

No. 671,530.

Patented Apr. 9, 1901.

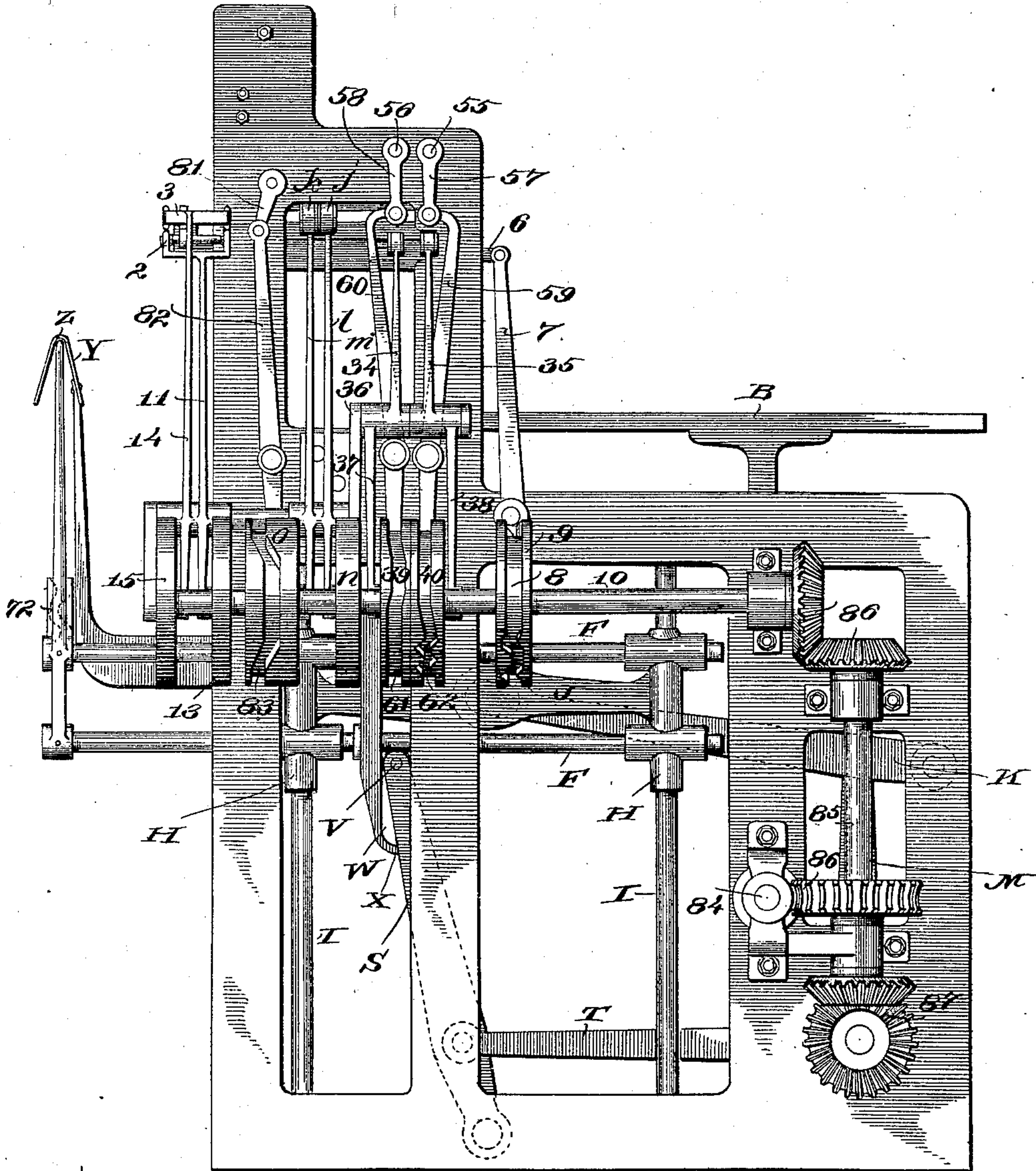
W. G. TREVETTE.  
BOOK SEWING MACHINE.

(Application filed Mar. 5, 1900.)

(No Model.)

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Fig. 1.



