **25**, **25** and the selector cam followers **33**, **33**, **33**. The three selector cam members are so provided as to be operated in response to the four patterns **202** to **205** for buttonhole stitching in FIG. 10.

As shown in FIG. 7, the cam **92** is additionally provided on the selector cam shaft **37** for regulating the cloth-feed ratio and direction of buttonhole stitching. The cam **92** has a profile the periphery of which is composed of the four portions **93** for non-cloth feeding, **94** for close forward cloth-feeding, **95** again for non-cloth feeding, and **96** for close backward cloth-feeding, which correspond to the four processes of buttonhole stitching. The cam follower **98** is mounted rotatably on the shaft **97** fixed to the supporting member **27**. One end of the cam follower **98** forms the engaging portion **99** to follow the periphery of the cam **92**, and the other end **100** is connected with the link **101** rotatably by means of the screw **102**. The link **101** is connected to the lever **72** by means of the screw link **103** as shown in FIG. 2. The lever **72** is connected to the cloth-feed regulating device **75** of known structure by means of the lever **73** and the link **74** in accordance with known practice.

The regulation of cloth-feed ratio and direction in the sewing machine of the present invention may require no detailed explanation, because it is quite the same as known practice. Only a brief reference will be made in the present paragraph to cloth-feed regulation. As shown in FIGS. 3 and 9, the crank **107** and the eccentric cam **108** are provided on the main drive shaft **13** in the frame **11**. The crank **107** is connected with the rod **109**. The eccentric cam **108** is connected with the branched link **110** provided with the roller **111**, which is received in the groove **105** of the cloth-feed regulating case member **75**. The cloth-feed ratio is varied according as the inclination angle of the case member **75**, i.e., that of the groove **105** is varied, as the hand-rotation of the dial makes the horizontal member **114** move in an axial direction in contact with the pin **113** provided in the case member **75**. The cloth-feed direction is reversed when the inclination angle of the case member **75**, i.e., that of the groove **105** is reversed by the push **115** provided in the dial **112**. Both the dial **112** and the push **115** are manipulated for hand-operation only. The cloth-feed regulating case member **75** is mounted on the supporting member **116** rotatably by means of the screw shaft **117**.

In the buttonhole stitching operation of the sewing machine in accordance with the invention, the dial **112** is initially rotated for the maximum forward cloth-feeding so that the automatic cloth-feeding may be carried out for buttonhole stitching without the possibility of interference made by hand-operated parts. Then, the push button **81** is actuated for the index to be aligned with the buttonhole-end stitch pattern **202** marked on the indicator **84**. As a result, the stitching cam member *a* shown in FIG. 8 is put into contact with the corresponding cam follower **25** by means of the corresponding selector cam member **38** and the cam follower **33**, while the disc cam **92** on the shaft **37** meets the engaging portion **99** of the cam follower **98** at the non-cloth-feeding portion **93** on its periphery to rotate the cam followers **98** on the shaft **97** in such a manner that the cloth-feed reg-

ulating case member **75** is positioned at the inclination angle for non-cloth feeding by means of the link **101**, levers **72**, **73**, and link **74**. Accordingly, the needle bar **16** carries out transverse oscillation for buttonhole-end stitching on the stopped cloth sheet in response to the profile of the cam member *a* by means of the corresponding cam follower **25** and the needle bar operating plate **39**. Thus one of the buttonhole ends has been stitched.

Now, the push button **81** is actuated again for the index to be aligned with the buttonhole-side stitch pattern **203**. As a result, the cam member *a* is released from the corresponding cam follower **25** by means of the corresponding selector cam member **38** and cam follower **33**, while the disc cam **92** releases the engaging portion **99** of the cam follower **98** from the portion **93** on its periphery. Instead, the stitching cam member *b* shown in FIG. 8 is put into contact with the corresponding cam follower **25** by means of the corresponding selector cam member **38** and cam follower **33**, while the disc cam **92** meets the engaging portion **99** of the cam follower **98** in the close forward cloth-feeding portion **94** on its periphery to rotate the cam follower **98** on the shaft **97** in such a manner that the case member **75** is positioned at an inclination angle for close forward cloth-feeding. Accordingly, the needle bar **16** carries out transverse oscillation for stitching closely only one side of the buttonhole on the advancing cloth sheet in response to the profile of the cam member *b* by means of the corresponding cam follower **25** and the needle bar operating plate **39**. Thus, one of the buttonhole sides has been stitched.

