No. 887,554. PATENTED MAY 12, 1908.

F. L. O. WADSWORTH.

ETCHING OR ENGRAVING MACHINE.

APPLICATION FILED DEC. 13, 1905. 4 SHEETS—SHEET 1.

Fig. 1.

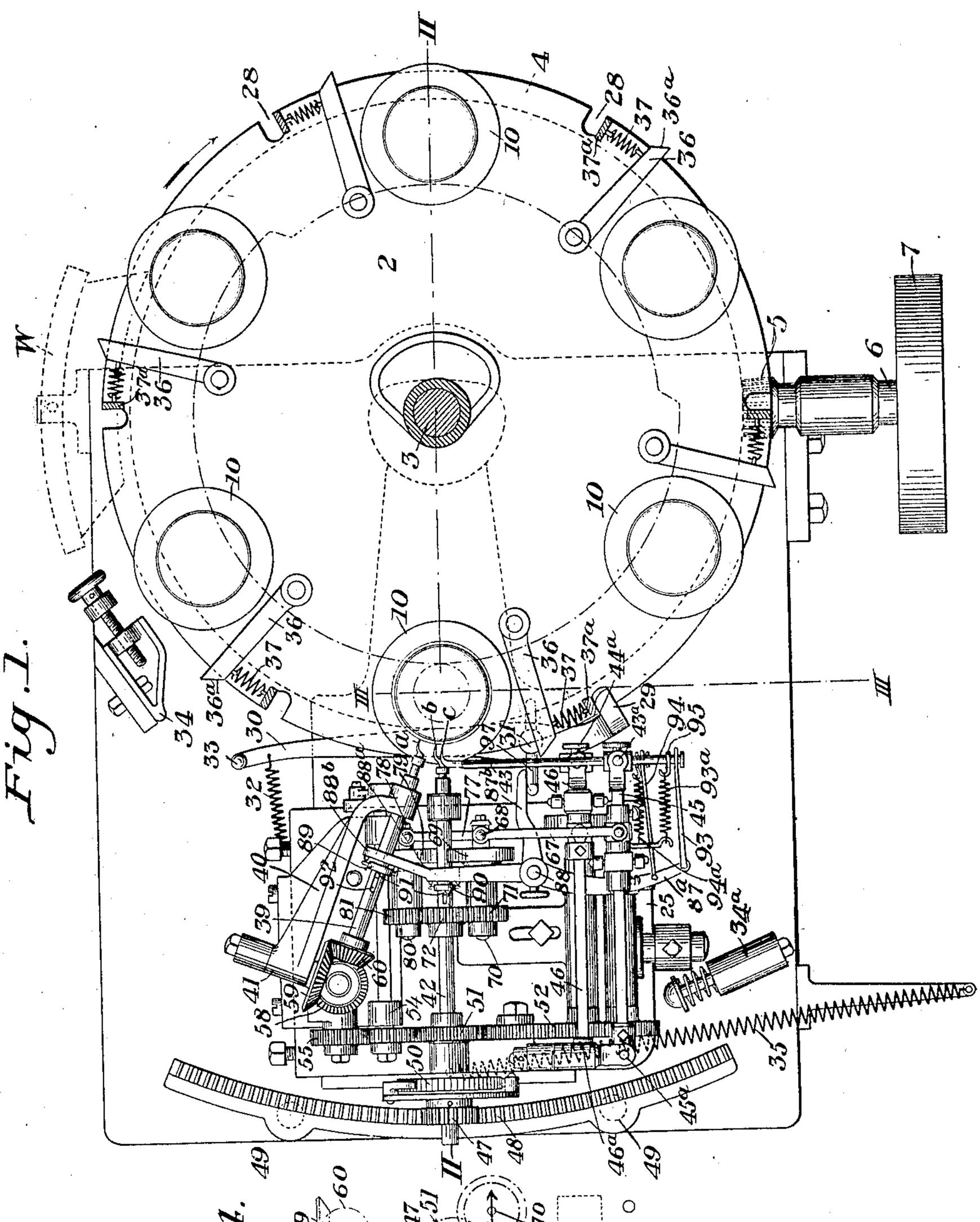

Fig. 4.

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4 SHEETS—SHEET 2.

Fig. 2.

