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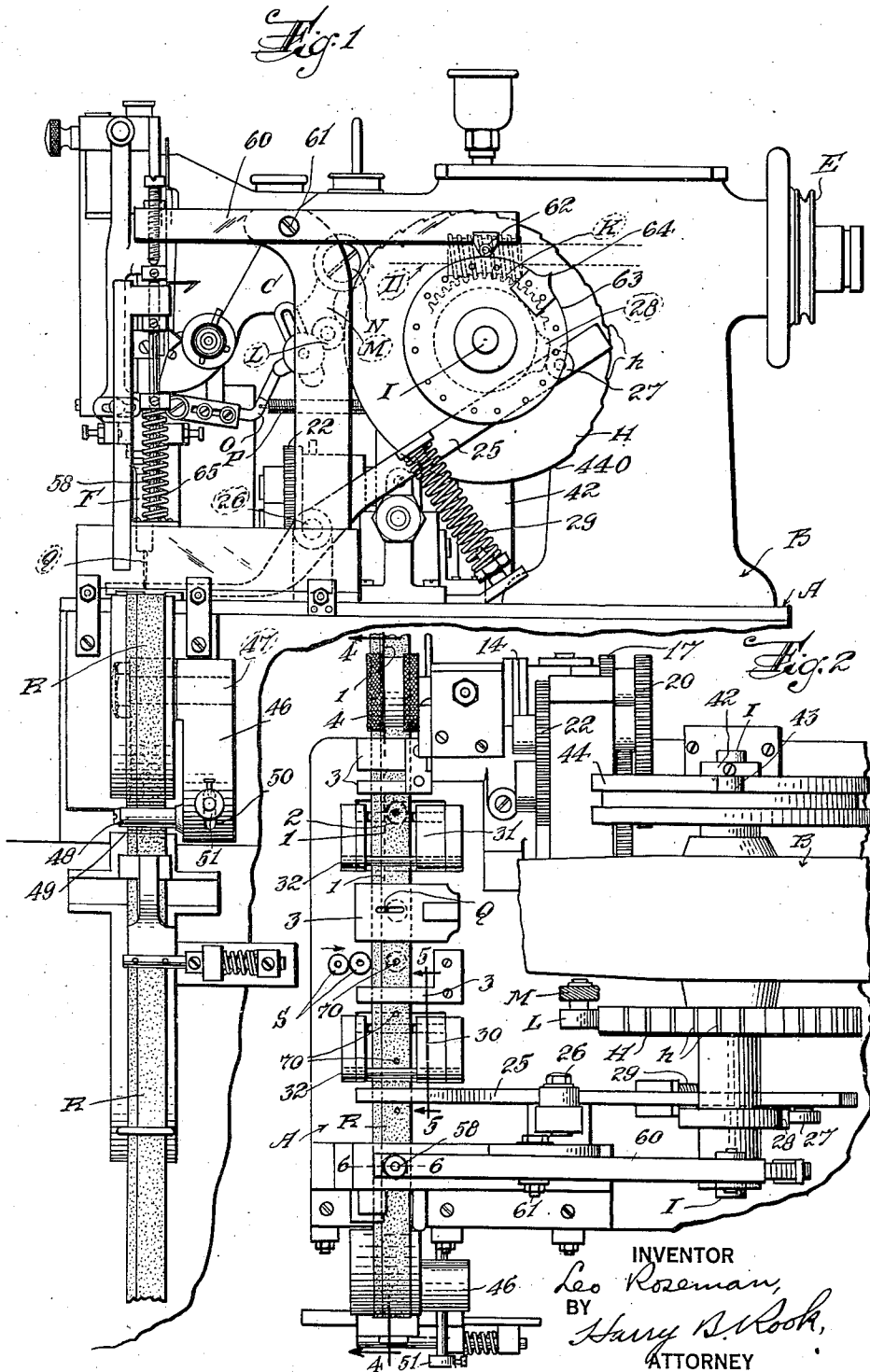
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SEWING MACHINE AND METHOD OF SEWING

Filed June 5, 1933

5 Sheets-Sheet 1



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SEWING MACHINE AND METHOD OF SEWING

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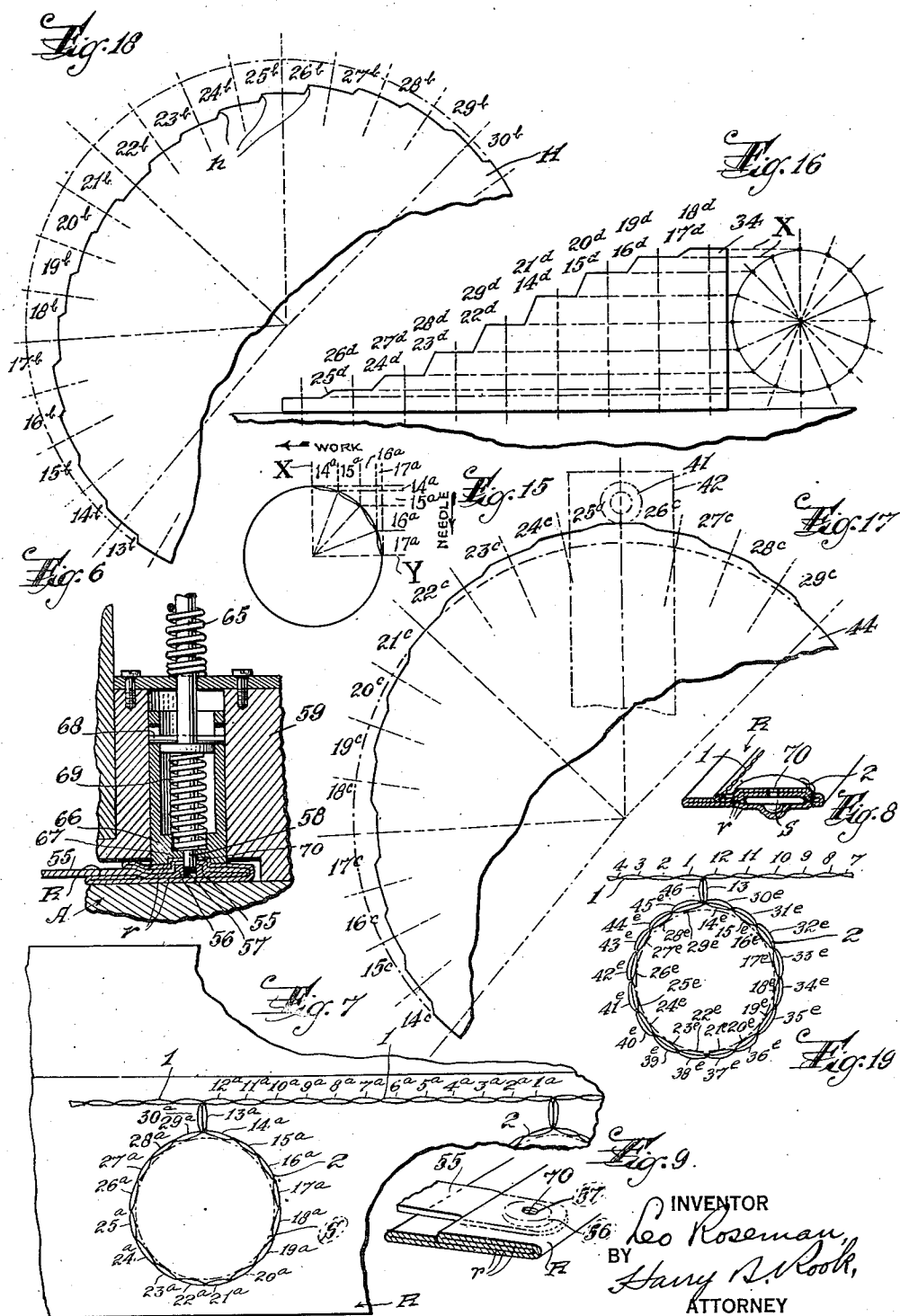
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SEWING MACHINE AND METHOD OF SEWING

