No. 711,273. Patented Oct. 14, 1902.

# P. V. AVRIL.

## ENGRAVING MACHINE.

(Application filed Sept. 3, 1901.)

(No Model.) 10 Sheets—Sheet 1.

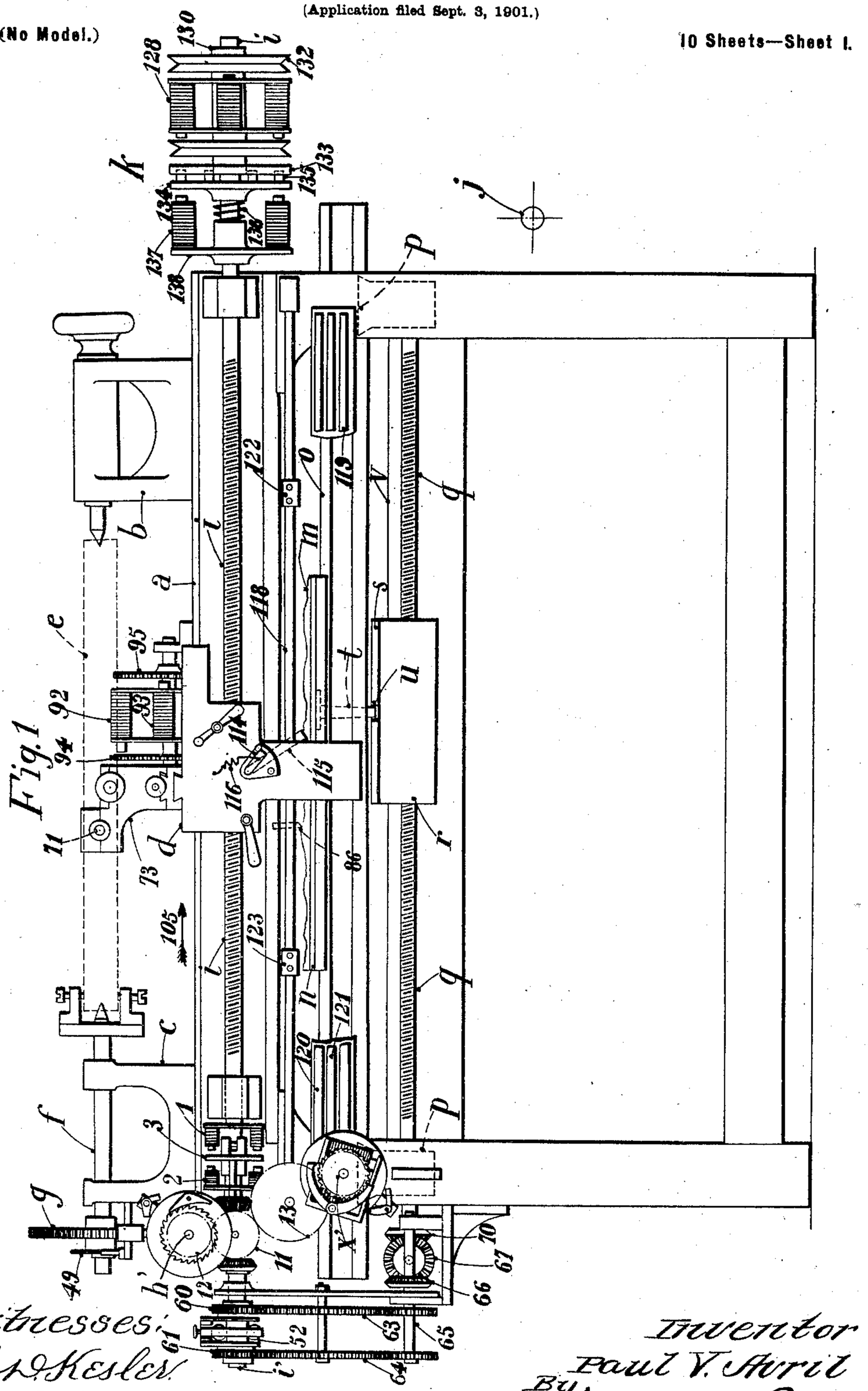

Fig. 1

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(No Model.) 10 Sheets—Sheet 2.

Fig. 2.

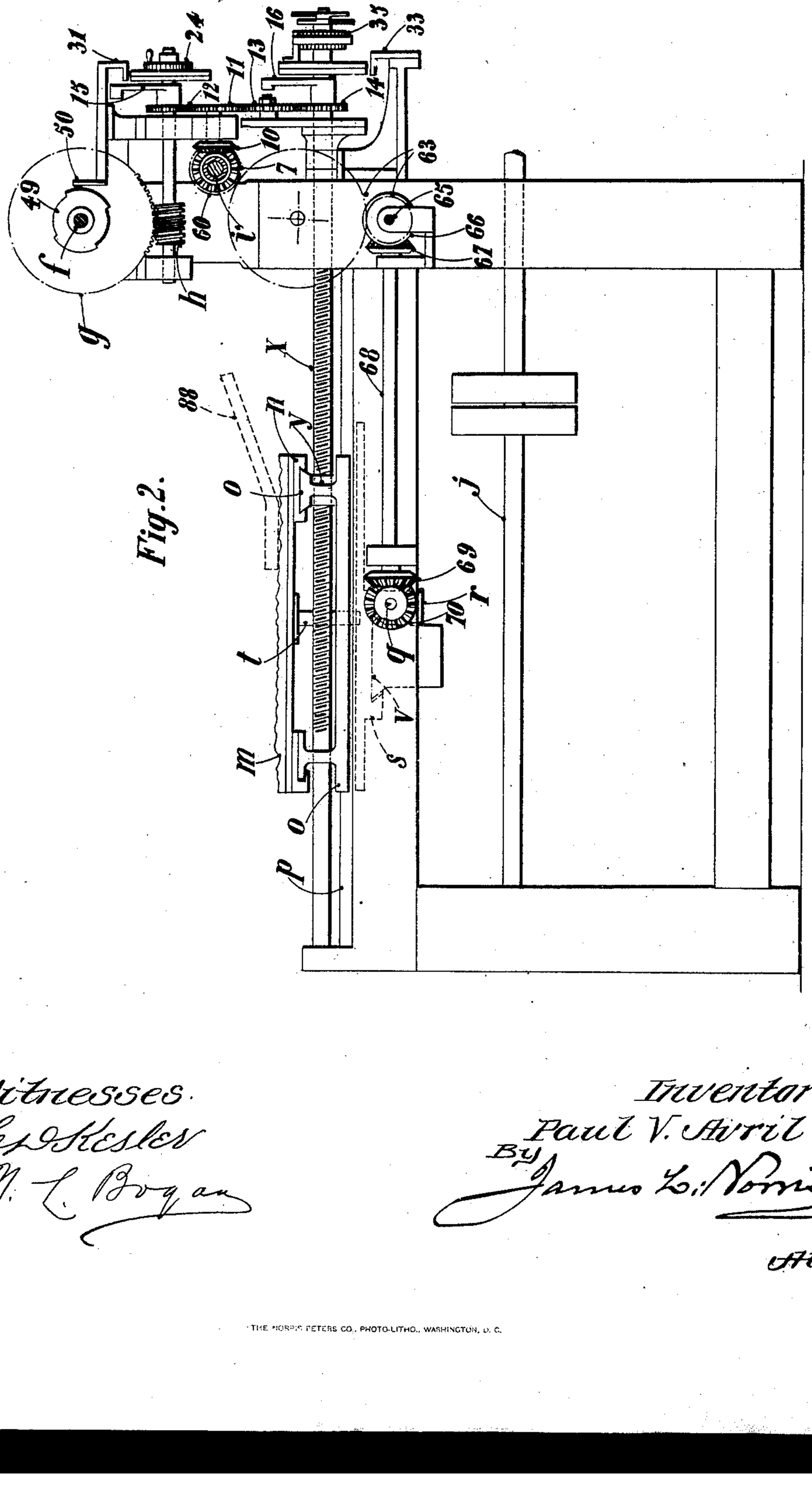


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Fig. 3.

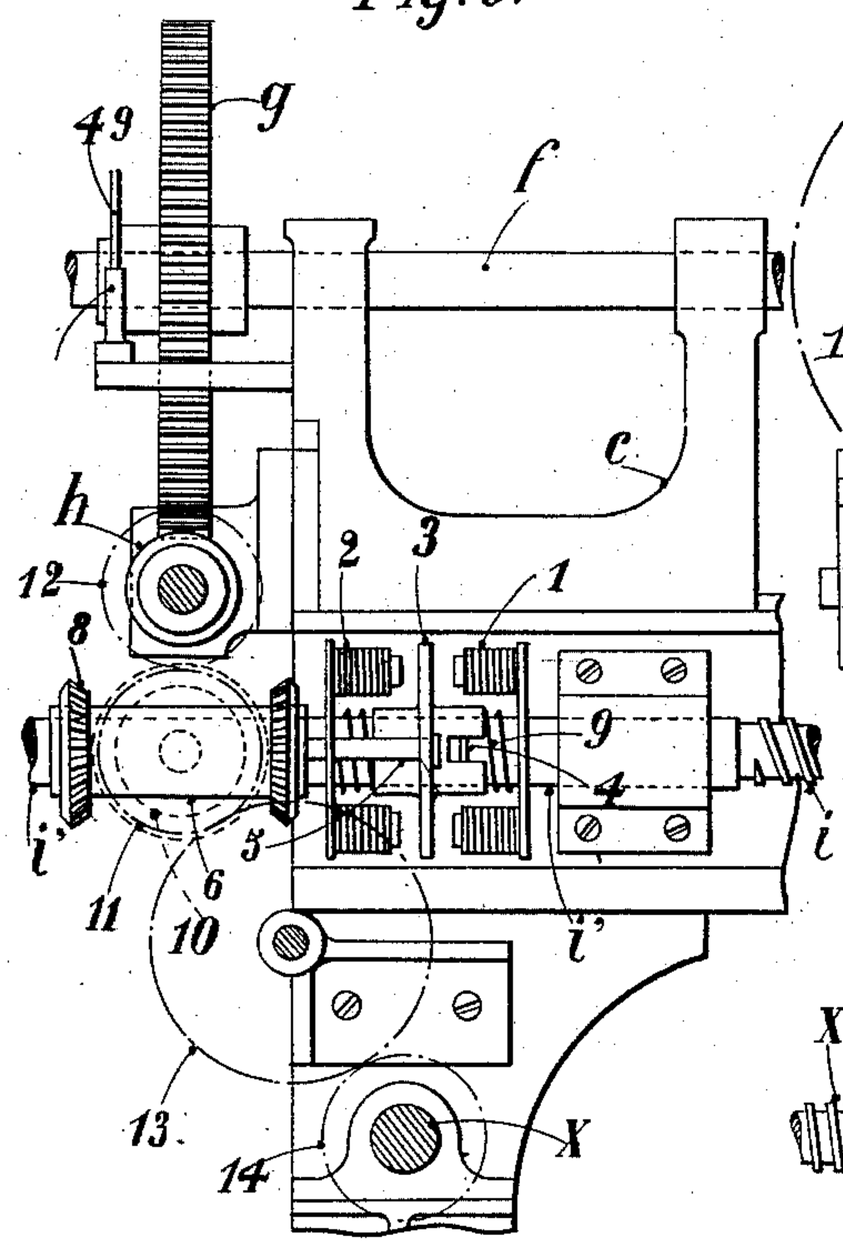



Fig. 4

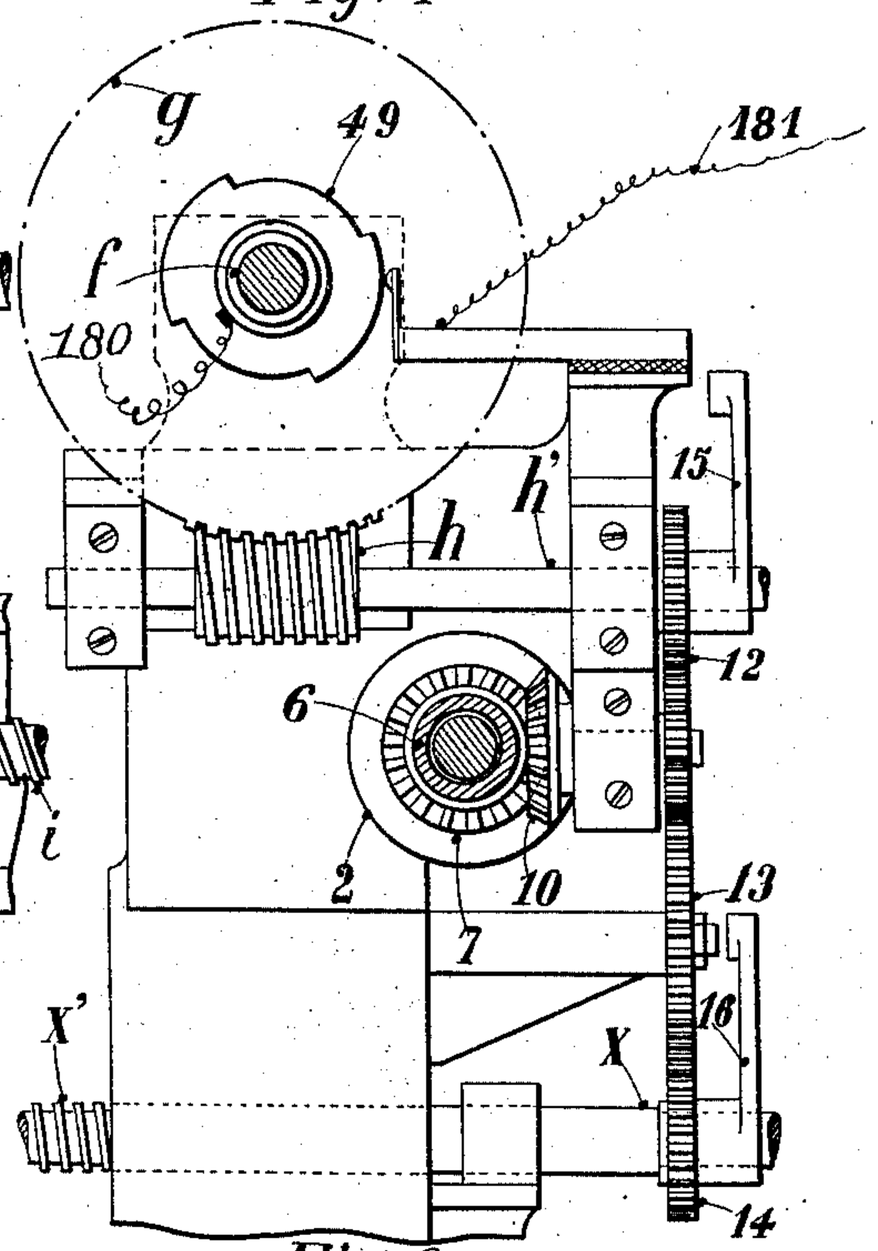



Fig. 5.