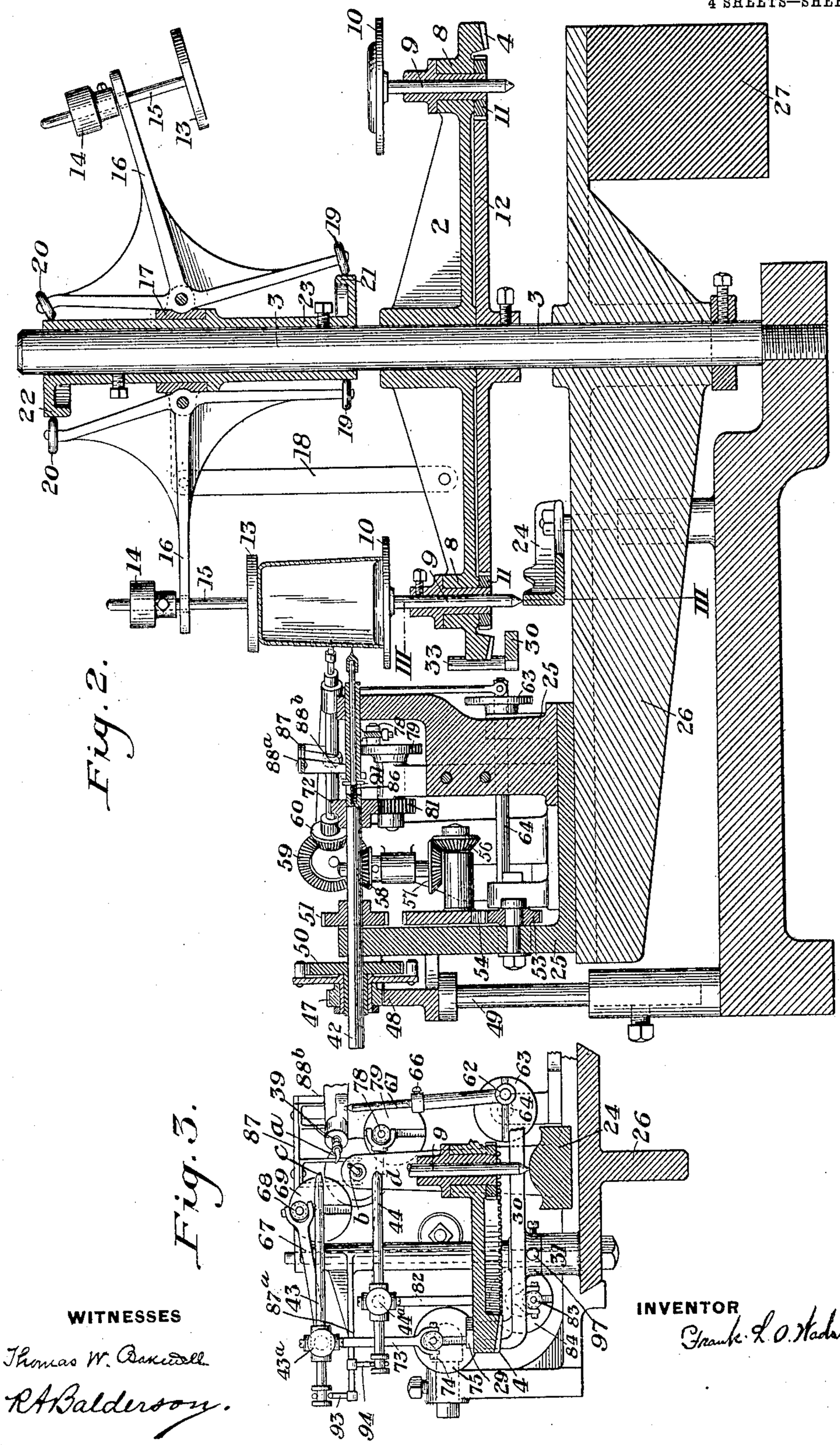

Fig. 3.

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4 SHEETS—SHEET 3.

Fig. 8.

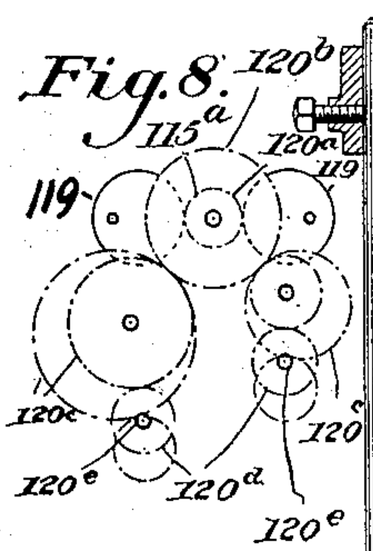


Fig. 5.