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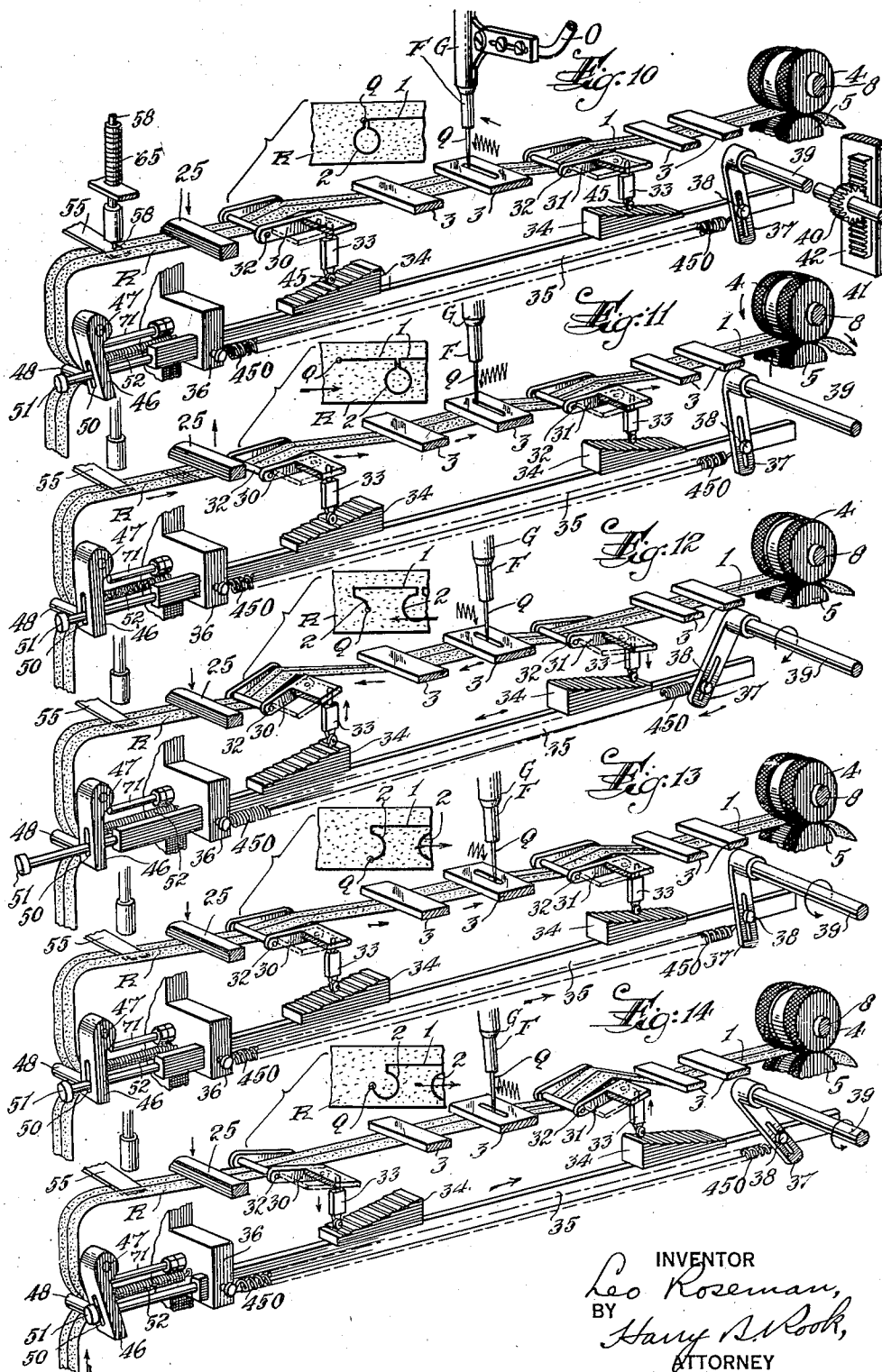
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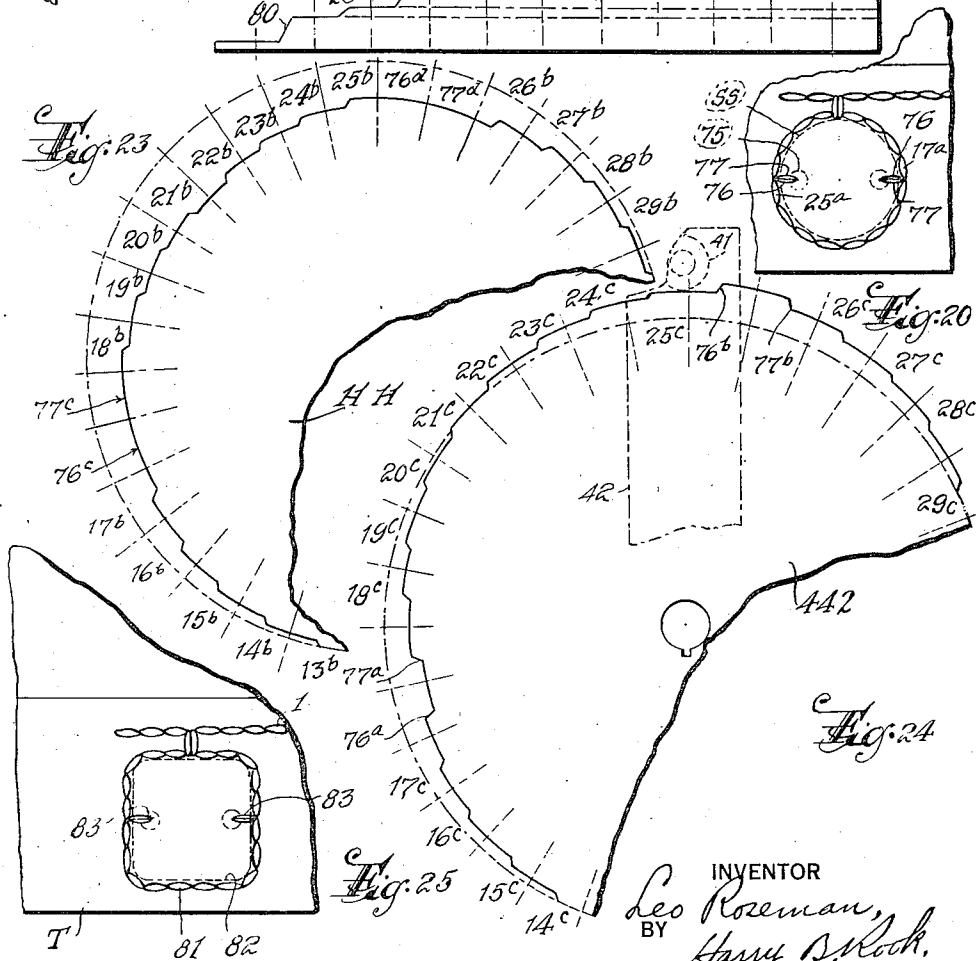
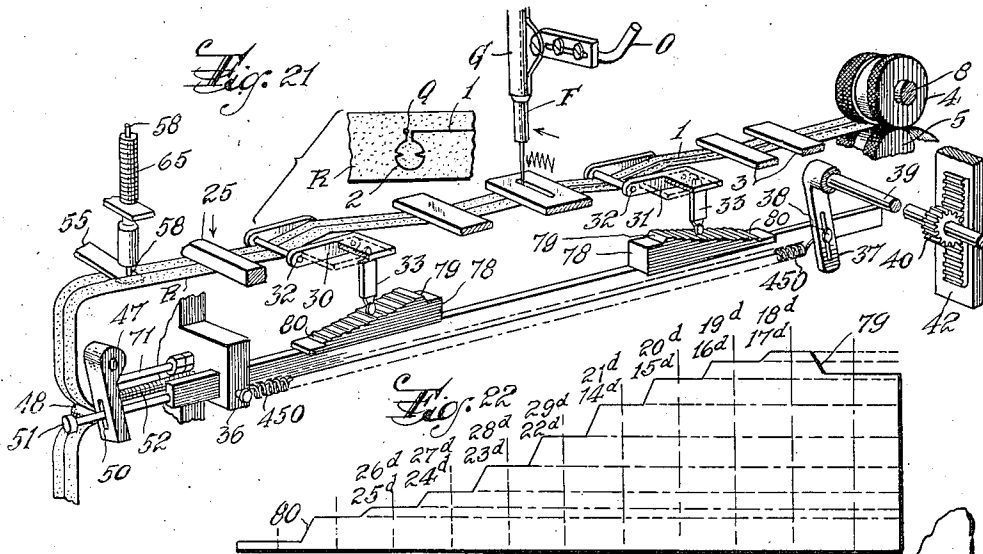
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5 Sheets--Sheet 5



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SEWING MACHINE AND METHOD OF SEWING

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35 Claims. (Cl. 112—2)

This invention relates particularly to a machine for and method of making annular or ring-like rows of stitching, for example, circular or rectangular rows, although the invention is susceptible of use for making other curved or zig-zag rows of stitches. The machine and method are specially adapted for use in sewing snap fastener elements on strips of fabric for making garment fastener tape, the machine and method of the invention providing means for forming an annular row of stitches around each fastener element, and a straight row of stitches continuous with and running longitudinally of the fabric strip between each annular row of stitches, the invention thereby making it possible to secure a plurality of snap fastener elements on a strip of fabric with one continuous line of stitches and in one continuous operation.

I am aware that circular rows of stitches have been made heretofore, but the making of such stitches has required either a special rotatable mounting of the needle or the use of special work gripping or clamping means and actuating mechanism therefor to rotate or reciprocate the work. Such methods and mechanisms are complicated and expensive and not entirely reliable. Therefore another object of my invention is to provide a novel and improved simple and reliable sewing machine and method of the general character described wherein a circular or annular row of stitches can be produced with a stitch forming mechanism including a reciprocating needle which is also capable of lateral movement, by holding the work, for example, a strip of fabric, against longitudinal movement at points ahead of and behind the needle and maintaining or storing between said holding points an amount of work in excess of the straight line distance between said holding points, and then moving or transferring the excess or reserve amount of work between said holding points back and forth beneath the needle in directions which are angularly disposed to the directions of lateral movement of the needle, whereby the row of stitches thus formed is a composite of the movements of the work and the needle.