WITNESSES—

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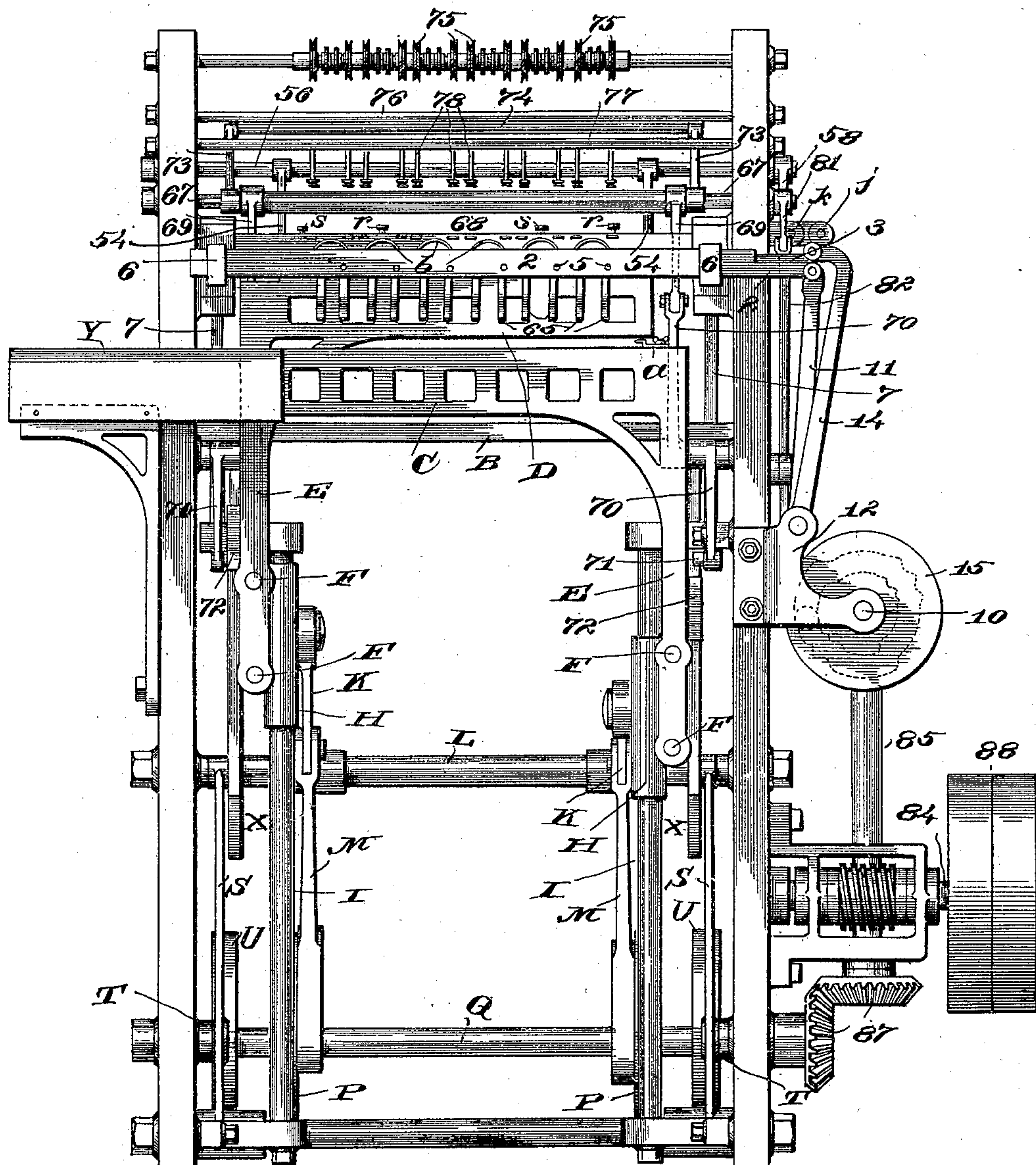
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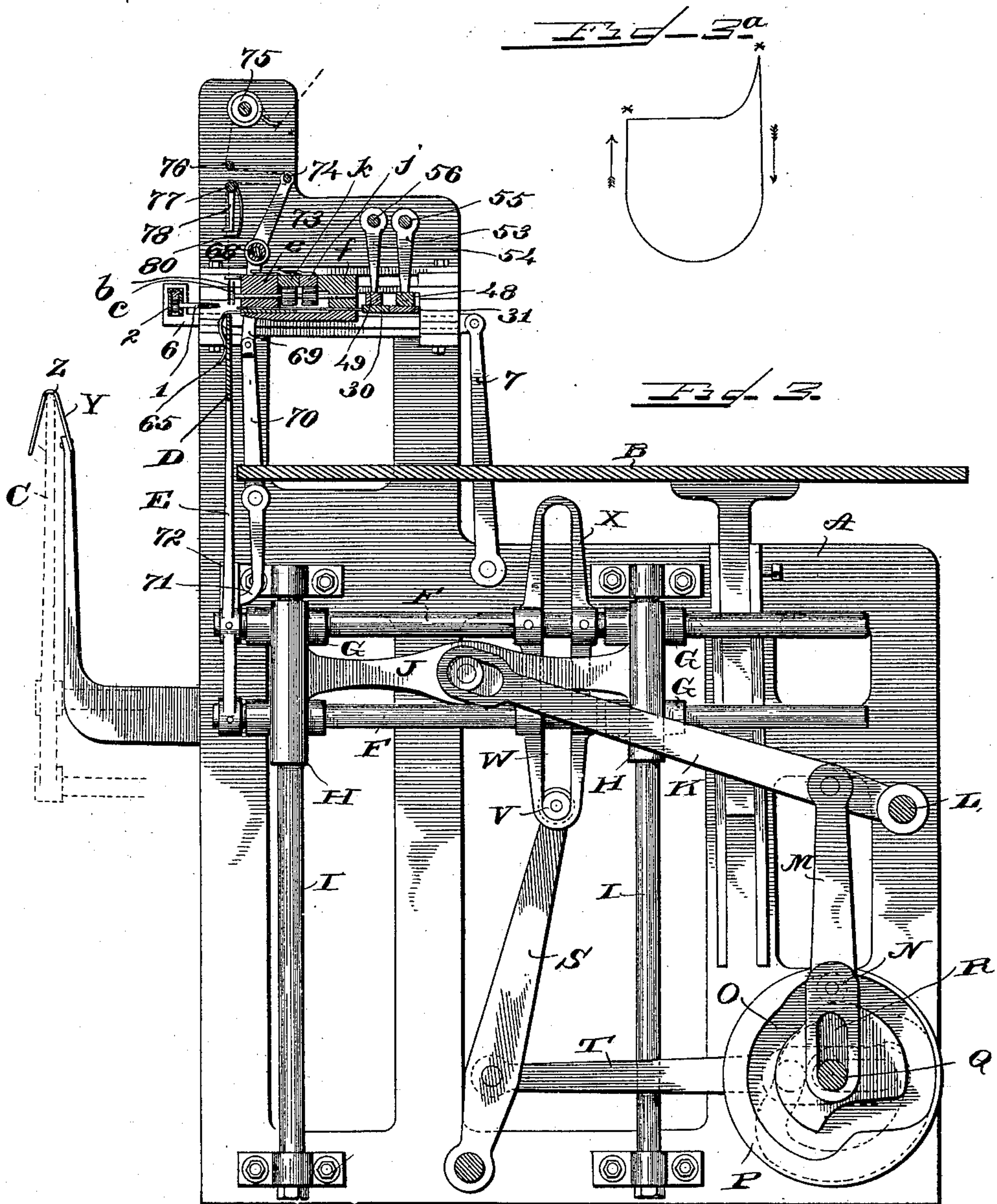
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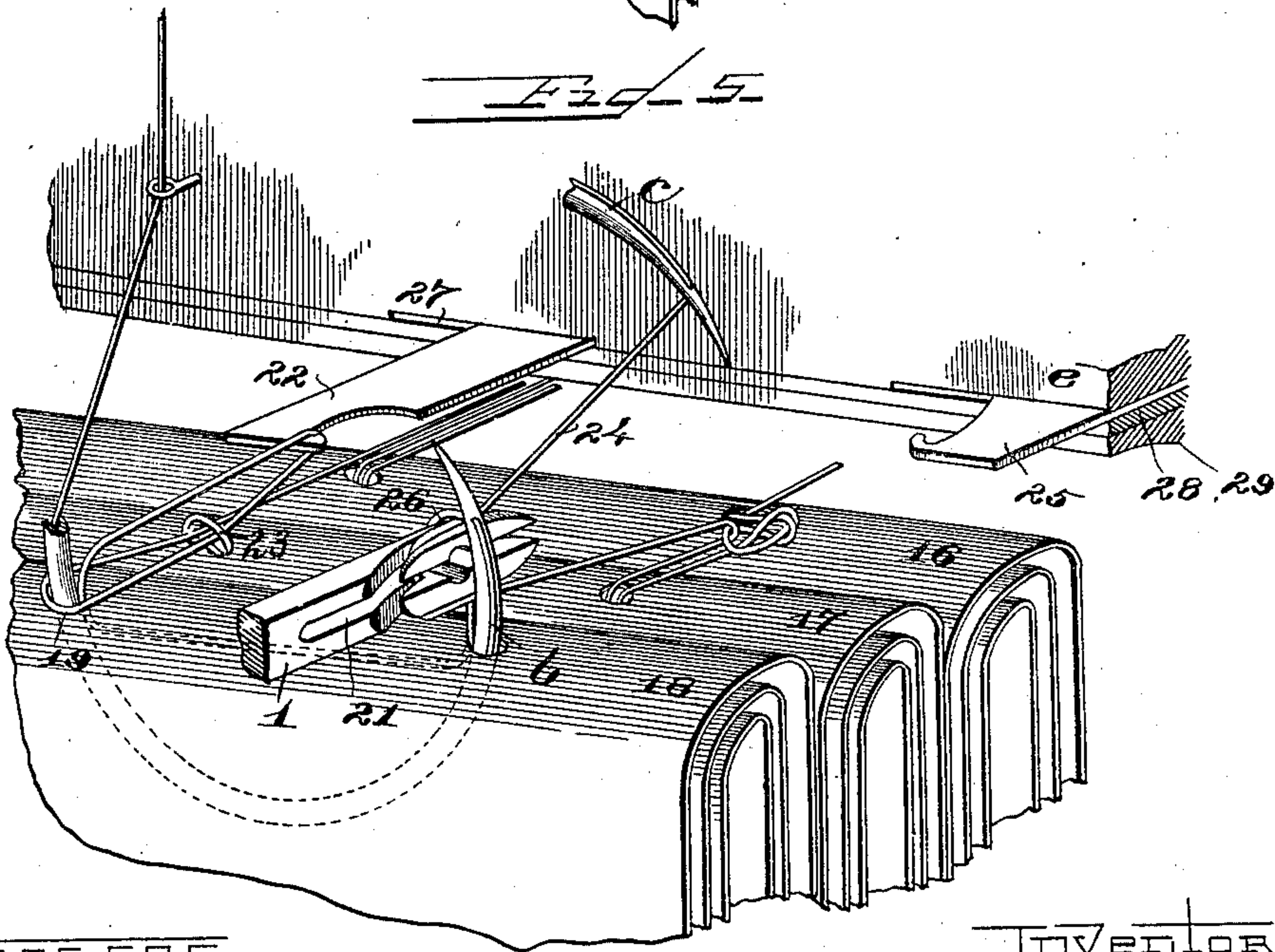
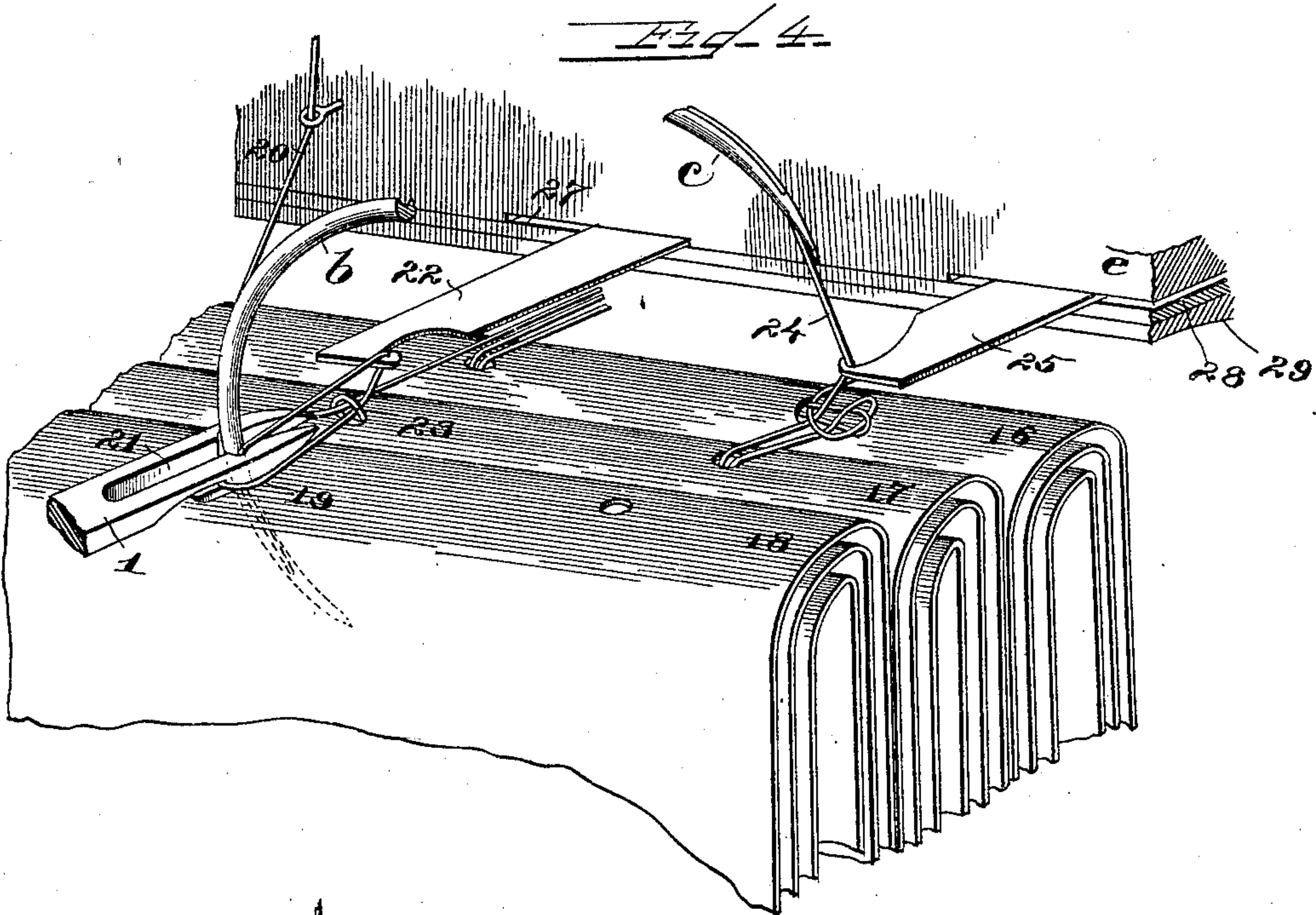
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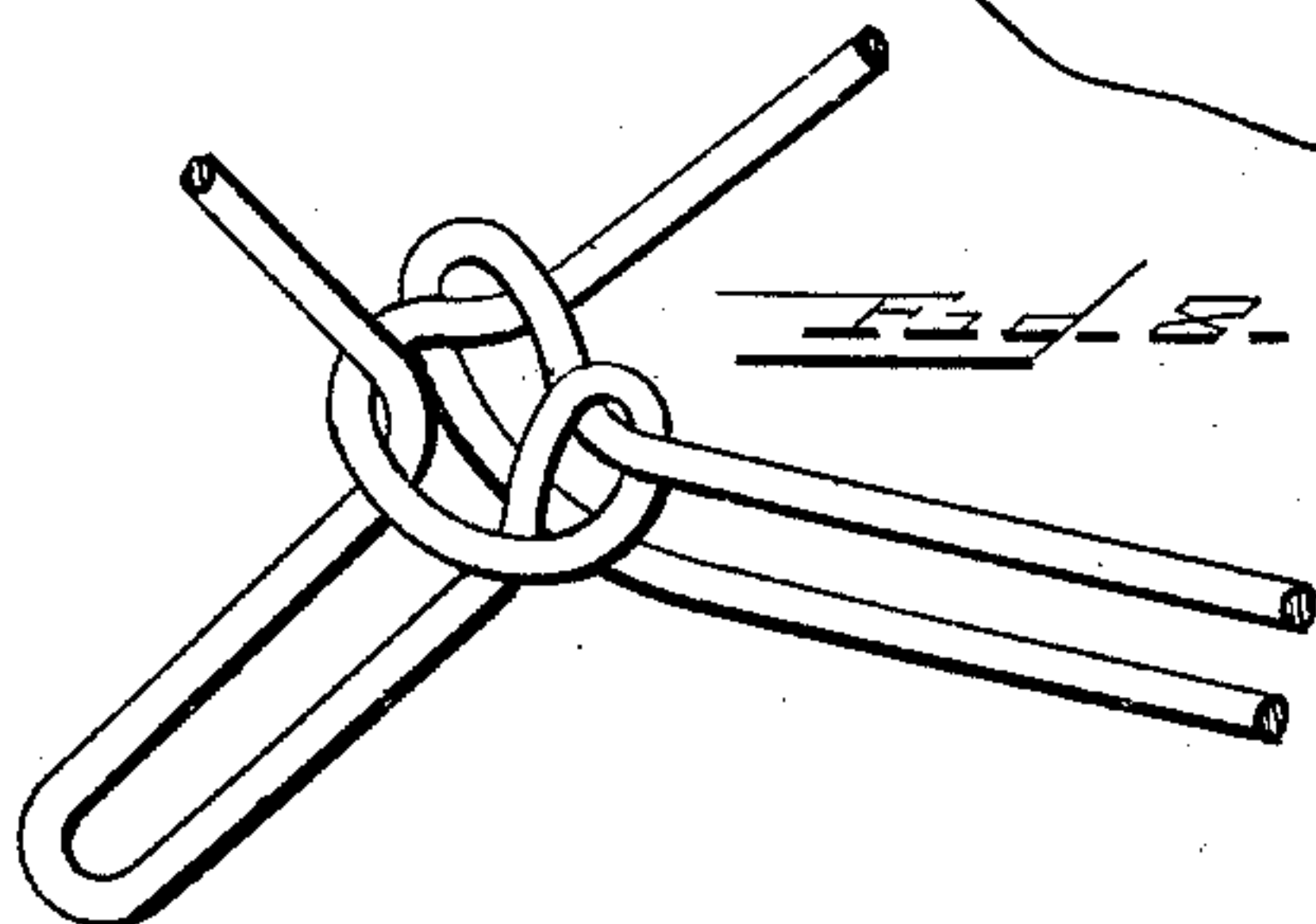
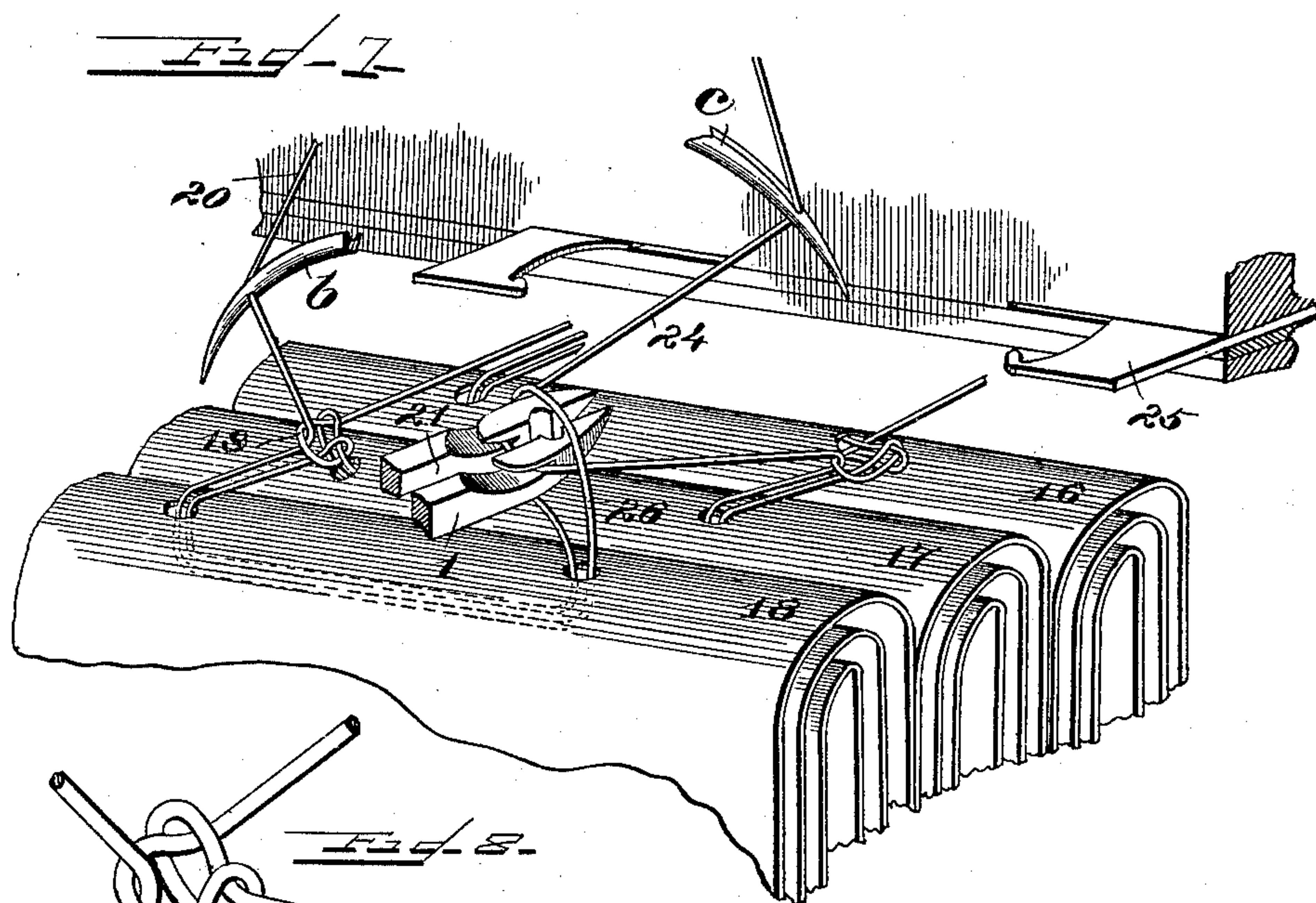