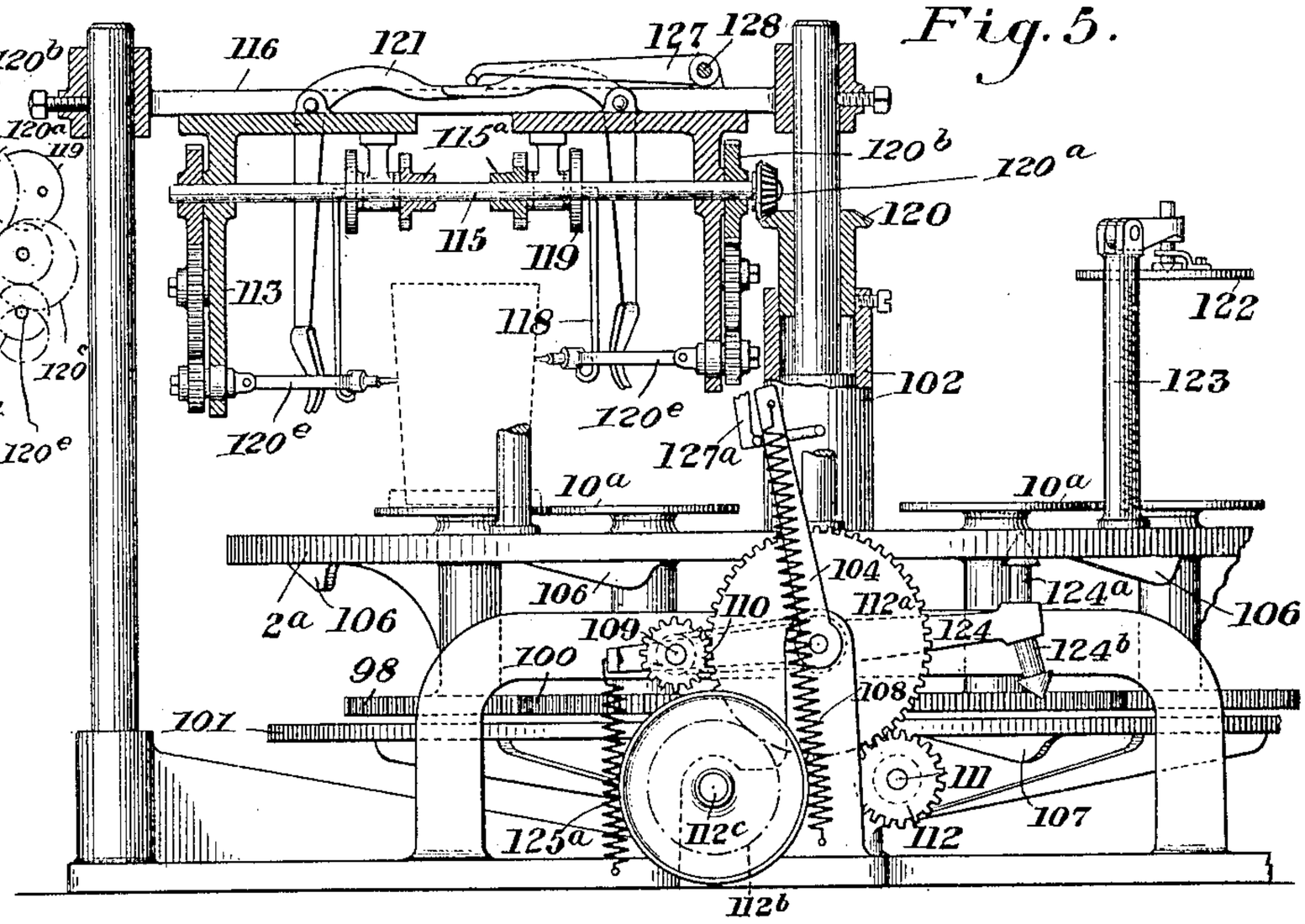
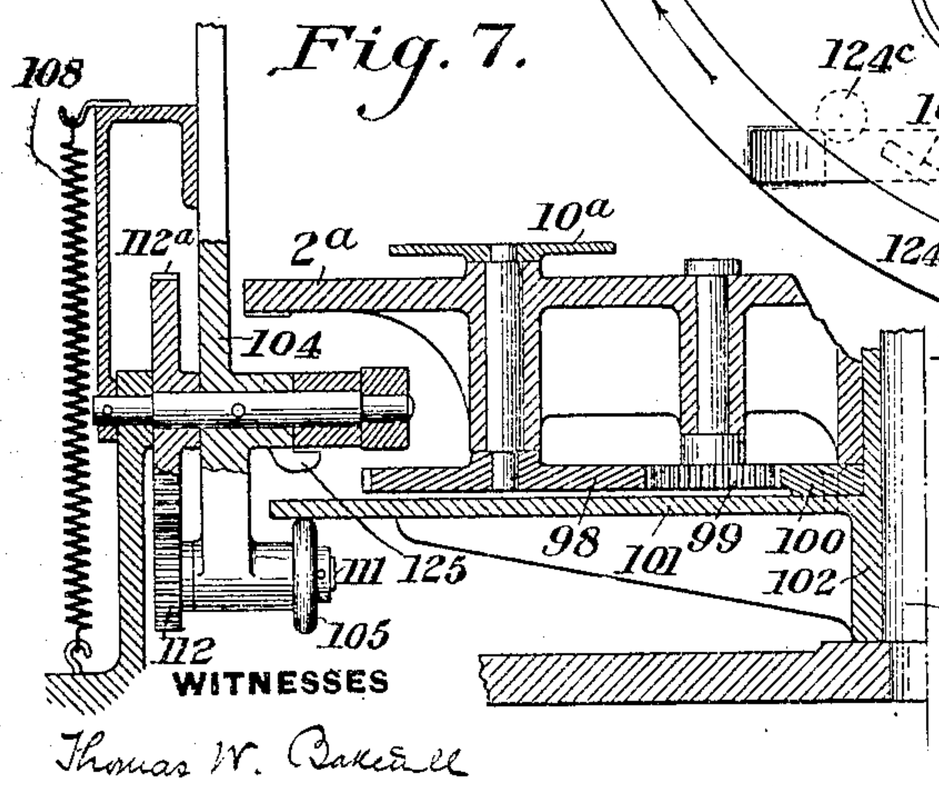