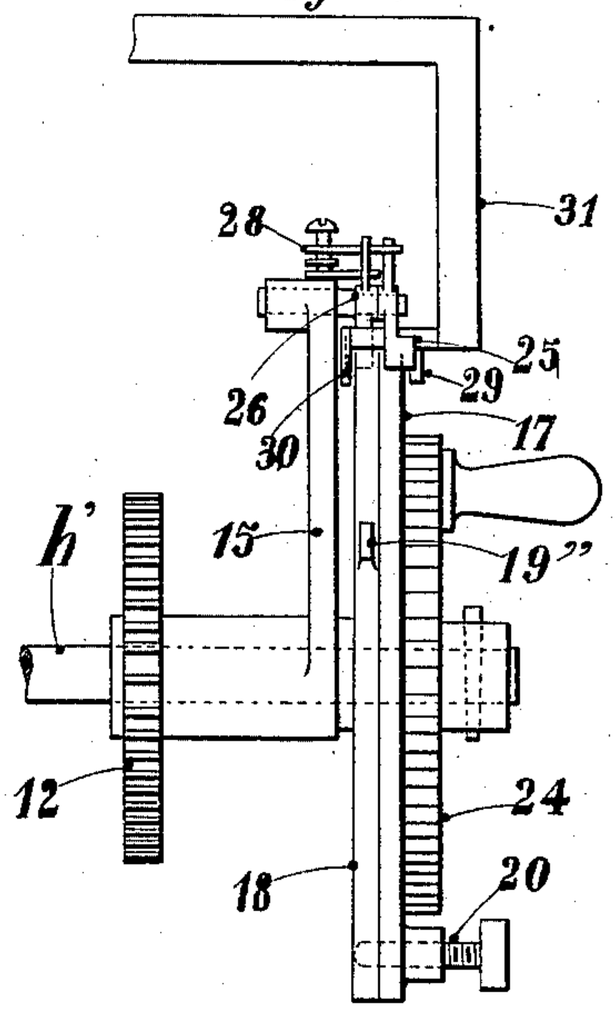
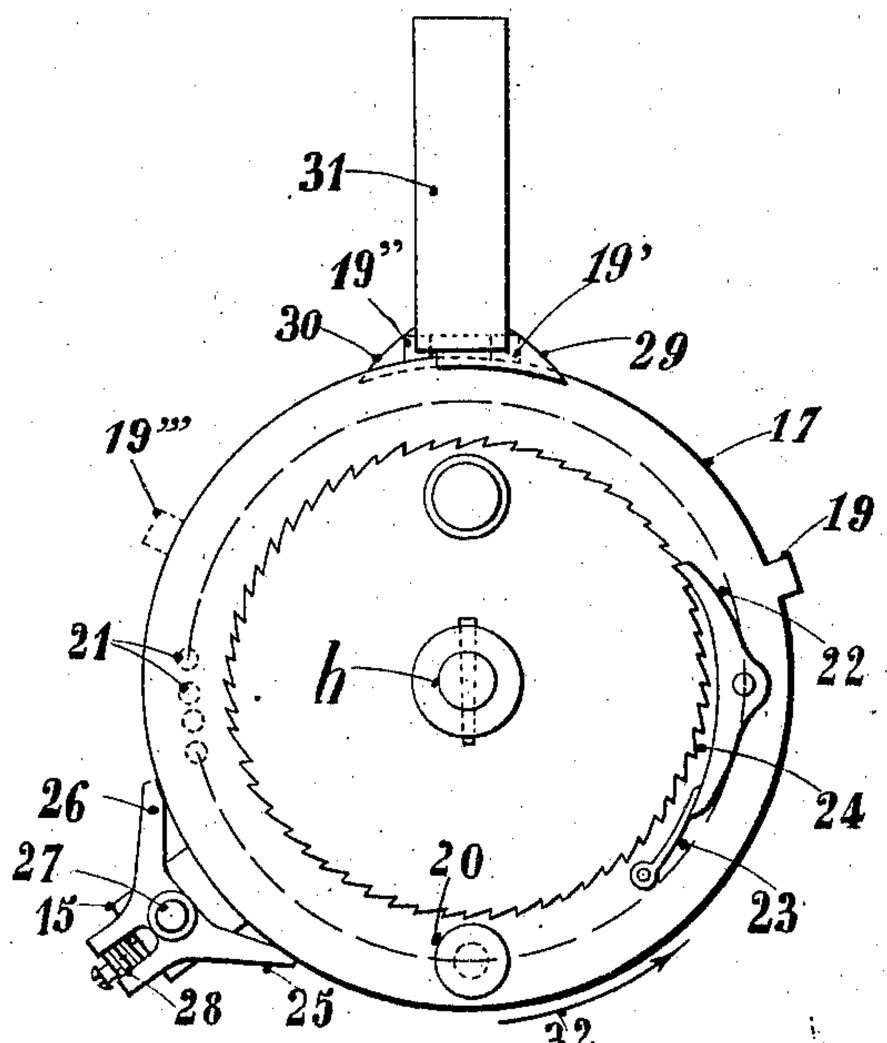



Fig. 6.

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## ENGRAVING MACHINE.

(Application filed Sept. 3, 1901.)

(No Model.) 10 Sheets—Sheet 4.