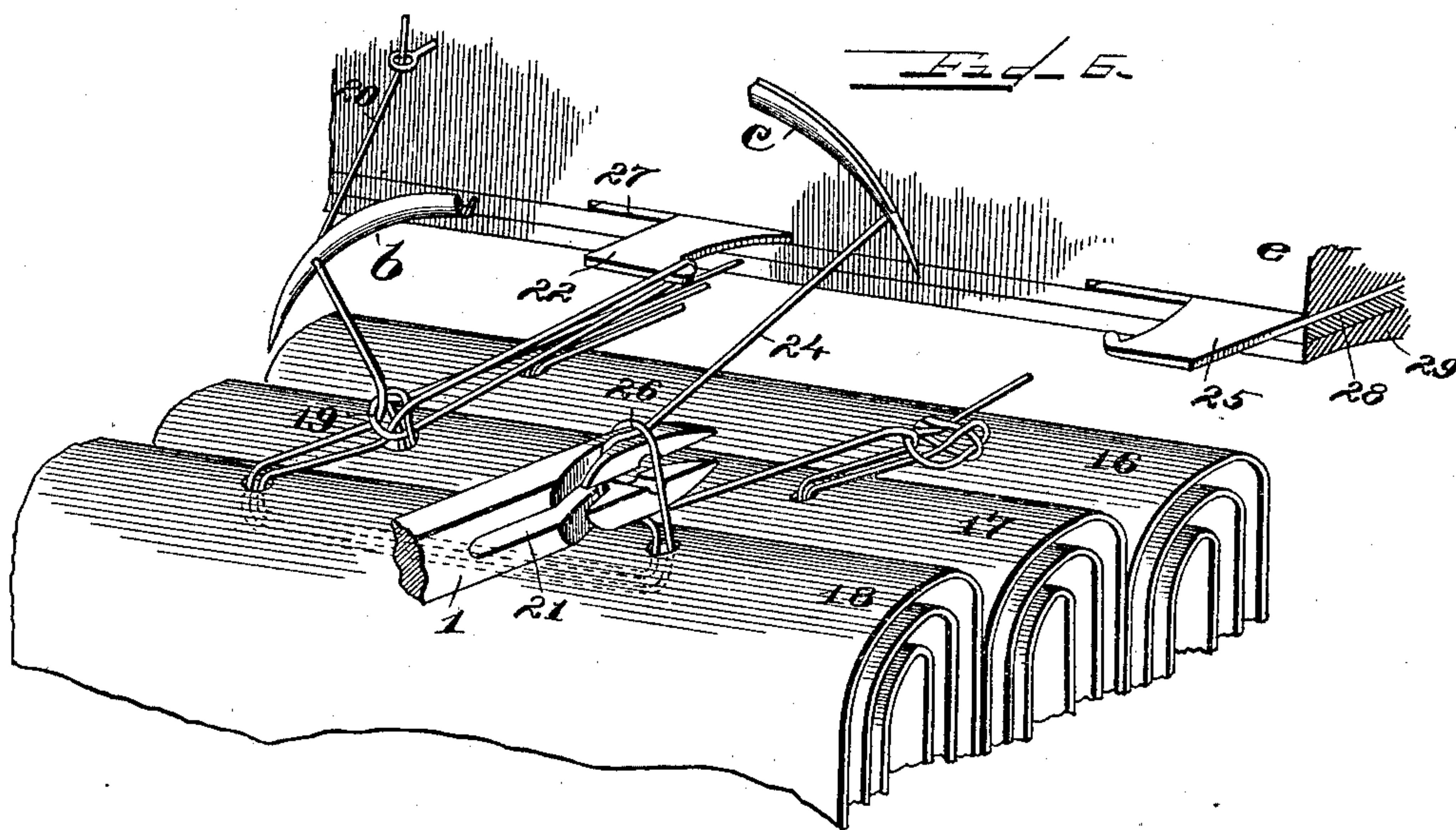
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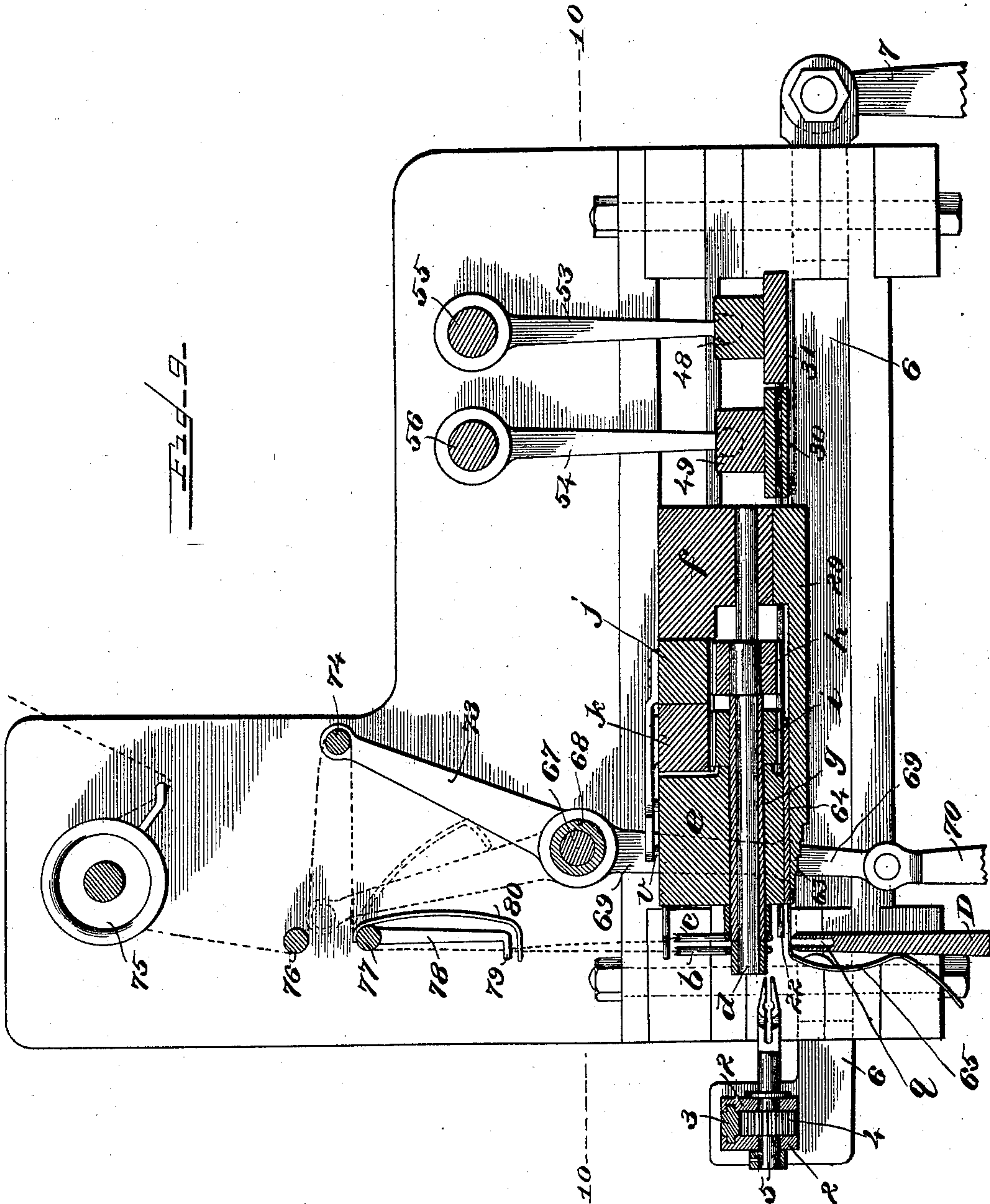
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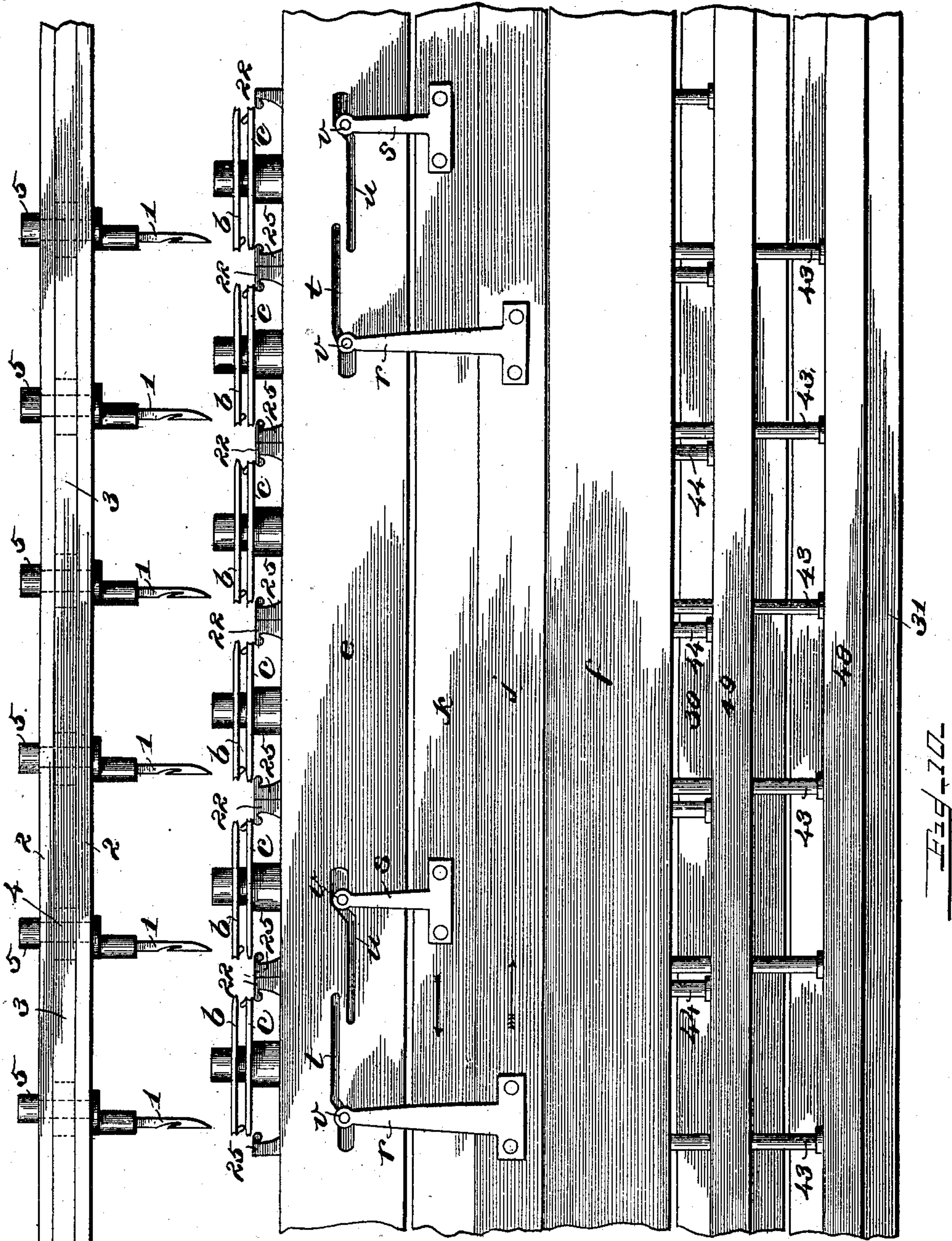
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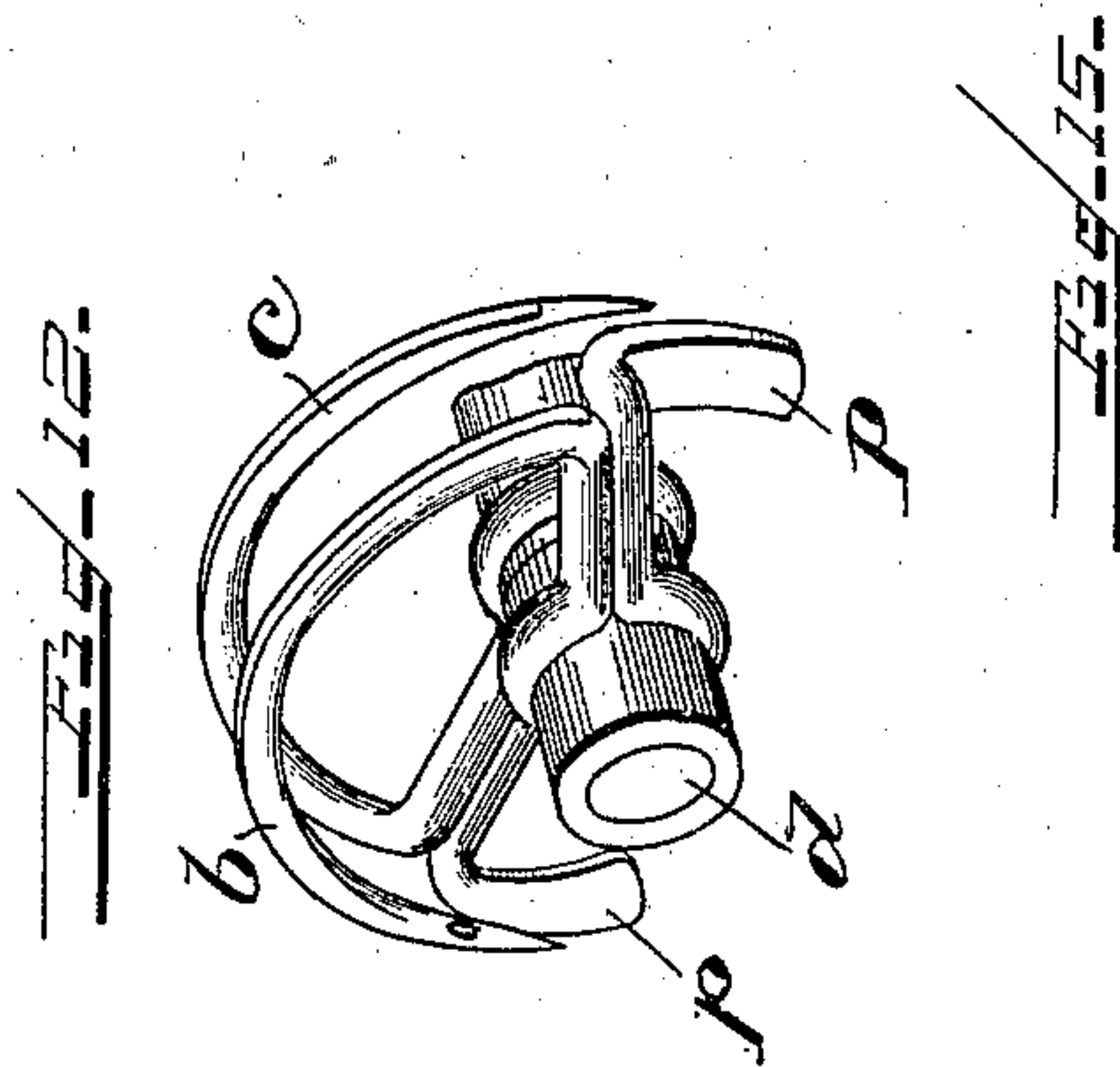
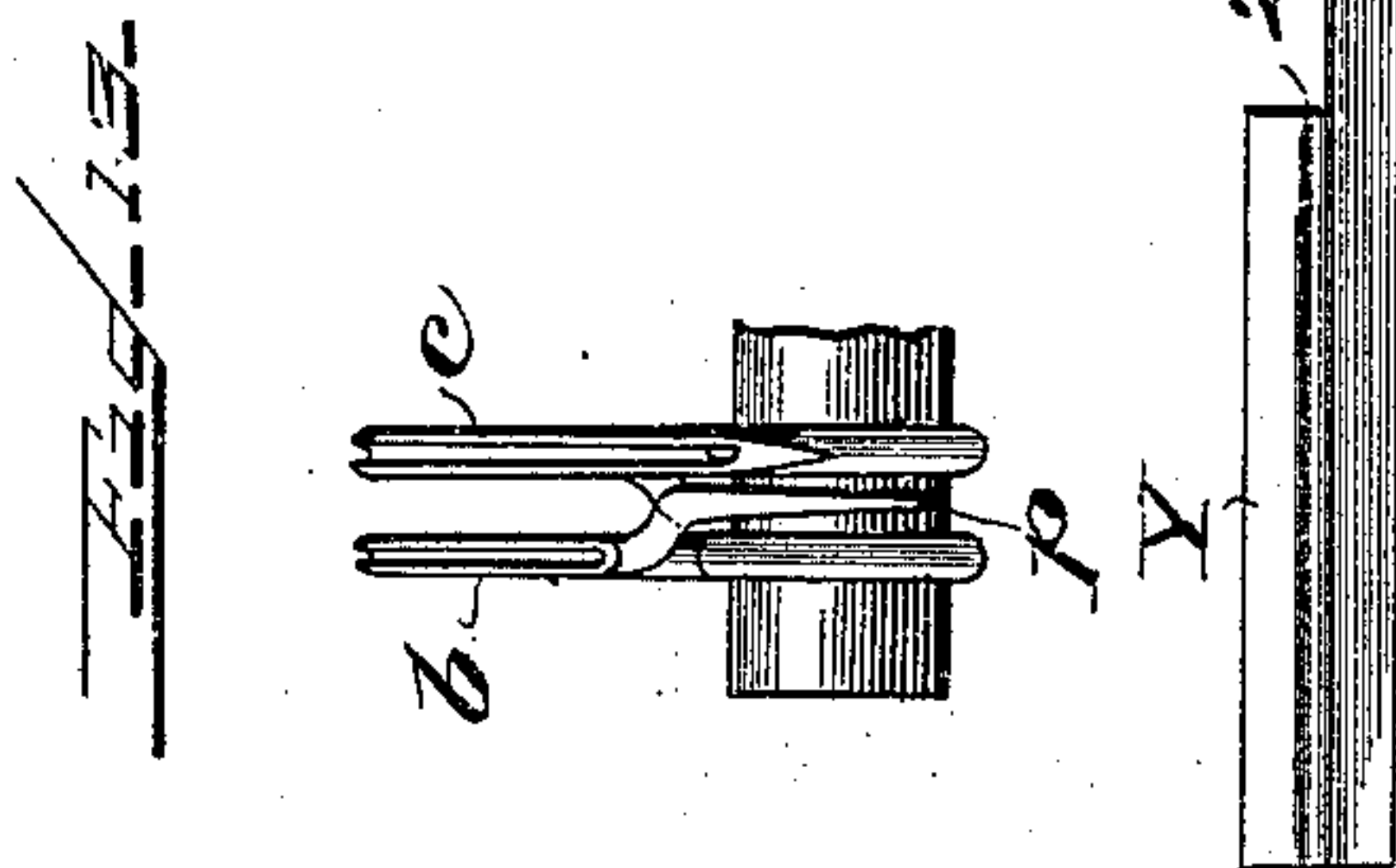
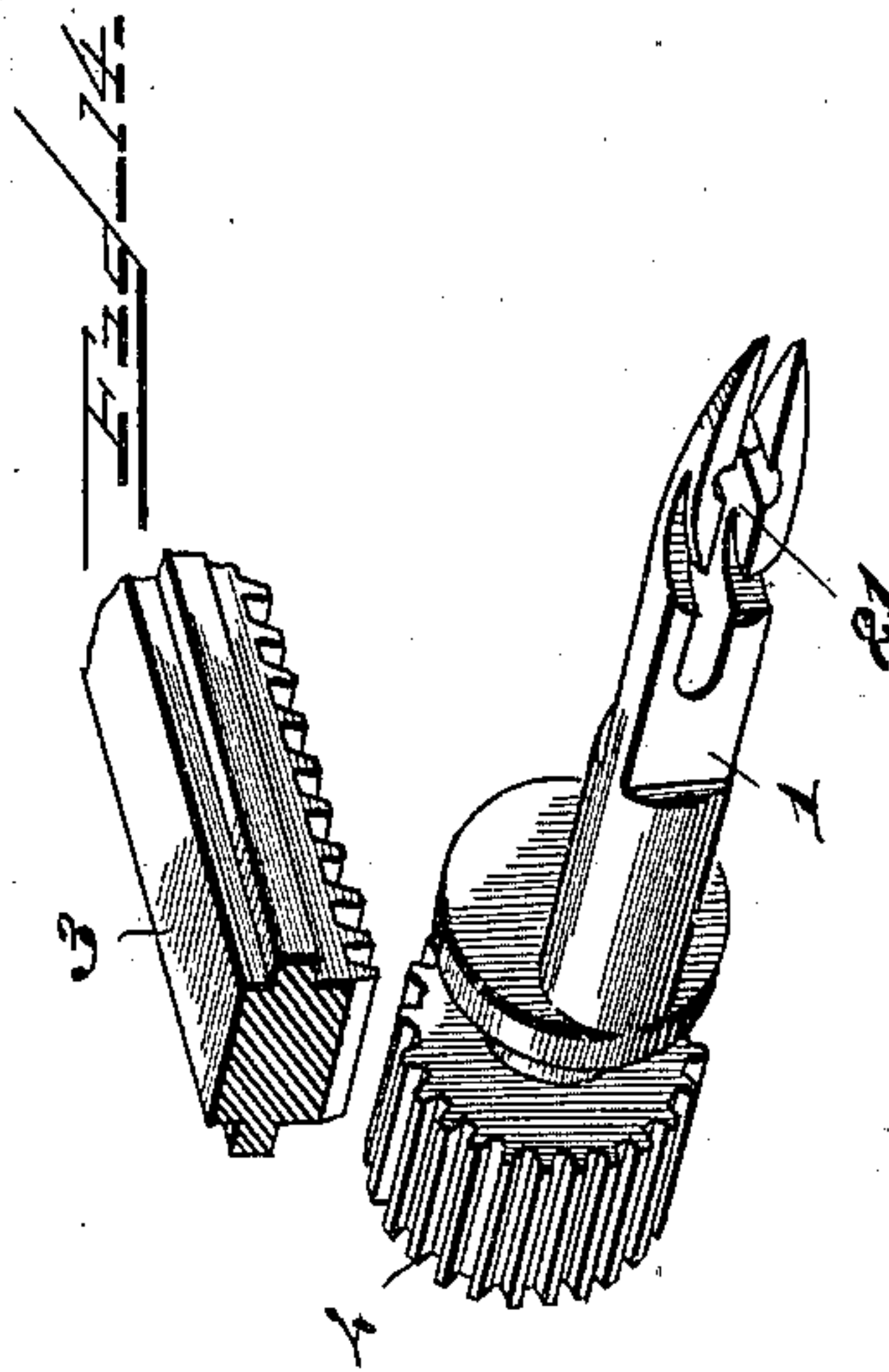
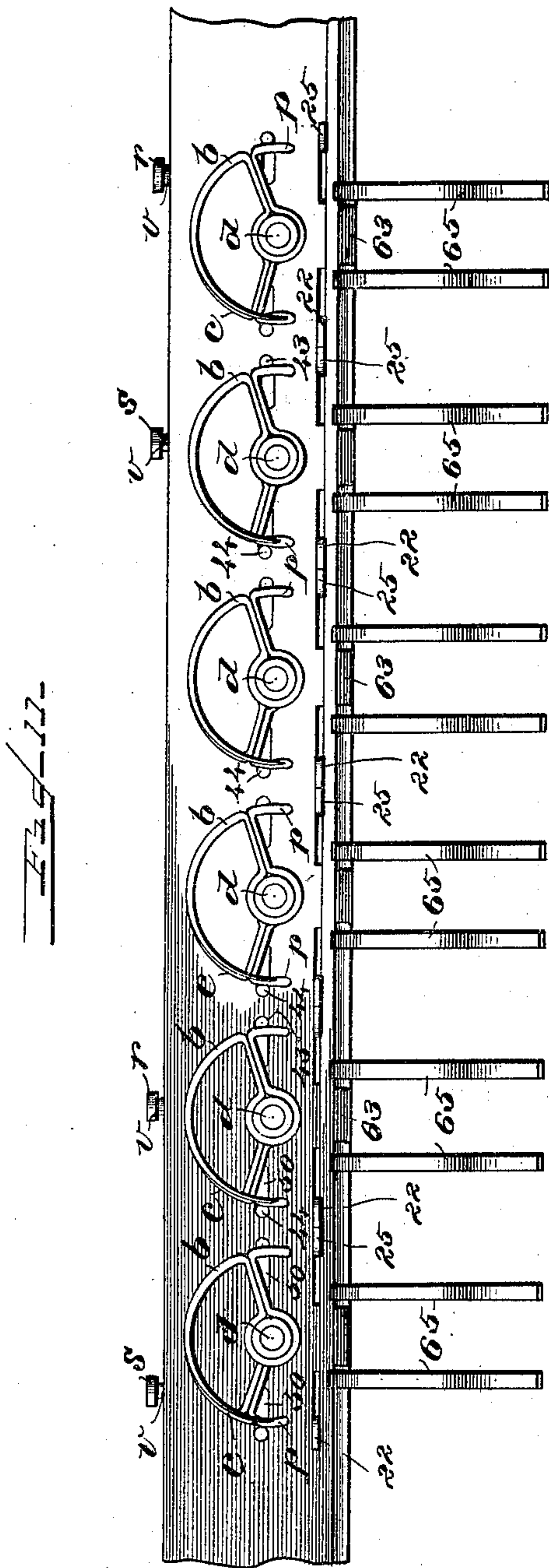