Similarly, the other patterns **204**, **205** will be stitched only by actuating the push button for the index to be aligned with the stitch pattern marks to operate the needle bar **16** in response to the profiles of the cam members *a*, *c* by means of the selector members **38**, selector cam followers **33**, cam followers **25**, and plate **39**, while the disc cam **92** makes the case member **75** positioned correspondingly to the stitch patterns **204**, **205** by means of the periphery portions **95**, **96**, lever **98**, link **101**, levers **72**, **73**, and link **74**. Because the cam *c* has a smaller average diameter than the cam *b*, and the basic stitch line is shifted from one side to the other side of the buttonhole as the rocking motion of the rocker case **46** is shifted in response to the operation of the cam members *b*, *c*, while the oscillatory amplitude of the needle bar is kept constant during the operations carried out by the cam members *b*, *c*. Thus, the whole buttonhole is stitched satisfactorily only by the simple manipulation of the push button **81** just like the other ornamental stitch patterns. In this case, the amplitude of buttonhole zigzag stitch patterns can be freely altered by means of the dial **23** provided for controlling the amplitude of needle bar oscillation.

In the sewing machine in accordance with the invention, the needle bar operating plate **39**, the cloth-fed regulating plate **40**, and the oscillatory amplitude controlling plate **41** are all operated in cooperation with spring means. The spring **51** pulling one end of the rocker case **46** connects the plate **39** functionally to the actuating portions **29** of the cam followers **25** corresponding to the cam **19***x* by way of the rocker piece **53**, lower rocker piece **55**, vertical shaft **54**, and upper rocker piece **56**. The spring **106** pulling one end of the cloth-feed regulating case member **75** connects the plate **40** functionally to the actuating portions **29** of the cam followers **25** corresponding to the cam **19***y* by way of the link **74**, levers **73**, **72**, and link **70**. The spring **64** pulling one end of the curved link **17** connects the plate **41** functionally to the actuating portions **29** of the cam followers **25** corresponding to the cam **19***z*. All these cam followers **25** retire their engaging portions **28** from the peripheries **19'** of the three-grouped cam members **19***x*, **19***y*, **19***z* with the forces of the springs **51**, **106**, **64**, when they are not pushed by the selector cam followers **33** from the selector cam members **38**. And the cam followers **25** actuate the plates **39**, **40**, **41** against the forces of the respective springs **51**, **106**, **64**, when they are pushed by the selector cam followers **33** from the selector cam members **38** to bring their respective engaging portions **28** into contact with the corresponding peripheries **19'**, **19'**, **19'** of the cam members **19***x*, **19***y*, **19***z*. In the meantime, the spring **106** pulling one end of the cloth-feed regulating case member **75** makes the engaging portion **99** of the cam follower **98** meet the periphery portions **93**, **94**, **95**, **96** of the disc cam **92** by means of the link **74**, levers **73**, **72**, screw link **103**, and link **101**.

It will, therefore, be seen that all the objects mentioned in the earlier part of the present specification are achieved, together with minor objects not particularly mentioned, by the zig-zag stitching sewing machine in accordance with the invention.

Obviously, many modifications and variations of the invention are possible in the light of the above principles. It is, therefore, to be understood that within the scope of the appended claims the invention may be practised otherwise than described above.

We claim:

1. In an ornamental stitch sewing machine for selectively producing a plurality of stitch patterns, a hollow frame, a needle mounted on said frame for endwise reciprocation and for lateral swinging movements transversely of the direction of reciprocation, a cam shaft supported within said frame, a stack of rotary stitching cams mounted in side-by-side coaxial relation on said cam shaft including groups of plural cams each for producing transverse oscillation of the needle and regulating amplitude of needle oscillations, means for driving said cam shaft to rotate said cams simultaneously about the axis thereof, a plurality of cam followers corresponding in number to said cams, pivot means defining pivot axes for said cam followers, means mounting said cam followers individually on said pivot means for independent movement of each cam follower about pivot axes in parallel planes perpendicular to the axis of said cam shaft alongside said cams in radial alinement with their respective cams without effecting movement of any of the other of said cam followers, said cam followers each having an engagement portion for engaging and following the periphery of its associated cam and an activating end portion spaced from their pivot axes, means producing transverse oscillation of the needle including an oscillation-producing plate, means for regulating the amplitude of oscillation of the needle including an oscillatory amplitude plate, each of said plates being slidably mounted on said frame for rectilinear reciprocative movement along axes paralleling said cam follower planes of movement, each of said plates being disposed to be directly driven by the activating end portions of the cam follower associated with a respective one of said groups of cams, and means for selectively positioning selected ones of said followers to dispose their activating end portions in driving engagement with said plates to activate said plates responsive to the cams followed by said cam followers.

