

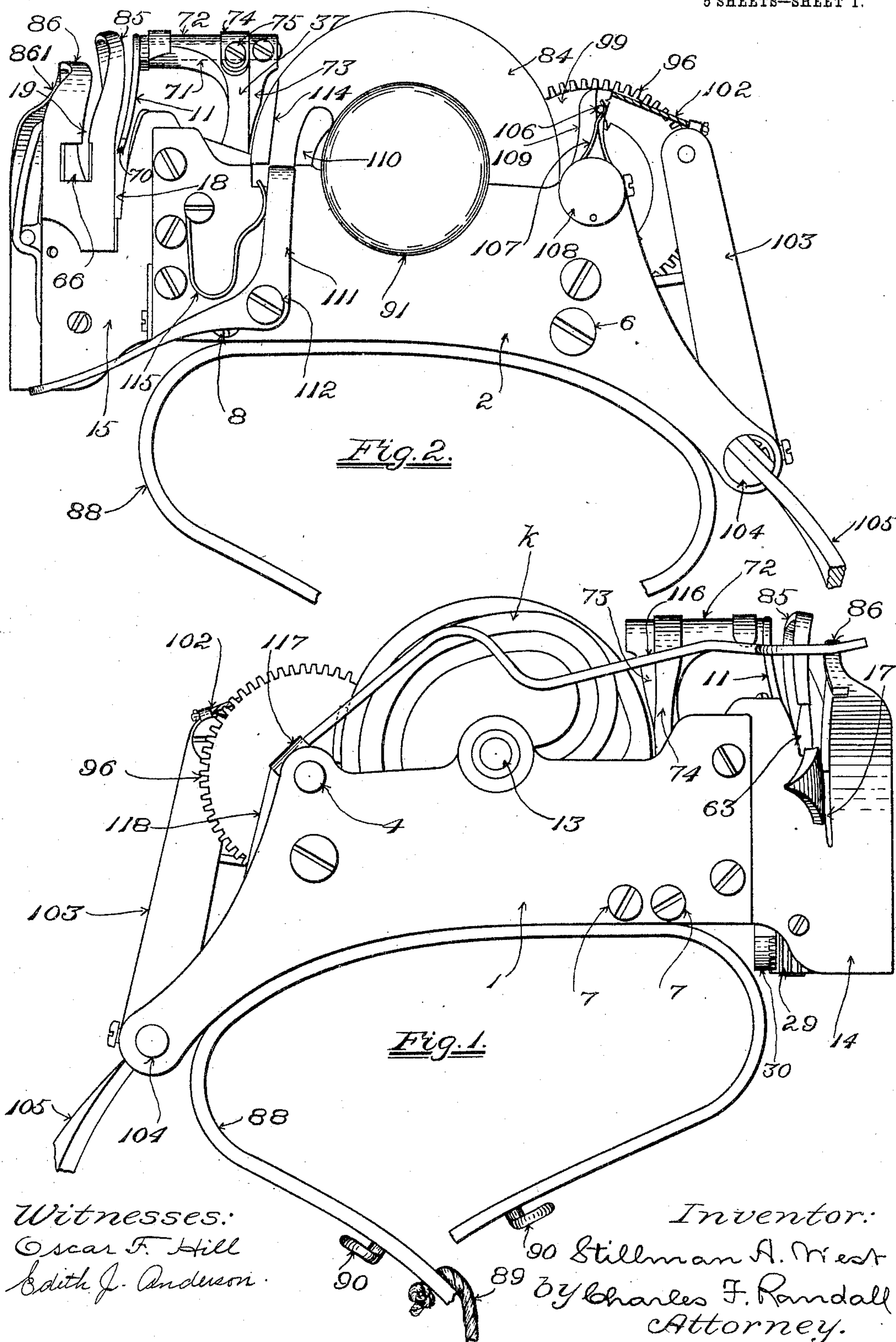
No. 789,468.

PATENTED MAY 9, 1905.

S. A. WEST.  
KNOT TYING MACHINE.

APPLICATION FILED DEC. 21, 1904.

5 SHEETS—SHEET 1.



Witnesses:  
Oscar F. Hill  
Edith J. Anderson.

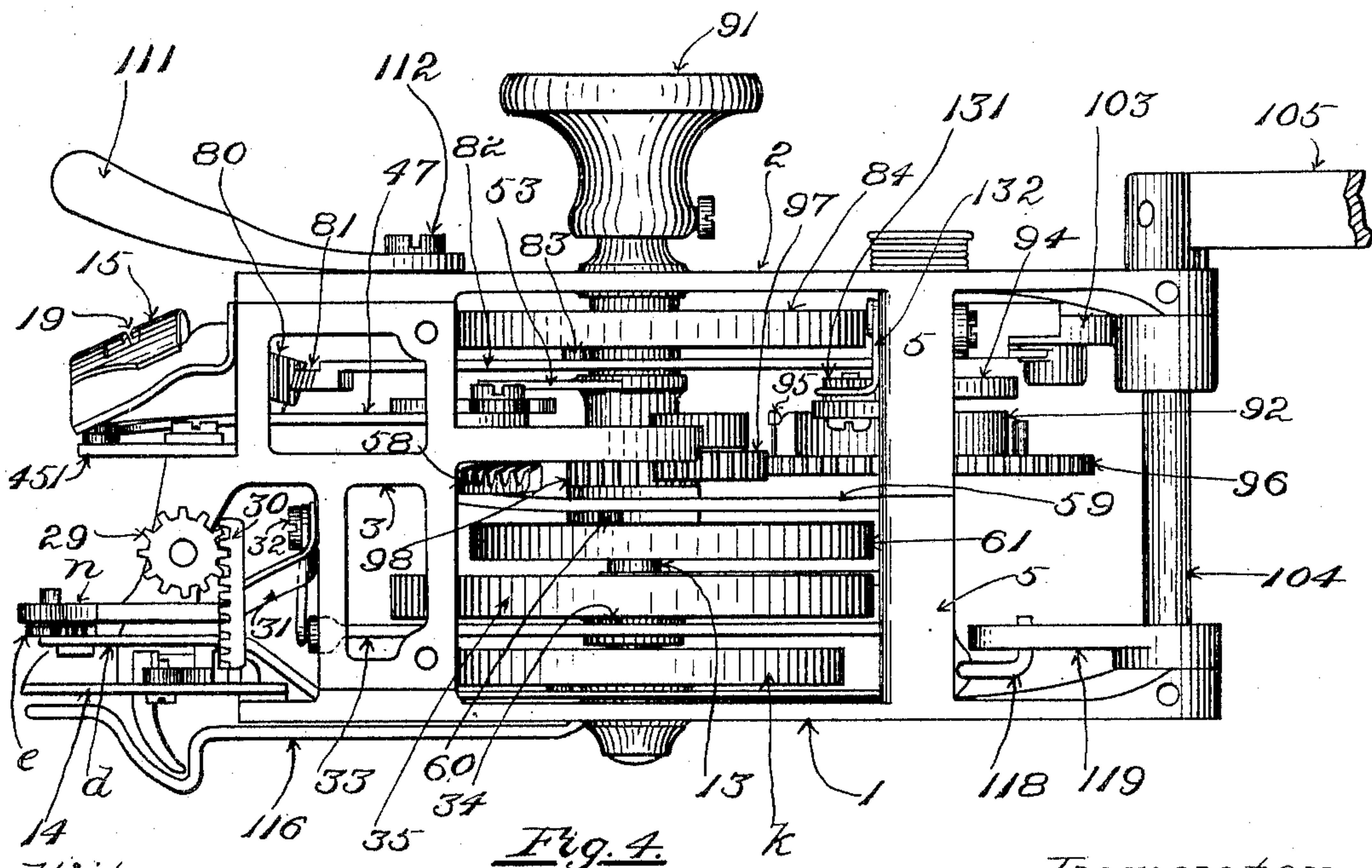
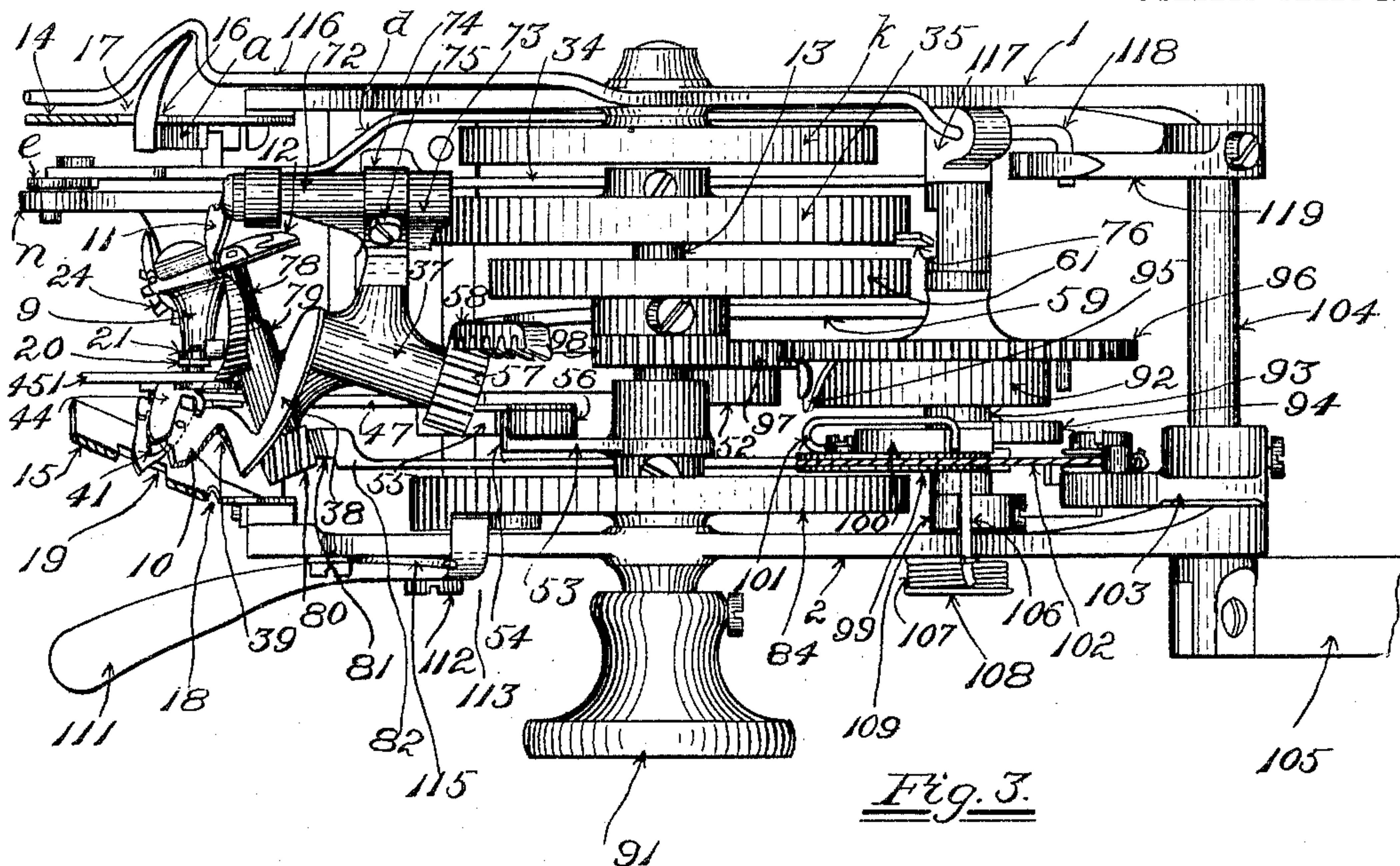
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5 SHEETS—SHEET 2.



