Feb. 28, 1939. S. W. AVIS 2,149,110

BUTTONHOLE SEWING MACHINE

Filed July 28, 1937 8 Sheets-Sheet 1

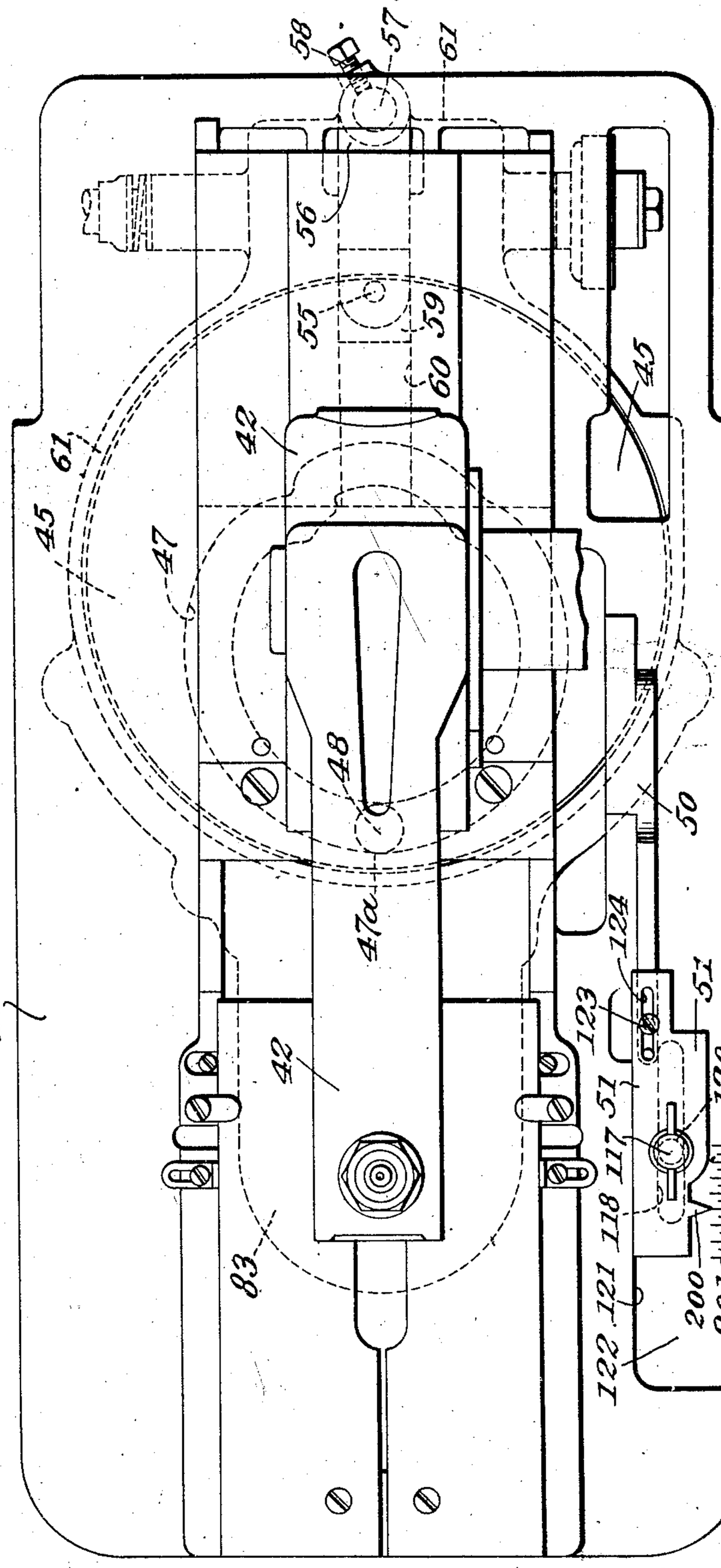

Fig. 1

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BUTTONHOLE SEWING MACHINE

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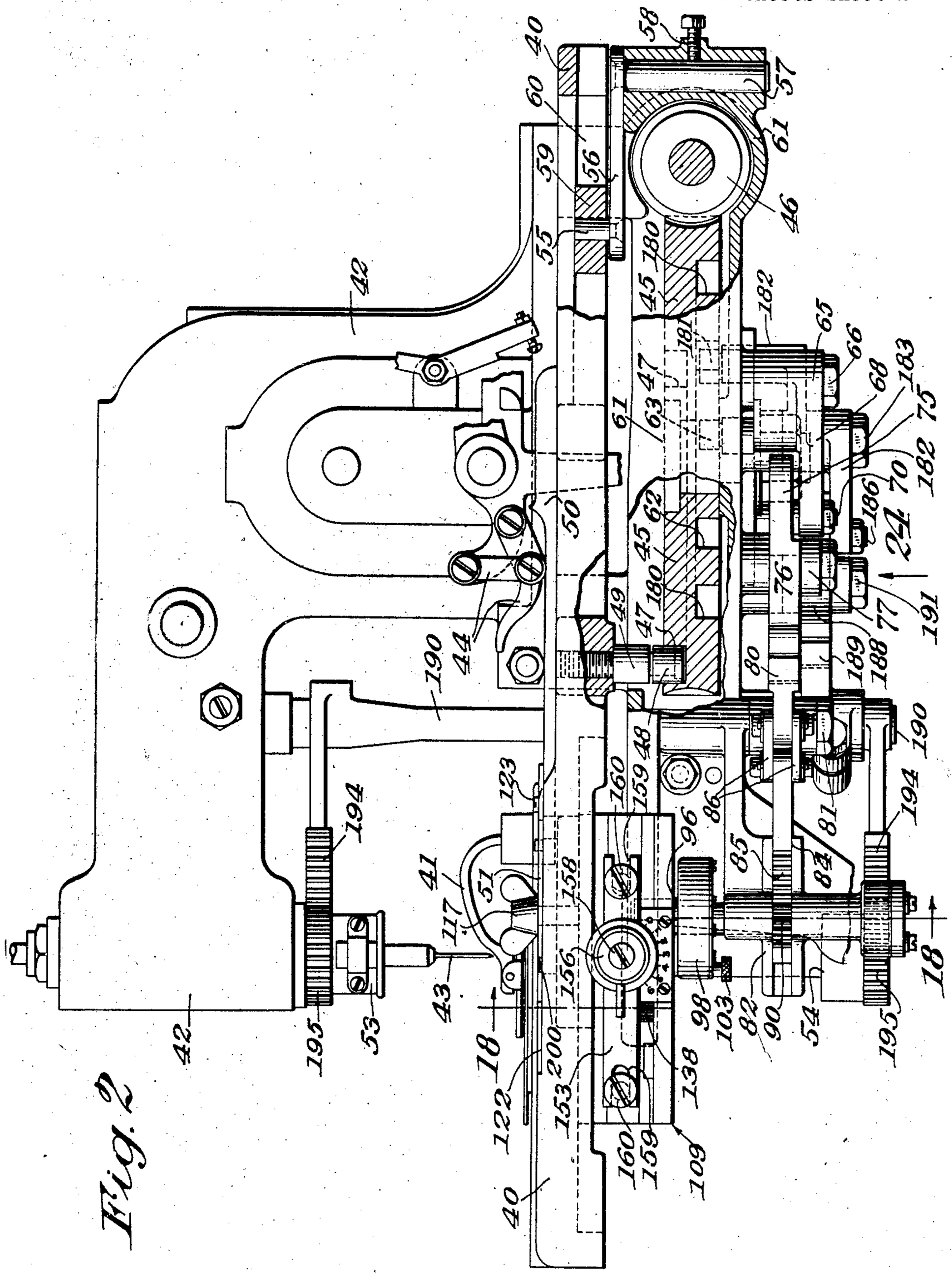

Fig. 2

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BUTTONHOLE SEWING MACHINE

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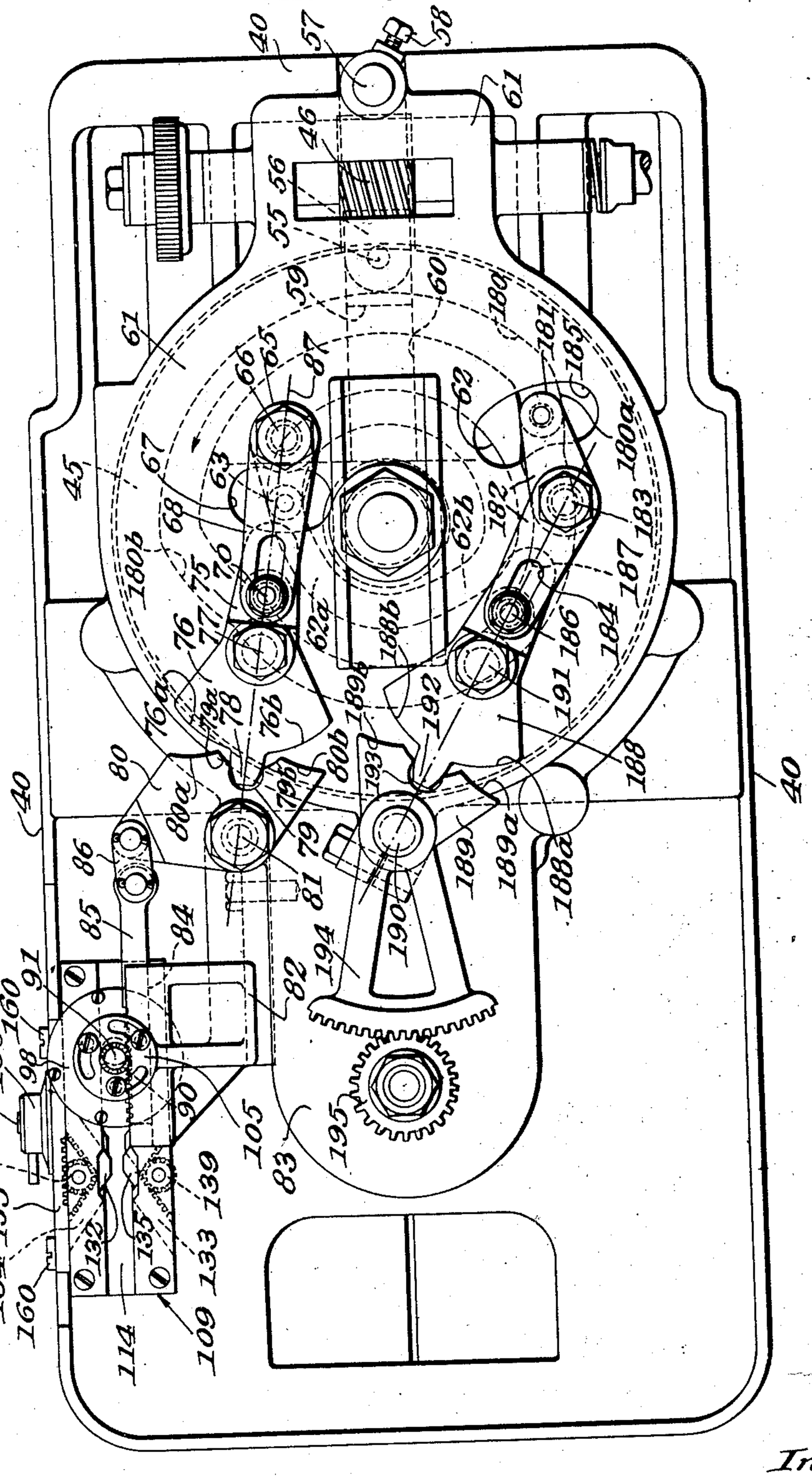
Fig. 3