Fig. 6.

Fig. 7.



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4 SHEETS—SHEET 4.

Fig. 9.

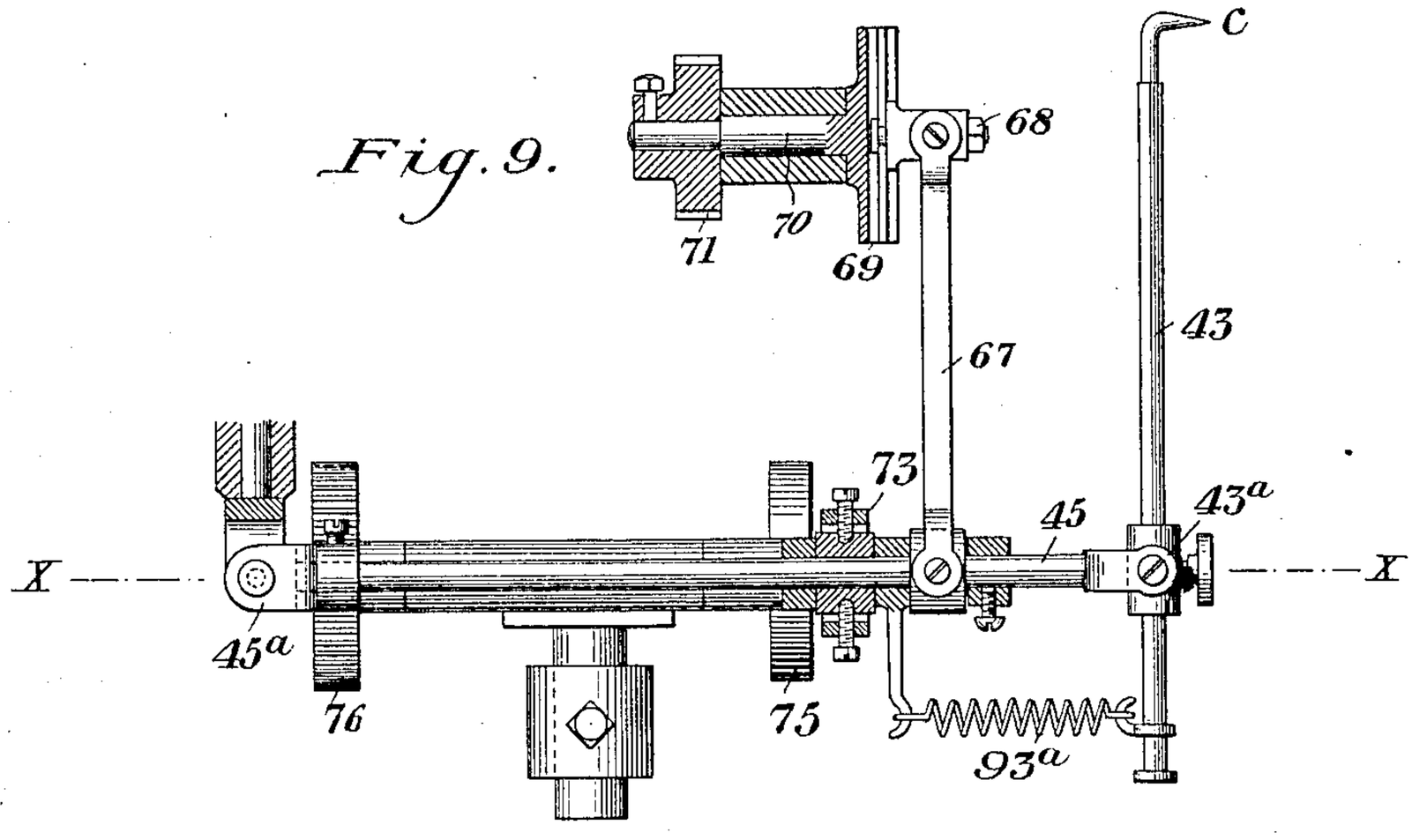


Fig. 10.

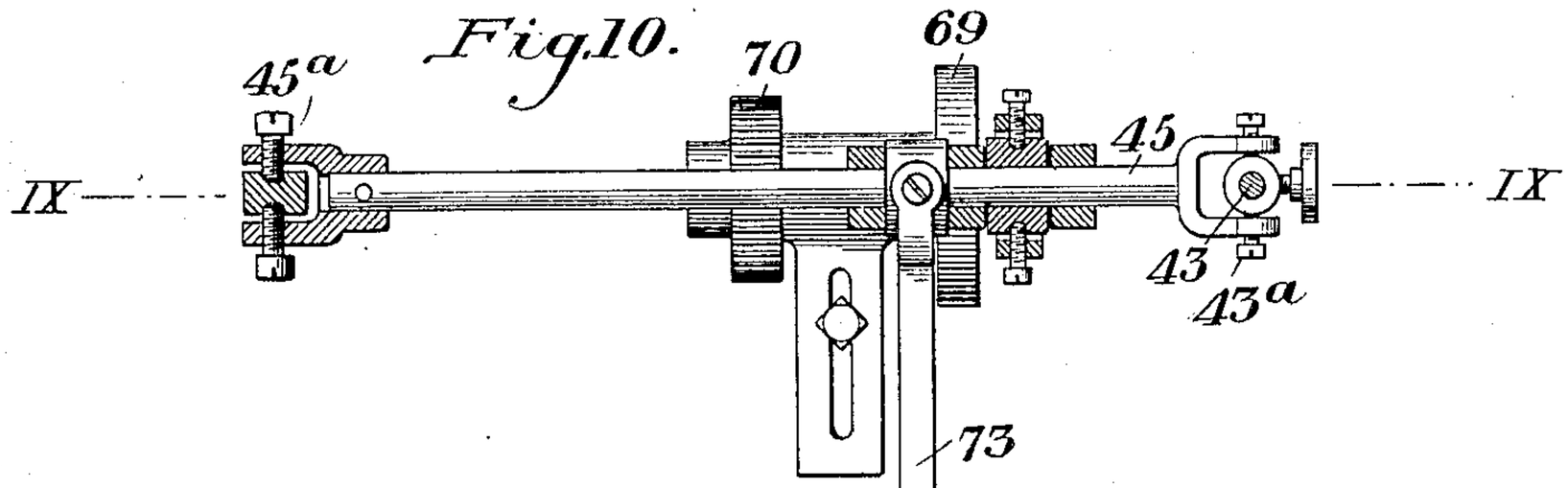


Fig. 11.