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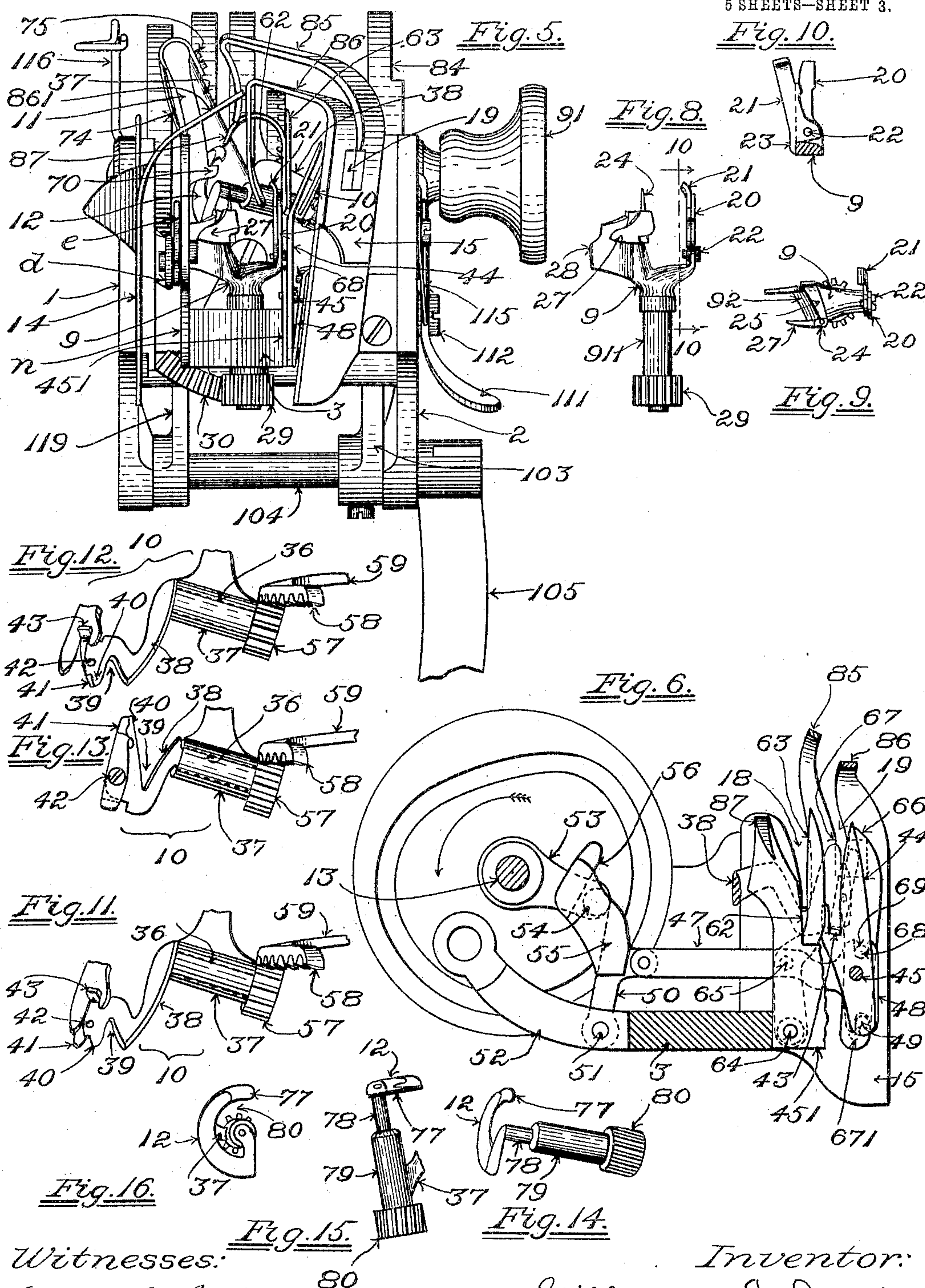
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5 SHEETS—SHEET 3.



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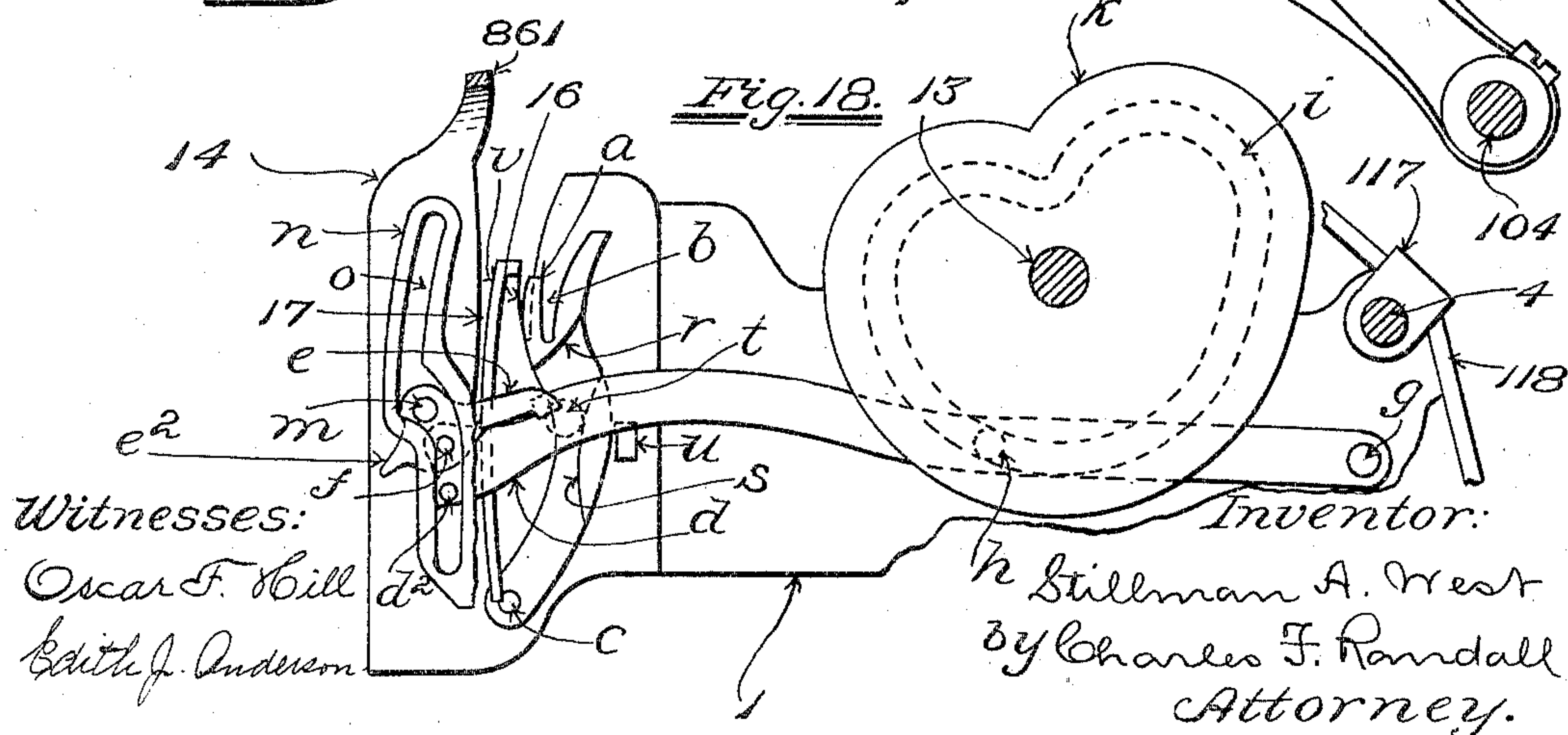
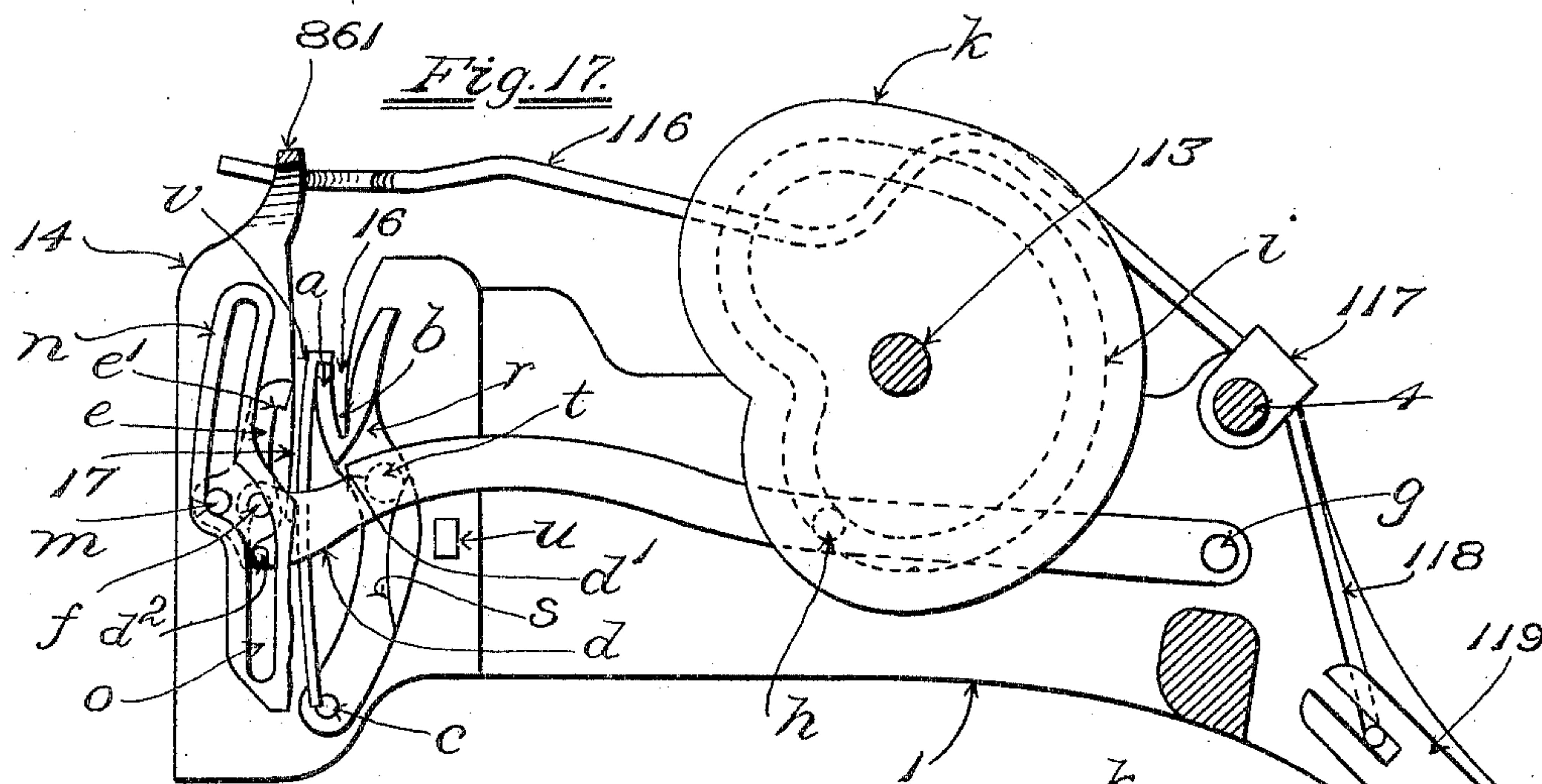
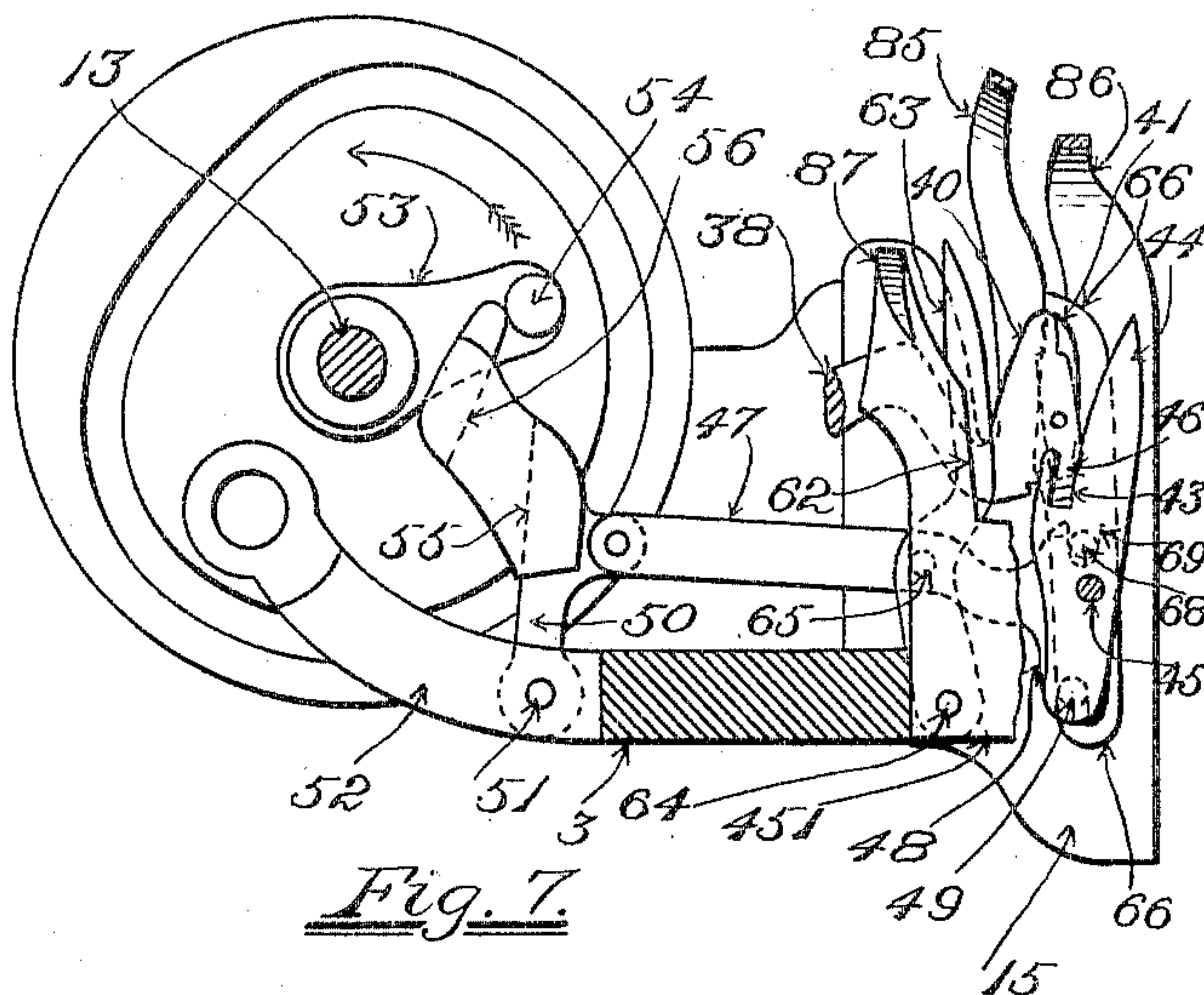
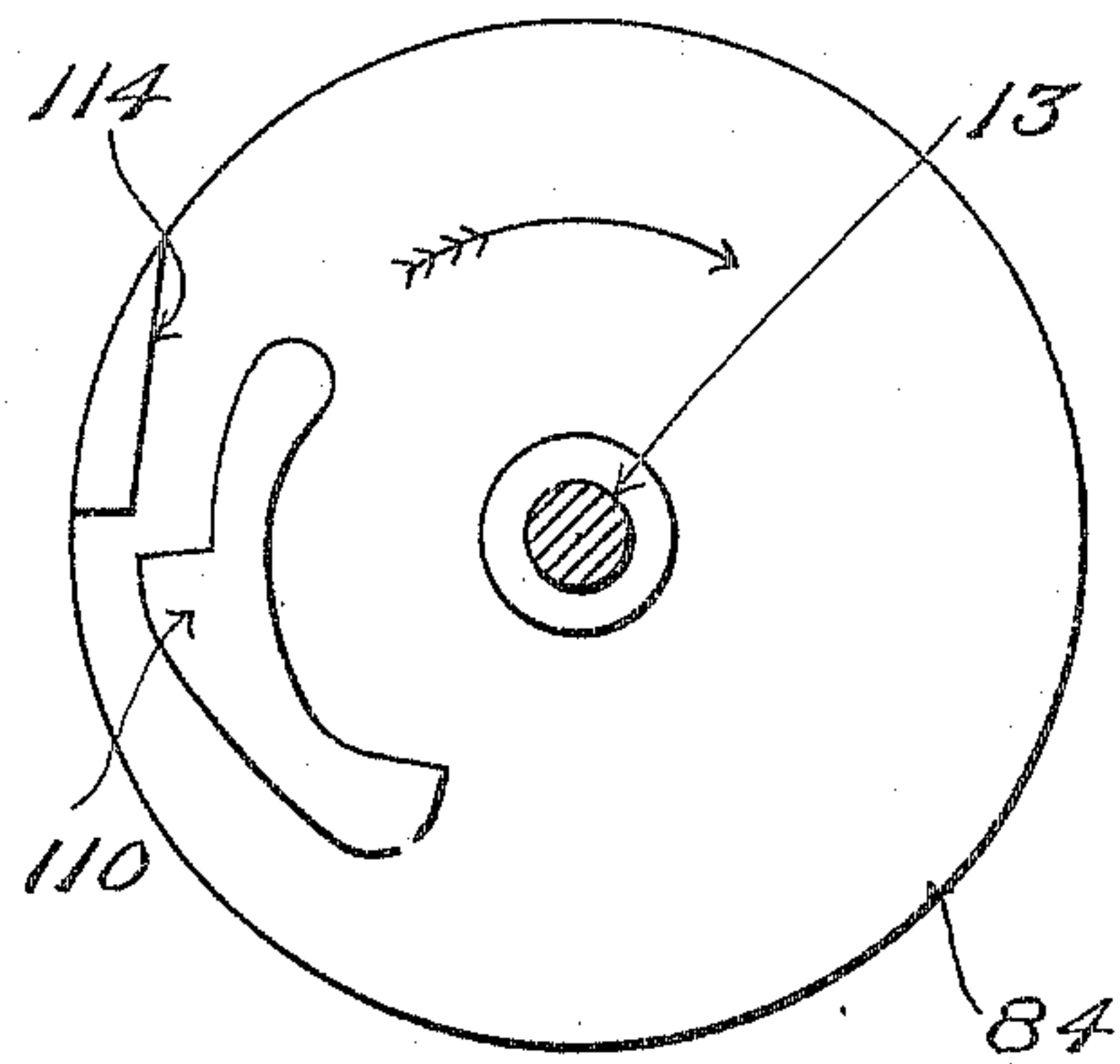