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BUTTONHOLE SEWING MACHINE

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Fig. 4

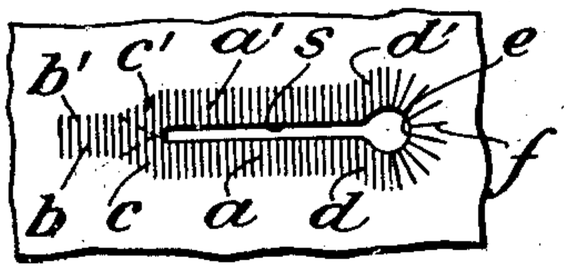

Fig. 5

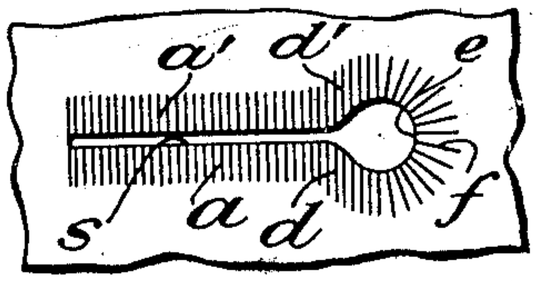

Fig. 6

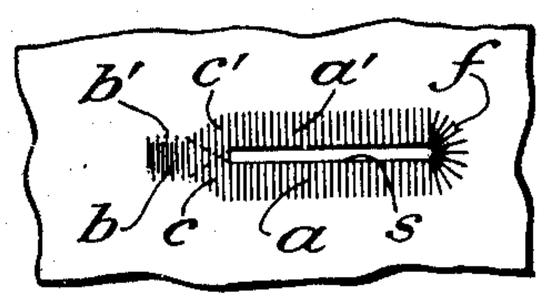

Fig. 7

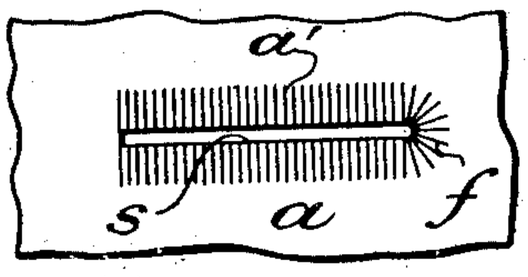

Fig. 8

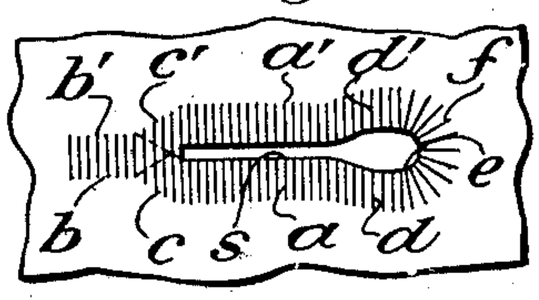

Fig. 9

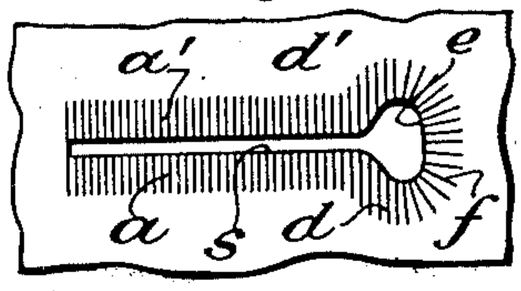

Fig. 10

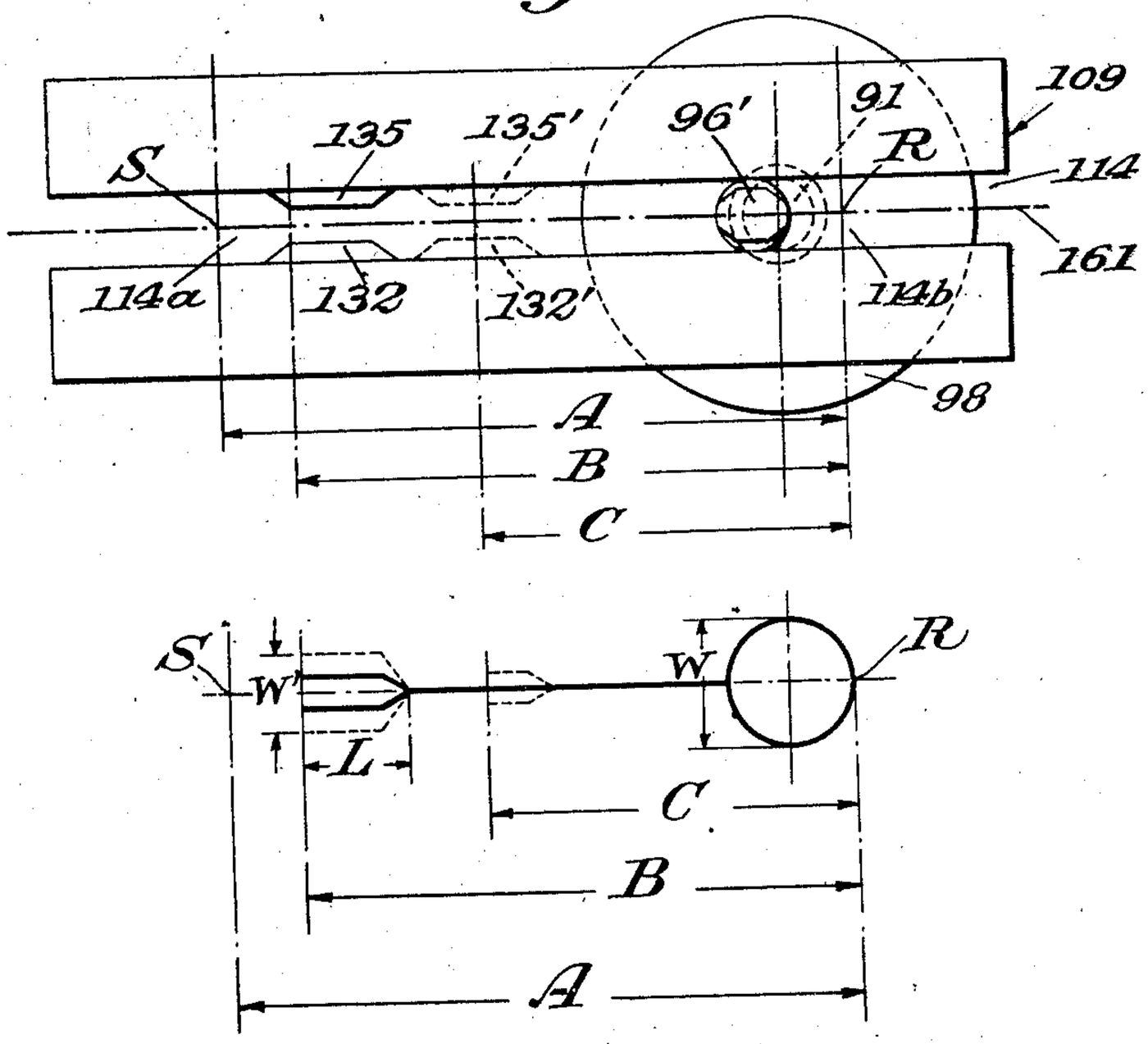

Fig. 10a

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BUTTONHOLE SEWING MACHINE

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Fig. 11

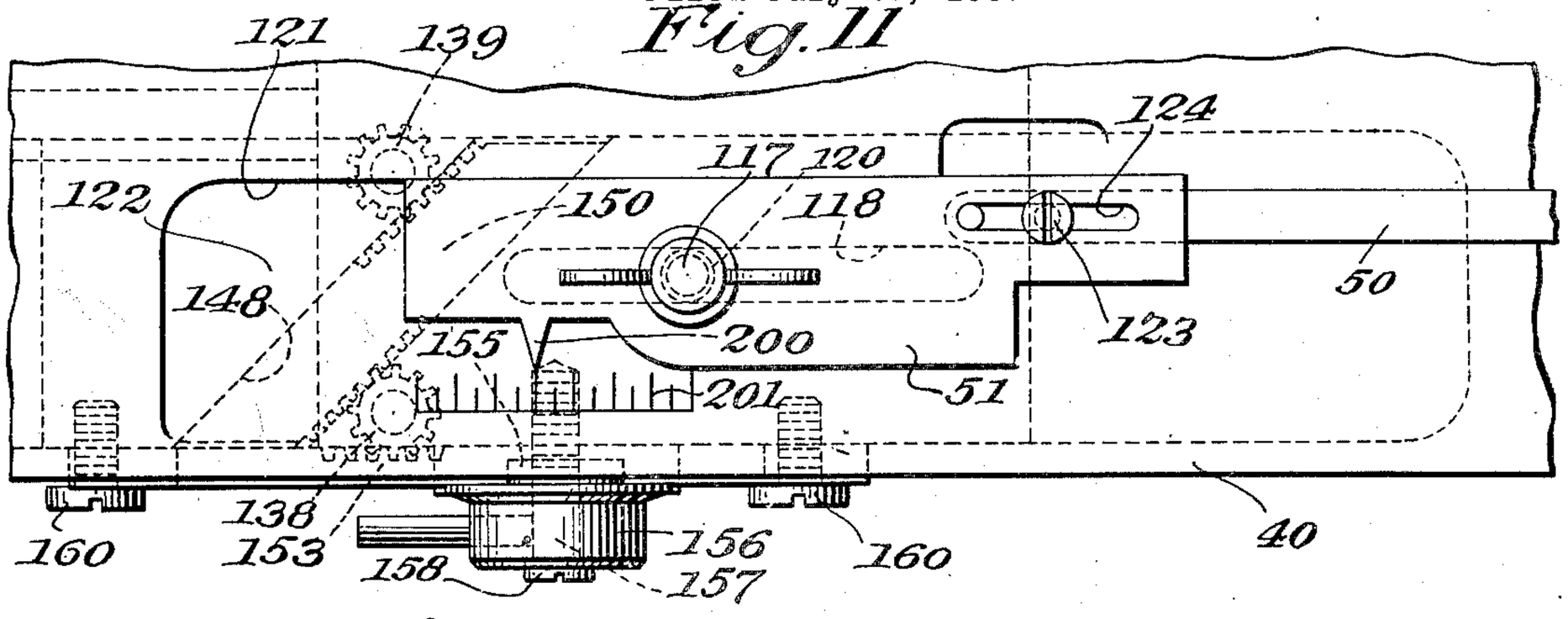

Fig. 12

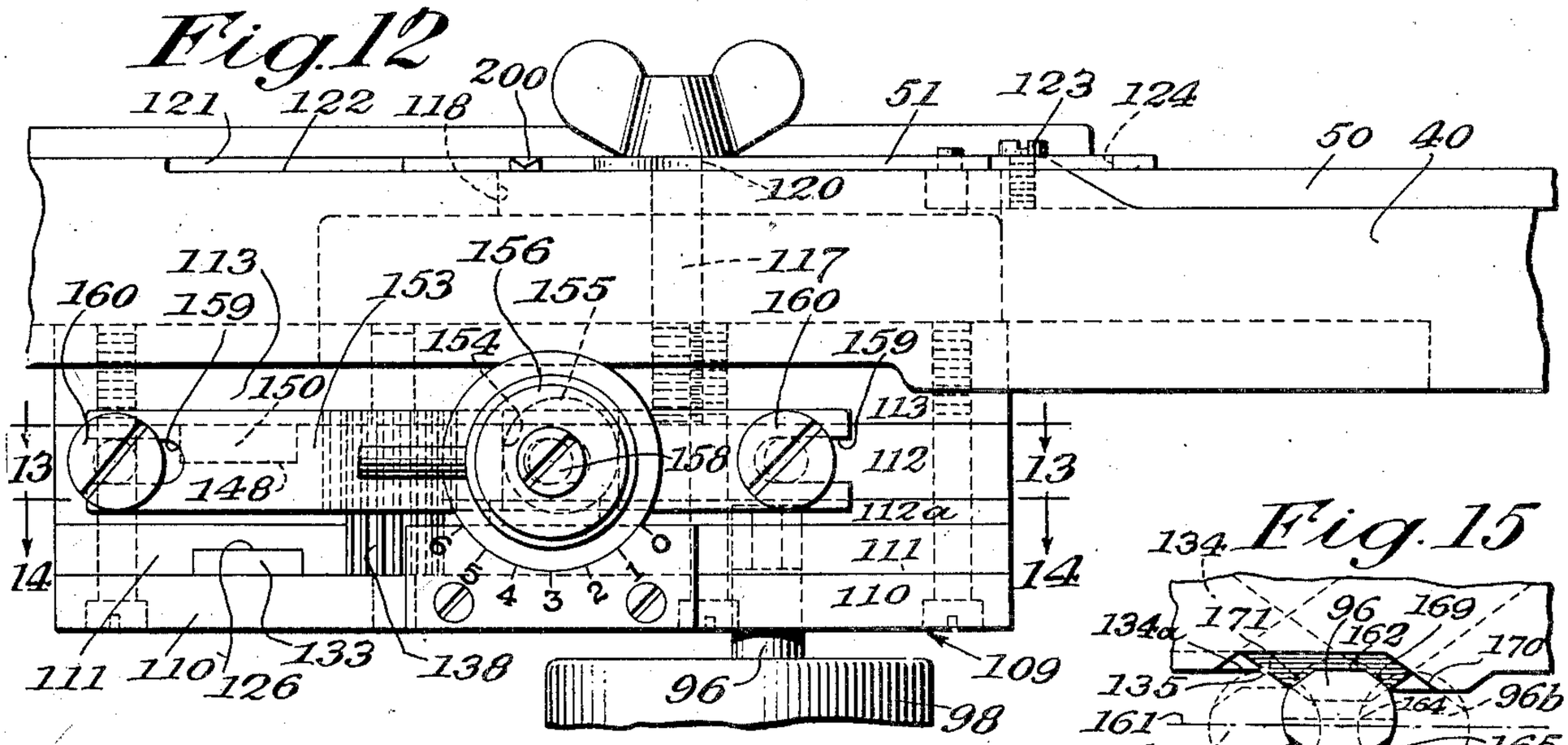

Fig. 13

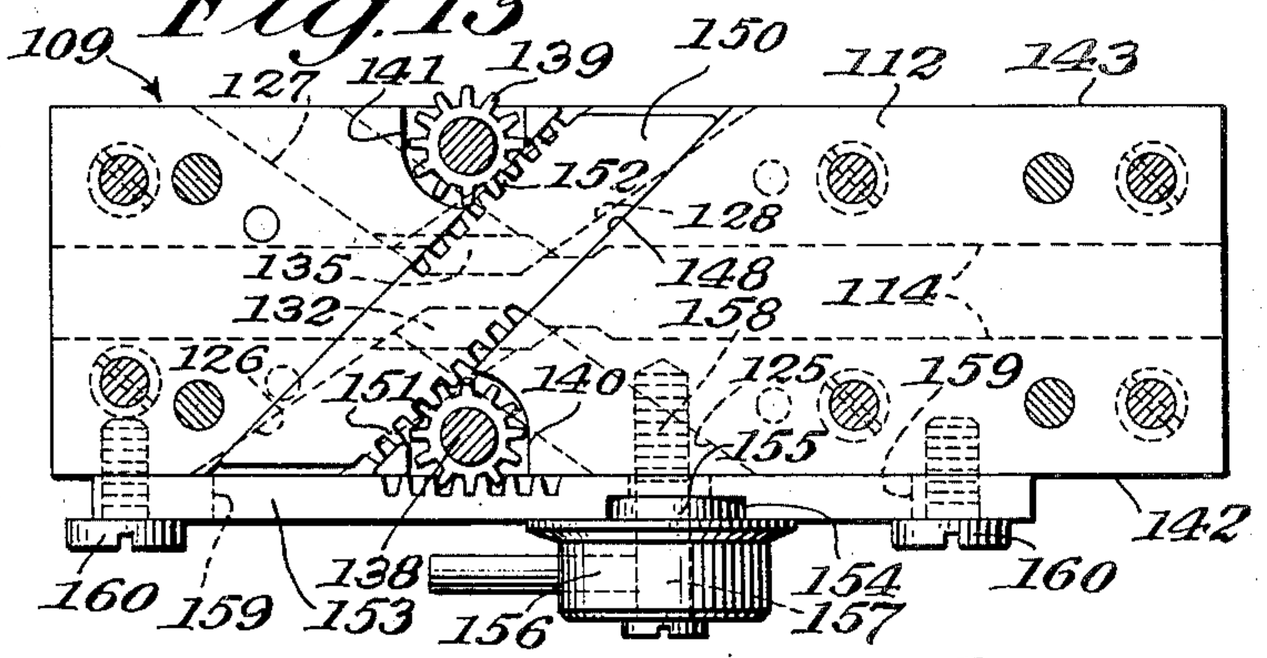

Fig. 14

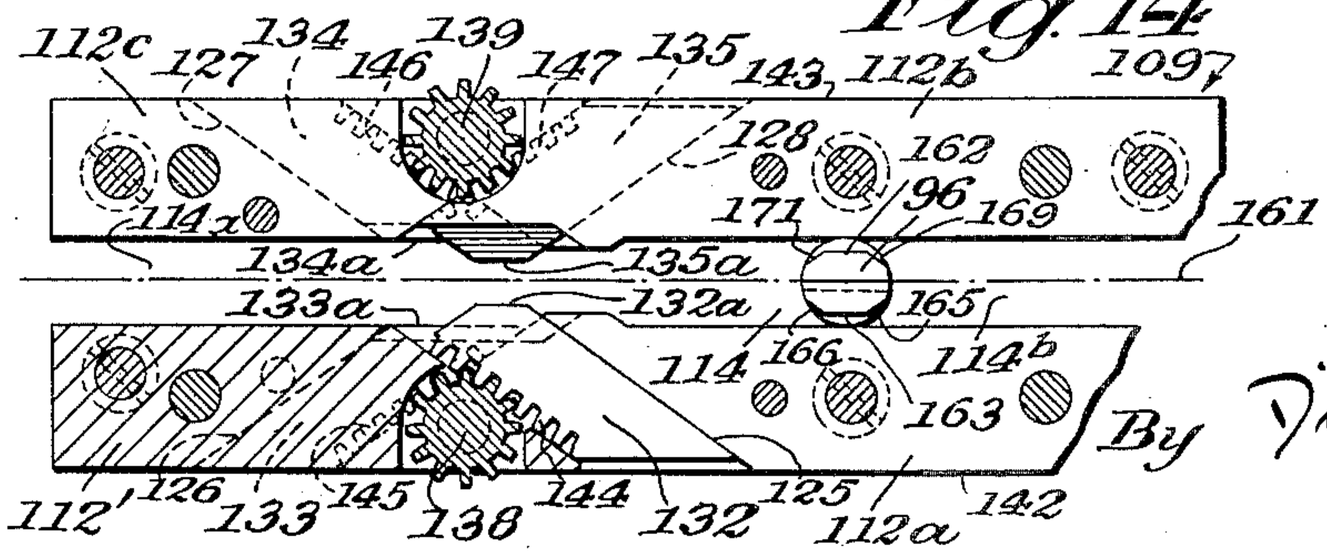

Fig. 15

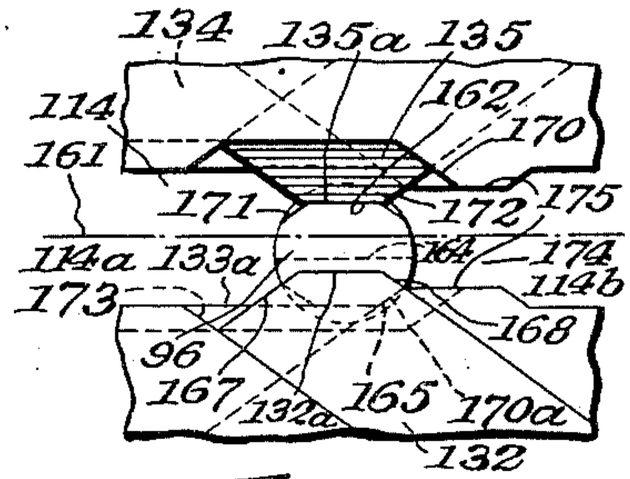

Fig. 16

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BUTTONHOLE SEWING MACHINE

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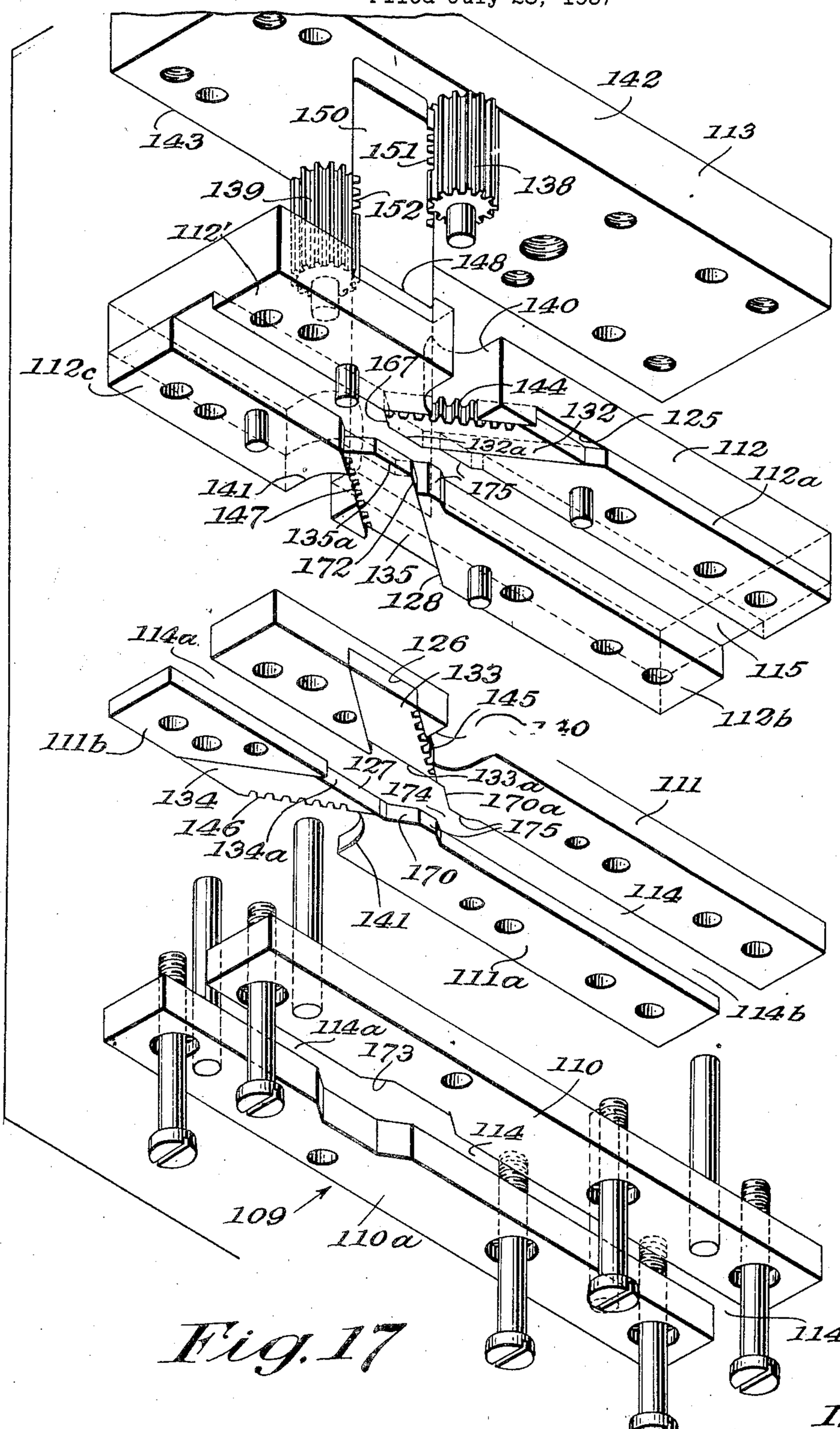