*Fig. 7.*

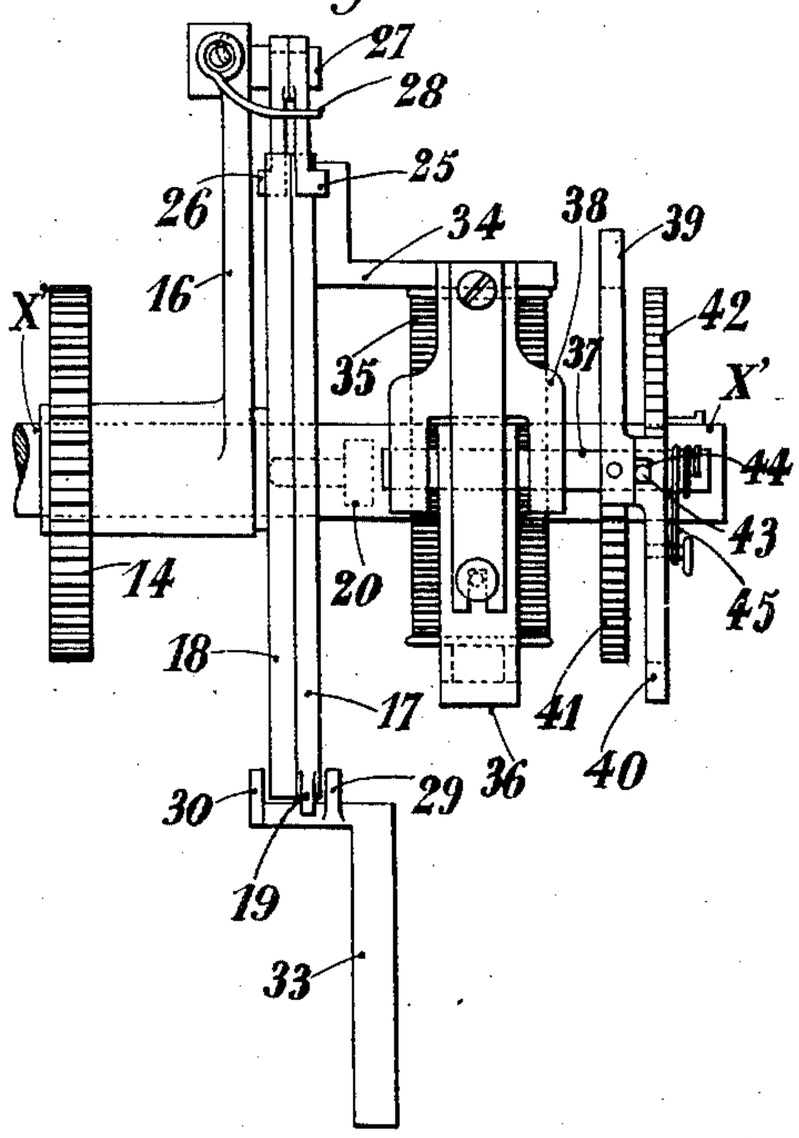



*Fig. 8.*

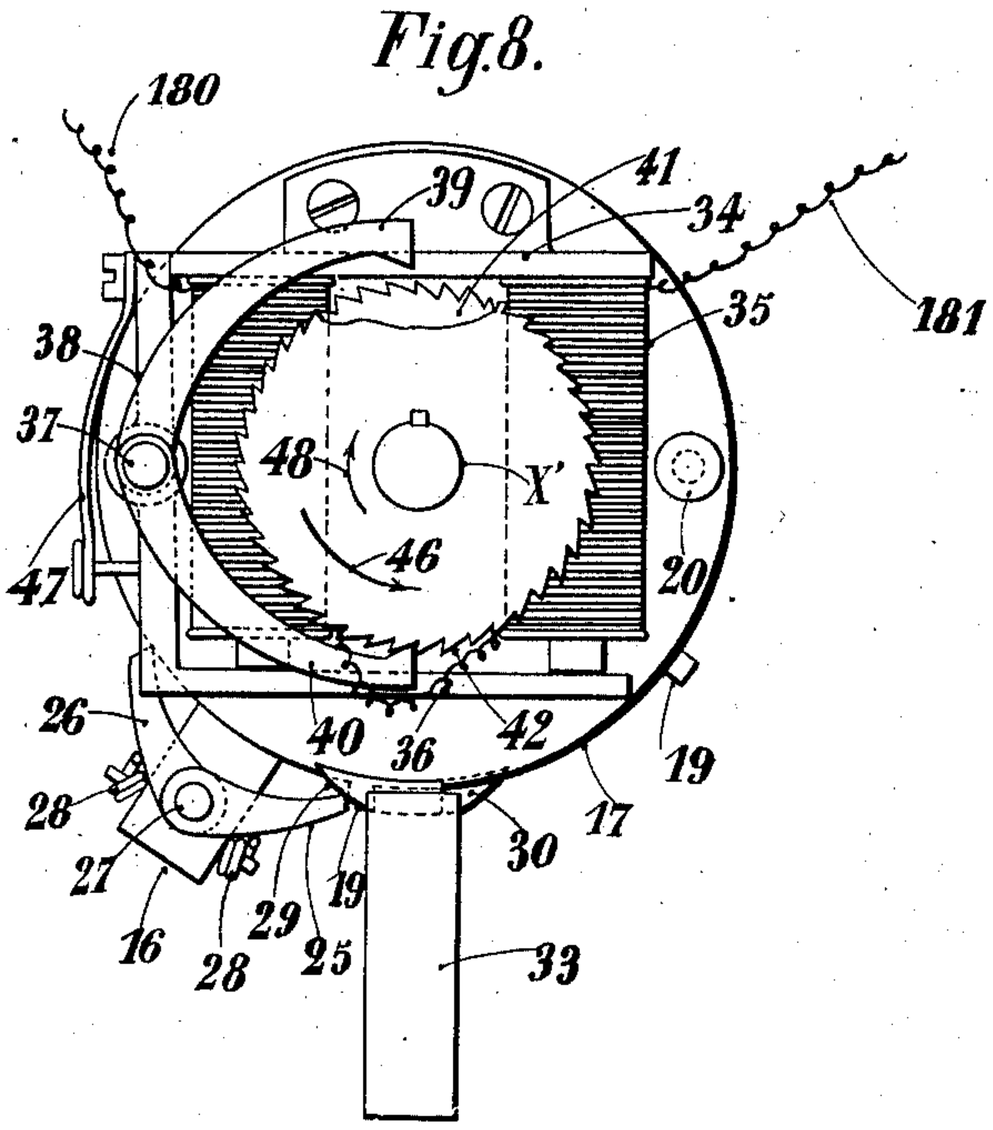



*Fig. 9.*

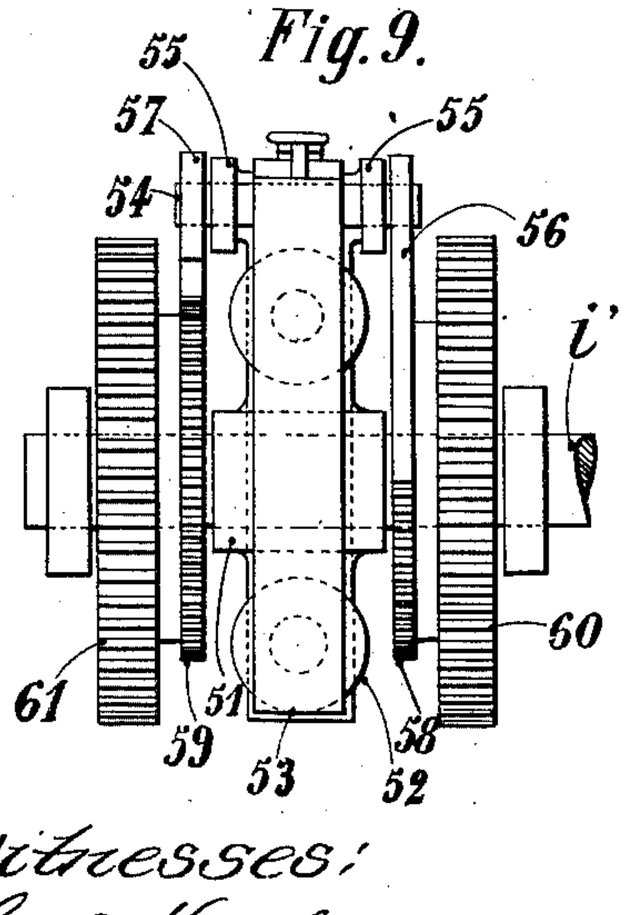
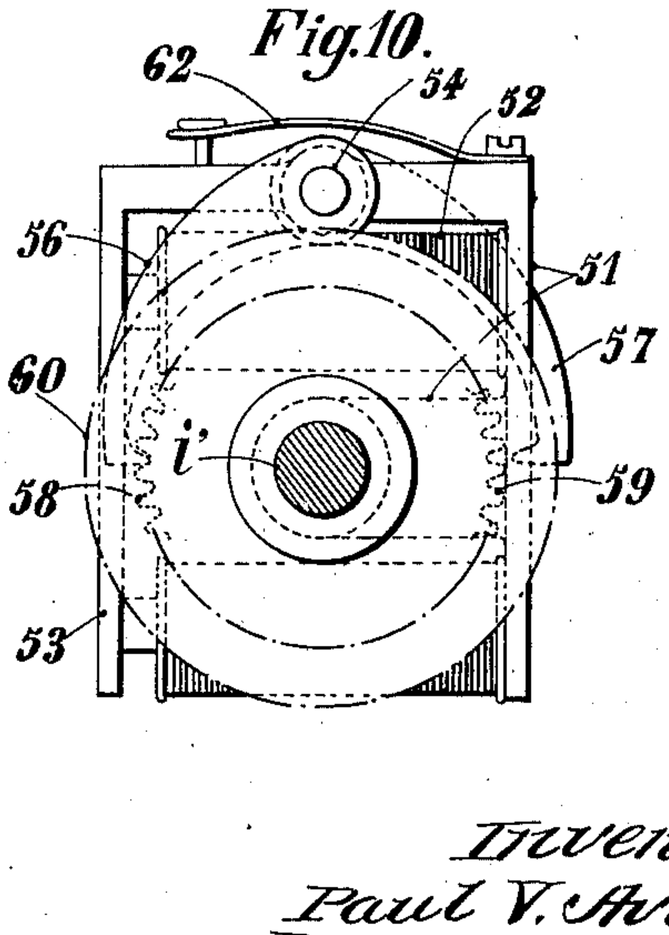



*Fig. 10.*

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# P. V. AVRIL.

## ENGRAVING MACHINE.

(Application filed Sept. 3, 1901.)

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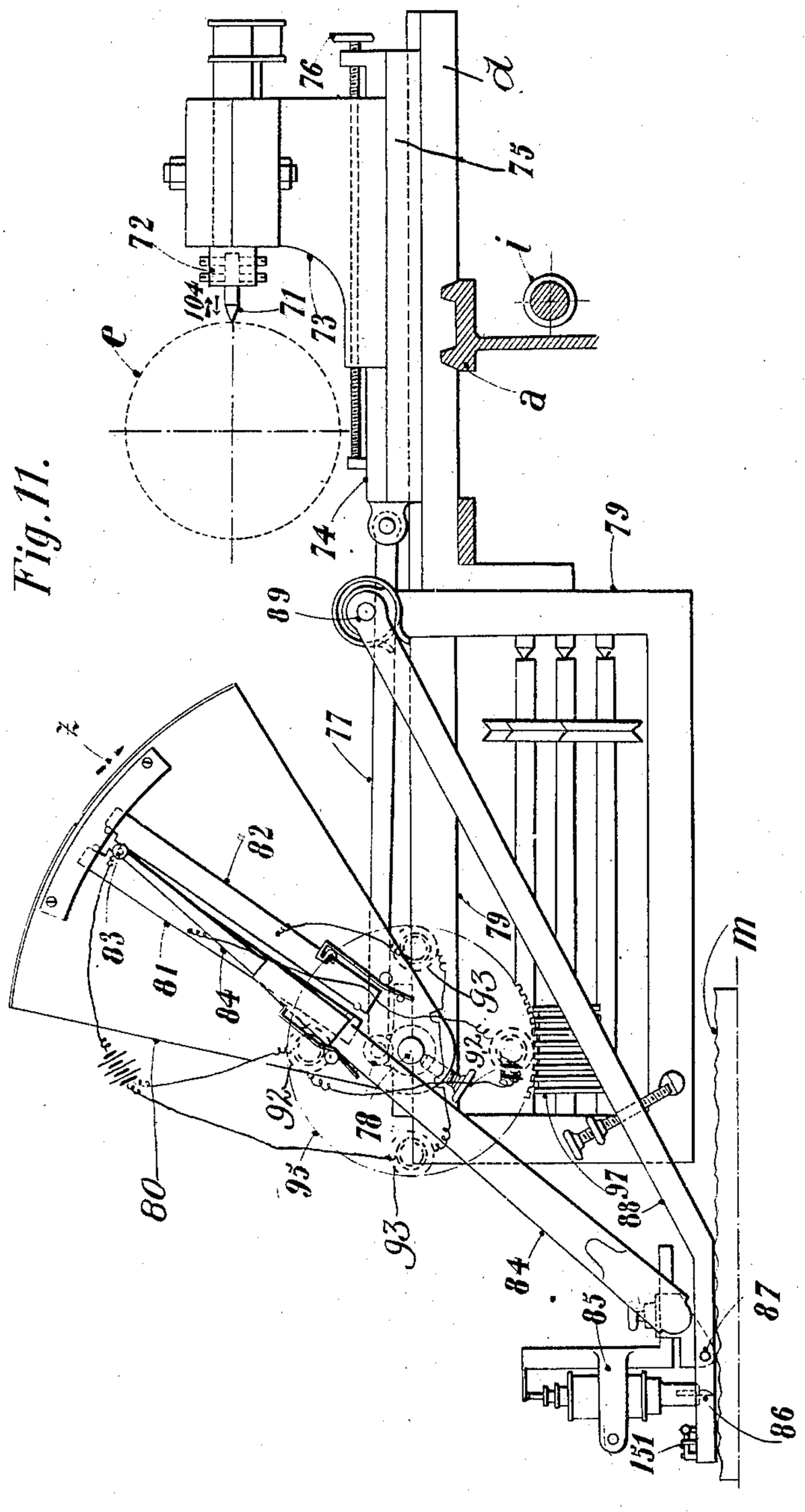
Fig. 11.

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# P. V. AVRIL.

## ENGRAVING MACHINE.

(Application filed Sept. 3, 1901.)

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Fig. 12.

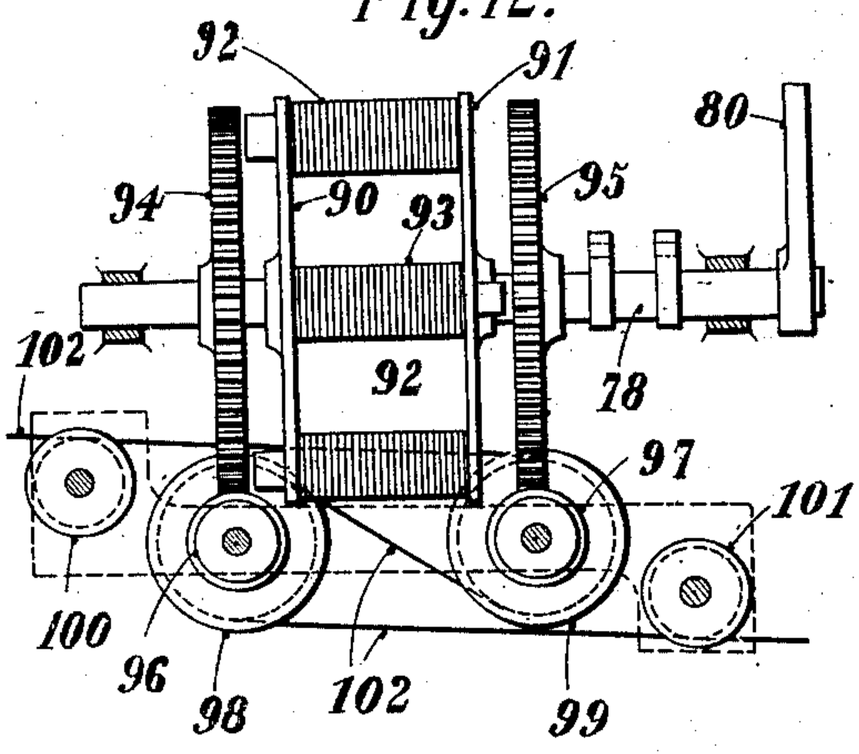



Fig. 13.

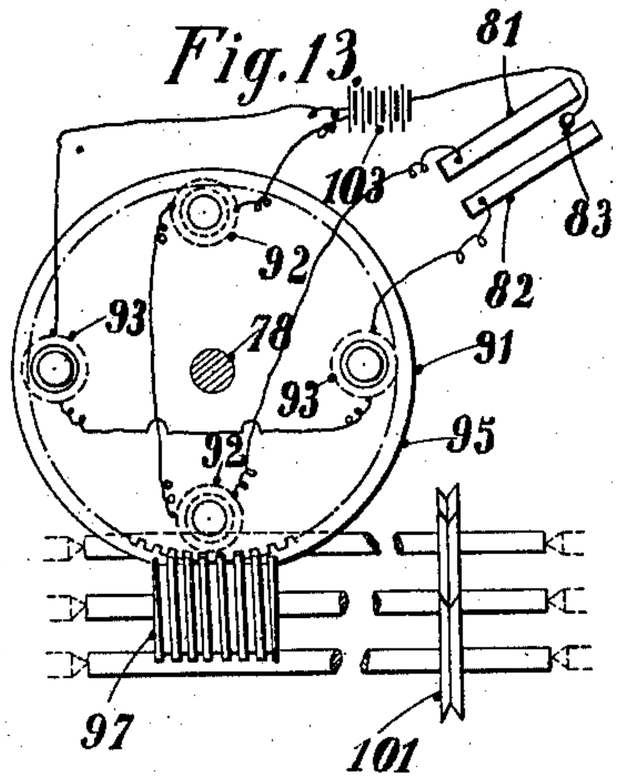



Fig. 14.