Further important objects are to provide in a machine of the character described novel and improved means for maintaining or storing such an excess or surplus or the work between said holding points, and moving or transferring said surplus back and forth beneath the needle; to thus provide means for guiding or moving the work or strip between said holding points in a zig-zag path or in different directions at angles

to the general plane of movement of the work to provide such a surplus of work, and for moving or transferring said surplus back and forth alternately in opposite directions beneath the needle; and to provide such a machine wherein one guide is provided ahead of and another guide is located behind the needle, and each guide moves alternately in opposite directions transversely of the general direction of movement of the work in sliding engagement with the work, the movement of one guide and the work in one direction out of the general plane of movement of the work compensating the movement of the other guide in the other direction, so that said surplus of work is shifted or transferred from one side of the needle to the other with a back and forth movement of the work beneath the needle.

Another object of the invention is to provide a novel and improved sewing machine and method of this character wherein a straight line of stitches extending longitudinally of the work can be produced automatically in continuation of the circular or annular rows of stitches, whereby the longitudinal and circular rows of stitches can be produced in one continuous automatic operation and breaks or jump stitches between the circular and longitudinal rows can be avoided.

A further object is to provide a sewing machine including novel and improved automatic means for moving work beneath a needle back and forth or alternately in opposite directions to provide a plurality of superposed tying stitches extending parallel to the direction of movement of the work; and to provide such means in combination with the hereinbefore mentioned means for making ring-like rows of stitches, whereby a ring-like row of stitches may be made in continuation and in one continuous operation with superposed tying stitches disposed radially of the ring-like row.

In the manufacture of snap fastener tape it is necessary to perforate the fabric strip to provide openings which will register with the sockets of the socket members and the heads of the head members, and accordingly another object of my invention is to provide a sewing machine including novel and improved means for perforating the fabric strip prior to the attachment to the strip of the snap fastener elements whereby the fabric may be perforated, the snap fastener elements inserted into the strip and the strip can be stitched, in one continuous operation.

In accordance with the invention, particularly when applied to the manufacture of snap fastener tape, accuracy in the feeding of the fabric strip

from a supply roll to the stitch forming mechanism is highly important, particularly to locate the perforations in the proper relation to each other, and also because inaccuracies in feeding might lead to breakage of the needle by contact with the snap fastener elements. It has been customary to withdraw the fabric strip directly from a supply roll by means of intermittently rotated feeding supply rollers, but due to the stretching of the strip and the heavy tension thereon necessary to unroll it from the roll, as well as the difference in tension required for unrolling tape from large rolls and small rolls and possible slipping of the tape between the feed rollers and lack of uniformity in the feed of the tape, such feeding is not entirely satisfactory for my present purpose.

Accordingly further objects of my invention are to provide an auxiliary or supplementary work feed mechanism for progressively withdrawing the strip directly from the supply roll and presenting the strip so withdrawn to the usual work feed mechanism such as intermittently operated feed rollers which feed the strip beneath the needle for producing straight lines of stitches, whereby the auxiliary feed mechanism shall assume the strain of unrolling the strip from the supply roll and shall maintain or store a quantity of the strip in advance of the feed rollers so that the feed rollers draw the strip to be fed beneath the needle from said store instead of from the supply roll; to provide novel and improved spring means in such auxiliary feed mechanism whereby the work supplied by said auxiliary feed mechanism to said feed rollers shall be maintained under constant and uniform tension; to provide such spring means whereby the work stored in advance of and behind the needle as above described shall be held uniformly taut, so as to ensure that a constant predetermined quantity of stored work shall always be present to permit back and forth movement of the work beneath the needle between the before-mentioned holding points.

Still another object is to provide in a sewing machine of the character described the combination with a reciprocating needle which is also capable of lateral movement, and means for moving the needle step-by-step laterally alternately in opposite directions, of means for moving the work step-by-step alternately in opposite directions which are approximately right angularly disposed to the directions of movement of the needle, the length of the steps of movement of the work increasing and decreasing and increasing respectively, whereby the composite of the movements of the needle and the work shall constitute approximately a circle or curve.

Other objects of the invention are to provide a novel and improved sewing machine of the general character described which shall be simple and relatively inexpensive in construction and reliable and durable in operation, and to obtain other advantages and results as will be brought out by the following description.

Referring to the accompanying drawings in which corresponding and like parts are designated throughout the several views by the same reference character,

Figure 1 is a front elevation of the sewing machine embodying my invention.

Figure 2 is a top plan view thereof with portions of the sewing machine goose neck or standard omitted.

Figure 3 is a rear elevation of the machine por-

tions being broken away for clearness in illustration.

Figure 4 is a transverse vertical sectional view on the line 4-4 of Figure 2.

Figure 5 is a similar view on the line 5-5 of Figure 2, looking in the direction of the arrows.

Figure 6 is an enlarged vertical sectional view on the line 6-6 of Figure 2.

Figure 7 is an enlarged fragmentary plan view of a piece of fastener tape having stitching thereon formed in accordance with the invention.

Figure 8 is a transverse sectional isometric view of the tape.

Figure 9 is a fragmentary perspective view showing a portion of the punching mechanism for perforating the tape.

Figures 10 to 14 inclusive, are schematic composite perspective views of the apparatus and the tape being sewed showing the various steps in the formation of the stitching, the illustrations of the tape showing the portions of the stitching which have just been completed by the apparatus with the parts thereof in the position shown in the corresponding figures.

Figure 15 is a diagram illustrating the composite of the movement of the needle and work.

Figure 16 is a fragmentary side elevation of one of the cams for actuating the work reciprocating mechanism.

Figure 17 is a fragmentary side elevation of the rotary cam for reciprocating the cam shown in Figure 16.

Figure 18 is a similar view showing the cam for laterally moving the needle.

Figure 19 is a plan view of a modified arrangement of the annular row of stitches.

Figure 20 is a fragmentary plan view of a piece of fastened tape having a modified form of stitching thereon.

Figure 21 is a view similar to Figure 11 showing a modification of the apparatus for producing the stitching shown in Figure 20.

Figure 22 is a view similar to Figure 16 showing a modification of a cam which is required for making said stitching.

Figures 23 and 24 are views similar to Figures 18 and 19 showing modifications of the cams H and 44, and

Figure 25 is a fragmentary plan view of a further modified form of the tape.

For the purpose of illustrating the principles of my invention, I have shown it in connection with a known type of sewing machine which includes a base A a standard B and a goose-neck C. The machine has the usual drive shaft D to be driven by a belt passing over a pulley E on the drive shaft. At the free end of the goose-neck C is mounted a needle bar F which is reciprocated in the usual manner from the drive shaft D. The needle bar is also mounted in a bracket arm G to oscillate or move laterally simultaneously with its reciprocation. For oscillating the bracket G, I have shown a cam wheel H mounted on a counter-shaft I journaled in the standard B and driven through worm and worm wheel gearing K from the drive shaft D. The cam H which will be hereinafter more fully described, has cam projections h to engage a follower roller L carried by a lever M pivoted to the goose-neck C at N and connected by a link O to the bracket G. The roller L is held in engagement with the cam H by a tension spring P. The needle bar F carries a needle Q which is threaded and cooperates with a bobbin in known manner common to such stitch-forming mechanism. All of the above-de-

scribed details of construction are old in the art, some thereof being shown by my Patent No. 1,742,221 dated January 7, 1930 and by Patent No. 1,239,825 dated September 11, 1917.

5 The work to be operated upon, for example, the fastened tape, is passed beneath the needle Q to provide in the work a line of stitching as the needle is actuated. In the present instance the work is in the form of a fastener tape R including
10 a plurality of thicknesses *r* of fabric between two of which is secured a row of circular snap fastener elements S substantially equidistantly spaced longitudinally of the strip. The specific purpose of my machine is to sew these head and socket
15 fastener elements upon the tape by longitudinal lines of stitches *l* which are disposed between the fastener elements and have in continuation thereof lateral and circular rows of stitches 2 surrounding each of the fastener elements. The tape R is
20 passed beneath guides 3 secured to the bed A of the machine, the guides directing the tape in proper relation to the needle Q as clearly shown in Figures 2 and 4.

For feeding the tape longitudinally past the
25 needle Q to form the longitudinal stitches *l*, I utilize a pair of feed rollers 4 and 5 one of which is mounted on a shaft 6 journaled in a fixed bracket 7 on the bed of the machine and at the rear side of the needle, that is, at the side of the needle from
30 which the work leaves. The other roller 4 is mounted on a spindle 8 journaled in a bearing block 9 vertically slidable in a bracket 10 secured to the bed of the machine. These rollers 4 and 5 grip the fastener tape or other work between
35 them, and the roller 4 is yieldingly forced toward the roller 5 to cause a gripping pressure of the rollers upon the tape, by a compression spring 11 interposed between the bearing block 9 and a bracket 12.

