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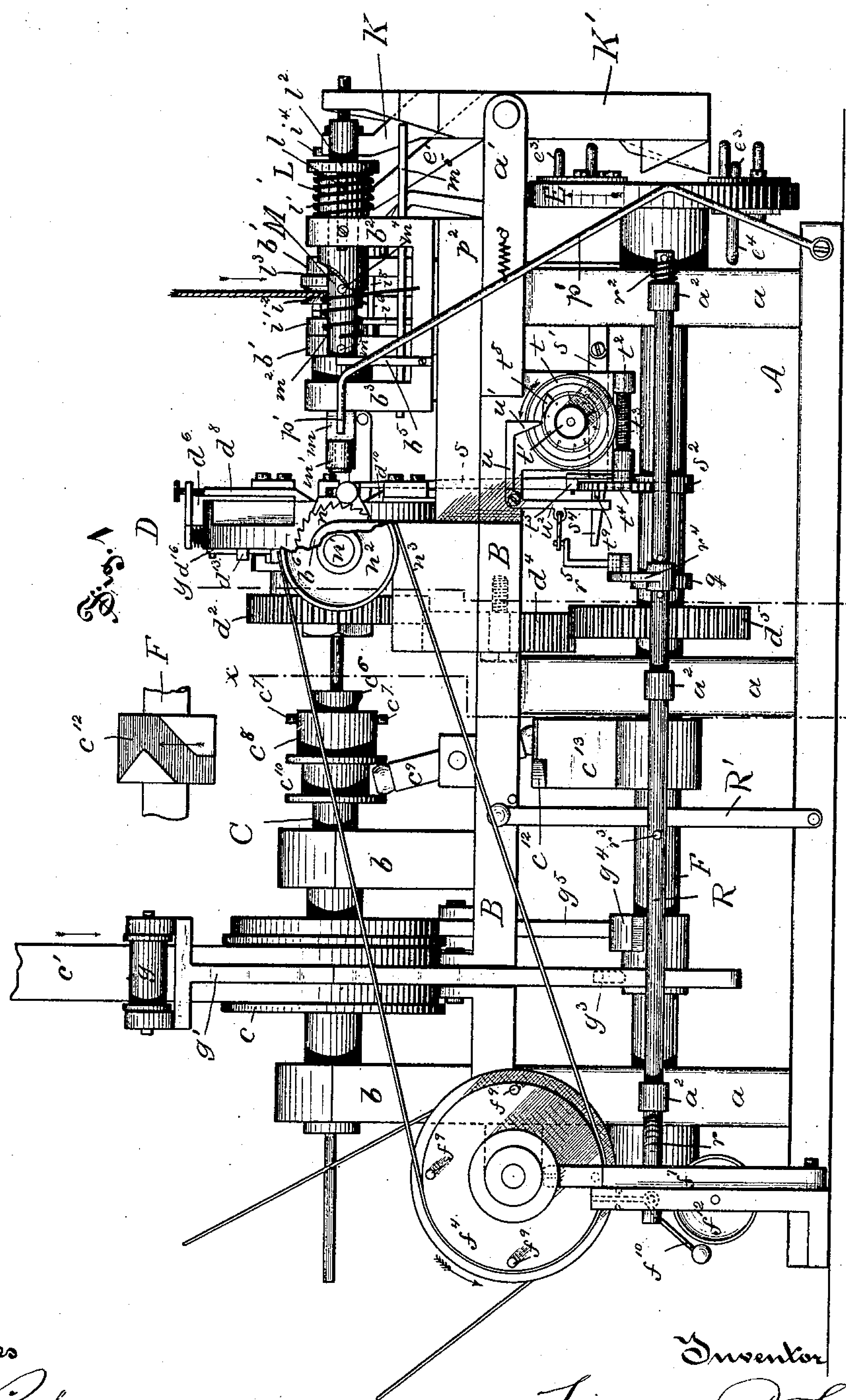
9 Sheets—Sheet 1.

L. P. SMITH.

METAL SCREW MACHINE.

No. 321,059. Patented June 30, 1885.



Witnesses

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E. F. Dimock.

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by Simonds & Burdett,

Attys.

N. PETERS, Photo-Lithographer, Washington, D. C.

(No Model.) 9 Sheets—Sheet 2.

L. P. SMITH.

METAL SCREW MACHINE.

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Fig. 12

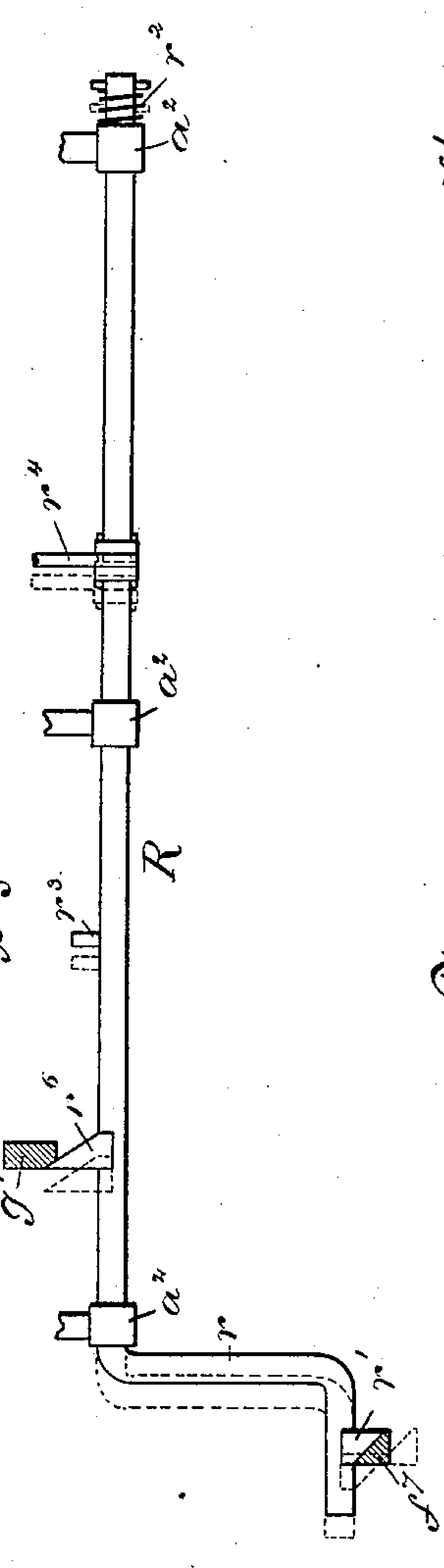
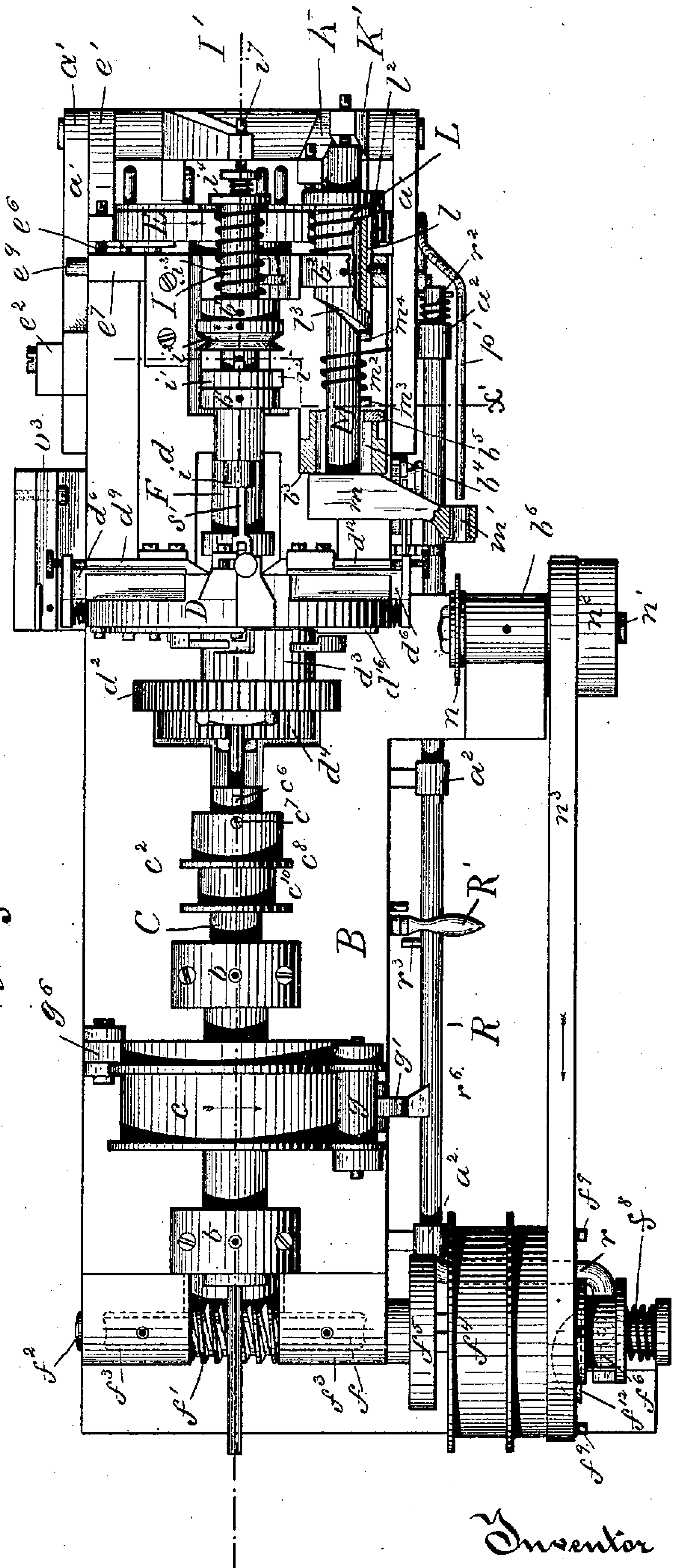


Fig. 2



Witnesses

W. M. Bjorkman

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(No Model.) 9 Sheets—Sheet 3.

L. P. SMITH.

METAL SCREW MACHINE.

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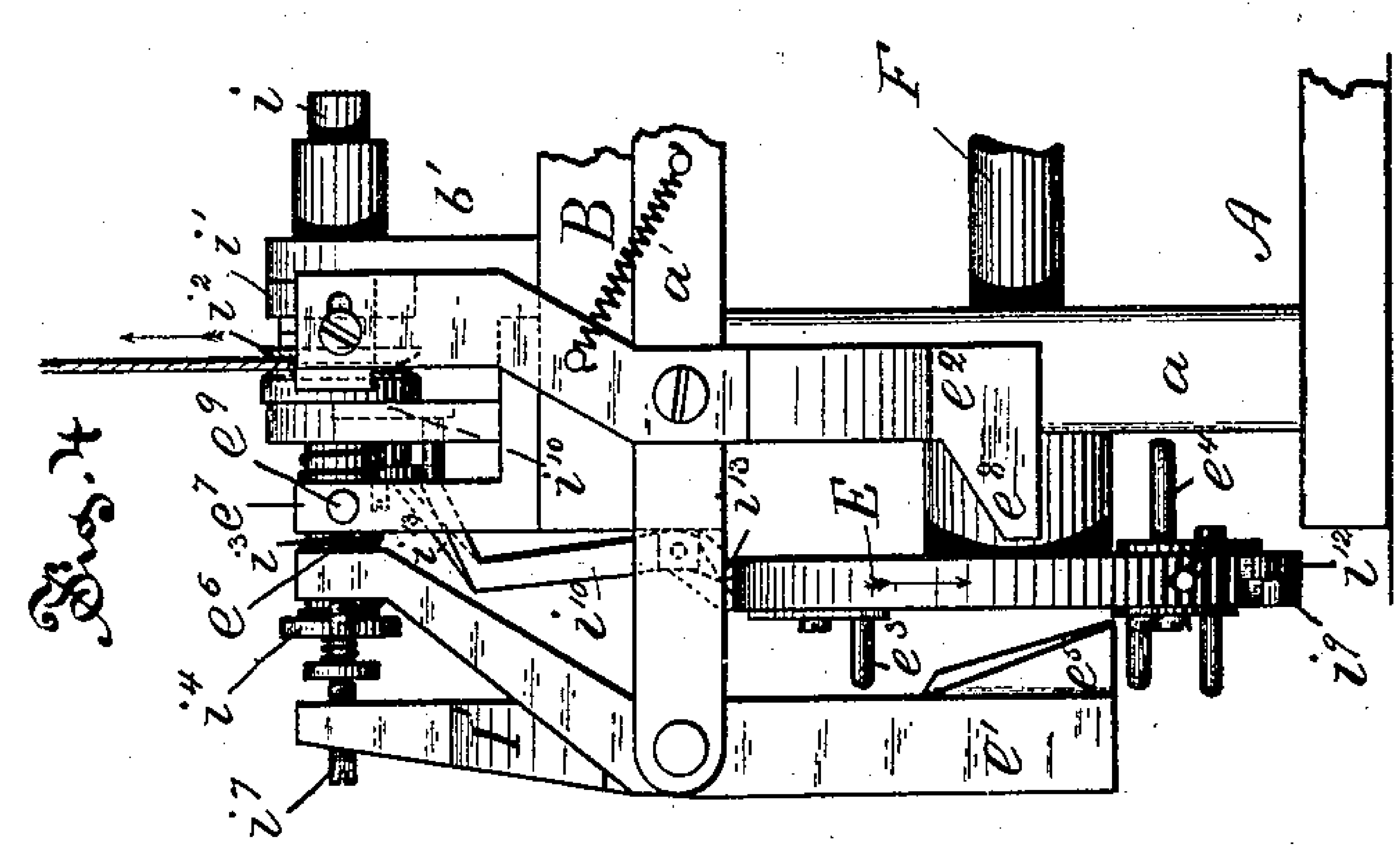