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6 SHEETS—SHEET 4.



*Witnesses:*

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5 SHEETS—SHEET 5.

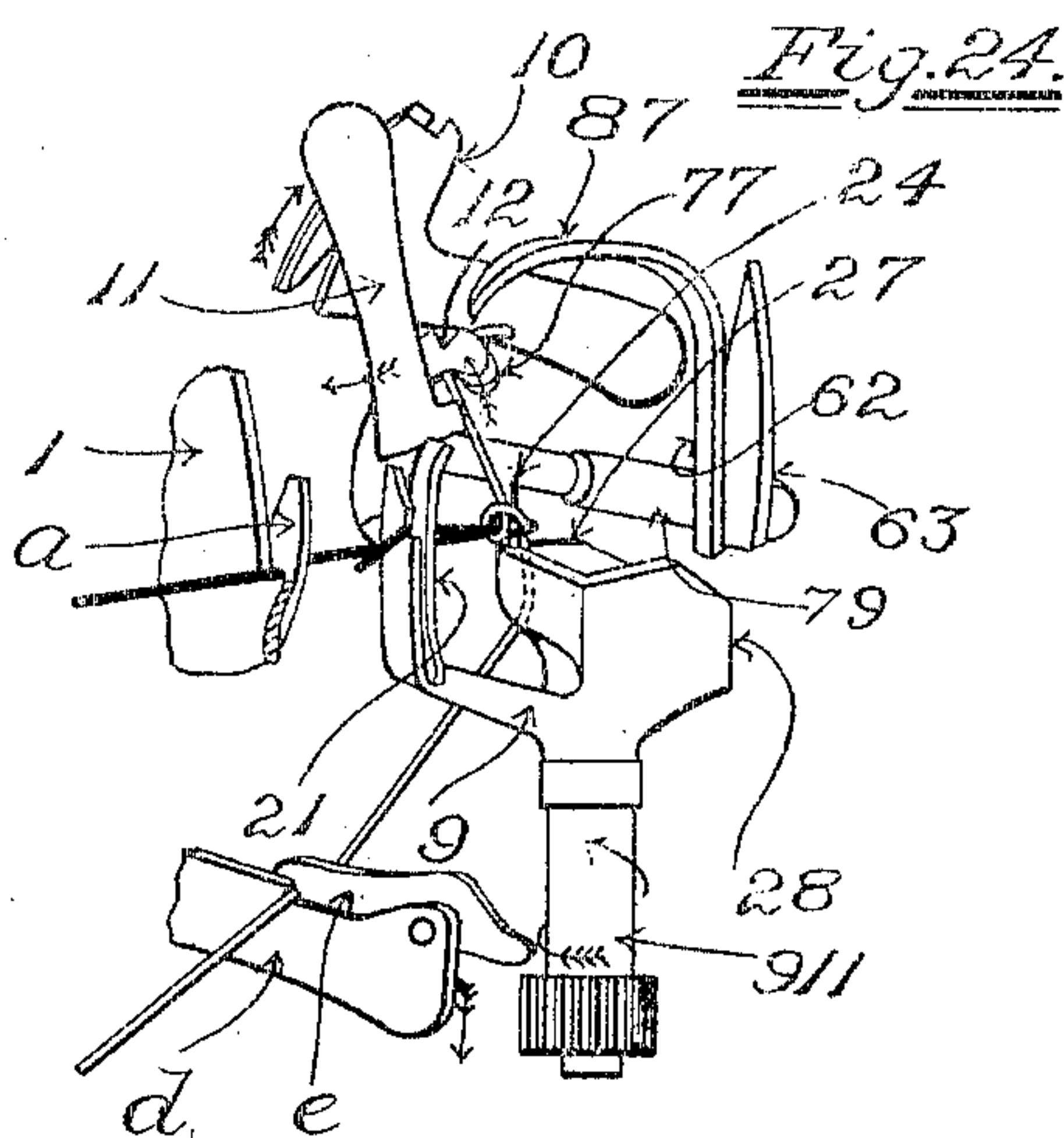
