Oct. 6, 1936. E. B. ALLEN ET AL 2,056,759

BUTTONHOLE SEWING MACHINE

Original Filed Dec. 26, 1934 18 Sheets-Sheet 1

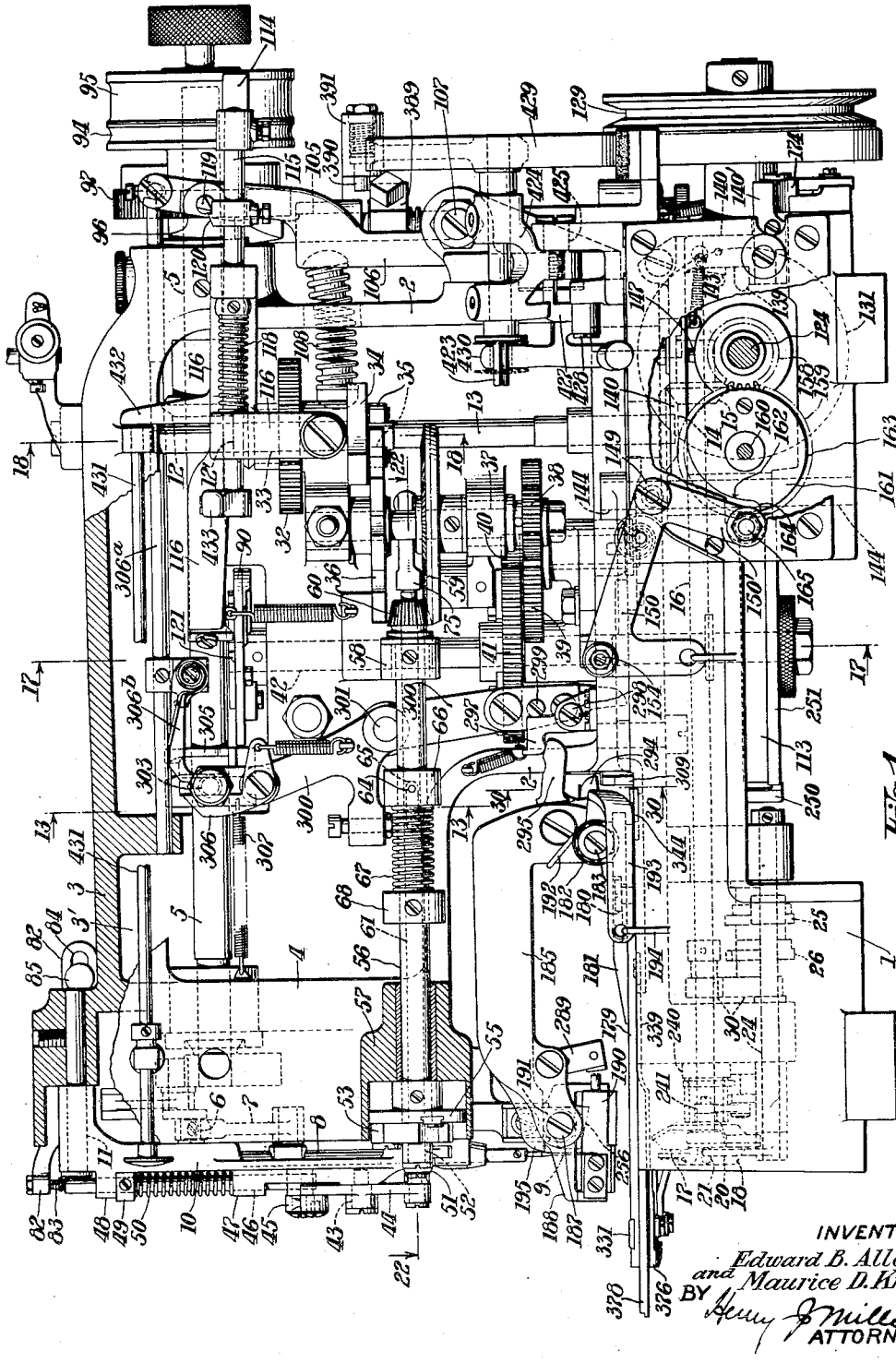


Fig. 1.

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BUTTONHOLE SEWING MACHINE

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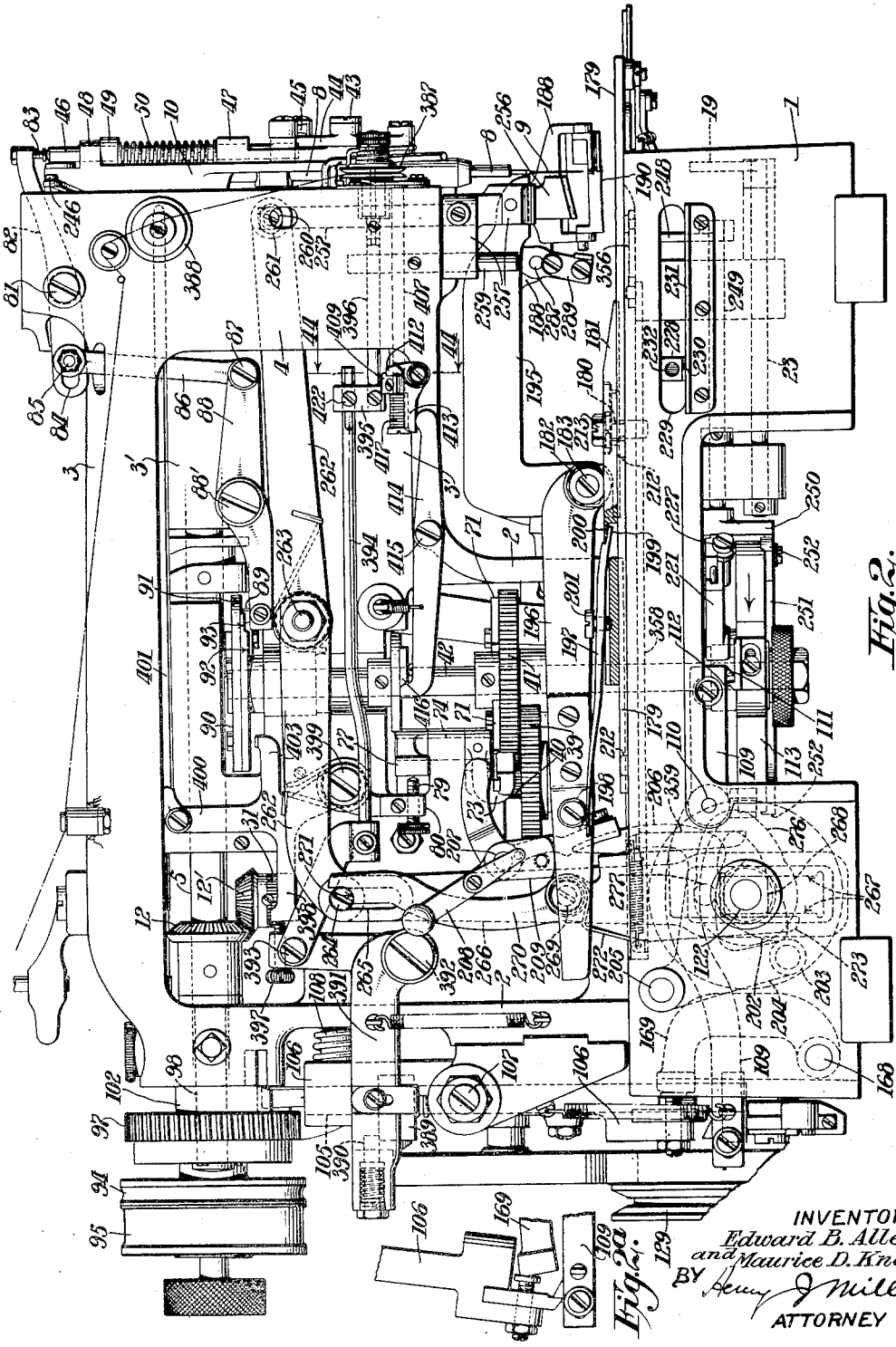


Fig. 2.

Fig. 2a.

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BUTTONHOLE SEWING MACHINE

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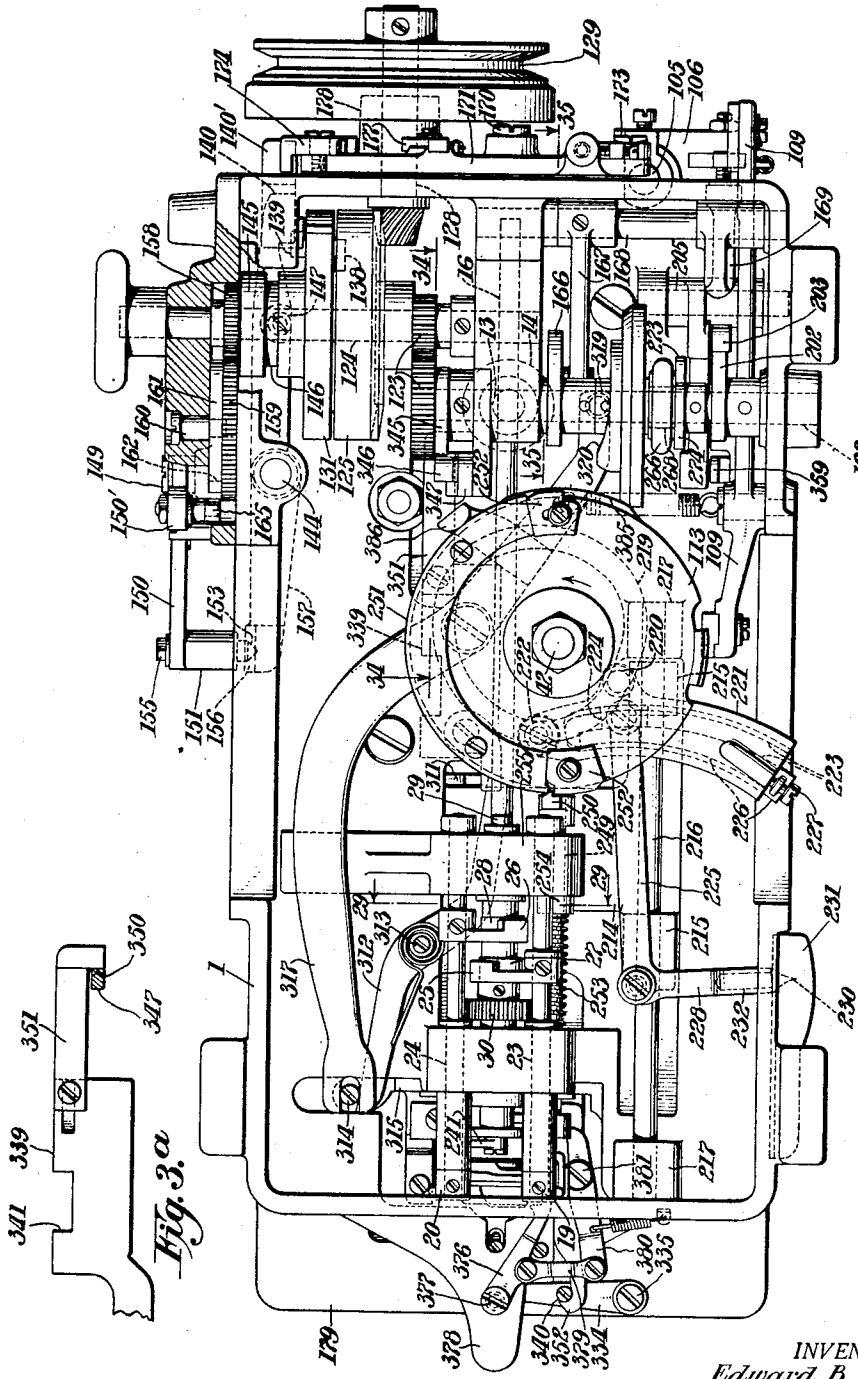


Fig. 3.

Fig. 3a.

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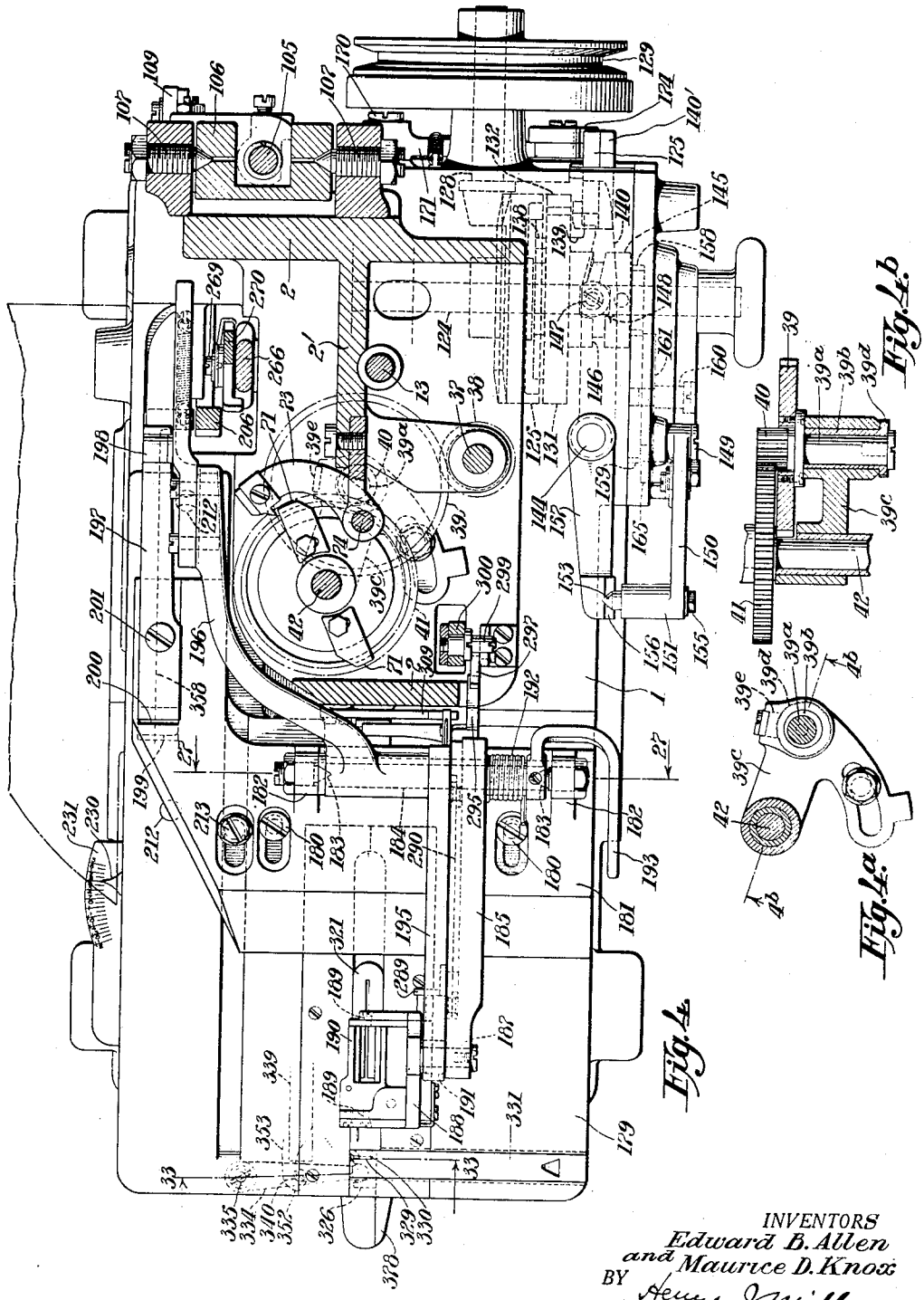


Fig. 4.

Fig. 4b.

Fig. 4a.

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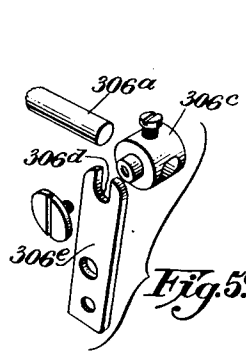


Fig. 5a

Fig. 5.

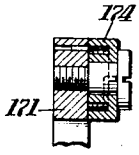


Fig. 5b

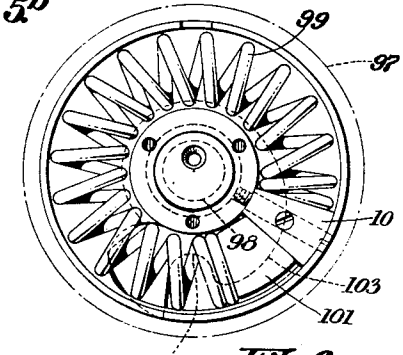


Fig. 6.

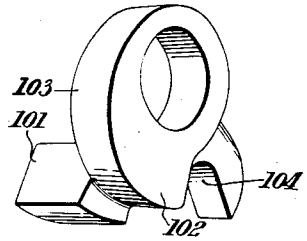


Fig. 7.