Fig. 4.

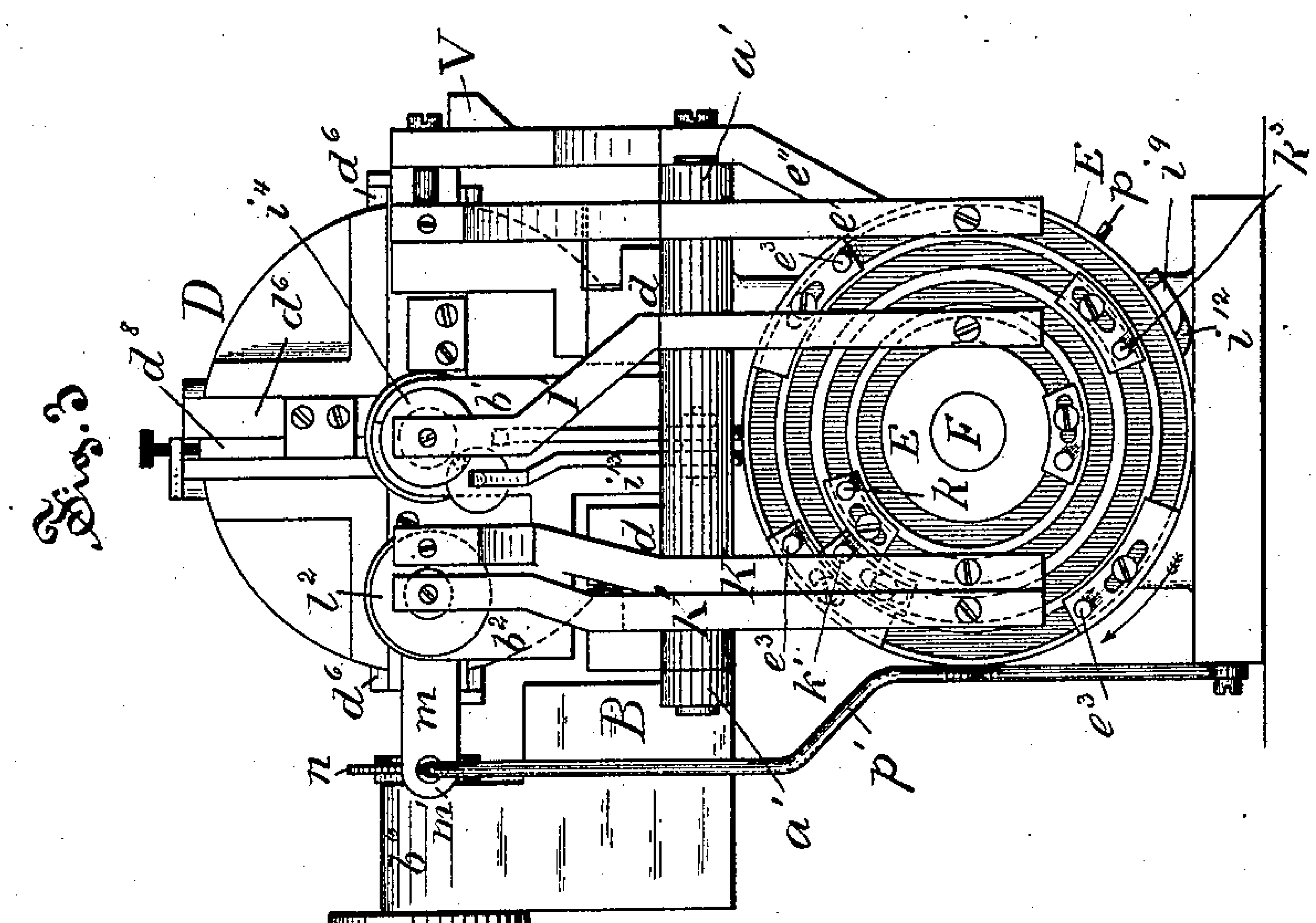

Fig. 3.

Witnesses
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L. P. SMITH.

METAL SCREW MACHINE.

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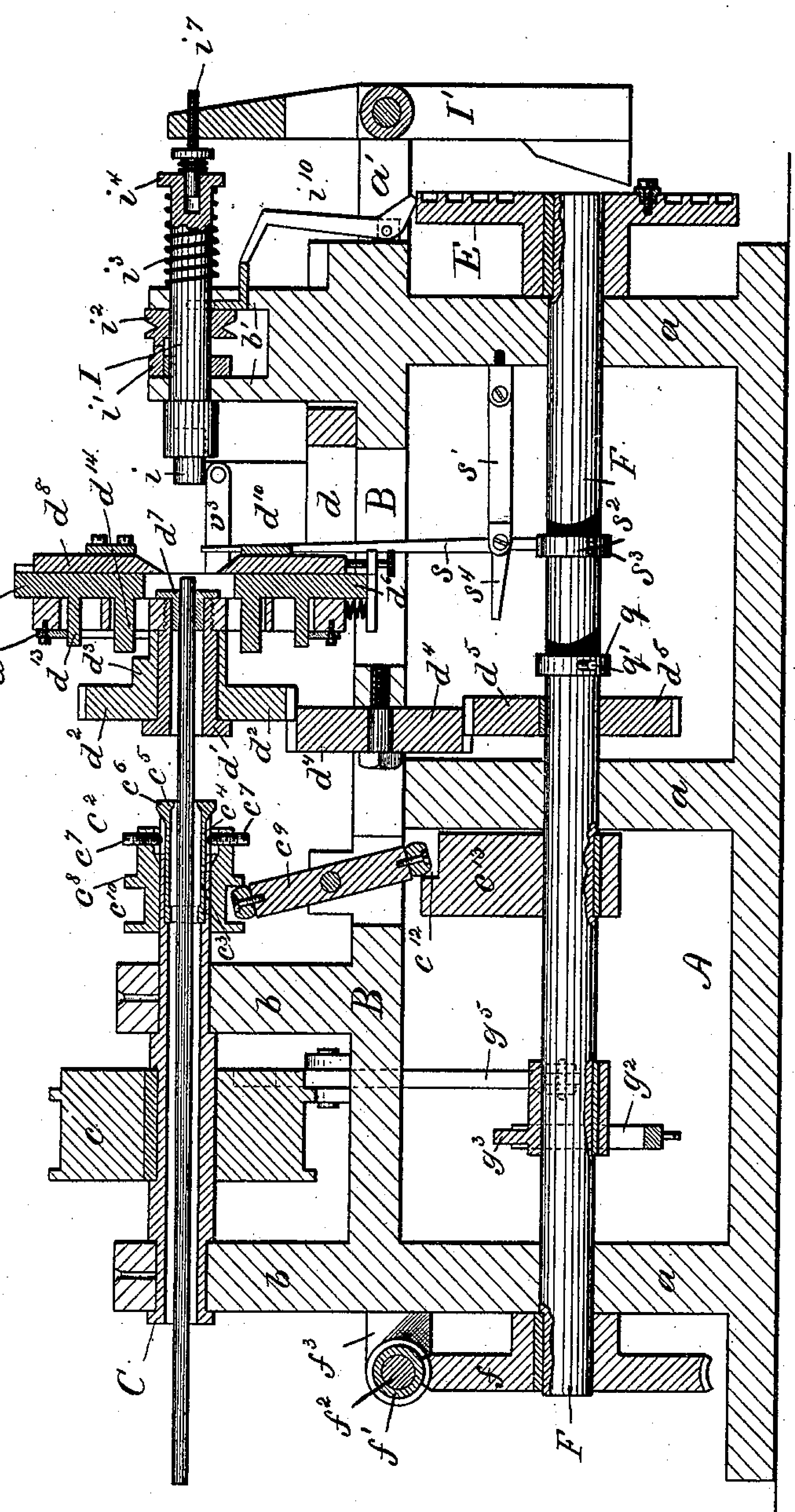
Fig. 5



Witnesses
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L. P. SMITH.

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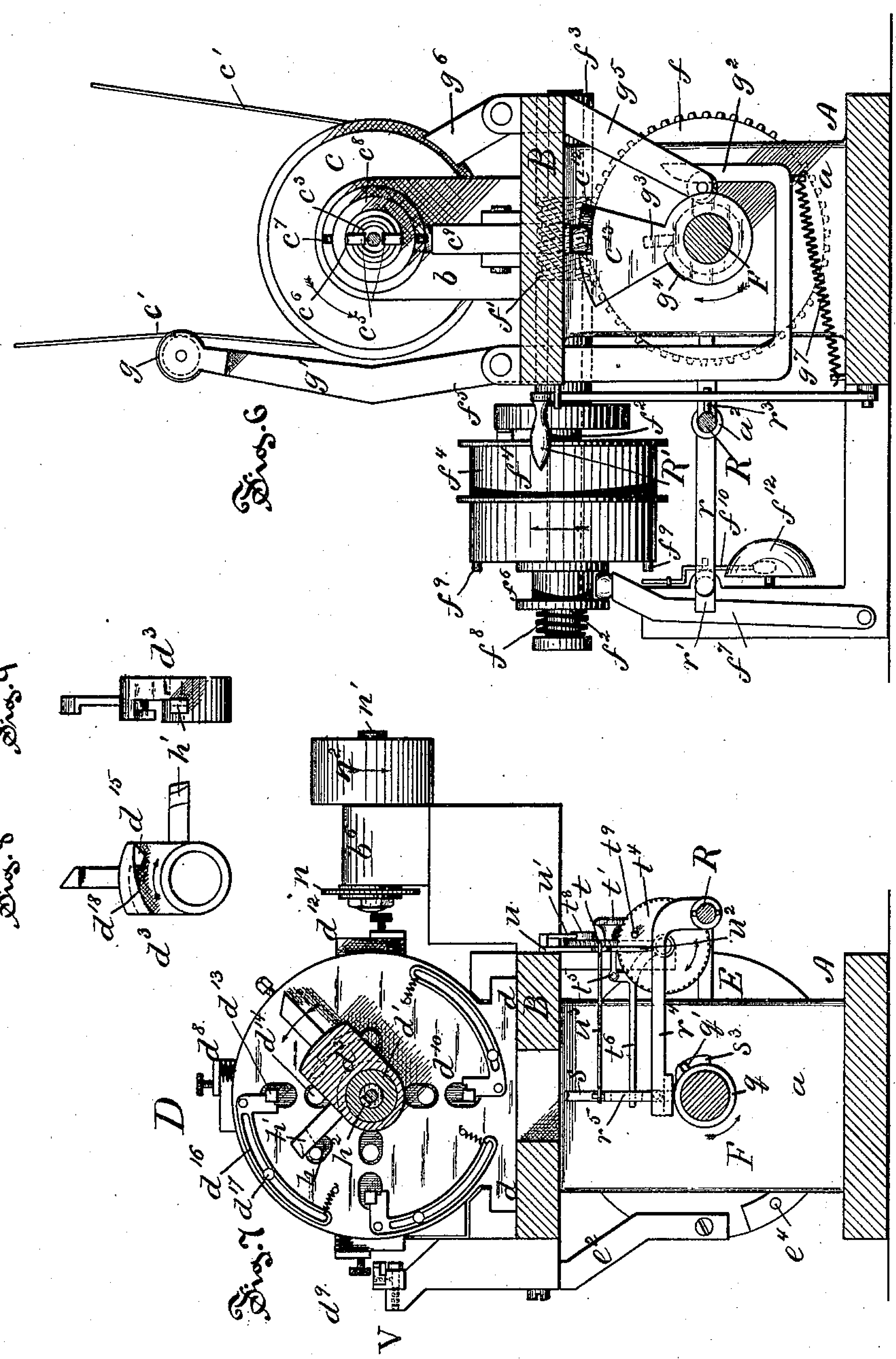

Witnesses

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(No Model.)