40 The rollers 4 and 5 are driven from the drive shaft D of the machine in any suitable manner so as to feed the tape with an intermittent step-by-step motion each step being equal to the length of the desired stitch, which in cooperation with the stitch-forming mechanism causes
45 a longitudinal line of stitches to be formed in the work as it is fed by the roller; and as shown, the shaft 8 of the roller 4 is connected by a universal coupling 14 to a shaft 15 journaled in a standard 16 on the base A of the machine. The
50 coupling 14 permits movements of the spindle 8 with respect to the shaft 15. The shafts 15 and 6 are geared together by gears 17 and 18, the first of which is mounted on the shaft 15, and the shaft 15 has another gear 19 which
55 meshes with a drive gear 20 mounted on a shaft 21 journaled in the standard 16. A pinion 22 on the shaft 21 meshes with a pinion on another shaft which is in turn connected through gearing to the drive shaft D of the machine. The
60 connection to the drive shaft of the machine is through a suitable clutch or separable gears, whereby the feed rollers 4 and 5 can be started and stopped periodically. Gearing such as
65 shown in Figures 6 and 7 of my Patent No. 1,742,221 may be utilized for the purpose and need not be further described in detail since the particular drive mechanism is immaterial to the present invention. For the purpose of the present
70 invention it is merely essential that some drive means be provided for rotating the feed rollers 4 and 5 with an intermittent or step by step motion, each step being equal to the length of the desired stitch, which in cooperation with
75 the stitch forming mechanism will cause a lon-

gitudinal line of stitches to be formed in the work as it is fed between said feed rollers, and that by suitable means movement of the feed rollers shall be stopped temporarily as each fastener element reaches the needle of the stitch-forming mechanism so that longitudinal feeding of the work is interrupted to permit formation of the circular rows of stitches 2.

Now, more specifically describing the novel features of the present invention, I have shown
10 the machine and method particularly for use in sewing circular fastener elements S between the plies *r* of a strip of fabric R for producing fastener tape, the sewing consisting of a longitudinal line of stitches *l* comprising twelve stitches
15 between each two adjacent elements S, which line of stitches is continuous with lateral and circular rows of stitches around the fastener elements which comprise together eighteen
20 stitches. In Figure 7 of the drawings, the 20 stitches of the longitudinal lines are numbered 1a to 12a respectively, while the lateral stitches are numbered 13a and 30a respectively, and the
25 stitches of the circular rows are numbered 14a to 29a. In operation of the machine, the feed 25 rollers 4 and 5 move the tape beneath the needle Q to form the longitudinal rows of stitches 1a—12a, and movement of the feed rollers is interrupted at each fastener element, whereupon
30 the lateral stitch 13a is produced, after which 30 the circular row of stitches 14a—29a is formed, following which the lateral stitch 13a is produced. During the formation of the longitudinal
35 stitches 1a—12a, the work is moved longitudinally and the needle bar is merely vertically 35 reciprocated, while when the lateral stitches 13a and 30a and the circular row of stitches 14a to 29a are produced, the needle bar is moved laterally simultaneously with its reciprocation. While
40 the circular row of stitches is being formed the 40 work is moved alternately in opposite directions simultaneously with the lateral movement of the needle. The diameter of each circular row of stitches is preferably slightly greater than the
45 diameter of the snap fastener element S so as 45 to closely surround the snap fastener element, and the lateral stitches 13a and 30a are provided for offsetting the longitudinal rows of
50 stitches from the circular rows. As hereinbefore 50 stated, the circular rows of stitches are composites of the longitudinal movement of the work and the lateral movement of the needle, and it is desirable that the stitches be of equal length. It is also necessary that the needle and work
55 move step-by-step to form the stitches, and the 55 lengths of the steps of movement of the work and the lengths of the steps of lateral movement of the needle must vary during different portions of the complete movements of the work and needle. For determining the lengths of the various
60 steps of movement, a circle having a diameter 60 equal to that of the circular row of stitches, is laid out (see Figure 15) and divided into a number of segments equal to the number of stitches to be formed in the row, said segments representing the stitches and being of equal length. Two series of lines X and Y are projected from these segments in right angularly disposed relation, the series of lines X representing movements of work and the other series Y representing movements of the needle. The distance between the lines of the respective series represents the lengths of the steps of movement of the work and needle respectively. This is clearly
75 illustrated in the diagram of Figure 15 where the 75

relation of the movement of the work to the movement of the needle during the formation of the first four stitches of a circular row is schematically illustrated, the steps being designated by reference characters corresponding to the stitches. The steps of movement of the work in the direction of the arrow gradually decrease, while the corresponding steps of movement of the needle in the direction indicated by the arrow at right angles to the direction of movement of the work, gradually increase in length, the longest step of the needle corresponding to the shortest step of the work and vice versa. It will be easy to observe that during the formation of the next four stitches of the circular row, the direction of movement of the work would be reversed, while movement of the needle would continue in the same direction but the length of the steps of movement of the needle would gradually decrease while the length of steps of movement of the work would gradually increase.

To so form the stitches, in accordance with the invention the work or fabric strip is positively held against movement at two spaced points one ahead of the needle and the other behind the needle, with an amount of tape between said holding points in excess of the straight line distance between the holding points sufficient to permit longitudinal movement of the work beneath the needle a distance equal to the diameter of the circular row of stitches, or to the distance traversed in the direction of the movement of the tape by other curved or zig-zag rows of stitches; and while the work is so held, said work between said holding points is transferred or shifted back and forth beneath the needle alternately in opposite directions. As shown in the drawings, one of the holding means consists of the feed rollers 4 and 5 which positively hold the tape against movement when they are stopped, while the other holding means consists of a lever 25 pivotally mounted intermediate its ends as at 26 on the bed of the machine and having a follower roller 27 at its other end which is held in engagement with a cam roller 28 on the countershaft I by means of a compression spring 29. The cam roller 28 periodically raises the lever 25 from the tape and releases the lever 25 into engagement with the tape under the influence of the spring 29 so as to periodically clamp the tape against the bed of the machine, the period of clamping being equal to the time required for making the lateral row of stitches 2. While the tape is so held, the surplus of the tape between the holding points is placed under tension and moved longitudinally alternately in opposite directions beneath the needle to form the circular row of stitches in conjunction with the needle which at the same time moves laterally alternately in opposite directions. Generally the mechanism for moving the tape between the holding points consists of two vertically oscillating loop-shaped pull levers or guides 30 and 31, one at each side of the needle and each of which is pivotally mounted at one end at 32 on the bed of the machine while its other end is oscillated in a vertical plane by a reciprocable push rod 33 mounted in a bearing 330 and reciprocated by a wedge cam 34 that is mounted on a reciprocating bar 35 in suitable bearings 36 beneath the bed of the machine. The tape is threaded beneath the guides 3 and through the pull members so that the tape is guided in a zig-zag path in directions at angles to the general plane of movement of the tape, so that

there is an amount of work between said holding lever and said feed rollers in excess of the straight-line distance therebetween, and the tape beneath the needle is held taut. The bar 35 is reciprocated by a crank arm 37 having a pin and slot connection 38 with the bar and connected to a shaft 39 journaled in the bed of the machine and carrying a pinion 40 which meshes with a rack 41 mounted on a slide bar 42 which carries a roller 43 that in turn follows a cam 44 mounted on the counter-shaft I. The roller 43 is held in engagement with the cam 44 by a tension spring 450 which is connected between the pin and slot connection 38 and one of the bearings 36 on the bed of the machine. The wedge cams 34 and the pull levers 30 and 31 are so related to each other that as the reciprocating bar 35 is moved in one direction, one pull lever is lowered and the other is raised while when the reciprocating bar is moved in the other direction the first-mentioned pull is raised and the other is lowered, which action causes a reciprocating movement of the work beneath the needle between the pull members. Obviously the cam 44 will cause a reciprocation of the bar 35.

In order to make the stitches of the circular row of equal lengths, the cams 34 and 44 actuating the work, and the cam H which laterally oscillates the needle bar must be specially constructed. First describing the cam H, it is necessary that the surface of the cam have a number of cam projections h equal to the total number of the lateral stitches $13a$ and $30a$ and the stitches of the circular row $14a$ to $29a$. Also, nine of these projections must be so arranged as to move the needle in one direction while the other nine must move the needle bar in the other direction. Furthermore the cam must have a long concentric dwell 440 to hold the needle against lateral movement while the longitudinal rows of stitches l are formed. With particular reference to Figure 18 of the drawings which illustrates the cam H, the cam projections h have reference characters corresponding to the reference characters designating stitches in Figure 7 except that the exponent is b instead of a . In other words, the cam projection $13b$ in Figure 18 corresponds to the stitches $13a$ in Figure 7, while $29b$ in Figure 18 corresponds to $29a$ in Figure 7. It will be observed that the cam projections from $14b$ to $17b$ inclusive gradually increase in height so as to move the needle bar with steps of gradually increasing length, as illustrated in Figure 15, while the cam projections $18b$ to $21b$ gradually decrease in height. The projections $22b$ to $25b$ gradually increase in height and the projections $26b$ to $29b$ again decrease in height. The projections $13b$ and $30b$ are of the same height, which corresponds to the stitches $13a$ and $30a$ which are of the same length and which are produced while the work is stationary. The projections $13b$ to $21b$ move the needle bar in one direction, while the projections $22b$ to $30b$ move the needle bar in the other direction, both of these directions being at approximately right angles to the direction of movement of the work R.