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BUTTONHOLE SEWING MACHINE

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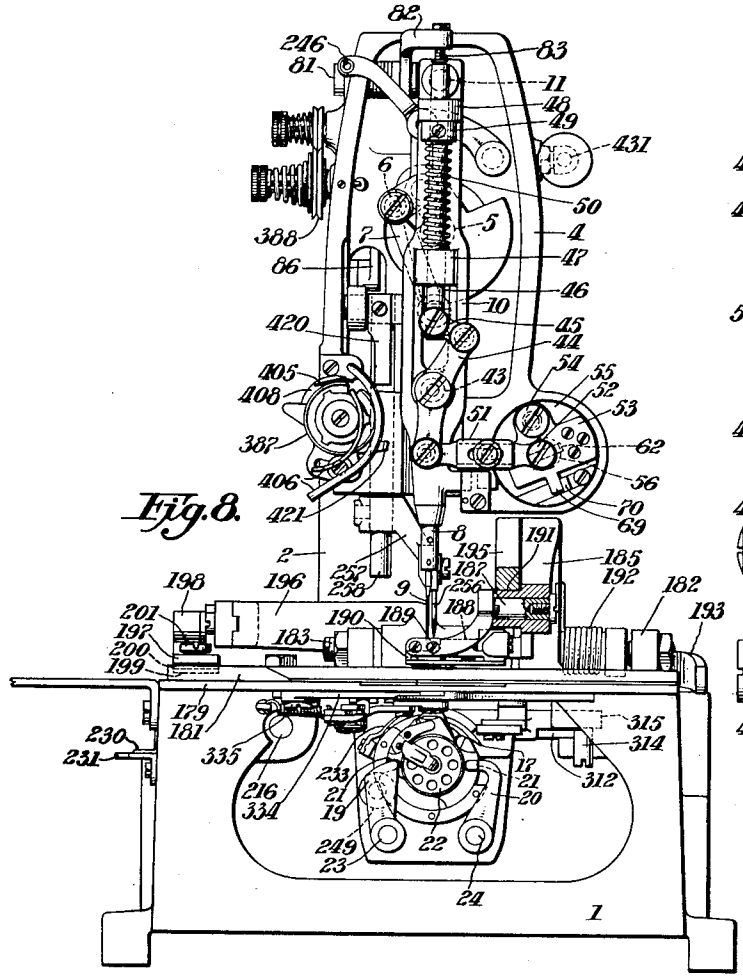


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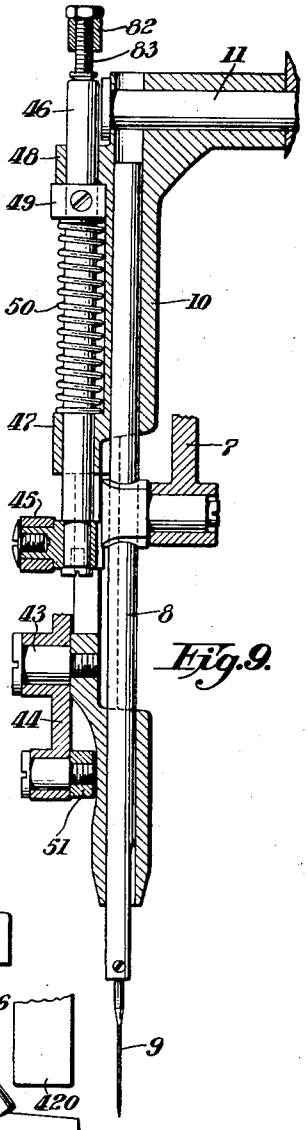


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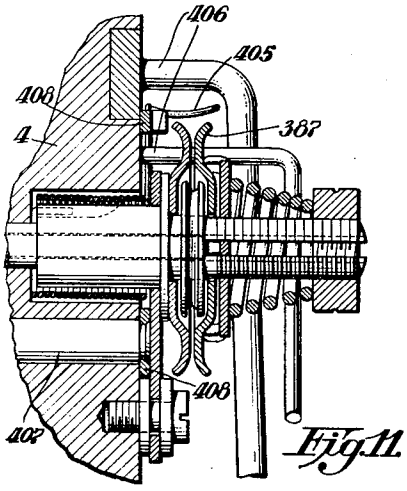


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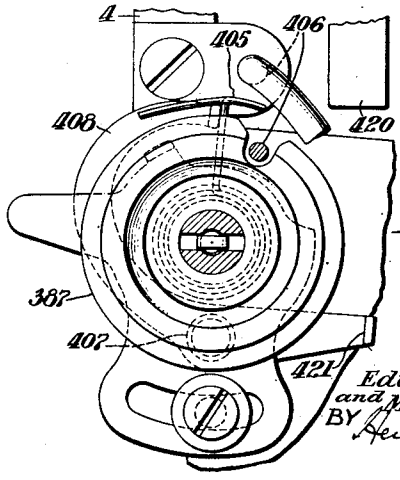


Fig. 10.

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BUTTONHOLE SEWING MACHINE

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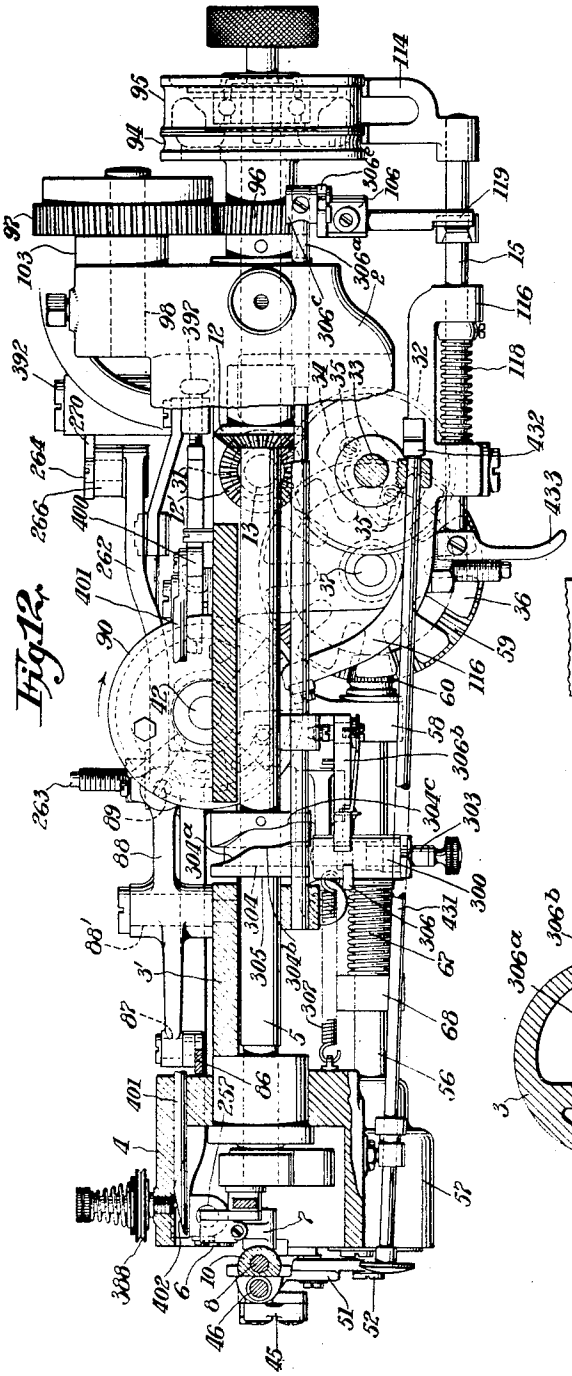


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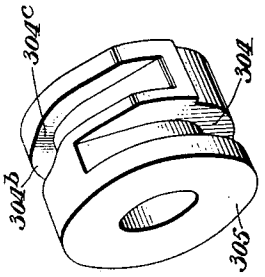


Fig. 15.

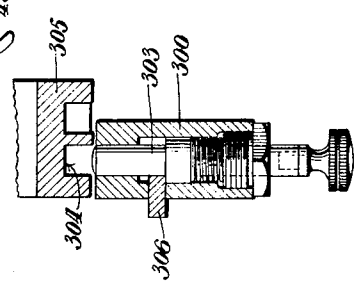


Fig. 14.

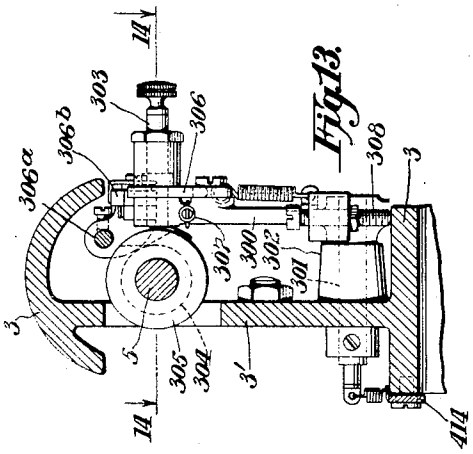


Fig. 13.

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BUTTONHOLE SEWING MACHINE

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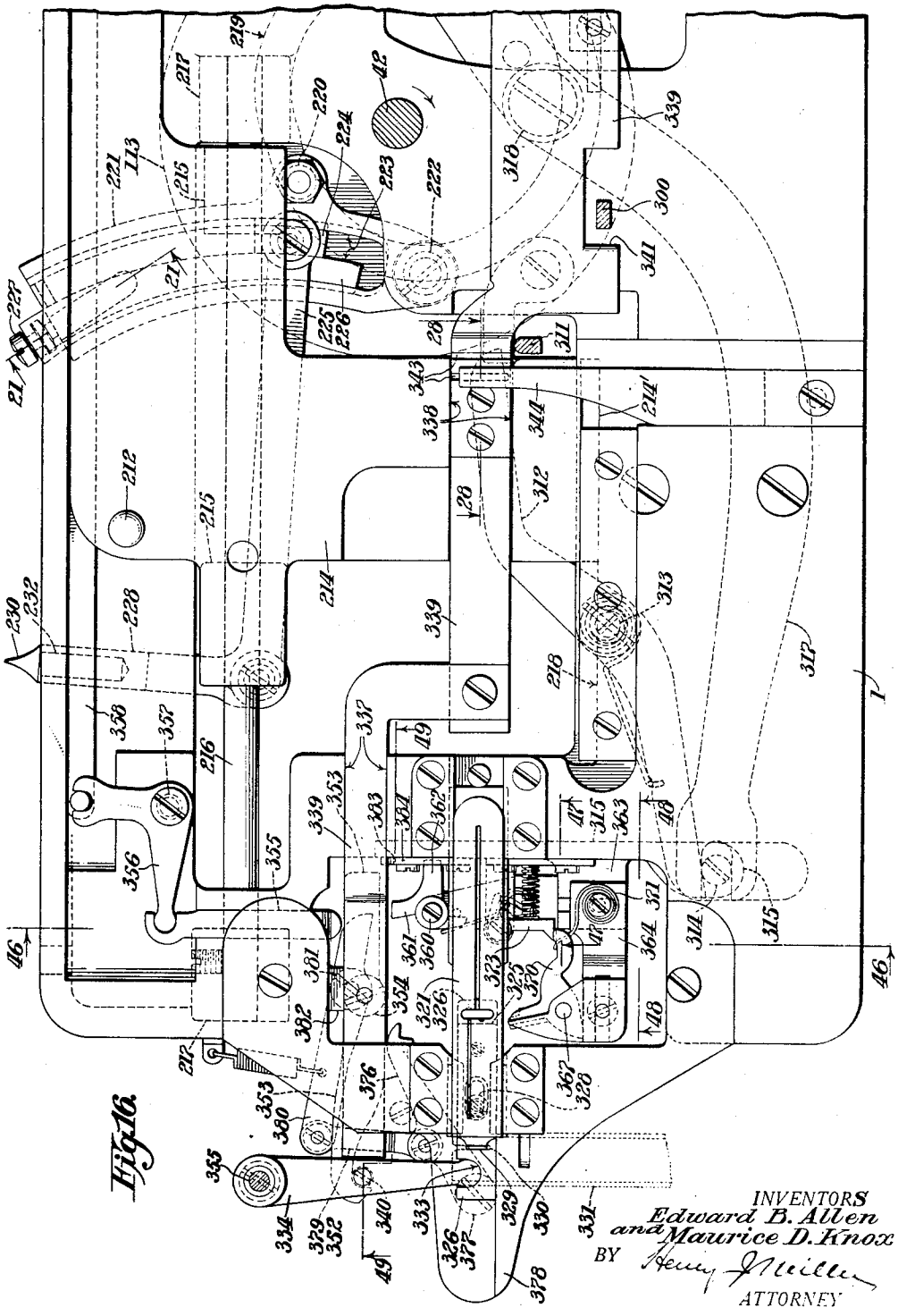


Fig16.

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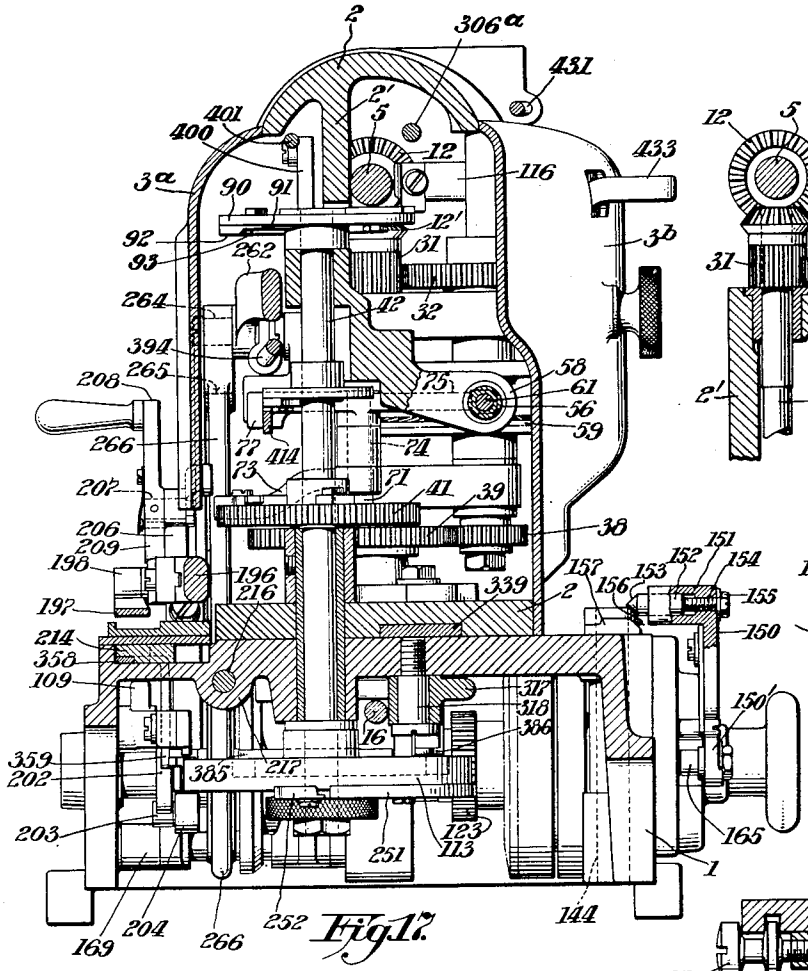


Fig.17.

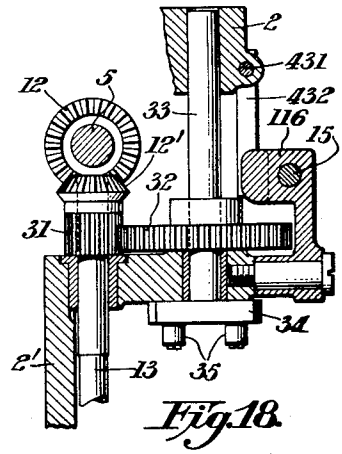


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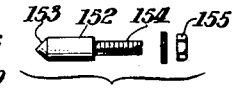


Fig.19

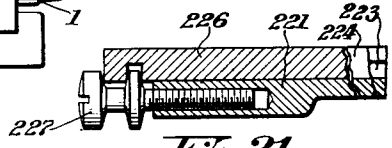


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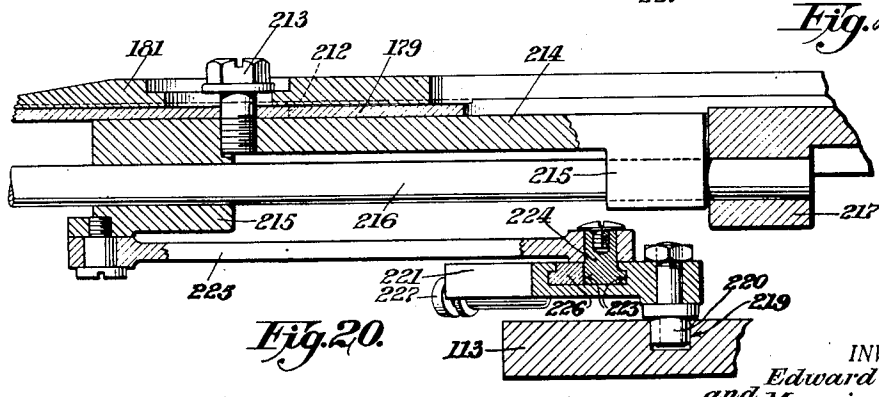


Fig.20.