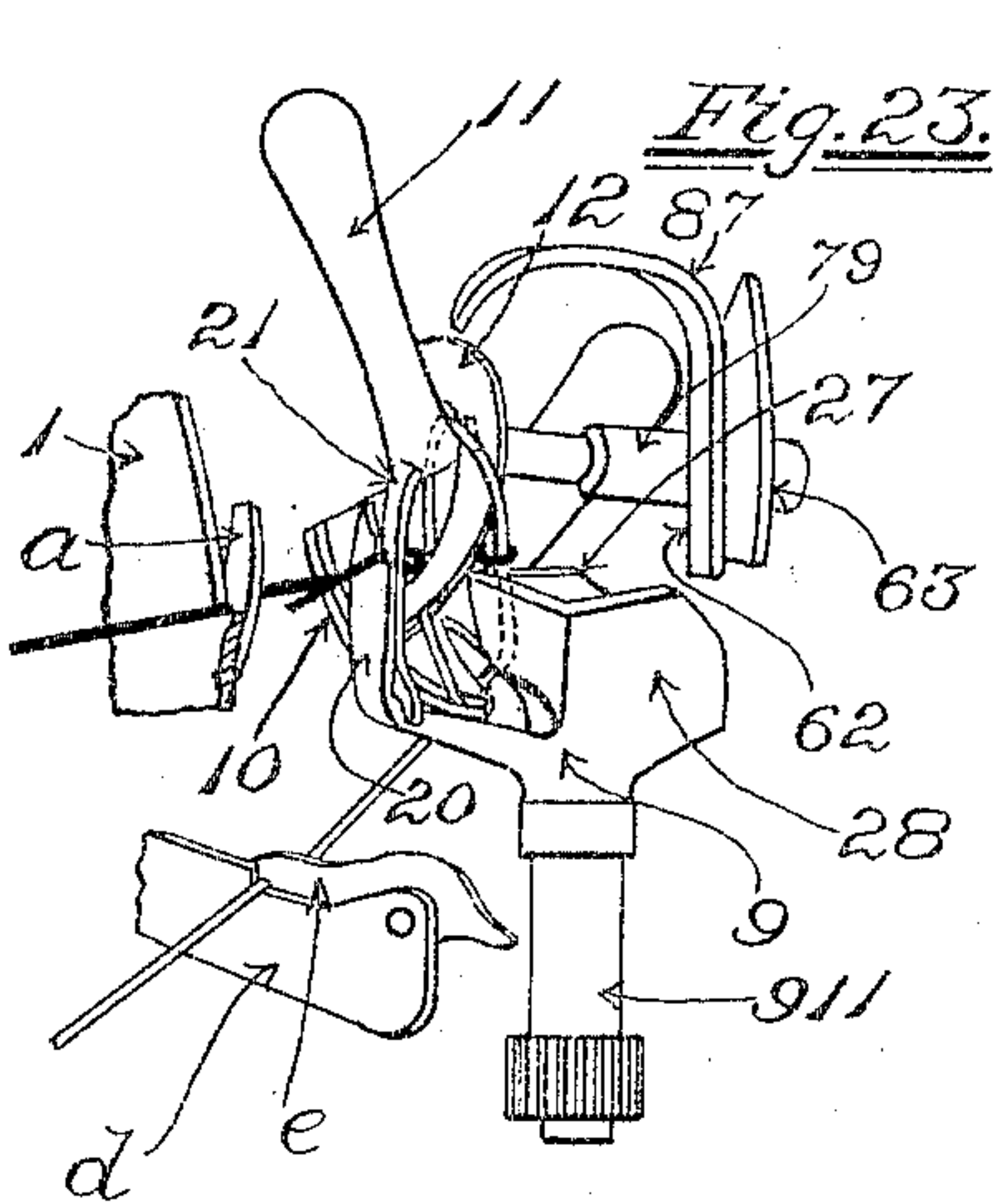
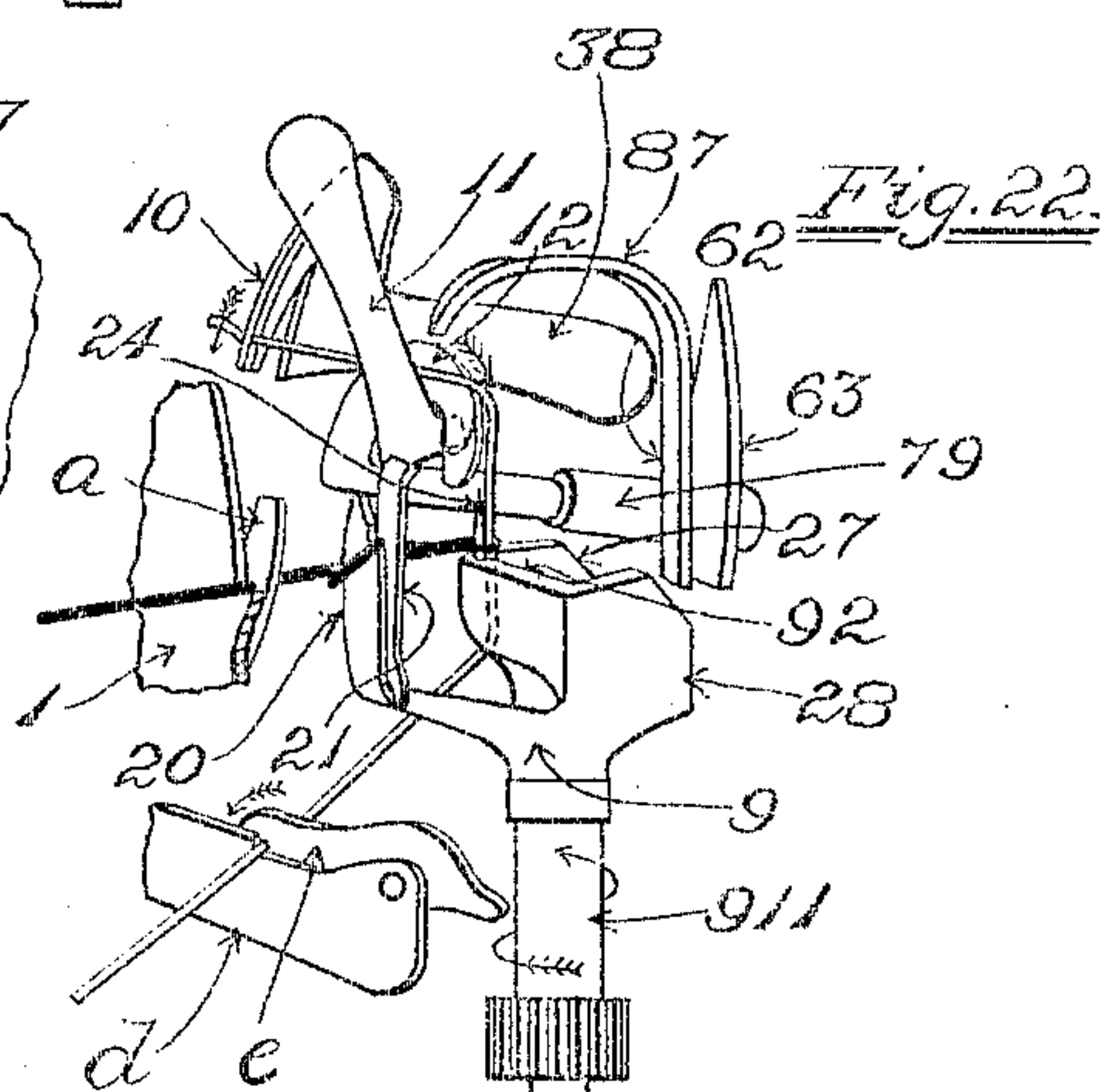
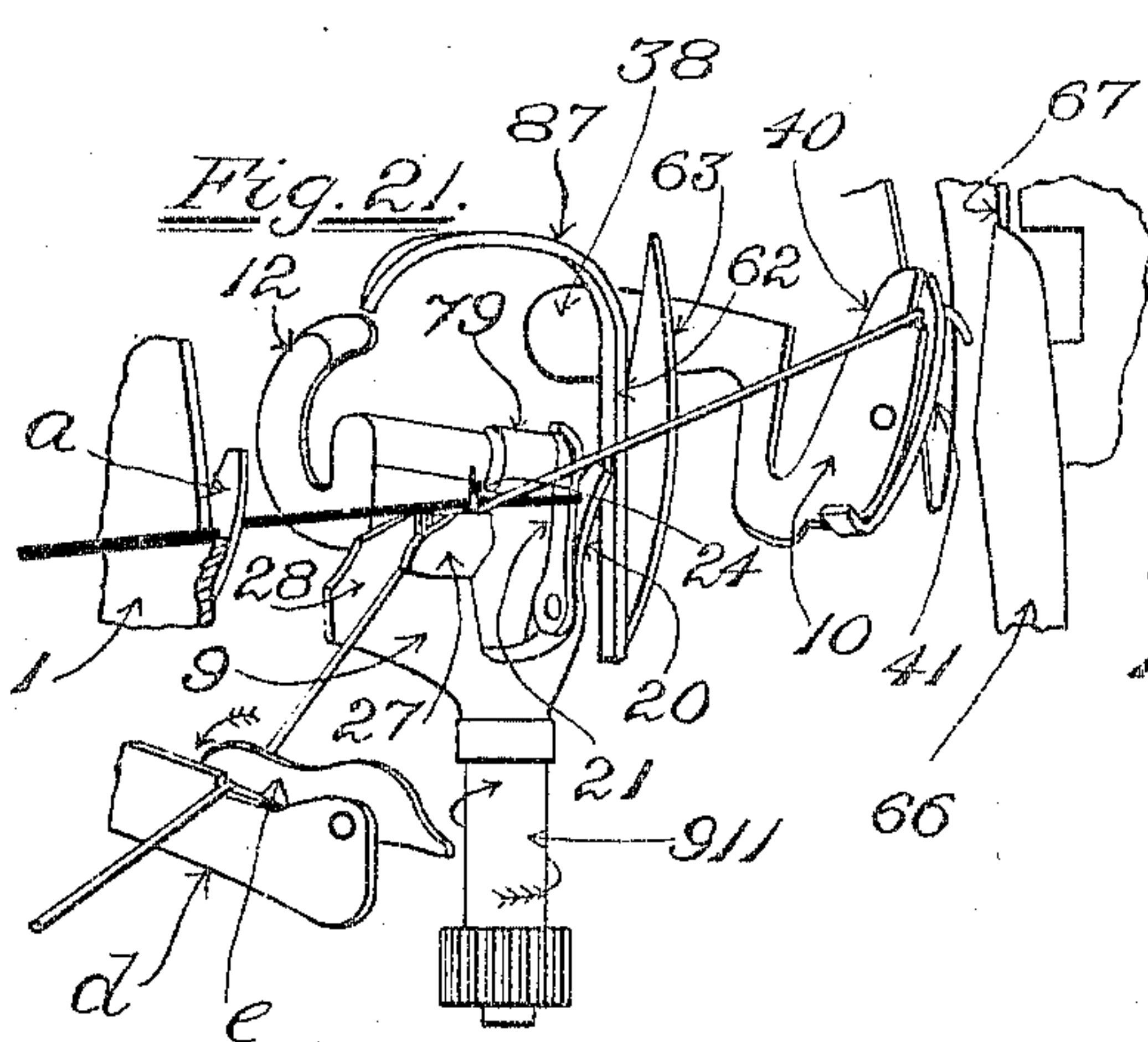
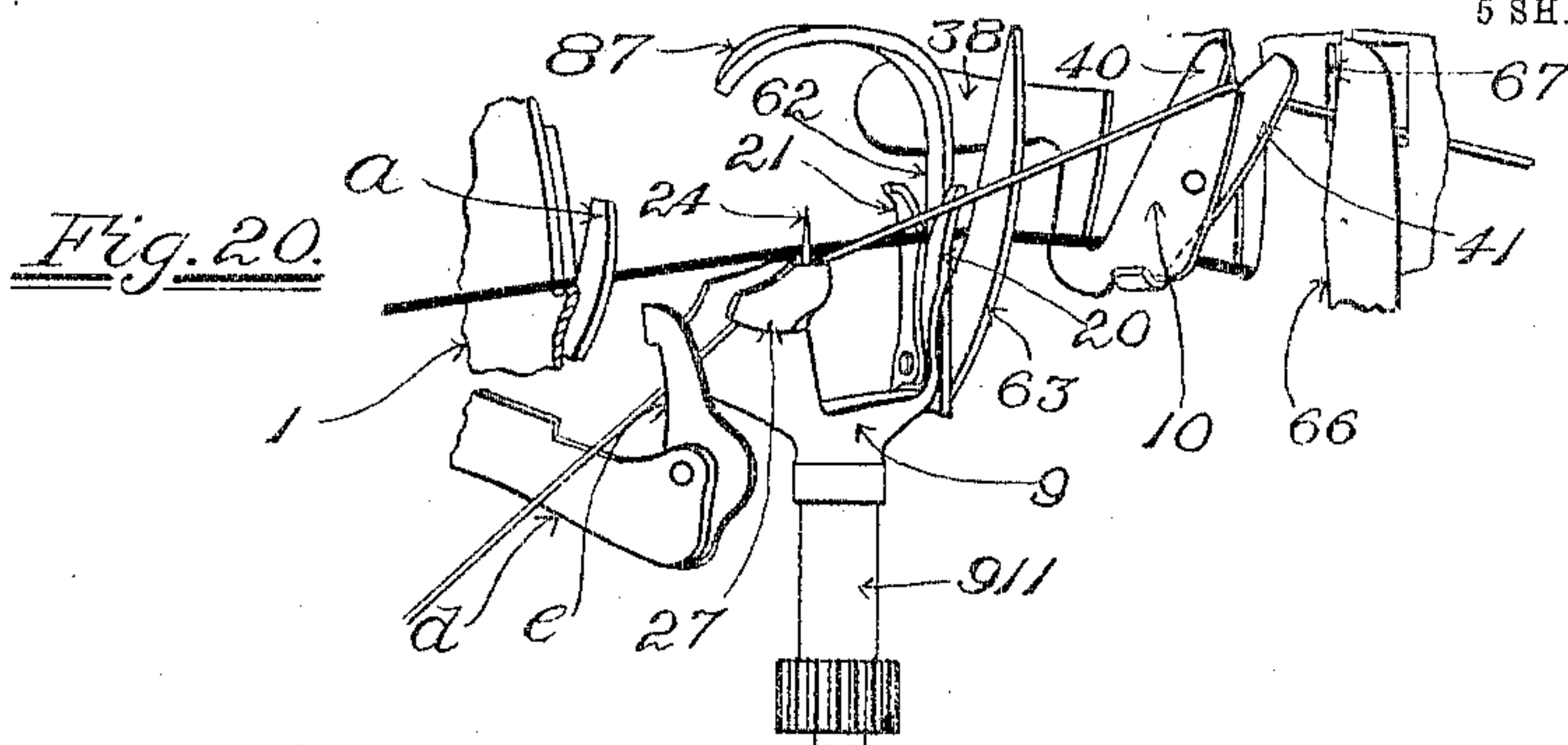


Fig. 25.