Fig. 17

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BUTTONHOLE SEWING MACHINE

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Fig. 18

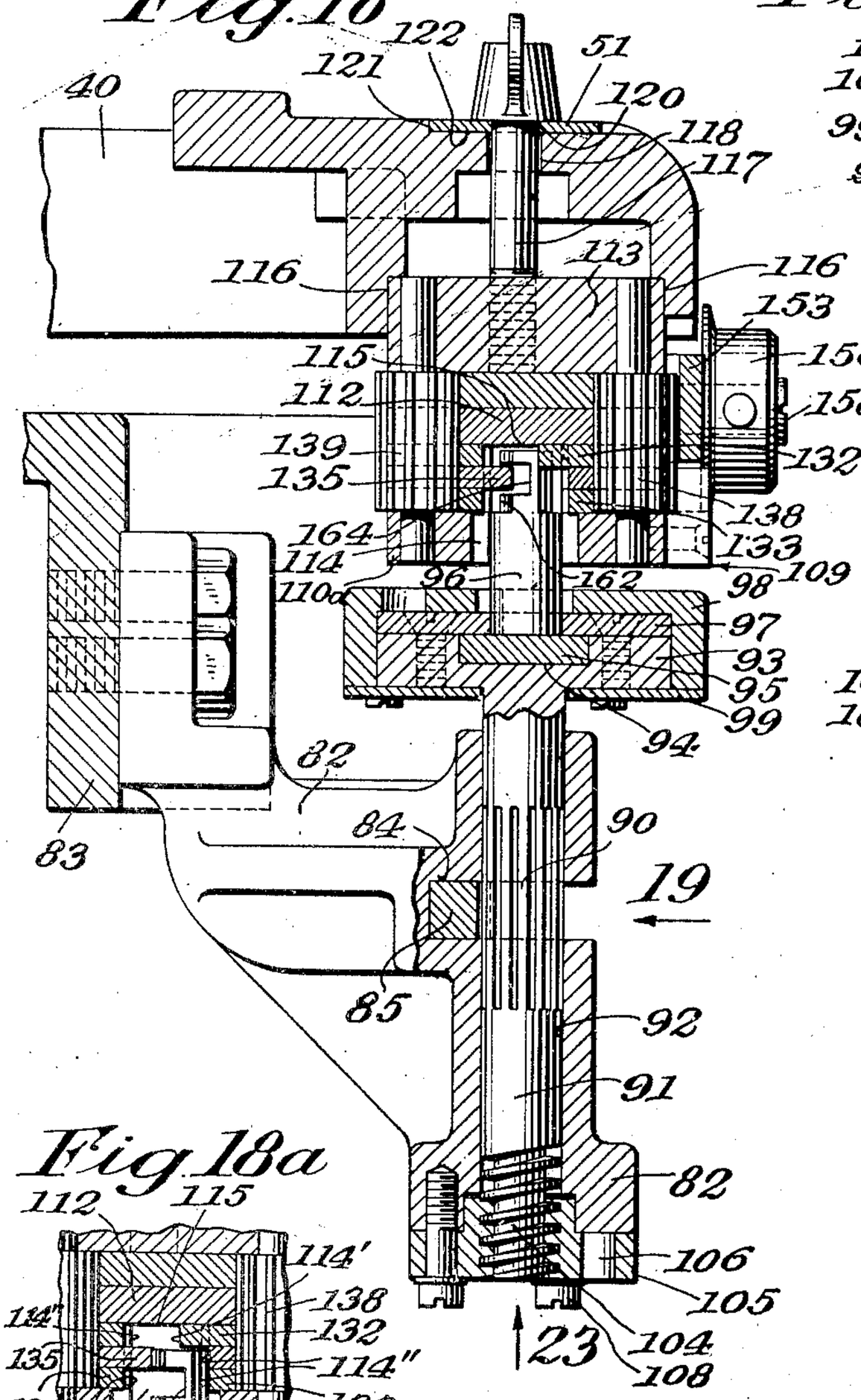


Fig. 20

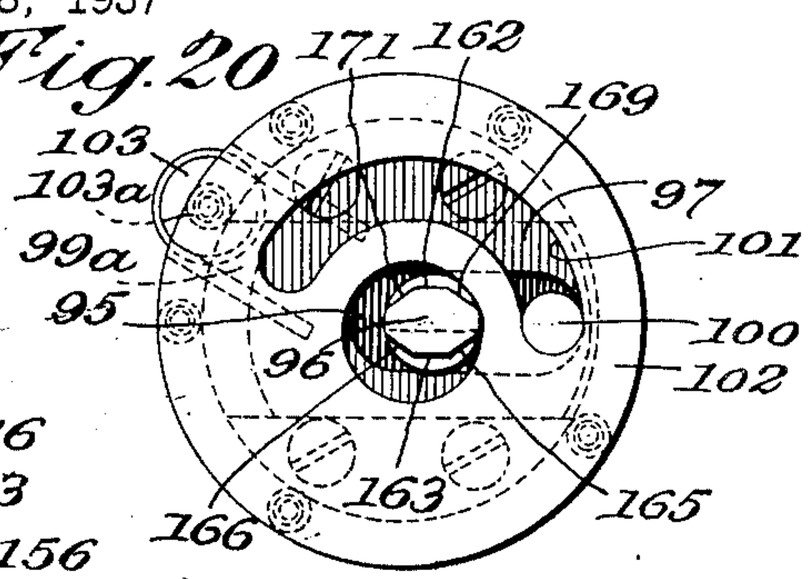


Fig. 19

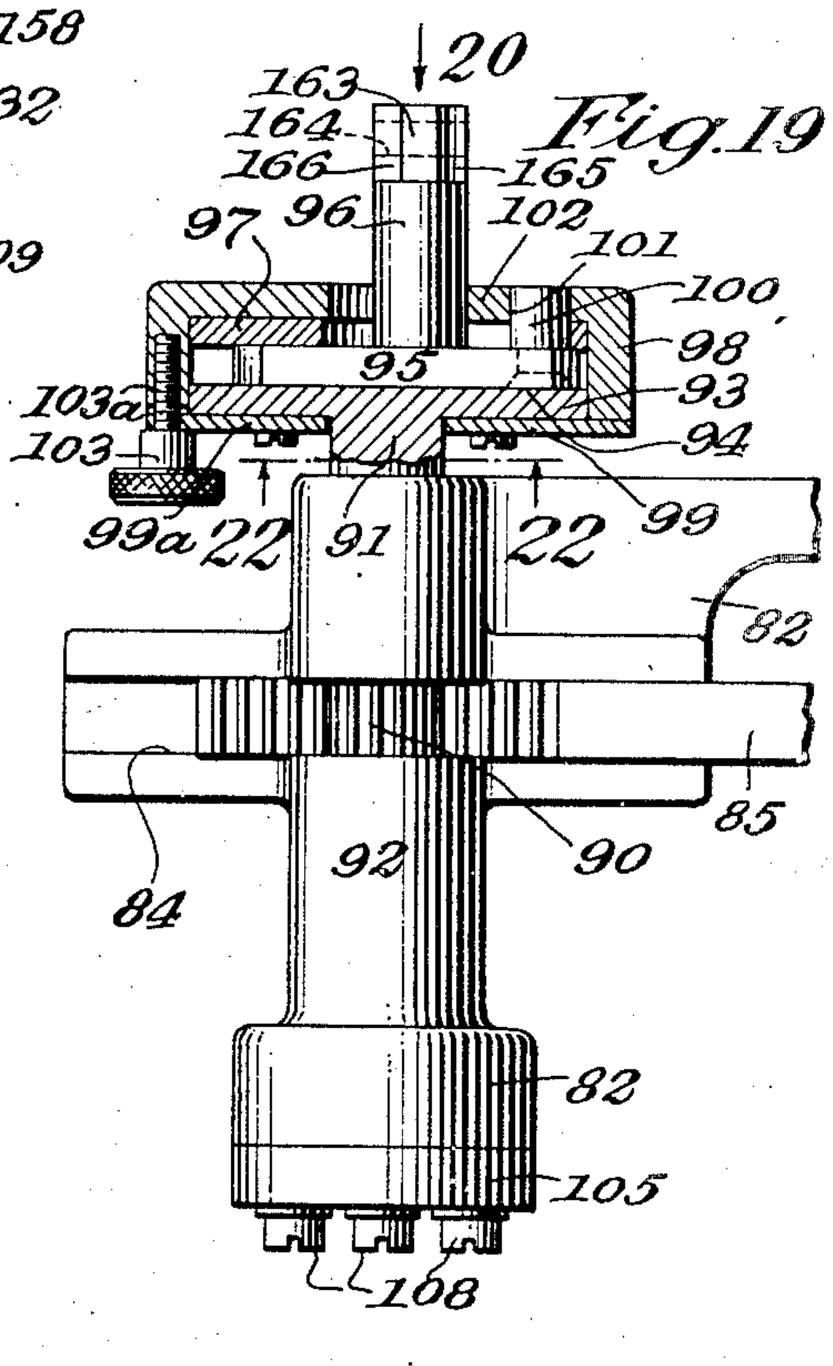


Fig. 18a

Fig. 23

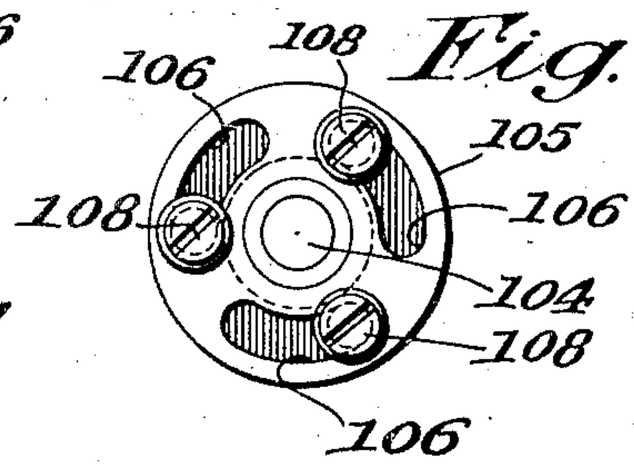


Fig. 22

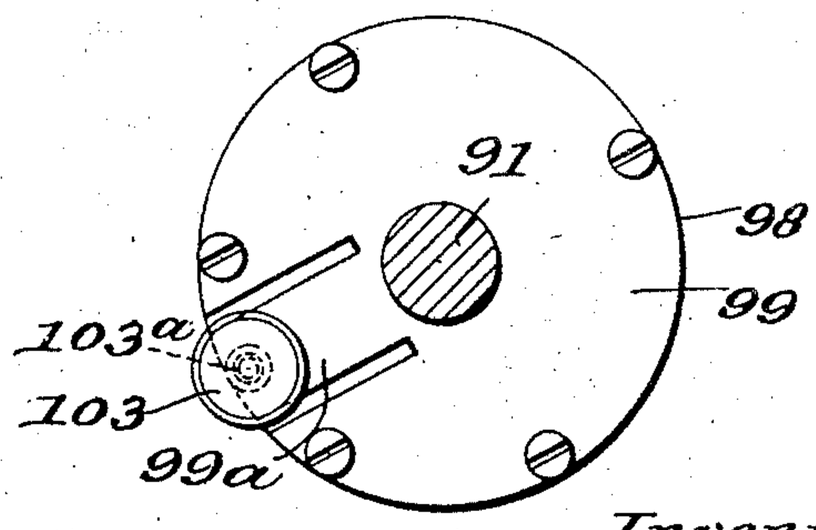
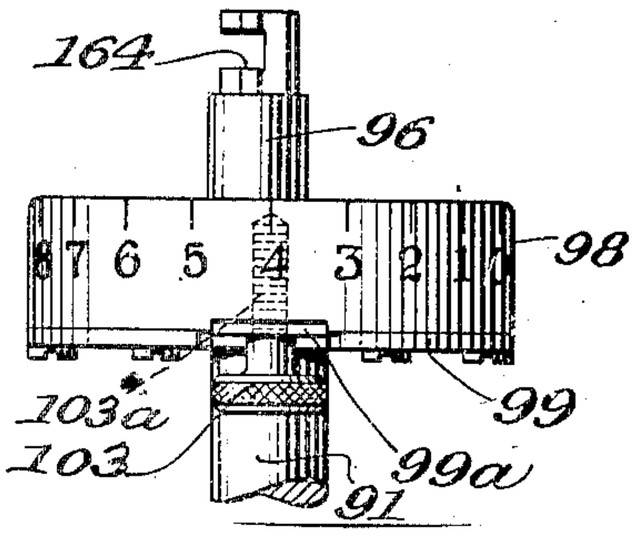