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BUTTONHOLE SEWING MACHINE

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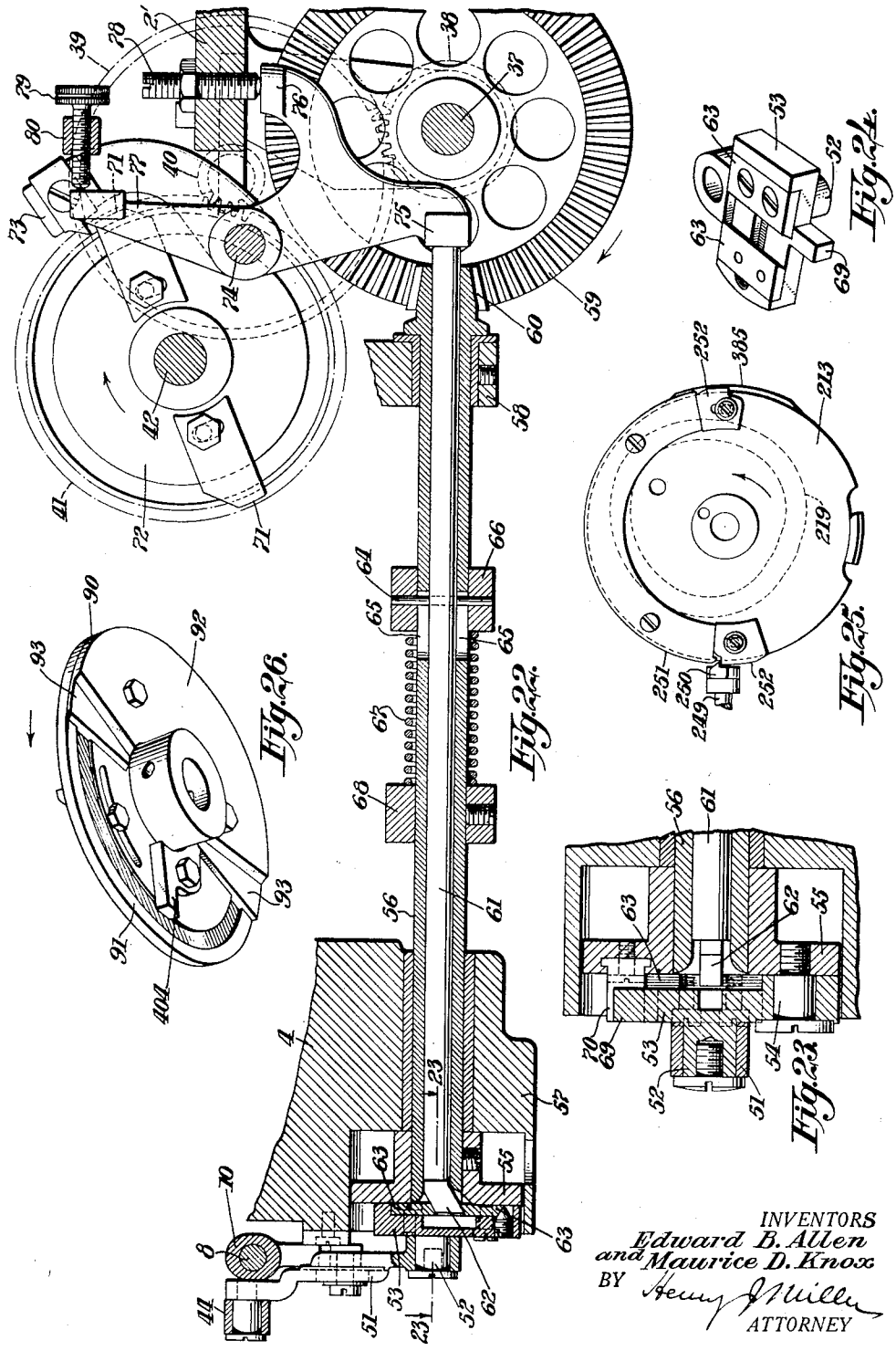


Fig.22.

Fig.24.

Fig.25.

Fig.26.

Fig.23.

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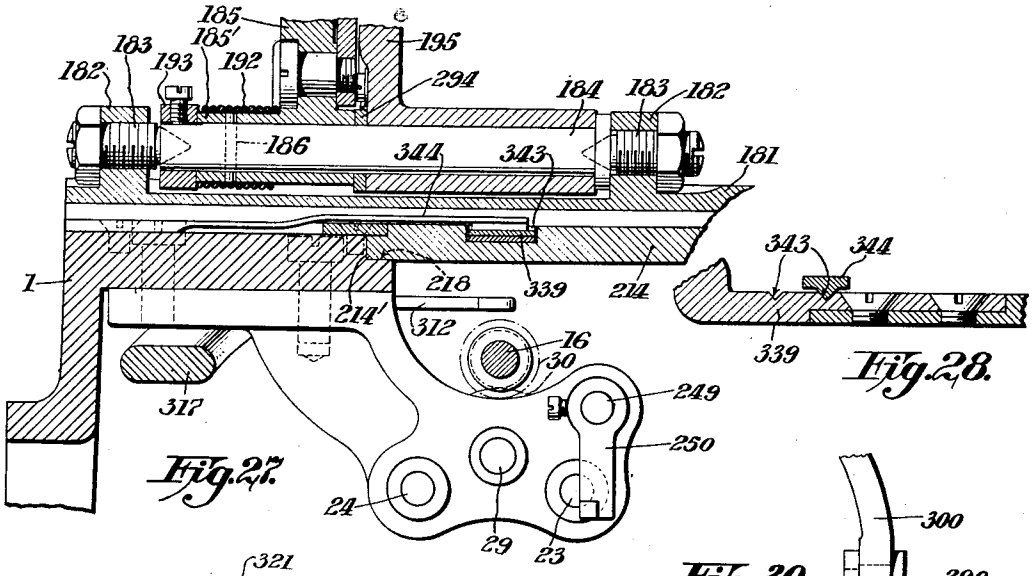


Fig.27. Fig.28.

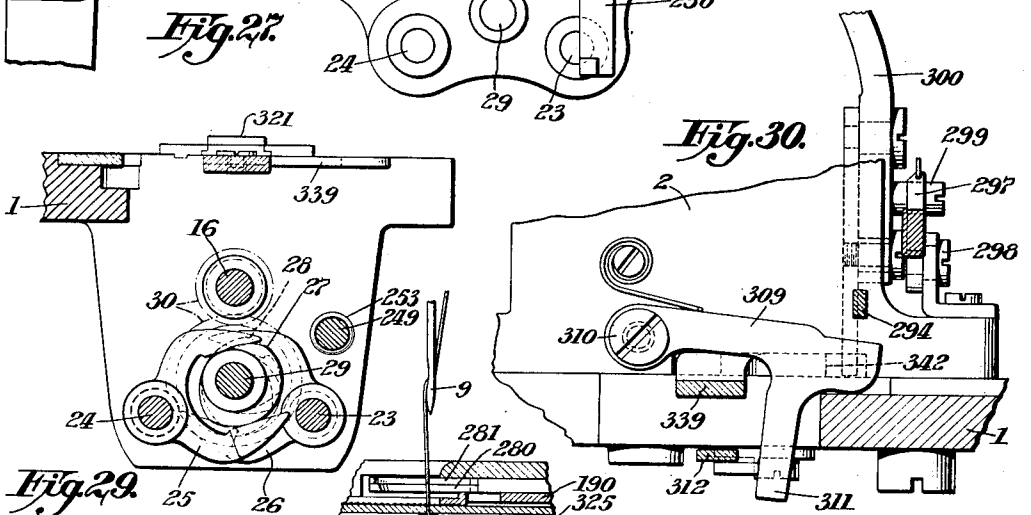


Fig.29. Fig.30. Fig.31a

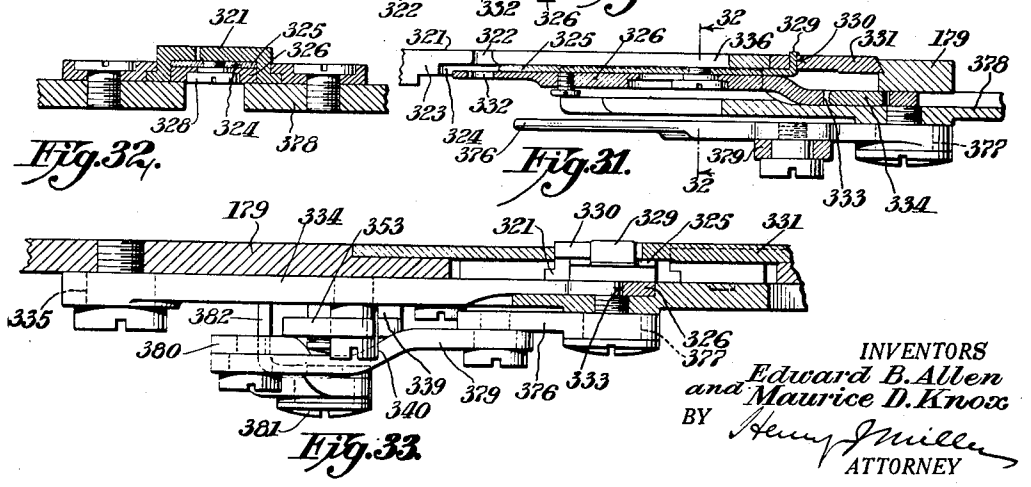


Fig.32. Fig.31. Fig.33.

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BUTTONHOLE SEWING MACHINE

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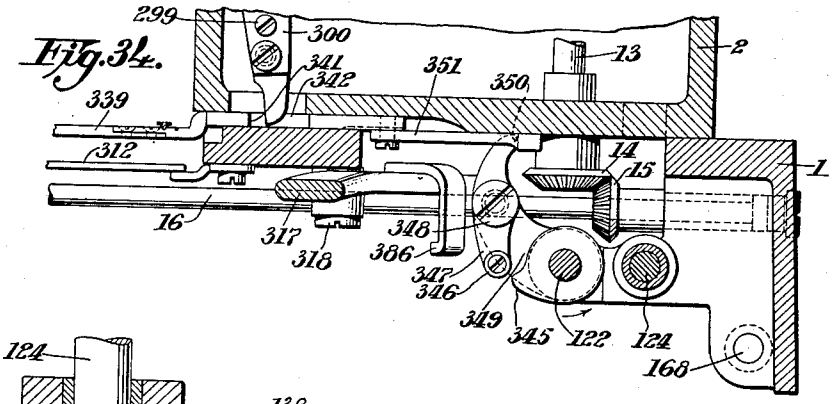


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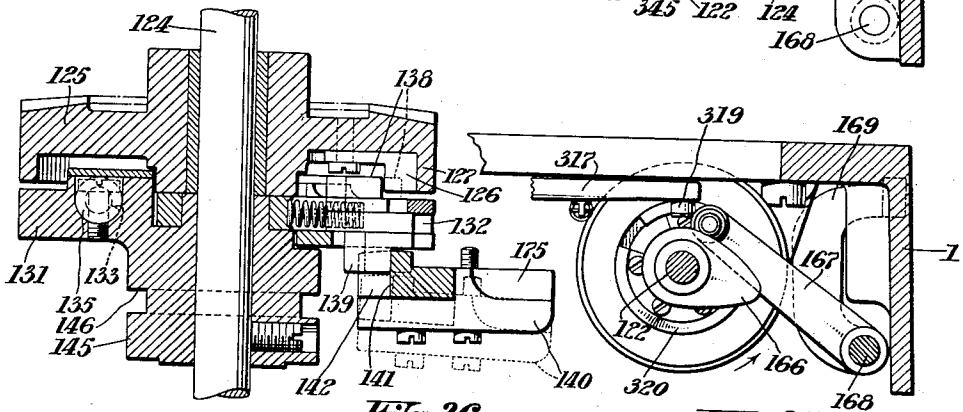


Fig. 36. Fig. 35.

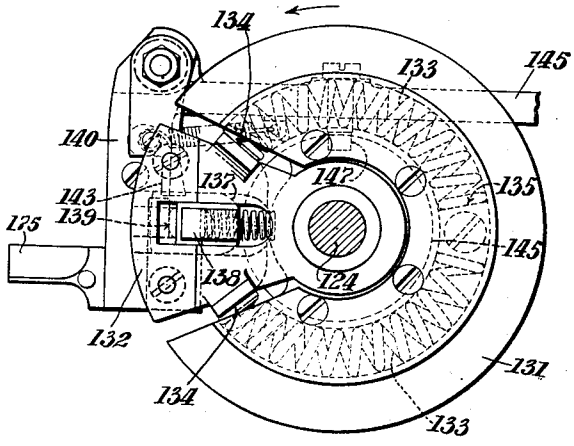


Fig. 37.

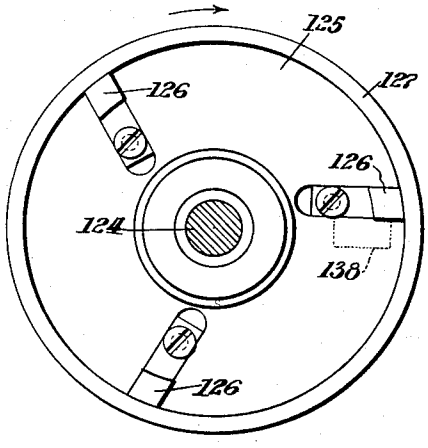


Fig. 38.

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BUTTONHOLE SEWING MACHINE

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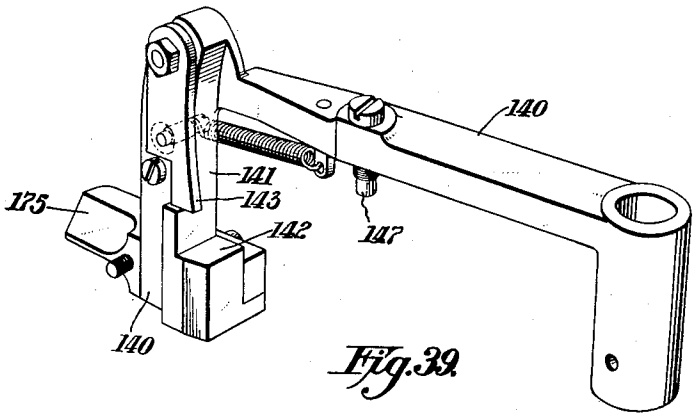


Fig. 39.

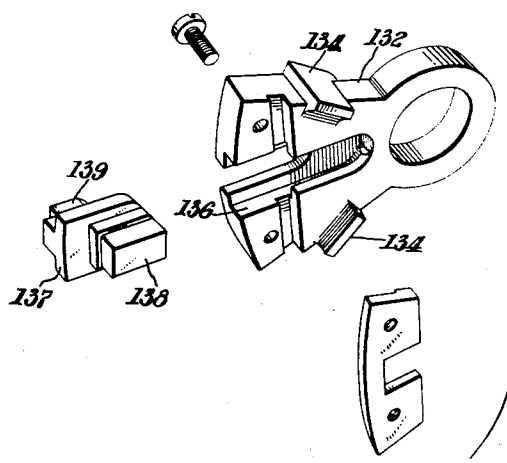


Fig. 40.

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BUTTONHOLE SEWING MACHINE

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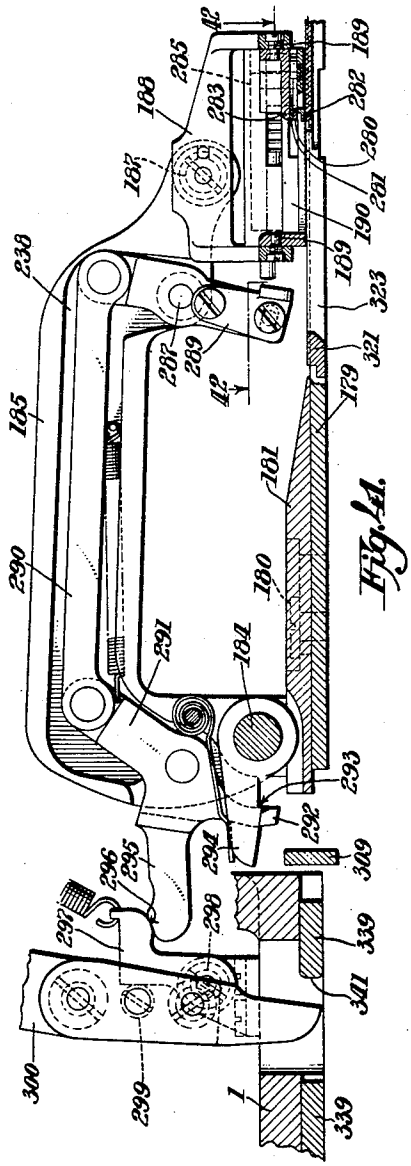


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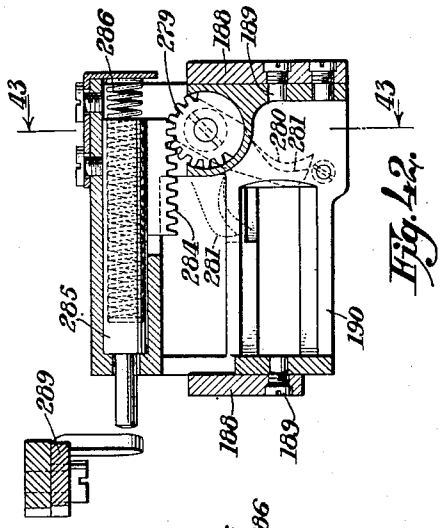


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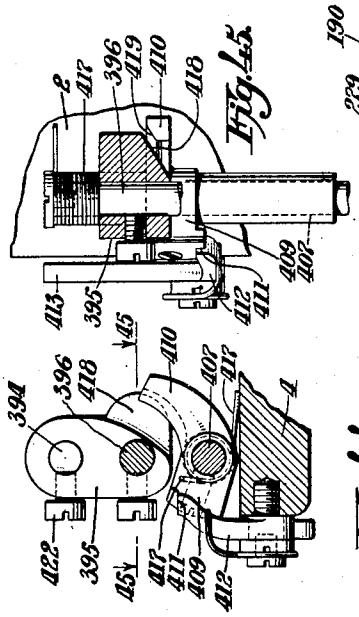


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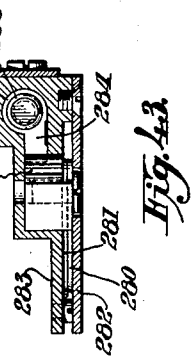


Fig. 43.