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# UNITED STATES PATENT OFFICE.

STILLMAN A. WEST, OF BROOKLINE, MASSACHUSETTS.

## KNOT-TYING MACHINE.

SPECIFICATION forming part of Letters Patent No. 789,468, dated May 9, 1905.

Application filed December 21, 1904. Serial No. 237,789.

*To all whom it may concern:*

Be it known that I, STILLMAN A. WEST, a citizen of the United States, residing at Brookline, in the county of Norfolk, State of Massachusetts, have invented a certain new and useful Improvement in Knot-Tying Machines, of which the following is a specification, reference being had therein to the accompanying drawings.

The invention consists in an automatic machine which unites two yarns, threads, or the like with a weaver's knot, it comprising, essentially, in combination, means whereby two yarns are assembled with one thereof inclosed in a bight of the other and devices by which the extremity of the inclosed yarn is carried around the doubled portions of the other yarn and interlocked with the encircling portion of itself.

I have illustrated the invention herein as embodied in a mechanism which automatically bends or doubles one yarn or thread around the other thereof in the form of a bight with the free extremity of the first yarn or thread adjacent to the main portion of such yarn or thread, then carries the free extremity of the other yarn or thread completely around the two proximated portions of the first yarn or thread and passes the said extremity of the second yarn or thread between the said two proximated portions and the encircling portion of the second yarn or thread to effect the interlocking.

So far as I am aware the idea of automatic means to produce a weaver's knot by operating in the manner above set forth upon the yarns or threads which are to be united is entirely new, and therefore in the case of the broader and more generic principles of the invention the invention is not dependent upon the precise mechanical construction and arrangement of the parts of the machine.

In the drawings, Figure 1 is a side elevation of a portable knot-tying machine containing the embodiment aforesaid of the invention, the said figure showing only a portion of the lacing-cord that is employed in connection with the strap, which in this instance it is contemplated using for the purpose of binding the machine upon the wrist of the user

thereof and also only a portion of the lever which is employed for winding up the actuating-spring. Fig. 2 is an opposite elevation of the said embodiment, the said lacing-cord and portions of the strap and lever aforesaid being omitted. Fig. 3, Sheet 2, is a plan of the machine with portion of the said lever broken away, as well as portions of the guide-strips, which are located adjacent and above the devices that are involved more immediately in the operation of tying a knot. Fig. 4, Sheet 2, is a bottom view of the machine, the said lever being partly broken away and the strap being removed. Fig. 5, Sheet 3, is a front end elevation of the machine with the lever partly broken away. Fig. 6, Sheet 3, is a view of the machine in longitudinal section, showing chiefly the two pairs of trimmers, their operating connections, and the carrier-grippers, the trimmers and grippers being represented in open condition. Fig. 7, Sheet 4, is a view similar to Fig. 6, but showing the trimmers and grippers in closed condition. Fig. 8, Sheet 3, is a detail view showing the bight-former separately in side elevation. Fig. 9, Sheet 3, shows the bight-former in plan. Fig. 10, Sheet 3, is a view in vertical section on the plane indicated by the dotted line 10 10, Fig. 8. Fig. 11, Sheet 3, is a detail view showing mainly the device, hereinafter termed "carrier," by which the second yarn is carried around the proximate portions of the bight of the first yarn, the said device being in its normal position and the jaws thereof being separated from each other. Fig. 12, Sheet 3, is a view of the carrier in the same position as in Fig. 11, but with the jaws closed. Fig. 13, Sheet 3, is a top or plan view of the carrier in one of its intermediate positions and with the jaws thereof closed together. Fig. 14, Sheet 3, is a detail view in elevation looking from the front in Fig. 5 of the device, hereinafter termed "interlocker," by which the free extremity of the second yarn or thread after having been carried around the two proximated portions of the first yarn or thread is passed between the said portions and the encircling portion of the second yarn or thread. Fig. 15, Sheet 3, is a detail plan view of the interlocker, viewing it as



in Fig. 3. Fig. 16, Sheet 3, is an end elevation of the interlocker. Fig. 17, Sheet 4, is a view of the machine in longitudinal section, showing chiefly the two clamps and their operating connections, the said clamps being open. Fig. 18, Sheet 4, is a view similar to Fig. 17, but with a portion broken away, showing the two clamps in closed condition. Fig. 19, Sheet 4, shows in elevation, detached, the detent-wheel, which is employed for the purpose of controlling the rotation of the actuating or cam shaft. Fig. 20, Sheet 5, is a diagram showing certain of the functional parts in their normal positions, with two yarns applied thereto in readiness for the performance of the knot-tying operations. Figs. 21 to 24, Sheet 5, are diagrams showing various stages in the process of tying a weaver's knot by the devices of the machine herein shown and described. Fig. 25 is a view, on an enlarged scale, showing the knot which is produced by the machine herein shown and described.

Having reference to the drawings, the framework of the machine comprises, essentially, the opposite side pieces 1 2 and the bottom piece 3. The side pieces are formed at their bottom edges with inwardly-extending lugs 5 5, Fig. 4, the inner or free ends of which abut against each other. A screw 6, Fig. 2, unites the said lugs with each other and holds their meeting ends together, in this way connecting the two side frames together at their rear ends. The bottom piece 3 is held in place between the side pieces by means of screws 7 7, Fig. 1, and 8, Fig. 2, the stems of said screws passing through holes in the side pieces and screwing into threaded holes, which are tapped in the opposite edges of the said bottom piece. Through their connection with the said bottom piece the side pieces are held in place at their forward ends.

To the framework aforesaid are applied the essential functional elements of the machine, such elements comprising the clamps shown in place in the machine in Figs. 3 and 4 of Sheet 2 and Fig. 5 of Sheet 3 and separately in Figs. 17 and 18 of Sheet 4, by which the main portions of the two yarns or parts of yarn in process of being tied together are held during the operation of forming the knot, one of the said clamps also cooperating with the interlocker in tightening the knot; the bight-former 9, which is shown in place in the machine in Figs. 3 and 5 and separately in Figs. 8, 9, and 10, Sheet 3; the carrier 10, by which the extremity of the second yarn is carried around the proximated portions of the bight of the first yarn, the said carrier being shown in place in the machine in Figs. 3 and 5 and separately in Figs. 11, 12, and 13, Sheet 3; the trimmers (shown in place in the machine in Figs. 3 and 5 and separately in Fig. 6, Sheet 3, and Fig. 7, Sheet 4) by which after the two yarns or parts of yarn have been

grasped by the holding portions of the bight former and carrier the extremities of the said yarns or parts of yarn are trimmed off close to the said holding portions preliminary to the formation of the knot; the spreader 11, Figs. 3 and 5, by which the loop of the second yarn is held open and taut until the interlocker has engaged with the extremity of such yarn and the carrier has released its hold upon such extremity, and the interlocker 12, by which the extremity of the second yarn is passed between the two proximated portions of the first yarn and the encircling portion of the second yarn or thread, the said interlocker being shown in place in the machine in Figs. 3 and 5 and separately in Figs. 14, 15, and 16, Sheet 3. The various functional elements which have been enumerated are in operative connection with an actuating or cam shaft 13 through operative trains of devices, which presently will be described. The said shaft is intermittently rotated by or under the control of the operative for the purpose of causing the said elements to act when it is desired to tie a knot. At opposite sides of the said functional elements are located fixed cheek-pieces 14 and 15, respectively, which are attached to adjoining parts of the fixed framework, they constituting portions of the said framework. The cheek-piece 14 is formed with vertical notches or slots 16 17, Figs. 1, 3, 17, and 18, extending downward into the same, and the cheek-piece 15 is formed with like notches or slots 18 19, Figs. 2, 3, 5, 6, and 7. These four vertical notches or slots are designed to receive the two yarns or threads which are to be tied together. In practice when applied to the machine for the purpose of being tied together the said yarns or threads are extended substantially parallel with each other crosswise of the machine, one thereof being passed downward into the oppositely-located notches or slots 16 and 18, the other being passed downward into the oppositely-located notches or slots 17 and 19. The bobbins or the like upon which the main portions of the said yarns or threads are contained are to be understood as located at the left-hand side of the machine in Fig. 5 and below the portion of the machine, the free extremities of the said yarns or threads being extended toward the right-hand side, so as to extend or hang from the notches or slots 18 and 19.

The clamping devices are located in proximity to the notches or slots 16 and 17 in position to engage with the respective yarns or threads. The chief function of the said devices is to hold the yarns or threads at points between the sources of supply thereof and the knot-tying devices and keep the same in a proper state of tension during the knot-forming operations. One of the said clamps has other functions also, as will be explained. For engagement with the yarn, which is entered



into the notch or slot 16, a movable clamp member *a*, Fig. 3 of Sheet 2 and Figs. 17 and 18 of Sheet 4, is provided. This clamp member *a* is formed with an open-topped notch *b*, (shown best in Figs. 17 and 18,) which normally—i. e., in its position of rest—registers with the notch or slot 16, as in Fig. 17, and into which the yarn enters when it is placed within the said notch or slot 16. The said clamp member is constituted by an arm, which at its lower end is mounted by means of a pivot *c* upon the cheek-piece 14. The acting portion of the clamp member *a* is located at the front of the slot *b* of the said cheek-piece. It coacts with the portion of cheek-piece 14 which is located at the rear of the notch or slot 16. For the purpose of clamping the yarn aforesaid movement is communicated to the clamp member *a* rearward from the position in Fig. 17 to that in Fig. 18. This movement carries the notch *b* out of register with the notch or slot 16 of the cheek-piece 14. It also causes the yarn to be compressed between the opposing and proximate lateral faces of the said cheek-piece and acting portion. Thereby the said yarn is clamped. For engagement with the yarn which is entered into the notch or slot 17 movable clamp members *d* and *e* are provided, the said clamp members operating to engage the said yarn between them. The clamp member *e* is mounted upon the clamp member *d* by means of a pivot, as *f*. The said clamp member *d* is constituted by an arm or lever which is mounted at the rear end of the machine upon the side plate 1 by means of a pivot *g*, (shown in Figs. 17 and 18.) For the purpose of actuating the clamp *d e* the said arm or lever is furnished with a pin or roll *h*, which works in a cam-groove *i* (shown by dotted lines in Figs. 17 and 18) in a cam-disk *k*, that is fast upon the shaft 13. When the shaft is rotated, the walls of the said cam-groove communicate movement up and down to the clamp *d e*. For the purpose of occasioning relative movement of the clamp members *d* and *e* with respect to each other the clamp member *e* is furnished with a projection or pin *m*, located eccentrically with reference to the pivot *f*, and a cam-piece *n* is supported from the bottom piece 3 of the machine-frame, the said cam-piece being formed with a cam-slot *o*, into which the projection or pin *m* enters, as shown in Figs. 17 and 18. The normal position of rest of the clamp members is represented in Fig. 17, in which the clamp member *e* is raised relative to clamp member *d* suitably to admit between them the yarn that is placed within notches or slots 17 19. When the clamp members *d e* are caused to descend from the position of Fig. 17, the walls of the lower portion of the cam-slot *o* act to swing the clamp member *e* relative to clamp member *d* so as to close the clamp members together, as in Fig. 18. For the purpose of confining the thread at the rear between the cheek-piece 14 and the clamp members *d e*, so as to prevent the same from winding or swerving rearward out from under the free end of the swinging clamp member *e* as it descends a guide-strip *v* is affixed to the cheek-piece 14, so as practically to bridge the space or interval between the inner surface of the said cheek-piece and the clamp members *d e*. In order to prevent the yarn from slipping along the acting face of the clamp member *d* out from under the free end of the clamp member *e* as the latter swings into the closed position thereof, the respective clamp members are furnished with shoulders *d' e'*, Fig. 17, constituting stops which limit the extent of the movement of the yarn as the acting portions of the clamp members come together. When the clamp members *d e* are raised into their highest position by the cam-disk *k*, the action of the upper portions of the walls of the cam-slot *o* upon the projection or pin *m* causes the acting portion of clamp member *e* to separate from the coacting portion of clamp member *d* and to assume an open position, as in Fig. 17, the said clamp member *e* retaining its open position when the clamp members *d e* are restored to the normal intermediate position, which is represented in Fig. 17. The extent of the swinging movement of the clamp member *e* in opening is determined by the engagement of a tail *e'*, with which the same is furnished, with a fixed stop *d''* upon the clamp member *d*. For the convenient actuation of the clamp member *a* in proper unison with the clamp members *d e* the arm of the said clamp member *a* is furnished with oppositely-located cam-surfaces *r s*, and the arm or lever *d* is furnished with a laterally-projecting pin *t*. When the arm or lever *d* is moved downward from the normal position of Fig. 17, in which both clamps are open, the projection or pin *t* by its action against the cam-surface *s* moves the clamp member *a* rearward into the position of Fig. 18, so as to cause the yarn occupying the notches or slots 16 and *b* to be compressed between the proximate surfaces of the acting portion of clamp member *a* and the cheek-piece 14, as aforesaid. In the subsequent complete rise of arm or lever *d* the projection or pin *t* acts against the cam-surface *r* to return the clamp member *a* from the position of Fig. 18 to that of Fig. 17, thereby moving the said clamp member to its open position and releasing the yarn which previously was held fast thereby.