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L. P. SMITH.

METAL SCREW MACHINE.

No. 321,059. Patented June 30, 1885.

Fig. 11

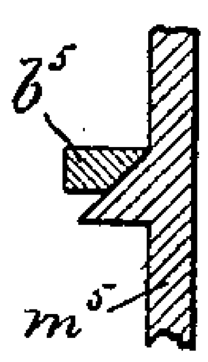


Fig. 10

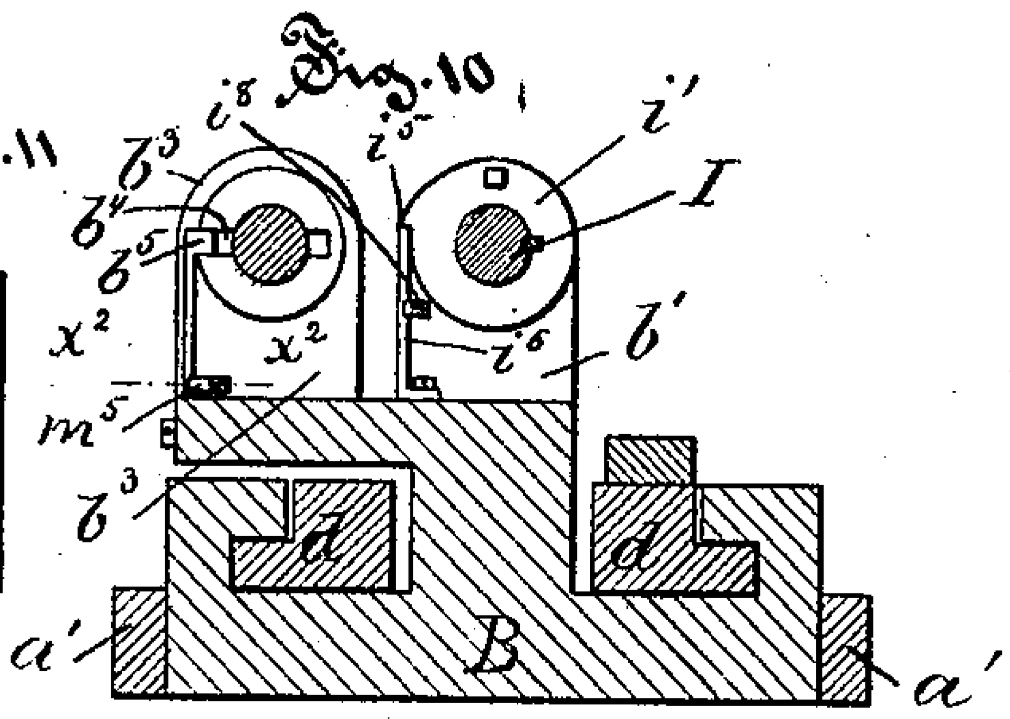


Fig. 13

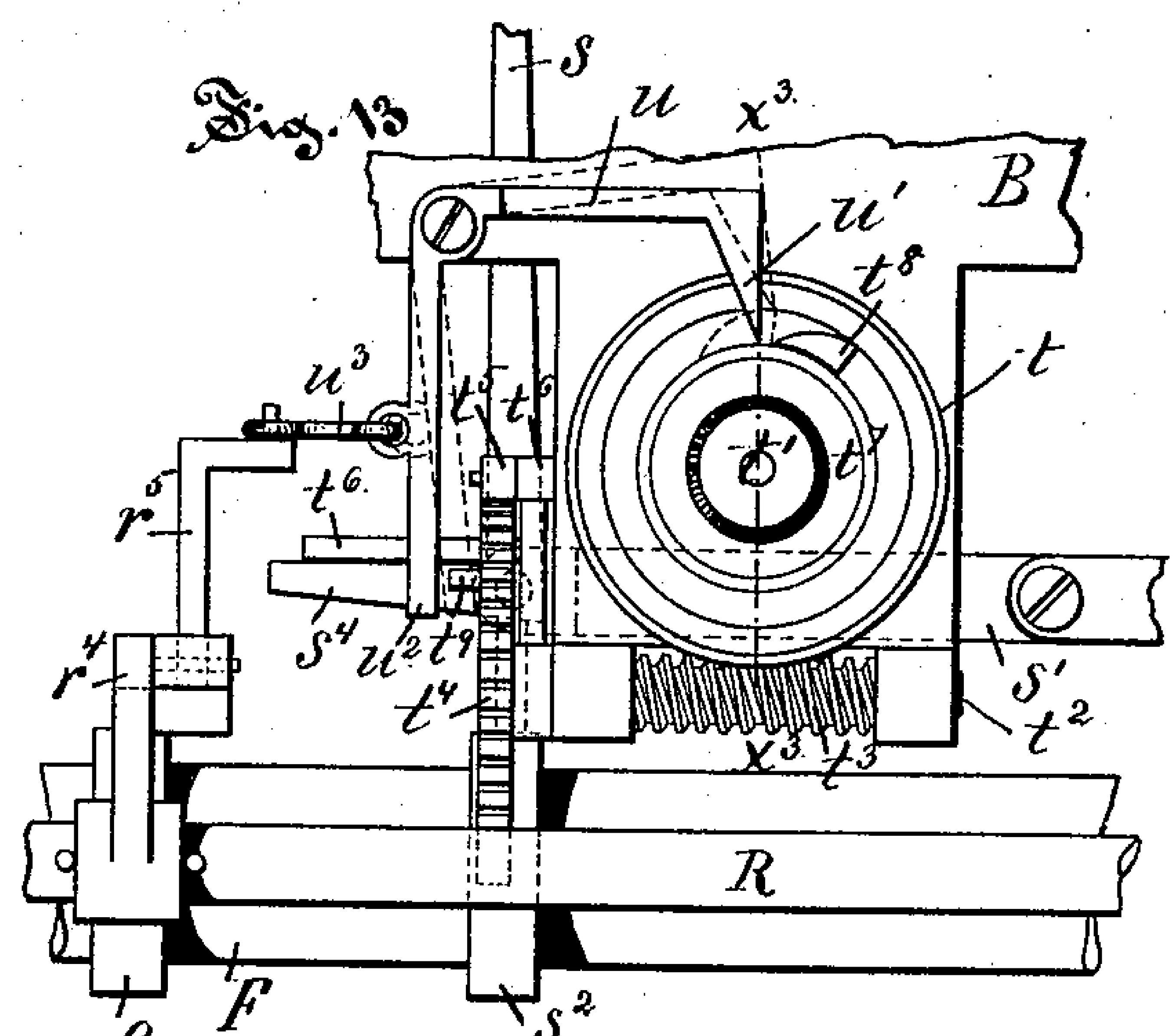


Fig. 16

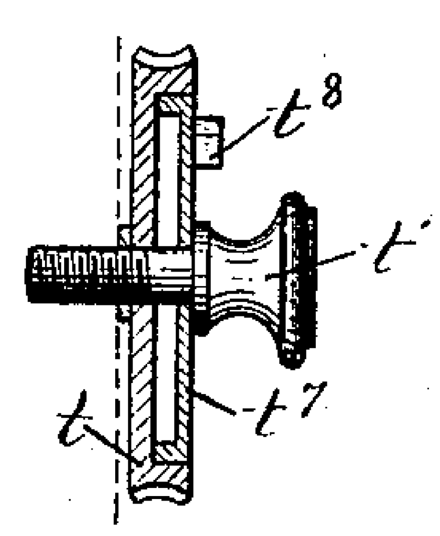


Fig. 14

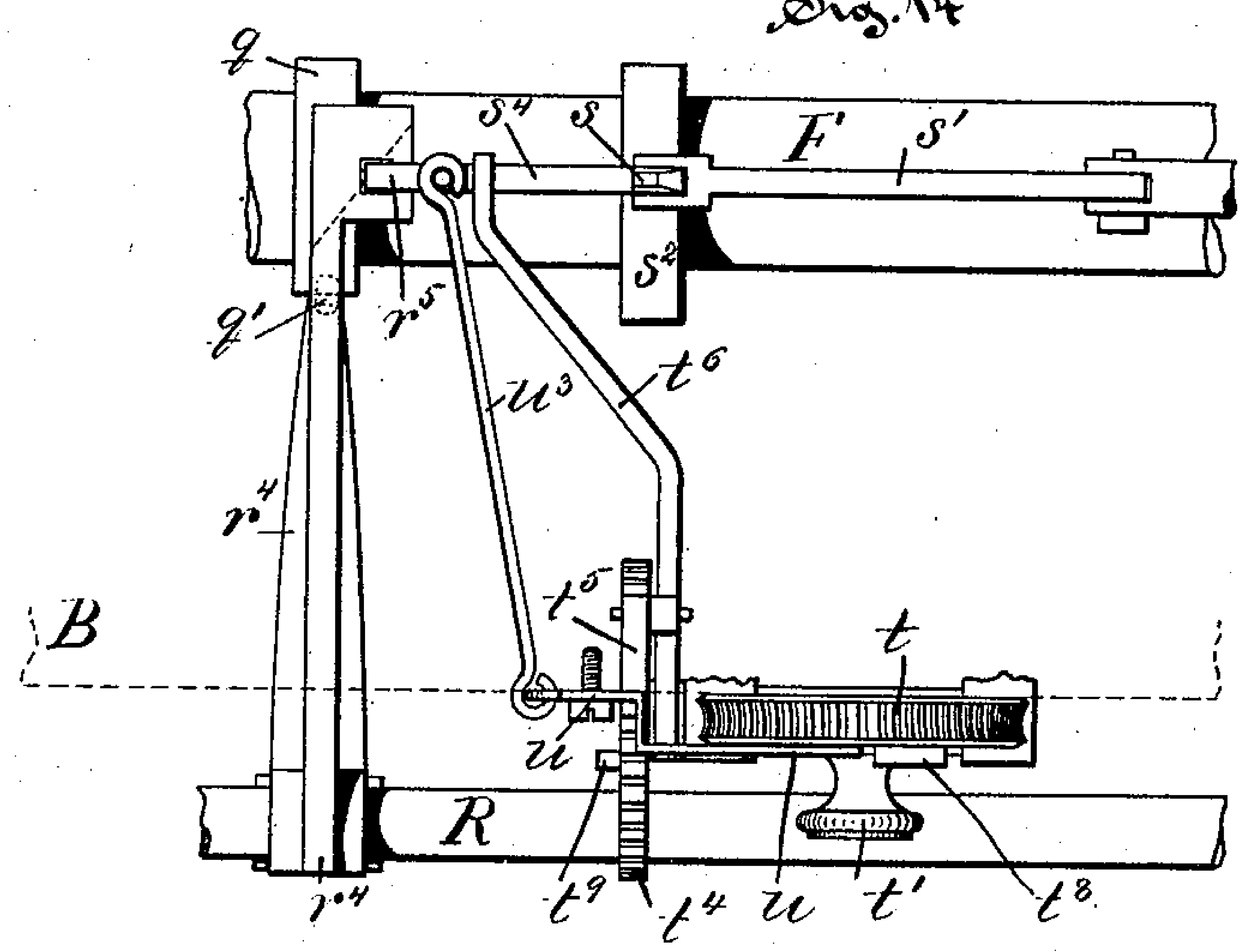
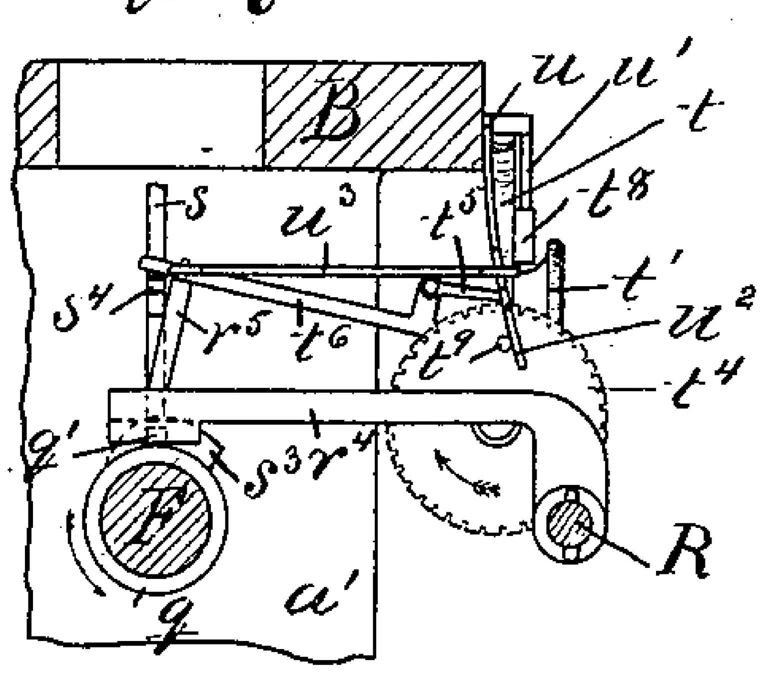