Fig. 46.

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BUTTONHOLE SEWING MACHINE

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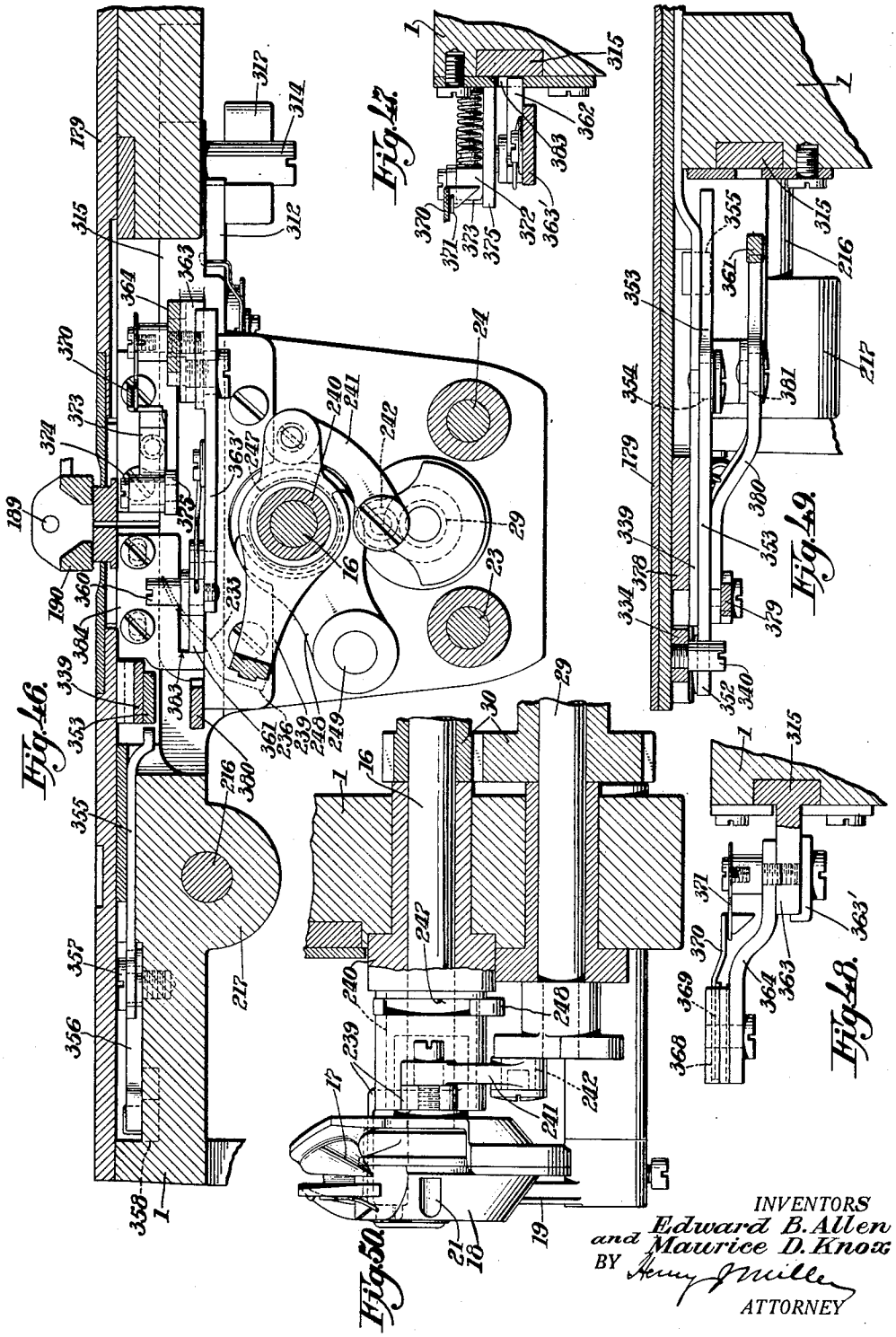


Fig. 46.

Fig. 47.

Fig. 48.

Fig. 49.

Fig. 50.

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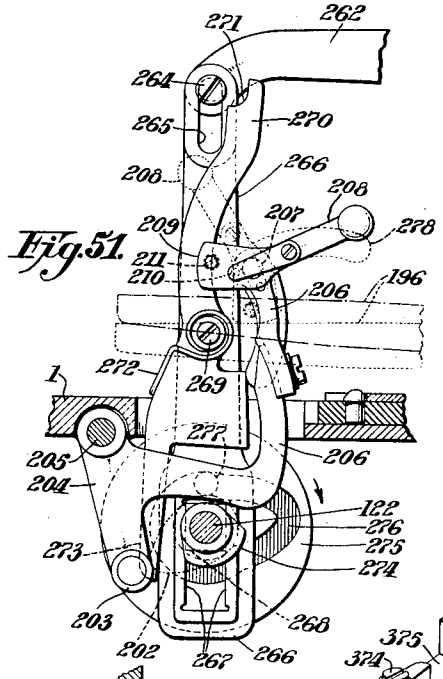


Fig.51.

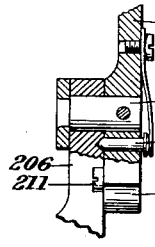


Fig.51a

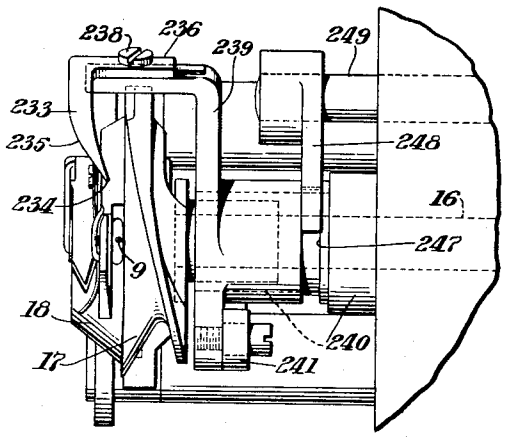


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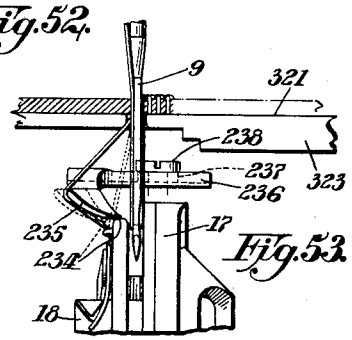


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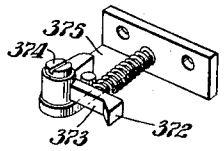


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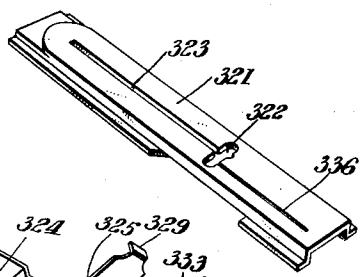


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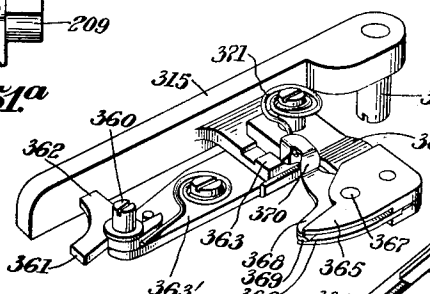


Fig.54.

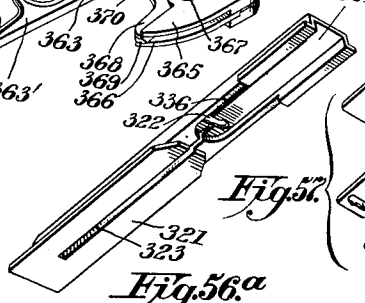


Fig.56a

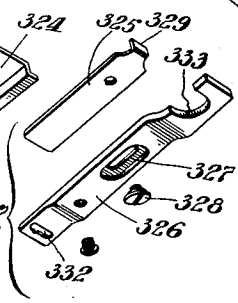


Fig.57.

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BUTTONHOLE SEWING MACHINE

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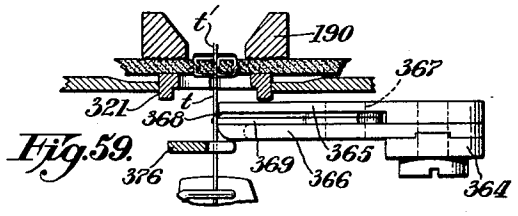


Fig.59.

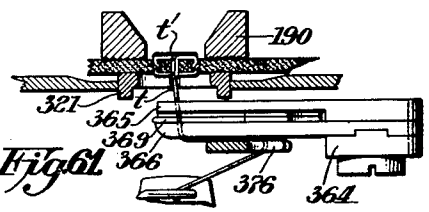


Fig.61.

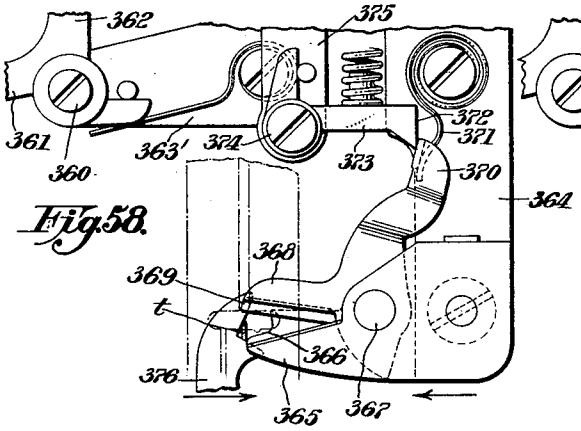


Fig.58.

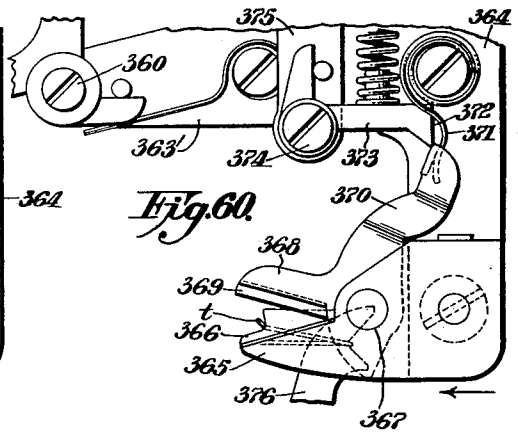


Fig.60.

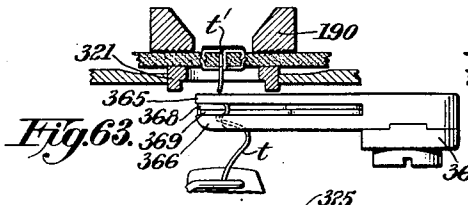


Fig.63.

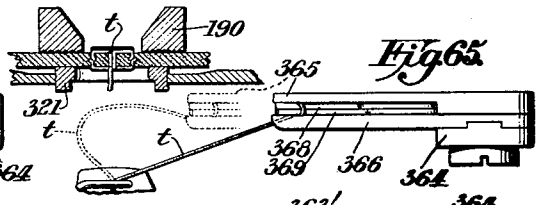


Fig.65.

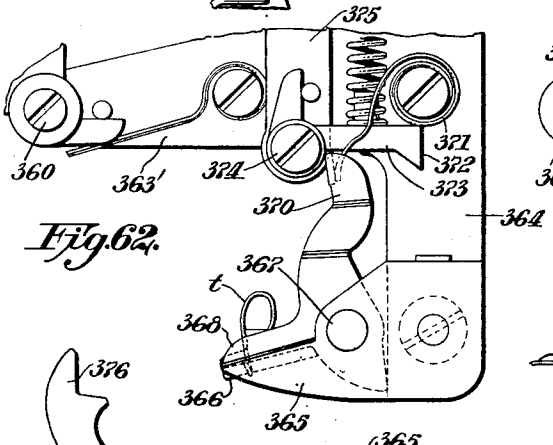


Fig.62.

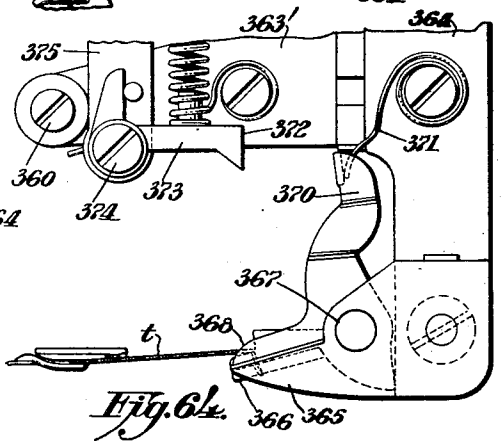


Fig.64.

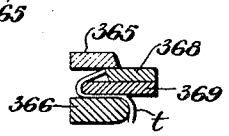


Fig.66.

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Oct. 6, 1936. E. B. ALLEN ET AL 2,056,759

BUTTONHOLE SEWING MACHINE

Original Filed Dec. 26, 1934 18 Sheets-Sheet 18

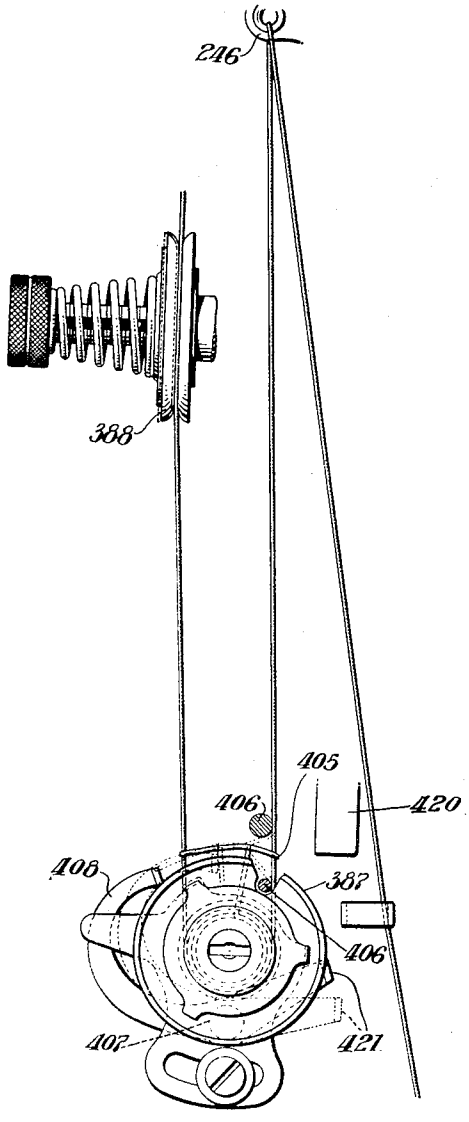


Fig. 67.

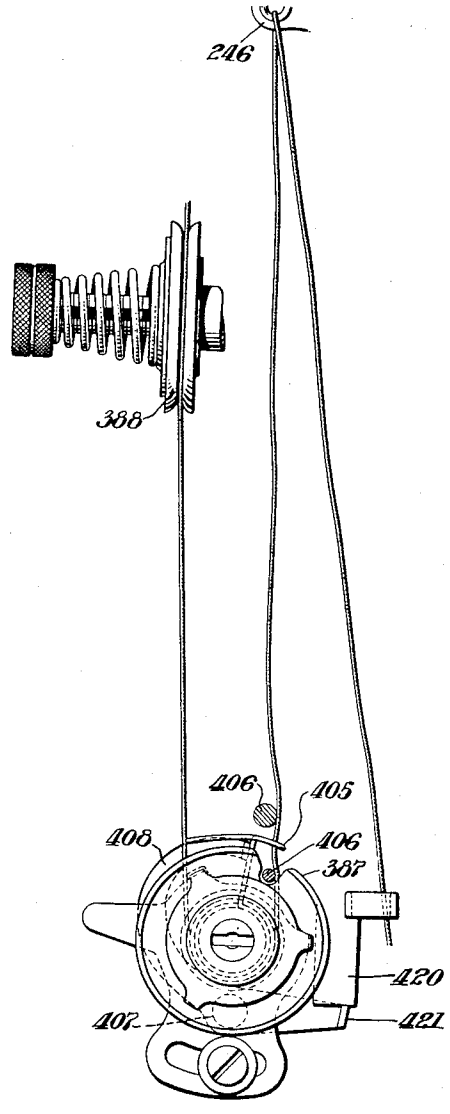


Fig. 68.