Now, describing the cam 44 which moves the work between the holding points and is illustrated in Figure 17, this cam operates only during the formation of the circular row of stitches $14a$ — $29a$ and the cam projections are designated with reference characters corresponding to the reference characters designating the stitches in Figure 7 except that the exponent of the refer-

ence characters in Figure 17 is *c* instead of *a*. In this cam, the cam projections are all of the same height, since the cam is intended to move the reciprocating bar 35 step by step in steps of equal length, the variations in the lengths of steps of movement of the work being produced by the wedge cams 34. The cam projections 14*c* to 17*c* actuate the reciprocating bar 35 and the wedge cams 34 during the formation of the stitches 14*a*—17*a* to move the work in one direction, while the projections 18*c* to 25*c* move the work in the other direction during the formation of the stitches 18*a* to 25*a*; the projections 26*c* to 29*c* then move the work in the first direction during the formation of the stitches 26*a* to 29*a*. A concentric dwell 44*i* holds the cams 34 stationary.

Each wedge cam 34 has eight cam projections and nine dwells over which ride rollers 45 on the ends of the push rods 33. In each cam, each projection cooperates in forming two stitches of each circular row and therefore these cam projections gradually decrease in height from the middle dwell toward the ends of the cam, and the follower rollers 45 are normally disposed in the middle dwell of each cam, which locates the work so that the ends of the lateral stitches 13*a* and 30*a* on a diameter of the circular row of stitches laterally of the tape are directly beneath the needle, (see Figures 10 and 11). From this normal position, during the formation of the circular row of stitches, the cams 34 are first moved in the direction of the arrow shown in Figure 12 so that the cam projections 14*d* to 17*d* inclusive of one of the cams are caused to ride under the follower roller 45 of the push rod 33 which actuates the pull lever 30 so as to raise said pull lever and move the work in the direction of the arrow indicated by the arrows in Figure 12, and in conjunction with the simultaneously reciprocating and oscillating needle to form the stitches 14*a* to 17*a* inclusive. While the pull lever 30 is so actuated, the other cam 34 lowers the other pull lever 31 so as to release the tape while the latter is being pulled by the pull lever 30. Thereupon the reciprocating bar 35 is moved in the opposite direction so that the same projections of the cams also designated 18*d* to 21*d*, cause actuation of the pull levers 30 and 31 to move the work in the opposite direction and form the stitches 18*a* to 21*a* inclusive (see Figure 13). Movement of the cams in this direction is continued so that the projections 22*d* to 25*d* form the stitches 22*a* to 25*a* (see Figure 14), whereupon the direction of movement of the cam is reversed so as to form the stitches 26*a* to 29*a*. Obviously, one of the cams 34 might be omitted by simply connecting the push rods 33 together by a lever so that the push rods would move simultaneously in opposite directions.

It is extremely desirable that the feed of the tape beneath the needle be of utmost accuracy to ensure equidistant spacing of the fastener elements and to avoid the striking of the fastener elements by the needle, and accordingly I contemplate the use of a work feeding means to supplement the feed rollers 4 and 5 whereby the feed rollers shall be relieved of the strains incident to pulling the tape over long distances from a supply roll, and the tape shall be relieved of tension which would arise from pulling of the tape by the feed rollers directly from the supply roll. This supplementary feed mechanism comprises a lever 46 which is pivotally mounted on the front of the base of the machine at 47 and carries a roller 48

movable into and out of a notch 49 so as to pull the tape into said notch. The tape is fed from a supply roll (not shown) beneath the roller 48 and across the notch 49, and while the tape is held against movement by the lever 25 and the feed rollers 4, 5, this lever 46 is actuated to pull the tape into the notch 49 and thereby withdraw the tape from the supply roll. The movement of the roller 48 into the notch is such as to withdraw from the supply roll by the lever 46 an amount of tape equal to the distance between each two fastener elements. Upon release of the work by the lever 25 and the beginning of rotation of the feed rollers, the tape which has been pulled from the supply roll by the lever 46 is moved toward the needle by the feed rollers. As shown on the drawings, the lever 46 is actuated to pull the tape from the supply roll by the reciprocating bar 35 which has a portion projecting through a slot 50 in the lever 46 and having a head 51 to abut the lever. A spring 52 normally holds the lever 46 with the roller 48 in the notch, but said spring may yield to permit the roller to move outwardly as the tape is moved by the feed rollers toward the needle. With this construction, the feed rollers are required to move only the amount of tape between the lever 46 and the rollers, while the lever 46 assumes the burden of pulling the tape from the supply roll and the spring 52 maintains the tape between said spring and the feed rollers under uniform tension, thereby ensuring a uniform and accurate feeding of the tape at all times.

Where the machine is used for sewing snap fastener elements on tape, it is desirable to provide means for perforating the fabric of the tape to form openings which will register with the sockets or heads of socket and head members respectively. Such a means may comprise a die 55 (see Figures 6 and 9) which is disposed between the plies *r* of the fastener tape and which cooperates with a punch die arranged above said plies of the tape. The die 55 has a boss 56 and a concentric opening 57, the boss being of a diameter substantially the same as a fastener element and the opening being of the same diameter as the opening which it is desired to form in the tape. The punch die consists of a plunger 58 slidably mounted in a bracket 59 on the bed of the machine and reciprocated by a lever 60 pivotally mounted intermediate its ends at 61 and having a follower roller 62 engaging a cam 63 which is mounted on the counter-shaft I. The cam 63 has a projection 64 to engage the roller 62, the cam and its gearing being such that the plunger 58 will be actuated downwardly periodically at intervals corresponding to the desired spacing of the openings to be formed in the tape. The plunger 58 is actuated upwardly by a compression spring 65. Cooperating with the plunger 58 is an embossing die 66 which has a recess 67 to receive between itself and the boss 56, the plies of the fabric which are to be perforated. This embossing die is connected by a pin and slot connection 68 to the plunger 58, and a spring 69 is interposed between the plunger and the embossing die. In operation, the tape normally slides along the bed of the machine with the die member 55 between the plies as shown in Figures 6 and 9. Periodically the plunger 58 is actuated downwardly and brings with it the embossing die 66 which strikes the tape before the plunger 58. Continued movement of the plunger independently of the embossing die is permitted by the spring 69 so that the plunger may enter the

opening 57 and punch the tape, and at the same time the spring 69 exerts pressure on the embossing die so as to emboss the tape and provide a pocket to receive a snap fastener element. The dies 57 and 66 also stretch the fabric or draw it taut, so as to facilitate the punching of the fabric.

The snap fastener elements may be inserted into the tape in any suitable manner before the tape reaches the needle. For example, the snap fastener elements designated S in Figure 2 may be inserted into the tape as indicated by dotted lines in Figure 2 just in advance of the needle so that the head or socket of the fastener element as the case may be, enters or registers with the opening 70 formed in the tape by the punch.

The operation of the machine probably will be understood from the foregoing, but generally and briefly it may be stated as follows. The tape properly folded is fed into the machine beneath the punch plunger 58 and with the die 55 between the plies of the tape, the extremity of the tape being threaded through the pull levers and inserted between the feed rollers 4 and 5 so that said pull levers ensure an amount of work between the holding lever 25 and the feed rollers in excess of the straight line distance between said lever and feed rollers. As shown, this excess is such as to permit the tape to be threaded through the pull levers and allow for movement of the tape by said pull levers back and forth beneath the needle a distance equal to the diameter of the annular row of stitches. Thereupon the machine is started in operation, the feed rollers moving the tape longitudinally in one direction and the needle bar being reciprocated but not moving laterally, whereby a longitudinal row of stitches 1 is formed. After the predetermined number of longitudinal stitches have been produced, for example twelve stitches in the present case, the feed rollers are stopped, whereupon the needle bar is started on its lateral movement transversely of the tape to the right in Figure 2 of the drawings so as to form the lateral stitch 13a. Slightly before this action or simultaneously therewith, the holding lever 25 is operated to clamp the tape against further movement, and as the stitch 13a is completed, the surplus work between the guides or pull members 30 and 31 is moved longitudinally in the direction of the arrows shown in Figure 12, by the cam 44, pinion and rack 40, 41, reciprocating bar 35, cams 34, push rods 33 and pull levers 30 and 31. The needle continues to move laterally so that the stitches 14a-17a are formed, and movement of the work is then reversed into the direction shown in Figure 13 of the drawings so as to form the stitches 18a to 25a inclusive, the direction of movement of the needle reversing after the formation of stitch 21a. After the stitch 25a has been completed the direction of movement of the work is again reversed so as to form the stitches 26a to 29a whereupon the movement of the tape is stopped by the dwell 441 of cam 44 passing under roller 43. Lateral movement of the needle continues in the direction of the arrow shown in Figure 10 to complete the lateral stitch 30a. The holding lever 25 is then released from the work and the feed rollers 4 and 5 are started in operation to move the tape in the direction of the arrows as shown in Figure 11 so as to form another longitudinal line of stitches 1, the needle being held against lateral movement by the dwell 440 of cam H. This action continues as shown in Figure 11 until the last stitch of said longitudinal line is completed and the next lateral stitch

13a is to be made, whereupon the operation above-described is repeated, the work being clamped by the holding lever 25 and the feed rollers. While the work is held by the holding lever 25 and the feed rollers, and during the formation of the stitches 26a to 29a, the lever 46 is actuated to pull a supply of tape from the supply roll as shown in Figure 14, and upon the next movement of the feed rollers, this supply of tape is pulled toward the needle.