Fig. 15



Witnesses

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(No Model.) 9 Sheets—Sheet 7.

L. P. SMITH.

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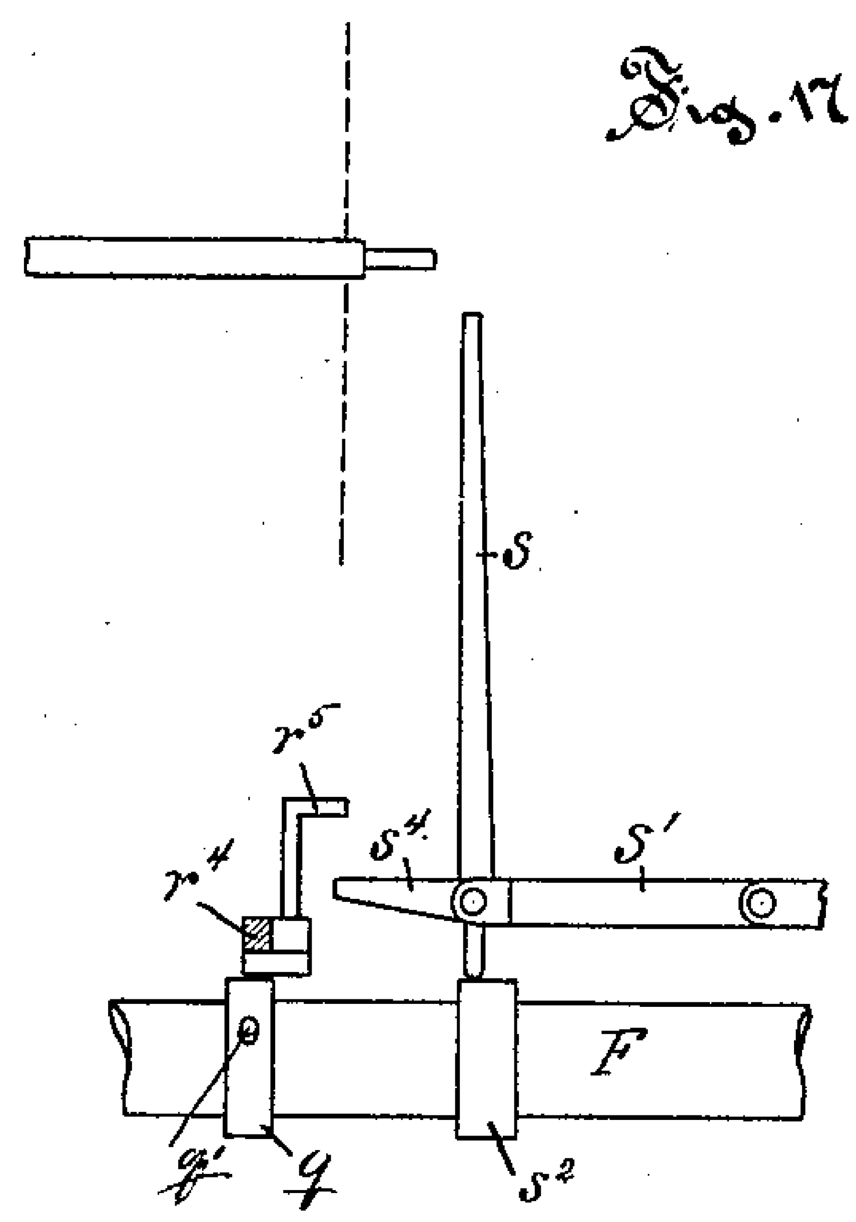

Fig. 17

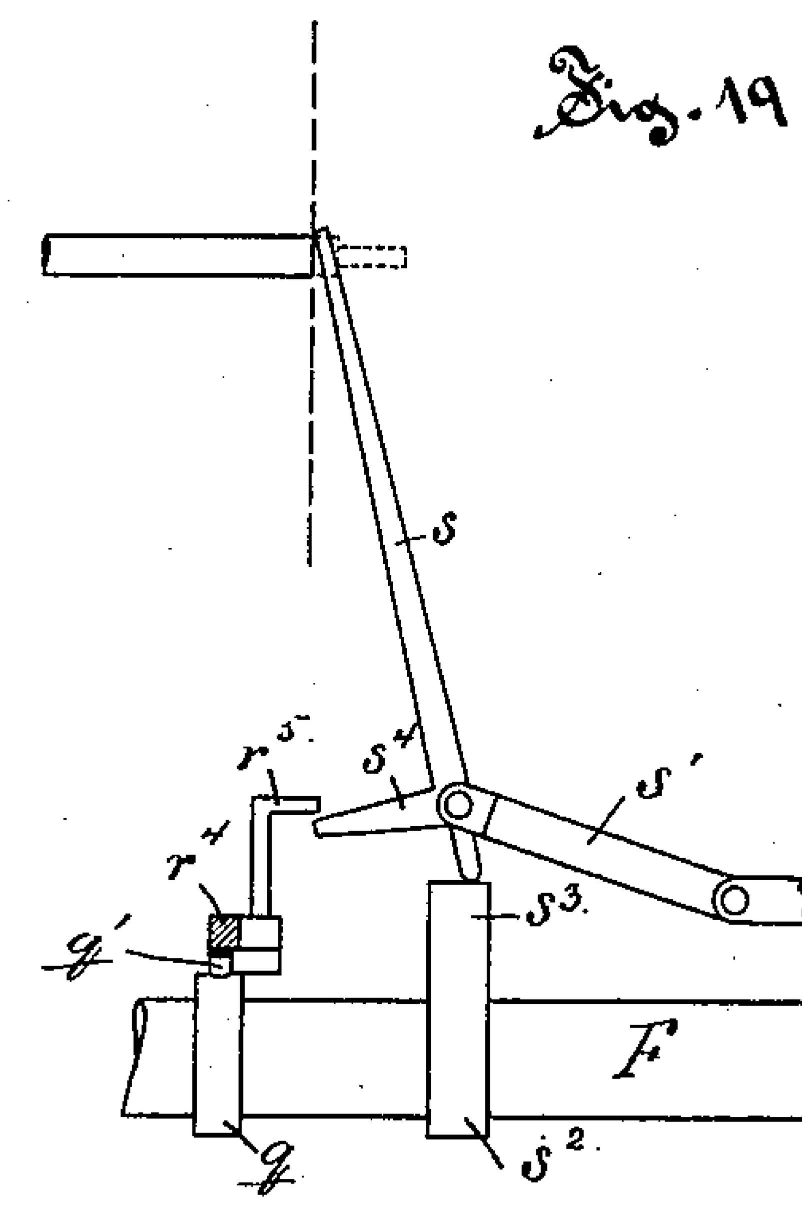

Fig. 19

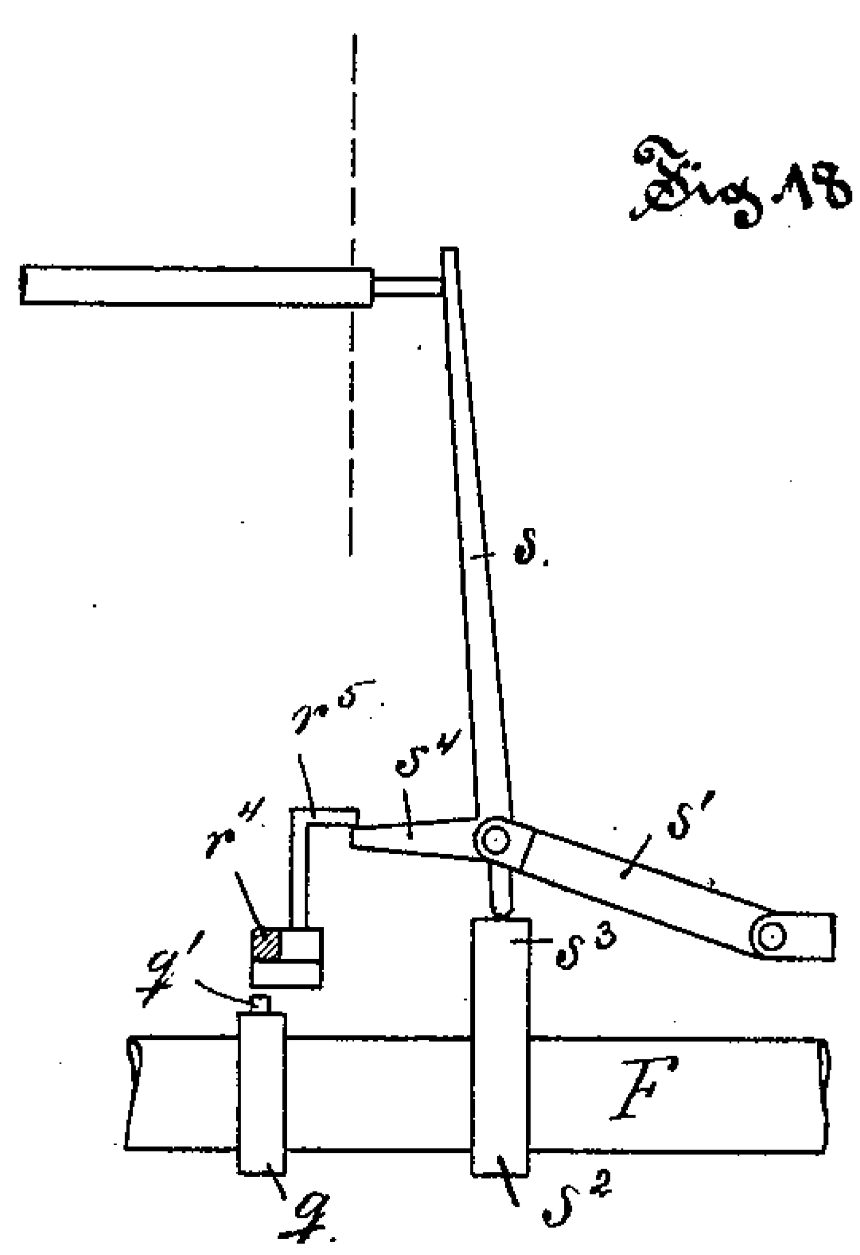

Fig. 18

Witnesses
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(No Model.)