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Patented Oct. 6, 1936 2,056,759

UNITED STATES PATENT OFFICE

2,056,759

BUTTONHOLE SEWING MACHINE

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Original application December 26, 1934, Serial No. 759,200. Divided and this application May 23, 1935, Serial No. 22,970

9 Claims. (Cl. 112—252)

This invention relates to buttonhole sewing machines, more particularly of the automatic lock-stitch "straight" type, commonly used for sewing buttonholes in white goods such as men's shirts, collars, cuffs and the like.

In United States Patent No. 1,966,432, of July 17, 1934, there is disclosed rotary-hook lock-stitch mechanism capable of so handling the needle-thread loops and bobbin-thread that pyramid purl buttonholes may be accurately sewn at rates as high as 3000 stitches per minute.

An object of the present invention is to provide an automatic straight buttonhole sewing machine, the various cooperative parts and devices of which are so improved and coordinated as to be commensurate in efficiency and speed with the rotary hook and bobbin-thread-handling mechanisms of said Patent No. 1,966,432, with which they are caused to work in harmony.

The invention further aims to provide the machine with improved thread-cutting mechanism and devices ancillary thereto.

With the above and other objects in view, as will hereinafter appear, the invention comprises the devices, combinations, and arrangements of parts hereinafter set forth and illustrated in the accompanying drawings of a preferred embodiment of the invention from which the several features of the invention and the advantages attained thereby will be readily understood by those skilled in the art.

The present application is a division of our copending application Serial No. 759,200, filed Dec. 26, 1934.

In the accompanying drawings, Fig. 1 is a right side elevation, partly in section, of a button-hole sewing machine embodying the invention. Fig. 2 is a left side elevation of the machine. Fig. 2ª is a similar view of the mechanism at the lower end of the tilting stop-motion lever for the sewing mechanism of the machine, showing such lever latched in its tilted or running position. Fig. 3 is a bottom plan view of the machine. Fig. 3ª is a detail bottom plan view of a part of Fig. 3. Fig. 4 is a horizontal sectional view through the bracket-arm standard of the machine, showing the machine bed in plan. Fig. 4ª is a detail plan view of the stitch-gear adjusting bracket shown in Fig. 4. Fig. 4ᵇ is a section on the line 4ᵇ—4ᵇ, Fig. 4ª. Fig. 5 is a rear end elevation of the machine. Fig. 5ª is a disassembled perspective view of a connection between the top of the sewing stop-motion lever and a latch-tripping rod for the upper thread-cutter and -nipper release mechanism. Fig. 5ᵇ is a detail sectional view of an element of Fig. 5. Fig. 6 is a face view of the sewing stop-motion buffer spring and its carrier. Fig. 7 is a perspective view of the notched stop-cam of the sewing stop-motion device. Fig. 8 is a front end elevation of the machine. Fig. 9 is a vertical section through the pendulous needle-bar carrier or gate.

Figs. 10 and 11 are respectively enlarged face and vertical sectional views of the needle-thread tension device shown at the lower end of the bracket-arm head in Fig. 8. Fig. 12 is a horizontal sectional view through the overhanging bracket-arm of the machine. Fig. 13 is a section on the line 13—13, Fig. 1. Fig. 14 is a section on the line 14—14, Fig. 13. Fig. 15 is a perspective view of the actuating cam of the upper thread-cutter and -nipper release mechanism. Fig. 16 is a plan view of the forward end portion of the machine bed with the work-clamp removed. Fig. 17 is a vertical section through the machine bed and bracket-arm standard on the line 17—17, Fig. 1. Fig. 18 is a section on the line 18—18, Fig. 1. Fig. 19 is a disassembled elevation of certain small parts shown in Fig. 16.

Fig. 20 is a left side elevation, partly in section, of the connections with feed-cam for imparting to the work-clamp its travelling movements lengthwise of the machine bed. Fig. 21 is a section on the line 21—21, Fig. 16. Fig. 22 is a horizontal section on the line 22—22, Fig. 1, but on a larger scale. Fig. 23 is a section on the line 23—23, Fig. 22. Fig. 24 is a perspective view of the inner face of the needle-bar-vibrating crank-head shown in Figs. 22 and 23. Fig. 25 is a bottom face view of the feed-cam. Fig. 26 is a perspective view of the cam which controls the field or center line of vibration of the needle. Fig. 27 is a transverse vertical section through the machine bed on the line 27—27, Fig. 4. Fig. 28 is a section on the line 28—28, Fig. 16, Fig. 29 is a section on the line 29—29, Fig. 3.

Fig. 30 is a fragmentary vertical section on the line 30—30, Fig. 1. Fig. 31 is a longitudinal vertical section through the forward end-portion of the needle-throat-plate of the machine, showing the under nipper for the needle-thread; the nipper being open or in position to receive the needle on its first descent in the sewing of a buttonhole. Fig. 31ª is a similar view showing the nipper closed on the beginning end of the needle-thread after the needle has risen clear of the work and the take-up lever has reached the top of its first up-stroke. Fig. 32 is a transverse section through the throat-plate on the line 32—32, Fig. 31. Fig. 33 is a section substantially on the line

33—33, Fig. 4. Fig. 34 is a fragmentary vertical section longitudinally of the machine bed at the rearward end thereof adjacent the bracket-arm standard on the line 34—34, Fig. 3. Fig. 35 is a similar sectional view on the line 35—35, Fig. 3. Fig. 36 is a horizontal sectional view through the one-rotation clutch mechanism for driving the auxiliary shaft of the machine which drives the work-clamp closing and opening mechanism the buttonhole-cutting mechanism and various other mechanisms auxiliary to the stitch-forming mechanism in the buttonhole producing cycle. Fig. 37 is a face view of the driven or bottom element of the clutch shown in Fig. 36. Fig. 38 is a face view of the live or top clutch-element shown in Fig. 36. Fig. 39 is a perspective view of the clutch-controlling gate.

Fig. 40 is a disassembled perspective view of parts of the driven clutch-element. Fig. 41 is a longitudinal vertical sectional view through the work-clamp, showing the operating mechanism for the upper thread-cutter and -nipper. Fig. 42 is a section on the line 42—42, Fig. 41. Fig. 43 is a section on the line 43—43, Fig. 42. Fig. 44 is a section on the line 44—44, Fig. 2. Fig. 45 is a section on the line 45—45, Fig. 44. Figs. 46, 47 and 48 are, respectively, transverse vertical sectional views on the lines 46—46, 47—47 and 48—48, Fig. 16. Fig. 49 is a sectional view on the line 49—49, Fig. 16.

Fig. 50 is a vertical sectional view through the front hook-shaft bearing showing the bobbin-thread pull-off driving connections. Fig. 51 is a fragmentary left side elevational view of the clamp closing-and-opening and buttonhole-cutting mechanisms. Fig. 51ª is a sectional view of the element of Fig. 51. Fig. 52 is a top plan view of the rotary hook and bobbin-thread pull-off devices. Fig. 53 is a fragmentary right side elevation of the needle, rotary hook and bobbin-thread pull-off devices. Fig. 54 is a perspective view of the bobbin-thread-nipper and -cutter. Fig. 55 is a perspective view of the latch which controls the opening and closing movements of the bobbin-thread-nipper and -cutter. Figs 56 and 56ª are, respectively, top and bottom perspective views of the throat-plate. Fig. 57 is a disassembled perspective view of the under needle-thread-nipper. Fig. 58 is a top plan view of the bobbin-thread-nipper and -cutter advancing and opening to seize and cut the bobbin-thread at the end of a sewing period. Fig. 59 is a front elevation, partly in section, of the parts shown in Fig. 58.

Fig. 60 is a view similar to Fig. 58 with the bobbin-thread-cutter and -nipper almost fully advanced and about to close upon the bobbin-thread. Fig. 61 is a front elevation, partly in section, of the parts shown in Fig. 60. Fig. 62 shows the bobbin-thread-cutter and -nipper fully advanced and closed upon the bobbin-thread. Fig. 63 is a front elevation, partly in section, of the parts shown in Fig. 62. Fig. 64 shows the closed bobbin-thread-nipper and -cutter, fully retracted to pull off a measured length of bobbin-thread for the beginning of the next sewing operation. Fig. 65 is a front elevation, partly in section, of the parts shown in Fig. 64, the bobbin-thread-cutter and -nipper being also shown in dotted lines in its subsequently partially advanced position to slacken the bobbin-thread so that it may be easily pulled to position in the work by the first needle-loop to be tightened in the next sewing operation. Fig. 66 is a transverse section through the bobbin-thread-cutter and -nipper. Fig. 67 shows the parts of the needle-thread-controlling mechanism at the end of a sewing period, and Fig. 68 is a similar view of the parts at the start of the next button-hole producing cycle.

Frame

The machine frame comprises a box-like bed or casing 1 on top of which is secured the stand-and 2 of the overhanging bracket-arm 3 terminating in the head 4. The space above the bed 1 and under the overhanging portion of the bracket-arm 3 constitutes a work-receiving throat and it is within this throat that the work-clamp of the machine is customarily mounted for step-by-step travelling movements longitudinally of the bed 1 to distribute the stitches lengthwise of the buttonhole being produced. The present work-clamp is so constructed that almost the entire depth of the throat of the frame is available for reception of work and the machine is thus well adapted for sewing buttonholes in shirt bosoms. The standard and bracket-arm have open sides and coplanar inner vertical webs 2′, 3′, the open sides being closed by removable cover-plates 3ª and 3ᵇ, Fig. 17.

Stitch-forming mechanism

The main sewing shaft 5 of the machine is journaled in the bracket-arm 3 and at its forward end carries the usual crank 6 connected by the link 7 to the reciprocatory needle-bar 8 carrying the eye-pointed needle 9. The needle-bar 8 is mounted for endwise reciprocation in the pendulous carrier or gate 10, Figs. 8 and 9, suspended from the pivot 11 and vibrated transversely of the bracket-arm 3 by mechanism to be described.

Mounted on the main sewing shaft 5 is a bevel-gear 12, Fig. 1, which meshes with the bevel-gear 12′ fixed to the vertical shaft 13 to the lower end of which is fixed the bevel-gear 14 meshing with the bevel-gear 15 on the lower horizontal shaft 16 carrying at its forward end the rotary hook 17 which cooperates with the needle 9 to form stitches.

The rotary hook 17 embraces the stationary bobbin-case 18 which is journaled within it and is restrained against rotation by the independently oscillatory fingers 19, 20, Fig. 8, received in the notches 21, in the thread-case. The bobbin-case 18 carries the usual bobbin 22 of under thread. The fingers 19, 20 are carried by the respective parallel rock-shafts 23, 24 which are oscillated one at a time, to clear the bobbin-case in the loop-casting operation, by the respective cam-followers 25, 26 in engagement with the respective cams 27, 28 on the cam-shaft 29 connected by gears 30 to the hook-shaft 16 to run at half the speed of the latter. The present rotary hook and bobbin-case devices, as well as the cam-mechanism for operating the openable rotation-restraining fingers 19, 20 are constructed substantially in accordance with the disclosure of said U. S. Patent No. 1,966,432. While any of the usual loop-taking mechanisms may be used, the particular loop-taking mechanism disclosed is preferred because of the extreme ease and freedom with which the needle-loops are passed thereby around the bobbin-case at high operative speeds.

The vertical sewing shaft 13, Fig. 18, carries a pinion 31 which drives the gear 32 on the short vertical shaft 33 to the lower end of which is fixed the head 34 carrying the diametrically opposed

pins 35 which mesh with and impart step-by-step impulses to the radially slotted star wheel 36, Figs. 1 and 12, fast on the vertical shaft 37. The shaft 37 has detachably fixed to its lower end a stitch-gear 38, Figs. 1 and 22, of any desired diameter meshing with a gear 39 concentric with and fixed to which is a pinion 40 meshing with the gear 41 on the vertical cam-shaft 42 which is journaled within the standard 2 and is slowly driven in step-by-step fashion through one complete revolution for each buttonhole-producing cycle. The gear 39 and concentric pinion 40 are fixed to the stub-shaft 39a which is journaled in the eccentric bushing 39b rotatively adjustable in the bracket 39c swingable about the shaft 42 as an axis. The bushing 39b has a knurled head 39d which is engaged by the keeper 39e to hold the bushing in its position of adjustment to properly mesh the pinion 40 with the gear 41. The swing-bracket 39c permits the gear 39 to be properly meshed with a selected stitch-gear 38 of any desired size; the larger the gear 38, the smaller the number of stitches made per buttonhole-producing cycle.

Needle-bar vibrating mechanism

The pendulous needle-bar carrier or gate 10 has pivoted thereon at 43, Figs. 8 and 9, a lever 44 the upper end of which is connected by the inclined link 45 to the lower end of the vertical rod 46 slidably mounted in the bearing bosses 47, 48 on the gate 10. Fixed to the slide-rod 46 is a stop-collar 49 which is urged into engagement with the upper bearing boss 48 by means of the coil-spring 50. The lower end of the lever 44 is connected by a short two-piece link 51 of adjustable length to a crank-pin 52 on the crank-head 53. The crank-head 53 is fulcrumed on the stud-screw 54 carried by the crank-disk 55 fixed to the hollow horizontal crank-shaft 56 journaled in bearings 57, 58 at the level of the lower end of the bracket-arm head 4, as far as possible below the pivotal suspport 11 for the needle-bar gate. The shaft 56 is driven by the bevel-gear 59 which meshes with the bevel-pinion 60 on such shaft. The ratio of gearing is such that the shaft 56 is driven one-half revolution for each impulse imparted to the star-wheel 36; the crank 52 being substantially horizontally offset from the axis of the shaft 56 at the end of each semi-rotation, so that the point of connection of the link 51 to the lever 44 is in one or the other of its extreme positions relative to the axis of the shaft 56.

Provision is made for varying the eccentricity of the crank 52 while the machine is in operation, so that the amplitude of needle-vibration may be increased to sew barring stitches at the ends of the buttonhole. To this end there is slidably mounted in the shaft 56, Fig. 22, a push-rod 61 having at one end an inclined head 62 snugly fitting between the spaced guide-blocks 63, Fig. 24, mounted in the back face of the crank-head 53. Endwise movement of the push-rod 61 will shift the crank-head 53 about its pivot-screw 54 and vary the eccentricity of the crank 52. The present crank-adjusting mechanism is similar, in principle, to that disclosed in U. S. Patent No. 1,864,165, of June 21, 1932, but differs therefrom in that the present crank-head is pivotally adjustable whereas the crank-head of said patent is bodily adjustable in a guideway. In the present instance there is a cross-pin 64 passing tightly through the shaft 61 and loosely through enlarged slots 65, Fig. 1, in the tubular shaft 56. The ends of the cross-pin 64 are tightly received in the collar 66 slidably mounted on the shaft 56. A coil-spring 67 reacting against a collar 68 on the shaft 56 urges the collar 66 and push-rod 61 to the right, Fig. 22, and shifts the crank 52 to its position of minimum eccentricity, in which position the stop-arm 69 on the crank-head 53 is arrested by the stop-lug 70 on the disk 55, Fig. 8, and the amplitude of needle-vibration is correct for the side-stitches of the buttonhole.

When the stitching reaches the ends of the buttonhole the amplitude of needle-vibration must be increased for the barring stitches and this is accomplished by the cams 71 peripherally adjustable on the gear-wheel 41 fixed to the cam-shaft 42. The cams 71 alternately engage and rock the lever 73 which is fixed to the shaft 74 to which is also fixed the three-armed lever 75, 76, 77, the arm 75 of which pushes the rod 61 endwise to bar-stitching position. The arm 76 of the three-armed lever engages the stop-screw 78 when the cams 71 are not in engagement with the lever 73. The arm 77 of the three-armed lever engages the screw 79 threaded into the shiftable tension-release lever 80 to be later described.

As the work-clamp of the machine to be described has a motion longitudinally only of the machine-bed, and no lateral motion, it is necessary, not only to increase the amplitude of needle-vibration in sewing the barring stitches, but also to shift the field or center line of needle-vibration, so that it will coincide with the center line of the buttonhole. It is also necessary to further shift the field or center line of needle-vibration in sewing the return side of the buttonhole.

To accomplish the necessary shifts of the field of vibration of the needle-bar, provision is made for automatically depressing the slide-rod 46 in the needle-bar gate 10 to rock the lever 44 on the pivot 43 and thus shift the gate 10 relative to the left end of the link 51, Fig. 8, which vibrates such gate. Fulcrumed on the pin 81, Fig. 2, is a lever 82 carrying at its forward end an adjustable screw 83 the rounded head of which engages the upper end of the slide-rod 46. The lever 82 has in its rearwardly extending arm a slot 84 in which is adjustably fastened a connection pin 85 for the upper end of the link 86 connected at its lower end at 87 to the lever 88 fulcrumed at 88' on the vertical web 3' of the bracket-arm 3. The lever 88 has a follower-point or nose 89 which engages the needle-bar-vibration field-control cam 90 on the cam-shaft 42. The cam 90, Fig. 26, has on its under face the upper and lower flat faces 91, 92, respectively, which control the field of vibration of the needle in sewing the first and return sides of the buttonhole. There are also two intermediate flat faces 93 of small angular extent which control the field of vibration of the needle when sewing the barring stitches. Inasmuch as the point of engagement of the screw 83 with the upper end of the slide-rod 46 is in or near coincidence with the axis of suspension of the pendulous needle-bar gate 10, the vibratory movements of such gate have no appreciable effect upon the endwise position of the slide-rod 46. The extreme down-motion of the slide-rod 46 required to shift the field of vibration of the needle from one to the other side of the buttonhole is not great. It is about enough to shift the inclined link 45, Fig. 8, to a horizontal position at right angles to the slide-rod 46. The link 45 is thus, in effect, a toggle-link. As it nears its horizontal position, a given

down-motion of the slide-rod 46 has but little effect upon the position of the lever 44. Furthermore the operative strains transmitted to the lever 44 by the crank 52 and link 51 are well withstood by the link 45 with little or no reactionary tendency to shift the rod 46 endwise. This is because of the fact that the link 45 is nearly or substantially at right angles to the slide-rod 46 at all working positions of the slide-rod 46 when the collar 49 is depressed below the bearing-boss 48. Further, by virtue of the present mechanism, the weight and inertia of the needle-bar gate and oscillatory parts connected thereto are greatly reduced and this is a matter of importance in a high-speed machine.