Fig. 21



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BUTTONHOLE SEWING MACHINE

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Fig. 24

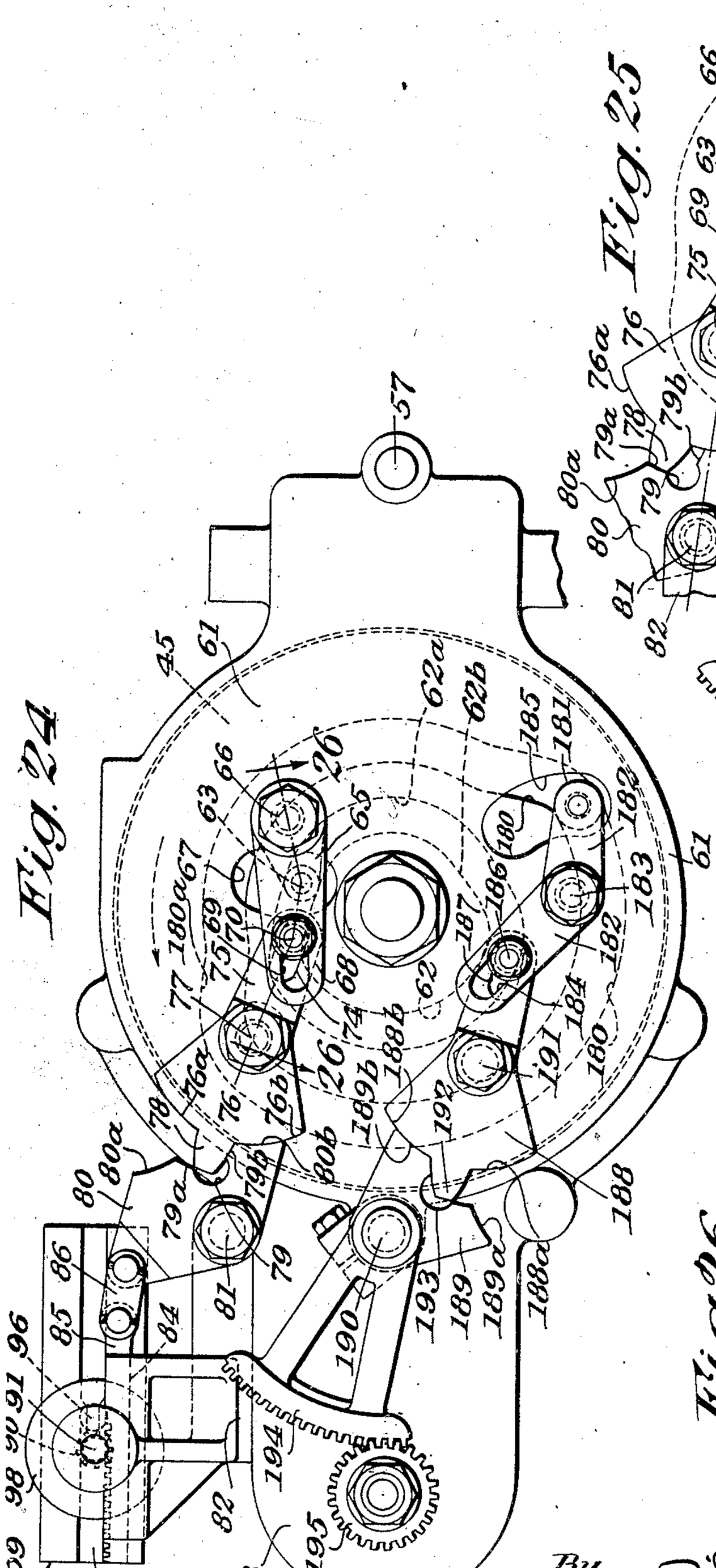


Fig. 25

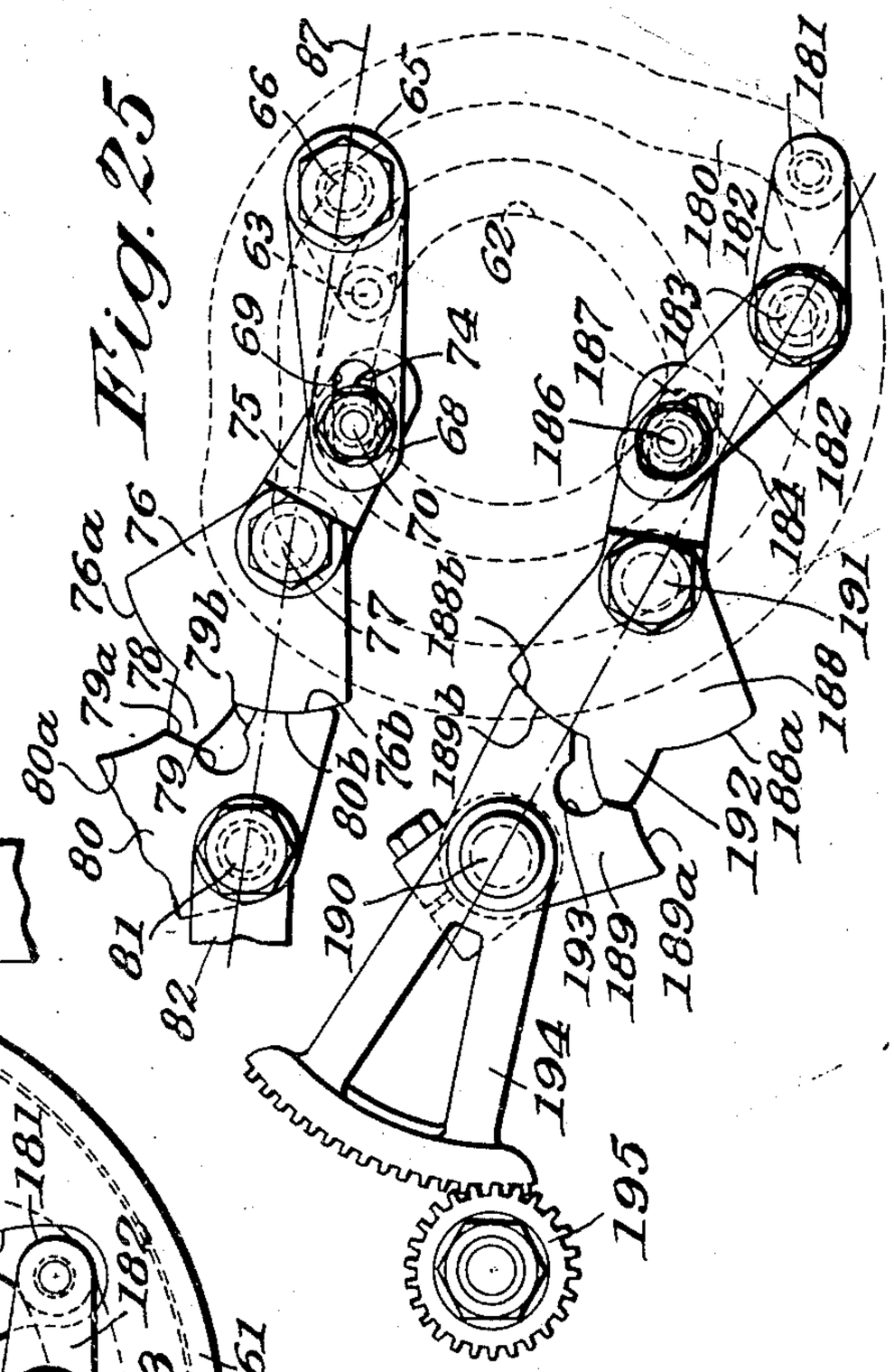
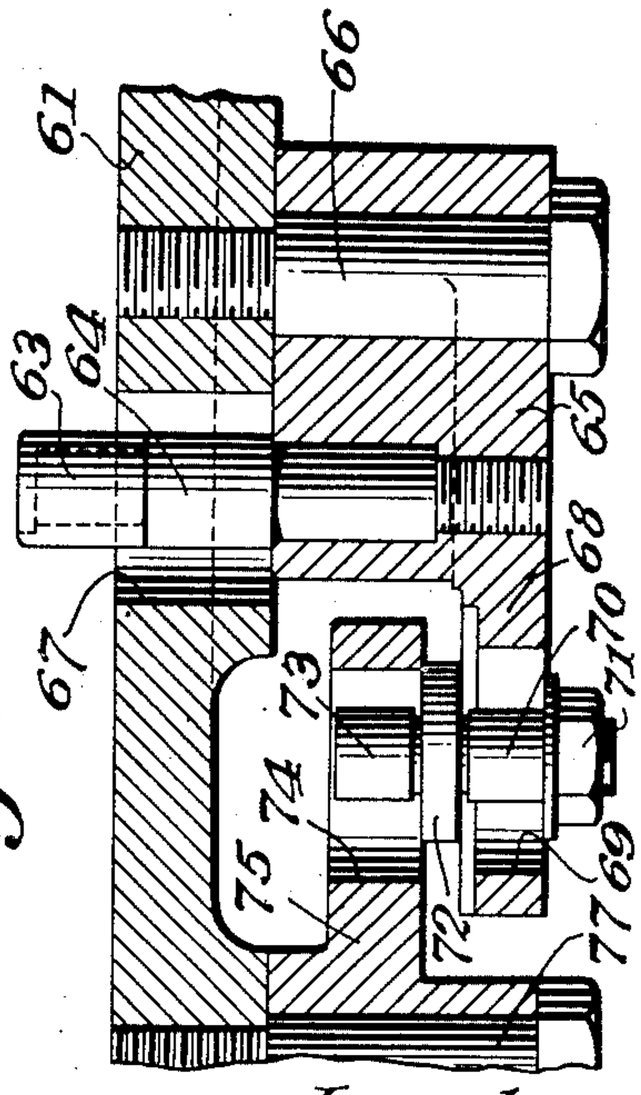


Fig. 26



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Patented Feb. 28, 1939

2,149,110

UNITED STATES PATENT OFFICE

2,149,110

BUTTONHOLE SEWING MACHINE

Samuel W. Avis, Providence, R. I., assignor to The Reece Button Hole Machine Company, Boston, Mass., a corporation of Maine

Application July 28, 1937, Serial No. 156,136

59 Claims. (Cl. 112—71)

This invention relates to button hole sewing machines, and more particularly, though not exclusively, to a machine of the eye and fly bar type, that is to say, a machine for sewing button holes having an eye at one end and a so-called fly bar at the other end.

It is the primary aim and object of the present invention to provide a machine of the above type which, by a minimum number of simple adjustments and without interchanging parts, adapts itself, within limits imposed by the design of the machine, to the sewing of button holes of any desired type and size, that is to say, button holes of any desired length, with or without eyes and with or without fly bars, the eyes, when formed, being of independently variable length and width, the bars, when formed, being likewise of independently variable length and width, the variability of the dimensions of the eyes being furthermore independent of the variability of the dimensions of the bars and vice versa, and both being independent of the variability of the length of the bottom hole.

It is another object of the present invention to provide a machine that will automatically perform all operations necessary to sew any selected type of button hole of a desired size, for which the machine has been adjusted, without further attention on the part of an operator after the machine is once started.

It is another object of the present invention to embody in the machine a mechanism which, by a simple adjustment and without interchanging parts, causes all stitches, diverging and parallel, of a buttonhole to be substantially uniformly spaced regardless of the length or width of the eye of the buttonhole.

Further objects and advantages of the present invention will be apparent from the following description of an illustrative and preferred embodiment thereof shown in the accompanying drawings, this, however, having been chosen for purposes of exemplification only, as it will be obvious to those skilled in the art that said invention, as defined by the claims hereunto appended, may be otherwise embodied without departure from its spirit and scope.

In said drawings:

Fig. 1 is a plan view of a machine embodying the present invention.

Fig. 2 is a side elevation partly in section, of the machine.

Fig. 3 is a bottom view of the machine.

Figs. 4 to 9, inclusive, illustrate examples of various types of button holes which the machine is capable of sewing.

Fig. 10 is a diagrammatic illustration of certain cooperating elements of the machine, showing more particularly the extent to which these elements can be adjusted for sewing button holes of various types and sizes.

Fig. 10*a* illustrates diagrammatically the extent to which certain dimensions of a button hole may be varied upon adjustment of the cooperating elements in Fig. 10.

Fig. 11 is an enlarged fragmentary view of part of the machine as illustrated in Fig. 1, and showing more particularly the disposition of a guide block which is part of a lateral feed mechanism for the sewing instrumentalities of the machine.

Fig. 12 is a fragmentary side elevation of that part of the machine which is illustrated in Fig. 11.

Figs. 13 and 14 are sections taken on the lines 13—13 and 14—14, respectively, of Fig. 12.

Figs. 15 and 16 are enlarged, fragmentary views of certain elements of the lateral feed mechanism in different positions of cooperation.

Fig. 17 is an exploded perspective view of the guide block shown in Fig. 12.

Fig. 18 is an enlarged fragmentary section, taken substantially on the line 18—18 of Fig. 2.

Fig. 18*a* is a fragmentary section, showing certain cooperating elements of the lateral feed mechanism in Fig. 18 in a different cooperative relation to each other.

Fig. 19 is an elevation, partly in section, of a part of the lateral feed mechanism as viewed in the direction of arrow 19 in Fig. 18.

Fig. 20 is a plan view of certain cooperating elements of the lateral feed mechanism as viewed in the direction of arrow 20 in Fig. 19.

Fig. 21 is a fragmentary side elevation of the cooperating elements shown in Fig. 20.

Fig. 22 is a section taken on the line 22—22 of Fig. 19.

Fig. 23 illustrates certain cooperating elements of the lateral feed mechanism as viewed in the direction of arrow 23 in Fig. 18.

Fig. 24 is a bottom view of certain cooperating structure of the machine, and is viewed in the direction of arrow 24 in Fig. 2.

Fig. 25 is a view similar to Fig. 24 showing the same structure in a different cooperative relation, however.

Fig. 26 is an enlarged, fragmentary section, taken substantially on the line 26—26 of Fig. 24.

Referring to the drawings, and more particu-

larly to Figs. 4 to 9 inclusive, there are shown, by way of example, a few of the different types and sizes of button holes which a machine embodying the present invention, is capable of sewing. Each button hole includes the usual slit *s* which, in some instances, terminates in an enlarged opening that constitutes an eye *e*, the hole being finished and surrounded by the usual button hole stitches.

As shown in Fig. 4, the button hole stitching includes two parallel lines of stitching *a*, *a'* along the straight edges of the slit *s*, said lines of stitching being connected at one end by offset stitches *c*, *c'* with two superimposed lines of stitching *b*, *b'* the latter constituting a fly bar, the median line of which is in alinement with the slit *s*. The stitches *a*, *a'* are also connected at the opposite end by offset stitches *d*, *d'* with radially disposed stitches *f* which, together with the stitches *d*, *d'*, surround the circular eye *e*.

Fig. 5 illustrates a button hole, the slit *s* of which is longer and the eye opening *e* of which is larger than in Fig. 4. Consequently, the lines of stitching *a*, *a'* are accordingly longer, and the stitches *d*, *d'* are offset to a greater extent, and extend longitudinally of the slit *s* for a greater distance, than the corresponding stitches in Fig. 4. The stitches *b*, *b'* and *c*, *c'* are omitted from this button hole. The result is a relatively long button hole with a relatively large circular eye, but no bar.

In the button hole shown in Fig. 6, the opening *e* and the offset stitches *d*, *d'* are omitted, and the stitches *a*, *a'* are directly connected by the radially disposed stitches *f*, thus constituting a button hole which is eyeless. The stitches *c*, *c* are less offset than the corresponding stitches in Fig. 4, with the result that the stitches *b*, *b'* are not completely superimposed but are merely overlapped to form a broader fly bar which is also somewhat shorter than that shown in Fig. 4.

In the buttonhole shown in Fig. 7, the stitches *b*, *b'* and *c*, *c'* as well as the stitches *d*, *d'* are omitted, resulting in a button hole having neither an eye nor a fly bar.

The button hole shown in Fig. 8 has a fly bar and an eye, the latter being oblong in shape and relatively narrow.

The button hole shown in Fig. 9 has no fly bar but an eye which is oblong in shape and relatively broad.

The invention is herein shown as embodied in a machine of the general type disclosed in the Kiewicz patents, No. 1,696,893, issued December 25, 1928, and No. 1,726,153, issued August 27, 1929, and in certain other prior patents referred to therein.

Referring to Figs. 1 and 2, such a machine comprises a stationary bed **40** which is provided with suitable work clamps **41**, and a stitching head **42** which carries the stitch forming device and is movably supported on the bed to position the stitches in work, held by the work clamps, for the formation of a stitched button hole. The stitch forming device comprises a laterally jogging needle **43** and cooperating loopers (not shown), as well as actuating mechanism therefor including a stitching control mechanism, generally indicated at **44** in Fig. 2, for controlling the start and finish of the stitching operation. The stitching head **42** is moved longitudinally over the bed **40** by a main cam **45** which is carried by said head and rotated by a power driver indicated at **46** (Fig. 2), said cam having in one face a cam groove **47** in which rides an anti-friction roller **48**, carried by a stud **49** which is secured to the bed **40**.

During one complete operation of a machine of this type, the stitching head **42** reciprocates once longitudinally of the button hole through a distance A (Fig. 10*a*) which is invariable and determined by the shape of the cam groove **47** in the main cam **45**. More particularly, the stitching head moves first rearwardly in the direction of arrow X (Fig. **4**) from a fixed starting point S (Fig. 10*a*) to a fixed point of reversal R and returns in the direction of arrow Y (Fig. 4) to the starting point S where the machine is stopped by a main stop mechanism (not shown). The location of the stitching at the extreme end of the eye *e* of a button hole is fixed and determined by the point of reversal of the reciprocatory movement of the stitching head, while the location of the end of the stitching at the bar end *b*, and consequently the over-all length of the entire stitching, is determined by coincident points in the rearward and return movements of the stitching head at which the operation of the stitch forming device is started and stopped, respectively. To this end, the stitching control mechanism **44** is controlled by a cam bar **50** (Figs. 1 and 2) which is longitudinally adjustably attached, as hereinafter described, to a calibrated index plate **51** on the bed **40**, whereby the position of said cam bar longitudinally of the bed may be varied so as to change the period of cooperation of said cam bar with the stitching control mechanism **44**. The needle **43** and cooperating loopers are carried by turrets **53** and **54**, respectively, which are carried by the head **42** and rotated through a semi-revolution in one direction at the eye end of the button hole to position the outwardly diverging stitches *f* (Figs. 4 to 9) as well as to condition the stitch forming device for placing the stitches *a'*, *c'* and *d'* at the other side of the button hole slit *s*, and through an idle semi-revolution in the opposite direction during the latter part of the return movement of the stitching head to starting position and immediately before the machine stops.