Between the movements of the tape by the feed rollers 4 and 5, the punch 53, 55 is operated to perforate the tape, and the fastener elements may be inserted into the tape between the punch and the needle as already described.

For the purpose of adjusting the amount of tape which is withdrawn from the supply roll at each operation of the lever 46, I may provide a stop rod 71 which is adjustably mounted in the base of the machine, for example in one of the bearings 36. By adjustment of the rod 71 the extent of movement of the lever 46 can be varied so as to vary the amount of fabric drawn into the notch 49 by the roller 48.

In some instances it may be desirable to provide a plurality of concentric circular or annular rows of stitches, as illustrated in Figure 19 of the drawings. Here, two rows of stitches are illustrated, the second row comprising the stitches 30e to 45e inclusive. This second row of stitches can be produced by simply repeating the movement of the parts which causes formation of the first row of stitches, the movement of the feed rollers 4 and 5 and the stop lever 25 being timed with respect to the work moving mechanism 30-45, so that the two rows of stitches 14e-29e and 30e-45e can be produced between each feeding movement of the tape by the rollers 4 and 5.

From the foregoing it will be observed that my invention provides a relatively simple and inexpensive method and machine for producing circular, annular, curved or zig-zag rows of stitches, and that the machine is especially suitable for sewing snap fastener elements upon fabric strips with one continuous row of stitches and in one operation with the stitches snugly surrounding the fastener elements so as to securely attach them to the tape.

In some instances it is desirable to provide a plurality of superposed tying stitches which are disposed radially of the annular row of stitches and some of which are arranged longitudinally of the tape; this is especially desirable where the snap fastener elements have openings in their edges to receive stitches for securing the fastener elements on the fabric strips. Such a fastener element is designated SS in Figure 20 and has transverse openings 75 to receive stitches. In the present instance, the fastener element is so arranged on the tape that the openings 75 are spaced longitudinally of the tape.

The stitching includes a circular row of stitches identical with that shown in Figure 7 which surrounds the fastener element, with the addition of two stitches 76 and 77 passing through each of the openings 75 and disposed radially of the annular row of stitches and longitudinally of the tape.

The annular row of stitches is formed in the same manner as hereinbefore described, and for making the longitudinal stitches 76 and 77, the cams 34 are modified as shown in the cams 78, in Figures 21 and 22 of the drawings. At one end of each of the cams an additional projection 79 is provided reversely arranged to the pro-

jections 14d to 17d, while the other end of the cam has a cam projection 80 to compensate for the movement of the roller on the push rod 33 over the projection 79 of the other cam. With this construction, after the cams 78 have been moved to cause the projections 17d and 25d respectively to pass under the push rods 33 so as to form the stitch 17a, movement of the cams is continued in the same direction so that the push rods are caused to pass over the projections 79 and 80. This reverses the direction of movement of the work longitudinally so as to form the stitch 76 in conjunction with the needle lateral movement of which is interrupted simultaneously with the reversal of direction of movement of the work as hereinafter described. Thereupon the direction of movement of the cams 78 is reversed so as to cause the projection 79 to ride under the push rod and again reverse the direction of movement of the work so as to form the stitch 77. Then the operation continues as hereinbefore described so that the stitches 18a to 25a are produced. After the formation of the stitch 25a, the second group of longitudinal stitches 76 and 77 are produced by cooperation of the other projections 79 and 80 on the cams 78 in the same manner as above described, whereupon the operation is continued to form the stitches 26a to 29a.

Obviously the cam 44 for actuating the cams 78 must be modified to properly actuate the cams 78 for forming the longitudinal tying stitches 76 and 77. The modified cam is designated 442 in Figure 24 and has between the projections 17c and 18c which cooperate in forming the stitches 17a and 18a, additional cam projections 76a and 77a to cooperate with the roller 43 for moving the cams 78 so as to bring the projections 79 and 80 into proper relation to the push rods 33. Similar additional cam projections 76b and 77b are provided between the projections 25c and 26c for actuating the cams 78 in producing the second group of longitudinal tying stitches 76 and 77. As above indicated it is necessary to interrupt lateral movement of the needle while the stitches 76 and 77 are being formed, and for this purpose the cam H is modified as shown in Figure 23. Here the cam is designated HH and has additional continuous dwells 76c and 77c between the cam projections 17b and 18b and similar continuous dwells 76d and 77d between the cam projections 25 and 26. It will be understood that the dwells 76c and 77c pass beneath the roller L so that the needle is held against lateral movement while one of the cam projections 79 passes back and forth beneath the corresponding push rod 33 to form the first group of longitudinal tying stitches 76, 77, while the dwells 76d and 77d pass beneath the roller L to prevent lateral movement of the needle while the projection 79 on the other cam 78 passes back and forth beneath the corresponding push rod 33 to form the second group of longitudinal stitches 76 and 77.

It will thus be observed that the invention also provides automatic means for moving work beneath the needle back and forth to provide a plurality of superposed tying stitches extending parallel to the direction of movement of the work, and the invention also permits of surrounding snap fastener elements with an annular row of stitches and also additionally securing the fastener elements with tying stitches extending radially of the annular row and passing through openings in the fastener elements.

From the foregoing it will be understood by those skilled in the art that the invention may be

adapted with slight modifications of mechanism and within the skill of the ordinary mechanic to provide rectangular rows of stitches such as are shown in Figure 25, for example rows of stitches surrounding rectangular snap fastener elements 82 secured on a fabric strip T. Also, tying stitches 83 corresponding to the stitches 76 and 77 may be provided with such rectangular rows of stitches.

It will be understood by those skilled in the art that the driving mechanism for the various parts will be so related and proportioned as to cause the relative movements thereof above-described and that the particular driving mechanisms illustrated in the drawings are primarily schematic and illustrative of the principles of the invention. Furthermore, the details of construction of the machine may be modified and changed by those skilled in the art without departing from the spirit or scope of the invention, and the machine and method may be used for forming circular, annular, irregular, zig-zag or curved lines of stitches for any desired purpose. An important feature of the invention is the automatic storing or maintaining between two points at which the work is held against movement, a quantity of material greater than or in excess of the straight line distance between said two points, and automatic shifting of said excess of the work back and forth relatively to a given point, i. e., the needle; and a further feature is the provision in a machine in combination with automatically periodically operated mechanism for forward feeding of work, of automatic means for shifting a portion of the work back and forth while said feeding mechanism is at rest.

Having thus described my invention, what I claim is:

1. The method of making an annular line of stitches in a piece of work with a stitch-forming mechanism for making straight lines of stitches, consisting in holding the work against movement at two points one ahead of and the other behind said stitch-forming mechanism with an amount of work between said holding points in excess of the straight line distance between said points, and causing movement of the stitch-forming mechanism and the surplus work between said holding points relatively to each other in angularly disposed directions while the work is held at said holding points.

2. The method of making an annular line of stitches in a piece of work with a stitch-forming mechanism for making straight lines of stitches, consisting in holding the work against movement at two points one at each of opposite sides of said stitch-forming mechanism with an amount of work between said holding points in excess of the straight line distance between said points, moving the surplus work between said holding points alternately in opposite directions, and moving said stitch-forming mechanism alternately in opposite directions which are approximately right angularly disposed to the directions of movement of the work.

3. The method of feeding work in a sewing machine consisting in holding the work at spaced points one ahead of and one behind the stitch-forming mechanism against movement relative to said mechanism with an amount of work between said holding points in excess of the straight line distance between said holding points, and then shifting the surplus work back and forth relatively to said stitch-forming mechanism while the work is held at said holding points.