Stop-motion device

The stop-motion device for the sewing shaft 5 is preferably constructed substantially in accordance with the disclosure of U. S. Patent No. 1,915,910, of June 27, 1933, with which is combined a belt-shipper mechanism constructed substantially in accordance with U. S. Patent No. 1,659,937, of Feb. 21, 1928.

The main shaft 5 carries the tight and loose belt-pulleys, 94 and 95, respectively. Integral with the hub of the tight pulley 94 is the pinion 96, Fig. 12, which meshes with the gear 97 of twice its diameter journaled on the stud-pin 98 which is offset to one side of the main shaft 5. The gear 97 houses the buffer spring 99, Fig. 6, which reacts at one end against the fixed block 100 and at the other end against the lug 101 on the usual stop-cam 102 having the eccentric portion 103 and stop-notch 104 which cooperate as usual with the upwardly spring-pressed plunger 105, Fig. 5, mounted in the tilting stop-motion lever 106 fulcrumed on the trunnion screws 107 and urged to its vertical or stopping position by the spring 108, Fig. 1, in which position the plunger 105 is in cooperative relationship with the stop-cam 102. When the stop-motion lever 106 is tilted in a direction to compress the spring 108, the plunger 105 is carried out of range of the stop-cam 102 and the main shaft 5 is unlocked for driving. The stop-motion lever 106 is latched in its tilted or running position, Fig. 2ª, by means of the latch-lever 109 which is fulcrumed at 110 in the bed 1 and carries a follower nose 111 in position to be acted upon at the close of a sewing period by a tripping point 112 on the feed-wheel 113 fixed to the cam-shaft 42.

The belt-shipper fork 114 is fixed to a slide-rod 115 carried by the lever 116 fulcrumed at 117 on the frame. A spring 118 urges the slide-rod 115 in a direction to shift the belt-shipper fork 114 to a position in register with the loose pulley 95. When the stop-motion lever 106 is tilted to running position, a laterally extending bar 119 fixed thereto engages a toothed block 120 fixed to the slide-rod 115 and shifts the latter in its carrier-lever 116 to carry the belt-shipper fork 114 to a position in register with the tight pulley 94, thus starting the main sewing shaft 5. When the stitching has progressed to the point of sewing the final bar of the buttonhole, a tripping point 121, Fig. 1, on the cam-wheel 90 engages and rocks the lever 116 to disengage the toothed block 120 from the laterally extending bar 119, whereupon the spring 118 projects the slide-rod 115 and belt-shipper fork 114 to stopping position, thus cutting off the power. The main shaft 5 and sewing mechanism then coast or run on momentum in sewing the final barring stitches, at the completion of which the stop-motion lever 106 is tripped by the tripping point 112 on the feed-wheel 113.

Driving and stopping mechanism for auxiliary shaft

The machine is provided with an auxiliary shaft 122 which makes a semi-rotation at the beginning of a buttonhole-producing cycle, before the stitch-forming mechanism is started, and a second semi-rotation at the end of a buttonhole-producing cycle, after the stitch-forming mechanism has been stopped. This auxiliary shaft is utilized to actuate various parts and mechanisms auxiliary to the stitch-forming mechanism in a buttonhole producing cycle. For example, the auxiliary shaft in its first semi-rotation, closes the work-clamp and tilts the stop-motion lever to running position and in its final semi-rotation trips the upper needle-thread-cutter and -nipper, actuates the bobbin-thread-cutter and -nipper, actuates the buttonhole cutter, and opens the work-clamp. It also performs certain other auxiliary operations as will be hereinafter described.

The auxiliary shaft 122, Figs. 2 and 3, is journaled within and below the top of the bed 1 and is driven through 2-to-1 reduction gears 123 by the drive-shaft 124 which when started, makes one complete rotation and then comes to rest; imparting a semi-rotation of the auxiliary shaft 122. Loose on the drive-shaft 124 is a continuously running live clutch-disk 125, Figs. 36 and 38, having three projecting clutch-teeth 126 within the flanged rim 127 thereof. The live clutch-disk 125 is gear-driven by the shaft 128, Fig. 3, which is at right angles to the shaft 124 and projects through the rear end-wall of the bed 1. Fixed to the shaft 128, externally of the bed 1, is the belt-pulley 129, Fig. 5, which is wrapped by one limb of the driving belt 130 which connects the tight and loose pulleys 94, 95, with the usual power pulley (not shown) below the bench or table upon which the machine is stationed for use. Heretofore two separate belts have customarily been used for driving the sewing mechanism and the auxiliary shaft mechanism. In accordance with the present improvement only one driving belt is required and a consequent saving in installation and upkeep costs may be effected.

The driven-clutch disk is composed of two relatively movable segmental sections 131, 132. The clutch-section 131 houses a pair of opposed buffer-springs 133 which engage the seats 134 on the clutch section 132 and are separated by the abutment block 135 fixed in the clutch section 131. The clutch-section 132 is formed with a radial guideway 136, Fig. 40, for the outwardly spring-pressed clutch-dog 137 having at one side a clutch-tooth 138 adapted, in its outer or dotted line position, Fig. 36, to be engaged by one of the driving teeth 126 in the live clutch-element 125. The clutch-dog 137 has at its other side the throw-out tooth 139 which at the end of one revolution of the driven clutch disk engages the usual clutch-controlling gate 140 and is forced inwardly in the clutch-element 132 to disengage the driven tooth 138 from the driving tooth 126. The gate 140 has the usual clutch-dog disengaging face 141 and stop-shoulder 142 above which is the rebound-preventing spring-energized latch 143. The gate 140 is fulcrumed to swing on the vertical shaft 144. The hub 145 of the two-part driven clutch disk 131, 132, is fast upon the driven

shaft 124 and is formed with the usual gate-controlling cam slot 146 entered by the follower 147 carried by the gate 140. The cam-slot 146 has the usual enlarged portion 148, Fig. 4, permitting a lateral swinging motion of the gate to dotted line position, Fig. 36, to throw in the clutch, following which the cam 146 engages the follower-pin 147 and automatically returns the gate to its full line or throw-out position in time to arrest the shaft 124 at the completion of a single rotation. The clutch-mechanism above described is old in principle, being disclosed in United States Patent No. 1,024,490, of Apr. 30, 1912, for controlling the buttonhole-cutter shaft.

At the beginning of a buttonhole-producing cycle the gate 140 is manually shifted to initiate the first semi-rotation of the auxiliary shaft 122. To this end there is fulcrumed at 149 on the bed 1 a treadle-operated spring-biased lever 150 having a boss 151, Figs. 17 and 19, in which is mounted for longitudinal adjustment a pin 152 having a conical tip 153 and a screw-threaded shank 154 threaded into the boss 151 and locked in adjusted position by means of the nut 155. When the lever 150 is pulled downwardly by the operator to start the machine, the conical tip 153 of the pin 152 engages the sloping face 156 of the lever 157 fast on the gate-shaft 144 and swings the gate to dotted-line or running position, Fig. 36.

Fixed to the shaft 124, Fig. 1, behind the side cover-plate on the bed 1, is a pinion 158 meshing with a gear 159 of twice its diameter on the stub-shaft 160. Integral with the gear 159 is a cam disk 161, having an eccentric portion 162 which is less than 180° in circumferential extent followed by a concentric portion 163 ending with the drop-off shoulder 164. This cam 161 cooperates with the follower 165 on the downwardly extending arm 150' of the lever 150 to forcibly return or elevate the lever 150 during the first semi-rotation of the auxiliary shaft 122. The concentric portion 163 of the cam 161 blocks the lever 150 against manual movement until after the auxiliary shaft 122 has executed its final semi-rotation and returned the cam 161 to the position shown in Fig. 1. Thus after the machine has been started it is impossible for the operator to again manipulate the lever 150 until after the machine has completed a buttonhole-producing cycle.

The auxiliary shaft 122 carries a cam 166, Fig. 36, which acts upon the follower arm 167 during the first semi-rotation of such shaft to rock the shaft 168 carrying the tappet-arm 169 which engages the stop-motion lever 106, Fig. 2, and tilts the latter to running position, Fig. 2a, thus starting the stitch-forming mechanism. Fulcrumed at 170, Fig. 5, at the rear end of the bed 1 is a trip-lever 171 carrying a spring-biased latch 172 adapted to be engaged and lifted by the block 173, fixed to the lower end of the stop-motion plunger 105, when the latter is depressed by the eccentric portion 103 of the stop-cam 102 and rises into the stop-notch 104. The lever 171 carries a pivoted and spring-biased latch-tooth 174 which, during the up-motion of the stop-motion plunger 105, engages the sloping face 175 on the gate-extension 140' and lifts the latter to running position to initiate the final semi-rotation of the auxiliary shaft 122. Referring to Fig. 5, it will be understood that the trip lever 171 and associated parts are shown in the respective positions which they occupy when the machine is at rest. When the machine is started and the stop-motion lever 106 is tilted to running position, the block 173 is displaced rearwardly from and releases the latch 172, whereupon the spring 176 rocks the lever 171 in a direction to snap the tripping tooth 174 upwardly past the gate extension 140' into position to subsequently actuate the gate as above explained. 177 represents a stop-arm on the lever 171 which engages the bearing boss 178, Figs. 3 and 5, for the shaft 128 and limits the motion of the lever 171 under the influence of the spring 176.

Work-clamp

The work-clamp comprises a lower work-supporting plate 179 upon the upper face of which is secured by screws 180 the fulcrum plate 181 having adjacent its rearward edge, which is substantially coincident with the rearward edge of the work-supporting plate 179, the upstanding lugs 182 for the trunnion-screws 183 supporting the fulcrum shaft 184 by which the upper clamp-arm 185 is carried and to which it is pinned at 186, Fig. 27. The upper clamp-arm 185 is upwardly arched and projects forwardly from its fulcrum at the rear perimetrical portion of the plate 179. At its forward end the clamp-arm 185 carries the pivot stud 187 rigid with the yoke 188 which pivotally carries at 189 the upper clamp-foot 190. The pivot-stud 187 is journaled in a lateral boss 191, Fig. 8, on the front end of the lever 185. A relatively weak coil-spring 192 surrounding the rear end boss 185', Fig. 27, of the upper clamp-arm 185 and at its opposite ends engaging under the arm 185, Fig. 1, and on top of the plate 181, tends at all times to elevate the clamp-foot 190 from the work.

Two means are provided for closing the clamp-foot upon the work, one a manual means which may be operated at any time prior to starting the machine to lightly close the work-clamp to enable the operator to use the clamp-foot as a sight in locating the work precisely in buttonhole-receiving position, and the other an automatic means for firmly closing the work-clamp after the machine has been started. The manual means for closing the work-clamp comprises the lever-arm 193 which is fixed to the fulcrum-shaft 184 and overhangs the right side edge of the work-supporting plate 179 and to which a treadle-rod 194 is connected. The automatic means for closing the work-clamp comprises the clamp-closing lever 195, 196, which is fulcrumed freely on the fulcrum-shaft 184. The forwardly extending arm 195 of the clamp-closing lever lies closely alongside and approximates the upwardly arched shape of the clamp-arm 185. The rearwardly extending arm 196 of the clamp-closing lever lies alongside the standard 2, Fig. 2, and reaches to a point over the auxiliary shaft 122. A strong leaf-spring 197 secured to the plate 181 bears upwardly under a roller-stud 198 on the lever-arm 196 to apply a strong clamp-closing pressure to the lever-arm 195 which transmits such pressure, when permitted, to the lateral boss 191 at the front end of the clamp-arm 185. The spring 197 has at its anchored end a lip 199 which engages under a lip 200 in the plate 181. An adjusting screw 201, threaded into the spring 197 and bearing upon the plate 181, enables the pressure of the spring 196 upon the roller-stud 198 to be regulated to suit the work.

Mounted on the auxiliary shaft 122 is a clamp-closing and -opening cam 202, Fig. 2, which at the beginning of a buttonhole-producing cycle

engages a roller 203 on the downwardly extending arm 204 of a two-armed lever fulcrumed in the bed 1 at 205. This two-armed lever includes a forwardly and upwardly extending arm 206 which has fulcrumed thereon at 207 a hand-lever 208 having a downwardly extending cam-portion 209 bearing upon the clamp-lever-arm 196 and holding the latter in its depressed or clamp-opening position. In the initial semi-rotation of the auxiliary shaft 122, the cam 202 is carried out of engagement with the roller 203 and the spring 197 is permitted to act to close the work-clamp. In the final semi-rotation of the auxiliary shaft 122, the cam 202 is carried around to the position shown in Fig. 2 and acts upon the two-armed lever 204, 206 to depress the lever-arm 196 and permit the work-clamp to open under the influence of the light spring 192. There is slidably mounted in the cam-member 209 a round-nosed spring-pressed detent pin 210, Fig. 51a, which enters a shallow hole in the lever-arm 206 to yieldingly hold the cam-member 209 in clamp-opening or dotted line position, Fig. 51. In this position the stop-screw 211 engages the side of the lever-arm 206. It will be observed that any tendency of the upwardly arched clamp-closing lever-arm 195 to flatten under the operative stresses to which it is subjected will not cause the clamp-foot 190 to creep forwardly relative to the lower work-supporting plate 179 since it merely presses directly down upon the boss 191 at the front end of the clamp-arm 185 carrying the clamp-foot 190.

The work-clamp is mounted for longitudinal travelling movements only, and no lateral movement, on the deck of the bed 1. To this end it is detachably connected by means of dowel pins 212 and a screw 213, Figs. 4 and 16, to the work-clamp carrier-plate 214 flush with the deck of the bed 1. The carrier-plate 214 is supported and guided mainly by the two lugs 215 on its under side which slidably fit the fixed guide-rod 216 carried at its opposite ends by the bed-lugs 217. The plate 214 is also supported along one edge 214', Fig. 16, by the guideway 218, Fig. 28, in the bed 1.

Traveling movements are imparted to the work-clamp carrier-plate 214 by the feed-cam groove 219 in the feed-wheel 113. The cam-groove 219 is entered by the follower 220 on the arcuate lever 221 on the bed 1. The lever 221 is formed with an arcuate slot 223 in which is adjustably gripped a block 224 which is connected by the link 225 to the work-clamp carrier-plate 214. The block 224 is gripped in the guideway by means of the endwise adjustable curved wedge 226, Figs. 3 and 21, moved endwise in opposite directions to wedging and releasing positions by means of the screw 227. The link 225 has rigid with it a laterally extending arm 228 which extends through a slot 229 in one side-wall of the bed 1 and terminates in a pointer 230 playing over a scale on the plate 231, Fig. 4. The scale is graduated from ⅜ inch to 1½ inches to indicate the length of the buttonhole which the machine is set to produce. The guideway 223 is concentric with the pivotal connection between the link 225 and carrier-plate 214 in the at-rest position of the parts, so that the work-clamp always starts from the same position on the bed but may be set to travel any desired distance, within limits, and return to a fixed and invariable starting position. The arm 228 has an end-aperture 232 which may be readily engaged by a suitable extension-rod or tool whenever it is desired to make an adjustment of the length of the buttonhole.

Bobbin-thread stitch-by-stitch pull-off

The machine is provided with a variable bobbin-thread pull-off in the form of an oscillatory blade 233, Figs. 46, 50, 52 and 53, having a pointed end 234 and an inclined bobbin-thread-engaging edge 235. The pull-off blade 234 has a shank 236 which is slotted at 237 to receive the screw 238 which adjustably secures it upon the carrier-lever 239 fulcrumed on the bearing bushing 240 for the rotary-hook shaft 16. The carrier-lever 239 is connected by the link 241 to the crank 242 on the shaft 29 journaled below and parallel to the hook-shaft 16. The shaft 29, it will be remembered, runs at half the speed of the hook-shaft 16 and thus the pull-off blade 233 is given one complete to-and-fro oscillation for each stitch-forming cycle. It is timed to begin its advance as the needle is starting down and to complete its advance at about the time the needle reaches the limit of its down-stroke. The pull-off blade 233 dwells in its advanced position while the needle is throwing out a loop of upper thread for seizure by the rotary hook 17. The pull-off then retracts so that slack bobbin-thread is available to be absorbed into the next stitch when the needle-loop is pulled up by the usual link take-up 246.