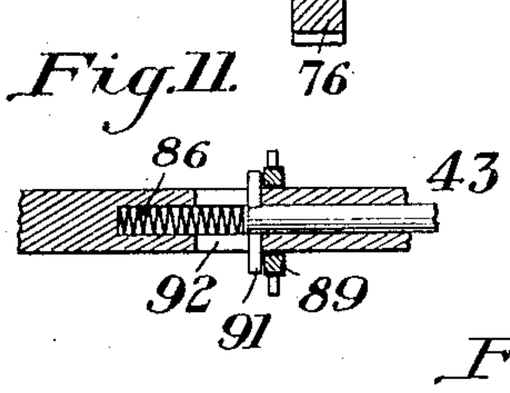
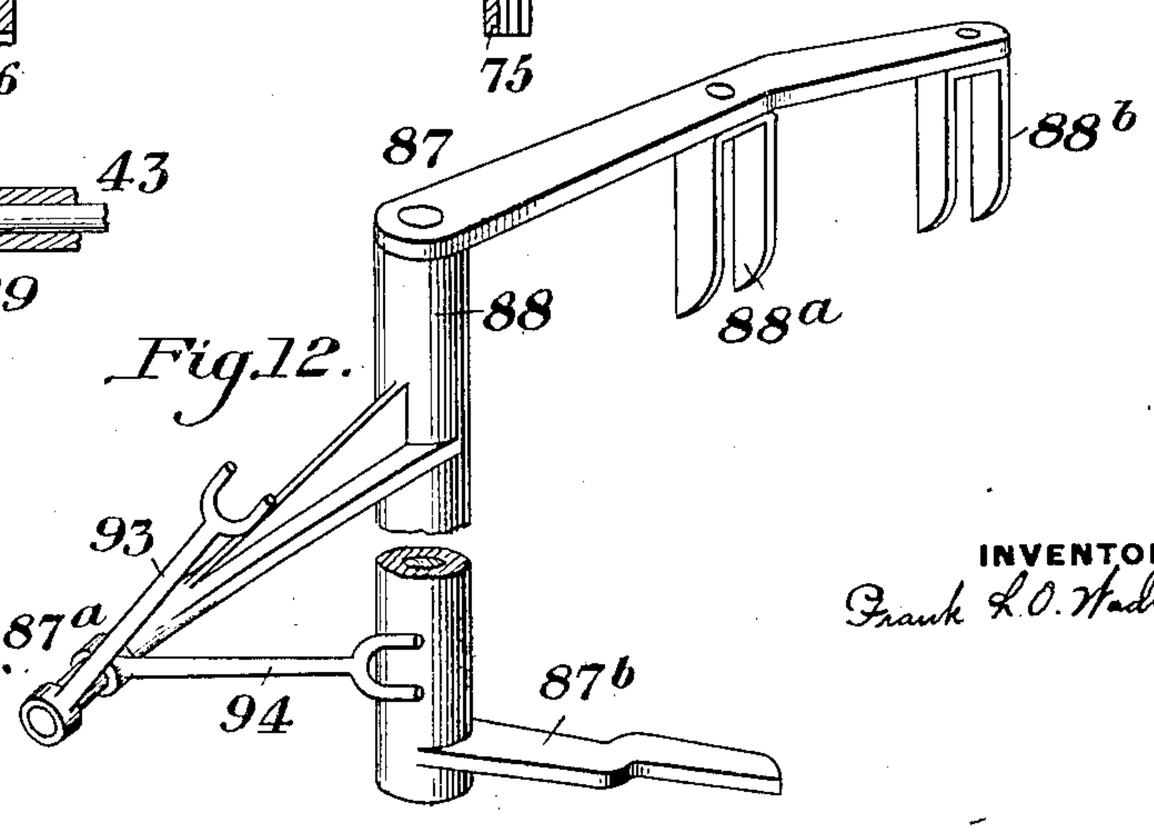


Fig. 12.



WITNESSES

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ETCHING OR ENGRAVING MACHINE.

No. 887,554. Specification of Letters Patent. Patented May 12, 1908.

Application filed December 13, 1905. Serial No. 291,503.