Except as hereinafter pointed out, or as they enter into combination with parts hereinafter described, the parts so far referred to constitute no portion of the present invention and may be of any usual construction and arrangement. Being fully described in the mentioned prior patents, they require no further description here.

Machines of this type, as disclosed in the above mentioned Kiewicz patents, are also provided with a lateral feed mechanism whereby the longitudinal reciprocation of the stitching head may be compounded with lateral movements to obtain a resulting movement of the needle and cooperating loopers of the stitch forming device around a buttonhole which may include an eye of a fly bar or both, according to requirements, as will be more fully explained herein. More particularly, the lateral motions of the stitching head are slight rocking motions about the axis of a stud **55** (Fig. 2) which is carried by an arm **56**, fast on a stud **57** which is suitably secured to a cam casing **61**, for instance by the disclosed set screw **58**. The stud **55** is journalled in a slide **59** which is guided for movement longitudinally of the bed in guideways **60**, provided by said bed. The cam casing **61** forms a part of the stitching head **42**, wherefore both are movable in unison. The stud **55** is, therefore, a pivot for the stitching head **42** which is floating longitudinally of the bed to permit the reciprocation of said head relative to the

bed. The floatability of the pivot **55** secures the added advantage of giving way to any longitudinal motions of the head which are not solely caused by the rotation of the main cam **45**, but by a slight rocking motion of said rotating cam relative to the stationary follower **48** during the rocking of the head by the lateral feed mechanism. Experience has taught, however, that such superimposed longitudinal motions of the head **42** must be indefinitely small as they are not noticeable and do not change the course of the needle and cooperating loopers of the stitch forming device as determined by the rotation of the cam **45** and the action of the lateral feed mechanism. The rocking motions imparted to the reciprocating head **42** by the lateral feed mechanism serve to position the offset stitches *c*, *c'* (Figs. 4, 6 and 8) in the formation of a fly bar, and to position the offset stitches *d*, *d'* (Figs. 4, 5, 8 and 9) and, in combination with the rotation of the turrets **53** and **54**, also the outwardly diverging stitches *f* in the formation of an eye. The present invention relates to a novel and improved lateral feed mechanism of this general character. As herein shown, this mechanism is as follows:

Referring now more particularly to Figs. 2, 3 and 24 to 26 inclusive, the main cam **45** has in its lower face a cam groove **62** with which cooperates an anti-friction roller **63** (Fig. 26) on a stud **64** which is carried by a lever **65**, pivotally mounted at **66** to the outside of the cam casing **61**. This cam casing is provided with an oblong slot **67** through which the stud **64** projects into the inside of said casing so that the roller **63** may cooperate with the cam groove **62**. An extension **68** of the lever **65** is provided with an elongated slot **69** within which a stud **70** is adjustably mounted by means of a nut **71**, drawing a collar **72** of said stud into firm engagement with said extension **68**. The stud **70** carries an anti-friction roller **73** which is received in an elongated slot **74** of an arm **75** of the driving element **76** of a novel one-tooth gearing which is similar in its operation to a Geneva gearing. This driving element **76** is pivotally mounted at **77** on the outside of the casing **61**, and is provided with a single tooth **78**, adapted to cooperate or mesh with the illustrated cavity **79** of the driven element **80** of said gearing. Both gear elements **76** and **80** are also provided with locking surfaces **76***a*, **76***b* and **80***a*, **80***b*, respectively, two cooperating surfaces of which are, in typical Geneva-gear fashion, in interlocking engagement with each other when the tooth **78** is not cooperating with the cavity **79**. Fig. 25 shows the cooperating surfaces **76***b*, and **80***b* of the elements **76** and **80**, respectively, in interlocking engagement with each other. The cavity **79** of the driven element may be considered the cavity between two successive teeth of a gear, the opposite flanks of which are indicated at **79***a* and **79***b* (Fig. 25). The driven element **80** is pivotally mounted at **81** to a bracket **82** which is in turn mounted in any suitable manner on an extension **83** of the gear casing **61** (see also Fig. 18). Slidable longitudinally in guideways **84**, provided by the bracket **82**, is a rock **85** which is connected with the driven element **80** by a link **86**. It can now be understood that rotation of the main cam **45** causes reciprocation of the rack **85** through intermediation of lever **65**, stud **70**, the one-tooth Geneva gearing **76**, **80** and link **86**. Moreover, the coordination between the cam groove **62**, the lever **65** and the driving element **76** is such that, with the stud **70** adjusted in the one extreme position shown in Fig. 24, the tooth **78** of the driving element **76** is in mesh with the recess **79** of the driven element **80** throughout its full rocking motion, i. e., from the position shown in Fig. 24 into a position in which the other locking surfaces **76***a* and **80***a* are engaged and the tooth **78** engages the other flank **79***a* of the recess **79**, and vice versa. It can now be understood that any greater rocking motion of the driving element **76**, as caused by any adjustment of the stud **70** other than that shown in Fig. 24, does not impart a greater rocking motion to the driven element **80** but merely results in a greater or lesser amount of angular lost motion of the driving element **76** relative to the driven element **80** which is rocked through an invariable angular distance. For reasons which will be explained later, the pivot supports **66**, **77** and **81** of the lever **65** and the gear elements **76** and **80**, respectively, are preferably in linear alinement with each other as shown by the dot and dash line **87** in Fig. 3. The maximum rocking motion of the driving element **76** is obtained when the stud **70** is adjusted in the position shown in Fig. 3. Obviously, in any adjusted position of the stud **70** other than that shown in Fig. 24, the driving element **76** has an angular lost motion relative to the driven element **80**. Since the time period for the rocking motion of said driving element through any angular distance is constant and determined by the shape of the groove **62**, it follows that the driving element **80** has different angular speeds at different adjustments of the stud **70**. Consequently, the rocking of the driven element **80** through its invariable angular distance takes place at greater or lesser speed, i. e., during a longer or shorter time period, depending on the adjustment of stud **70**.

Referring now more particularly to Figs. 18 to 23 inclusive, the rack **85** is in constant mesh with gear teeth **90** of a vertical shaft **91** which is journalled and axially slidable in a bearing **92**, provided by the earlier mentioned bracket **82**. Shaft **91** is provided at the top with a round head **93**, having a diametrically extending guide groove **94** for the base **95** of a stud **96**. A recessed plate **97** is secured to the head **93** and serves to retain the base **95** of the stud **96** in the guide groove **94**. The head **93** with its retainer plate **97** is rotatably housed in a casing **98** which has a cover **99** suitably secured thereto. Carried by the stud base **95** is a pin **100** which projects into an eccentric groove **101** in the recessed bottom **102** of the casing **98** (see particularly Fig. 20). It can now be readily understood that the stud **96** can be shifted longitudinally of the guide groove **94** upon rotation of the casing **98** and cover plate **99** relative to the head **93** and retainer plate **97** due to the cooperation of the pin **100** with the eccentric slot **101**. The eccentricity of the slot **101** is such that the stud **96** may be shifted from axial alinement with the shaft **91** into the most remote position therefrom which is illustrated in Figs. 19 and 20. The stud base **95** may be locked in adjusted position in the guide groove **94** in any suitable manner. In the present instance, a clamping screw **103** extends through a punched-out tongue **99***a* of the cover **99** and is threaded into the casing **98**. The annular rim of the casing **98** is slightly undercut adjacent the tongue **99***a* (Fig. 19). When tightening the screw **103** after proper adjustment of the stud **96**, the stem **103***a* of said screw forces the tongue **99***a* of the cover **99** into firm gripping engagement with the head **93**, thereby also forcing the retainer plate **97** into

firm engagement with the casing 98, thus locking the stud 96 in any adjusted position to the shaft 91. As earlier explained, the angular distance through which the geneva driven element 80 rocks remains constant irrespective of the variable range of angular travel of the driving element 76. More particularly, the rocking motion of the driven element is of such amplitude that the rack 85 is moved over a distance in which it will rotate the shaft 91 through one complete revolution. Consequently, if the stud 96 is disposed coaxially of the shaft 91, the former will be rotated through one complete revolution about its own axis. However, if the stud 96 is so adjusted that its axis is out of alinement with the axis of the shaft 91, as for instance in Fig. 19, the stud will rotate bodily around the axis of the shaft 91. Shaft 91 is provided at its lower end with a thread 104 which cooperates with the internal thread of an element 105, having a plurality of concentric slots 106 through which extend holding screws 108, threaded into the bracket 82. The element 105 serves as a non-rotatable nut for the threaded end 104 of the shaft 91, so that said shaft is given an axial motion upon rotation of the same by the rack 85, as can be readily understood. The concentric slots 106 of the nut element 105 permit a fine adjustment of the longitudinal disposition of the shaft 91 and stud 96 by merely loosening the screws 108 and turning said nut 105 relative to the shaft 91. The shaft 91 and the elements carried thereby as well as the described drive for said shaft form one part of the lateral feed mechanism, said part being exclusively carried by the stitching head 42. The purpose for imparting to the shaft 91 a rotary motion as well as a simultaneous axial motion will be fully explained in the following description of a guide block 109 which forms another part of the lateral feed mechanism, said part being carried by the bed 40, however.

Referring now more particularly to Figs. 11 to 18, inclusive, the guide block 109 comprises in the present instance an assembly of plate members 110, 110*a*, 111, 111*a*, 111*b*, 112, 112*a*, 112*b*, 112*c* and 113 (Fig. 17). The plates 110 to 112, inclusive, are properly correlated and secured to the mounting plate 113 by suitable dowel pins and screws shown in Fig. 17. More particularly the plate members 110 and 110*a* underlie the plate members 111, 111*a* and 111*b*, and the latter underlie the plate members 112, 112*a*, 112*b* and 112*c*. The plate members 112*a*, 112*b* and 112*c* also underlie plate member 112 which in turn underlies the mounting plate 113. The plate members 110, 110*a*, 111, 111*a*, 111*b*, 112*a*, 112*b* and 112*c* are so disposed as to form linear groove 114, the bottom of which is the surface 115 of plate member 112. The mounting plate 113 is guided for movement parallel to the guideways 60 of the bed 40 (see Fig. 2) in guideways 116, provided by said bed at the bottom side thereof (Fig. 18). The guide block assembly 109 is retained in adjusted position in the guideways 116 by a hand screw 117 which extends through an elongated slot 118 of the bed and through a hole 120 of the earlier mentioned index plate 51, thus connecting said index plate with the guide block 109 for combined movement. The index plate 51 is guided for movement parallel to the guideways 116 by a machined shoulder 121 and surface 122, and is provided with an elongated slot 124, receiving a screw 123 which is threaded into the earlier mentioned cam bar 50, thereby securing the latter to the index plate in suitably adjusted position relative thereto.

The plate member 111 is provided with a groove 126, machined in its bottom surface and disposed at an inclination to the linear groove 114, while the plate members 111*a* and 111*b* are so spaced apart as to form a groove 127 which is also disposed at an inclination to said linear groove 114 (see Figs. 14 and 17). The plate members 112*b* and 112*c* are also spaced apart to form a groove 128 which is disposed transversely to the groove 127 and inclined to the linear groove 114, while plate member 112*a* cooperates with a raised portion 112' to form a groove 125 which is disposed transversely to the groove 126 of plate member 111 and at an opposite inclination to the linear groove 114. Slidable in the grooves 125 to 128, inclusive, are elements 132 to 135, respectively, the elements 132 and 135 being cam elements proper and the elements 133 and 134 cooperating with the cam elements 135 and 132, respectively, to define laterally adjustable upper and lower cam grooves 114' and 114'' (Figs. 18 and 18*a*) which merge gradually into the linear groove 114 as will be more fully described later. The assembly of individual plate members to form the guide block 109 obviously facilitates the construction of the latter inasmuch as the guide grooves 125 to 128, inclusive, and a guide groove 148 to be described later, are formed by simply machining into surfaces of certain plate members or by spacing other plate members, while the contiguous plate members act to retain the elements 132 to 135, inclusive, in their respective guide grooves. Journalled in the plate members 110, 110*a* and 113 are two identical pinions 138 and 139, disposed in recesses 140 and 141, respectively, of the guide block 109 and projecting beyond the sides 142 and 143 of said guide block a distance which is substantially equal to the depth of a tooth. The pinions 138 and 139 (Fig. 14) are in constant mesh with rack teeth 144, 145, 146 and 147, formed on the edges of the elements 132 to 135, respectively. More particularly, pinion 138 is in permanent mesh with the rack teeth 144 and 145 of the elements 132 and 133, respectively, while pinion 139 is in permanent mesh with the rack teeth 146 and 147 of the elements 134 and 135, respectively. The plate member 112 is provided in its top surface with another groove 148 (Figs. 13 and 17) in which is guided a slide 150, having rack teeth 151 and 152 in its opposite edges. The rack teeth 151 are in constant mesh with the pinion 138, while the rack teeth 152 are in constant mesh with the pinion 139. Slidable on the machined side face 142 of the guide block 109 is another rack 153 which is in constant mesh with the pinion 138. This rack 153 is provided with a rectangular groove 154 (Figs. 12 and 13), receiving the eccentric 155 of a rotary handle 156 which is journalled on the shank 157 of a screw 158, secured to the guide block 109. The rack 153 is guided for movement at right angles to the axis of the pinion 138 by means of screws 160 which extend through elongated slots 159 in said rack and are secured to the guide block 109. It can now be understood that, upon loosening the screws 160, the handle 156 may be rotated, whereby its eccentric 155 forces the rack 153 in either direction, depending on the direction of rotation of the handle 156. Such movement of the rack 153 causes rotation of the pinion 138 and, through intermediation of rack 150, simultaneous rotation of the pinion 139, however, in a direction opposite to that of the pinion 138. The rotary movements

of the pinions 138 and 139 are imparted to the respective elements 132 to 135, inclusive. Simultaneous rotation through equi-angular distances but in opposite directions, of the pinions 138, 139 results in simultaneous movements of equal amplitude of the cam elements 132 and 135 either toward the center of the linear groove 114 or away therefrom, and of the cooperating elements 133 and 134 in the same directions as their respective cam elements 135 and 132. All elements 132 to 135, inclusive, have been so initially positioned in their respective guide grooves in the guide block that the median line 161 of the groove 114 (Fig. 14) extends centrally between the front faces 132*a*, 134*a*, and 133*a*, 135*a* of the elements 132, 134, 133 and 135, respectively, and the horizontal distances between the front faces of both pairs of cooperating elements 132, 134 and 133, 135 as viewed in Fig. 17, are equal. It can now be understood that the horizontal distance between the front faces of each pair of cooperating elements 132, 134 or 133, 135 remains the same, irrespective of the adjusted position of said elements. This distance is substantially equal to the spacing of two parallel flats 162 and 163, machined on opposite sides of the top portion of the stud 96 at equal distances from the axis thereof. The width of the straight groove 114 is equal to the diameter of the cylindrical portion of the stud 96, which cylindrical portion projects into said groove at the most to the level of the top surfaces of the lowermost plates 110 and 110*a*, as viewed in Fig. 17, while the flattened top of said stud projects deeper into the groove 114 in order to be acted upon by the laterally adjustable cam grooves 114' and 114''. In order to guide the flattened top of the stud 96 from the linear groove 114 laterally into engagement with the front face of either cam element 132 or 135 and then return the same to said linear groove, all during reciprocation of the stitching head, cooperating surfaces, bevelled with respect to the linear groove 114, are provided by the stud 96, the guide block 109 and the cam elements 132 and 135, the bevelled surfaces of said guide block and said cam elements forming connecting guide grooves between the linear groove 114 and the laterally adjustable grooves 114' and 114'', respectively. Considering first the lateral displacement of the stud 96 from the linear groove 114 during the initial or rearward movement of the stitching head 42, it is the cam element 132 which is then in operative alinement with the stud 96 and causes the lateral displacement of said stud, and, consequently, of the stitching head for the sewing of the stitches *b* in the formation of a fly bar (Figs. 4, 6 and 8). During the initial or rearward movement of the stitching head, the stud 96 is in the elevation shown in Fig. 18. The stud 96 is provided with a notch 164 to provide clearance for the then inoperative cam element 135. At the start of the rearward movement of the stitching head 42, the stud 96 is located in the front part 114a of the linear groove 114, i. e., to the left of the laterally adjustable guide grooves 114' and 114'' as viewed in Fig. 14. While the stitching head 42 moves rearwardly, a bevelled surface 165 of the stud 96 cooperates with a bevelled surface 167 of the cam element 132 and gradually forces the stud from the dot-and-dash position 96*a* in Fig. 15 into a position in which the flat 163 of the stud rides on the front face 132*a* of said cam element 132 (see full line position of stud 96 in Fig. 15). The front face 134*a* of the cooperating element 134 engages the adjacent flat 162 of the stud 96, thus forming, together with the front face 132*a* of cam element 132, the laterally adjustable guide groove 114'. Sometime during the latter movement of the stud 96, the stitch forming device is automatically started, depending on the adjustment of the cam bar 50 relative to the stitching control mechanism 44, and the stitching *b* of a fly bar (Figs. 4, 6 and 8) is positioned at one end of a button hole to be sewed. The stitching of *b* continues until the surfaces 132*a* and 163 of the element 132 and the stud 96, respectively, reach the end of their engagement, when another bevelled surface 166 of the stud is forced to ride down the side 168 of the cam element 132 by the cooperating, bevelled surfaces 169 and 170 of the stud 96 and the groove 114, respectively, thus returning the stud into the linear groove 114 as illustrated at 96*b* in Fig. 15. The stitching head, compelled to follow the stud, positions during this lateral return movement the offset stitches *c* which connect the fly bar stitching *b* with the line *a* of stitching along one side of the button hole. Continued rearward movement of the stitching head results in the stitching of *a* (Fig. 4) along the first side of the button hole, as the stud 96 then travels in the rear portion 114*b* of the linear groove 114. In order that the cylindrical part of the stud 96 in the groove 114, being of a width equal to the diameter of said stud, has ample clearance in said groove when laterally displaced by either offset guide groove 114' or 114'', the sidewalls of the linear groove 114 are either interrupted or undercut for a substantial length at both sides of the cooperating elements 132 to 135, inclusive (see also Fig. 17). For a better understanding of the cooperation of the stud 96 with the elements 133, 135 during the return movement of the stitching head, it may be stated in advance that the stud-carrying shaft 91 is rotated through one complete revolution at the point of reversal R of the reciprocating head (Fig. 10*a*). The pitch of the thread 104 on the lower end of the shaft 91 is substantially equal to the thickness of the cam element 132 (Fig. 18), and the direction of rotation of the shaft 91 at the point of reversal R is such that the shaft and stud, due to the cooperation between the shaft thread 104 and the nut 105, are lowered into the position of the stud shown in Fig. 18*a* in which the latter is in operative alinement with the cooperating elements 133 and 135 and clears the other cam element 132. During the return movement of the stitching head, and toward the end of the stitching *a'* along the other side of the button hole, the bevelled surfaces 171 and 172 of the stud 96 and cam element 135, respectively, cooperate and gradually move the flat 162 of said stud into engagement with the front face 135*a* of the cam element 135 (Fig. 16). A bevelled surface 170*a* (Fig. 17) of the linear groove 114 cooperates with the bevelled surface 165 of the stud while the latter travels along the bevelled surface 172 of the cam element 135. This gradual lateral movement of the stud, and consequently of the stitching head, results in the positioning of the offset stitches *c'* (Figs. 4, 6 and 8) which connect the finished line of stitching *a'* with the stitches *b'* to be sewed. The front face 133*a* of element 133 cooperates with the front face 135*a* of element 135 to form the laterally adjustable guide groove 114''. While the stud 96 rides in the laterally offset guide groove 114'' the fly bar stitches *b'* are positioned until the stitching control mechanism stops the operation of the stitch forming device at the end of the fly bar, i. e., while the