2. In an ornamental stitch sewing machine for selectively producing a plurality of stitch patterns, a hollow frame, a needle mounted on said frame for endwise reciprocation and for lateral swinging movements transversely of the direction of reciprocation, a cam shaft supported within said frame, a stack of rotary stitching cams mounted in side-by-side coaxial relation on said cam shaft including groups of plural cams each for producing transverse oscillation of the needle, regulating amplitude of needle oscillations, and regulating direction and extent of cloth feed, means for driving said cam shaft to rotate said cams simultaneously about the axis thereof, a plurality of cam followers corresponding in number to said cams, pivot shaft means defining a common stationary pivot axis for said cam followers, means mount-

ing said cam followers individually on said pivot shaft means for independent movement of each cam follower about said common stationary pivot axis in parallel planes perpendicular to said pivot axis alongside said cams in radial alinement with their respective cams without effecting movement of any of the other of said cam followers, said cam followers each having an engagement portion for engaging and following the periphery of its associated cam and an activating end portion spaced from said pivot axis, means producing transverse oscillation of the needle including an oscillation-producing plate, means for regulating the amplitude of oscillation of the needle including an oscillatory amplitude plate, means for regulating the direction and extent of feed of cloth through the machine including a cloth-feed regulating plate, each of said plates being slidably mounted on said frame for rectilinear reciprocative movement along axes paralleling said cam follower planes of movement, said oscillation-producing plate, said amplitude plate and said cloth-feed regulating plate being disposed to be directly driven by the activating end portions of the cam follower associated with the oscillation-producing cams, the amplitude regulating cams and the cloth feed regulating cams respectively, and means for selectively positioning selected ones of said followers to dispose their activating end portions in driving engagement with said plates to activate said plates responsive to the cams followed by said cam followers.

3. In an ornamental stitch sewing machine for selectively producing a plurality of stitch patterns, a hollow frame, a needle mounted on said frame for endwise reciprocation and for lateral swinging movements transversely of the direction of reciprocation, a cam shaft supported within said frame, a stack of rotary stitching cams mounted in side-by-side coaxial relation on said cam shaft including groups of plural cams each for producing transverse oscillation of the needle, regulating amplitude of needle oscillations, and regulating direction and extent of cloth feed, means for driving said cam shaft to rotate said cams simultaneously about the axis thereof, a plurality of cam followers corresponding in number to said cams supported for movement about a common stationary pivot axis in parallel planes perpendicular to said pivot axis alongside said cams in radial alinement with their respective cams, said cam followers each having an engament portion for engaging and following the periphery of its associated cam and an activating end portion spaced from said pivot axis, means producing transverse oscillation of the needle including an oscillation-producing plate, means for regulating the amplitude of oscillation of the needle including an oscillatory ampiltude plate, means for regulating the direction and extent of feed of cloth through the machine including a cloth-feed regulating plate, each of said plates being slidably mounted on said frame for rectilinear reciprocative movement along axes paralleling said cam follower planes of movement, said oscillation-producing plate, said amplitude plate and said cloth-feed regulating plate being disposed to be directly driven by the activating end portions of the cam follower associated with the oscillation-producing cams, the amplitude regulating cams and the cloth feed regulating cams respectively, and means for selectively positioning selected ones of said followers to dispose their activating end portions in driving engagement with said plates to activate said plates responsive to the cams followed by said cam followers, said means for positioning said cam followers including a plurality of angularly adjustable selector cams corresponding in number to said stitching cams arranged in spaced co-planar relation with their respective stitching cams and said cam followers with said cam followers located therebetween, a pivot shaft defining the pivot axis for said cam followers, said cam followers each having a slot therein elongated in the direction of their respective stitching cams and selector cams for receiving said pivot shaft and accommodating movement of the cam follower relative thereto between a cam tracking position and a spaced position relative to said stitching cams, and means for adjusting said cam followers to said tracking and spaced positions responsive to the peripheral contours of their respective selector cams.