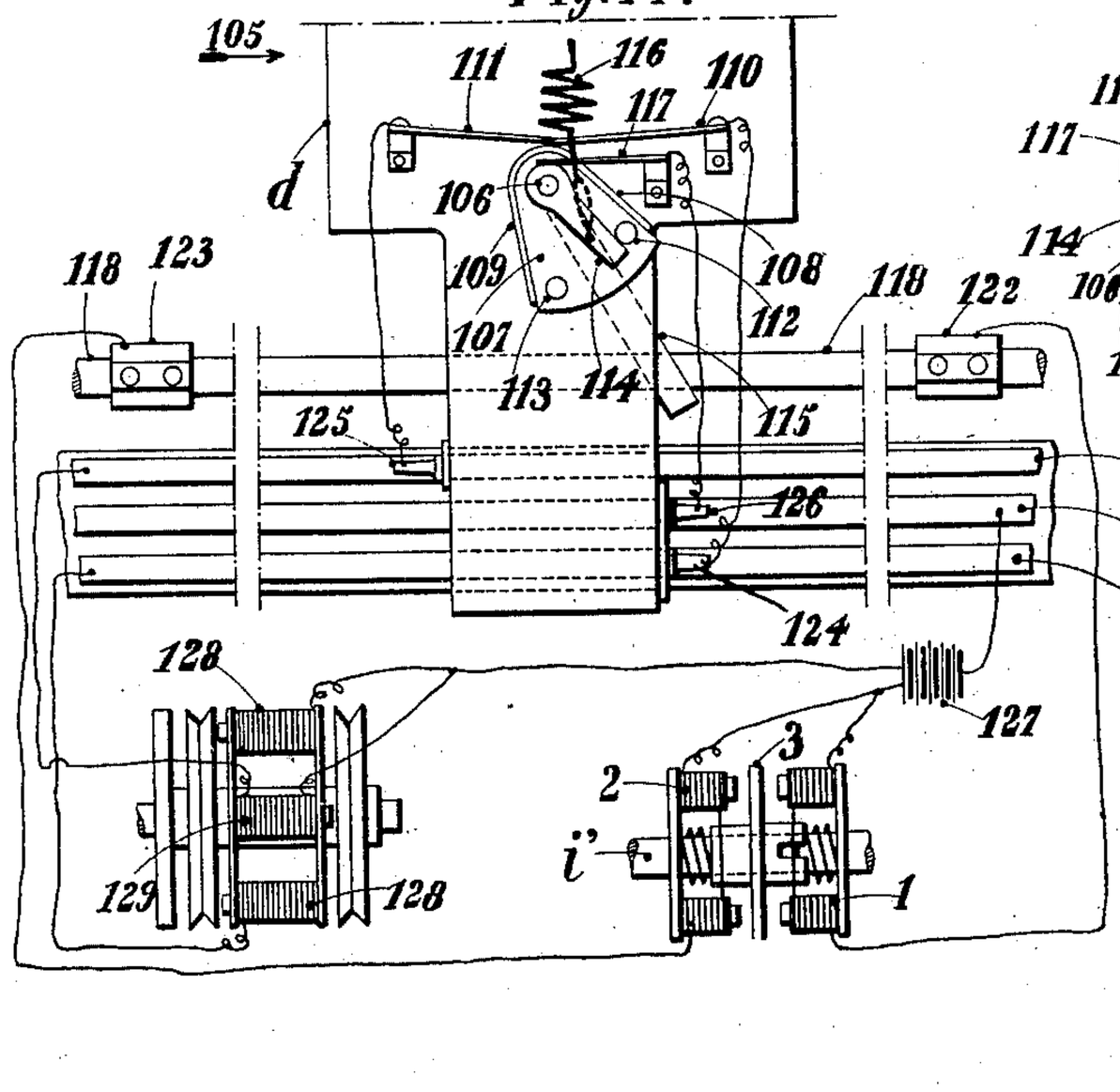
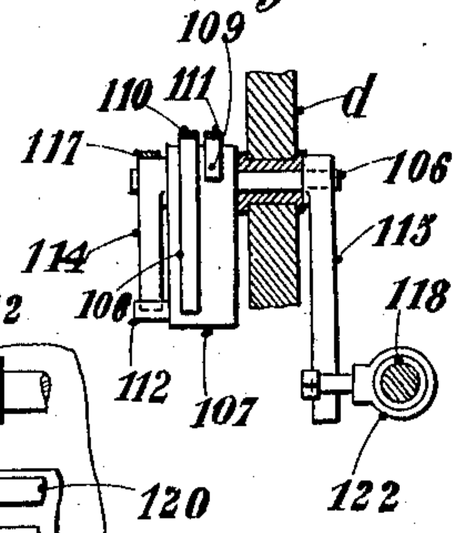



Fig. 15.

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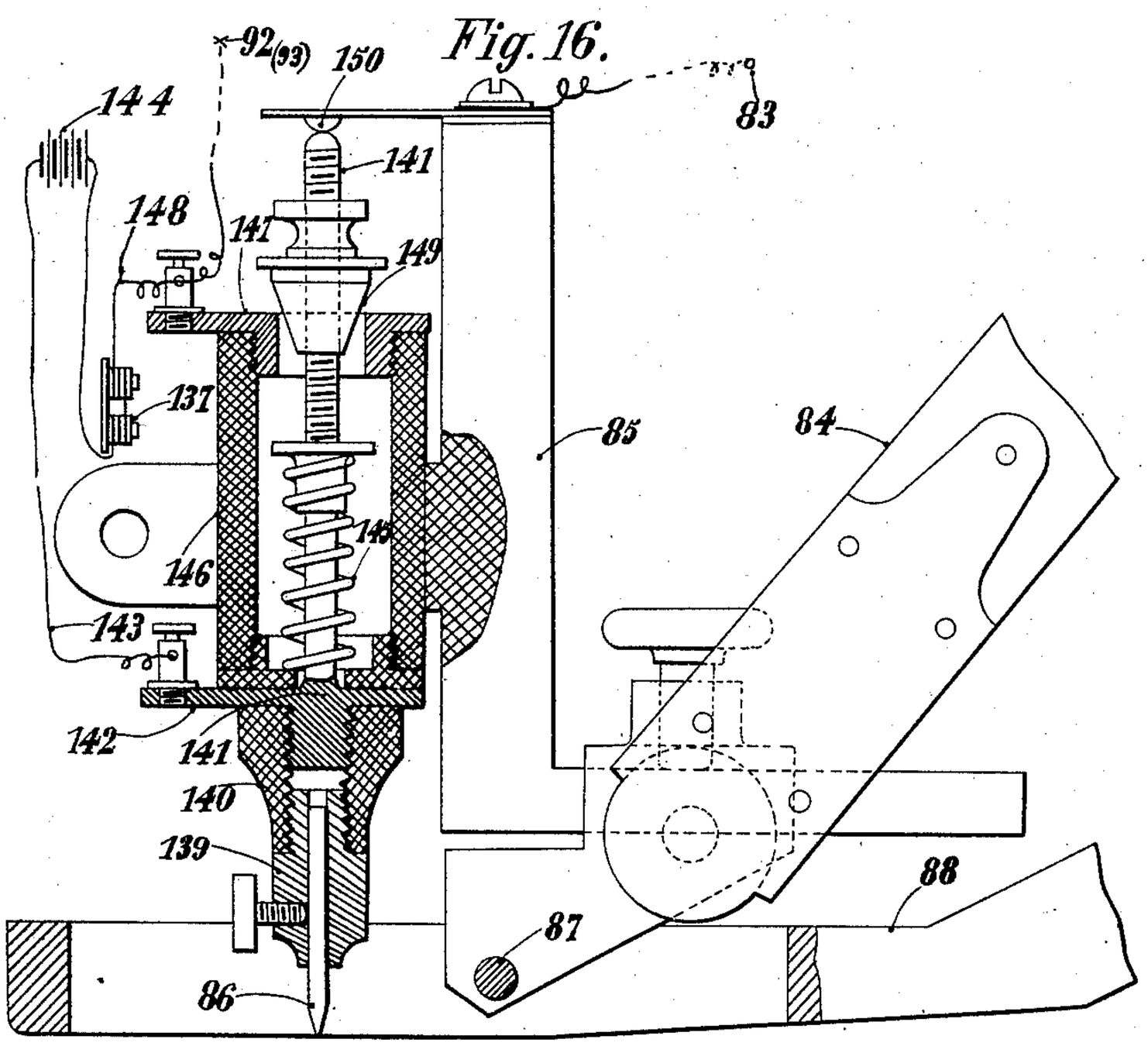
## ENGRAVING MACHINE.

(Application filed Sept. 3, 1901.)

(No Model.) 10 Sheets—Sheet 7.

Fig. 16.

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ENGRAVING MACHINE.

(Application filed Sept. 3, 1901.)

(No Model.) 10 Sheets—Sheet 8.

*Fig. 20.*

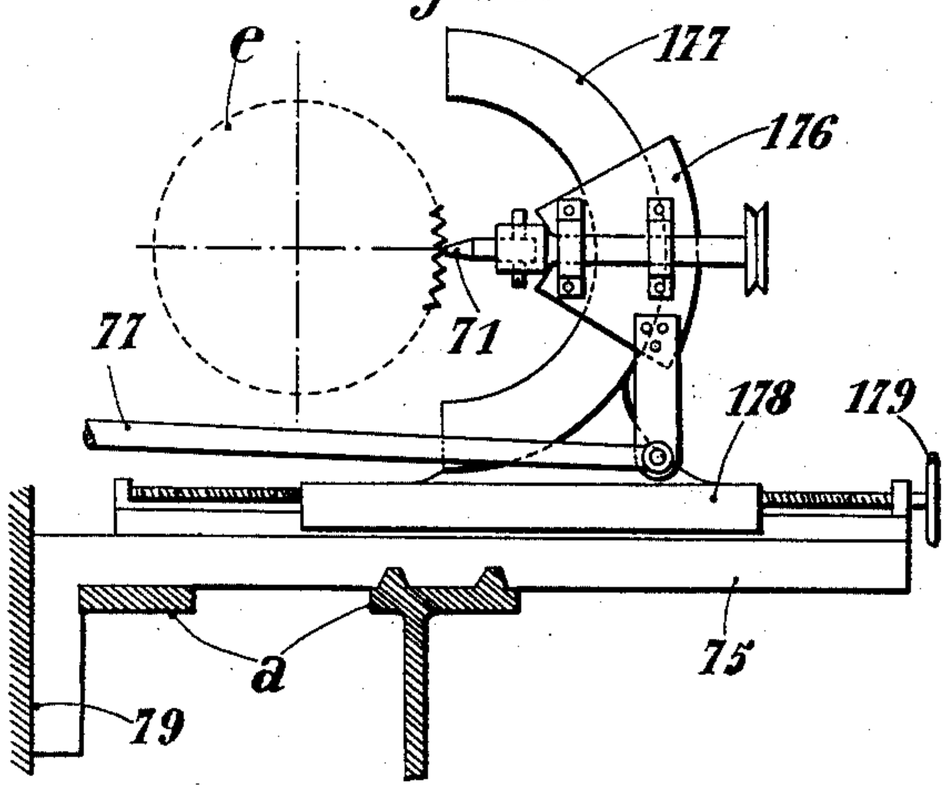



*Fig. 21.*

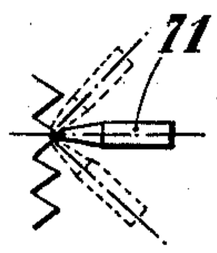
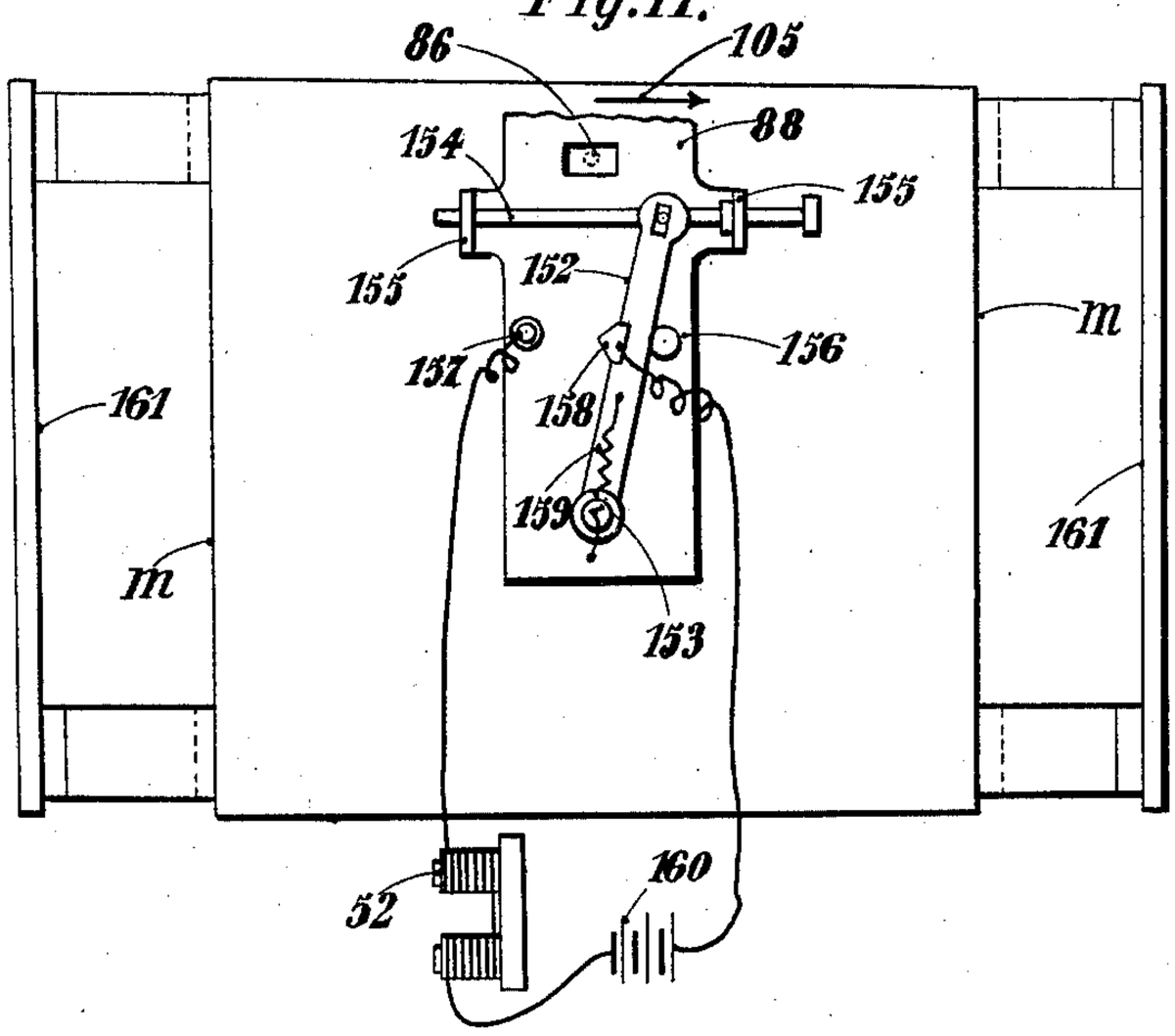



*Fig. 17.*

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ENGRAVING MACHINE.