stud 96 still rides in said guide groove 114''. During continued return movement of the stitching head to its starting point S, the stud continues to move to the left as viewed in Fig. 16, and is returned into the forward portion 114*a* of the linear groove 114 upon cooperation of the cylindrical part of the stud with a bevelled shoulder 173, the latter being part of one of the earlier mentioned undercuts in the sidewalls of said linear groove 114. Groove 114 is also provided with a narrow portion 174, formed by opposite wall portions 175 which are equally spaced from the median line 161 of said groove 114 and apart from each other a distance substantially equal to the distance between the opposite flats 162 and 163 of the stud 96. The earlier mentioned bevelled surfaces 170 and 170*a* of the groove 114 merge into this narrow groove portion, and said bevelled surfaces 170, 170*a* as well as the narrow groove portion 174 extend in the linear groove 114 down to the level of the top faces of the plates 110, 110*a* only as viewed in Fig. 12, in order to be out of the path of movement of the cylindrical portion of the stud 96. The narrow groove portion 174 assumes guiding control over the stud 96 longitudinally of the groove 114 when the bevelled surfaces 170 and 170*a* of the groove 114 have relinquished their guiding control over the stud during movement of the latter in the rearward portion 114*b* of groove 114 for a short distance toward and away from the cooperating elements 132 to 135, inclusive. The narrow groove portion 174 thus bridges a small gap in the linear groove in which neither the cooperating elements 132 to 135, inclusive, nor said linear groove assumes guiding control over the stud 96. This lack of guidance of the stud 96 over a short distance by the linear groove 114 is due to the fact that the earlier mentioned undercuts extend over a substantial length in order to provide clearance for the cylindrical portion of the stud 96 in any laterally displaced position as determined by the adjustment of the cooperating elements 132 to 135, inclusive. These undercuts extend in fact into the guiding region of the narrow groove portion 174, i. e. without the guiding region of the cooperating elements 132 to 135, inclusive, and of the linear groove 114 immediately adjoining said cooperating elements. Figs. 13 to 16, inclusive, show the cooperating elements 132 to 135, inclusive, adjusted for maximum lateral displacement of the stud 96. In the other extreme adjustment of these elements, their guide grooves 114' and 114'' form in fact continuations of the narrow groove portion 174, thus avoiding any lateral motion of the stud 96, as the groove 114 is then in fact linear throughout its length. In that case, no fly bar will be formed as can be readily understood. Since the bevelled surfaces 168 and 172 of the cam elements 132 and 135, respectively, are side faces thereof, it stands to reason that any adjustment of these cam elements, i. e., movement of the same in directions parallel to their side faces, does not vary the distance between said faces and their respective cooperating bevels 170 and 170*a* of the groove 114. It can now be understood that the stud 96 is positively guided throughout the sewing of a button hole of any desired fly-bar width, i. e., from some point in the laterally adjustable guide groove 114' into and through part of the rear portion 114*a* of groove 114 in one direction to the point of reversal R and again through said rear portion 114*b* of groove 114 in the opposite direction to some point in the other laterally adjustable guide groove 114''. While there is a short distance between the earlier mentioned undercut shoulder 173 (Fig. 16) in the front portion 114*a* of groove 114 and the cooperating elements 132 to 135, inclusive, through which the stud is only loosely guided, this has no effect whatever on the proper operation of the machine, as no operation is performed by the machine which depends on accurate guidance of the stud 96 through this distance.

As mentioned before, the stud carrying shaft 91 is rotated through one complete revolution adjacent the fixed point of reversal R (Fig. 10*a*) of the stitching head by earlier described mechanism, comprising main cam 45, lever 65, the one-tooth gearing 76 and 80, link 86 and rack 85. More particularly, and for reasons which will appear later, the rotation of the shaft 91 preferably takes place at substantially uniform angular speed, and said shaft completes one-half of its revolution at the time the stitching head reverses its direction of movement. The concurrence of the completion of one-half revolution of shaft 91 and the reversal of the direction of movement of the stitching head 42 is imperative for reasons which will appear later, and is accomplished by proper coordination of the cam grooves 47, 62 of the main cam 45 and of the cooperating elements 65, 76 and 80 which transmit the motion by the cam groove 62 to the shaft-driving rack 85. More particularly, the coordination of the last mentioned structure is such that the follower 63 of lever 65 is exactly halfway of its throw by the active portion 62*a* of the cam groove 62 (Fig. 3) and the tooth 78 of the driving element 76 has moved the driven element 80 through one half of its fixed range of movement, when the stationary follower 48 on the bed 40 cooperates with the outermost portion 47*a* of the cam groove 47 (Fig. 1), at which time the stitching head reverses its direction of travel from rearward to return movement. In view of the adjustability of stud 70 on the lever 65, it is further imperative that the longitudinal axes of the elongated slots 69, 74 of the elements 65 and 76, respectively, coincide (Fig. 3) when the follower 63 of element 65 is exactly halfway of its throw by the active portion 62*a* of the cam groove 62. With the above structure coordinated as described, the shaft 91 starts and ceases to rotate at points coincident in the rearward and return travel of the stitching head, and said shaft has concluded one-half of its revolution when the stitching head reverses its direction of travel at the eye end of the button hole. If the stud 96 is adjusted in coaxial alinement with the shaft 91, the former will merely rotate about its own axis and have no bodily movement, with the result that no lateral displacement of the stitching head takes place at the eye end, and no eye is formed. However, if the stud 96 is adjusted in any other position relative to the shaft 91, the stud will have an eccentric motion and, by cooperation with the relatively stationary rear portion 114*b* of groove 114, impart a rocking motion to the longitudinally travelling stitching head. The longitudinal and lateral component motions of the stitching head result in a motion of the needle 43 and cooperating loopers of the stitch forming device which is circumscriptive of an eye. Inasmuch as the beginning and end of the revolution of shaft 91 takes place at points coincident in the rearward and return travel of the stitching head, and since said shaft 91 has concluded one-half revolution when the stitch-

ing head reverses its direction of travel, an eye is formed which is symmetrical to the longitudinal axis of the button hole. Obviously, the guide groove 94 of the shaft 91 must be initially positioned so as to extend parallel to the linear groove 114 when said shaft is in its normal position of rest, as otherwise any adjustment of the stud 96 relative to the shaft 91 would result in an eye which is distorted and not symmetrical to the longitudinal axis of the button hole.

By adjusting the stud 96 relative to the shaft 91 to vary the eccentricity of the former, the amount of lateral motion of the stitching head and, hence, the width of an eye, is varied. By varying the time period of the rocking motion of the driven element 80 of the single tooth Geneva gearing by adjusting the stud 70 on lever 65, the eccentric stud 96 in the rear portion 114*b* of the linear groove 114 completes its rotary motion during a longer or shorter period of the longitudinal travel of the stitching head, thereby varying the length of the eye. By undertaking both adjustments, the width as well as the length of the eye are varied. Thus, eyes of practically all of the commercially required shapes and sizes may be obtained by suitable combinations of both adjustments (see examples in Figs. 4 to 9).

Referring now more particularly to Figs. 2 and 3, the present machine has also provisions for turning the stitch forming device during the sewing around the eye end of a button hole in order to obtain the radiating or outwardly diverging stitches *f* (Figs. 4, 5, 8 and 9), as well as to condition the stitch forming device for the sewing of the stitches *d'*, *a'*, *c'* and *b'* during the return movement of the stitching head 42 from the fixed point R to the fixed point S (Fig. 10*a*). The main cam 45 has in its lower face another cam groove 180 in which rides an anti-friction roller 181 of a lever 182 which is pivotally mounted at 183 to the outside of the cam casing 61 and provided with an elongated slot 184. The roller 181 of lever 182 projects through an elongated slot 185 of the cam casing 61 into cooperative relation with the cam groove 180. Adjustably mounted in the elongated slot 184 of lever 182 is a stud 186, carrying an anti-friction roller (not shown) which rides in an elongated slot 187 (Fig. 24) of the driving element 188 of a single tooth Geneva gearing, the driven element 189 of which is mounted in any suitable manner on an upright shaft 190. The driving element 188 is pivotally mounted at 191 on the cam casing 61 and is provided with a tooth 192 and locking surfaces 188*a* and 188*b*, while the driven element 189 is provided with a tooth-cavity 193 and locking surfaces 189*a* and 189*b*. The operation of the present single-tooth Geneva gearing 188, 189 is the same as that of the earlier described Geneva gearing 76, 80 and, therefore, needs no further description. The shaft 190 is journalled in suitable bearings provided by the stitching head 42 and the cam casing 61, respectively, and is provided with gear segments 194 fast thereon or integral therewith. These gear segments 194 are in constant mesh with the teeth 195 of the turrets 53 and 54. The invariable angular motion, imparted to the driven element 189 by the driving element 188 irrespective of the adjustment of the connecting stud 186 between element 188 and lever 182, causes rotation of the turrets 53, 54 through one-half revolution, with the result that the stitches will radiate and be inverted 180 degrees relative to each other at the beginning and end of the half revolution of the turrets. Moreover, the coordination between the cam grooves 180 and 47 and between the elements 182, 188 and 189 is such that the turrets will start and end their semi-revolution at points coincident in the rearward and return travel of the stitching head 42, and complete one-half of their semi-revolution when the stitching head reverses its direction of movement. To accomplish this, the tooth 192 of the driving element 188 must have moved the driven element 189 through one-half of its fixed range of movement when the follower 181 of lever 182 is exactly half-way of its throw by the active portion 180*a* of the cam groove 180. In view of the adjustability of the connecting stud 186 on the lever 182, it is further imperative that the longitudinal axes of the slots 184, 187 of the lever 182 and the driving element 188, respectively, coincide (Fig. 3) when the follower 181 of lever 182 is exactly half-way of its throw by the active portion 180*a* of the cam groove 180. Being so correlated, the elements 182, 188 and 189 in any adjusted position of the stud 186 will cooperate to start and end the semi-revolution of the turrets at points coincident in the rearward and return travel of the stitching head and to conclude one-half of the semi-revolution of the turrets when the stitching head reverses its direction of movement. With the stud 186 adjusted in the one extreme position shown in Fig. 24, the rocking motion of the driving element 188 is just sufficient to complete the fixed angular movement of the driven element 189. With the stud 186 adjusted in any other position (Figs 3 and 25), the driving element 188 has a lost motion with respect to the driven element 189, thus decreasing the time period for moving the driven element 189 and, consequently, for turning the turrets through their semi-revolution. It can now be understood that, by proper adjustment of the stud 186, the semi-revolution of the turrets can be made to coincide with one-half of the complete revolution of the stud 96, and more particularly with the second and third quarter-revolution of said stud 96. The result is then that the stitches will radiate or diverge outwardly around the end portion of an eye to one side of the greatest width thereof (Figs. 4, 5, 8 and 9). Furthermore, the stitch forming device in the present machine produces a uniform number of stitches per time unit which is preferably such that the radiating stitches do not crowd each other at the eyeless end of a buttonhole, i. e., when the stud 96 is in axial alinement with the shaft 91 and the turrets are rotated at their greatest possible speed during the shortest possible longitudinal travel of the stitching head as determined by the design of the cam grooves 47 and 180 in the main cam 45 and the adjustment of the stud 186 on lever 182 in the one extreme end position shown in Fig. 3. Obviously, it is unnecessary to undertake any special adjustment of the stud 70 on lever 65 for an eyeless buttonhole, as it is immaterial how long it takes the stud 96 (Fig. 18) to revolve so long as the start and end of its revolution takes place somewhere in the rear portion 114*b* of the linear groove 114, i. e., out of the operative region of the narrow portion 174 of said groove 114.

The uniformly reciprocating needle 43 and cooperating loopers move around, or circumscribe, a buttonhole of any shape at a speed which is practically uniform, inasmuch as the transverse movement of the needle and cooperating loopers, superimposed upon their invariable longitudinal movement during the formation of an

eye of any shape and size, does not appreciably vary their motion around the eye from their motion along the parallel sides of the buttonhole. Hence, a stitch is formed at recurrent intervals of the substantially uniform movement of the needle **43** and cooperating loopers around a buttonhole of any shape. All stitches of a buttonhole of any shape are, consequently, substantially uniformly spaced and cannot crowd each other, except at the far end of an eye where the parallel stitches, though uniformly spaced at the edge of the eye, would nevertheless crowd each other were it not for the rotation of the turrets which causes angular displacement of the stitches at said far end of the eye so that they diverge around said eye end in radial fashion. In a buttonhole having no eye, the turrets are naturally rotated at their greatest speed in order to radiate the stitches around the end of the buttonhole during the shortest possible longitudinal movement of the needle **43** and cooperating loopers, while the speed of rotation of the turrets for sewing around an eye of a given size is varied with a view toward obtaining diverging stitches around said eye which approximate radial disposition thereon as nearly as possible.

After a completed operation of the machine, i. e., upon the completion of the stitches *b'* at the fly-bar end of the buttonhole, cooperation in the usual manner of the stitching control mechanism with the cam bar **50** causes the operation of the stitch forming device to be stopped. During the remaining idle return movement of the stitching head into home position, i. e., during movement of the stud **96** in the forward portion **114***a* of the linear groove **114**, the follower **63** rides in the other active portion **62***b* of the cam groove **62**, causing an idle revolution of the stud **96**, and the follower **181** rides in the other active portion **180***b* of the cam groove **180**, causing the turrets **53**, **54** to rotate idly through one-half revolution and position the stitch forming device for the sewing of the next button hole, whereupon the machine is stopped automatically by the main stop mechanism (not shown).