9 Sheets—Sheet 8.

L. P. SMITH.

METAL SCREW MACHINE.

No. 321,059. Patented June 30, 1885.

Fig. 20

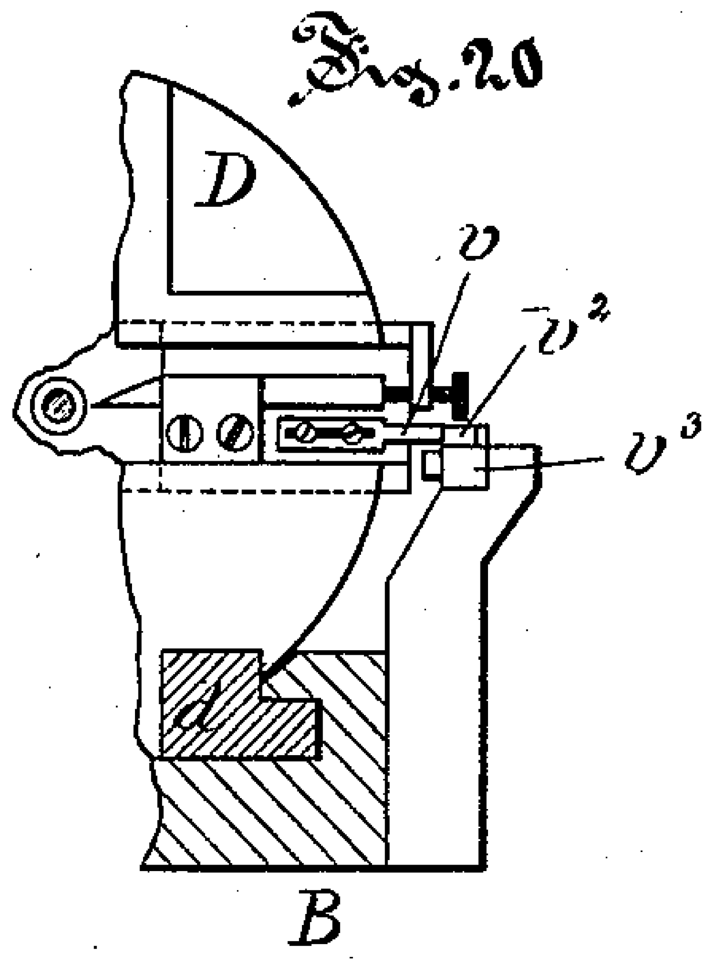


Fig. 21

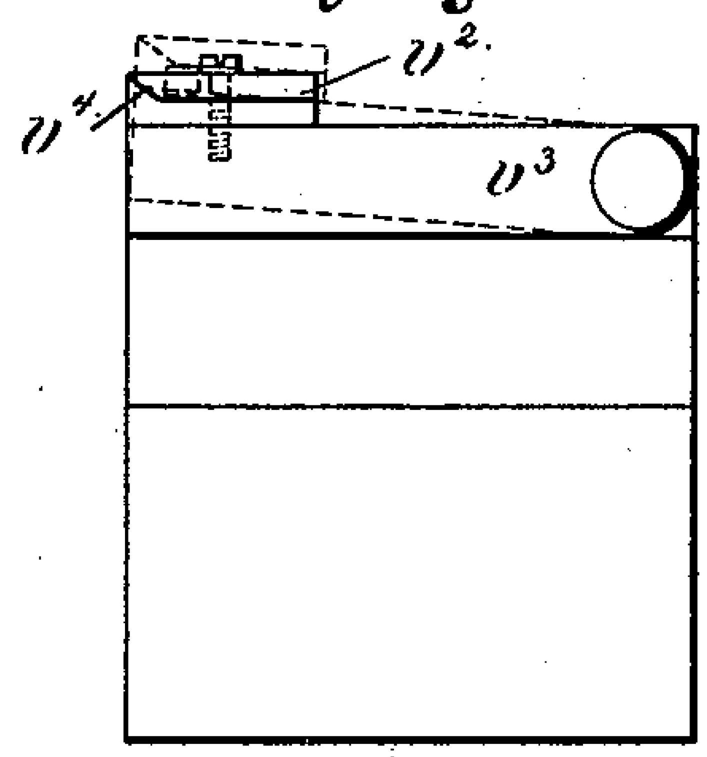


Fig. 22

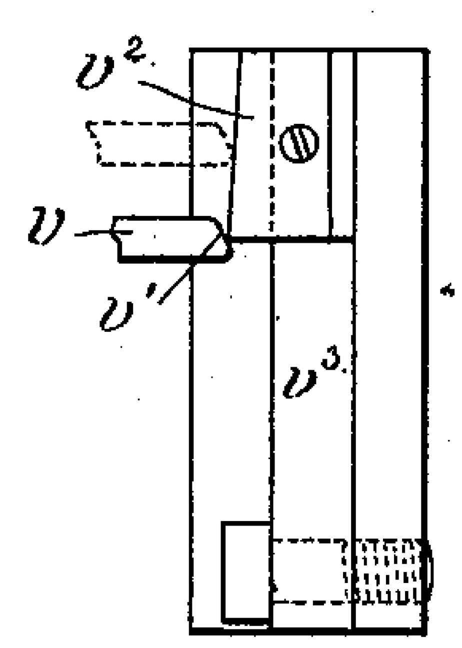


Fig. 23

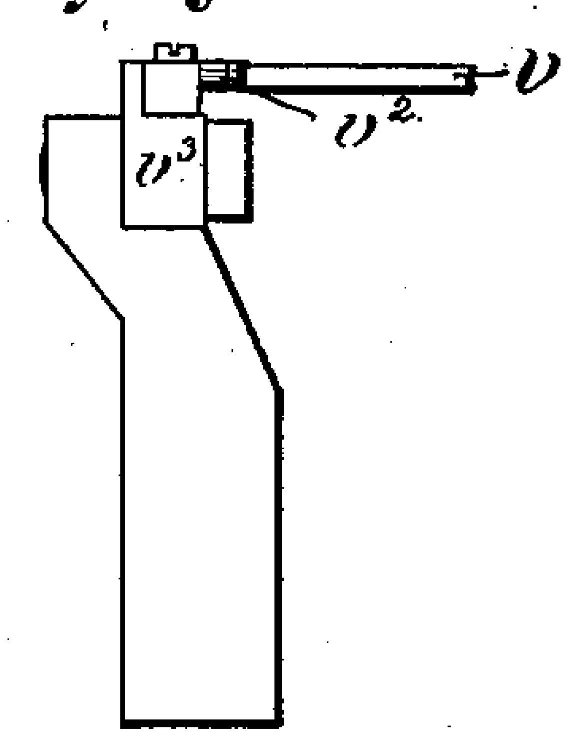
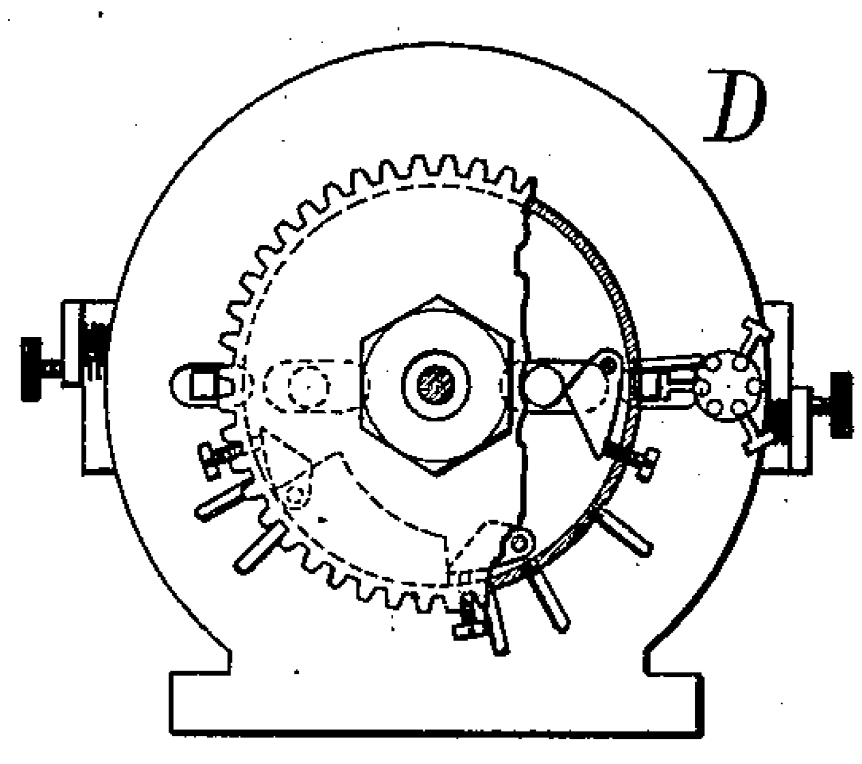


Fig. 24



Witnesses

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(No Model.) 9 Sheets—Sheet 9.

L. P. SMITH.

METAL SCREW MACHINE.

No. 321,059. Patented June 30, 1885.