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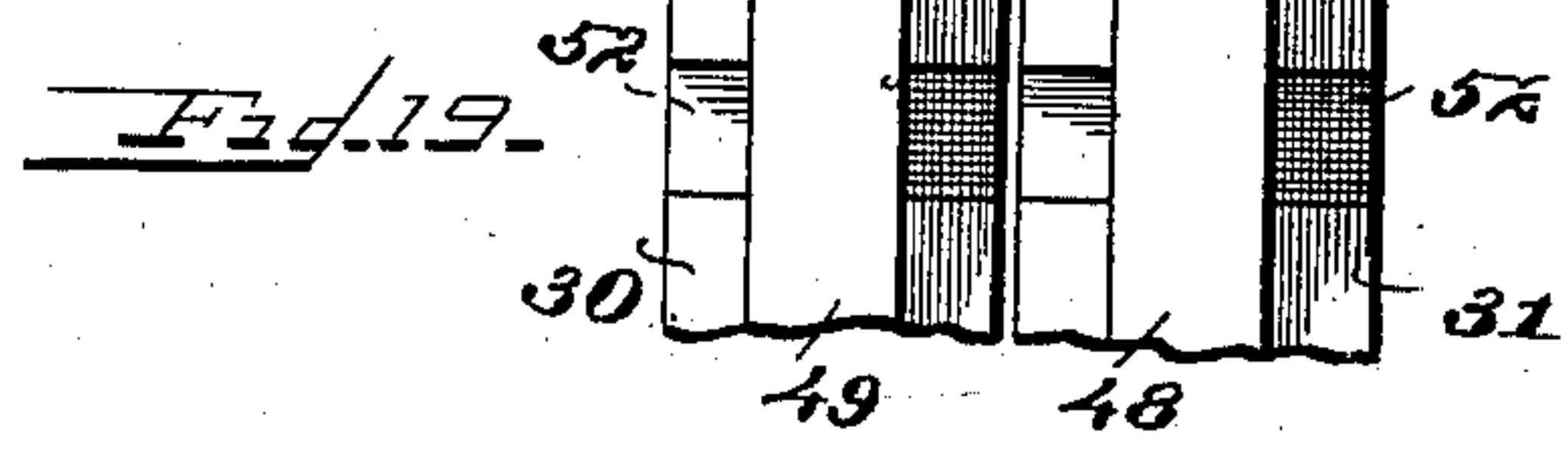
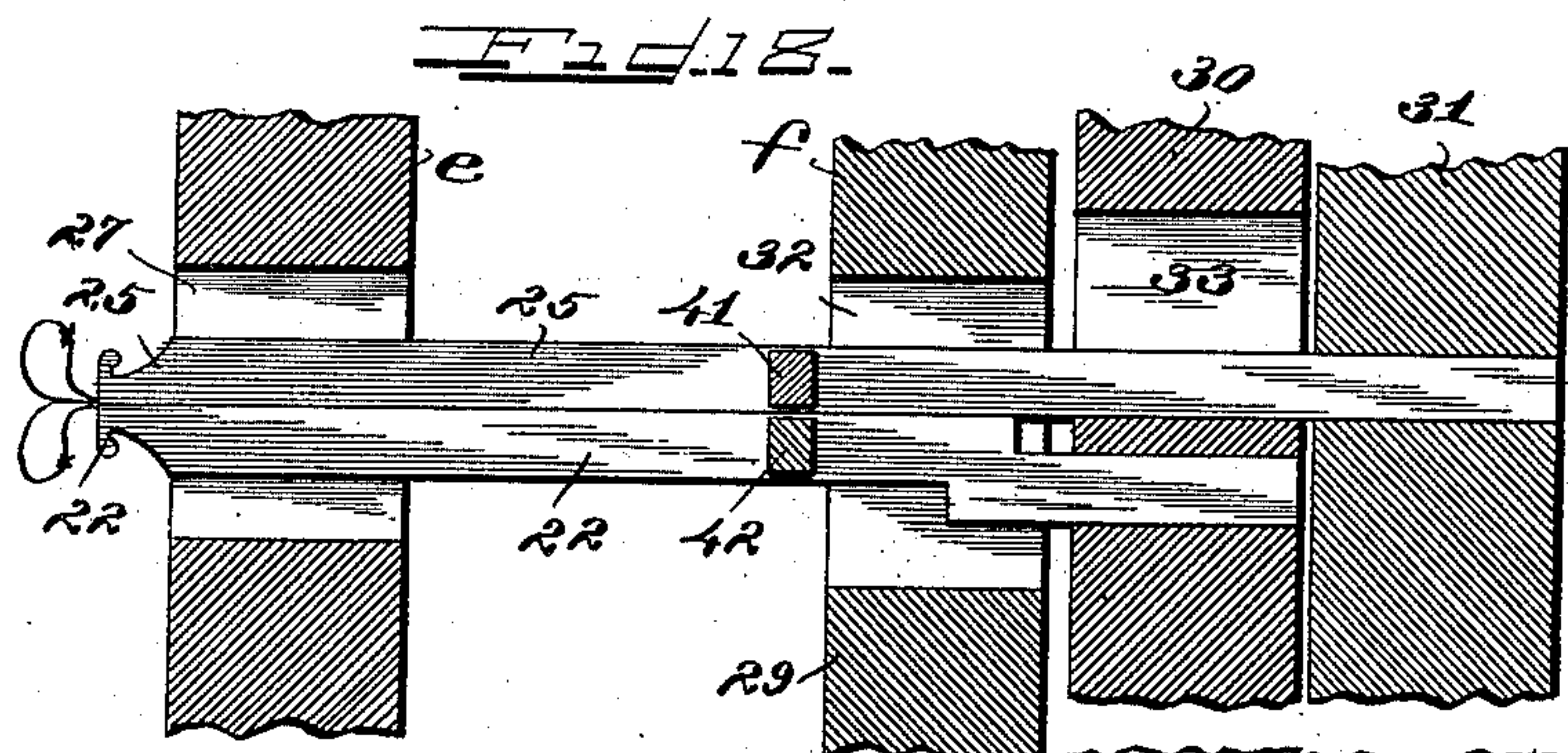
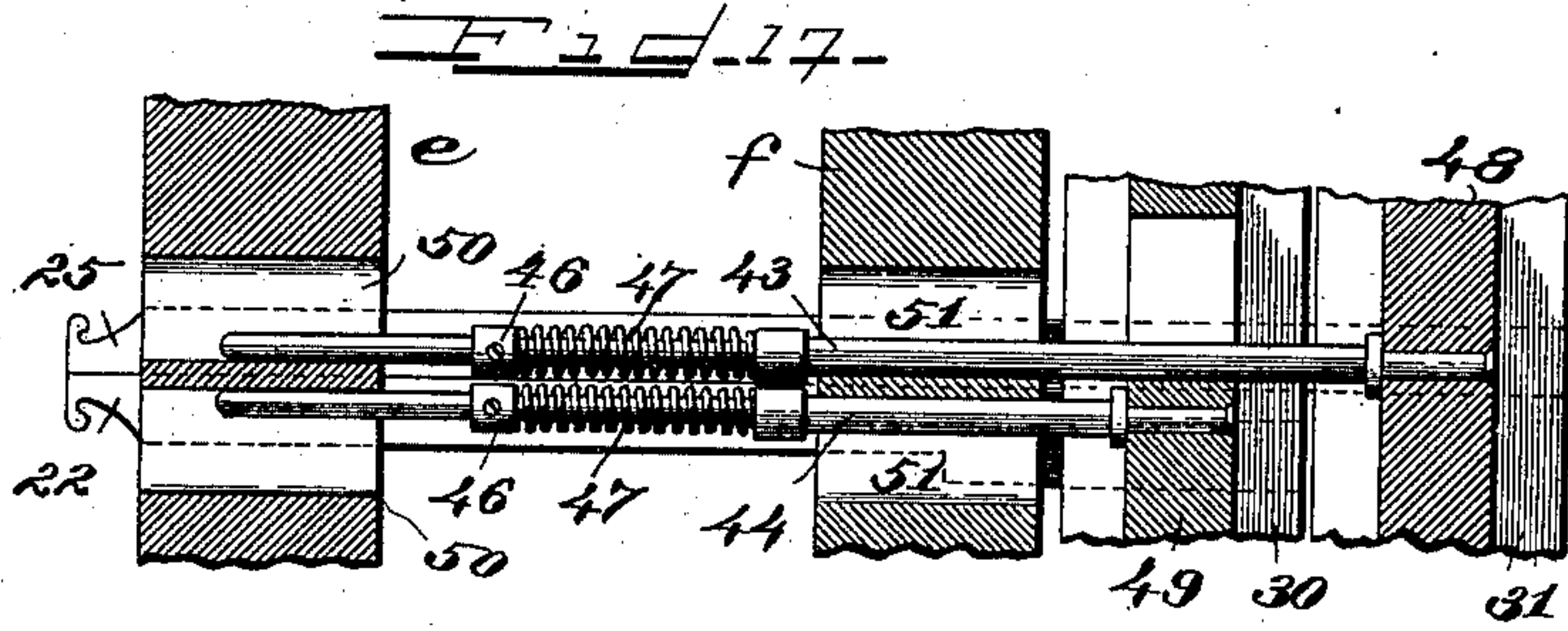
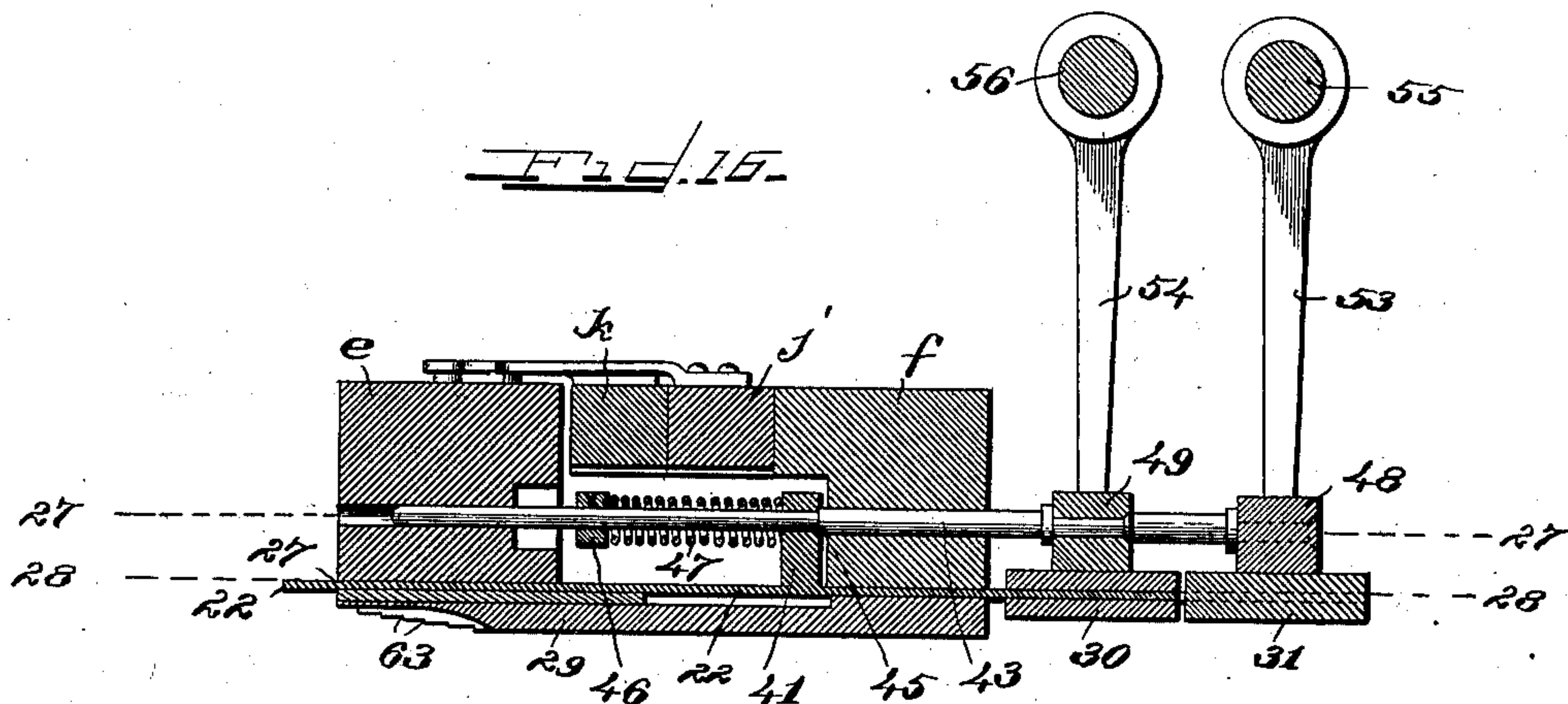
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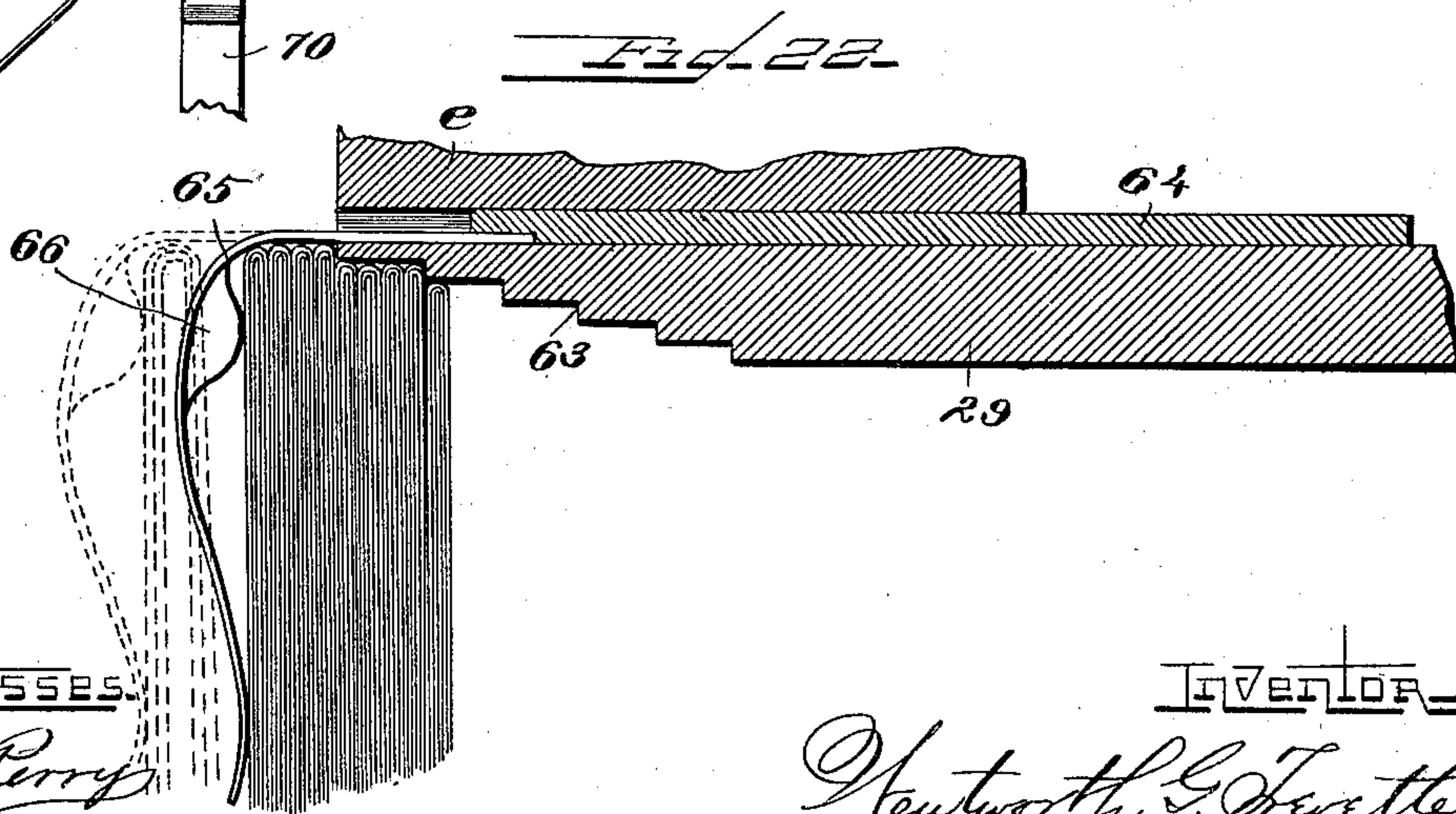
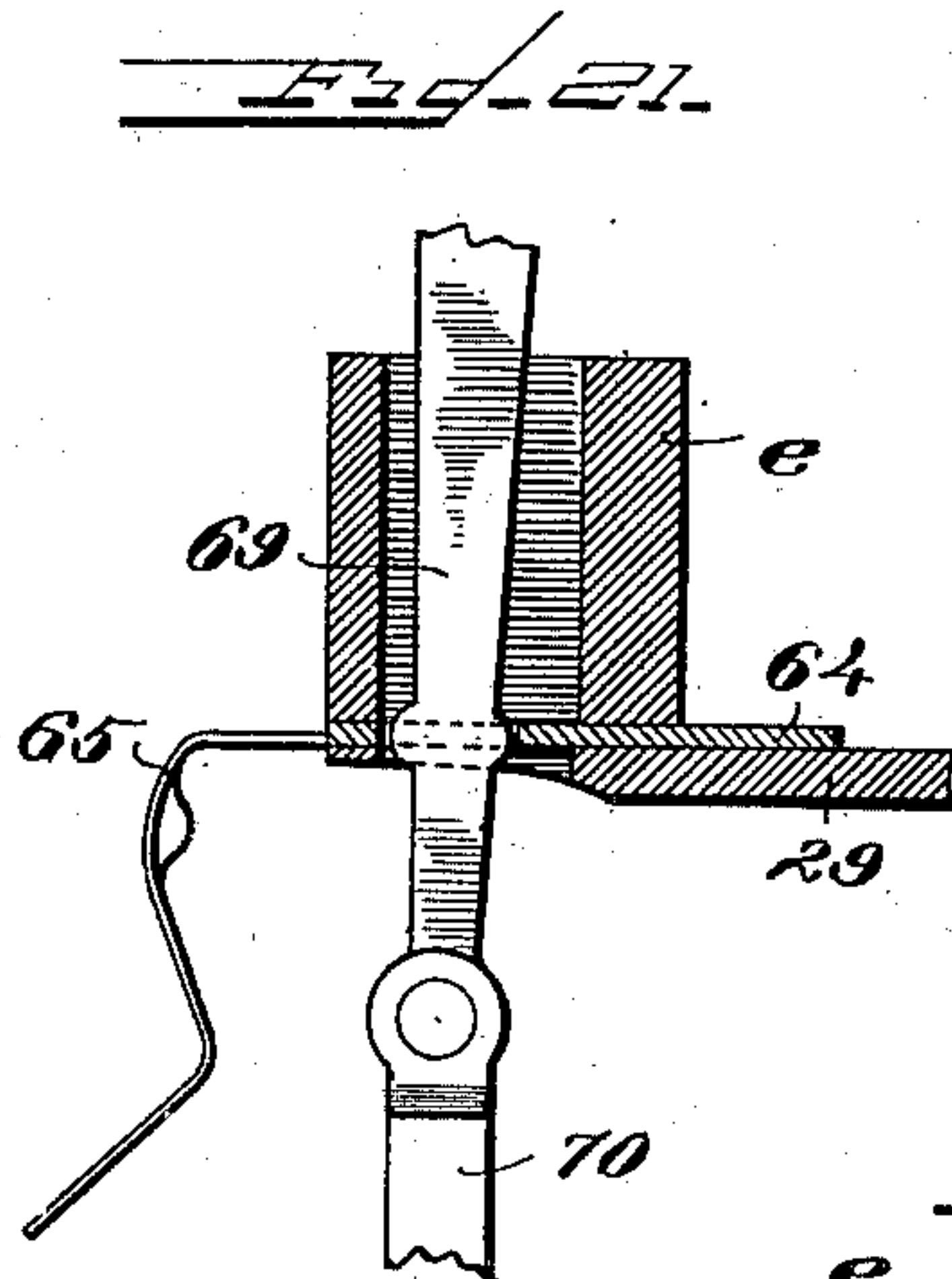
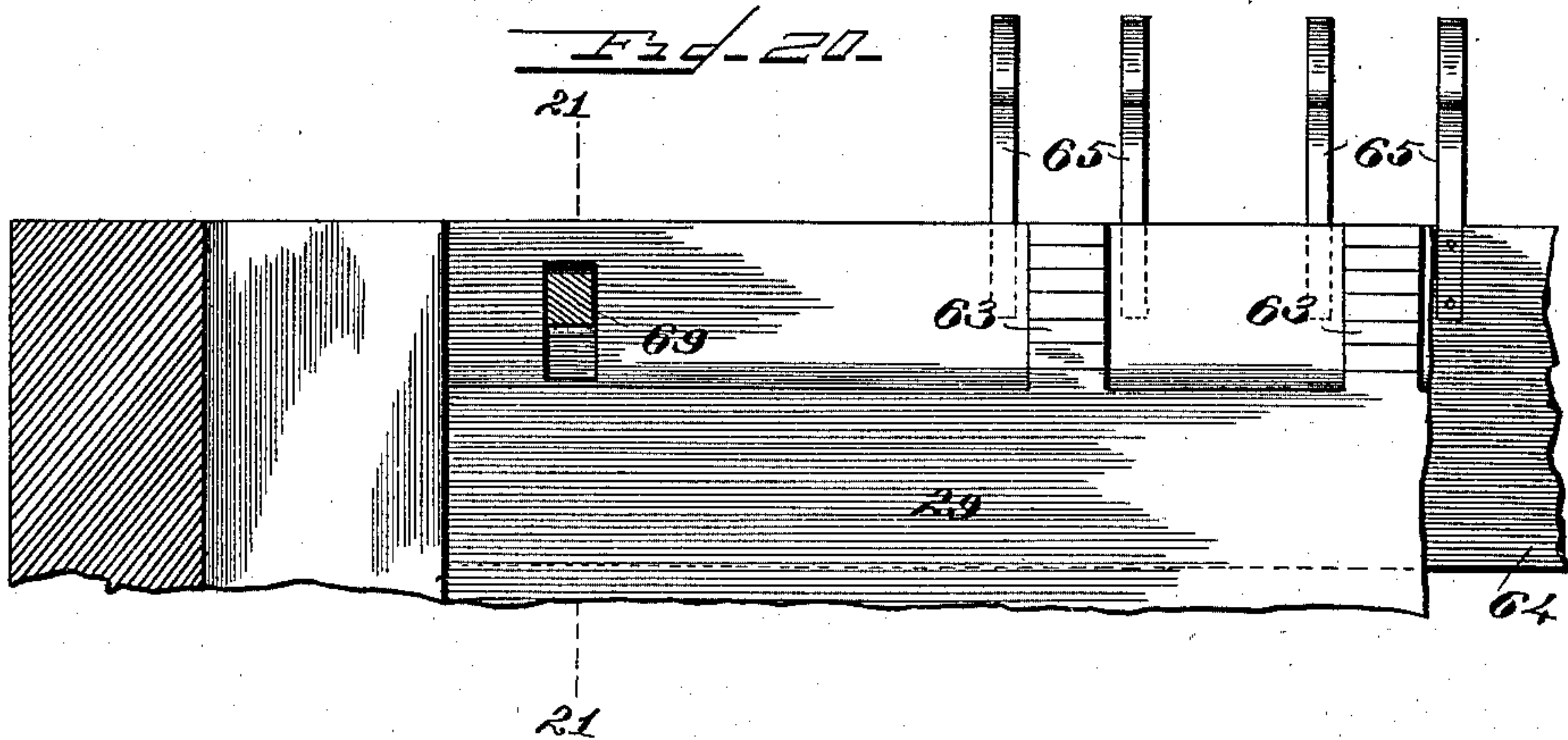
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# UNITED STATES PATENT OFFICE.