The bight-former 9 is mounted to turn around a vertical axis, it having a journal 911, Fig. 8 of Sheet 3, that works in a bearing, (shown in Fig. 5 of Sheet 3,) with which the bottom piece 3 of the fixed framework of the machine is formed or furnished. At its top the bight-former is furnished at one side of the axis of rotation thereof with a gripper comprising a fixed jaw 20, extending upward from the body of the bight-former, and a



movable jaw 21, having a pivot 22 adjacent its lower end, the free extremity of the said movable jaw extending upward. The movable jaw is furnished with a projection or tail 23, Fig. 10, which by its engagement with the body of the bight-former, as in Fig. 10, acts as a stop to limit the extent of the opening movement of the movable jaw. In the normal position of the bight-former, which is represented in Figs. 3 and 5, the acting portion of the movable jaw is located at the rear of the corresponding portion of the fixed jaw and is separated from the latter by a space or opening sufficient to enable a yarn conveniently to be passed between the two jaws, the said space or opening being presented in position to receive the yarn or thread, which is passed down into the rear pair of the notches or slots 16 18 of the cheek-pieces. Nearer the axis of rotation of the bight-former, but eccentrically with relation to the said axis, and toward the front in the position normally occupied by the bight-former, (shown in Figs. 5 and 8,) the bight-former is furnished with a pin 24, rising vertically therefrom and around which the said yarn or thread is bent to form the bight by the movement of partial rotation which is communicated to the bight-former for the purpose. The pin 24 is slightly tapered to facilitate the discharge of the bend or bight of yarn or thread upwardly therefrom. The distance separating the gripper and pin from each other corresponds with the desired or necessary length of the portion of the first yarn that is swung around toward the main portion of the said yarn in forming a bight. Adjacent the pin 24 the bight-former is provided with an upright wall 92, Fig. 9, at the top of which is a transversely-extending surface 25, Fig. 9. The said surface 25 serves as a support for the two yarns during different stages of the operations. Adjoining the pin 24 the bight-former is furnished at the side thereof which is turned to the front in Figs. 5 and 8 with a horizontally-projecting spur 27. In the turning movement of the bight-former the said spur engages with the second yarn and confines the latter in place adjoining the pin 24, while the first yarn is being doubled around upon itself and the said pin to form the bend or bight therein. The said second yarn is guided into a position at the rear of the said pin and spur in Figs. 5 and 8 in being placed within the vertical notches or slots 17 and 19, as indicated in Fig. 20, Sheet 5. The bight-former has also at the rear in Figs. 5 and 8 a vertical web or flange 28, in front of which the said second yarn is placed in being passed into the said notches or slots. The outer end of the said web or flange projects into proximity to the clamp members *d e* at the inner side of the latter and is designed to hold the second yarn at such side from bending toward the rear out from the grasp of the clamp members *d e*, its pur-

pose in this connection being similar to that of the guide-piece *v*, which is located at the other side of the said clamp members. The second yarn thus is restrained at both sides of the clamp members *d e* from bending or swerving rearward out from the grasp thereof. For the purpose of communicating to the bight-former a rotary oscillating movement around its vertical axis, a pinion 29 is affixed to the bight-former at the lower end of the journal 91, the said pinion being engaged by a rack 30, Figs. 4 and 5, which is provided on a bell-crank 31. The said bell-crank is pivoted at 32, Fig. 4, to the bottom piece 3 and is operatively engaged by a lever 33, the latter carrying a pin 34, which works within a cam-groove that is formed in one side of a cam-disk 35, the said cam-disk being fast upon the shaft 13.

The carrier 10 is provided with a shaft or journal 36, (shown by dotted lines in Figs. 11, 12, and 13, Sheet 3,) that is fitted within a bearing which is provided in or upon a stand 37, Figs. 3, 11, 12, and 13, rising from the bottom piece 3. The axis of the said shaft or journal extends in a somewhat diagonal direction—*i. e.*, is upwardly as well as transversely inclined toward the front end of the machine, as indicated in the figures just referred to. With the front end of the shaft or journal 36 is fixedly connected an arm 38, the outer portion of which is bent forward in the direction of the length of the said shaft or journal. In the normal position of the carrier (shown in Fig. 3 of Sheet 2, Figs. 5 and 6 of Sheet 3, and Fig. 7 of Sheet 4) the said outer portion of the arm 38 is located adjacent the cheek-piece 15. A notch or depression 39 is formed in the said portion to accommodate the yarn which is entered into the notch or slot 18 and to permit the said yarn to descend sufficiently within the said notch or slot. The arm 38 is furnished with means for engaging with the yarn which is entered into the other notch or slot 19 and holding the same, the said means consisting in the present instance of a gripper comprising a fixed jaw 40, Figs. 11, 12, and 13 of Sheet 3, and a movable jaw 41, the latter being pivoted to the former at 42 and provided with a bent tail or lug 43 by means of which to actuate the same. The movable jaw 41 is operated to open and close the same relative to the fixed jaw 40 by means of an arm 44, Figs. 3, 5, 6, and 7, which is pivoted at 45, Figs. 5 and 6, to an upright plate 451, which is attached to the bottom piece 3. The said arm 44 is formed with a notch 46, opening upwardly, which receives the bent tail or lug 43 when the carrier occupies its normal position. At the proper times in the working of the machine the arm 44 is swung in one direction or the other by actuating connections, which are shown best in Figs. 6 and 7, and when thus swung it operates the movable jaw 41 to open or close the same, as aforesaid. The said actuating connections com-



prise a bar 47, extending lengthwise of the machine and having at its forward end a vertical portion 48, which is notched at its lower end, the said notch receiving a pin 49, carried by the arm 44 below its pivot. When the bar 47 is moved in the direction of its length, the arm 44 is turned about its pivotal axis and the movable jaw 41 of the carrier is operated. The bar 47 is moved lengthwise through the agency of an arm 50, which is mounted at its lower end upon a pivot 51, connecting it to an arm 52, Figs. 6 and 7, projecting rearwardly from the bottom piece 3, and also of an arm 53, fixed upon the shaft 13 and carrying a pin or roll 54. The said arm 50 is furnished with cam-surfaces 55 56. In the rotation of the shaft 13 in the direction indicated by the arrow in Fig. 6 the pin or roll 54 contacts with the said cam-surfaces successively. The action of the pin or roll 54 against the cam-surface 55 in passing along the latter occasions movement of the arm 50 and bar 47 toward the right-hand side in Fig. 6 into the position in which such parts are represented in the said figure, moving thereby the upper portion of arm 44 rearward. This movement of the said upper portion operates through the engagement of the same with the tail or lug 43 to turn the movable jaw 41 into its open position, as in Figs. 6 and 11. Normally the parts in question stand at rest in the positions in which they are represented in Fig. 6, with the pin or roll 54 in contact with cam-surface 55 and the jaws of the carrier open. When the shaft 13 is set in motion, the action of the pin or roll 54 against the cam-surface 56 moves arm 50 and bar 47 toward the left-hand side in Figs. 6 and 7, swinging the arm 44 into the position in which it is shown in Fig. 7, the said arm 44 operating the movable jaw 41 to cause it to close against the fixed jaw 40. For the purpose of causing the carrier to turn about the axis of its shaft or journal 36, so as to carry its yarn-engaging portion and the end of yarn which is held thereby upward and around in a curved path in a transversely-extending oblique plane, as required in laying the second yarn around the proximated portions of the bend or bight of the first yarn, the carrier is furnished at the inner or rear end of the said shaft or journal with a pinion 57, Figs. 3, 11, 12, and 13, and a rack 58 is provided for engagement with the said pinion, the said rack being carried by an arm or lever 59, Figs. 3 and 4, having a pin or roll 60, which works in a cam-groove in one side of a cam-disk 61, that is fast upon the shaft 13.

The trimmers by which, after the two yarns have been grasped by the holding portions or grippers of the bight former and carrier, the extremities of the said yarns are trimmed off close to the said holding portions or grippers are shown best in Figs. 5 and 6, Sheet 3, and Fig. 7, Sheet 4. The trimmer which acts on

the extremity of the first yarn adjacent the outer side of the holding portion or gripper of the bight-former comprises a fixed blade 62 and a movable blade 63. The fixed blade 62 is constituted by the forward edge of an upwardly-extending portion of the vertical plate 451, which latter, as before stated, is attached to the bottom piece 3. The movable blade 63 is pivotally mounted at its lower end upon the stem of the screw 64, which screws the plate 451 to the bottom piece 3. The said movable blade is actuated by means of a pin 65 engaging it with the bar 47. The blades 62 and 63 constitute a pair of shears and are located closely adjacent the position which is occupied by the gripper of the bight-former when this last stands in its normal position of rest, as in Fig. 5 of Sheet 3. When the blade 63 is separated from the fixed blade 62, as in Fig. 6, the space between the two blades is in line with the opening between the jaws 20 21 of the bight-former gripper and also with the notch or slot 18 of the cheek-piece 13. Consequently as the first yarn is moved down into place in the machine it passes into position between the blades 62 and 63, as well as between the jaws of the said gripper. The trimmer which is employed to trim the extremity of the second yarn adjacent the outer side of the holding portion or gripper of the carrier comprises a movable blade 66 and a fixed blade 67. The said fixed blade is constituted by a portion of the rear wall of the notch or slot 19 in the cheek-piece 15, while the said movable blade is mounted by a pivot 671, Fig. 6, upon the said cheek-piece. The movable blade 66 is provided with a pin 68, projecting therefrom and entering a notch 69 in the outer or forward end 48 of the bar 47. The blades 66 67 are located closely adjacent the outer side of the holding portion or gripper of the carrier 10 when the latter is at rest in its normal position. When the blade 66 is separated from the fixed blade 67, as in Fig. 6, the opening between the said blades registers with the opening between the jaws of the carrier-gripper and also with the notch or slot 19 of the cheek-piece 15, so that as the second yarn is moved down within the said notch or slot 19 it passes simultaneously between the jaws of the carrier-gripper and the blades 66 67. In consequence of the engagement of the gripper-actuating arm 44 and movable blades 63 and 66 with the bar 47 the movable jaw of the carrier-gripper and the movable trimmer-blades are all actuated in unison when the said bar 47 is moved lengthwise. Thus the movement of the said bar toward the left in Figs. 6 and 7, which is produced by the action of the pin or roll 54 of the arm 53 against the cam-surface 56 of the arm 50, occasions the closing of the carrier-gripper and also causes the extremities of the two yarns to be trimmed off by the trimmers, the timing being such that the yarns are held



fast by the grippers as the severing of the extremities thereof takes place.

The spreader 11 consists of a swinging arm that is provided adjacent its free extremity with a yarn-engaging projection 70. (Shown best in Fig. 5 of Sheet 3.) The said arm is provided with a shaft or journal 71, (shown by dotted lines in Fig. 2,) that is mounted within a bearing 72 in an upwardly-extending portion of the stand 37. To the rear extremity of the said shaft or journal 71 an arm 73 is attached. For the purpose of holding the spreader 11 in its normal working position, with its yarn-engaging projection 70 extended into the path which the second yarn is caused to take in being moved by the carrier 10 around the bight of the first yarn, a leaf-spring 74 is attached to the stand 37 by means of a screw 75, the free extremity of the said spring bearing against the said arm 73. The spreader is moved to disengage its projection 70 from the second yarn at the proper time in the working of the machine—namely, after the extremity of the said second yarn has become engaged by the interlocker and the disengagement of the said extremity from the grasp of the carrier has taken place through the agency of a cam projection 76, Fig. 3, which is carried by the periphery of the cam-disk 35 on shaft 13. After the cam projection passes out of engagement with the arm 73 the spreader is returned to the normal position thereof by the action of the spring 74.