Fig. 25

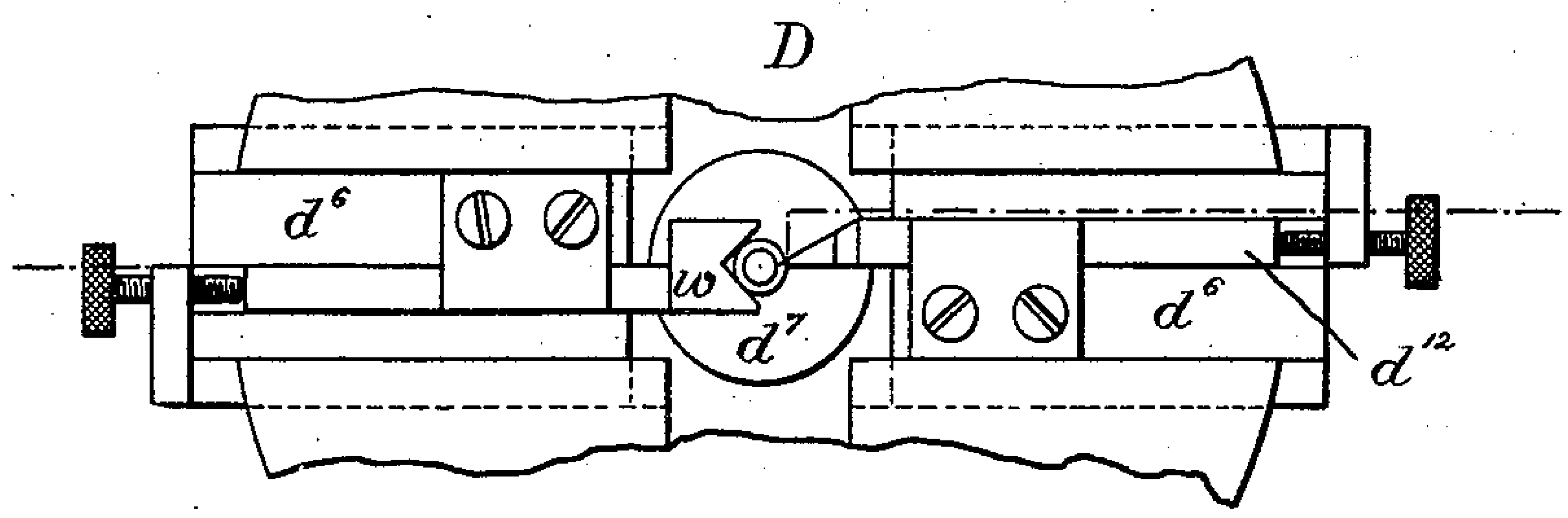


Fig. 26

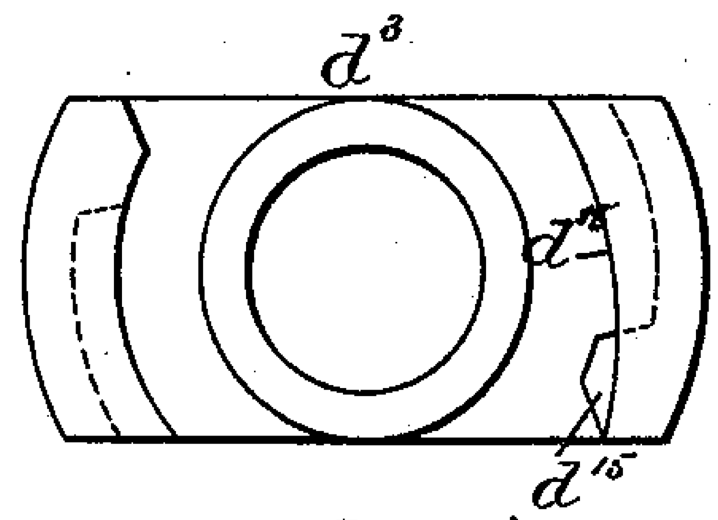
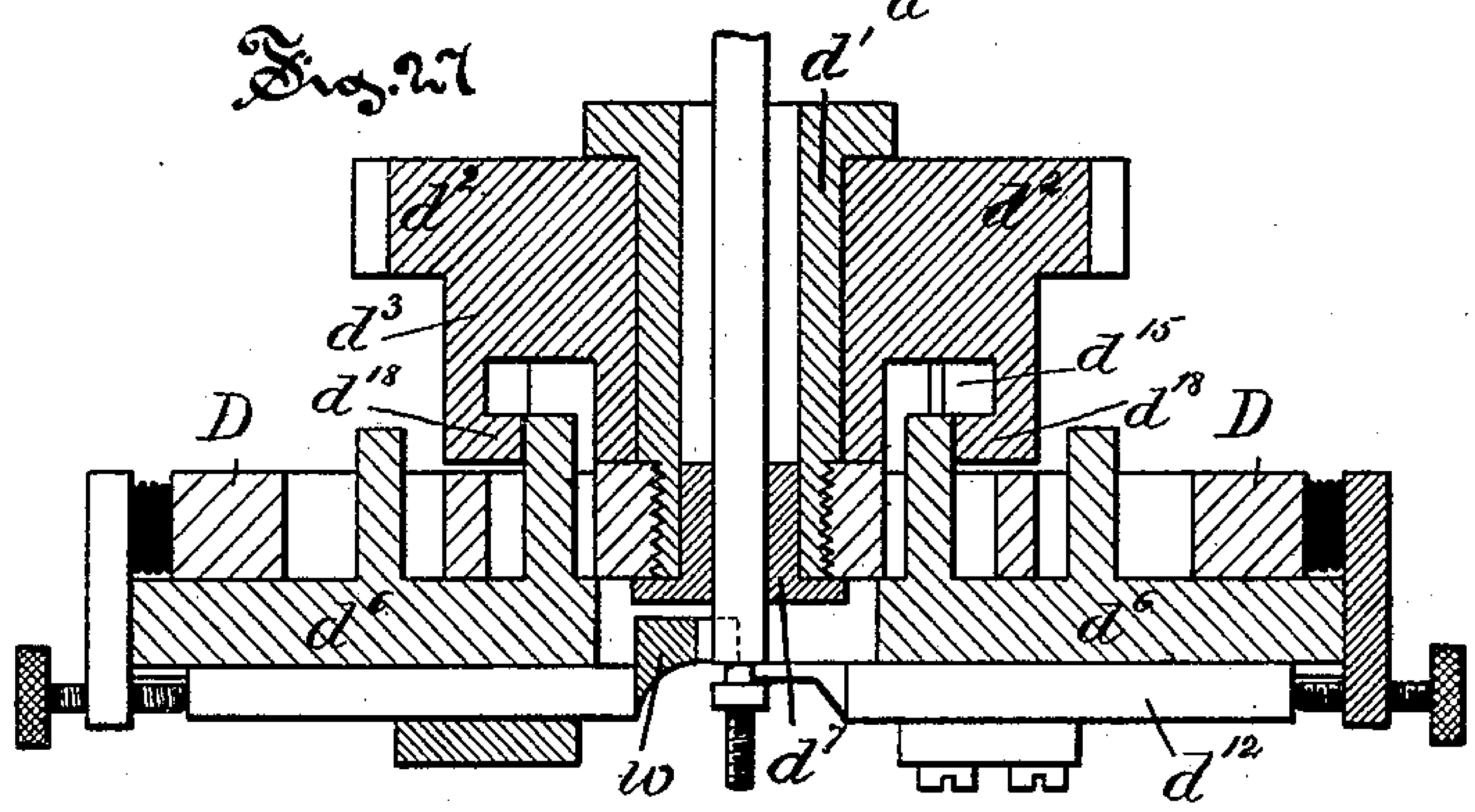


Fig. 27



Witnesses

W. M. [illegible]

E. F. Dimock.

Inventor

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UNITED STATES PATENT OFFICE.

LUCIEN P. SMITH, OF HARTFORD, CONNECTICUT, ASSIGNOR OF ONE-HALF TO GEORGE BEST, OF SAME PLACE.

METAL-SCREW MACHINE.

SPECIFICATION forming part of Letters Patent No. 321,059, dated June 30, 1885.

Application filed September 8, 1884. (No model.)

To all whom it may concern:

Be it known that I, LUCIEN P. SMITH, of Hartford, in the county of Hartford and State of Connecticut, have invented certain new and useful Improvements in Machines for Making Metal Screws; and I do hereby declare that the following is a full, clear, and exact description thereof, whereby a person skilled in the art can make and use the same, reference being had to the accompanying drawings, and to the letters of reference marked thereon.

Like letters in the figures indicate the same parts.

Figure 1 is a view in side elevation of my improved machine. Fig. 2 is a top view of the same. Fig. 3 is a view in end elevation of the machine, showing particularly the relative arrangement of the various feed-levers and the pin-disk operating those levers. Fig. 4 is a detail view in side elevation of a part of the end of the machine, looking from the side opposite to the point of view of Fig. 1. Fig. 5 is a view in central vertical section through the machine. Fig. 6 is a view in vertical cross-section of the machine on plane denoted by line x x of Fig. 1, looking toward the main driving-pulley. Fig. 7 is a view in vertical cross-section through the machine on plane denoted by line y y of Fig. 1, and looking toward the pulley-head. Fig. 8 is a detail face view of the revolving cam-arm removed from the tool-head. Fig. 9 is a detail side view of the same, looking from the left of Fig. 7. Fig. 10 is a detail view in cross-section of the bed of the machine and through the die-holder and slotter-shafts on plane denoted by line x' x' of Fig. 2. Fig. 11 is a detail longitudinal section of a part of the sliding bar that operates the spring-catch on plane x^2 x^2 of Fig. 10, and on enlarged scale. Fig. 12 is a detail view of the stop-rod and its immediate connections as removed from the machine. Fig. 13 is a detail face view of the counting mechanism and part of the stop mechanism on enlarged scale. Fig. 14 is a detail plan view of the counting and part of the stop mechanism on enlarged scale. Fig. 15 is a detail view in cross-section of part of the machine, illustrating the operation of the mechanism to stop the machine after a specified number of screws have been cut. Fig. 16 is a detail view in cross-section of the counting-disk and connected worm-gear on plane x^3 x^3 of Fig. 13. Fig. 17 is a diagram view of part of the stop mechanism, showing the feeler before it is lifted. Fig. 18 is a diagram view of the same parts, showing the feeler lifted, finding the screw, lifting also the arm to prevent stopping the machine. Fig. 19 is a diagram view showing the feeler lifted, and, owing to the absence of the screw, allowing the arm to remain down and the machine to be stopped. Fig. 20 is a detail face view showing part of the tool-head and part of the bed of the machine with the bracket supporting the taper device. Fig. 21 is a detail view of the taper device on enlarged scale, looking outward from the center of the machine. Fig. 22 is a detail plan view of the top of the bracket and the taper-block. Fig. 23 is a detail end view of the parts shown in Fig. 22, looking from the side opposite to that shown in Fig. 20. Fig. 24 is a detail view in elevation of an alternate form of tool-head and cam for operating the sliding tools, a single cutting-tool being used with a cam-disk having a series of cams. Fig. 25 is a detail face view on an enlarged scale, showing a part of the tool-head and a cutting-tool and rest for the rod or stock. Fig. 26 is a detail face view of the cam-arm with cams that operate the tool and rest simultaneously. Fig. 27 is a view in horizontal section of the parts shown in Fig. 25.

My invention relates to the class of machines adapted to making metal screws; and it consists in certain devices, and also in combinations of the same, for automatically doing this work in the manner and by the means as more particularly hereinafter described, the improvements being made in the feeding, forming, stopping, and counting mechanisms.

In the accompanying drawings, the letter A denotes the frame of the machine, preferably of cast-iron, and having standards a, that support the bed B, rising from which are standards b, supporting in suitable bearings the hollow rod-spindle C. Fast to the latter is a pulley, c, arranged to be driven by a belt, c', from any suitable counter-shaft, and on the inner end of the spindle is attached a chuck, c^2.

The tool-head D is arranged in a plane at right angles to the axis of the rod-spindle and with its center in line with the axis. This tool-head is supported on and moves with the sliding frame d that is reciprocated on the bed B by means of the levers e' e^2, that are pivoted in brackets a', fast to the end of the frame A. These levers are moved by means of the projecting pins e^3 e^4, that are adjustably attached to the rotary disk E, that is fast to the end of the main or feed shaft F. This feed-shaft F is supported in bearings in the standards a, and is arranged below the bed B, with its axis in the same vertical plane with that of the rod-spindle C. A worm-gear, f, is secured to the feed-shaft on the end opposite to that bearing the pin-disk E, and is in mesh with a worm, f', on the worm-shaft f^2. This worm-shaft f^2 is borne in bearings f^3, and is set transversely of the feed-shaft and the bed of the machine. It bears, on an end that projects beyond the frame A, a sliding pulley, f^4, that turns freely on the shaft, except when in contact with a clutch, f^5, fast to the shaft and of any ordinary construction. The pulley has, in the surface of a tubular extension from its outer side, an annular groove, f^6, in which plays a friction-roller that is on the upper end of a shifter-lever, f^7, whose lower end is pivoted to a part of the bed-frame, and which lever is operated by the sliding stop-rod R. (See Figs. 6 and 12.) The spiral spring f^8, arranged between a collar on the worm-shaft f^2 and the outer face of the pulley f^4, tends to keep the pulley constantly in contact with the clutch, so as to drive the feed-shaft F; but when the pulley is at the outer limit of its play the pins f^9, projecting from the side of the pulley, strike the arm of the pivoted bell-tongue f^{10} and cause the hammer to strike and ring the bell f^{12}. The belt c' slips on the pulley c and fails to turn it, except when the roller g, held on the upper end of the lever g' of the belt-tightener, is pressed against the belt. This lever is pivoted to the frame, and has its lower end bent partly around the shaft F, so that an upward-projecting arm, g^2, (see Fig. 6,) is in position to be struck and moved by a pin, g^3, that projects from a hub fast to the feed-shaft F. This hub also bears the projecting lug g^4, that operates the brake-lever g^5, that is pivotally connected to the bed, so that its upper arm, g^6, may be pressed against the face of the pulley, when the cam-lug throws the lower end of the lever outward. The spring g^7, fast at one end to the frame and at the other to the lever g', holds the roller against the belt, and thus causes the belt-tightener to operate, except when the pin g^3 strikes the arm g^2 and throws the roller away from the belt, and as soon as the roller is thus thrown back the cam-lug g^4 operates the brake and stops the rotation of the pulley and rod-spindle. The chuck c^2 is made up of a tubular body, c^3, slotted for part of its length to form spring-arms c^4 and fastened within the hollow spindle C at its inner end. These arms bear jaws c^5, on the backs of which are lugs c^6, that extend through slots in the inner end of the spindle C and have sloping cam-surfaces, upon which the adjustable pins c^7 are moved by the sliding of the sleeve c^8, in which those pins are each seated in a threaded socket. The chuck-sleeve c^8 fits upon the outside of the rod-spindle C and is reciprocated by the lever c^9, that is pivoted to the bed B, with its upper end in an annular groove, c^{10}, in the sleeve, its lower end projecting below the bed in position to be operated by the cam-slot c^{12} in the outer end of an arm, c^{13}, that is secured to the feed-shaft F. (See Figs. 1 and 5.)