Provision is made for rendering the pull-off 233 ineffective during the sewing of the barring stitches so that the locking points of these stitches will not be pulled through the work as are the side stitches of the buttonhole. To this end the working position of the carrier-lever 239 is shifted longitudinally of the bushing 240 so that the point 234 of the pull-off blade will, in its advance, miss the bobbin-thread, as shown in dotted lines in Fig. 53. The hub of the carrier-lever 239 is formed with a groove 247 which receives the forked end of an arm 248 on the slide-shaft 249, Fig. 2, carrying at its rearward end the arm 250 which bears upon the cam-members 251 and 252 on the feed-wheel 213, Fig. 3. A spring 253, surrounding the shaft 249 and pressing upon a collar 254 fixed to such shaft urges the latter at all times in a direction toward the feed-wheel 213. At the beginning of a buttonhole-producing cycle, the parts are in their relative positions shown in Figs. 3 and 25. During the first side stitching operation, the arm 250 rides upon the cam-section 251 which so controls the working position of the pull-off 233 that the right amount of bobbin-thread is pulled off for purl-stitching the first side of the buttonhole. When the first bar is reached, the first higher cam-section 252 acts upon the arm 250 to shift the pull-off so that its point 234 entirely misses the bobbin-thread and no bobbin-thread is pulled off during the whip-stitching of the first bar. After the first bar is completed, the arm 250 rides off of the first cam-section 252 and the collar 254 seats itself against the bearing lug 255, Fig. 3, in which position the pull-off 233 is located to pull a little less bobbin-thread per stitch in purl-stitching the return side of the buttonhole than in purl-stitching the first side of the buttonhole. This is desirable to compensate for the reduced friction of the needle-thread in the needle in sewing the return side of the buttonhole when the needle-thread leads from the needle-eye directly to the last stitch without being wrapped half-way around the needle by the feed of the work as it is in sewing the first side of the buttonhole. At the end of the return side-stitching operation the second-cam-section 252 shifts the pull-off 253 to inef-

fective position in sewing the final barring stitches.

Buttonhole cutting mechanism

The buttonhole is cut by a knife **256**, Figs. 2 and 8, which is detachably secured to the bracket **257** carried by the vertically reciprocatory knife-bar **258** mounted in the head **4**. The bracket **257** slidably embraces the vertical pin **259** fixed in the head **4** which steadies the bracket **257** and knife-bar **258** against turning. The knife-bar **258** carries at its upper end a roller-stud **260** which enters a slot **261** in the spring-biased actuating lever **262** fulcrumed at **263** on the bracket-arm web **3'**. The lever **262** carries at its rearward end a lateral screw-pin **264** which enters a vertical slot **265** in a vertically reciprocatory bar **266** having at its lower end a slot **267** embracing a guide-block **268** free on the auxiliary shaft **122**.

Fulcrumed on the side of the bar **266**, at **269**, is a lever **270** having at its upper end a shoulder **271** which is moved under the pin **264** just prior to the buttonhole cutting operation by the action of the spring **272**. The lever **270** has a downwardly extending arm **273** in position to be acted upon by the cam **274** on the auxiliary shaft **122** which also carries the cam disk **275** formed in one side face with the cam-groove **276** entered by the follower **277** on the bar **266**. When the machine is at rest at the beginning of a buttonhole-producing cycle, the cams **274** and **276** are positioned as shown in Fig. 51 and the shoulder **271** is held under the pin **264** by the spring **272** as shown in Fig. 2; the cam **274** permitting the lever **270** to be so positioned by the spring **272**. During the first semi-rotation of the auxiliary shaft **122**, the cam **274** rocks the coupling lever **270** to its open position shown in Fig. 51 and holds it there during the sewing. The concentric portion of the cam-slot **276** engages the follower **277** at this time and has no effect upon the cutter-operating bar **266**. During the final semi-rotation of the auxiliary shaft **122**, the cam **274** first allows the coupling-bar **270** to move to closed position with its shoulder **271** under the pin **264**, following which the eccentric portion of the cam-groove **276** reciprocates the cutter-operating bar **266** to cut the buttonhole.

Fixed to the fulcrum-shaft **207**, Fig. 51, of the hand-lever **208** is an arm **278** which during normal operation of the machine occupies dotted line position, Fig. 51, or full line position, Fig. 2. If the thread should break during the sewing, it is desirable that the buttonhole-cutting and work-clamp-opening operations should not take place, so that the defectively stitched buttonhole may be re-stitched in exactly the same position in the work-clamp. To prevent the operation of the buttonhole-cutting and work-clamp-opening mechanisms in the final semi-rotation of the auxiliary shaft **122**, it is merely necessary for the operator to grasp the hand-lever **208** and pull it from dotted to full line position, Fig. 51, thereby displacing the cam **209** from the clamp-closing lever **196** and also causing the arm **278** to engage the coupling lever **270** and hold it in uncoupling position during the final semi-rotation of the auxiliary shaft **122** during which the slot **265** moves up and down relative to the pin **264** without actuating the cutter-operating lever **262**.

Thread-cutting and thread-end-holding mechanism

Referring to Figs. 41, 42 and 43, it will be seen that the upper clamp-foot **190** has rotatably mounted therein a segmental gear **279** carrying the thread-cutting and nipping blades **280**, **281** cooperating, respectively with the lower stationary cutter-blade **282** and the upper stationary nipper-blade **283** in the usual manner. Meshing with the gear **279** is a rack **284** on the slide-rod **285** carried by the clamp-foot **190**. A spring **286** urges the slide-rod **285** and rack **284** in a direction to carry the thread-cutting and -nipping blades **280**, **281** to closed position, Fig. 41, to cut the needle-thread above the work at the end of a sewing period and hold the end of needle-thread below the needle-eye during the first downstroke of the needle in the next sewing period. Fulcrumed at **287** in a channel **288** in the side of the clamp-arm **185** is a tappet-arm **289** arranged to engage the slide-rod **285**. The lever **289** is connected by the link **290** to the arm **291** of a spring-biased three-armed lever, the arm **292** of which is adapted to be engaged by the shoulder **293** of the spring-pressed latch **294** fulcrumed on and movable relatively to the shaft **184**. The three-armed lever has a third arm **295** which, when the work-clamp is in starting position, extends rearwardly under the nose **296** of the spring-biased lever **297** fulcrumed at **298** on the bed **1**.

The lever **297** is rocked by the lateral pin **299** at the lower end of the lever **300**, Fig. 1, fulcrumed at **301** in the bracket-arm bearing-boss **302**, Fig. 13. The lever **300** carries at its upper end an endwise movable spring-influenced follower pin **303** which, when released, operatively engages the cam-groove **304** in the main-shaft cam **305** for one revolution only, during which the lever **300** receives a single rocking impulse in a clockwise direction, Fig. 1, and following which the pin **303** is ejected from the cam-groove **304** and is latched in ejected position by the spring-biased latch **306**, Fig. 1. This cam and follower pin mechanism for imparting a rocking impulse to the follower-pin carrier-lever is disclosed, for example, in United States Patent No. 1,369,371, of Feb. 22, 1921. The release of the plunger-pin **303** is effected when the stop-motion lever **106** is tilted to running position. Mounted in the bracket-arm **3** is a slide-rod **306a** carrying a pivotally mounted and spring-biased tripping arm **306b** adapted to engage the latch **306** and shift the latter to release the plunger-pin **303**. The slide-rod **306a**, Figs. 5 and 5a, has fast on its rearward end a cylindrical block **306c** an axially reduced portion of which engages the slot **306d** in the bracket **306e** screwed to the stop-motion lever **106**. After its single impulse actuation by the cam **305**, the lever **300** is returned to initial position by the spring **307** with the stop-screw **308** in engagement with the frame-member **3**, Fig. 13. The single impulse imparted by the cam **305** to the lever **300** causes the lateral pin **299** to rock the lever **297** and depress the arm **295** of the three-armed lever **291**, **294**, **295**, to open the needle-thread-cutter and -nipper in the clamp-foot **190**. The needle-thread-cutter and -nipper is held open by engagement of the latch **294** with the lever-arm **292**. The mechanism is timed to open the needle-thread-cutter and -nipper immediately after the point of the needle has risen clear of the path of opening movement of the blades **280**, **281**, at which time the needle-loop has been seized and partially distended by the rotary hook. As soon as the beginning end of needle-thread is released, it is drawn down below the work by the further loop-distending action of the rotary hook in its initial loop-casting rotation.

Mechanism is provided for tripping the latch 294 to release the thread-cutting and -nipping blades 280, 281 at the close of a sewing period. To this end the latch 294 is engaged by a spring-biased tripping lever 309, Fig. 30, fulcrumed at 310 on the standard 2 and having a depending arm 311 in the path of movement of a spring-biased lever 312, Fig. 16, fulcrumed at 313 below the bed 1. The lever 312 is moved by the screw-pin 314 depending from the slide-bar 315 mounted in a slideway 316, Figs. 46, 47, 48 and 49, in the bed 1 and carrying the bobbin-thread-cutter and -nipper to be described. The screw-pin 314 is operatively engaged by the forked forward end of a lever 317 fulcrumed at 318 below the bed. The rearward end of the lever 317 carries a follower roll 319 which is engaged by the cam 320 on the auxiliary shaft 122. The cam 320 is ineffective upon the lever 317 during the initial semi-rotation of the auxiliary shaft. During the final rotation of the auxiliary shaft, however, the cam 320 actuates the lever 317 which, in turn, actuates the lever 312 and trips the needle-thread-cutter and -nipper before the clamp-foot 190 is lifted.

Throat-plate and under nipper for needle-thread

The beginning end of needle-thread which is released by the upper nipper and drawn down below the work by the rotary hook in its initial loop-casting excursion, is seized below the work by an under nipper and held throughout the sewing operation at a point close to the work so that the starting end of needle-thread will be as short as possible. The needle-throat plate 321, Figs. 55 and 56, is formed with the transverse clearance slot 322 for the vibratory needle 9. Leading rearwardly from the slot 322 centrally of the throat-plate is the clearance slot 323 for the buttonhole-cutting knife 256. The throat-plate 321 is formed in its under side with a longitudinal channel or slideway 324 for the under nipper assembly shown in Fig. 57. This assembly comprises an upper blade 325 and a lower blade 326 having a slot 327 for the screw 328 which is threaded into the upper blade 325. The screw 328 does not clamp the blades 325, 326 tightly together. It merely holds them snugly together but permits longitudinal sliding movements of the blades relative to one another. The upper blade 325 has at its forward end an upturned anchor-lip 329 which enters the anchor slot 330 in the transverse slide-plate 331 mounted in the traveling clamp-plate 179. The lower blade 326 has a slot 332 to receive the needle on its first descent. The shank of the blade 326 has a notch 333 in one edge which is engaged by the rounded end of a lever 334 fulcrumed at 335 on the under side of the clamp-plate 179. Thus, the upper nipper-blade 325 is anchored to the work-clamp and the lower nipper-blade 326 is connected to an operating lever carried by the work-clamp so that it may be moved relatively to the blade 325 between nipping and releasing positions; both blades partaking of the traveling movements of the work-clamp by sliding along the groove 324 in the under side of the throat-plate which has a thread-clearance slot 336 leading forwardly from the first stitch end of the needle-slot 322. The beginning end of the needle-thread which is seized and held by the nipper-blades 325, 326 traverses the slot 336 during the ensuing sewing operation.

After the beginning end of the needle-thread has been released by the top nipper 281, 283 and drawn down through the work by the initial loop-casting rotation of the rotary hook 17, the lever 334 is operated to close the bottom nipper 325, 326. To this end there is mounted in the slideways 337, 338, Fig. 16, in the deck of the bed 1, a slide-bar 339 the front end of which is in position to strike the pin 340 depending from the lever 334 and actuate the latter to close the bottom nipper 325, 326. The slide-bar 339 is slid forwardly for this purpose by means of the lower end of the single-impulse lever 300, Fig. 16, which engages the front wall 341 of a notch 342 in the bar 339. The bar 339 has two parallel V-shaped notches 343 in its upper face which are alternately engaged by the leaf-spring 344 to yieldingly detain the bar 339 in its two extreme positions.

The slide-bar 339 is returned to its initial position, after the sewing operation is completed, by the final semi-rotation of the auxiliary shaft 122. To this end there is mounted on the shaft 122 a cam 345, Fig. 34, which engages a follower roll 346 on a lever 347 fulcrumed at 348 on the bed-lug 349. The upper end of the lever 347 engages a shoulder 350 on an extension-bar 351 screwed to the rear end of the slide-bar 339. In the return motion of the slide-bar 339 the nipper-blade 326 is returned to open or thread-releasing position, Fig. 16, by engagement of the pin 340 by the hooked end 352 of a lever 353 fulcrumed at 354 on the slide-bar 339. During the sewing operation, which occurs intermediate the forward and rearward impulses of the slide-bar 339, it is necessary to displace the hooked end 352 of the lever 353 to one side of the pin 340 to permit the lever 334 which is carried by the work-clamp to travel forwardly with the latter. To this end the lever 353 is swung on its fulcrum 354 by a push-bar 355, Figs. 16 and 46, which is connected to the bell-crank lever 356 fulcrumed at 357 on the bed 1 and actuated by the slide-bar 358 having at its rearward end a rigidly depending arm 359, Figs. 2 and 17, in position to be engaged by the high point of the clamp-closing cam 202 and pushed forwardly by the latter at the end of the first semi-rotation of the auxiliary shaft 122.

The hooked lever 353, after having been disengaged from the pin 340 to permit the lever 334 to travel with the work-clamp during the sewing operation, must be restored to its original position in engagement with the pin 340 before the slide-bar 339 is shifted rearwardly by the cam 345. This is accomplished by the motion of the slide-bar 315 which carries the fulcrum-screw 360 for the spring-biased bell-crank lever 361, 362 to be described. This fulcrum-screw rises to the level of the lever 353, Fig. 46, and closes the latter before the bar 339 is shifted rearwardly.

Bobbin-thread cutter and nipper

The slide-bar 315, Figs. 16 and 54, has a forwardly extending shelf 363 upon which is mounted the plate 364 carrying the spaced cutting and nipping blades 365 and 366, respectively. Fulcrumed at 367 between the blades 365 and 366 are the cooperating cutting and nipping blades 368 and 369, respectively, which are connected together to move as one piece and have a tail 370 which is acted upon by the spring 371 to move the blades 368, 369 to closed position, Fig. 62. In the advance of the slide-bar 315 from the position shown in Fig. 16 at the close of a sewing period, which advance is caused by the actuation of the lever 317 by the cam 320 on the auxiliary shaft 122 in the final semi-rotation of the latter, the tail 370 of the intermediate cutter and nipper-blades

368, 369 is detained by the end-wall 372, Fig. 58, of the spring-biased latch-arm 373 fulcrumed at 374 on the supporting bracket 375 screwed to the bed 1. Thus, as the bobbin-thread-cutter and -nipper blades advance lengthwise of themselves, the intermediate blades are opened to embrace the bobbin-thread *t*. In the continued advance of the blades the tail 370 snaps past the detaining arm 373, Fig. 60, and the blades spring shut, Figs. 62 and 63, thereby severing and nipping the bobbin-thread. Simultaneously with the advance of the bobbin-thread-cutter and -nipper, an implement 376 is advanced in the opposite direction to engage the bobbon-thread between the bobbin and the bobbin-thread-cutter and -nipper. The implement 376 is moved from retracted position, Fig. 16, to the position shown in Figs. 60 and 61, to exert a strain on the bobbin-thread and thereby pull down the severed end of needle-thread *t'*, Figs. 59 and 61, sticking up above the work. The implement 376 is in the form of a lever which is fulcrumed at 377 on the bed-extension plate 378. The lever 376 is connected by the link 379 to a spring-biased lever 380 fulcrumed at 381 on the bed-lug 382 in position to be engaged by the arm 361 of the spring-biased bell-crank lever 361, 362 fulcrumed on the screw 360 carried by the shelf 363' secured to the under side of the shelf 363 of the slide-bar 315 previously described. When the bell-crank-lever-arm 361 has shifted the lever 380 to fully advance the implement 376, Figs. 60, 61, the other arm 362 of the bell-crank lever engages a stop-shoulder 383 on an adjustable abutment-piece 384, screwed to the bed 1, and causes the bell-crank lever-arm 361 to be swung to one side and to release the lever 380 which is immediately restored to initial position by its spring.

After the bobbin-thread is seized and cut, the closed blade-assembly is shifted in the reverse direction a measured distance, as shown in full lines, Fig. 65, to pull a measured length of bobbin-thread from the supply. The blade assembly is then immediately returned to dotted line position, Fig. 65, so that the bobbin-thread-end will be slack enough to enable it to be pulled to proper position in the work by the first formed stitch. Thus the actuating cam 320 for the bobbin-thread-cutter and -nipper is shaped to act on the follower 319 in the final semi-rotation of the auxiliary shaft 122 to advance the blades to seize and cut the bobbin-thread, then to retract the blades a measured distance to pull off bobbin-thread, and then to again partially advance the blades to give slack to the bobbin-thread while retaining a grip on the free end thereof.

In the sewing of the next buttonhole, however, it is desirable to release the end of bobbin-thread after the initial stitches have been formed. This is accomplished by a cam 385, Figs. 3, 17 and 25, on the feed-wheel 213, which cam engages an arm 386 on the lever 317 after about six stitches have been taken and moves the lever 317 sufficiently to cause the tail 370 to engage the stop-arm 373 and open the nipper-blades 366, 369 just enough to release the bobbin-thread. After several more stitches have been taken, the cam 385 passes the arm 386 and the nipper-blades are restored to initial position, Fig. 16, in which position the blades are closed; yet the tail 370 is just touching the opener-arm 373.