4. The method of making a curved row of stitches with a sewing mechanism having a reciprocating needle which is also capable of lateral movement, said method consisting in moving the work alternately in opposite directions and simultaneously moving said needle laterally alternately in opposite directions which are approximately right angularly disposed to the directions of movement of the work, the movements of the needle and the work in each direction being step-by-step and the length of the step of movement of said work increasing and decreasing and the length of the steps of movement of said needle decreasing and increasing, respectively.

5. The method of feeding work in a sewing machine consisting in holding the work at spaced points one ahead of and one behind the stitch-forming mechanism, guiding the work in a zig-zag path in directions at angles to the general plane of movement of the work to provide an amount of work between said holding points in excess of the straight line distance between said points, and moving the work between said holding points ahead of and behind the stitch-forming mechanism alternately in opposite directions at angles to the general plane of movement of the work so as to move the excess work back and forth relatively to said stitch forming mechanism.

6. A machine of the character described comprising a stitch-forming mechanism which includes a vertically reciprocable needle that is also capable of lateral movement, means for holding work against movement at spaced points one at each of opposite sides of said needle with an amount of work between said holding points in excess of the straight line distance between said holding points, means for moving said surplus work beneath said needle between said holding points alternately in opposite directions, and means for moving said needle laterally alternately in opposite directions which are approximately right angularly disposed to the directions of movement of the work.

7. A machine of the character described comprising a stitch-forming mechanism which includes a vertically reciprocable needle that is also capable of lateral movement, means for moving work beneath said needle alternately in opposite directions, and means for moving said needle laterally alternately in opposite directions that are approximately right angularly disposed to the directions of movement of the work, said two means moving the work and the needle respectively simultaneously in steps which gradually vary in length.

8. A machine of the character described comprising a stitch-forming mechanism which includes a vertically reciprocable needle that is also capable of lateral movement, means for moving work beneath said needle alternately in opposite directions, and means for simultaneously moving said needle laterally alternately in opposite directions that are approximately right angularly disposed to the directions of movement of the work, said two means moving the work and needle respectively in each direction step-by-step in steps of varying lengths, said steps of movement of the needle gradually varying in lengths inversely to the variations in the steps of movement of said work.

9. A machine of the character described comprising a stitch-forming mechanism which includes a vertically reciprocable needle that is

also capable of lateral movement, means for holding work against movement at spaced points one at each of opposite sides of said needle with an amount of work between said holding points in excess of the straight line distance between said holding points, means ahead of and means behind said needle for shifting the excess work between said holding points alternately in opposite directions back and forth beneath said needle, and means for moving said needle laterally alternately in opposite directions which are approximately right angularly disposed to the directions of movement of the work.

10. A machine of the character described comprising a stitch-forming mechanism which includes a vertically reciprocable needle that is also capable of lateral movement, means for holding work against movement at spaced points one at each of opposite sides of said needle with an amount of work between said holding points in excess of the straight line distance between said holding points, means for holding said work between said holding points under tension beneath said needle and for moving said work alternately ahead of and behind said needle alternately in opposite directions at angles to the general plane of movement of the work to shift the excess work back and forth beneath the needle, and means for moving said needle laterally alternately in opposite directions which are approximately right angularly disposed to the directions of movement of the work.

11. A machine of the character described comprising a stitch-forming mechanism which includes a vertically reciprocable needle that is also capable of lateral movement, means for holding work against movement at spaced points one ahead of and one behind said needle with an amount of work between said holding points greater than the straight-line distance between said points, movable pull members one ahead of and one behind said needle for guiding said work beneath the needle in a zig-zag path in directions at angles to the general plane of movement of the work and for retaining the work under tension, means for simultaneously moving both said pull members alternately in opposite directions at angles to the general plane of movement of the work to shift said work beneath the needle alternately in opposite directions, and means for moving said needle laterally alternately in opposite directions which are approximately right angularly disposed to the directions of movement of the work.

12. The machine set forth in claim 10 wherein said two means for moving the work and the needle are constructed to move the work and the needle respectively simultaneously step-by-step in each direction with the steps of movement of the needle gradually varying in length inversely to the variations in the steps of movement of the work.

13. A machine of the character described comprising a stitch-forming mechanism which includes a vertically reciprocable needle that is also capable of lateral movement, means for holding work against movement at spaced points one ahead of and one behind said needle with an amount of work between said holding points greater than the straight-line distance between said points, movable pull members one ahead of and one behind said needle for guiding said work beneath the needle in a zig-zag path in directions at angles to the general plane of movement of the work and for retaining the work under ten-

sion, means for simultaneously moving both said pull members alternately in opposite directions at angles to the general plane of movement of the work to shift said work beneath the needle alternately in opposite directions, and means for moving said needle laterally alternately in opposite directions which are approximately right angularly disposed to the directions of movement of the work, said means for moving said pull members and said means for laterally moving the needle being operable to move the work and the needle respectively simultaneously step-by-step in each direction in steps of gradually varying lengths, with the steps of movement of the needle varying in length inversely to the variations in the steps of movement of the work.

14. A machine of the character described comprising a stitch-forming mechanism which includes a vertically reciprocable needle which is also capable of lateral movement, means for holding work against movement at spaced points one ahead of and one behind said needle with an amount of work between said holding points greater than the straight-line distance between said points, movable pull members one ahead of and one behind said needle, means for simultaneously moving said pull members to shift said work between said members beneath the needle, and means for moving said needle laterally simultaneously with the movement of the work in a direction right angularly disposed to the movement of the work.

15. The machine set forth in claim 14 wherein said means for simultaneously moving said pull members is constructed to actuate said pull members step-by-step in steps of gradually varying length, and said means for moving the needle is constructed to move the needle step-by-step in steps gradually varying in length inversely to the variations in the steps of movement of the work.

16. A machine of the character described comprising a stitch-forming mechanism which includes a vertically reciprocable needle that is also capable of lateral movement, means for holding work against movement at spaced points one at each of opposite sides of said needle with an amount of work between said holding points greater than the distance between said points, means for holding taut the work beneath the needle and for moving said taut work beneath the needle between said holding points while the work is held at said points, and means for moving said needle laterally simultaneously with said movement of the work and in a direction approximately right angularly disposed to the direction of movement of the work.

17. A machine of the character described comprising a stitch-forming mechanism which includes a vertically reciprocable needle that is also capable of lateral movement, means for holding work against movement at spaced points one at each of opposite sides of said needle with an amount of work between said holding points greater than the distance between said points, means for holding taut the work beneath the needle and for moving said taut work beneath the needle step-by-step with steps of gradually varying length, and means for moving said needle laterally step-by-step simultaneously and in a direction right angularly disposed to the direction of movement of the work and with the steps of movement of the needle gradually varying inversely to the variations in the steps of movement of the work.

18. A machine of the character described com-

prising stitch-forming mechanism including a vertically reciprocable needle which is also capable of lateral movement, work-feed means for feeding work step-by-step longitudinally beneath said needle to form a longitudinal row of stitches, means for periodically interrupting longitudinal movement of said work by said work-feed means, periodically operated means one of which is said work feed means at opposite sides of said needle for holding said work against movement while said work-feed mechanism is at rest and for releasing said work when said work-feed means is operated, there being an amount of work between said two holding means greater than the distance therebetween, work pulling means for holding taut said work between said two holding means and for moving said taut work step-by-step beneath said needle while said work is held by said two holding means, and means for laterally moving said needle step-by-step simultaneously with and in a direction right angularly disposed to the direction of movement of the work by said work pulling means to form a lateral row of stitches in continuation of said longitudinal row of stitches.

19. The machine set forth in claim 18 wherein said work pulling means and said means for laterally moving the needle are constructed to move the work and needle respectively in steps of gradually varying length with the steps of movement of the needle varying inversely to the variations in the steps of movement of the work so that the composites of the steps of movements of the work and needle are of equal length.

20. A machine of the character described comprising stitch-forming mechanism including a vertically reciprocable needle which is also capable of lateral movement, work-feed means for feeding work step-by-step longitudinally beneath said needle to form a longitudinal row of stitches, means for periodically interrupting longitudinal movement of said work by said work-feed means, periodically operated means one of which is said work-feed means at opposite sides of said needle for holding said work against movement while said work-feed mechanism is at rest and for releasing said work when said work feed means is operated, there being an amount of work between said two holding means greater than the distance therebetween, work pulling means for holding taut said work between said two holding means and for moving said taut work beneath said needle while said work is held by said two holding means, said work pulling means first moving the work step-by-step in one direction and then step-by-step in the opposite direction and then again step-by-step in the first-mentioned direction, and means for laterally moving said needle simultaneously with and in a direction right angularly disposed to said movements of the work by said work pulling means, said needle being moved in one direction step by step during the first-mentioned movement and the first half of the second-mentioned movement of the work, and the needle being moved in the opposite direction step by step during the other half of the second-mentioned movement of the work and during the third-mentioned movement of the work.

21. The machine set forth in claim 20 wherein said work pulling means and said means for laterally moving the needle are constructed to move the work and needle respectively in steps of gradually varying length with the steps of movement of the needle varying inversely to the variations in the steps of movement of the work

so that the composites of the steps of movements of the work and needle are of equal length.