WENTWORTH G. TREVETTE, OF CHICAGO, ILLINOIS, ASSIGNOR, BY DIRECT AND MESNE ASSIGNMENTS, TO TREVETTE MACHINE COMPANY, OF SAME PLACE.

## BOOK-SEWING MACHINE.

SPECIFICATION forming part of Letters Patent No. 671,530, dated April 9, 1901.

Application filed March 5, 1900. Serial No. 7,314. (No model.)

*To all whom it may concern:*

Be it known that I, WENTWORTH G. TREVETTE, a citizen of the United States, residing at 115 Monroe street, Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Book-Sewing Machines, of which the following is a specification.

This invention relates to improvements in that class of machines especially designed for sewing together the leaves and signatures of a book, of which there are many examples in the art. It is the common practice in this art to first form the printed leaves of a book into signatures, a number of which when united in successive order constitute a complete book. The signatures are generally arranged in proper order in a pile in convenient reach of the operator, by whom they are fed to the book-sewing machine. The signatures are fed continuously and sewed together in successive order without regard to the number which constitutes a book; but after being sewed together the threads uniting the last signature of each book with the first signature of the next book are cut so as to leave a complete volume with all of the signatures constituting the book sewed together.

There is common to many such machines cooperating groups of mechanism for supporting and presenting the signatures to the needles, for punching or perforating the signatures for the threaded needles to pass through, for operating semicircular needles to sew the thread through the signatures, for looping the thread in cooperation with the needle to form successive knots in the thread, for packing or grouping the sewed signatures, and for the formation of some peculiar style of knot whereby the various signatures are connected together during the sewing operation.

My invention has for its primary object to improve upon the construction of, the mode of operation of, and the result produced by each such group of mechanism in machines of this class, whereby the construction and mode of operation of the machine will be greatly simplified, the product thereof will be greatly increased, the labor and power for

operating the machine will be considerably lessened, the making of false stitches or the skipping of stitches is obviated, the use of two separate threads to form a lock-stitch is rendered possible, and the formation of a novel style of knot in these threads after the sewing of each signature is accomplished, whereby is prevented the unraveling of the stitches or the separation of the signatures should any threads between the knots be cut or broken.