Figs. 10 and 10*a* illustrate, by way of example, the extent to which the guide block **109** and the cooperating stud **96** can be adjusted to obtain certain maximum and minimum dimensions of a buttonhole. The invariable amplitude of the longitudinal reciprocation of the stitching head and, consequently, of the stud **96** is represented by the distance A between the points S and R. By shifting the guide block into the position shown in Fig. 10 in which the cam elements **132** and **135** assume the illustrated full line position, a buttonhole of the maximum overall length B and of the maximum fly-bar length L (Fig. 10*a*) may be obtained. By shifting the guide block **109** to the right as viewed in Fig. 10 so that the cam elements **132**, **135** thereof assume the illustrated dot-and-dash positions **132'** and **135'**, a buttonhole of a shorter over-all length C is obtained. By aljusting the stud **96** in its most remote position **96'** from the shaft **91**, an eye of the maximum width W is obtained. By adjusting the stud in its other extreme position, i. e., in axial alinement with shaft **91**, no eye is formed. Also, by laterally adjusting the cam elements **132**, **135** and their cooperating elements **134** and **133**, respectively, either no fly bar or a fly bar of the maximum width W' may be obtained. The various adjustments of which the machine is capable will be more fully described in the following paragraphs.

In order to increase the over-all length of the buttonhole, the guide block **109** and cam bar **50** are shifted to the left as viewed in Figs. 2 and 11, whereby the point of reversal of the reciprocation of the stud **96** is moved farther away from the starting point of the stitching operation somewhere between the cam elements **132**, **135** in the guide block **109**. The pointer **200** of the index plate **51** being movable with said guide block, cooperates with a graduated scale **201** on the bed **40** and gives the operator an indication of the necessary amount of adjustment of said guide block for a bottonhole of a given over-all length, Adjustment of the cam bar **50** with respect to the index plate **51** will locate the starting point of the stitching operation at any desired point between the cam elements **132** and **135** of the adjusted guide block **109**. In order to form a shorter fly bar, as shown in Fig. 6, the cam bar **50** is shifted to the right as viewed in Figs. 2 and 11 relative to the index plate **51** and guide block **109**, thereby starting the operation of the stitch forming device somewhat later during the travel of the stud **96** in the laterally offset guide groove **114'** on initial or rearward movement of the stitching head.

In order to form a wider fly bar, as also shown in Fig. 6, the cooperating elements **132**, **134** and **133**, **135** are shifted in the earlier explained manner relative to the linear groove **114**. Consequently, there will be less offsetting of the stitches *b* and *b'* at the fly-bar end, and the stitches *b* and *b'* will be more or less spread out laterally and appear overlapping instead of completely superimposed as in Figs. 4 and 8. While the adjustability of the cooperating elements **132**, **135** and **133**, **134** may thus be employed to vary the width of the fly bar, its chief importance is in permitting the exact superposition of the fly bar stitches *b*, *b'*, as is usually desirable, irrespective of their width. In machines of this type it is customary to provide means for varying the amplitude of the lateral jogging motion of the needle and, consequently, the width of the button hole stitches, or depth of "bite", in order to adapt the machine to the sewing of button holes in different materials. When the depth of "bite" is changed, the amount of lateral offsetting of the fly bar stitches must be correspondingly changed if they are to be exactly superimposed. In other words, it is usually desirable that the width of the fly bar be equal to the width of the stitches of which it is composed, and in the present machine this relationship can be preserved, when the width of the stitches is changed by suitable adjustment of the cooperating elements **132**, **134** and **133**, **135** to change the width of the fly bar correspondingly.

To form a button hole without a fly bar, as shown in Figs. 5, 7 and 9, the cooperating elements **132**, **134** and **133**, **135** are so adjusted as to form one groove which is in alinement with the narrow portion **174** of the linear groove **114**. Consequently, there will be no lateral offsetting of the stitches when the stitching operation commences while the stud **96** travels somewhere between the opposite faces of said cooperating elements **132** to **135**, inclusive. The same result can also be accomplished by adjusting the cam bar **50** so far away from the guide block **109** that the stitching operation will not be started until the stud **96** moves in the rearward portion **114***b* of the linear groove **114**. Of course, the over-all

length of a bar-less buttonhole is necessarily smaller by the last mentioned kind of adjustment than by the first mentioned kind, and the choice of the kind of adjustment depends on the desired over-all length of the button hole, as can be readily understood.

To form a longer eye, as shown in Fig. 8, the stud 70 is shifted in the slot 69 of lever 65 to the right as viewed in Fig. 3, thereby causing the eccentric motion of the stud 96 to take place at lower speed and, consequently, during a longer period of the longitudinal motion of the stitching head. The result is that the offsetting of the stitches *d* and *d'* will start and end, respectively, at coincident points in the rearward and return movement of the stitching head 42 which are farther away from the point of reversal of said stitching head. Corresponding adjustment of the stud 186 in the slot 184 of lever 182 will cause the stitches *f* to diverge around an end portion of the longer eye to one side of the greatest width thereof in the manner shown in Fig. 8.

To form a wider eye, as shown in Fig. 9, the eccentricity of the stud 96 relative to the shaft 91 is varied in the earlier explained manner, thereby causing a greater lateral offsetting of the stitches *d*, *d'* and *f*.

To form an eye which is both longer and wider, as shown in Fig. 5, all of the adjustments referred to in the two preceding paragraphs are undertaken, as can be readily understood.

To form a buttonhole without an eye, as shown in Figs. 6 and 7, the stud 96 is adjusted coaxially of the shaft 91, wherefore no lateral offsetting of the stitches takes place while said stud is rotated through one revolution in the rearward portion 114*b* of the linear groove 114.

Adjustment of the stud 186 (Fig. 3) with each change of the length of an eye, so that the stitches diverge outwardly around an end portion of the eye to one side of the greatest width thereof, secures the further advantage that all the stitches of a buttonhole, diverging and parallel, are substantially equally spaced and the diverging stitches around an eye of any shape and size appear to be disposed in substantially radial fashion, for reasons which have been earlier explained.

The disclosed machine, embodying the present invention in a preferred form, is a self-contained structure of rugged and durable construction and does not require interchanging of any parts thereof in order to accomplish the manifold results explained in the preceding description. The commercial value of the present machine is further enhanced in that its adaptation to the sewing of a buttonhole of practically any desired shape and size requires only a minimum number of simple adjustments. Thus, mere rotation of the casing 98 (Fig. 19) results in a different width of an eye or no eye, while mere adjustment of the stud 70 on lever 65 (Fig. 3) results in a different length of an eye. Mere adjustment of the stud 186 on lever 182 causes the stitches to diverge around an end portion of an eye of any length to one side of the greatest width thereof. Mere rotation of the handle 156 (Figs. 2 and 13) results in a different width of a fly bar or no fly bar, while mere adjustment of the cam bar 50 relative to the index plate 51 results in a different length of a fly bar or no fly bar. Mere sliding of the cam block 109 (Figs. 11, 12 and 17) into another adjusted position on the bed 40 results in a different over-all length of a buttonhole. Any one of these adjustments can be accomplished quickly by an operator of ordinary skill.

I claim:

1. A buttonhole sewing machine comprising, in combination, a work-holding device; a stitch-forming device; and mechanism for causing relative movement between said devices around a buttonhole, said mechanism including adjustable means for rotating the stitch-forming device during relative movement around an end portion of the buttonhole between any two points thereof of predetermined coordination and within a certain range longitudinally of the longitudinal axis of the buttonhole.

2. A buttonhole sewing machine comprising, in combination, a work-holding device; a stitch-forming device; and mechanism for causing relative movement between said devices around a buttonhole having one end variable between eyeless and an eye of variable length, said mechanism including adjustable means for rotating the stitch-forming device during relative movement around said one end between any two points thereof of predetermined coordination and within a certain range longitudinally of the longitudinal axis of the buttonhole.

3. A buttonhole sewing machine comprising, in combination, a work-holding device; a stitch-forming device; and mechanism for causing relative movement between said devices around a buttonhole, said mechanism including adjustable means for rotating the stitch-forming device through an invariable angular distance during relative movement around an end portion of the buttonhole between any two points thereof of predetermined coordination and within a certain range longitudinally of the longitudinal axis of the buttonhole.

4. A buttonhole sewing machine comprising, in combination, a work-holding device; a stitch-forming device; and mechanism for causing relative movement between said devices around a buttonhole having one end variable between eyeless and an eye of variable length, said mechanism including adjustable means for rotating the stitch forming device through an invariable angular distance during relative movement around said one end between any two points thereof of predetermined coordination and within a certain range longitudinally of the longitudinal axis of the buttonhole.

5. A buttonhole sewing machine comprising, in combination, a work-holding device; a stitch-forming device; mechanism for causing relative movement between said devices around a buttonhole having an eye of variable shape; and adjustable mechanism for rotating the stitch forming device at said eye at such speed that the diverging and parallel stitches of the buttonhole are substantially equally spaced regardless of the shape of the eye.

6. A buttonhole sewing machine comprising, in combination, a work-holding device; a stitch-forming device; mechanism for causing relative movement between said devices around a buttonhole having an eye of variable size; and adjustable mechanism for rotating the stitch forming device at said eye at such speed that the diverging and parallel stitches of the buttonhole are substantially equally spaced regardless of the size of the eye.

7. A buttonhole sewing machine comprising, in combination, a work-holding device; a stitch-forming device; mechanism for causing relative movement between said devices around a but-

tonhole having an eye end of a width variable between zero and a certain maximum width; and adjustable mechanism for rotating the stitch forming device at said eye end at such speed that the diverging and parallel stitches of the buttonhole are substantially equally spaced regardless of the width of said eye end.

8. A buttonhole sewing machine comprising, in combination, a work-holding device; a stitch-forming device; mechanism for causing relative movement between said devices around a buttonhole having an eye end of a length variable between zero and a certain maximum length; and adjustable mechanism for rotating the stitch-forming device at said eye end at such speed that the diverging and parallel stitches of the buttonhole are substantially equally spaced regardless of the length of said eye end.

9. A buttonhole sewing machine comprising, in combination, a work-holding device; a stitch-forming device; mechanism for causing relative movement between said devices around a buttonhole having an eye end of a length and width variable between zero and a certain maximum length and width, respectively; and adjustable mechanism for rotating the stitch forming device at said eye end at such speed that the diverging and parallel stitches of the buttonhole are substantially equally spaced regardless of the length and width of said eye end.

10. A buttonhole sewing machine comprising, in combination, a work-holding device; a stitch-forming device; mechanism for causing relative movement between said devices around a buttonhole having an eye of variable length; and adjustable mechanism for rotating the stitch forming device at said eye at variable speed so that the number of diverging stitches varies substantially proportionally with the length of the eye.

11. A buttonhole sewing machine comprising, in combination, a work-holding device; a stitch-forming device; mechanism for causing relative movement between said devices around a buttonhole having an eye of variable width; and adjustable mechanism for rotating the stitch forming device at said eye at variable speed so that the number of diverging stitches varies substantially proportionally with the width of the eye.

12. A buttonhole sewing machine comprising, in combination, a work-holding device; a stitch-forming device; mechanism for causing relative movement between said devices around a buttonhole having an eye of variable length, the time period of the relative movement around the eye varying proportionally with the length thereof; and adjustable mechanism for rotating the stitch forming device at said eye during a time period varying proportionally with the length of the eye.

13. A buttonhole sewing machine comprising, in combination, a work-holding device; a stitch-forming device; mechanism for causing relative movement between said devices around a buttonhole having an eye of variable width, the time period of the relative movement around an eye of any width being invariable; and adjustable mechanism for rotating the stitch forming device at said eye during a time period varying substantially proportionally with the width of the eye.

14. A buttonhole sewing machine comprising, in combination, a work-holding device; a stitch-forming device; mechanism for causing relative movement between said devices around a buttonhole having an eye of variable length and width, the time period of the relative movement around the eye varying proportionally with its length only; and adjustable mechanism for rotating the stitch-forming device at said eye during a time period varying substantially proportionally with the length and width of the eye.

15. A buttonhole sewing machine comprising, in combination, a work-holding device; a stitch-forming device; mechanism for causing relative movement between said devices around a buttonhole having an eye of variable length, the time period of the relative movement around the eye varying proportionally with the length thereof; and adjustable mechanism for rotating the stitch forming device at said eye at a speed varying substantially inversely proportionally with the length of the eye.

16. A buttonhole sewing machine comprising, in combination, a work-holding device; a stitch-forming device; mechanism for causing relative movement between said devices around a buttonhole having an eye of variable width, the time period of the relative movement around an eye of any width being invariable; and adjustable mechanism for rotating the stitch forming device at said eye at a speed varying substantially inversely proportionally with the width of the eye.

17. A buttonhole sewing machine comprising, in combination, a work-holding device; a stitch-forming device; mechanism for causing relative movement between said devices around a buttonhole having an eye of variable length and width, the time period of the relative movement around an eye of any length and width varying substantially proportionally with its length only; and adjustable mechanism for rotating the stitch-forming device at said eye at a speed varying substantially inversely proportionally with the length and width of the eye.

18. A buttonhole sewing machine comprising, in combination, a work-holding device; a stitch-forming device; and mechanism for causing relative movement between said devices around a buttonhole, said mechanism including eccentrically driven means of adjustable eccentric stroke for causing a component relative movement of variable amplitude between said devices transversely of the buttonhole, thereby obtaining an eye of variable width.

19. A buttonhole sewing machine comprising, in combination, a work-holding device; a stitch-forming device; and mechanism for causing relative movement between said devices around a buttonhole, said mechanism including eccentrically driven means of an eccentric stroke variable between zero and a certain maximum stroke for causing a component relative movement of variable amplitude between said devices transversely of the buttonhole, thereby obtaining a buttonhole having no eye or an eye of variable width.

20. A buttonhole sewing machine comprising, in combination, a work-holding device; a stitch-forming device; and mechanism for causing relative movement between said devices around a buttonhole, one of said devices having a groove longitudinally of the buttonhole and said mechanism including a rotatable stud of variable eccentric stroke projecting into said groove and immovable relative to the other device laterally of the buttonhole, for the formation of an eye of variable width.

21. A buttonhole sewing machine comprising, in combination, a work-holding device; a stitch-

forming device; and mechanism for causing relative movement between said devices around a buttonhole, one of said devices having a groove longitudinally of the buttonhole and said mechanism including a stud of an eccentric stroke adjustable between zero and a certain maximum stroke, said stud projecting into said groove and being immovable relative tc the other device laterally of the buttonhole and rotatable for the formation of no eye or an eye of variable width.

22. A buttonhole sewing machine comprising, in combination, a work-holding device; a stitch-forming device; and mechanism for causing relative movement between said dvices around a buttonhole, said mechanism including eccentrically driven means and an adjustable driver therefor for causing a component relative movement between said devices transversely of the buttonhole during a variable period of the relative movement longitudinally of the buttonhole thereby obtaining an eye of variable length.

23. A buttonhole sewing machine comprising, in combination, a work-holding device; a stitch-forming device; and mechanism for causing relative movement between said devices around a buttonhole, said mechanism including eccentrically driven means of an adjustable eccentric stroke and an adjustable driver therefor for causing a component relative movement of variable amplitude between said devices transversely of the buttonhole during a variable period of the relative movement longitudinally of the buttonhole, thereby obtaining an eye of variable width and length.

24. A buttonhole sewing machine comprising, in combination, a work-holding device; a stitch-forming device; and mechanism for causing relative movement between said devices around a buttonhole, said mechanism including eccentrically driven means having an eccentric stroke variable between zero and a certain maximum stroke, and an adjustable driver therefor for causing a component relative movement of variable amplitude between said devices transversely of the buttonhole during a variable period of the relative movement longitudinally of the buttonhole, thereby obtaining no eye or an eye of variable width and length.

25. A buttonhole sewing machine comprising, in combination, a work-holding device; a stitch-forming device; and mechanism for causing relative movement between said devices around a buttonhole, said mechanism including two single members cooperating to cause component relative movements between said devices transversely to the buttonhole for the formation of an eye and a fly bar, and said members being alternately driving and driven members during the formation of said eye and fly bar, respectively.

26. A buttonhole sewing machine comprising, in combination, a work-holding device; a stitch-forming device; and mechanism for causing relative movement between said devices around a buttonhole, said mechanism including two cooperating single members carried by said devices, respectively, and forming the sole driving connection therebetween for causing component relative movements between said devices transversely to the buttonhole for the formation of an eye and a fly bar, and said members being alternately driving and driven members during the formation of said eye and fly bar, respectively.

27. A buttonhole sewing machine comprising, in combination, a work-holding device; a stitch-forming device; a pivot connecting said devices, said pivot being floatable longitudinally of a buttonhole relative to at least one device; and mechanism for causing relative movement between said devices around the buttonhole, said mechanism including two cooperating single members carried by said devices, respectively, for causing component relative movements therebetween transversely to the buttonhole for the formation of an eye and a fly bar, said members also guiding the devices during the remaining relative movement and being alternately driving and driven members during the formation of said eye and fly bar, respectively.