(Application filed Sept. 3, 1901.)

(No Model.)

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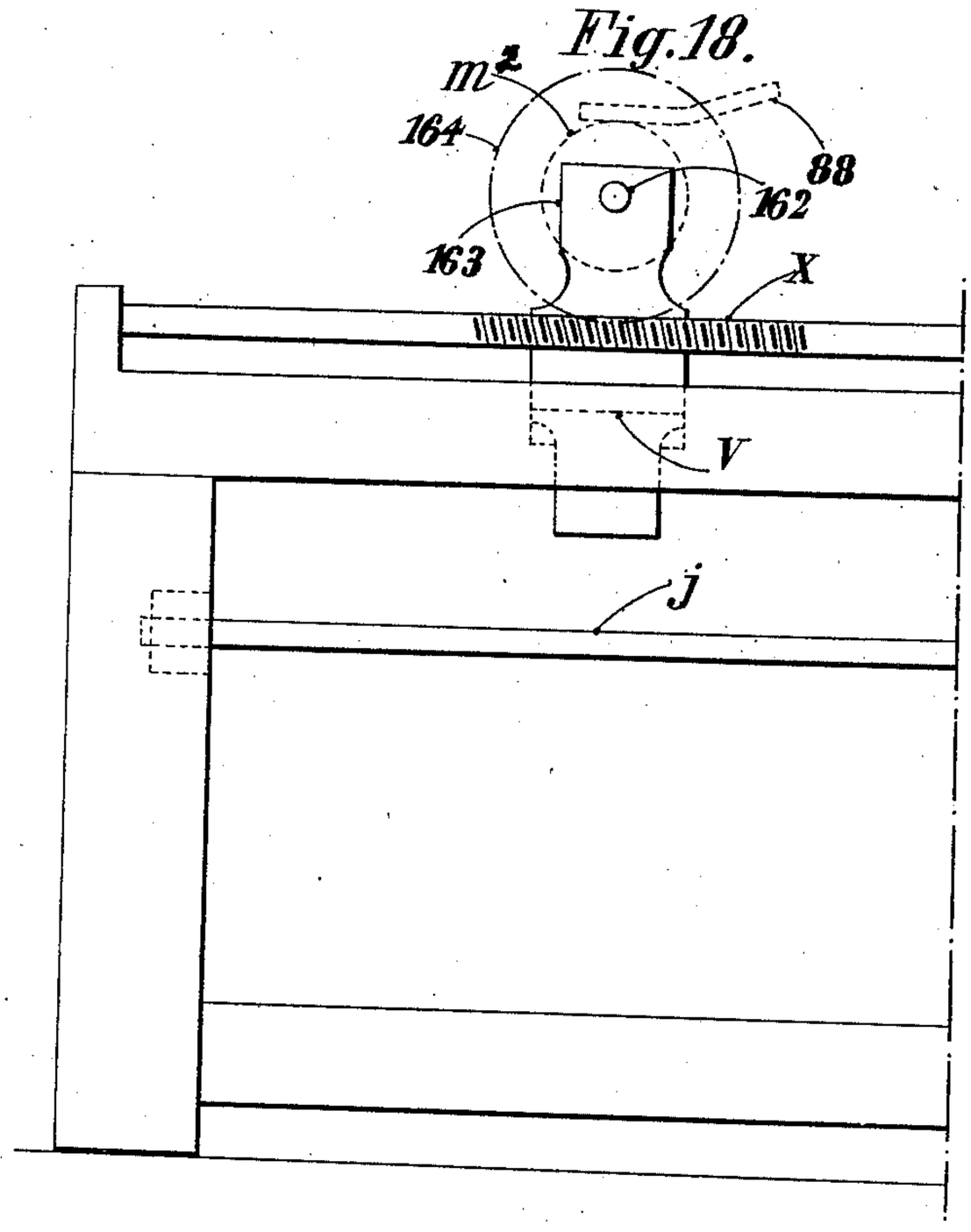
Fig. 18.

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(No Model.)

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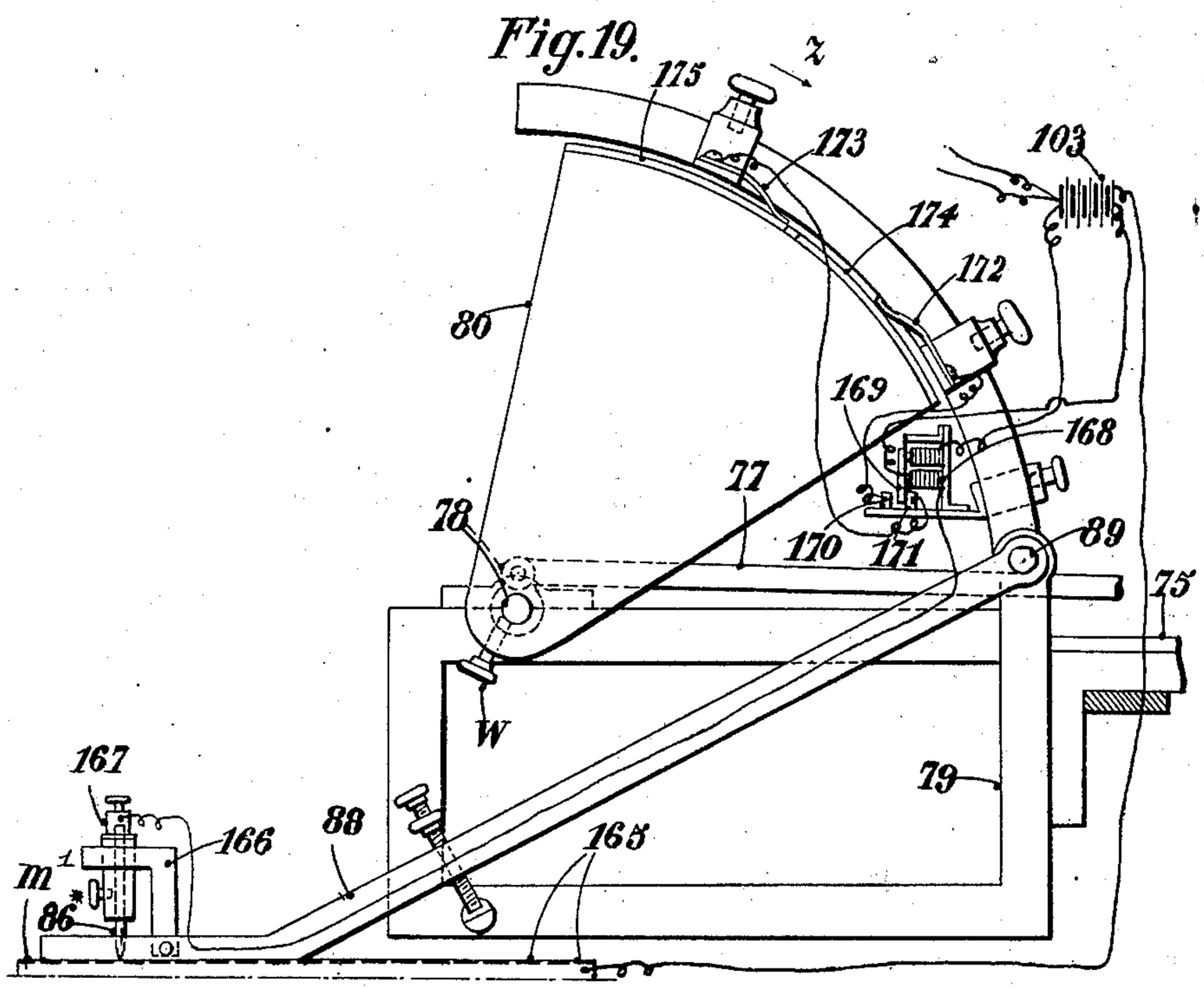
Fig. 19.

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# UNITED STATES PATENT OFFICE.

PAUL VICTOR AVRIL, OF PARIS, FRANCE, ASSIGNOR TO HIMSELF AND LA SOCIÉTÉ MARINIER, NAVOIT ET JEANSON, OF PARIS, FRANCE.

## ENGRAVING-MACHINE.

SPECIFICATION forming part of Letters Patent No. 711,273, dated October 14, 1902.

Application filed September 3, 1901. Serial No. 74,241. (No model.)

*To all whom it may concern:*

Be it known that I, PAUL VICTOR AVRIL, engineer, a citizen of the French Republic, residing at Paris, France, (post-office address 55 Quai des Grands Augustins, in said city,) have invented certain new and useful Improvements in Engraving-Machines, of which the following is a specification.

The object of this invention is to provide a machine in which carving, engraving, or chasing tools are operated automatically from a suitable model or pattern.

The invention will be understood from the following description, with reference to the accompanying drawings, of which—

Figure 1 is a front elevation of a machine constructed according to this invention. Fig. 2 is a side elevation thereof, some parts of the machine being removed. Figs. 3 and 4 are elevations at right angles to each other of a clutch device forming part of the machine. Figs. 5 and 6 represent driving mechanism actuated through the medium of the clutch shown in Figs. 3 and 4, which also controls the operating mechanism represented in Figs. 7 and 8. Figs. 9 and 10 show a second clutch device also forming part of the machine. Fig. 11 is a side elevation of the tool-holding carriage or slide. Figs. 12 and 13 represent an electromagnetic coupling for operating the tool. Figs. 14 and 15 are detail views of an electrical switch. Fig. 16 illustrates a method of fitting the style or point adapted to slide over the pattern to be reproduced by the machine. Fig. 17 shows an electric cut-out. Fig. 18 is a partial side elevation of a modified form of machine enabling a cylindrical pattern to be employed. Fig. 19 represents a modification of the tool-holding carriage. Fig. 20 illustrates a modified method of fitting the tool. Fig. 21 shows by full lines and dotted lines the tool in various positions.

In Fig. 1, *a* designates a lathe frame or bench on which are arranged head and tail stocks *b* and *c* and the tool-supporting carriage *d*. Between the head and tail stocks *b* and *c* is secured the article *e*, on which the tool supported by the carriage *d* is adapted to operate. The spindle *f* of the head-stock *c* is rotated by a wheel *g* and worm *h*, Fig. 2. The tool-holding carriage is actuated by a screw *i*, rotated from a driving-shaft *j* through the medium of suitable gearing and of an electromagnetic operating device (shown at *k*) upon one end of the said screw. The pattern or model *m* (which may be of plaster-of-paris, wax, or the like) is secured to a platform *n*, arranged to slide on another platform *o*, which in its turn is capable of sliding transversely on two benches *p*. The platform *n* receives motion through a screw *q*, engaging with a nut or tapped sleeve *r*, secured to a platform *s*, having a transverse groove *u* therein which engages with a pin *t*, fixed to the under side of the said platform *n*. The platform *s* slides on a bench *v*, Fig. 2. The platform *o* is operated by means of a screw *x*, Fig. 2, engaging a nut *y*. Upon the screw *i*, which operates the carriage *d*, there is mounted an electromagnetic clutch device. (Shown in Fig. 3.) This device consists of two electromagnets 1 and 2, between which a disk-shaped armature 3 is interposed. The frame of each electromagnet is carried on a sleeve fast on the smooth end of the screw *i*, while the armature or disk 3 is free to slide longitudinally upon the spindle *i'*, but is caused to rotate with the said spindle through the medium of a pin or stud 4. The armature-disk is connected by rods 5 to a sleeve 6, mounted loosely upon the spindle *i'*, the said rods passing through the frame of the electromagnet 2. To each end of the sleeve 6 is rigidly secured a bevel-wheel 7 and 8, respectively. When the electromagnets 1 or 2 are not energized, two helical springs 9 maintain the armature-disk 3 out of contact with the pole-pieces of the electromagnets. The moment one of the electromagnets is excited, however, it attracts the armature-disk, which in shifting its position throws one of the wheels 7 or 8 into gear with a bevel-wheel 10, Fig. 4. Fast on the spindle of the wheel 10 is a spur-wheel 11, which is in gear with a wheel 12, loosely mounted on the spindle *h'* of the worm *h*. The wheel 11 is in gear with a wheel 13 and imparts thereby motion to a wheel 14, loosely mounted on the smooth end *x'* of the screw-shaft *x*. The wheels 12 and 14 carry arms 15 and 16, respectively, on the