More specifically my invention has for its objects the provision of groups of cooperating mechanisms for attaining the foregoing objects, among which are the following: First, pairs of semicircular needles mounted upon a common center, whereby the use of two threads simultaneously to form a novel and improved lock-stitch is rendered possible; second, substantial, simple, and efficient means for punching the holes in the signatures in order that the needles may pass freely through the same, such punches being formed and cooperating with the needles in such manner as to obviate the use of separate and independent punches and the machinery necessary to operate the same; third, a looper cooperating with each pair of needles so constructed and arranged that it performs the different functions allotted to it positively with a minimum of machinery and so as to render it impossible for the point of the needle to pass outside of the loop formed in the thread by the looper, and thus skip a stitch, make an improper stitch, or cut or break the thread, and, fourth, means for producing such a sequence and cycle of operations of the foregoing groups of mechanism or instrumentalities as that the signatures will at the proper time be presented to the needle, will be punched, will have the needles threaded therein and sewed therethrough, and will have the separate threads of each pair of needles so interlooped, locked, and knotted upon one another as to form the so-called "lock-stitch," not only providing a knot for each signature, but connecting each signature with those upon either side of it in such manner that the stitches will not unravel or the signatures separate notwithstanding the threads



connecting the signatures are cut or broken, as has heretofore been the case. These and such other objects, as may hereinafter appear, are attained by the devices illustrated in the accompanying drawings, in which—

Figure 1 represents a side elevation of a book-sewing machine embodying my invention. Fig. 2 is a front elevation thereof. Fig. 3 is a central longitudinal section of the same; Fig. 3<sup>A</sup>, a diagrammatic representation of the path of movement of the feed-arms. Figs. 4, 5, 6, and 7 are detail perspective views showing the various steps of sewing and forming the knot in the thread, which will be hereinafter described in detail. Fig. 8 represents a perspective view of a knot formed in the threads, but before it is tightened. Fig. 9 is an enlarged vertical section through the upper part of the machine on substantially the same line as Fig. 3. Fig. 10 represents a plan view of the gang of needles and their directly-coöperating parts, taken on the line 10 10 of Fig. 9. Fig. 11 is a front elevation of the needle-gang, packers, and knotters detached. Figs. 12 and 13 are respectively a perspective view of a side elevation of a pair of needles. Fig. 14 is a detail perspective view of a looper. Fig. 15 is a detail plan view of the saddle for holding the signatures. Figs. 16, 17, 18, and 19 are detail views of the loop holders and tighteners and their operating mechanisms. Figs. 20, 21, and 22 are detail views of the packer and its directly-coöperating mechanism.

Similar characters of reference indicate the same parts in the several figures of the drawings.

Referring by characters to the accompanying drawings, A indicates the side frames, which may be of any suitable configuration, dimensions, and arrangement and united together in any well-known or convenient manner, so as to form a support for the operating parts of my device. Below the table B is arranged the mechanism for operating the feed-arms, which I will first describe. These arms C and D are preferably two in number, extending horizontally across the front of the machine forward of the frames and are in the shape of gibbon-arms, being respectively supported at opposite sides by vertical posts E, each mounted upon the forward end of a pair of horizontal guide-rods F, disposed in the same vertical plane, one above the other. As these feed-arms and their operating mechanisms are exact duplicates, a description of one and the reference characters applied thereto will suffice for both. The guide-rods F are supported at opposite ends in horizontal bearings G, formed upon vertical sleeves H, loosely mounted upon vertical guide-bars I and rigidly connected together by a cross-bar J. It will thus be seen that the guide-rods F are free to have a horizontal longitudinal movement in their bearings G and may also have imparted thereto a vertical bodily movement through the intermediary of bearing-sleeves H, which

slide freely up and down upon their guide-bars. This capability of movement is provided so that an orbital travel may be imparted to the feed-arms carried by the guide-rods. The orbit traversed by the feed-arm is indicated diagrammatically with substantial correctness in Fig. 3<sup>A</sup>, the arrows showing the direction of movement of the arm in traversing its orbit. To produce this movement of the feed-arm, I provide a system of cams and cam-levers, that are more clearly illustrated in Fig. 3, and the bodily vertical movement of the guide-rods is produced by means of the cam-lever K, connected at one end by a pin-and-slot connection with the cross-bar J at the center of length thereof and at its opposite end pivoted at L to the rear side of the frame A of the machine. Pivotaly connected with the lever K, between its ends, is a cam-arm M, carrying a roller N thereon, near the opposite end thereof, which roller travels in a camway O, formed in the face of a cam-wheel P, rigidly mounted upon a shaft Q, journaled in the frame of the machine. The lower end of the cam-arm M is provided with a longitudinal slot R, through which the shaft Q passes, thus affording a guide for the said arm in its movements induced by the cam.

To produce the horizontal longitudinal movement of the guide-rods F, I provide a lever S, a cam-arm T, and a cam-wheel U, provided with a camway, which are duplicates in construction and mode of operation of the lever K, cam-arm M, and cam-wheel P, the cam-wheel U being also rigidly mounted on the shaft Q, while the lever S is pivoted near the bottom of the side frames of the machine, so as to stand in a nearly upright position. The upper end of the lever S carries a pin or roller V, engaging a straight camway W in a slotted frame X, rigidly secured to the guide-rods F.

I propose to so arrange the camways of the cam-wheels P and U, which rotate in unison, as that part of the time during each revolution of the shaft both a horizontal and a vertical movement shall be imparted to the guide-rods, and consequently to the feed-arm, and at other times only one of said movements shall be imparted thereto, while still at other times no movement shall be imparted thereto, the feed-arm at such time being momentarily at rest. Without describing in detail the movements as produced, I will state that if the cams are so arranged as to impart to the feed-arm substantially the orbital travel illustrated in Fig. 3<sup>A</sup>, which any skilled mechanic can readily produce, the results sought by me will be attained. At the two points indicated by a "\*" the feed-arm is at rest, the lower "\*" indicating the point at which it receives the signature, corresponding to the dotted position shown in Fig. 3, and the upper "\*" indicating the point at which the arm holds the signature up to the needles during the sewing operation, corresponding with the position of the feed-arm shown by the



full lines in Fig. 3. It will also be understood that the feed-arms are intended to alternate with each other in their movements, so as to successively receive the signatures and carry the same to the needles. In the drawings I have shown two of these feed-arms, which I have before stated are in the shape of gibbet-arms, which, although they extend nearly across the machine, will pass each other in traversing their orbit, because as one goes up the other goes down in different planes. Operating in conjunction with these feed-arms is the stationary saddle Y, secured to a bracket-arm extending from one of the side frames A of the machine, said saddle being substantially V-shaped in end view, with the apex uppermost, as will be seen by an inspection of Fig. 3. The inner side of the saddle, at the inner end thereof—that is, the end toward the feed arms—is cut away, as shown at Z in Fig. 15, so as to permit the feed-arms to come up underneath the front side of the saddle and pass out of the back side through the cut Z, thus insuring that the feed-arms will come up as close as possible to the saddle to insure ease in sliding the signatures from the saddle onto the arms, while the latter are momentarily at rest on a line with the saddle, as illustrated in Fig. 2.

The peculiar mode of operation of the feed-arms is of the utmost importance in a machine of this class, as the operation of these arms, or rather the mode of feeding, practically determines the speed at which the machine may be run, and therefore limits and determines the capacity of the machine. The advantages of the described arrangement of the feed-arm and saddle are that they allow the attendant or feeder to place the signatures in position to be presented to the needles for sewing with a minimum expenditure of time, of energy, and skill, thereby enabling the operator to feed the signatures more rapidly than has heretofore been possible, and consequently enabling the machine to sew a much greater number of books during a day than by the present method of placing the signatures directly on the intermittently-moving feed-arm. This will be appreciated when it is understood that to feed the signatures to the feed-arm as at present constructed and operated the feeder must pick up a signature with the left hand, bring it forward, and hold it suspended for a time, afterward grasping it with the right hand and carefully placing it on the feed-arm, which must remain in position, inactive, a sufficient length of time to allow this to be done properly and uniformly each time. With my invention, however, the signature is picked up by the feeder with his left hand and thrown carelessly across the saddle, where it remains until the moving arm presents itself, when it is slid onto the arm by a simple sweep of the right hand. It will thus be seen that as soon as the signature has been thrown across the saddle the left hand is free to reach for another signature, not being com-

pelled to hold the signature suspended and pass it to the right hand, while the time that the feed-arm must remain at rest to receive the signature is reduced to the minimum and, in fact, is merely momentary, being scarcely appreciable and little more than sufficient to change the direction of its movement from the vertical to the horizontal, as shown by the diagram in Fig. 3<sup>A</sup>. As the speed at which a book-sewing machine can be run is governed entirely by the time it requires the attendant to pick up and place the signatures in proper position on the feed-arms, the importance of my arrangement will be readily understood, for the movements of the operator are so simplified that this time is reduced to the minimum. The machine can be allowed to run very rapidly, and the product of the machine as compared with other machines as heretofore constructed and operated is increased two three, and even four fold, according to the dexterity of the individual operator, while at the same time a mere novice can feed the machine more rapidly than a skilled operator can feed a machine of prior constructions. To insure the best results, a gage *a* of some suitable construction should be secured to the upper edge of the feed-arm, so as to insure the stopping of the signatures at the proper place upon the arm when slid thereon.

The needles by which the sewing is done are arranged in a horizontal gang at the front edge of the machine, as shown more clearly in Figs. 10 and 11, the gang being composed of any desired number of pairs of semicircular needles, the needles of each pair being mounted on a common center, but pointing in opposite directions and moving alternately in opposite directions to pass the thread-loop through the signatures. Taking a single pair of such needles, which is illustrated in detail in Figs. 12 and 13, *b* and *c* indicate the two needles, which may be of the usual form common in this art, excepting that the needles while mounted upon a common center are fastened to independently-rotatable supports. For instance, the needle *b* (see Fig. 9) is mounted rigidly upon the end of a shaft *d*, suitably journaled in an elevated frame extending above the table B of the machine, two parallel bars *e* and *f* extending transversely of the machine, one fixed and the other laterally movable, as will be explained further on, constituting the bearings for said shaft. The other needle *c* is fixedly mounted upon the end of a sleeve *g*, which is loose upon the shaft *d* and is confined between the hub of the needle *b* or a collar on the end of the shaft *d*, carrying said needle, and a pinion *h*, keyed or otherwise rigidly secured to the shaft *d* next to the fixed bar *f*. A companion pinion *i* is keyed upon the sleeve *g* near its inner end. These pinions afford means for actuating the needles, which are passed back and forth through the signatures in the sewing operation by means of the rack-bars *j* and *k*, located side by side between the



bars *e* and *f* and respectively engaging the pinions *h* and *i*. The rack-bars project beyond the side frames of the machine, as shown in Figs. 1 and 2, and are respectively reciprocated by vibrating cam-levers *l* and *m*, pivoted to the side frame of the machine, which levers carry pins or rollers upon their lower ends engaging camways in the side faces of the cam-wheels *n* and *o* in a manner which will be well understood, whereby the movement of the needles is accomplished in proper time with reference to the time of action of all of the other parts of the machine.

Each needle is provided on its heel with a punch *p* on the same radius as the needle, by which the holes in the backs of the signatures are made through which to pass the needles and threads. It will be noted by reference to Figs. 12 and 13 that these punches stand in a central position between the two needles, each punch being set to one side of the needle to which it is attached. The needles of each pair work alternately—that is to say, while one needle is forming a knot the other needle is, to all intents and purposes, at rest, as it is out of engagement with the signature. In this way each pair of needles forms two separate lines of sewing, although each line is knotted and interlocked with the other, as will be explained farther on, and each needle forms a knot on the alternate signatures, so that in the completed sewing the knots are alternately disposed in the parallel lines of stitching. It is therefore necessary that two holes should be formed in the back of the signature in a straight line, one for the needle-point to enter and the other for it to pass out of, it being understood, of course, that the needle backs out or retraces its path of movement, and as the needles cannot, in the nature of things, be located in the same vertical plane, but must be side by side, it is necessary that they be alternately shifted in opposite directions, so as to bring them successively and in proper time to the central line of the punches, so that each needle may pass through the pair of holes punched therefor on the central line of the back of the signature. It will be noted by reference more particularly to Fig. 9 that the upper edge of the feed-arm *D* has formed thereon a longitudinal groove *q* to receive the needles in the act of sewing after they have passed through the signature, which straddles the arm in the usual way, with the center of its back immediately above the groove, the punches *p* being also normally located immediately above said groove, centrally thereof. Thus when the signature is brought up under the needles in position for sewing the first operation is a slight reversed rotation of each of the needles, which forces the punches down instead of the needles, the punches thus perforating the signature on a line at the center of the back of the signature. This action is reversed to withdraw the punches from the signature, and then, according to which of the needles

*b* or *c* is to perform the sewing of the particular signature, the needles and their directly-operating mechanism are shifted laterally—that is, parallel to their axes—so as to bring the point of the needle in a line with the holes punched in the back of the signature, in which position they are bound to “find” the holes, because they were formed by the punches on the same radius as the needles. This operation of the needles is brought about by the lateral shifting of the guide-bar *e*, in which the shafts operating the needles are longitudinally immovable, although free to rotate—that is to say, the shaft *d*, the sleeve *g*, the pins, and the needle-hubs are arranged to so abut against one another that the bar *e* cannot be moved laterally without moving both of the needles, punches, and the needle-operating shafts and gears. This lateral shifting of the needles alternately in opposite directions is very simply brought about by the devices illustrated more particularly in Figs. 9 and 10, comprising two pairs of arms *r* and *s*, one pair of which—say the pair *r*—is rigidly secured at one end to the rack-bar *j*, while the other pair, *s*, is rigidly secured at one end to the rack-bar *k*, both of said arms projecting freely forward above the bar *e*. In the top of said bar is formed, adjacent to each set of arms, a pair of cam-grooves *t* and *u*. Depending from the pair of arms *r* is a pin or other projection *v*, engaging the cam-groove *t* of each pair of grooves, and a like pin or projection on each of the arms *s* engages the groove *u* of each pair. Each of the four cam-grooves *t* and *u* has two straight portions extending longitudinally of the bar *e* and an intermediate angular portion connecting the two straight portions. The opposite straight end portion of each groove of a pair is considerably wider than the diameter or thickness of the pin or projection *v*, so as to allow of lateral movement of the pin therein, while the opposite straight ends of each pair of grooves, as well as the angular portions thereof, are of a width substantially corresponding with that of the pin or projection, so that when the pin or projection is in the narrow straight portion or the angular portion of the groove it is active, while in the wider portions of each groove it is inactive, the pin or projection on the pair of arms *s* being in the wide portions of the grooves *u* whenever the pins on the pair of arms *r* are in the narrow angular or straight portions of the grooves *t*, and vice versa.

In Fig. 10 I have shown by arrows the directions of movements of the rack-bars *j* and *k* when the needles are commencing to work and after the punching has been done, the parts being shown in their respective positions either immediately before or immediately after the punching operation has been performed. It will be noted that all of the pins *v* are in the wide parts of the grooves and that a movement of the rack-bars either simultaneously or successively in the opposite direc-



tions from those indicated by the arrows on the drawings will cause the pins to traverse the broad portions of the grooves *t* and *u* toward the outer ends thereof without causing any movement whatever of the bar *e*, the engagement of the pins *v* of the respective pair of arms with the opposite side walls of the grooves *t* and *u* in fact serving to prevent movement of the bar *e*, which is thus locked in its normal middle position during the punching operation. If now we assume that the first needle to commence work is the needle *b*, operated by the rack-bar *j*, it will be seen that the first movement of said bar in the direction indicated by the arrow will cause the bar *e* to shift toward the rack-bar *j*, carrying with it both of the needles and their operating-shafts to a point half-way between the normal position of the two needles—that is, on the central line of the signature immediately above the groove *q* in the feed-arm and in position to pass through the two holes previously punched in the signature, the needle being maintained and locked in this position during its movement forward and backward through the signature—that is, during a complete reciprocation of the bar *j*—by the engagement of the pins *v* on the arms *r* with the narrow straight portions of the grooves *t*, the engagement of the pins with the angular portions of which grooves have caused the lateral movement of the bar. The return of the bar *j* to its initial position restores the parts to the position shown in Fig. 10, and if now after the operation of the punches, as before described, the other needle *c* commences work the first operation will be the shifting of the bar *e* outwardly or away from the rack-bar *k*, carrying the needle *c* to the central line of the back of the signature, the operation of the parts with this needle exactly duplicating the operations of the needle *b*. It will thus be seen that the needles *b* and *c* operate alternately to form a knot, one forming a knot on one line of punches or line of stitching and the other forming its knot on the other line of punches and stitching, each forming a knot on the back of alternate signatures, which are successively and timely brought in position for operations of the punches and needles, it being understood that the punches must operate for the operation of each needle.