22. A machine of the character described comprising a stitch-forming mechanism including a reciprocable needle that is also capable of lateral movement, means for holding work against movement at spaced points at each of opposite sides of said needle with an amount of work between said holding points greater than the distance between said points, work pulling means for holding taut the work between said holding points and for moving said taut work beneath said needle, said work pulling means first moving the work in one direction step-by-step and then in the opposite direction step-by-step and then again step-by-step in the first-mentioned direction, and means for laterally moving said needle simultaneously with and in a direction right angularly disposed to said movements of the work by said work pulling means, said needle being moved step-by-step in one direction during the first-mentioned movement and the first half of the second-mentioned movement of the work, and the needle being moved step-by-step in the opposite direction during the other half of the second-mentioned movement of the work and during the third-mentioned movement of the work.

23. The machine set forth in claim 22 wherein said work pulling means and said means for laterally moving the needle are constructed to move the work and needle respectively in steps of gradually varying length with the steps of movement of the needle varying inversely to the variations in the steps of movement of the work so that the composites of the steps of movement of the work and needle are of equal lengths.

24. A machine of the character described comprising a stitch-forming mechanism which includes a vertically reciprocable needle that is also capable of lateral movement, means for holding work against movement at spaced points one at each of opposite sides of said needle with an amount of work between said holding points greater than the distance between said points, a pull member at each of opposite sides of said needle movable transversely of the plane of the work and in slidable engagement therewith, said pull members making said work taut between said holding points, means for simultaneously moving said pull members step-by-step in opposite directions to cause longitudinal movement of the work between said members beneath said needle, and means for laterally moving said needle step-by-step simultaneously with and in a direction right angularly disposed to the direction of the movement of the work.

25. Work feeding mechanism for reciprocating work relative to an instrumentality comprising means for holding work against movement at two spaced points one at each of opposite sides of said instrumentality with an amount of work between said holding points greater than the straight-line distance between said points, a pull member at each of said opposite sides of said instrumentality movable transversely of the plane of the work and in slidable engagement therewith, said pull members making said work taut between said holding points, and means for simultaneously moving said pull members in opposite directions to cause longitudinal movement of the work between said members past said instrumentality.

26. A machine of the character described comprising stitch-forming mechanism including a vertically reciprocable needle which is also capable of lateral movement, work-feed means for

feeding work step-by-step longitudinally beneath said needle to form a longitudinal row of stitches, means for periodically interrupting longitudinal movement of said work by said work-feed means, periodically operated means one of which is said work feed means at opposite sides of said needle for holding said work against movement while said work-feed mechanism is at rest and for releasing said work when said work-feed means is operated, there being an amount of work between said holding points greater than the straight-line distance between said points, movable pull members one ahead of and one behind said needle for guiding said work between said points in a zig-zag path in directions at angles to the general plane of movement of the work and for retaining the work under tension, means for simultaneously moving both said pull members alternately in opposite directions at angles to the general plane of movement of the work to shift said work beneath the needle alternately in opposite directions step-by-step in each direction while said work is held by said two holding means, and means for laterally moving said needle step-by-step in each direction simultaneously with and in a direction right angularly disposed to the direction of movement of the work by said work pulling means to form a lateral row of stitches in continuation of said longitudinal row of stitches.

27. Work feeding mechanism for reciprocating work relative to an instrumentality comprising means for holding the work against movement at spaced points one ahead of and one behind said instrumentality with an amount of work between said holding points in excess of the straight line distance between said points, and movable pull members one ahead of and one behind said instrumentality between said holding means engaging and holding said work taut, and means for simultaneously moving said pull members to move said work between said members past said instrumentality.

28. A machine of the character described comprising a stitch-forming mechanism which includes a vertically reciprocable needle, means for holding work against movement relative to said stitch forming mechanism at spaced points one at each of opposite sides of said needle with an amount of work between said holding points in excess of the straight line distance between said holding points, automatic means for moving said surplus work beneath said needle between said holding points alternately in opposite directions while the work is held at said holding points.

29. A machine of the character described comprising a stitch-forming mechanism which includes a vertically reciprocable needle that is also capable of lateral movement, means for holding work against movement at spaced points one at each of opposite sides of said needle with an amount of work between said holding points in excess of the straight line distance between said holding points, means for moving said surplus work beneath said needle between said holding points alternately in opposite directions, and means for moving said needle laterally alternately in opposite directions which are approximately right angularly disposed to the directions of movement of the work, and for periodically interrupting lateral movement of said needle while said surplus work is being moved alternately in opposite directions.

30. A machine of the character described comprising a stitch-forming mechanism including a vertically reciprocable needle which is also

capable of lateral movement, work-feed means for feeding work step-by-step longitudinally beneath said needle to form a longitudinal row of stitches, means for periodically interrupting longitudinal movement of said work by said work-feed means, periodically operated means one of which is said work feed means at opposite sides of said needle for holding said work against movement while said work-feed mechanism is at rest and for releasing said work when said work-feed means is operated, there being an amount of work between said two holding means greater than the distance therebetween, work pulling means for holding taut said work between said two holding means and for moving said taut work step-by-step back and forth longitudinally beneath said needle while said work is held by said two holding means, and means for laterally moving said needle step-by-step simultaneously with and in a direction right angularly disposed to the direction of movement of the work by said work pulling means to form a lateral row of stitches in continuation of said longitudinal row of stitches, said means for laterally moving the needle also periodically interrupting lateral movement of the needle while said work is moving back and forth to form a plurality of superposed longitudinal stitches in continuation of said lateral row.

31. A machine of the character described for sewing on a strip a longitudinal row of fastener elements each having transverse holes to receive stitches, including a vertically reciprocable needle which is also capable of lateral movement, a work-feed means for feeding work step-by-step longitudinally beneath said needle to form a longitudinal row of stitches, means for periodically interrupting longitudinal movement of said work by said work-feed means, periodically operated means one of which is said work feed means at opposite sides of said needle for holding said work against movement while said work-feed mechanism is at rest and for releasing said work when said work-feed means is operated, there being an amount of work between said two holding means greater than the distance therebetween, work pulling means for holding taut said work between said two holding means and for moving said taut work step-by-step beneath said needle while said work is held by said two holding means, and means for laterally moving said needle step-by-step simultaneously with and in a direction right angularly disposed to the direction of movement of the work by said work pulling means to form a lateral row of stitches in continuation of said longitudinal row of stitches, said means for laterally moving the needle also being formed to periodically vary the lateral movement of the needle, and said work moving means being formed to periodically vary the movement of the work simultaneously with said variation of lateral movement of the needle to form stitches through said holes in continuation of said lateral row of stitches.

32. A machine of the character described comprising stitch-forming mechanism including a vertically reciprocable needle which is also capable of lateral movement, work-feed means for feeding work step-by-step longitudinally beneath said needle to form a longitudinal row of

stitches, means for periodically interrupting longitudinal movement of said work by said work-feed means, periodically operated means one of which is said work feed means at opposite sides of said needle for holding said work against movement while said work-feed mechanism is at rest and for releasing said work when said work-feed means is operated, there being an amount of work between said two holding means greater than the distance therebetween, work pulling means for holding taut said work between said two holding means and for moving said taut work step-by-step beneath said needle while said work is held by said two holding means, and means for laterally moving said needle step-by-step simultaneously with and in a direction right angularly disposed to the direction of movement of the work by said work pulling means to form a lateral row of stitches in continuation of said longitudinal row of stitches, and periodically actuated means operable while said work feed means is at rest for successively withdrawing from a supply quantities of said work each equal to the length of the work fed by said work-feed means during each operation of the latter.

33. A machine of the character described comprising a stitch-forming mechanism which includes a vertically reciprocable needle that is also capable of lateral movement, means for holding work against movement at spaced points one at each of opposite sides of said needle with an amount of work between said holding points in excess of the straight line distance between said holding points, means for moving said surplus work beneath said needle between said holding points alternately in opposite directions, and means for moving said needle laterally alternately in opposite directions which are approximately right angularly disposed to the directions of movement of the work, said means for laterally moving the needle also being formed to periodically vary the lateral movement of the needle and said work moving means being formed to periodically vary said movement of the work simultaneously with said variation of lateral movement of the needle.

34. The method of applying stitches in a piece of work with a stitch-forming mechanism having a reciprocating needle which is also capable of lateral movement, which consists in moving the work longitudinally, and simultaneously moving the needle laterally, in directions which are approximately at right angles to each other, the movements of the needle and the work being step-by-step and the lengths of the steps of movement of said work increasing or decreasing as the lengths of the steps of movement of said needle decrease or increase respectively to make a line of stitches extending transversely of the material in a curve.

35. The method as claimed in claim 34, characterized by the feature that the work and the needle are respectively alternately moved in opposite directions, the movements of the needle and the work in each direction being step-by-step and the length of the steps of movement of said work increasing and decreasing as the lengths of the steps of movement of said needle decrease and increase respectively.

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