4. In an ornamental stitch sewing machine for selectively producing a plurality of stitch patterns, a hollow frame, a needle mounted on said frame for endwise reciprocation and for lateral swinging movements transversely of the direction of reciprocation, a cam shaft supported within said frame, a stack of rotary stitching cams mounted in side-by-side coaxial relation on said cam shaft including groups of plural cams each for producing transverse oscillation of the needle, regulating amplitude of needle oscillations, and regulating direction and extent of cloth feed, means for driving said cam shaft to rotate said cams simultaneously about the axis thereof, a plurality of cam followers corresponding in number to said cams supported for movement about a common stationary pivot axis in parallel planes perpendicular to said pivot axis alongside said cams in radial alinement with their respective cams, said cam followers each having an engagement portion for engaging and following the periphery of its associated cam and an activating end portion spaced from said pivot axis, means producing transverse oscillation of the needle including an oscillation-producing plate, means for regulating the amplitude of oscillation of the needle including an oscillatory amplitude plate, means for regulating the direction and extent of feed of cloth through the machine including a cloth-feed regulating plate, each of said plates being slidably mounted on said frame for rectilinear reciprocative movement along axes paralleling said cam follower planes of movement, said oscillation-producing plate, said amplitude plate and said cloth-feed regulating plate being disposed to be directly driven by the activating end portions of the cam follower associated with the oscillation-producing cams, the amplitude regulating cams and the cloth feed regulating cams respectively, and means for selectively positioning selected ones of said followers to dispose their activating end portions in driving engagement with said plates to activate said plates responsive to the cams followed by said cam followers, a dial shaft, an indicator dial on said dial shaft having markings designating various stitch patterns obtainable by the operation of said stitching cams, a toothed ring on said shaft rotatable in selected correspondence with the indicator dial, a push-button actuating rod reciprocaive substantially tangentially of said ring having a bifurcated pawl member providing first and second projections for interfitting with the teeth of said toothed ring to rotate the ring through a selected arc during manual depression of said operating rod through a selected stroke and prevent rotation of said ring beyond said arc during said stroke, resilient means for returning said operating rod to raised position, and said means for positioning said cam followers including a plurality of selector cams corresponding in number to said cam followers for angularly adjusting said cam followers responsive to movement of said toothed ring.

5. In an ornamental stitch sewing machine for selectively producing a plurality of stitch patterns, a hollow frame, a needle mounted on said frame for endwise reciprocation and for lateral swinging movements transversely of the direction of reciprocation, a cam shaft supported within said frame, a stack of rotary stitching cams mounted in side-by-side coaxial relation on said cam shaft including groups of plural cams each for producing transverse oscillation of the needle, regulating amplitude of needle oscillations, and regulating direction and extent of cloth feed, means for driving said cam shaft to rotate said cams simultaneously about the axis thereof, a plurality of cam followers corresponding in number to said cams supported for movement about a common stationary pivot axis in parallel planes perpendicular to said pivot axis alongside said cams in radial aline-

ment with their respective cams, said cam followers each having an engagement portion for engaging and following the periphery of its associated cam and an activating end portion spaced from said pivot axis, means producng transverse oscillation of the needle including an oscillation-producing plate, means for regulating the amplitude of oscillation of the needle including an oscillatory amplitude plate, means for regulating the direction and extent of feed of cloth through the machine including a cloth-feed regulating plate, each of said plates being slidably mounted on said frame for rectilinear reciprocative movement along axes paralleling said cam follower planes of movement, said oscillation-producing plate, said amplitude plate and said cloth-feed regulating plate being disposed to be directly driven by the activating end portions of the cam follower associated with the oscillation-producing cams, the amplitude regulating cams and the cloth feed regulating cams respectively, and means for selectively positioning selected ones of said followers to dispose their activating end portions in driving engagement with said plates to activate said plates responsive to the cams followed by said cam followers, said group of stitching cams for producing transverse oscillation of the needle including three buttonholing cams for controlling the width of transverse oscillation and center-line of oscillation of the needle for the ends and right and left hand edges of a buttonhole, said means for positioning said cam followers including a selector cam having a suitably curved periphery for positioning

the cam followers to engage and track said buttonholing cams automatically in selected succession to sew along one end, one side, the other end and the other side of a buttonhole, and a cam member driven in coordinated relation to said selector cam for automatically regulating the direction and extent of cloth feed during the complete buttonhole sewing procedure.

6. An ornamental stitch sewing machine as defined in claim 2 wherein said cam followers each have a slot therein which is elongated in a radial direction relative to the axis of said stitching cams for receiving said pivot shaft means and accommodating limited translatory movement of the cam follower relative to said pivot shaft means between a cam tracking position and a position spaced from the periphery of the associated stitching cam, and means for selective adjusting said cam followers to said tracking and spaced positions.

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