To all whom it may concern:

Be it known that I, FRANK L. O. WADSWORTH, of Morgantown, Monongalia county, West Virginia, have invented a new and useful Etching or Engraving Machine, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming part of this specification, in which—

Figure 1 of the drawing is a plan view of a machine embodying my invention, with the top holding members or clamps for the work removed; Fig. 2 is a central vertical section of the machine on the line II—II of Fig. 1 with the top-holding members or clamps shown; Fig. 3 is a section on the line III—III of Fig. 2 looking towards the left of such figure; Fig. 4 is a diagram of the gearing for actuating and operating the needle carriers; Fig. 5 is a side view partly in section of a modified form of the machine; Fig. 6 is a partial plan view of the machine of Fig. 5; Fig. 7 is a sectional view of a portion of the gearing at the base of the machine; Fig. 8 is a diagram of the needle actuating gearing of Fig. 5; Fig. 9 is an enlarged detail view of the needle 43 and its actuating parts the plane of section of those parts which are shown in section being on the line IX—IX of Fig. 10, and Fig. 10 is a transverse sectional view of the same on the line X—X of Fig. 9; Fig. 11 is a detail view of a portion of the needle showing the cushion spring, and Fig. 12 is a perspective view of the three-part lever.

My invention has relation to machines for etching or engraving upon glass or other articles, and is designed to provide a machine of this class having means whereby a plurality of articles may be placed upon a common movable carrier or support and be brought successively and automatically to the action of an engraving or etching tool or tools. In such a machine it is necessary that the work shall be held in a relatively fixed relation to the etching tool or tools while it is given either a complete revolution or such other movement as may be necessary to complete the formation of the pattern. This may be accomplished either by a constant movement of the common support or carrier in connection with means whereby the tool or tools are caused during proper intervals of time to move with such support or carrier, or by intermittently moving the support or carrier and keeping it in relatively fixed relation to the tool or tools during the time that each article is being operated upon. Both these forms are within the broad scope of my invention.

The invention is also designed to provide a machine of this character having a plurality of etching tools capable of a variety of movements with respect to the work and one or more of which have compound oscillating movements, together with means for varying either the period or extent of such movements or both, whereby a great variety of more or less complicated patterns or designs may be produced upon the same machine.

My invention is also designed to provide means whereby as each article is placed upon the support or carrier it will be automatically held in proper position thereon until such time as it is ready to be removed from the machine, when it will be automatically released.

Various other objects and advantages of my invention will hereinafter appear, and my invention will be best understood by reference to the accompanying drawings.

I will first describe the form of my invention shown in Figs. 1, 2, 3 and 4, in which the rotary support or carrier for the work is constantly rotated, while the machine is in operation, and the etching tool or tools are caused to intermittently move therewith while performing their work upon the successive articles.

2 designates the rotary support or carrier which is mounted upon a fixed shaft 3 and which is provided on its under side with a toothed gear 4 engaged by pinion 5 of an actuating shaft 6 driven by a pulley 7 or any other suitable means. Journaled to rotate in bearings 8 of the support or carries 2, and placed at equi-distant intervals, are a series of spindles 9, each of which carries a table 10 which forms the support upon which the article to be etched or engraved is held. The spindles 9 are driven by means of pinions 11 which engage the teeth of a fixed gear 12 secured to the shaft 3. As the support or carrier 2 is rotated the pinions 11 travel around this fixed gear 12 and the entire series of spindles 9, with the tables 10, are simultaneously rotated.

In Fig. 2 one of the articles to be etched or engraved is shown in position on one of the tables 10, being held thereon by a cap or top-plate 13 carrying a weight 14 on a vertical stem 15. To automatically bring these plates or caps into position to hold the work,

and also to release the work at the proper time, I provide the levers 16 which are pivoted to a rotary sleeve or hub portion 17 journaled around the fixed shaft 3 and which is connected by arm 18 or other suitable means to the support or carrier 2 to rotate therewith. Each lever 16 is provided with rollers 19 and 20 which travel in contact with fixed cams 21 and 22, carried by sleeve 23 fixed to the shaft 3. The cams 21 and 22 are placed oppositely to each other and coact upon the rollers 19 and 20 in such a manner that after each article has been placed upon one of the tables 10 the top-plate 13 is moved down to hold the article, and remains in this position until the work has been done, when the lever 16 is moved to raise the plate as shown at the right of Fig. 2.

The gear 12 is preferably a mutilated gear as indicated by its dotted pitch line in Fig. 1, the mutilated portion being so located that the supports, chucks, or tables 10, will be at rest, in so far as rotation is concerned, at the time the articles are being placed thereon and removed therefrom. At this time the holding caps or plates are also moved away from the chucks or supports, as described.