Tension-release and check-spring control mechanism

Two tension-devices 387 and 388 of known construction are mounted on the machine-head 4. These tension-devices are both released at the end of a sewing period by the following mechanism. The stop-motion plunger 105 carries a block 389, Fig. 2, which, in its down-and-up motion to stop the main-shaft 5 engages under and lifts the spring-pressed plunger 390 carried by the spring-biased lever 391 fulcrumed at 392 on the standard 2. Connected to the lever 392 at 393 is a push-rod 394 coupled at 395 to the tension-release push-rod 396 for the tension-device 387. The lever 391 carries an adjustable push-screw 397 which engages the arm 398 of a four-armed spring-biased lever fulcrumed at 399 on the standard 2. The arm 400 of the four-armed lever is connected to the rod 401, having at its forward end an inclined face 402, Fig. 12, which releases the tension 388. These tensions are both restored when the stitch-forming mechanism is started, at which time the tilting of the stop-motion lever 106 to running position carries the block 389 inwardly and releases the pin 390.

The tension 388 is also released when the barring stitches are being sewn across the opposite ends of the buttonhole, so that the tension-device 387 only will be in control of the needle-thread at these times and a weaker tension on the needle-thread will result. This is accomplished by the engagement of the tension-release lever 77 with the arm 80 of the four-armed lever described. The fourth arm 403 of the four-armed lever is arranged to be engaged by a holding cam 404 on the under face of the cam-disk 92 to hold the upper tension 388 open one stitch beyond the time the cam 71 releases the follower 73 to restore the side-stitch amplitude of vibration of the needle. If it were not for the holding cam 404 the tension 388 would be restored simultaneously with the restoration of the side-stitch amplitude of needle-vibration. It is found to be preferable to delay the restoration of the side stitching tension slightly beyond the time of restoration of the side-stitch amplitude of needle-vibration in sewing the first bar.

Associated with the tension-device 387 is the usual check-spring 405, Figs. 10 and 11, which engages the needle-thread between the two fixed guides 406, Fig. 67, and controls the slack in the needle-thread as the needle starts down, so that the point of the needle will not catch the needle-thread. Fixed to the shaft 407 in the head 4 in rear of the tension-device 387 is a check-spring controlling lever 408 the upper end of which is adapted at times to block or partially block the recovery motion of the check-spring.

The fulcrum-shaft 407 has fixed to its rearward end a block 409, Figs. 2, 44 and 45, having a tail-piece 410 and a shoulder 411 engaged at times by the spring-biased latch-lever 412 having a tail-piece 413 which is engaged by a spring-biased tripping lever 414 fulcrumed at 415 on the bracket-arm 3 and actuated by the cam 416 on the feed-wheel shaft 42. The fulcrum-shaft 407 and parts carried thereby are rotatively biased by the spring 417 in a direction to hold the shoulder 411 seated against the latch-lever 412, so that the shaft 407 and check-spring controlling lever 408 will be moved counter-clockwise, Fig. 67, when the latch-lever 412, 413, Fig. 2, is tripped.

The coupling block 395, Figs. 44 and 45, which connects the tension-release push-rods 394 and 396, is formed with a lateral extension having an inclined cam-face 418 which, when the push-rod 394 is actuated by the lever 391, Fig. 2, to release the tension 387 at the end of a sewing pe-

riod, engages the inclined face 419 of the tail-piece 410 of the block 409 and rocks the shaft 407 clockwise, Fig. 67, sufficiently to carry the check-spring blocking lever from its ineffective full-line position to dotted line position. This rocking motion of the shaft 407 is not enough, however, to engage the shoulder 411 with the latch 412. Just before the tensions 387 and 388, Fig. 67, are released, the machine is stopped with the take-up 246 at its highest point. The last stitch is fully set and the needle-thread is holding the check-spring 405 in its fully strained or full-line position. When the tensions 387 and 388 are released, the blocking arm 408 is shifted from full-line to dotted line position, Fig. 67, and the check-spring settles back against the stop-arm 408 and, in so doing, steals a measured amount of thread from the supply through the open tensions 387, 388.

When the buttonhole is cut by the final semi-rotation of the auxiliary shaft 122, an arm 420, Fig. 8, fixed to the cutter-bar 258 strikes the tail 421 of the stop-lever 408 and shifts the latter from dotted-line position, Fig. 67, to full-line position, Fig. 68, thereby moving the check-spring 405 to its fully strained position where it is detained by engagement of the latch-arm 412 with the shoulder 411 of the block 409, Figs. 44 and 45. Thus the slack needle-thread pulled from the supply is made available for use in the first reciprocation of the needle in the next buttonhole-producing cycle.

It will be remembered that at the beginning of a sewing period the end of needle-thread is held above the work. This end is released during the first upstroke of the needle and is drawn down below the work by the rotary hook. It is then seized below the throat-plate 321 by the closure of the under nipper-blade 326. The take-up in its up-stroke then draws up the end of needle-thread until it is quite short, as shown in Fig. 31a. It will be obvious that the shortness of the needle-thread-end in the under nipper 325, 326 will depend upon the amount of thread measured from the supply by the check-spring 405 at the close of the previous sewing period. If no needle-thread at all were pulled from the supply by the check-spring 405 at the close of the sewing period, the take-up would pull the end of needle-thread entirely through the under nipper 325, 326, Fig. 31a, in its first up-stroke in the next sewing period. The dotted-line position of the stop-arm 408, Fig. 67, may be regulated by shifting the position of the coupling block 395, Fig. 2, on the push-rod 394; the screw 422 being loosened for the purpose. The cam 416, Fig. 2, trips the latch 412 after two or three stitches of a sewing period have been formed. The end of needle-thread, however, is held by the under nipper throughout the sewing period. This method of controlling the needle-thread insures the elimination of unsightly thread-ends above the work and the proper tightening of the initial stitches, so that the purl of the buttonhole will have a uniform appearance throughout the first and second sides of the buttonhole.

The machine is preferably equipped with a bobbin-winder comprising a bobbin-winding spindle 423 journaled in a spring-biased bracket 424 fulcrumed at 425 on a bracket 426 screwed to the bed 1. The bracket 424 has the usual latch-shoulder 427 engaged by the latch 428 when the bracket 424 is manually swung from full-line to dotted-line position, Fig. 5, to engage the pulley 429 with the live pulley 129. The latch 427 has the usual feeler arm 430 which engages the mass of thread being wound on the bobbin and trips the latch 427 when the bobbin is full.

The machine is provided with manually operated means for tripping the belt-shipper lever 116 at any time during a sewing period to stop the stitch-forming mechanism in case of needle-breakage. Such means comprises a push-rod 431, Fig. 1, mounted alongside the bracket-arm 3 and arranged to engage the upstanding arm 432 of the lever 116. When so stopped, the stitch-forming mechanism may be restarted by pulling forwardly on the handle 433 to re-set the belt-shipper-carrier rod 115 in running position.

Operation

The cycle of operations is briefly, as follows:—

The operator pulls down on the starting lever 150 which shifts the gate 140 to start the auxiliary shaft which makes its first semi-rotation and then comes to rest. The auxiliary shaft, in its first semi-rotation, operates to close the work-clamp and at the same time the cam 274 on such shaft shifts the buttonhole-cutter safety-latch 270 to open position, Fig. 51, where it remains during the sewing period. The cam 166 then acts to tilt the stop-motion lever 106 to running position, Fig. 2a, to start the stitch-forming mechanism. When the stop-motion lever is tilted it releases the spring-biased lever 391 which restores the tensions 387 and 388 to sewing condition. The tilting of the stop-motion lever also exerts a push upon the rod 306a, Fig. 1, to trip the latch 306 and allow the plunger 303 to enter the cam-groove 304 in the cam 305 which gives to the lever 300 its single impulse. The cam-groove 304 has a first operative portion 304a, Fig. 12, which acts as soon as the needle-point is out of the work to open the upper thread-nipper 281, 283 which is latched in open position by engagement of the latch 292, Fig. 41, with the shoulder 293. The active cam-portion 304a is followed by a short dead portion 304b which is followed by a second active portion 304c which acts to shift the slide-bar 339 forwardly to close the under nipper 326 on the needle-thread end drawn down below the work by the rotary-hook. The auxiliary shaft 122, in its first semi-rotation, further acts to turn the cam 161, Fig. 1, to raise and lock the starting lever 150 to prevent an accidental repeat operation of the gate 140. The work-clamp-lifting and -lowering cam 202 on the auxiliary shaft also operates upon the arm 359 of the push-bar 358 to shift the lever 353, Fig. 16, to release the pin 340 so that the work-clamp and the lever 334 carried thereby may freely travel forwardly.

During the sewing of the first side stitches both tensions 387 and 388 are on. The cam 416 on the feed-wheel-shaft 42 trips the latch 412, Fig. 2, to release the check-spring stop 408 after the third reciprocation of the needle. After sewing about eight stitches the cam 385 on the feed-wheel advances the bobbin-thread-cutter and -nipper just enough to release the bobbin-thread end and holds such cutter and nipper in open position until the travel of the work-clamp pulls the bobbin-thread clear of the nipper, which then returns to initial position, Fig. 16.

The bobbin-thread pull-off control follower 250, Fig. 25, rides on the first half-circle cam 251 which slightly increases the amount of bobbin-thread pulled off for each stitch in sewing the first side of the buttonhole to compensate for

the friction of the needle-thread in its wrap about the needle. When the first bar is reached the bobbin-thread pull-off is further shifted by the cam **252** so that its point misses the bobbin-thread completely. At the same time the top tension **388** is released so that in sewing the bar whip-stitches the bobbin-thread will not be pulled through the work as it is in sewing the side purl stitches. The machine makes one or two stitches after the first bar is formed, before the top tension is restored. This is controlled by the holding cam **404**, Fig. 26, which engages the arm **403** of the four-armed tension-control lever, Fig. 2. In sewing the final bar, the pull-off **234** is again caused to miss the bobbin-thread and the top tension is again released. Also, the belt is thrown onto the loose pulley so that the stitch-forming mechanism may coast while sewing the final bar.

When the final bar is completed, the stop-motion lever **106** is tripped by the tripping point **112** on the feed-wheel. When the stop-motion plunger **105** is depressed by the eccentric portion **103** of the stop-cam **102**, the block **173**, Fig. 5, is hooked by the latch **172** of the gate-actuating lever **171**. Also the block **389** on the plunger **105** is depressed below the spring-pressed plunger **390** which snaps over said block. When the plunger **105** rises into the stop-notch **104** of the stop-cam **102**, it swings the gate **140** to initiate the final semi-rotation of the auxiliary shaft **122**. It also rocks the lever **391** to release both tensions **387** and **388**. The check-spring stop **408** is also advanced to its intermediate position (dotted lines in Fig. 67). The last stitch is made in the center of the final bar.

The final semi-rotation of the auxiliary shaft **122** actuates the lever **317** to advance the bobbin-thread trimmer and through the lever **312**, Fig. 16, trips the needle-thread trimmer latch **294**. The advance of the bobbin-thread trimmer opens and closes the trimmer-blades and shifts the lever **376** to engage the bobbin-thread and pull down the trimmed finishing end of needle-thread. The advance of the under thread-trimmer assembly also causes the lever **353**, Fig. 16, to be shifted to close its hooked end **352** upon the pin **340**.

The buttonhole cutter safety latch **270** is next restored to the position shown in Fig. 2 and the buttonhole cutter is actuated by the cams **274** and **276**, respectively. The cam **202** then operates to raise the work-clamp foot **190** to release the finished work. The cam **345** shifts the slide-bar **339** rearwardly to return the nipper **326** to open position, Fig. 31. The retreat of the under thread-trimmer assembly to its extreme position pulls off a measured length of bobbin-thread which, after the said assembly returns to its intermediate starting position, shown in dotted lines, Fig. 65, is rendered slack for the beginning of the next sewing operation. Finally, the cam **161** is returned to the position shown in Fig. 1 to unlock the starting lever **150**.

Having thus set forth the nature of the invention, what we claim herein is:—

1. In a buttonhole sewing machine, stitch-forming mechanism including a reciprocatory and laterally vibratory needle and a cooperating loop-taker, a work-clamp, means for imparting a traveling movement to said work-clamp to space the stitches lengthwise of the buttonhole, a thread-nipper above the work for holding the beginning end of the needle-thread on the first downstroke of the needle, means for opening said thread-nipper on the first upstroke of the needle to release the end of the needle-thread in time to be drawn down to the under side of the work by the loop-taker, a stationary throat-plate having a needle-aperture therein, a thread-nipper mounted below said throat-plate for a traveling movement with the work-holder, and means for closing said last-mentioned thread-nipper in time to seize the end of needle-thread drawn down by the loop-taker, said throat-plate having a needle-thread-end clearance slot therein in communication with the needle-aperture.

2. In a buttonhole sewing machine, stitch-forming mechanism including an endwise reciprocatory and laterally vibratory needle, a loop-taker, a traveling work-clamp, a stop-motion device for controlling the period of operation of the stitch-forming mechanism, a stationary throat-plate, means below the throat-plate for gripping the beginning end of needle-thread drawn down by the loop-taker, and means for releasing said gripping means after the sewing operation has been completed.

3. In a buttonhole sewing machine, in combination, stitch-forming mechanism including a reciprocatory needle, a loop-taker, a work-clamp, mechanism for imparting a step-by-step traveling movement to the work-clamp to distribute the stitches lengthwise of the buttonhole being produced, thread-gripping means below the work constructed and timed to close upon the beginning end of the needle-thread drawn down by the loop-taker, and means for thereafter moving said gripping means lengthwise of the buttonhole while closed upon the needle-thread.

4. In a buttonhole sewing machine, a throat-plate having a needle-opening therein and a slideway in its under face, relatively movable needle-thread-nipping blades mounted in said slideway, and a traveling work-clamp to which said blades are connected, said throat-plate having a needle-thread-end clearance slot in communication with said needle-opening.

5. In a buttonhole sewing machine, a needle, a stationary needle-throat-plate, a traveling work-clamp, and a needle-thread nipper mounted at the under side of the needle-throat-plate and partaking of the traveling movement of the work-clamp.

6. In a buttonhole sewing machine, stitch-forming mechanism including an endwise reciprocatory and laterally vibratory needle, a stop-motion device for the stitch-forming mechanism, a traveling work-clamp, a stationary needle-throat-plate having a needle-aperture and a slideway below its upper face, upper and lower thread-nipping blades mounted in said slideway and extending forwardly beyond the forward end of said needle-throat-plate, means connecting said upper thread-nipping blade in fixed relation with said work-clamp, a lever fulcrumed at the under side of said work-clamp and operatively connected to said lower thread-nipping blade, means for actuating said lever in one direction at the beginning of a sewing operation to cause the beginning end of needle-thread to be seized by said thread-nipping blades, and means for reversely actuating said lever at the close of a sewing operation to cause said blades to release the beginning needle-thread end, said throat-plate having a clearance slot for the beginning needle-thread end held by said nipping blades.

7. In a sewing machine, in combination, a frame having a bed and an overhanging bracket-arm, stitch-forming mechanism including a recipro-

catory needle, a loop-taker, a main sewing shaft mounted in said bracket-arm, a stop-motion device for the main sewing shaft, a throat-plate, a work-clamp, a top needle-thread-nipper carried by the work-clamp, a bottom needle-thread nipper mounted at the under side of the throat-plate, a rotary cam carried by the main sewing shaft in said bracket-arm, automatic throw-out cam-follower mechanism associated with said cam and including a downwardly extending lever connected to said top and bottom needle-thread-nippers and timed to open the top needle-thread-nipper before the initial needle-loop is fully expanded by the loop-taker and to close the bottom needle-thread-nipper after the loop-taker has drawn down the beginning needle-thread-end released by the top needle-thread-nipper, and means to open the bottom needle-thread-nipper.

8. In a sewing machine, in combination, stitch-forming mechanism including a reciprocatory needle, a loop-taker, a take-up, a tension-device, a check-spring, a needle-thread cutter and nipper, a stop-motion device for the stitch-forming mechanism arranged to stop the latter with the take-up at the end of its stitch-setting action and the check-spring under the strain of the needle-thread, means for opening the tension-device, a check-spring arrester movable to a predetermined position in the path of recovery motion of the check-spring to arrest such recovery motion when the check-spring has stolen a measured length of thread from the supply through the open tension-device, and means for thereafter moving said check-spring arrester to return the check-spring to its fully strained position until after the initial stitches of the next buttonhole have been formed.

9. In a buttonhole sewing machine in combination, stitch-forming mechanism including a reciprocatory needle, a loop-taker and a take-up, a stop-motion device for the stitch-forming mechanism, a work-clamp, means above the work for nipping the beginning end of the needle-thread, means for opening the needle-thread-end-nipping means above the work in the first reciprocation of said needle so that the beginning end of needle-thread will be pulled down below the work by the loop-taker, means below the work for seizing the needle-thread end pulled down by the loop-taker before the take-up reaches the end of its first up-stroke, and means for stealing a measured length of needle-thread from the supply through the open tension-device at the close of a sewing period.

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