The use of two semicircular needles mounted on a common center and moving alternately in opposite directions to pass the thread-loop through the signatures is entirely novel, so far as I am aware, and is superior to any previous construction or arrangement of the needles in that it permits of the use of two threads, in that it enables the formation of a lock-stitch, by which the unraveling of the threads or the separation of the signatures is prevented when the signatures are cut apart, and in that they permit of a more rapid operation of the machine, as I have two needles at work where heretofore but one has been em-

ployed. The use of the pair of needles also permits the use of the substantial, simple, and efficient means of punching the holes in the back of the signature in order that the curved needles may pass freely through the paper, which punches, being mounted on the same radius as and on the heel of the needles, obviate the use of separate punches and the machinery necessary to operate the same, as by my invention the same mechanism that operates the needles also operates the punches by simply "backing up" the needles. Another important advantage in the cooperation of the punches and needles arises from the punches being formed on the same radius as the needles, which renders it impossible to punch the holes in any but the proper place and compels the needles to always find the holes. Furthermore, while in carrying out the broad idea of my invention I do not desire to limit myself to any particular construction of needles and punches, except that they shall be in pairs upon a common center, I am enabled to produce an exceedingly cheap, simple, and strong needle and punch out of a single piece of wire, as clearly illustrated in Figs. 12 and 13, by bending the same between the needle and the punch, so as to form the hub therefor, the ends of the wires terminating in and forming the punch and needle-point, respectively. Of course the needle has the usual groove in its back or outer periphery, in which the thread laces while being passed through the signature. Cooperating with each pair of needles is a looper of novel construction and mode of operation, it having heretofore been invariably necessary to provide a looper for each needle. As my needles, however, operate alternately, I am enabled to utilize a single looper for each pair of needles, said looper cooperating alternately with said needles. There is therefore one looper for each pair of needles, as shown in Fig. 10, these loopers being in the form of hooks and having the general shape of a half of an arrow-head cut transversely through the point and provided with a hole for the passage of the needle through the hook. These loopers 1 are all mounted in a gang in front of the needles in a movable frame 2, having a rack-bar 3 slidably and longitudinally mounted therein, a tongue-and-grooved or dovetail connection between the frame and the rack-bar serving to prevent displacement of said bar. The rack-bar, which is toothed on its under side, engages a pinion 4 on each of the shafts 5, on which each of the loopers 1 are eccentrically mounted, as clearly shown in Fig. 10. Thus when the rack-bar is reciprocated, causing a corresponding rotation of the eccentric shafts 5, not only will the loopers be rotated thereby, but they will also be caused to have a bodily movement on the arc of a circle moving about the axis of the shaft 5 and partially rotating at the same time. The action of the loopers just described—that is, their rotation as well as their bodily



movement about the axes of their shafts—takes place in conjunction with each of the needles; but there are still two other movements which are imparted to the gang of loopers simultaneously, one being a movement toward the needles to release the loop and the other a lateral movement from one needle to the other. The former movement is produced by having the frame 2 mounted slid-  
 10 ingly at opposite ends thereof in slide-bars 6, slidably mounted in the frame of the machine, with the opposite ends of which bars, at the back of the frame, is connected a cam-lever 7, (see Figs. 1 and 9,) pivoted to the  
 15 frame of the machine and carrying on its opposite end a roller engaging a cam-groove 8 in a cam-wheel 9, mounted upon the shaft 10, on which the cam-wheels *n* and *o* are also mounted at one side of the machine. Obvi-  
 20 ously whenever the lever 7 is vibrated the slide-bars 6 will be moved back and forth in their guides, carrying bodily with them the frame 2, in which the loopers are journaled.

The lateral shifting of the gang of loopers from position to cooperate with one set of needles of each pair to position to cooperate with the other set of needles of each pair is effected by sliding the frame 2 through their bearings in the ends of the slide-bars 6, which  
 30 is accomplished by pivotally connecting to a prolongation of the frame 2 at one end (see Figs. 1 and 2) one end of a cam-lever 11, which lever is pivoted in a bracket 12, attached to a side frame of the machine, while  
 35 the other end of said lever carries a roller engaging a camway in the cam-wheel 13. Thus whenever the cam-lever is vibrated the frame 2 will be shifted endwise through its bearings in the slide-bars 6, so as to bring the loopers  
 40 in position for cooperation with the one or the other set of needles, as the case may be.

Reciprocation of the rack-bar 3 is effected by pivotally connecting to the prolonged end thereof a cam-lever 14, also pivoted in the  
 45 bracket 12 and carrying on its opposite end a roller engaging a camway in the cam-wheel 15, which cam-wheel, as well as the cam-wheel 13, is mounted upon the shaft 10.

The disposition of the various camways to bring about the desired movements of the various parts at the proper time is a matter of easy accomplishment by any skilled mechanic once the sequence of operations is understood, and that will be brought about in the  
 55 description of the operation of the needles in forming a knot, to which I will now refer.

I will first state that the loopers are constructed in such a manner as to enable them to hook and form a loop in the thread and  
 60 present a loop for the needle to pass through and that it performs the different functions allotted to it in a positive manner with a minimum of machinery. By bringing the loop forward and holding it open by reason of the  
 65 thread forming the loop being passed around and held open by the hook of the looper and allowing the needle to pass through a hole in

the hook of the looper surrounded by the loop in the thread it will be seen that it is impossible for the point of the needle to pass on  
 70 the outside of the looper or to strike, cut, or enter between the meshes of the thread, thereby failing to make the proper stitch or cut or break the thread, one looper performing these various functions for each pair of needles. 75

Referring now more particularly to Figs. 4 to 8, inclusive, I will now describe the action of the needles and their immediate cooperating parts in forming the parallel lines of stitching along the backs of the signatures. As I  
 80 have before stated, each needle of a pair forms a line of stitching parallel with the other needles of the gang; but the knots formed by the needles of a pair alternate with each other, so that taking the three signatures 16, 17, and  
 85 18 (shown in the drawings) the needle *c* will form a knot at the back of the signatures 16 and 18, while the needle *b* will form a knot at the back of the signature 17; but each needle uses the thread of the other needle of  
 90 each pair to form a knot, so that the threads of each needle are interlocked and tied to the threads of the other needle. The knot which I propose to form is shown in detail in Fig. 8, and a completed knot is also shown at the  
 95 back of signature 16 in Figs. 4 to 7, inclusive; but none of said knots are shown as drawn tight, as they necessarily must be in practice. I am now going to describe the formation of  
 100 the knot at the back of signature 17 by the needle *b*, and it will be understood that throughout the operation of this needle the needle *c* remains practically stationary in the position shown in the drawings. In Fig. 4  
 105 the parts are in the position which they assume when the needle first enters the signature. In this position the loop 19, formed in the thread 20 of the needle *b* by the hook of the looper 1, is held so that the needle passes  
 110 through the loop at right angles thereto, carrying the feed end of the thread along with it. The thread 20 will be readily traced as passing from the guide-loop on the frame down the back of the needle, through the eye  
 115 thereof and up the front of the needle, back through the transverse slot 21 in the looper, through which the needle passes. Thence the thread passes back to the knotter 22, which is shown fully projected, and thence forward  
 120 again around the hook of the looper at right angles thereto and back to the knot previously formed in this line, that portion of the thread passing forward from the knotter and  
 125 back again around the looper-hook to form the loop 19 being passed through a loop 23, formed in the thread 24 of the needle *c*, which has been previously passed through the perforation in the back of the signature 17 during the formation of the knot on the signature 16. As the needle passes on through the signa-  
 130 ture and comes out of the perforation in the back of the signature 18 in a line with the stitching formed by the needle *c* to assume the position shown in Fig. 5 the looper 1



moves forward, so as to disengage the hook thereof from the loop 19, and when so disengaged retreats and makes a quarter-revolution, at the same time moving laterally to the right until it is substantially in a line with the point of the needle *b*, when it is again moved forward, passing through the thread on the inner arc of the needle near the eye thereof and on forward until its hook engages the thread 24 of the needle *c*, which at this instant is released by the knotter 25 and carries the thread back with it to a position at rest, with the loop thus made around it drawn back through the loop 26 in the thread 20 of the needle *b*, as plainly shown in Fig. 5. The loop 19 in the thread 20 during this operation will be held extended, because the body of the needle is through it, and it will remain so extended until the needle *b* moves back again to its normal position. The needle *b* now commences to withdraw from the signature 18 in its original path, the looper remaining in substantially the same position until the needle is entirely withdrawn from the signature, while the knotter 22 is gradually retracted, so as to take the slack out of the thread, drawing down the loop 19 after the needle passes out of it. The various parts are now in the position shown in Fig. 6, and the completion of the tying of the knot on the signature 17 is effected when the looper is withdrawn from the loop 26 in the thread 24 of the needle *c*, for as soon as this operation takes place the needle *b* rises to its highest position, thus drawing down the loop 26 close to the back of the signature 18. The looper now makes a quarter-turn to the position shown in Fig. 7, in which turn of course it moves bodily sidewise as well, because of its eccentric support, thus helping to draw the slack out of the loop 19. The looper next moves backward, withdrawing from the loop 26, and at the same time makes a half-revolution as well as a lateral bodily movement, bringing it back again to a line with the stitching formed by the needle *c*, but in the position in which it is shown at the opposite side in Fig. 4, ready to receive the needle for commencing the formation of the next knot in the signature 18. It will of course be understood that when the looper comes to rest it lies immediately above the signature next to be entered by the needle *c*, the slot 21 therein, which is transverse to the hook, lying immediately above the perforation in such signature. Of course in its backward movement the looper carries with it the thread 24, looped around the hook thereon, so as to form a new loop for the needle to pass through in entering the next signature. During these movements of the looper the knotter 25 advances and hooks the thread 24 between the looper and the needle *c*, thus holding the thread ready for the formation of the next loop in the same manner as does the knotter 22 in Fig. 4. The formation of the next loop

is of course a mere repetition of the operations just described.

In Figs. 4 to 7, inclusive, I have shown only the knotters that cooperate with the needles *b* and *c* of a pair; but in the construction of the machine, as more clearly shown in Fig. 10, between each pair of needles there is arranged a pair of these knotters, one of which cooperates with one of the needles of one pair, while the other cooperates with one of the needles of the adjacent pair, and of course one needle of each pair and one knotter of each pair have gangs of needles and knotters operating simultaneously. The mechanism for producing the necessary movements of the knotters is shown more particularly in Figs. 9, 10, 16, and 17. The path of movement of each knotter is approximately illustrated diagrammatically in Fig. 18 at the front of the pair of knotters, the point marked with a \* therein indicating the position at rest which the knotter assumes during the part of the operation previously described.

The knotters 22 and 25 are operated alternately to cooperate with their respective needles and are in the shape of flat bars, each pair of which extends through a slot 27, formed in the under side of the movable bar *e*, being confined in said slots by a movable packer-bar 28, which slides upon a fixed abutment 29. The slots 27 are of a length about double the width of the knotter-bars, so as to afford ample room for the lateral movements of said bars. The disposition and shape of the knotters are clearly illustrated in Fig. 18, which is a horizontal section taken on the line 18 18 of Fig. 16 immediately above the knotters. The mechanism for imparting the independent and alternate lateral movements to the knotters 22 and 25 consists of a pair of parallel bars 30 and 31, arranged side by side to the rear of the bar *f*, being supported and guided in the same frame as the bars *e* and *f*. The rear end of the knotter-bar 22 is slidingly secured in the bar 30, so that it may have endwise but not lateral movement therein, while the rear end of the knotter-bar 25 is likewise secured in the bar 31. Both of said knotter-bars pass through a long slot 32, formed in the rear edge of the fixed abutment 29, while the knotter-bar 25 also passes through a long slot 33 in the bar 30, so that the knotter-bar 25 may be moved laterally without affecting the bar 30, or the bar 30 may be moved longitudinally without affecting the knotter-bar 25. It will thus be seen that each of the knotter-bars 22 and 25 may be moved laterally independently of each other, and while they are also free to have longitudinal movement in their respective operating-bars 30 and 31 such movement is of course never sufficient to disengage them from said bars.

A longitudinal movement of the bars 30 and 31, which causes the lateral movement of the knotters 22 and 25, is obtained by pivotally



connecting one end of said bars respectively with the cam-levers 34 and 35, (see Fig. 1,) pivoted in a suitable bracket 36, secured to the side frame of the machine, the opposite ends 37 and 38 of which levers carry antifric-

tion-rollers engaging camways in the side faces of the cam-wheels 39 and 40, mounted upon the shaft 10.

The mechanism for imparting a longitudinal or endwise movement to the knotters will be best understood by reference to Figs. 16 and 17, the latter being a horizontal section taken on the line 17 17 of Fig. 16.

The knotter-bars just forward of the bar *f* are provided with posts 41 and 42, respectively, through which posts respectively and loosely pass the rods 43 and 44, each of which is provided with a shoulder 45 immediately back of the posts. Confined between said posts and an adjustable collar 46 on each of said rods is a coil-spring 47. The rear end of the rod 43 is rigidly secured to a bar 48, mounted upon the bar 31, while the rear end of the rod 44 is rigidly secured to a bar 49, mounted upon the bar 30. Each of the rods 43 and 44 passes freely through elongated slots 50 and 51 in the bars *e* and *f*, respectively, while the rod 43 also passes freely through an elongated slot in the bar 49, thus permitting lateral movement of either the bar 43 or a longitudinal movement of the bar 49 without one affecting the other. The rods 43 and 44 must of course move laterally with the knotter-bars, to which end the bars 48 and 49, which are mounted upon the bars 30 and 31, are provided with depending lugs at two or more points along their length engaging transverse slots 52 in the bars 30 and 31, as shown in Fig. 19. Thus while the bars 48 and 49 are compelled to move longitudinally in unison with the bars 30 and 31 at the same time they may have lateral movement upon said bars independently thereof, and it is this lateral movement of said bars which gives to the rods 43, and consequently to the knotter-bars 22 and 25, their longitudinal movement, which movement is imparted to the knotters simultaneously with their lateral movement, thus giving to the ends of said bars the peculiar orbital travel shown by the diagrams at the ends of said bars in Fig. 18.

Lateral movement is imparted to the bars 48 and 49 by means of crank-arms 53 and 54, depending from a pair of transverse shafts 55 and 56, journaled in the frame of the machine, the outer ends of which shafts beyond the side frame A of the machine have rigidly secured thereto, respectively, the crank-arms 57 and 58. To these crank-arms are pivotally connected, respectively, cam-levers 59 and 60, (see Fig. 1,) pivoted to the frame of the machine and carrying on their ends antifric-

tion-rollers engaging peripheral camways 61 and 62 in the cam-wheels 39 and 40, respectively.

The purpose of the spring 47 is to afford a yielding pull for the knotter, for while the shoulder 45 upon the rod 43, abutting against

the post 41, will cause a positive forward movement of the knotter the backward movement of the knotter will be caused by the force imparted from the rod 43 through the spring 47, so that if for any reason the slack in the thread should not pay out readily or the thread should be cut the knotter will not be positively retracted, which would result in the breaking of the thread under such circumstances, but will be drawn back with a yielding force, so that as soon as the obstruction to the movement of the thread is removed the spring will complete the retraction of the knotter.