bosses of which arms the wheels 12 and 14 are shown in the drawings as being keyed, the said arms 15 and 16 being thus free to rotate upon the spindles $h'$ and $x'$, respectively. The arm 15 actuates the worm $h$ through the medium of an arrangement represented in detail in Figs. 5 and 6. Upon the spindle $h'$ there are loosely mounted two disks 17 and 18, each provided with a stop 19. The two disks are connected together by means of a screw 20, passed through both disks. The disk 17 is provided with a single tapped opening for the passage of the screw 20, while the disk 18 is provided with a series of smooth perforations 21, permitting the two stops 19 to be brought closer together or moved farther apart, as required. The said disk 17, furthermore, carries a pawl 22, which a spring 23 keeps in engagement with a ratchet-wheel 24, keyed onto the spindle $h'$. The ratchet-wheel 24 is provided with as many teeth as the disk 18 has perforations. The arm 15 carries two tappets 25 and 26, which are independent of each other and free to oscillate on a spindle 27, secured to the end of the said arm 15. A spring 28 presses the tappets 25 and 26, respectively, against the disks 17 and 18. Two inclines 29 and 30, formed on a stationary support 31, are situated on either side of the disks 17 and 18. The operation of this arrangement is as follows: Assuming that the wheel 12 and also consequently the arms 15 are revolving in the direction of the arrow 32, Fig. 6, the moment the tappet 25 comes into contact with the stop 19 of the disk 17 it begins to communicate its rotary motion to the disks 17 and 18, and through the pawl and ratchet-wheel 22 24 the spindle $h'$ also is caused to participate in this rotary motion. This transmission of motion ceases the moment the tappet 25 reaches the highest point of the incline 29, where it passes over the stop 19 of the disk 17. This stop 19 has by this time reached the point 19′, while the stop of the disk 17 18 has moved from the position 19″ to the point 19‴. At this juncture the arm 15 becomes capable of revolving in the same direction indefinitely without the disks 17 18 or the spindle $h'$ being again set in motion, since the tappet 25 when it reaches the point 19′ must pass over the incline 29 and over the stop 19 of the disk 17 without abutting at 19′. The movement thus imparted to the spindle $h'$ corresponds to the arc comprised between the points 19 and 19′. This movement of the said spindle $h'$ is transmitted through the medium of the worm $h$, Fig. 2, and wheel $g$ to the cylindrical blank $e$, Fig. 1, which is subjected only to a slight angular displacement. The stops 19 of the disks 17 and 18 are brought back to their initial positions by the tappet 26 the moment the direction of rotation of the arm 15 is reversed, for when such reverse motion takes place the tappet 26 by striking the stop 19 of the disk 18 at 19‴ imparts motion to both disks 17 and 18 until the tappet 26 is elevated by ascending the incline 30, whereupon it releases the stop 19 of the disk 18. This stop therefore has thus been brought from the position 19‴ to the position 19″, while at the same time the stop 19 of the disk 17 has been moved back from 19′ to 19, and while these movements are taking place the pawl 22 passes over the toothed rim of the ratchet-wheel 24 without engaging therewith, and consequently without setting the spindle $h'$ in motion. While transmitting rotary motion in alternate directions to the wheel 12, or, in other words, to the arm 15, the worm $h$, Fig. 2, and consequently also the wheel $g$ and blank $e$, Fig. 1, receive movements equal in extent and in the same direction. The amplitude of these successive movements may be accurately adjusted by means of the stops 19, Figs. 5 and 6, the distance between which should be determined beforehand according to the movements which the blank $e$ is required to receive. The reversion of the direction of rotation of the wheel 12 is effected, as hereinafter described, through intermediate agency of electromagnetic clutch mechanism arranged upon the screw-shaft $i$. Thus by means of the arrangement described with reference to Figs. 5 and 6 the blank $e$ receives a series of successive movements to the same extent and in the same direction. The arm 16, Figs. 2 and 4, actuates the screw-shaft $x$, and consequently the platform $n$, carrying the pattern $m$, through the medium of the arrangement represented in Figs. 7 and 8. This arrangement, like that shown in Figs. 5 and 6, comprises two disks 17 and 18, mounted loosely upon the smooth end $x'$ of the said screw-shaft $x$ and each provided with a stop 19. The two disks are connected together by means of a screw 20. The arm 16 carries tappets 25 and 26, adapted to oscillate on the spindle or pivot 27, springs 20 pressing them against the disks 17 and 18, respectively. On either side of the disks there are arranged inclines 29 30, held up by the standard 33. On the disk 17 there is fitted, by means of a bracket 34, an electromagnet 35, whereof the armature 36 is rigidly mounted upon a spindle 37, adapted to turn freely within a fork or yoke 38, which is secured to the said bracket 34. Upon the spindle 37 there are mounted two pawls 39 and 40, adapted to engage with the ratchet-wheels 41 and 42, respectively, securely mounted upon the spindle $x'$. The pawl 39 is fast upon the spindle 37, while the pawl 40 participates in the rocking movements of such spindle, owing to the provision of a stud or pin 43, engaging in a slot 44, which is formed in the sleeve or hub of the pawl 40. Between this slot and the stud a little play is allowed, which is neutralized by a spring 45, so that the pawl 40 may participate in the oscillatory motion of the spindle 37 and permit the ratchet 42 to slip past in the direction of the arrow 46 with the pawl 40 in gear.

In Fig. 8 the armature 36 is assumed to be attracted and the pawl 40 in gear. In this

case the spindle $x'$ receives successive movements in the direction of the arrow 46. The method of imparting motion to the spindle $x'$ through the medium of the tappets 25 26 and stops 19 is identical with that adopted for the operation of the spindle $h'$ in the arrangement shown in Figs. 5 and 6. The difference between the two arrangements, however, is that the device represented in Figs. 7 and 8 enables the spindle $x'$, or, in other words, the screw $x$, to be turned in either of two directions, as required, whereas the mechanism illustrated in Figs. 5 and 6 is specially contrived to cause the worm $h$ invariably to revolve in the same direction.

The excitation of the electromagnet 35 is controlled by means of a cam 49, Fig. 4, attached to the wheel $g$. This cam in conjunction with a rubber 50 constitutes a cut-out placed in the same circuit with the electromagnet 35. This circuit is closed upon the electromagnet so long as the rubber 50 presses upon a projecting part of the cam 49. During the rotation of the wheel $g$ and conversely the circuit remains open during all the time that a recessed part of the said cam 49 continues to face the rubber 50. To the closing of the circuit corresponds the engagement of the pawl 40, while the pawl 39 engages while the circuit is broken, and the alternate engagement of the two pawls results in a reversion of the direction of rotation of the screw $x$ and also consequently of the direction of the transverse of the pattern $m$.

In Fig. 4 the cam 49 is shown insulated from the shaft $f$ by a ring, as illustrated in cross-hatched lines. The electric circuit enters the cam, as shown at 180, and leaves the contact 50 through the wire 181. The support of the contact 50 is also insulated from the frame of the machine.

Figs. 9 and 10 show an electromagnetic clutch which controls the motion-transmitting mechanism connecting the screw-shaft $i$ to the screw-shaft $q$. Upon the smooth end $i'$ of the screw-shaft $i$ there is securely fastened a frame 51, supporting an electromagnet 52. The armature 53 of this electromagnet is fast upon a spindle 54, which is journaled in a fork or yoke 55, forming part of the said frame 51. Upon the spindle 54 are keyed two pawls 56 57, adapted to engage with the wheels 58 and 59, respectively, which are loose upon the spindle $i'$ and are connected with the gear-wheels 60 and 61, also loose upon the said spindle $i'$. In Fig. 10 the armature 53 is represented as being attracted by the electromagnet and the pawl 56 as engaging with the wheel 58. In this case it is the wheel 60 which is set in motion as the spindle $i'$ rotates. If the circuit to the electromagnet 52 be broken, the armature 53 is pulled back by a spring 62 and causes the spindle 54 to oscillate, so as to release the pawl 56 from its engagement with the wheel 58 and throw the pawl 57 into gear with the wheel 59. It is then the wheel 61 which is set in motion during the rotation of the spindle $i'$. The wheels 60 and 61 are connected by a double train of gear-wheels 63 and 64, Figs. 1 and 2, to a shaft 65, carrying a bevel-gearing 67, 68, 69, and 70, communicating with the screw-shaft $q$. In some cases the double set of gear-wheels 63 and 64 may be dispensed with or the manner in which they are made up may be varied so as to enable one screw-shaft to be revolved in one direction and the other in an opposite direction and at a different rate of speed. The clutch-gear shown in Figs. 9 and 10, owing to the alternate engagement of the pawls 56 and 57, respectively, permits the screw-shaft to receive rotary motion, either in one direction or in the other, whence there will result a corresponding reversion of the direction and speed of the longitudinal motion of the pattern $m$ or alternating periods of rest and motion of such pattern if one only of the sets of gear-wheels be omitted. The alternate excitation of the electromagnet 52 is secured through the agency of a cut-out hereinafter described.

Fig. 11 is a side elevation of the tool-holding carriage. The tool 71 is secured in a sleeve or socket 72, supported in a head-stock or frame 73, which is attached to a platform 74, adapted to slide on the platform 75 of the carriage. In order to move the tool into contact with the cylindrical blank $e$, the wheel 76 is operated. A connecting rod or link 77 connects the platform 74 to a crank-shaft or crank-axle 78, mounted in a frame 79, secured to the platform 75 of the carriage. Upon the said shaft 78 there is rigidly secured a sector 80, of insulating material, carrying two metal plates 81 82, between which alternately engages a metal point 83, projecting from a lever 84. This lever is connected with a bracket or frame 85, fitted with a point or style 86, which is applied to the pattern $m$. The whole arrangement formed by the lever 84 and the frame or bracket 85, supporting the style 86, is adapted to turn on the pivot 87. This pivot is mounted on an arm 88, resting upon the pattern $m$ and pivoted at 89 to the frame 79. The frame or bracket 85 is made adjustably removable, so that the style 86 may be brought nearer to or moved farther away from the pivot 87, as desired. Upon the shaft 78 there are keyed two iron disks 90 91, Figs. 12 and 13, between which are fitted two electromagnets 92 93. The poles of the electromagnet 92 extend beyond the disk 90, while those of the electromagnet 93 pass beyond the disk 91. Contiguous to these poles are two worm-wheels 94 95, constituting armatures mounted loosely upon the shaft 78 and made to engage with worms 96 97, respectively. These worms, and consequently the wheels 94 95, turn in opposite directions and are controlled by a transmission-gearing (shown in Fig. 12) consisting of two grooved pulleys 98 99, fast upon the spindles carrying the worms, and, further, two

guiding-pulleys 100 and 101. These pulleys are operated by means of an endless cord 102, their spindles or shafts turning on centers in the frame 79, Fig. 11. The two electromagnets 92 and 93 are comprised within two separate circuits, communicating on the one hand with a source of current, such as 103, and on the other with the metal plates 81 and 82. These two circuits are shown diagrammatically in Fig. 13. When the point 83, which communicates with the source of electricity 103, touches the plate 81, the circuit of the electromagnet 92 is closed, while when the point meets the plate 82 the circuit of the electromagnet 93 is completed. In the former case it is the wheel 94 which communicates its rotary motion to the shaft 78 and to the sector 80 through the medium of the mechanism constituted by the disks 90 and 91 and the electromagnets 92 and 93, while in the latter case it is the wheel 95 which actuates both the shaft 78 and sector 80 through the same agency. The direction of rotation of the wheels 94 95 should be so determined that in the first case the sector 80 may turn in the direction in which the plate 82 tends to recede from the point 83, while in the second case the sector should turn in accordance with the tendency of the web 81 to move away from the said point 83. The plates 81 82 consequently never remain in contact with the point 83, though the clear space or "play" between such point and webs is very minute. The successive positions of the point 83 are obtained automatically through the medium of the point or style 86, Fig. 11, which as it passes in turn over the depressed and raised portions of the pattern causes the arm 84 to oscillate upon its pivot 87, and as this arm carries the insulated point 83 this point imparts oscillatory motion to the shaft 78, which motion is changed by the intermediate agency of the link 77, so as to cause the tool 71 to move in the direction of the arrow 104. Now it will be readily understood that as the tool-carriage travels along the tool will cut more or less deeply into the blank *e* and will therefore produce therein a longitudinal groove or score. The section and depth will exactly correspond to the line followed by the style 86 upon the pattern *m*. In order to reverse the section, or, in other words, to obtain a counterpart of the pattern, it would be sufficient to loosen the screw *w*, so as to render the sector 80 independent of the shaft 78, then turn the crank one hundred and eighty degrees, and lastly to tighten the screw *w* again, so as to restore the connection between the sector 80 and the shaft 78.

Upon a pivot 106, Figs. 14 and 15, projecting from the front plate of the carriage *d*, there is made fast a sector 107, of insulating material, fitted with two conducting-plates 108 109, which are pressed upon, respectively, by the brushes 110 111, insulated from the carriage *d*. The two plates 108 and 109 respectively communicate with two terminals 112 113, with which the sector 107 is also provided. Upon one end of the pivot 106, which is suitably insulated from the carriage *d*, there is loosely mounted a lever 114, and upon its other end a lever 115 is fixed. The lever 114 is constantly maintained by a spring 116 against one of the terminals 112 113. The spring 116 is insulated from the lever 114, upon which rests the rubber 117, insulated from the carriage. This arrangement, supported by the carriage, is supplemented by five conductors—viz., two wires running along the rod 118 and three plates 119 120 121, mounted on the frame of the machine and suitably insulated. Each of the wires communicates, on the one hand, with one of the insulated stops 122 123, secured on the rod 118, and, on the other hand, with one of the electromagnets 1 2 of the electromagnetic coupling mounted upon the screw-shaft *i*, Figs. 1 and 3. Upon the three plates or webs 119 120 121 there press three rubbers 124, 125, and 126, communicating with the brushes 110, 111, and 117, respectively. The conducting web or bar 121 is connected to a source of current 127, while the two remaining webs 119 and 120 communicate with two electromagnets 128 129 of an electromagnetic clutch, which owing to the alternate excitation of the two electromagnets effects the required reversion of the direction of rotation of the worm-shaft *i*. This clutch device will be hereinafter more fully described.