The letter d' denotes a hollow stem, that is secured in the tool-head D and holds between a shoulder on the stem and the back of the tool-head a rotary gear-wheel, d^2, free to turn on the stem, and having a hub bearing a cam-arm, d^3. This gear-wheel d^2 is in mesh with an idler, d^4, that is pivoted to the frame and is in mesh with and driven by a cog-wheel, d^5, fast to the feed-shaft F. The idler d^4 is of sufficient width to permit the gear-wheel d^2 to slide some distance without being thrown out of gear. Sliding tool-holders d^6 are seated in radial slots in the face of the tool-head D, and these holders may be of any desired number, as they are so arranged as to operate in succession upon the rod as it is moved through the central opening in the head. To hold the rod from being pushed aside by the tool in cutting, a bushing, d^7, with a bore closely fitting the rod, is fastened in the hollow stem, and these bushings can be changed with the rods, each size having a suitable bushing.

In the machine as illustrated, the head is fitted with four tools—a reducing-tool, d^8, a shoulder-cutter, d^9, a head-former, d^{10}, and a cutting-off tool, d^{12}, and a description of the construction and operation of one will do for all. The holder of each tool (except the cutting-off tool) as thus arranged in series has two arms, d^{13} and d^{14}, that extend through slots in the head; but when the cutting-off tool is opposite a rest for backing up the work, it likewise has the two arms, as shown in Fig. 27. The arm nearest the axis of the stem is rounded in cross-section, and extends far enough through the head to be struck and moved by a cam, d^{15}, on the cam-arm d^3, and this pulls the holder far enough inward for the square arm d^{13} to be caught under the lower end of the short arm of the bent latch d^{16}, that is pivoted on the back of the head. The long arm of each latch is curved for convenience, and has a longitudinal slot, along which a pin, d^{17}, is adjustable. A finger with a sloping end projects radially from the cam-arm d^3, and its end strikes the pin as the arm revolves, and, throwing the long arm of the latch outward, releases the arm of the holder and allows it to be thrown outward by a spring suitably attached to the head and each holder. A lateral extension, h', from this cam-arm bears a cam on its under side, (next the head,) that, striking a pin on the back of a sliding bolt, h^2, (see Fig. 1,) pulls it in and holds it firmly upon the rod, forming what I term the "clamp" h. This clamp h grasps the rod within the head just as the cutting-off tool has cut off a screw-blank, (see Fig. 1,) and at this moment, by the means already described, the clamp c^2 releases the rod that till now has rotated with the rod-spindle, and this may be done without stopping the rotation of the latter. In my machine the rod turns while the various tools are forming the blank and the tool-head is being moved along the rod by the pins e^3 on the disk E, striking in succession the face of the removable cam-block e^5, that is attached to the lower end of the feed-lever e'. The upper end of this lever bears an adjustable pin, e^6, in a threaded socket, and the end of this rests against the back of an arm, e^7, that rises from the sliding frame d, on which the tool-head is supported. The pin e^4 on the back of the rotary disk E strikes the cam e^8 on the return-lever e^2, and causes it to move the slide d back again by pressure of the upper end of the lever against the pin e^9 on the side of the arm e^7, and as this pressure from the return-lever e^2 is applied just after the clamp h has grasped the rod the latter is moved with the tool-head, thus drawing forward the desired length of stock or rod. When the tool-head stops, the extension h' on the cam-arm that operates the clamp slips off the pin on the back of the bolt h^2, and the bolt, flying back under the impulse of a spring releases the rod. At the same time the lever c^9, moved by the cam c^{12} on the arm c^{13} borne on the feed-shaft, has moved the sleeve c^8 forward and caused the chuck-jaws to regrasp the rod. The belt-tightener, by the means already described, tightens the belt c', and the brake is thrown off by the means already described, so that the rod is rotated. The cam d^{15} on the revolving arm d^3 now engages the pin d^{14} on the back of the holder of the reducing-tool and forces it inward until the latch d^{16} catches over the square arm d^{13}, and thus holds the cutting-tool in position to reduce the body of the rod to the proper diameter. The latter is determined by the adjustment of the tool in the holder. As soon as the reducing-tool has been brought to this position the tool-head, by the rotation of the pin-disk E and the means already described, (and the head,) is fed along the rod longitudinally, the bushing sliding along the rod. As the arm d^3 continues to revolve the tools for forming the shoulder and the head and the cutting off blade are successively brought into operation on the rod until a screw-blank is completed from the stock at the forward end of the rod. The thread on the screw-blank is cut by means of a die, i, that is removably secured to the end of a die-spindle, I. The latter is supported in bearings in a standard, b', rising from the bed B, (see Fig. 5,) having its axis in line with the axis of the rod-spindle and the center of the opening through the tool-head. This die-spindle has a rotary and also a longitudinal movement in its bearings, the clutch part i' being splined on the spindle and the pulley part i^2 sliding as well as turning freely on the spindle. These latter parts are arranged on the spindle between the upright arms of the bearing, and the spindle is limited in its backward play by a shoulder, and held in a retracted position normally by means of a spiral spring, i^3, thrusting against the bearing, and a collar, i^4, on the rear end of the spindle. The pulley i^2 is, by a belt, driven in the same direction with the rod-spindle C, and the fixed part i' of the clutch bears a ratchet-tooth, i^5, that, when resting upon the pawl i^6, prevents the rotation of the spindle. The die-spindle I is moved forward by means of the feed-lever I', that is pivoted to the end of the machine in a substantially vertical plane, and bears on its lower end a removable cam that is operated by a pin projecting from the rotary disk E.

A yielding pressure of the lever upon the spindle is obtained by means of the pin i^7, having a threaded stem fitting in a socket in the lever and its forward end moving in a socket in the rear end of the spindle, while a spring is located between the rear end of the spindle and a shoulder on the pin. While the spindle is held by the pawl against rotation, it is thrust forward by the lever I' and connected mechanism and forces the die i against the end of the rotating rod. As soon as the teeth of the die begin to cut, the pitch of the thread serves to draw the die forward until the collar i^4 on the die-spindle comes in contact with the pin projecting from a disk on the rear end of a sliding rod, i^8, (this disk is seen in plan view in Fig. 3,) whose front end (shown in section in Fig. 10) is wedge-shaped and may be thrust behind the pawl, so that it throws it out from the ratchet and leaves the die and its spindle free to revolve with the rod. At this point a cam, i^9, on the periphery of the disk E has, by contact with the lower end of a pivoted lever, i^{10}, whose upper and forked end is in contact with the rear side of the loose pulley i^2, moved the latter forward, engaging the clutch and causing the die-spindle to rotate in the same direction with the rod, whose rotation has been stopped by the release of the belt-tightener and application of brake. The result of this is that the die, withdrawn from the screw by the backward pull of the spring i^3, resumes its first position. In order, however, to prevent the tooth on the ratchet from engaging with the pawl before the clutch parts are disengaged, another cam, i^{12}, on the periphery of the disk e lifts the arm of a lever, i^{13}, and forces this upper arm against the disk on the rear end of the sliding rod i^8. This latter cam is longer than the first, (see Fig. 3,) and it holds the pawl out of contact with the ratchet until the loose part i^2 of the clutch has disengaged from the fixed part i', and when the latter is turning by inertia only the pawl is released and stops it with but little jar. After the die i has thus cut the thread on the screw-blank the cut-off mechanism separates the screw from the rod; but while this is being done the slotting mechanism is in operation.

The letter k denotes an adjustable pin on the rotary disk E; K, a slotter-lever pivoted to the frame A, with its upper end in contact with the rear end of the cam-sleeve L, that is held from rotation in the bearing b^2 by means of a pin fixed in the latter, and taking into a slot, l, in the sleeve. The latter is held in contact with the lever by means of the spring l', compressed between the bearing and a shoulder, l^2, on the sleeve.

The letter M denotes the cylindrical slotter-shaft that moves freely within the sleeve L, and is supported also in the bearing b^3, on the front side of which rests the arm m, bearing at its outer end a holder, m', whose central line is at a distance from the axis of the shaft M equal to the distance between the latter and the axis of the die. This arm is held outward and horizontal by means of the spring m^2, and a pin, m^3, projects from shaft M, just back of the bearing b^3. The slot b^4 within the bearing is closed at its rear end by a spring-stop, b^5. (See Fig. 2.) The front end of the sleeve L is beveled to form a cam, l^3, that, when the sleeve is thrust forward by the lever, strikes the pin m^4 on the shaft M and rotates the latter to the right until the holder m' is directly in front of the screw-blank. The slotter-lever K' is then operated by a pin, k', on the disk E, sliding against a cam-block on the lever, and the slotter-shaft is moved up so that the screw-blank is embraced by the holder m', the arm being guided by the pin m^3, that moves in the slot b^4 in the bearing. At this moment the screw-blank is cut completely from the rod, and the pressure of the pin k' on the lever K' being removed, the shaft is drawn back, and as soon as the pin m^3 leaves the slot b^4 the shaft is thrown over by the spring m^2, carrying the screw in the holder over to the first position of the latter. In this position the axis of the holder is in the plane of a saw, n, that is mounted on a shaft, n', held in a bearing in the standard b^6, and bearing a pulley, n^2, driven by a belt, n^3, from the pulley f^4. (See Figs. 1 and 2.) Another pin, k^3, on the disk E now strikes the cam on lever K', and its upper end pushes on the slide-rod m^5, that, by means of a sloping projection, throws the spring-stop back so as to uncover the slot b^4. The lever also thrusts the shaft M forward, and carries the head of the screw in the holder against the saw that then slots it. A pin, p, on the periphery of the disk E, strikes the lower slope of the bend in the swinging extractor-rod p', thrusts the extractor forward and holds it there until the lever K' has released the shaft M, which in its return draws back the holder against the extractor that enters it and thrusts out the screw, and then resumes its first position under pull of the spring p^2.