As rapidly as the signatures are sewed together they must be moved away from the needles to make room for the next signature, and in order to hold the bunch of signatures in proper position during operation the common practice is to have a spring-follower which presses forward toward the needles opposing the packers. I propose to avoid the necessity of employing any such follower by providing a packer of new and novel construction comprising the fixed abutment-plate 29, which is beveled on the under side at its forward edge, steps or serrations 63 (see Fig. 22) being preferably provided such beveled or inclined surface to afford resistance to the passage of the signatures between the abutment 29 and the table B upon which the signatures rest. Sliding upon the abutment and between it and the bar *e* is a reciprocating packer-bar 64, having rigidly secured thereto at regular intervals a series of spring-packers 65. These arms depend from the forward edge of the bar 64 a suitable distance below the front edge of the abutment 29, and substantially opposite the abutment the spring is thickened, as at 66, to afford a contact with the signatures a suitable distance below the backs thereof, so as to provide for the free action of the needle and thread in their passage through the signatures. The bar 64 reciprocates laterally—that is, toward and away from the beveled edge of the abutment, as shown by the dotted lines in Fig. 22—being moved outward to the position shown by the dotted lines when the feed-arms carry up a signature to be sewed, which signature is forced up under the packer-springs. As soon as the feed-arm is withdrawn from the signature the bar 64 is moved laterally and the packers force the newly-sewed signature and the entire book of sewed signatures inward along between the abutment and the table.

In practice the distance between the forward edge of the beveled surface of the abutment 29 and the upper surface of the table B substantially corresponds with the height of the signatures, the table being made adjustable to bring about this result when operating upon signatures of different sizes. Hence the beveled and, if desired, serrated or stepped surface of the abutment affords a substantial resistance to the action of the packers



in forcing the book of sewed signatures along between the abutment and the table, and thus serves to maintain a yielding cushion against which the newly-sewed signatures are packed and held without the necessity for the usual spring-follower against which the packers have heretofore worked. Hence the signatures may be cut apart as rapidly as desired after passing under the abutment without in any wise affecting the efficiency of the packer.

Heretofore it has been impossible to draw tight the loop passing through the signatures and the knot or chain of thread linking one signature to the other, owing to the inability to press the signatures closely together while the loop or knot is being so drawn up, for the reason that the back or finished end of the book or row of sewed signatures must be left free, while the machine is in operation, to permit the attendant to cut apart and remove each separate book; but by having the frictional abutment above described arranged to come in contact with the sewed signatures sufficient resistance is offered to allow of proper pressure in front to squeeze the signatures solidly together and allow the knots to be drawn tightly.

The reciprocation of the packer-bar 64 is brought about by the mechanism shown more plainly in Figs. 2, 3, 9, 20, and 21, the latter being a transverse section taken on the line 21 21 of Fig. 20, while Fig. 20 is an inverted plan view of the abutment, packer, and packer-bar. Mounted upon a transverse rocking shaft 67 is a sleeve 68, from which depends a pair of arms 69, to the lower end of each of which arms is pivotally connected a lever 70, pivoted to the frame of the machine and having its free end laterally bent, as at 71, (see Figs. 2 and 3,) so as to project into the path of a cam 72 upon the feed-arms E. Thus the lever 70 will be alternately vibrated, first by one feed-arm and then by the other, so as to properly cooperate therewith in the packing of each signature as sewed, the arms 69 causing a positive movement of the packer-bar, and consequently of the packer, in opposite directions in proper time with the operation of the feed-arms and the needles. While I may employ in connection with my machine any suitable form of tension and feed devices, many forms of which are well known and common in the art, I have shown in the drawings a novel device especially adapted to cooperate with my needles and their coacting devices. This mechanism comprises a pair of arms 73, (see Figs. 2, 3, and 9,) rigidly secured at one of their ends to the rocking shaft 67 and connected at their opposite ends by a take-up rod 74, extending entirely across the machine, so as to simultaneously act upon the threads of all of the needles, each of which threads passes around a tension device 75 of ordinary construction and around fixed bars 76 and 77, being drawn around the rod 74 between the bars 76 and 77,

which latter are located substantially on a line between the tension device 75 and the needles. Attached to the lower thread-guide bar 77 is a series of depending arms 78, having thread-guiding eyes 79 in their lower ends, there being one of said arms for each thread, and to said bar 77 is also secured one end of a series of spring thread take-ups 80, corresponding in number with the thread-guides and provided with an eye in the lower free end thereof, through which the thread passes, the tension of the thread serving to hold the take-up in substantially a parallel position with the arm 78. When, however, the tension is removed from the thread, as during the forward movement of the rod 74, the take-up will spring back to substantially the position shown by dotted lines in Fig. 9, and thus maintain the thread taut under all conditions.

The rod 74 is caused to reciprocate by the vibration of the arms 73, by which it is carried, and it is so timed in its operation that it not only serves to take up slack in the thread and the tightening of the knots after they are tied by the needle mechanism, but such rod also serves to draw the feed end of the thread from the spools over the tension device 75 after the knots are properly tightened and preparatory to the next operation of the needles, moving forward and affording the necessary slack in the thread for the needles to take up in forming the knots and afterward taking the surplus in tightening the knots.

The vibration of the arm 73 is produced by means of a crank-arm 81 on one end of the shaft 67, to which arm is pivotally secured one end of a vibrating lever 82, pivoted to the frame of the machine, the opposite end of which lever carries an antifriction-roller engaging a peripheral camway 83 in the cam-wheel C, mounted upon the shaft 10 at one side of the machine.

So far as relates to the broad idea of my invention it is obvious that many different means may be employed and many different arrangements of such means may be provided for operating the various parts of the machine, and I therefore do not desire to limit myself to the particular construction or arrangement of the operating means herein shown. I find it advantageous, however, to mount all of the cams for operating the needles and the other elevated mechanism from the single shaft 10, which is driven in proper time from the power-shaft 84 by means of a counter-shaft 85, having a gear connection 86 with said shaft 10, said counter-shaft having a worm-and-gear connection 86 with the power-shaft. Said counter-shaft is also provided at its opposite end with a gear connection 87 to the shaft Q, operating the feed-arms. Power may be communicated from any suitable source to the power-shaft by means of the belt-pulleys 88, which are removed in Fig. 1, or in any other well-known and convenient manner.



I do not desire to herein claim the signature-feeding mechanism and the packing mechanism illustrated and described in this application, for I have made these inventions the subject-matter of separate applications filed as divisions of this application. One of these mechanisms is fully described and claimed in my application for signature-packers for book sewing, stapling, and binding machines, Serial No. 27,444, filed August 20, 1900, and the other of said inventions is described and claimed in my application for signature-feeder for book sewing, stapling, and like machines, Serial No. 27,445, also filed August 20, 1900.

Having thus fully described my invention, what I claim, and desire to secure by Letters Patent, is—

1. In a book-sewing machine, the combination with means for presenting and holding the signature during the sewing operation, of a gang of needles composed of a series of pairs of semicircular needles, complementary stitch-forming mechanism, each pair of said needles being mounted on a common center and means for operating said needles alternately, substantially as described.

2. In a book-sewing machine, the combination with means for presenting and holding the signature during the sewing operation, of a pair of semicircular needles mounted side by side upon a common center, complementary stitch-forming mechanism, and means for alternately operating said needles in opposite directions, substantially as described.

3. In a book-sewing machine, the combination with means for presenting and holding the signature during the sewing operation, of a pair of semicircular needles mounted side by side upon a common center, complementary stitch-forming mechanism, means for operating said needles alternately in opposite directions and means for shifting said needles so as to cause both of said needles to sew on the central plane between said needles, substantially as described.

4. In a book-sewing machine, the combination with means for presenting and holding the signature during the sewing operation, of a pair of semicircular needles mounted side by side upon a common center, complementary stitch-forming mechanism, a punch on the heel of each needle disposed in a central plane between said needles and immediately above the feed-arm, means for operating said needles simultaneously in opposite directions to punch the signature, means for operating said needles alternately in opposite directions to sew through the holes thus punched in the signature and means for shifting said needles so as to bring them alternately in line with the punched holes in the signatures, substantially as described.

5. In a book-sewing machine, the combination with means for presenting and holding the signature during the sewing operation and a gang of needles composed of a series

of pairs of semicircular needles, complementary stitch-forming mechanism, each pair of said needles being mounted side by side upon a common center, and one needle of each pair being fixedly mounted on a shaft, while the other is fixedly mounted upon a sleeve on said shaft, of pinions mounted respectively upon said sleeve and shaft, a pair of rack-bars respectively engaging said pinions and means for alternately operating said rack-bars, substantially as described.

6. In a book-sewing machine, the combination with means for presenting and holding the signature during the sewing operation, and a gang of needles composed of a series of pairs of semicircular needles, complementary stitch-forming mechanism, each pair of said needles being mounted side by side upon a common center, and one needle of each pair being fixedly mounted on a shaft, while the other is fixedly mounted upon a sleeve on said shaft, of pinions mounted respectively upon said sleeve and shaft, a pair of rack-bars respectively engaging said pinions, means for alternately reciprocating said rack-bars in which said shaft and sleeve are loosely journaled, but held as against endwise movement and means connecting said rack-bars with the bearing-bar for alternately shifting the bearing-bar laterally in opposite directions during the reciprocations of the rack-bars, substantially as described.

7. In a book-sewing machine, the combination with means for presenting and holding the signature during the sewing operation, a gang of needles composed of a series of pairs of needles, complementary stitch-forming mechanism, each pair of said needles being mounted side by side upon a common center, a punch on the heel of each needle offset to a central plane between each pair of needles and immediately above the feed-arm, a shaft upon which one of said needles is rigidly mounted and a sleeve upon said shaft carrying the other needle of each pair, of a pinion upon each of said sleeves and shafts respectively, a pair of parallel rack-bars respectively engaging the series of pinions, means for alternately actuating said rack-bars in opposite directions, a bearing-bar parallel with the rack-bars in which said series of shafts and sleeves are loosely journaled, but held as against endwise movement therein and means connecting the rack-bars with said guide-bar for alternately shifting said guide-bar in opposite directions laterally during the reciprocations of said rack-bars, substantially as described.

8. In a book-sewing machine, the combination with means for presenting and holding the signature during the sewing operation, a gang of needles composed of a series of pairs of needles, complementary stitch-forming mechanism, each pair of said needles being mounted side by side upon a common center, a punch on the heel of each needle offset to a central plane between each pair of needles



and immediately above the feed-arm, a shaft upon which one of said needles is rigidly mounted and a sleeve upon said shaft carrying the other needle of each pair, of a pinion upon each of said sleeves and shafts respectively, a pair of parallel rack-bars respectively engaging the series of pinions, means for alternately actuating said rack-bars in opposite directions, a bearing-bar parallel with the rack-bars in which said series of shafts and sleeves are loosely journaled, but held as against endwise movement therein, cam-slots in said bearing-bar and arms upon the rack-bars respectively engaging said cam-slots for shifting the bearing-bar laterally and alternately in opposite directions, substantially as described.

9. In a book-sewing machine, the combination with means for presenting and holding the signature during the sewing operation and a gang of needles composed of a series of pairs of semicircular needles, each pair being mounted upon a common center, of a series of loopers corresponding in number with the pairs of needles and means for operating each of said loopers to coact alternately with the needles of a pair, substantially as described.

10. In a book-sewing machine, the combination with means for presenting and holding the signature during the sewing operation and a gang of needles composed of a series of pairs of semicircular needles, each pair being mounted upon a common center, of a series of loopers corresponding in number with the pairs of needles and means for imparting to said loopers a bodily movement both longitudinally and laterally, and a rotary movement about the axes of their supports whereby each of said loopers coacts alternately with the needles of a pair, substantially as described.

11. In a book-sewing machine, the combination with means for presenting and holding the signature during the sewing operation and a gang of needles composed of a series of pairs of semicircular needles, each pair being mounted upon a common center, of a series of loopers corresponding in number with the pairs of needles, of a series of shafts to which said loopers are eccentrically secured upon axes parallel to the axes of said shafts, a pinion on each of said shafts, a rack-bar engaging all of said pinions, means for reciprocating said rack-bar, a frame in which all of said shafts are journaled and means for imparting to said frame both a lateral and a longitudinal movement.

12. In a book-sewing machine, the combination with means for presenting and holding the signature during the sewing operation and a gang of needles composed of a series of pairs of semicircular needles, each pair being mounted upon a common center, of a series of loopers corresponding in number with the pairs of needles and means for imparting to said loopers a bodily movement both longitudinally and laterally, and a rotary move-

ment about the axes of their supports, each of said loopers terminating in a rearwardly-pointing hook and being slotted from the end inwardly transversely through said hook, substantially as described.

13. In a book-sewing machine, the combination with means for presenting and holding the signature during the sewing operation and a gang of needles, of a series of loopers each provided at its free end with a backwardly-pointed hook and a slot extending from the end inwardly and transversely of the hook, means for causing said looper to coact alternately with two adjacent needles, means for causing said looper to hook and present a loop in each thread alternately for each of the needles to pass through, said needles passing through the slot in the looper and means for causing said loopers to advance and retreat to release the loop after the needle passes through the same, substantially as described.

14. In a book-sewing machine, the combination with means for presenting and holding the signature during the sewing operation, a semicircular needle and a looper, of a knotter and means for imparting thereto an orbital travel in a plane at right angles to the plane of the needle and for causing a pause thereof while traversing its orbit, substantially as described.

15. In a book-sewing machine, the combination with means for presenting and holding the signature during the sewing operation, a semicircular needle and a looper, of a knotter and means for simultaneously moving said knotter laterally and longitudinally, whereby said knotter will be caused to traverse an irregular orbit, substantially as described.

16. In a book-sewing machine, the combination with means for presenting and holding the signature during the sewing operation, a semicircular needle and a looper, of a knotter and means for simultaneously imparting to said knotter a longitudinal and a lateral movement, the forward longitudinal movement being positive while the backward or retracting movement is yielding, substantially as described.

17. In a book-sewing machine, the combination with means for presenting and holding the signature during the sewing operation, a gang of needles and a series of loopers, of a series of knotters corresponding in number with the needles, a pair of parallel bars for imparting lateral movement to said knotters, another pair of parallel bars mounted upon the first-mentioned bars, but capable of lateral movement thereon for imparting a longitudinal movement to said knotters and means for operating all of said bars, substantially as described.

18. In a book-sewing machine, the combination with means for presenting and holding the signature during the sewing operation, a gang of needles and a series of loopers, of a series of knotters corresponding in number



with the needles, a pair of parallel bars for imparting lateral movement to said knotters, another pair of parallel bars mounted upon the first-mentioned bars, but capable of lateral movement thereon for imparting a longitudinal movement to said knotters, a yielding connection between said last-mentioned bars and the knotters for positively advancing, but yieldingly retracting, said bars and means for operating all of said bars, substantially as described.

19. In a book-sewing machine, the combination with a needle-gang, the loopers and the knotters, said needle-gang being composed of a series of semicircular needles arranged in pairs, each pair being mounted upon a common axis and caused to alternately operate, of a series of tension devices corresponding in number with the needles, means for taking up and letting out the slack in all of the threads simultaneously, and individual spring take-ups corresponding in number with the needles for taking up the slack in the threads of the needles at rest as paid out by the first-mentioned take-up device, substantially as described.

20. In a book-sewing machine, the combination with means for presenting and holding the signature during the sewing operation and a needle-gang composed of a series of

pairs of semicircular needles, each pair of which is mounted on a common center and alternately operated, of means for punching the signatures, means for alternately moving the needles of each pair in line with the holes in the signature, means for forming a loop in the thread of the needle being operated upon, through which the needle passes, means for forming a loop in the thread of the stationary needle and drawing the same through a loop formed in the thread of the operating-needle as its point emerges from the signature and means for taking up the slack in the various loops upon the withdrawal of the operating-needle from the first-mentioned loop, substantially as described.

21. In a book-sewing machine the combination with a needle-gang, the loopers and the knotter, said needle-gang being composed of a series of semicircular needles arranged in pairs, each pair being mounted upon a common axis, and caused to alternately operate, of a series of tension devices corresponding in number with the needles, substantially as described.

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