The operating of the electric controlling mechanism described with reference to Figs. 14 and 15 is as follows: Assuming that the carriage is about to reach the end of its journey, having moved in the direction of the arrow 105, the lever 115 as it meets the stop 122 first closes the circuit of the electromagnet 1 of the coupling mounted upon the screw-spindle *i'*. The current coming from the source of electricity 127 (see the diagram Fig. 14) to the web 121 passes through the rubber 126, brush 117, lever 114, spindle 106, and lever 115 to the stop 122, whence it enters the coil of the electromagnet 1 and returns to the source 127. The armature 3 being attracted by the electromagnet 1 throws the wheel 8 into gear with the wheel 10, Figs. 3 and 4, with the result that the worm *h* and screw *x* are actuated, as has been stated with reference to Figs. 5 to 8. As the carriage continues to move in the direction of the arrow 105 the lever 115, being arrested by the stop 122, shifts the lever 114, which presently is drawn back against the terminal 113 by the sudden action of the spring 116. As the lever 114 has left the terminal 112 and is now in contact with the terminal 113, commutation has taken place in the excitation of two electromagnets 128 129, as will be readily understood upon inspection of the connection shown in Figs. 14 and 15. The result is a reversing of the direction of rotation of the screw-shaft

$i'$, Fig. 1, and consequently of the wheel 8, Fig. 3, which is still in gear with the wheel 10, as previously described. The carriage $d$ will now be impelled in the direction opposite to that indicated by the arrow 105. At the moment when the lever 115 leaves the stop 122 the circuit which comprises the electromagnet 1 is broken, and consequently the wheel 8 becomes immediately disengaged from the wheel 10. When the lever 115 comes into contact with the stop 123, it is the electromagnet 2 which is excited, and the wheel 7 engages with the wheel 10, Fig. 4, in the direction opposite to that in which it had previously turned the wheel 8. As the lever 115 is retained at rest by the stop 123, while the carriage continues to travel in the opposite direction, (indicated by the arrow 105,) the lever 114 will be drawn back by the spring 116 against the terminal 112, whereby there will be caused a fresh commutation in the excitation of the electromagnets 128 and 129. Hence there will follow a change in the direction of rotation of the worm-shaft $i$, Figs. 1 and 3, and the wheel 7. The carriage will once more be set moving in the direction of the arrow 105, and the same engagements and disengagements as before described will be repeated, and so on.

The operation of the electric controlling apparatus described with reference to Figs. 14 and 18 has the effect that whenever the carriage reaches the end of its stroke the reversion of the direction of motion of the screw $i$ and wheel 10 takes place automatically.

The electromagnetic coupling (shown at $k$, Figs. 1 and 14) is constructed as follows: The frames of the two electromagnets 128 129 are rigidly secured upon a sleeve 130, Figs. 1 and 14, loose upon the end of the screw-shaft $i$. Upon the sleeve 130, facing the poles of the two electromagnets 128 129, there revolve freely two pulleys 131 and 132. These two pulleys turn in opposite directions to each other and are both connected to the driving-shaft $j$, one by a straight belt and the other by a crossed belt. The one of the electromagnets 128 129 which happens to be excited attracts the pulley which is arranged in front of the said poles, and the sleeve 130 is set in motion in the direction in which that pulley rotates. The sleeve 130 communicates its rotary motion to the screw $i$ through the medium of a disk 133, keyed upon the sleeve 130 and serving to impart motion to a plate or disk 134 by the aid of studs 135, with which the latter is fitted. The plate 134 is adapted to slide upon a spline forming part of the screw-shaft $i$, but causes such screw to participate in the rotary motion which is transmitted to the plate 134 by the disk 133. A spring 136 insures the engagement of the plate 134 with the disk 133. Facing the plate 134 there is arranged an electromagnet 137, the frame or stock of which is fast upon the screw-shaft $i$. When this electromagnet is excited, it attracts the plate 134, and thereby causes the release of the screw $i$ from engagement. The excitation of this electromagnet is controlled in the manner hereinafter described.

Having now described the principal devices constituting the machine, the method of operation will now be described. Assuming that it is desired to reproduce a flat rectangular pattern—say an ornamental design, such as $m$, Figs. 1 and 2—upon a cylindrical blank, such as $e$, and that the carriage is traveling in the direction of the arrow 105 and that the transmission-gearing which connects the screw $i$ to the worm $q$ is out of gear—in other words, that the device shown in Figs. 9 and 10 has been removed from the screw-spindle $i'$, so that the pattern may not move in the longitudinal direction of the machine—the tool will cut a longitudinal groove in the cylindrical blank varying in depth according to the sectional profile of the undulating line followed by the style 86 upon the pattern $m$. When the carriage arrives at the end of its course, the lever 115 meets the stop 122, and thereby closes the circuit of the electromagnetic clutch 1 2, mounted upon the worm-shaft $i$, and the lever 115 at the same time produces a commutation of the excitation of the electromagnets 128 129, Figs. 1 and 14, whence there follows a reversion of the direction of motion of the worm-shaft $i$. The worm $h$ and $x$ being thus set in operation impart a slight angular movement to the blank $e$ and a slight forward movement to the pattern $m$. The screw $i$ next imparts to the carriage a movement from right to left. During this second journey of the carriage the tool cuts another groove—*i. e.*, widens the original groove in the blank. When the lever 115 strikes the stop 123, the cylinder $e$ receives a fresh angular movement and the pattern $m$ a corresponding forward movement. Then the screw $i$ again moves the carriage from left to right, and so on, until the complete pattern is reproduced by the tool upon the blank $e$. Where a pattern is required to be reproduced on a blank more than once, the carving extending all around the cylindrical blank, the cut-out 49 50 comes into operation. The cam 49 is provided on its periphery with a number of projections and recesses equal to the desired number of successive reproductions of the pattern upon the cylinder $e$. Thus the cam 49 (represented in Figs. 7 to 11) allows for four reproductions of a pattern upon and around the same cylindrical blank. Suppose a pattern has once been copied on such blank in the manner described and that it is desired to reproduce it four times in succession around the cylindrical surface so that the four reproductions join. During the first reproduction a depression of the cam 49 has passed under the rubber 50 and the circuit of the electromagnets 35, Figs. 7 and 8, of the device controlling the screw $x$ has remained open. During

the second reproduction a projection of the cam 49 passes under the rubber 50. The circuit of the electromagnet 35 therefore is closed, and the screw $x$ is set in motion by the pawl 40. From this moment at each reverse motion of the carriage the pattern $m$ recedes upon the screw $x$, while the direction of the angular movements of the cylinder to be carried remains the same. The second reproduction is symmetrical with the first, and inasmuch as the cut-out 49 50 after each reproduction brings about a reversion of the direction of rotation of the screw $x$ it is obvious that the succeeding reproductions are all symmetrical and in coincidence with each other, and if the number of reproductions is an even number the last of them will fit in with the first.

It may happen that the style 86, Fig. 11, in sliding over the pattern should get caught in one of the parts in relief where there is a practically vertical ridge or wall too high for the style to clear. Now in order to obviate any defacement which would be apt to ensue in such a case and to permit the style 86 to rise to the requisite height the said style is so arranged as to set the electromagnetic coupling 137 134, mounted upon the screw $i$, Fig. 1, in operation the moment it meets an obstacle of the nature stated. To this end the style 86 is fitted in a tapped socket or nut 139, Fig. 16, screwed into a sleeve 140, of insulating material. Into this sleeve is also screwed a rod 141, integral with which is a washer 142, connected to a source of current 144 through a wire 143. The washer 142 is maintained in contact with the lower end of a sleeve or socket 146, of insulating material, by a spring 145. Onto the upper end of the sleeve or socket 146 is screwed a nut 147, connected to the electromagnet 137, Fig. 1, by a wire 148. The said nut 147 furthermore communicates with the one of the electromagnets 92 93, Figs. 12 and 13, the excitation of which has the effect of setting in motion the sector 80, Fig. 11, in the direction of the arrow $z$, Figs. 11 and 19. With the nut 147 engages loosely a metal cone 149, screwed onto the upper end of the rod 141, which is pressed upon by a plate 150, connected by wire to the point or pin 83, Fig. 11. Assuming that the style 86 becomes caught, as stated, as the carriage, and consequently the frame 85, Figs. 11 and 16, proceed on their course, the cone 149 will come into contact with the sleeve 147, while at 150 the contact will at the same time be interrupted. Hence the circuit of electromagnet 137, Figs. 16 and 1, will be completed, while the circuit comprising the point 83, Fig. 11, will be broken. Consequently the screw $i$ will instantly come out of gear, since the armature 134, Fig. 1, will no longer receive any motion from the disk 133, and the carriage will stop, and inasmuch as the sleeve 147 also communicates with one of the electromagnets 92 93 the sector 80 will be set moving in the direction of the arrow $z$, Fig. 11, as described above. The point 83, which the plate 81 will cause to move in the direction of the arrow $z$, will cause the lever 84 to turn upon the pivot 87 until the style 86 gets clear of the obstacle, at which moment the rod 141, Fig. 16, will resume its vertical position and the contact between the cone 149 and nut 147 will be interrupted, while at 150 the contact will be restored. It follows that the carriage will now resume its journey.

Suppose that it is desired to reproduce a small pattern several times over on the same cylinder, but in the direction of the length of such cylinder. In that case the mechanism shown in Figs. 9 and 10 must be mounted upon the end $i'$ of the shaft $i$, Fig. 1, and one of the two trains of gear-wheels 63 and 64 must be omitted, while the arm 88, Fig. 11, should support at 151 the cut-out, as shown in Fig. 17. This cut-out consists of a lever 152, of insulating material, pivoted at 153 on a pivot projecting from the arm 88. The lever 152 is coupled with a rod 154, which is guided in its movements by the arm 88. On either side of the lever 152 there are secured upon the arm 88 brackets 155, formed on the said arm 88, a stop 156, and a terminal 157, respectively. With the latter there is arranged to come in contact a contact-piece 158, with which the lever 152 is provided. A spring 159 maintains the lever 152 in contact either with the stop 156 or with the terminal 157. The contact-piece 158 communicates with a source of current 160, while the terminal 157 is connected to the coil of the electromagnet 52, Figs. 9 and 10, which, on the other hand, communicates with the source of current 160. The pattern $m$ is on either side provided with stops 161, facing the ends of the rod 154. The machine being thus complete is capable of reproducing a small pattern several times in succession in the direction of the length of the cylindrical blank $e$.

Supposing the pattern is stationary, during the traversing motion of the carriage the tool marks upon the blank a score or groove corresponding in depth to the profile of the undulating line followed by the style 86 upon the pattern. The moment the rod 154, Fig. 17, meets the bar 161 on the right the lever 152 is shifted and the contact 158 comes into touch with the terminal 157. The electromagnet 52, Figs. 9 and 10, therefore is excited, so that the screw $q$, Fig. 1, is set in rotary motion, as has already been explained, and the pattern receives axial motion. The operation of the gearing which connects the screws $i$ and $q$ should be so timed that the speed of motion of the pattern is equal to twice the speed of progress of the carriage. The tool will now prolong the groove it has commenced, making a score the section of which it had cut while the pattern was at rest, so that the scores or grooves will join. Then the moment the bar 161, situated on

the left-hand side of the pattern, abuts against the rod 154, which will swing over the lever 152, this lever will once more be drawn back against the stop 156 by the spring 159. As now the circuit of the electromagnet 52 is broken the pattern ceases to move. If the carriage continues to travel in the same direction, the tool will continue to cut the same groove, and so on. When the carriage has reached the end of its journey, the screw *i* reverses its direction of rotation, while the blank *e* receives a slight angular movement and the pattern a slight transverse movement. Now the carriage commences its return journey in the opposite direction. During this return of the carriage the tool enlarges the original groove, the cut-out shown in Fig. 17 operating in the manner described above.

In order to reproduce the profile of the pattern on an enlarged or a reduced scale, it is only necessary to determine accordingly the relation of the respective speeds of the carriage and pattern and also the direction of the motion of the latter. Hence it follows, too, that the copy of a pattern may be deformed or distorted in any desired manner in the direction of the length of the cylindrical blank. It will be readily understood that the several modes of reproduction herein considered may be variously combined according as a given pattern is to be enlarged, reduced, or deformed in any way.

Where it is desired to copy a cylindrical pattern, it suffices to secure such pattern between the head-stocks mounted upon the bench *v*, Figs. 1, 2, and 18. Upon the spindle 162, Fig. 18, of the head-stock 163 there should be made fast a worm-wheel 164, gearing with the screw *x*. The platform *o*, Fig. 2, has first been removed. The arm 88 rests upon the pattern $m^2$. Inasmuch as the modification made in the machine for this purpose is extremely simple, the operation of this form of machine need not be specially described.