The stop mechanism.—The stop mechanism has three functions: First, to stop the machine when the rod has been used up; second, to stop it as soon as a predetermined number of screws has been cut, and, third, when the belt breaks. The stop-rod R is attached to one side of the machine in the horizontal plane of the feed-shaft F, and has a sliding movement only in the bearings a^2, that are fast to the sides of the uprights a. The stop-rod is parallel to the feed-shaft except at the end near the driving-pulley f^4, where an offset, r, is formed, so that the cam-block r' is in contact with the side of the shifter-lever f^7 in such position that when the stop-rod is slid toward that end of the machine the lever is thrown outward and the pulley f^4 is disengaged from the clutch and turns freely on the worm-shaft, thus stopping the feed-shaft F. In its normal position the stop-rod is held back by the spiral spring r^2, and it is returned to this position by the spring as soon as any temporary force that has slid it is removed. The stop-rod may be moved by hand to stop the machine by means of the stop-lever R', that is pivoted to the frame of the machine, and in its movement strikes a pin, r^3, that projects laterally from the stop-rod. The lower arm of the belt-tightener lever g' is moved outward by the spring g^7, and this pushes a beveled part on the lever against a cam-block, r^6, fast to the stop-rod, (see Fig. 12,) and so slides the latter as to stop the machine. The stop-rod turns freely in the outer end of the arm r^4, that is held against sliding motion on the rod, and the inner end of this arm rests on the upper side of a collar, q, that, fast to the feed-shaft F, bears a pin, q', that projects radially from the periphery of the collar. This inner end of the arm r^4 bears on its lower side a cam, with its working-face in a vertical plane and arranged obliquely across the feed-shaft F. When the pin q' in the rotation of the feed-shaft strikes the cam on the arm r^4, the arm is pushed aside, and being rigid carries with it the stop-rod, so as to stop the machine, as before described. In order to prevent such stopping at every rotation of the feed-shaft, the inner end of this arm r^4 must be lifted out of the path of the pin q', and this is done by the feeler mechanism S. The feeler s is a bent lever pivoted at its angle to a bar, s', that is pivoted also to an upright of the frame, and the vertical part of the feeler extends upward through the bed B, and ends just below the line of the axis of the rod-spindle and in front of the tool-head. The foot of this upright part of the feeler rests on a collar, s^2, fast to the feed-shaft F, and the collar s^2 bears a cam, s^3, arranged to lift the feeler at a certain period of the rotation of the feed-shaft. The horizontal short arm s^4 of the feeler extends toward the arm r^4, and under the horizontal part of the vertical tilter r^5, that is pivoted to the inner end of the arm. The operation of this automatic stop device is as follows, (see Figs. 17, 18, 19:) Just previous to the forward motion of the die to cut a thread on the screw-blank the feed-shaft F in its rotation lifts the feeler s by the cam s^3 until the arm s^4 is caught under the tilter r^5. The upper end of the feeler strikes the point of the screw-blank, and as the feeler cannot tilt any farther its continued upward motion imparted by the cam s^3 causes it to lift the arm r^4 and the cam on its under side out of the way of the pin q'. The cam then passes from under the feeler s, which falls and pulls its upper end out of the way of the die, that is then moved forward to cut the thread on the blank. If no screw-blank projects from the end of the rod the upper end of the feeler tilts so far forward that its short arm cannot lift the arm r^4 out of the path of the pin q', which then operates on the cam to stop the machine in the manner before described.

The counting mechanism T (see Figs. 1, 7, 13, 14, 15, 16) is operated in connection with the feeler mechanism, and in the former the letter t denotes a worm-gear, pivoted by the thumb-screw t' to a vertical part on the side of frame B. t^2 is a worm-shaft bearing a worm, t^3, in mesh with gear t, and a ratchet-gear, t^4, that is rotated by a pawl, t^5, on the pawl-lever t^6. The latter is pivoted at its outer end on the worm-shaft t^2, and its inner end rests on the arm s^4, just in front of the tilter r^5, so that the lifting of the feeler s turns the ratchet-gear t^4 by means of the pawl t^5. (See Fig. 7.) A counter-disk, t^7, is seated in a socket in the face of the gear-wheel t, and pivoted on the same screw t', by means of which the disk can be clamped to the gear-wheel t, so as to turn with it. (See Fig. 16.) A cam-lug, t^8, projects from the disk t^7, near its rim, and the face of the disk is graduated to ten thousand in spaces of one thousand each. Of course this number is not material; but for convenience it is used, and the ratchet-gear t^4 has fifty teeth, so that it makes twenty rotations to each division of the counting-disk. The index-finger u' is borne on the end of a bent lever, u, and in its normal position is in the path of the lug t^8. The bent lever is pivoted at its angle to the bed and swings in the plane of the worm gear-wheel t, with one leg, u^2, projecting downward near the side of the ratchet-gear t^4, (see Figs. 1 to 13,) and connected by a rod, u^3, to the upper end of the tilter r^5 on the arm r^4. The leg u^2 of the bent lever u is of spring-steel, and when the lug t^8 on the counter-disk lifts the finger u', and swings the leg u^2 into the path of the pin t^9, that projects from the side of the ratchet-gear t^4, this pin springs the leg u^2 outward, and pulls the tilter r^5 out of the way of the arm s^4, on the feeler, so that it fails to lift the arm r^4. The result of this is that the machine is stopped by the pin q', moving this arm and the stop-rod.

To set the automatic counter, the thumb-screw is unscrewed, the pawl then raised, and the pin t^9 on the ratchet-gear is set just past the leg u^2 of the bent lever by turning the ratchet-gear. The counter-disk is then rotated until the index-finger points to the desired number on the disk, and the thumb-screw is then clamped. The machine, after making this number, will be stopped by the lug t^8 in the manner already described. The number of stopping-pins in the side of the ratchet-gear may evidently be increased so as to more readily determine the number and adjust the counter.

Taper-forming attachment.—On the side of the machine, opposite the counting device, and along the path of the sliding head D, a taper-forming device, V, is attached to a bracket on the bed B. To the slide that bears the reducing-tool an arm, v, is attached, so as to bring its beveled outer end, v', in contact with the face of the taper-block v^2, that is removably attached to the top of a block, v^3, that is pivoted in a socket on the upper and inner face of the bracket, so as to lift at the upper end. The taper-block is undercut on a slope, v^4, so that when the end v' leaves the taper-face of the block it slips under the latter, lifts it on the backward slide of the tool-head, and lets it fall again as the arm clears it. This block falls into the path of the arm on the tool-slide, and as the end of the arm strikes the face of the block in the upward feed of the tool-head in cutting the body of the screw the point of the tool moves in a line at an angle with the axis of the screw-blank determined by the angle of the face of the taper-block with this same axis.

By using a variety of taper-blocks the screws can be made to any desired taper by changing the blocks. After the thread has been cut the screw-blank is severed from the rod by the cutting-off tool, and this latter tool is operated by the longer cam d^{18} on the arm d^3. (See Figs. 8, 9.)

Instead of using a series of tools movable radially in the sliding head, I may use the alternate device of a single forming-tool moved by a series of cams arranged in succession on the face of a revolving disk, the method of and means for moving, holding, and releasing the single tool being substantially the same as already described.

Diagram views of such an alternate device are shown in Figs. 26 and 27.

In place of the bushing to support the rod in the tool-head while the screws are being made, I may use a back rest, w, Figs. 25 and 27, and this is of especial advantage when working up stock of irregular cross-section.

I claim as my invention—

1. In a metal-screw machine, in combination, a rotary feed-shaft bearing a disk having projecting pins, and levers bearing each a cam and movable in a plane parallel to the axis of the feed-shaft, the projecting pins and the cams co-operating to translate the rotary motion of the disk into the vibratory motion of the lever, all substantially as described.

2. In a metal-screw machine, in combination, a rotary feed-shaft bearing a disk having projecting pins that are adjustable as to circular position and degree of projection, and a feed-lever movable in a plane parallel to the

axis of the shaft and bearing a cam in the path of one or more of the pins, all substantially as described.

3. In a metal-screw machine, in combination, a rotary feed-shaft bearing a disk having projecting and adjustable pins, and the feed-lever movable in a plane parallel to the axis of the feed-shaft and bearing a removable cam, all substantially as described.

4. In a metal-screw machine, in combination, a rotary hollow rod-spindle bearing a chuck, a sliding tool-head bearing a clamp, a rotary feed-shaft having a disk with projecting pins, and levers bearing cams, whereby the sliding tool-head is reciprocated, all substantially as described.

5. In combination, in a metal-screw machine, a rotary feed-shaft bearing a disk with projecting pins or lugs, the levers with cams movable by said disk, the sliding tool-head, and cog-wheel fixed to the feed-shaft and in mesh with an idler pivoted to the bed-frame of the machine, and the latter in mesh with a cog-wheel borne on a stem fast in the tool-head and bearing a cam-disk, whereby the tool-slides are operated, all substantially as described.

6. In combination, in a screw-machine, a rotary rod-spindle, with means for holding the rod or stock against longitudinal motion while the screw is being formed, a sliding tool-head, a rotary cam-arm with cams, and tools radially movable in the tool-head and advanced and released by the said cams in working, all substantially as described.

7. In a screw-cutting machine, a sliding tool-head, rotary cam-arm with cams, one or more cutting-tools, and a work-rest opposite each tool and movable by the said cams simultaneously with and in opposite direction to the tool, all substantially as described.

8. In combination, a sliding tool-head bearing a series of sliding tools, a rotary cam-arm bearing cams, whereby the tools are operated, and a locking-latch, d^{16}, all substantially as described.

9. In combination, a sliding tool-head bearing a cutting-tool, a rotary cam-arm bearing cams whereby the tool is operated, and a locking-latch, d^{16}, with an adjustable pin, d^{17}, all substantially as described.

10. In combination, in a screw-cutting machine, the rotary rod-spindle C, bearing chuck c^2, a sliding die-holder and die, with means for rotating the die after the thread has been cut by the rotation of the rod held in the spindle, feed-lever e, return-lever e', and disk E, borne on the feed-shaft F, all substantially as described.

11. In a screw-machine, in combination, a sliding die-holder bearing a clutch device, the part fixed to the holder bearing a tooth, and a pawl and trip device, all substantially as described.

12. In a screw-machine, in combination with rod-spindle C, bearing chuck c^2, the die-spindle I, with its axis in the line of the rod-spindle bearing clutch part i', pulley i^2, spring i^3, pawl i^6, and trip device i^8, with feeding mechanism, all substantially as described.

13. In combination, the cam-sleeve L, bearing cam l^3, slotter-shaft M, bearing pins m^3 m^4, slotted bearing b^3, the spring-stop b^5, the slotter-arm m, with holder m', the spring m^2, arranged on the slotter-shaft, and the slotter-feeding mechanism, all substantially as described.

14. In combination, the oscillating and sliding slotter device bearing a holder, m', and an extractor-rod, p', pivoted to the frame of the machine and operated by a pin projecting from the rotary disk E, all substantially as described.

15. In a screw-machine, in combination, the worm-shaft f, bearing the sliding pulley f^4, the shifter-lever f^7, the sliding stop-rod R, bearing block r', and the stop-lever R', all substantially as described.

16. In combination, the worm-shaft f^2, with sliding pulley f^4, and clutch device f^5, the shifter-lever f^7, the stop-rod R, and the device whereby the rod is shifted by the breaking of the belt c', all substantially as described.

17. In a screw-machine, in combination, the worm-shaft f', bearing a sliding pulley and clutch device, the shifter-lever f^7, the sliding stop-rod R, the arm r^4, bearing a cam, and feed-shaft F, bearing a pin whereby the arm is moved, all substantially as described.

18. In a screw-machine, in combination, the rotary rod-spindle C, bearing the chuck device c^2, the sliding tool-head arranged transversely of the axis of the rod-spindle and bearing a series of cam-operated tools, a die borne in a sliding holder fixed against rotation while the thread is being cut, the sliding and oscillating slotting device, the rotary saw, and the feed mechanism whereby the devices are operated, all substantially as described.

19. In a screw-machine, in combination with the stop-rod R, the feed-shaft F, bearing collar q, having pin q', the arm r^4, bearing the cam, the feeler mechanism S, the arm s^4 of which projects toward and underneath a projection on the arm r^4, all substantially as described.

20. In combination with the feeler mechanism S, the pawl-lever t^6, bearing pawl t^5, ratchet-gear t^4, fast to worm-shaft t^2, that bears the worm t^3 in mesh with worm-gear t, bearing counter-disk t^7, removably connected to the gear t, and bearing a lug, t^8, all substantially as described.

21. In combination with the feeler mechanism S, a counting mechanism, T, the bent lever u, bearing an index-finger, u', having the lug u^2, connected by a rod, u^3, to the tilter r^5, borne on the arm r^4 of the stop mechanism, and a projecting lug or pin, t^9, on the ratchet-gear, all substantially as described.

22. In a counting device, in combination with the feeler and stop mechanism, the worm-

gear t, bearing the adjustable counter-disk t^7, and means for securing the disk to the gear-wheel, all substantially as described.

23. In a screw-machine, in combination with the sliding tool-head D, the taper device V, all substantially as described.

24. In a taper device, in combination with the sliding tool-head, having a tool-holder with projecting arm v, the taper-block v^2, and the tilting-block v^3, pivoted to the bracket and having the undercut end v^4, all substantially as described.

25. In a screw-machine, in combination with the sliding tool-head, a sliding cutting-tool and tool-rest arranged in line with each other and operated in opposite directions by means of a rotary cam-block, all substantially as described.

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