28. A buttonhole sewing machine comprising, in combination a work-holding device; a stitch-forming device; and mechanism for causing relative movement between said devices around a buttonhole, one of said devices providing longitudinally aligned grooves, one extending longitudinally of the buttonhole and the other having a laterally offset portion and said mechanism including a cam immovable relative to the other device laterally of the buttonhole and rotatable in said one groove for the formation of an eye and relatively movable in said other groove for the formation of a fly bar.

29. A buttonhole sewing machine comprising, in combination, a work-holding device; a stitch-forming device; and mechanism for causing relative movement between said devices around a buttonhole, one of said devices providing a groove having a linear portion longitudinally of the buttonhole merging into a laterally offset portion, and said mechanism including a cam carried by the other device and projecting into said groove, said cam being rotatable in said linear portion for the formation of an eye and relatively movable in said offset portion for the formation of a fly bar.

30. A buttonhole sewing machine comprising, in combination, a work-holding device; a stitch-forming device; a pivot connecting said devices, said pivot being flotable longitudinally of a buttonhole relative to at least one device; and mechanism for causing relative movement between said devices around a buttonhole, one of said devices providing a groove having a linear portion longitudinally of the buttonhole merging into a laterally offset portion thereof, and said mechanism including a cam carried by the other device, said cam being rotatable in and relatively movable through a length of said linear portion for the formation of an eye, and relatively movable through said offset portion and the remaining length of said linear portion for forming a fly-bar, respectively for guiding said devices during the formation of the buttonhole length between the eye and fly bar.

31. A buttonhole sewing machine comprising, in combination, a work-holding device; a stitch forming device; and mechanism for causing relative movement between said devices around a buttonhole, one of said devices providing a groove having a linear portion longitudinally of the buttonhole merging into a laterally adjustable portion, and said mechanism including a cam immovable relative to the other device laterally of the buttonhole and projecting into said groove, said cam being rotatable in said linear portion for the formation of an eye and relatively movable in said adjustable portion for the formation of a fly bar of variable width.

32. A buttonhole sewing machine comprising, in combination, a work-holding device; a stitch-forming device; and mechanism for causing relative movement between said devices around a

buttonhole, one of said devices providing a groove having a linear portion longitudinally of the buttonhole merging into a laterally offset portion, and said mechanism including a stud of variable eccentricity immovable relative to the other device laterally of the buttonhole and projecting into said groove, said stud being rotatable in said linear portion for the formation of an eye of variable width, and relatively movable in said offset portion for the formation of a fly bar.

33. A buttonhole sewing machine comprising, in combination, a work-holding device; a stitch-forming device; and mechanism for causing relative movement between said devices around a buttonhole, one of said devices providing a groove having a linear portion longitudinally of the buttonhole merging into a laterally adjustable portion, and said mechanism including a stud of variable eccentricity immovable relative to the other device laterally of the buttonhole and projecting into said groove, said stud being rotatable in said linear portion for the formation of an eye of variable width, and relatively movable in said adjustable portion for the formation of a fly bar of variable width.

34. A buttonhole sewing machine comprising, in combination, a work-holding device; a stitch-forming device; and mechanism for causing relative movement between said devices around a buttonhole, one of said devices providing a groove having a linear portion longitudinally of the buttonhole merging into a portion laterally adjustable between alinement with said linear portion and a certain maximum displacement therefrom, and said mechanism including a cam immovable relative to the other device laterally of the buttonhole and projecting into said groove, said cam being rotatable in said linear portion for the formation of an eye, and relatively movable in said adjustable portion for the formation of no fly bar or a fly bar of variable width.

35. A buttonhole sewing machine comprising, in combination, a work-holding device; a stitch-forming device; and mechanism for causing relative movement between said devices around a buttonhole, one of said devices providing a groove having a linear portion longitudinally of the buttonhole merging into a laterally offset portion, and said mechanism including a rotatable stud adjustable between coaxial alinement with its axis of rotation and a certain maximum eccentric stroke and immovable relative to the other device laterally of the buttonhole, said stud being rotatable in said linear portion for the formation of no eye or an eye of variable width, and relatively movable in said offset portion for the formation of a fly bar.

36. A buttonhole sewing machine comprising, in combination, a work-holding device; a stitch-forming device; and mechanism for causing relative movement between said devices around a buttonhole, one of said devices providing a groove having a linear portion longitudinally of the buttonhole merging into a portion laterally adjustable between alinement with said linear portion and a certain maximum displacement therefrom, and said mechanism including a rotatable stud adjustable between coaxial alinement with its axis of rotation and a certain maximum eccentric stroke and immovable relative to the other device laterally of the buttonhole, said stud being rotatable in said linear portion for the formation of no eye or an eye of variable width, and relatively movable in said adjustable portion for the formation of no fly bar or a fly bar of variable width.

37. A buttonhole sewing machine comprising, in combination, a work-holding device; a stitch-forming device; and mechanism for causing relative movement between said devices around a buttonhole, one of said devices providing a groove having a linear portion longitudinally of the buttonhole merging into a laterally offset portion, and said mechanism including a cam immovable relative to the other device laterally of the buttonhole and projecting into said groove, and adjustable driving means for rotating the cam in said linear portion during a variable period of the relative movement longitudinally of the buttonhole for forming an eye of variable length, said cam being also relatively movable in said offset portion for the formation of a fly bar.

38. A buttonhole sewing machine comprising, in combination, a work-holding device; a stitch-forming device; and mechanism for causing relative movement between said devices around a buttonhole, one of said devices providing a groove having a linear portion longitudinally of the buttonhole merging into a laterally offset portion, and said mechanism including a stud of variable eccentricity immovable relative to the other device laterally of the buttonhole and projecting into said groove, and adjustable driving means for rotating said stud in said linear portion during a variable period of the relative movement longitudinally of the buttonhole for forming an eye of variable width and length, said stud being also relatively movable in said offset portion for the formation of a fly bar.

39. A buttonhole sewing machine comprising, in combination, a work-holding device; a stitch-forming device; and mechanism for causing relative movement between said devices around a buttonhole, one of said devices providing a groove having a linear portion longitudinally of the buttonhole merging into a laterally adjustable portion, and said mechanism including a stud of variable eccentricity immovable relative to the other device laterally of the buttonhole and projecting into said groove, and adjustable driving means for rotating said stud in said linear portion during a variable period of the relative movement longitudinally of the buttonhole for forming an eye of variable width and length, said stud being also relatively movable in said offset portion for the formation of a fly bar of variable width.

40. A buttonhole sewing machine comprising, in combination, a work-holding device; a stitch-forming device; a pivot connecting said devices, said pivot being floatable longitudinally of a buttonhole relative to at least one device; mechanism for causing relative reciprocation of invariable amplitude between said devices longitudinally of the buttonhole; other mechanism for causing relative rocking motions between said devices, said other mechanism including an element carried by one device adjustable in a direction longitudinally of the buttonhole and providing a groove extending in the same direction, and an eccentric carried by the other device and projecting into said groove to guide the devices during said relative reciprocation, and being rotatable in said groove for the formation of an eye; and an adjustable mechanism for starting and stopping the operation of the stitch-forming device at any location of the eccentric within a certain range in the groove, thus obtaining a buttonhole of variable overall length and having an eye.

41. A buttonhole sewing machine comprising,

in combination, a work-holding device; a stitch-forming device; a pivot connecting said devices, said pivot being floatable longitudinally of a buttonhole relative to at least one device; mechanism for causing relative reciprocation of an invariable amplitude between said devices longitudinally of the buttonhole; other mechanism for causing relative rocking motions between said devices, said other mechansim including an element carried by one device adjustable longitudinally of the buttonhole and providing a groove having a linear portion longitudinally of the buttonhole merging into a laterally offset portion, and an eccentric carried by the other device and projecting into said groove to guide the devices during said relative reciprocation, said eccentric being rotatable in said linear portion for the formation of an eye, and movable in said offset portion for the formation of a fly bar; and an adjustable mechanism for starting and stopping the opertion of the stitch-forming device at any location of the eccentric within a certain range in said offset groove portion, thereby obtaining a buttonhole of variable overall length and having a fly bar of variable length and an eye.

42. In a buttonhole sewing machine, the combination of a needle bar; and mechanism for rotating said needle bar, said mechanism including a single-tooth segmental gearing of Geneva type.

43. In a button hole sewing machine, the combination of a needle bar; a work-holder; and mechanism for causing relative movement between said needle bar and work-holder, said mechanism including a single-tooth segmental gearing of Geneva type.

44. In a buttonhole sewing machine, the combination of a work-holding device; a stitch-forming device; and mechanism for causing relative rotation between said devices at variable speed, said mechanism including a single-tooth segmental gearing of Geneva type.

45. In a buttonhole sewing machine, the combination of a work-holding device; a stitch-forming device; and mechanism for causing relative rotation between said devices, said mechanism including a single-tooth segmental gearing of Geneva type, and means for rocking the driving element of said gearing through a variable angular distance during an invariable time period.

46. In a buttonhole sewing machine, the combination of a work-holding device; a stitch-forming device; and mechanism for causing relative movement between said devices, said mechanism including a single-tooth segmental gearing of Geneva type, the driven element of said gearing being rocked through an invariable angular distance during a variable time period and the driving element thereof being rocked through a variable angular distance during an invariable time period.

47. In a buttonhole sewing machine, the combination of a work-holding device; a stitch-forming device; and mechanism for causing relative movement between said devices, said mechanism including a single-tooth segmental gearing of Geneva type, a lever element rotatable through an invariable angular distance and a pivot drivingly connecting the driving element of said gearing with said lever element, said elements being provided with grooves and said pivot extending through the groove of one of said elements and being adjustably secured in the groove of the other element toward and away from the axis of rotation of the latter.

48. In a buttonhole sewing machine, the combination of a needle bar; a frame carrying said needle bar; a work-holding frame; mechanism for rotating said needle bar, said mechanism including a single-tooth segmental gearing of Geneva type; other mechanism for causing relative movement between said frame, said other mechanism also including a single-tooth segmental gearing of Geneva type; a single cam element; and followers connecting said cam element with the driving elements of both gearings.

49. A buttonhole sewing machine comprising, in combination, a work-holding device; a stitch-forming device; mechanism for causing relative reciprocation between said devices longitudinally of the buttonhole; and other mechanism for causing a superimposed transverse relative reciprocation between said devices, said superimposed relative reciprocation to start and end at two coincident points of said longitudinal relative reciprocatory movements in opposite directions and one-half of the stroke thereof to take place on each side of the buttonhole axis, said other mechanism including a single-tooth segmental gearing of Geneva type and a pivoted lever element rotatable through a preassigned angular range and drivingly connected with the driving element of said gearing, said elements being so coordinated that the driven element of said gearing is midway of its rocking range when said lever element is midway of its rocking range.

50. A buttonhole sewing machine comprising, in combination, a work-holding device; a stitch-forming device; mechanism for causing relative reciprocation between said devices longitudinally of the buttonhole; and other mechanism for causing a superimposed transverse relative reciprocation between said devices so that one-half of the stroke thereof takes place on each side of the buttonhole, said superimposed relative reciprocation to start and end at any coincident points within a certain range of said longitudinal relative reciprocatory movements in opposite directions, and said other mechanism including a single-tooth segmental gearing of Geneva type whereof the driving element has a slot, a pivoted lever element having a slot and being rotatable through a preassigned angular range, and a pivot adjustable in the slot of one element and projecting into the slot of the other element, said elements being so coordinated that the rotary driven element of said gearing is midway of its angular range and the longitudinal axes of said slots are in alinement when said lever element is midway of its rocking range.

51. A buttonhole sewing machine comprising, in combination, a work-holding device; a stitch-forming device; mechanism for causing relative reciprocation between said devices longitudinally of the buttonhole; and other mechanism for rotating the stitch-forming device, said rotation to start and end at any coincident points within a certain range of said relative reciprocatory movements in opposite directions, said other mechanism including a single-tooth segmental gearing of Geneva type whereof the driving element has a slot, a pivoted lever element having a slot and being rotatable through a preassigned angular range, and a stud adjustable in the slot of one element and projecting into the slot of the other element, said elements being so coordinated that the rotary driven element of said gearing is midway of its angular range and the longitudinal axes of said slots are in alinement when said lever element is midway of its angular range.

52. A buttonhole sewing machine comprising, in combination, a work-holding device; a stitch-forming device; and mechanism for causing relative movement between said devices around a buttonhole having a fly bar, one of said devices providing a groove having a linear portion longitudinally of the buttonhole merging into laterally alined and equally offset, parallel portions at different levels and on opposite sides of said linear portion, and said mechanism including a stud immovable relative to the other device laterally of the buttonhole and projecting into said groove, said stud being brought into operative alinement with either offset groove portion on relative movement between said one device and said stud axially of the latter.

53. A buttonhole sewing machine comprising, in combination, a work-holding device; a stitch-forming device; and mechanism for causing relative movement between said devices around a buttonhole having a fly bar and an eye, one of said devices providing a groove having a linear portion longitudinally of the buttonhole merging into laterally alined and equally offset, parallel portions on opposite sides of, and at different levels within, said linear portion, and said mechanism including a cam immovable relative to the other device laterally of the buttonhole and projecting into said groove, and means for simultaneously rotating said cam while in said linear groove portion and axially moving the same from operative alinement with one offset groove portion into operative alinement with the other offset groove portion.

54. A buttonhole sewing machine comprising, in combination, a work-holding device; a stitch-forming device; and mechanism for causing relative movement between said devices around a buttonhole having a fly bar of variable width, one of said devices providing a groove having a linear portion longitudinally of the buttonhole merging into laterally adjustable, parallel groove portions on opposite sides of, and at different levels within, said linear portion, and said mechanism including a stud immovable relative to the other device laterally of the buttonhole and projecting into said groove, said stud being brought into operative alinement with either lateral groove portion on relative movement between said one device and said stud axially of the latter.

55. A buttonhole sewing machine comprising, in combination, a work-holding device; a stitch-forming device; and mechanism for causing relative movement between said devices around a buttonhole, one of said devices providing a groove having a linear portion longitudinally of the buttonhole merging into two other portions at different levels within said linear portion, said other portions being adjustable from alinement with the linear portion into certain maximum offset positions on opposite sides of said linear portion, and said mechanism including a stud immovable relative to the other device laterally of the buttonhole and projecting into said groove, said stud being brought into operative alinement with either offset groove portion on relative movement between said one device and said stud axially of the latter, thereby obtaining no fly bar or a fly bar of variable width.

56. A buttonhole sewing machine comprising, in combination, a work-holding device; a stitch-forming device; mechanism for causing relative movement between said devices around a buttonhole having a fly bar of variable width, said mechanism including means carried by one device and providing a groove having a linear portion longitudinally of the buttonhole merging into laterally adjustable, parallel groove portions on opposite sides of, and at different levels within, said linear portion, and a stud immovable relative to the other device laterally of the buttonhole and projecting into said groove, said stud being brought into operative alinement with either lateral groove portion on relative movement between said one device and said stud axially of the latter; and means including a single manually operable element for simultaneously adjusting said lateral groove portions equal distances from said linear groove portion.

57. A buttonhole sewing machine comprising, in combination, a work-holding device; a stitch-forming device; and mechanism for causing relative movement between said devices around a buttonhole having a fly bar, one of said devices providing a groove having a linear portion longitudinally of the buttonhole merging into laterally alined and equally offset, parallel portions at different levels within, and on opposite sides of, said linear portion, and said mechanism including a threaded stud element immovable relative to the other device laterally of the buttonhole and projecting into said groove, a nut element in threaded engagement with said stud element, and means for rotating one of said elements relative to the other element so as to bring said stud element into operative alinement with either offset groove portion.

58. A buttonhole sewing machine comprising, in combination, a work-holding device; a stitch-forming device; and mechanism for causing relative movement between said devices around a buttonhole having a fly bar and an eye, one of said devices providing a groove having a linear portion longitudinally of the buttonhole merging into laterally alined and equally offset, parallel portions at different levels within and on opposite sides of, said linear portion, and said mechanism including a threaded cam immovable relative to the other device laterally of the buttonhole and projecting into said groove, a nut in threaded engagement with said cam, and means for rotating said cam in said linear groove portion for the formation of the eye, thereby also bringing said cam from operative alinement with one offset groove portion into operative alinement with the other offset groove portion.

59. In a buttonhole sewing machine, the combination of a work-holding device; a stitch-forming device; and mechanism for guiding the relatively movable devices around a buttonhole, one of said devices providing a linear groove longitudinally of the buttonhole, and said mechanism including a shaft carried by the other device and having a diametrical groove in one end thereof, and a stud projecting into said linear groove and being adjustable in said diametrical groove, the shaft being rotated through one revolution for the formation of an eye, and the diametrical groove extending longitudinally of the buttonhole except during rotation of the shaft.

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