The interlocker 12 (see more particularly Fig. 3, Sheet 2, and Figs. 5, 14, 15, and 16 of Sheet 3) consists, essentially, of a curved or arc-shaped rigid finger provided with a thread-engaging clamp 77 and having a shaft or journal 78. The shaft or journal is fitted to a bearing at 79, with which the stand 37, rising from the bottom piece 3, is furnished. For the purpose of oscillating the interlocker around the axis of the said shaft or journal the latter has fixed thereon a pinion 80, which is engaged by the rack 81, Fig. 3, the said rack being provided upon an arm or lever 82, carrying a pin or projection 83, Fig. 4, working in a cam-groove that is formed in the inner face of a cam-disk 84, fast upon the shaft 13. By the action of the walls of the said cam-groove upon the pin or projection 83 in the rotation of the said shaft and cam-disk the arm or lever 82 is swung so as to communicate to the interlocker a partial forward rotation and return. The clamp 77 of the interlocker consists of a flat spring which is fixed alongside one side of the curved finger constituting the rigid portion of the interlocker, the said spring pressing closely against the said side of the finger except at the point or extremity of the finger, which last diverges transversely slightly from the spring-clamp 77 to facilitate the entrance of a yarn between the two. The free extremity of the spring

projects a short distance in advance of the tip of the rigid finger.

The operation of the machine which has been described herein is illustrated by Figs. 20 to 24, inclusive, which show certain of the main stages in the working. The said figures are on the order of diagrams, the parts being shown therein separated more widely apart from one another than in the preceding views in order to secure greater clearness. In the said figures for convenience in identifying and tracing the respective yarns one of the latter is shown as black the other as light. In Fig. 20 the parts are represented at rest prior to beginning the knot-tying operations and the two yarns are represented in the relations to the working parts which they assume when placed within the notches or slots 16 18 and 17 19 of Figs. 1, 2, 3, &c. Thus the first yarn—*i. e.*, the black one—is shown as lying behind the clamp member *a* (the latter being in open condition) and between the jaws 20 21 of the gripper of the bight-former, as well as between the blades 62 63 of the trimmer which is adjacent the bight-former, while the second yarn—*i. e.*, the light one—extends over the clamp member *d*, over the support or rest of the bight-former, between the jaws 40 41 of the gripper of the carrier, and between the blades 66 67 of the trimmer which is adjacent the position normally occupied by the carrier-gripper. When now the shaft 13 is caused to rotate, movement is communicated therefrom to the respective parts, causing them to assume the successive positions in which they are represented in Figs. 21 to 24. Thus the clamp member *d* is lowered from its position in Fig. 17, Sheet 4, and Fig. 20, Sheet 5, to that in Figs. 18 and 21, the clamp member *e* being closed down partially upon the clamp member *d*, so as to clasp the second or light yarn lightly between them, as in Fig. 21. This movement of the clamp members *d e* causes the portion of the said yarn which extends toward the left of the bight-former to be depressed, as in the said figure, thereby bending the said yarn downward at the rear of the spur 27 over the rest or support of the bight-former. Simultaneously a rearward movement communicated to clamp member *a* causes it to grip the first or black yarn against the cheek-plate 14. A turning movement of the bight-former of small extent in the direction of the arrow which is marked on the shaft or journal thereof in Fig. 21 presses the movable jaw of the gripper of the bight-former against the exterior of the stationary bearing 79 of the shaft or journal of the interlocker, thereby causing the said movable jaw to be closed against the fixed jaw 20, so as to clamp firmly the first or black yarn. The movable jaw 41 of the carrier-gripper also is closed relative to the fixed jaw 40, (by the action of the arm 44 of Figs. 6 and 7, &c.,) thus clamp-



ing the second or light yarn. Movement communicated to the movable blades 63 and 66 of the two trimmers causes the portions of the two yarns which extend beyond the two grippers to be cut off closely adjacent the latter. (See Fig. 21.) Rotary movement of the bight-former in the direction of the arrow upon its shaft or journal in Fig. 22 to the extent of a little more than half a revolution, causing it to assume the position in which it is shown in Fig. 22, next carries the bight-former gripper and the extremity of the first or black yarn held thereby forward below the portion of the second or light yarn that extends from the rest or support of the bight-former to the carrier-gripper in Fig. 21 and doubles the first or black yarn around the pin 24 and light yarn, forming thus a bight or bend of the first or black yarn, inclosing the second or light yarn as well as the pin 24, as shown in Fig. 22. Simultaneously the carrier swings upward and around in the direction that is indicated by the arrow near the same in the said figure, taking over with it the extremity of the second or light yarn. As this swinging movement of the carrier occurs the interlocker begins to swing forward in the direction indicated by the arrow near the same in Fig. 22, the second or light yarn being laid by the movement of the carrier across the convex outer side or back of the interlocker. In consequence of the eccentric position of the pin 24 and the spur 27 upon the bight-former the movement of the latter in turning from the position of Fig. 21 to that of Fig. 22 carries the said pin and spur toward the rear nearer to the shaft of the interlocker, thereby shifting the bight of the first or black thread into close proximity to the said shaft and within the radius of the arc which is described by the finger of the interlocker in its forward turning movement in order that as such forward movement continues the finger of the interlocker may pass down in front of the bight, as in Fig. 23. The advance of the carrier lays the second or light yarn upon the projection or hook of the spreader 11 also, as in Fig. 23, and is continued until the grasping portions of the jaws of the carrier-gripper pass by the gripper of the bight-former and approach the central portion of the bight-former, as in Fig. 23, which causes the said yarn to practically encircle the approximated portions of the first or black yarn. During the first portion of the swinging movement of the carrier it pulls the second or light yarn forward somewhat in the direction of its length, drawing the said yarn between the partially-closed clamp-jaws *d e*, which operate to hold the yarn with just sufficient force to produce a degree of tension which will straighten it out and prevent the passage of kinks or the like as it is pulled forward by the action of the carrier. As the carrier approaches its position in Fig. 22 a slight addi-

tional closing movement of clamp members *d e* occurs, whereby the second or light yarn is clamped securely and held from rendering further between the said clamping members. The subsequent portion of the advancing movement of the carrier places the leading portion of the said yarn in position to enter between the leaf-spring 77 and the rigid finger of the interlocker. At this time the yarn is comparatively taut in consequence of being bent about the rounded back of the interlocker and the projection or hook of the spreader, and thereby is enabled to pass in between the rigid tip of the interlocker and the leaf-spring 77 as the interlocker completes its forward turning movement, the entrance of the yarn between the said members being facilitated by pressure transmitted laterally through the yarn against the leaf-spring, such pressure tending to separate the latter from the rigid finger. The second or light yarn having been entered between the spring and rigid finger of the interlocker, the carrier moves reversely, the jaws thereof withdrawing from the end of such yarn and leaving the same in the grasp of the interlocker, the yarn being prevented from accompanying the said jaws by the hold of the clamp *d e* upon the yarn coupled with the frictional resistance which results from bending the yarn around the back of the interlocker, the projection or hook of the spreader, and the tip portion of the rigid finger of the interlocker. The spreader now moves in the direction that is indicated by the arrow upon it in Fig. 24 to disengage its projection or hook from the loop of the second or light yarn, after which the interlocker is retracted, as indicated by the arrow near the same in Fig. 24, so as to draw the extremity of the second or light yarn across the proximated portions of the bight or bend of the first yarn and between such portions and the encircling portion of the second yarn, as will be clear from Figs. 23 and 24, thus effecting the interlocking. As the retraction of the interlocker proceeds the clamp-jaws *d e* are still further depressed, as indicated in Fig. 24, the movements of the interlocker and clamp-jaws *d e* in opposite directions drawing taut the portion of the second or light yarn between them which has been interlocked about the pin 24 and first or black yarn, so as to tighten the knot, the continuance of such movements effecting the release of the said second or light yarn from the clasp of the interlocker. A slight movement of the bight-former in the direction that is indicated by the arrow upon its shaft or journal in Fig. 24 presses the free extremity of the movable jaw 21 against the lower end of the spreader, thereby opening the said jaw relative to the fixed jaw 20, so as to release the end of the first or black yarn. The bight-former, carrier, and interlocker now are caused to return to their original positions. The clamp mem-



ber *a* is opened to release the first or black yarn. The clamp *d e* is raised and the member *e* opened relative to the member *d* to release the second or light yarn, the upward movement of the opened clamp *d e* being continued above the normal position of said clamp, which is represented in Fig. 17, so as to cause the arm or lever *d* to lift the yarns out of both of the slots 16 and 17 and also strip the knot off the pin 24 of the bight-former. In performing this last action the arm or lever *d* operates as a stripper. The completed knot is shown in Fig. 25 on an enlarged scale. As the carrier returns to the position which it occupies in Fig. 7 the projection or tail 43 of the movable jaw 41 thereof enters the notch 46 of the actuating-arm 44. Thereafter the bar 47 is operated to move the said actuating-arm and the movable blades of the two trimmers for the purpose of opening the carrier-gripper and the said trimmers, thereby placing them in readiness for receiving the yarns which are to be united by a subsequent operation of the machine. The gripper of the bight-former remains in the open condition which was produced through the engagement of its movable jaw with the lower end of the spreader. The clamp *d e* returns to its position in Fig. 17.

For the purpose of guiding into proper place the portions of the yarns which cross between the opposite cheek-pieces 14 and 15 as the yarns are passed into the notches or slots 16 18 and 17 19 of the said cheek-pieces in beginning operations the cheek-piece 15 is formed or provided with extensions 85 and 86, projecting inwardly at the upper end thereof and having downturned portions, as represented best in Fig. 5, the cheek-piece 14 having also an inward extension 861, Fig. 5. The extension 85 guides the second or dark yarn into place between the jaws 20 21 of the bight-former and also into place between the blades 62 63 of the adjacent trimmer. To further insure the entrance of the said yarn between the said blades, the fixed blade 62 itself is formed with an upwardly-extended guide portion 87, Figs. 5, 6, and 7, which arches over toward the middle of the machine, its inner end terminating above the acting portion of the interlocker at the front of the axis of rotation thereof and also adjacent the projection or hook 70 of the spreader 11, slightly to the rear thereof, while the blade 63 is continued upward above the place at which the blades mutually coact. The downturned inner end of the extension 86 of the cheek-piece 15 projects into proximity to the central portion of the bight-former, a little in front of the axis of rotation thereof, and serves to conduct the second or light yarn into place at the rear of the pin 24 of the bight-former, so that it will take position upon the rest or surface 25 of the latter. The inward extension 861 of the cheek-piece 14 extends in line with the upper

portion of the opposite extension 86 into close proximity to the downturned portion of the latter. The upper portion of the actuating-arm 44 extends upwardly to serve as a guide in conducting the second yarn into place between the jaws of the carrier-gripper and also between the blades 66 67 of the trimmer for such yarn. The arched guide portion 87 deflects forwardly the portion of yarn which is swung around by the carrier in the turning movement of the latter, preventing such portion from passing too far to the rear with respect to the interlocker.

My machine may be attached to a suitable fixed support; but I contemplate constituting a portable machine of the same to enable it to be carried about by the person making use thereof. It is especially adapted for use by the attendant or operative in connection with a yarn-spooling machine. It may be attached to or supported by the person of the user in any convenient or approved manner. I have herein shown an attaching-strap 88, Figs. 1 and 2, suitable to encircle the wrist of the user, the said strap being furnished with a lacing-cord 89 and lacing hooks or studs 90 to serve as fastenings. Only a portion of the length of the lacing-cord 89 is represented in Fig. 2. Other attaching and fastening arrangements may be substituted in practice.