Instead of working from a pattern with a raised and depressed design a smooth metal pattern may be used, to the surface of which the design to be carried on the cylinder *e* may be applied in the shape of a layer of insulating material, such as a suitable varnish. Thus in Fig. 19 there is represented a pattern *m'*, of metal, which carries on its surfaces the design to be copied, modeled in insulating material, the outlines of such design being indicated by the heavy dashes 165. In the case of such a pattern the alternating excitation of the electromagnets 92 93, Figs. 12 and 13, is secured by means of the following arrangement: The metal style $86^{\times}$, Fig. 19, is insulated from its holder 166, supported by the arm 88. It is electrically connected to a terminal 167, which in its turn is connected to the coil of the electromagnet 168, communicating with the source of current 103. The armature 169 of the electromagnet, according as it is or is not attracted, touches one or the other of the terminals 170 and 171, which communicate with the rubbers 172 and 173, respectively. These two rubbers press upon two metal plates 174 175, mounted upon the sector 80. The said plates, which are similar to the plates 81 82, (shown in Figs. 11 and 13,) communicate with the electromagnets 92 93. The armature 169 communicates with the source of electricity 103. All these electrical connections are indicated by diagram. When the style $86^{\times}$ rests upon a metallic portion of the pattern *m'*, as it is supposed to do in Fig. 19, the circuit of the electromagnet 168 is closed and the armature 169 touches the terminal 171. In this case the circuit closed comprises that one of the electromagnets 92 93, Figs. 12 and 13, which communicates with the plate 175. When, on the other hand, the style $86^{\times}$ comes to bear upon a portion of the pattern covered with insulating material, the circuit of electromagnet 168 is broken and the armature 169 is pulled back by a spring against the terminal 170. In this case the circuit closed comprises that one of the electromagnets 92 93 which communicates with the plate 174, and as during the progress of the carriage the style $86^{\times}$ presses alternately upon metal and upon insulating material it follows that the required alternation of excitation of the two electromagnets 92 93 takes place, with the result that the tool reciprocates, as described with reference to Figs. 11 and 13. Inasmuch as the course of the tool as it moves in the direction of the arrows 104, Fig. 11, is invariably the same, it is so regulated that in one position it closely approaches, but does not touch, the surface of the cylinder *e*, while in the other position it always cuts to the same depth. It will be understood that the several parts of this machine may be used in enlarging, reducing, distorting, or repeating the design in the manner hereinbefore described.

Fig. 20 illustrates a modified method of fitting the tool 71. In this arrangement the link 77 imparts to the tool not rectilinear but circular movements—that is to say, inclines the tool at various angles. To this end the tool 71 is mounted upon a runner 176, adapted to slide on a circular table 177. This table is integral with a platform 178, which may be set in motion upon the platform 75 of the carriage by operating the wheel 179. The link 77 is connected with the runner 176. In Fig. 21 there are shown by way of illustration several of the positions which a cutter may take in working upon the ribs of a grooved cylinder *e* intended for use in rippling, ribbing, mohairing, watering textiles, fabrics, paper, leather, or the like. It is the link 77 which by imparting motion to the runner 176 causes the cutter to take up the different positions. The operation of the various devices already described is the same as where the tool is arranged to receive rectilinear motion, Fig. 11.

Throughout the foregoing description we have assumed that the tool works upon a cylindrical blank; but it will be readily understood that it is only necessary to connect the spindle of the head-stock *c* to a plate guided by a vertical supporting frame or standard by means of suitable transmission-gearing in order to adapt the tool for working upon such plate in the same manner as it did upon the cylinder *e*.

Having now particularly described and ascertained the nature of my invention and in what manner the same may be performed, I declare that what I claim is—

1. In an engraving-machine, a traveling carriage, means for imparting a suitable movement thereto, a tool, means for supporting the said tool upon the carriage, a shaft, connections between said supporting means and said shaft for reciprocating the former when said shaft is operated, a style adapted to travel over the face of a pattern, an electromagnetic device mounted upon said shaft and when energized putting it into operation, a lever connected with and operated by the style, and means engaged by the lever for closing an electrical circuit to energize said magnetic device.

2. In an engraving-machine, a traveling carriage, operating means therefor, a tool-support mounted upon the carriage, a shaft, connections between the shaft and tool-support for reciprocating the latter when the shaft is operated, a style, an electromagnetic device mounted upon said shaft and when energized putting it into operation, a sector carried by said shaft, a contact device carried by the sector, and a lever connected with and operated by the style to engage said contact device for closing an electric circuit and energizing the said magnetic device.

3. In an engraving-machine, a traveling carriage, a screw for operating the same, means for operating said screw, an electromagnetic device mounted on one end of said screw for reversing the operation thereof, an electromagnetic device mounted upon the other end of said screw, means for supporting the work to be operated on, connections between the last-named electromagnetic device and said supporting means for the work, said connections operating to displace the work when the said last-named electromagnetic device is operated, a pattern, means for supporting the pattern, operating means for said supporting means for the pattern, a style adapted to travel over the face of the pattern, a tool-support upon the carriage, an electromagnetic device mounted upon said carriage, mechanism for imparting a reciprocatory movement to said tool-support adapted to be connected with said last-named device, and a means connected with the style and engaging with the said mechanism for closing an electric circuit and energizing the magnetic device upon the carriage.

4. In an engraving-machine, a supporting-platform for the pattern, means for moving said pattern, a traveling carriage, means for imparting movement thereto, a tool-support carried by the carriage, a shaft supported by the carriage, connections between the shaft and the tool-support, an electromagnetic device mounted upon the shaft, a circuit making and breaking mechanism carried by the shaft and adapted to energize and deënergize said magnetic device, a style adapted to engage the pattern carried by the platform, and means connected with the style and adapted to engage said mechanism for making and breaking an electrical circuit.

5. In an engraving-machine, a traveling carriage, means for imparting movement thereto, a supporting-platform for a pattern, means for moving said platform, a tool-support mounted upon the carriage, a shaft supported by the carriage, connections between said shaft and said tool-support for reciprocating the latter, an electromagnetic device mounted upon the shaft and adapted when energized to operate said shaft, a style adapted to engage the surface of the pattern carried by the platform, and a circuit making and breaking mechanism suitably connected with and operated by said style for making and breaking an electrical circuit during the passage of the style over the pattern.

6. In an engraving-machine, means for supporting the work to be operated upon, a traveling carriage, a screw for imparting movement to said carriage, an electromagnetic device mounted on one end of said screw for reversing the movement thereof, an electrical mechanism connected with the other end of said screw and with said means for supporting the work and adapted when operated to impart a suitable displacement to said work, a tool-support mounted upon the carriage, an electrically-operated mechanism carried by the carriage and connected with said tool-support for reciprocating it when said mechanism is operated, a supporting-platform for a pattern, means for moving said platform, a style traveling over the surface of the pattern upon the platform, and a lever connected with the style and adapted to engage with said mechanism carried by the carriage for making and breaking an electrical circuit.

7. In an engraving-machine, means for supporting the work to be operated upon, a traveling carriage, operating means therefor, connections between said operating means and supporting means for the work for imparting a suitable displacement to the work, a supporting-platform for a pattern, means for moving said platform, a tool-support carried by the carriage, an electrically-operated mechanism connected with and adapted to reciprocate said tool-support, and means traveling over the surface of the pattern and adapted to engage with said mechanism for making and breaking an electrical circuit, caus-

ing thereby the operation and discontinuing of the operation of the said mechanism.

8. In an engraving-machine, a supporting-platform for a pattern, means for moving said platform, a traveling carriage, means for imparting movement thereto, a tool, reciprocatory means mounted upon said carriage for supporting the tool, a style traveling over the surface of the pattern, a shaft connected with the tool-supporting means for reciprocating it, an electromagnetic device mounted upon said shaft and when energized putting it into operation, a lever pivotally connected with the style and operated thereby, mechanism mounted upon the said shaft and engaged by the said lever for making and breaking an electrical circuit to energize and deënergize said magnetic device to cause the reciprocation of said supporting means and the operation of said shaft, electrical mechanism for alternately reversing the direction of travel of said carriage, and means for reversing the movement of said platform.

9. In an engraving-machine, means for supporting the work operated upon, means for imparting a suitable displacement to said work, a traveling carriage, suitable operating means for said carriage, a tool, a reciprocatory supporting means for the tool mounted upon the carriage, a shaft mechanism connected with said shaft and said supporting means for operating the latter, a supporting-platform for a pattern, suitable operating means for said platform, a style traveling over the surface of the pattern, an electromagnetic device carried by said shaft and when energized, putting it into operation, and a circuit making and breaking mechanism connected with the style, operated thereby and adapted when operated to energize and deënergize said device causing thereby the operation of said reciprocating means for the tool.

10. In an engraving-machine, means for supporting the work operated upon, means for imparting a suitable displacement of said work, a traveling carriage, suitable operating means for said carriage, a tool, a reciprocating supporting means for the tool mounted upon the carriage, a shaft, mechanism connected with said shaft and said supporting means for operating the latter, a supporting-platform for a pattern, suitable operating means for said platform, a style traveling over the surface of the pattern, an electromagnetic device mounted upon said shaft and when energized putting it into operation, a circuit making and breaking mechanism connected with the style, operated thereby and adapted when operated to energize and deënergize said device causing thereby the operation of said shaft, and means for automatically reversing the direction of travel of the carriage.

11. In an engraving-machine, means for supporting the work operated upon, an electrically-operated mechanism for imparting a suitable displacement to said work, a traveling carriage, means for imparting movement to said carriage, a tool operating upon the work, a reciprocatory tool-support mounted upon the carriage, a shaft upon the carriage, connections between the shaft and the said support for reciprocating the latter when the shaft is operated, a supporting-platform for the pattern, operating means for said platform, circuit-closing means carried by said shaft, an electromagnetic device carried by said shaft and when energized putting it into operation, a lever adapted to engage said circuit-closing means to make and break an electrical circuit causing thereby the energizing and deënergizing of said magnetic device carried by the shaft, and a style traveling over the surface of said pattern and connected with said lever for operating it.

12. In an engraving-machine, means for supporting the work to be operated on, a traveling carriage, a tool, supporting means for the said tool mounted upon the carriage, a shaft suitably connected with said supporting means and adapted when operated to reciprocate the said supporting means, a sector carried by said shaft, contact-plates carried by the said sector, a pair of electromagnets mounted upon the shaft and connected to operate the said shaft, a style adapted to travel over the surface of the pattern, and means connected to and operated by the style and adapted to engage said contact-plates to make and break an electrical circuit causing thereby the energizing and deënergizing of said magnets and the operation of said shaft.

13. In an engraving-machine, means for supporting the work to be operated on, a traveling carriage, a tool, supporting means for the said tool mounted upon the carriage, a shaft suitably connected with said supporting means and adapted when operated to reciprocate the said supporting means, a sector carried by said shaft, contact-plates carried by the said sector, a pair of electromagnets mounted upon the shaft and connected to operate the said shaft, a style adapted to travel over the surface of the pattern, and a lever connected with and operated by the style and adapted to engage said contact-plates to make and break an electrical circuit causing thereby the energizing and deënergizing of said magnets and the operation of said shaft.

14. In an engraving-machine, means for supporting the object to be operated upon, means for imparting a suitable displacement to said object, a traveling carriage, a tool, supporting means for the tool mounted upon the carriage, mechanism connected with the said supporting means for reciprocating it, a pair of electromagnets mounted upon the carriage and when energized putting said mechanism into operation, an electrical circuit making and breaking mechanism for energizing and deënergizing the said magnets, a supporting-platform for a pattern, means for imparting a suitable movement to said platform, a style traveling over the surface of the

pattern, means connected with the style and adapted to be operated thereby and when operated engaging with the said circuit making and breaking mechanism to cause the energizing and deënergizing of said magnets, means adapted to operate the said carriage, an electromagnetic clutch connected with said operating means for the carriage to reverse the movement thereof, means carried by the carriage and adapted to engage the said clutch for operating the same, and an electrical means for automatically reversing the direction of movement of the said platform.

15. In an engraving-machine, means for supporting the object to be operated upon, means for imparting a suitable displacement to said object, a traveling carriage, a tool, supporting means for the tool mounted upon the carriage, mechanism connected with the said supporting means for reciprocating it, a pair of electromagnets mounted upon the carriage and putting when energized said mechanism into operation, an electrical circuit making and breaking mechanism for energizing and deënergizing the said magnets, a supporting-platform for a pattern, means for imparting a suitable movement to said platform, a style adapted to travel over the surface of the pattern, means connected with the style and adapted to be operated thereby to engage the said circuit making and breaking mechanism to cause the energizing and deenergizing of said magnets, means adapted to operate the said carriage, an electromagnetic clutch connected with said operating means for the carriage to reverse the movement thereof, and means carried by the carriage and adapted to engage the said clutch for operating the same.

16. In an engraving-machine, a traveling carriage, operating means therefor, an electrically-operated clutch connected to and adapted to reverse the movement of said operating means, means carried by the carriage adapted to cause the operation of said clutch, a tool, supporting means for the tool mounted upon the carriage, a traveling platform carrying a pattern, operating means for said platform, mechanism connected with said supporting means for reciprocating it, electrical means mounted upon the carriage and when energized adapted to put said mechanism into operation, a style adapted to travel over the surface of said pattern, means connected with the style and adapted to be operated thereby to make and break an electrical circuit causing thereby the operation of the electrical means, and means for reversing the direction of travel of said platform.

17. In an engraving-machine, a carriage, a reciprocating tool-support mounted thereon, operating means for the carriage, a platform adapted to carry a pattern, a style adapted to travel over the surface of the platform, a frame connected with the carriage, suspending means connected with the frame for the style, mechanism supported by the carriage for connecting the style with the tool-support for imparting a reciprocatory movement thereto during the travel of the style, and electrical connections between the said suspending means for the style, the operating means for the carriage and the said mechanism for suitably operating the style when caught by the raised parts of the pattern.

In testimony whereof I have hereunto set my hand in presence of two subscribing witnesses.

PAUL VICTOR AVRIL.

Witnesses:
EDWARD P. MACLEAN,
EMILE KLOTZ.