The means and manner of operating the machine may vary in practice. I contemplate in some instances rotating the shaft 13 by hand and in the present instance have illustrated a provision for enabling the said shaft to be thus rotated, the said provision being in the shape of a thumb-wheel 91, Figs. 2, 3, 4, and 5, which is fast upon one end of the shaft. Power driving connections are within the scope of the invention. I have shown herein a means of storing up power and transmitting connections between the said storing-up means and the shaft 13, such means and connections forming part of the portable machine. Thus at 92, Figs. 3 and 4, is shown a clock-spring which surrounds the hub 93 of a ratchet-wheel 94, the said ratchet-wheel being mounted upon the rod 4, with capacity to turn freely thereon. The outer extremity of the said spring is engaged with a projection 95, carried by a gear-wheel 96, the latter being also mounted to turn freely upon the rod 4. With the spur-gear 96 meshes an intermediate or carrier gear 97, that is mounted upon the arm or projection 52, Figs. 3 and 6, of the bottom piece 3, the said carrier also meshing with a gear 98, Figs. 3 and 4, which is fast upon the shaft 13. When the clock-spring 92 is wound up, the tension thereof acts with a tendency to transmit rotary movement through the gears 96, 97, and 98 to the shaft 13. For the purpose of turning the ratchet-wheel 94 to wind up the spring and store power therein an arm 99 is mounted upon the rod 4 with capacity to turn thereon,



the said arm having pivoted thereto a pawl 100, Fig. 3, which is acted upon by a spring 101, operating with a tendency to press the pawl against the periphery of the ratchet-wheel. To the segmental outer end of the arm 99 is joined one extremity of a flexible connector 102, Figs. 2 and 3, the other extremity of which is joined to the free extremity of an arm 103, fast upon a rock-shaft 104, which is mounted in suitable bearings in the rear ends of the side pieces 1 and 2. The said rock-shaft 104 is provided with a projecting arm or lever 105, by means of which it may be rocked for the purpose of actuating the arm 99 and its pawl 100 to rotate the ratchet-wheel 94 for the purpose of winding up the spring 92. To save space, only a portion of the length of the said arm or lever 105 is shown in the different figures of the drawings. When the said arm or lever is pressed upon to turn the rock-shaft in one direction, movement is transmitted from the arm 103, through the flexible connector 102, to the arm 99 in the direction to cause the pawl to engage with one of the teeth of the ratchet-wheel 94 and turn the latter to wind up the spring. The arm 99 is moved in the reverse direction through the engagement of the pin 106, projecting outwardly from said arm, (see Figs. 2 and 3,) with the radial outer extremity of the spring 107, (see more particularly Fig. 2,) which spring is wound upon a spring-barrel 108 at one end of rod 4, the said spring acting with a tendency to hold the pin 106 pressed against a fixed stop-arm 109. A holding-pawl 131 for the ratchet-wheel 94 and a spring 132 to press the said holding-pawl against the periphery of the ratchet-wheel are shown in Fig. 4. For the purpose of restraining the shaft 13 from movement under the action of the force which is transmitted to the same from the spring 92, except when such movement is desired to occur, and of releasing the shaft to the action of the said spring when it is desired that the machine shall operate a stop projection 110, Fig. 19 of Sheet 4, is formed on or applied to the outer face of the cam-disk 84, and for engagement with the said stop projection 110 a detent-lever 111, Figs. 2 and 3, is pivotally mounted upon a screw 112 upon the side piece 2. The detent-lever has one extremity thereof—namely, 113—shaped, as shown in Fig. 3, to engage with the stop projection 110, the other extremity being formed as a thumb-piece, by pressure upon which the lever may be moved to disengage its extremity 113 by radial movement from the shoulder of the stop projection 110. When this disengagement is effected, the shaft 13 is free to rotate in response to the tension of the spring 92. By the action of an expanding-spring 115, which is shown best in Fig. 2, the detent-lever 111 is held normally in position for engagement with the shoulder of the stop pro-

jection 110 to insure that it shall continue in engagement with the said shoulder to hold the shaft 13 from rotation and also in order to cause it to catch against the shoulder at the end of a complete revolution of the shaft, so as to arrest the rotation thereof. In order to positively insure the said arrest, the cam-disk 84 is provided with a guiding-cam 114, the acting surface of which in the rotation of the shaft 13 and disk 84 makes contact with the extremity 113 of the detent-lever 111 in case such extremity is in an outer position and by such contact pushes the extremity radially inward toward the shaft 13 into the path of movement of the shoulder of the stop projection 110.

The machine which is shown in the accompanying drawings when fitted with the attaching-strap 88 is intended more especially to be worn upon the left wrist of the user thereof. When it is desired to connect the outer extremity of a yarn drawn from a supply-bobbin with the outer extremity of the yarn which has been wound on a spool mounted upon a winding-spindle forming part of a spooling-machine, the user of the machine rests the arm or lever 105 upon the head of the said spool, arresting the rotation of the spool by the pressure of the arm or lever thereagainst or of the latter and his hand combined. This action operates by turning the rock-shaft and actuating the spring-winding devices to partially wind up the clock-spring 92 and place the latter under greater tension. The user having hold of the extremities of the two yarns with his right hand, the said yarns are drawn by a movement of such hand side by side into the notches or slots 16 18 and 17 19 into position at the bottom of the said notches or slots, whereupon the detent-lever 111 is moved by a touch of a finger or other portion of the same hand, so as to disengage its acting extremity from the stop projection 110, the shaft 13 thus being freed to the action of the clock-spring and being rotated thereby, causing the machine to operate as hereinbefore explained. The pressure of the arm or lever 105 upon the head of the spool then is relieved, and the latter is allowed to resume its rotation and to wind the united yarns upon its periphery.

I make provision for insuring the withdrawal of the united portions of the yarns from the knot-tying machine as the spool winds the same up in rotating by means of a guide 116. The said guide is located alongside the side piece 1 of the machine-frame and is attached to a hub 117, that is mounted upon the rod 4 with capacity to turn freely thereon. The guide extends forwardly from the said hub, its acting extremity being arranged to move vertically alongside the side piece 1. For the purpose of transmitting movement to the said guide it is furnished with a tail portion 118, Figs. 3 and 4, the free extremity of



which is bent and enters a slot in an arm 119, that is fast upon the rock-shaft 104. Through the agency of the said arm and tail the guide is moved when the rock-shaft is operated. In consequence of the action of the spring 107 in holding the rock-shaft 104 and its arm 119 in the position which is represented in Figs. 1, 2, and 17 the guide is held normally in an upraised position, as shown best in Figs. 1, 5, and 17. The movement which is transmitted to the rock-shaft 104 by pressure upon the arm or lever 105, as aforesaid, for the purpose of actuating the pawl-carrying arm 99 to wind up the spring 92 is transmitted by the arm 119 to the guide and depresses the latter below the lower ends of the notches or slots 16 and 17 of the side piece 1, thus permitting the yarns to be passed down into proper position within the said notches. The continuance of the pressure upon the arm or lever 105 maintains the guide in depressed position until after the yarns have been applied to the machine, the detent-lever 111 has been touched to disengage its extremity 113 from the stop projection 110, and the machine has performed its function of tying the two yarns together and stopped. The pressure upon the arm or lever 105 then being relieved, as by raising the same out of immediate contact with the head of the spool, the spring 107, acting through the arm 99, the flexible connection 102, and the arm 103, operates to move the rock-shaft 104 and its arm 119 in the reverse direction, thus causing the guide to swing upward at its working end above the level of the knot-tying devices, so that the pull which is communicated to the united yarns by the spool in winding up the same shall draw the said yarns upward and away from the knot-tying devices.

It will be understood that while I have been careful to describe completely with reference to the drawings the construction of the particular machine in which in the present instance the invention is shown embodied my invention is not limited thereto, but may be embodied in many different constructions without involving a departure from the spirit of the invention. I have in the course of the preceding description referred to the spring-winding devices as being actuated by pressing the arm or lever 105 against a head of a spool upon a winding-spindle forming part of a yarn-spooling machine. It will be clear that for the purpose of actuating the spring-winding devices the said arm or lever may be pressed against any other part or member of the machine adjacent or in connection with which it may be used or against any other suitable rest or abutment.

I claim as my invention—

1. In a knot-tying mechanism, in combination, means whereby two yarns are assembled with one thereof inclosed in a bight of the other, and devices by which the extremity of

the inclosed yarn is carried around the doubled portions of the other and interlocked with the encircling portion of itself.

2. A mechanism for tying two yarns together with a weaver's knot, comprising, in combination, means by which one of such yarns is doubled around the other thereof in the form of a bight, and devices by which the free extremity of the other is carried around the doubled portions of the first and interlocked with its own encircling portion.

3. In a knot-tying mechanism, in combination, a bight-former, and devices by which a second yarn is positioned within the bight of yarn which is produced in a yarn by the action of said bight-former and its free extremity is passed around the doubled portions of said bight and interlocked with its own encircling portion.

4. In a knot-tying mechanism, in combination, devices, including a bight-former, by which two yarns are assembled with one thereof inclosed by a bight of the other, a carrier by which the extremity of the former yarn is carried around the doubled portions of the other yarn, and an interlocker which passes the said extremity between the said doubled portions and the encircling portion of yarn.

5. In a knot-tying mechanism, in combination, a bight-former, devices by which a second yarn is positioned within the bight of yarn produced by the action of said bight-former and its free extremity is passed around the doubled portions of said bight and interlocked with the encircling portion of the second yarn, and devices to trim off the surplus portions of the extremities of the respective yarn.

6. In a knot-tying mechanism, in combination, the bight-former operating to inclose one of the ends of yarn which are to be united within a loop or bight of the other, the carrier operating to encircle the said loop or bight by said inclosed end of yarn, and the interlocker.

7. In a knot-tying mechanism, in combination, the bight-former, the trimmer to cut off the surplus portion of the yarn engaged by the bight-former, the carrier, the trimmer to cut off the surplus portion of the yarn engaged by the carrier, and the interlocker.

8. In a knot-tying mechanism, in combination, the rotatable bight-former having the pin and the yarn-holding device, and devices by which the extremity of a yarn inclosed in the bight of yarn produced by the rotary movement of the bight-former is carried around the doubled portions of such bight and interlaced with the encircling portion of yarn.

9. In a knot-tying machine, in combination, a bight-former, a carrier by which a second yarn is carried around the doubled portions of the bight of yarn produced with the aid of the bight-former, a spreader engaging with the encircling loop of yarn, and an interlocker.



10. In a knot-tying machine, in combination, a bight-former having a holding device for one yarn, a carrier having a holding device for a second yarn, means to actuate said bight-former and carrier, and clamps engaging with the main portions of the respective yarns during the action of said parts.

11. In a knot-tying machine, in combination, the bight-former having the gripper, the carrier having the gripper, the interlocker, and the clamps for the main portions of the respective yarns.

12. In a knot-tying machine, in combination, the bight-former, the trimmer to cut off the surplus portion of the yarn engaged by the bight-former, the carrier, the trimmer to cut off the surplus portion of the yarn engaged by the carrier, the interlocker, and the clamps engaging with the main portions of the respective yarns during the action of the said parts.

13. In a knot-tying machine, in combination, a bight-former, devices by which a second yarn is caused to encircle the doubled portions of the bight of yarn produced by the action of the bight-former and its extremity is interlocked with the encircling portion, and a stripper.

14. In a knot-tying machine, in combination, knot-tying devices, a device for storing power, said storing device having driving connection with said knot-tying devices, and means to control the actuation of the latter devices by the stored power.

15. In a knot-tying machine, in combination, knot-tying devices, a device for storing

power, said storing device having driving connection with said knot-tying devices, and detent devices whereby the actuation of the knot-tying devices by the stored power is controlled.

16. In a knot-tying machine, in combination, knot-tying devices, a power-storing spring in driving connection with the said knot-tying devices, means to control the actuation of the said devices by the stored power of said spring, and means to intermittently wind up said spring.

17. In a knot-tying machine, in combination, knot-tying devices, a power-storing spring in driving connection with the said knot-tying devices, means to control the actuation of the said devices by the stored power, and spring-winding devices having an operating arm or lever.

18. In a knot-tying machine, in combination, the knot-tying devices, the power-storing spring in driving connection with the said devices, detent devices whereby the actuation of the knot-tying devices by the stored power is controlled, and spring-winding devices having an operating arm or lever.

19. A portable knot-tying machine provided with means for supporting the same upon the wrist or forearm of the user.

In testimony whereof I affix my signature in presence of two witnesses.

STILLMAN A. WEST.

Witnesses:

CHAS. F. RANDALL,  
ROBERT S. BOWEN.