In order to vary the pattern or design produced, each of the spindles 9 and tables 10 may be made to reciprocate, vertically while the etching tool or tools are operating, this being accomplished by means of fixed cams 24 which are engaged by the lower ends of the spindles 9, the spindles being slotted and movable vertically in their bearings and through the pinions 11 for this purpose. The top weights 14 are carried by shafts 15 which are movable in the arms of the levers 16 so that the top-plates 13 may move with the article as the table is reciprocated. By using cams 24 of different patterns it will be readily seen that great variations in design may be produced.

I will now describe the construction and arrangement of the etching head and etching tools and the means for operating the same.

The etching head has a frame 25 which is adjustably supported in ways or guides of a swinging arm 26, which is pivotally mounted upon the base portion of the fixed shaft 3, and is counterweighted at 27 for the purpose of balancing the weight of the head and thus preventing undue friction from its bearing on said shaft. In this form of my invention, as was premised, it is necessary that the etching head shall be locked in fixed relation to the carrier 2 while each article is being etched. To this end I form in the periphery of the carrier a series of equi-distant notches 28 adapted to be engaged by a pawl 29 of a lever 30 which is pivoted to the frame 25 at 31, under the action of a spring 32.

In the operation of the machine the carrier 2 will revolve until such time as the pawl 29 comes opposite one of the notches 28. The pawl then moves into such notch and thereby locks the frame 25 and arm 26 to the carrier, and the etching head is moved with the carrier on the arm 26 while the article on the table 10 is being etched and until such time as the opposite end 33 of the pawl lever comes in contact with an adjustable cam 34. This contact moves the lever 30 to disengage the pawl 29 from the carrier 2, and the arm 26, with the etcher head, is immediately moved back to its starting position against a buffer 34[a] by any suitable means such as the spring shown at 35. The head remains in this position until another notch 28 comes opposite the pawl 29 when the movement above described is repeated, and this occurs successively as each article is brought in position to be operated upon by the etching tools.

In order to prevent a shock on the machine due to a too abrupt connection between the frame for the etching head and the carrier 2, I provide the latter with a series of pawls 36, to each of which is connected one end of a compression spring 37, the other end being connected at 37[a] to the carrier 2. Shortly prior to the time when a notch 28 comes into position to be engaged by the pawl 29, the beveled end 36[a] of one of the pawls 36 engages the end portion 33 of the lever 30, thereby checking the pawl and compressing the spring 37. The effect of this is to overcome the inertia of the head and its carrier, so that the latter are substantially beginning to move at the time the pawl 29 makes its engagement with one of the recesses 28.

I have shown the etching head as provided with four etching points or needles, *a*, *b*, *c* and *a* arranged in different vertical planes and adapted for different movements. The needle *a* is mounted in and rotated by a shaft 39 supported and having its bearings in an arm 40 which is pivotally mounted on the frame 25 at 41, means such as hereinafter described being provided for rotating the shaft 39 and for oscillating the same about the center 41 as it is rotated. The point *b* is supported in and carried by a shaft 42 whose movement is one of rotation only. The points *c* and *d* are carried respectively by the needle bars 43 and 44, which are pivotally connected at 43[a] and 44[a] to the oscillating needle-bar supports 45 and 46, respectively, which are mounted for universal movement on the frame 25 at 45[a] and 46[a].

Mounted on the shaft 42 is a pinion 47, which, as the etching head is moved in the manner which has been described, engages the teeth of a curved rack 48. This rack is mounted on the vertically adjustable frame supports 49 so that it may be raised or lowered to permit the use of pinions 47 of varying diameters. The connection between the pinion 47 and the shaft 42 is made through a pawl and ratchet device 50 whereby said

shaft, and the trains of gearing actuated thereby, for operating the needle points *b*, *c* and *d*, will be operated only during the forward movement of the etching head with the carrier, and will remain idle during the return movement. The needle shaft 42 is operated directly by the pinion 47 and operates the other needle shafts or carriers through a suitable arrangement of gearing such as will now be described, particular reference being had to Fig. 4 which shows a diagram of such gearing.

Mounted on the shaft 42 is a pinion 51 which drives an idler 52. This in turn drives the train of spur wheels 53, 54 and 55. The spur wheel 55 actuates bevel gearing 56, 57, 58, 59 and 60, the bevel gear wheel 60 being on the needle shaft 39 and whereby said shaft is rotated. The shaft 39 is oscillated by an adjustable rod 61 upon which it rests (see Fig. 3), and which at its lower end is connected to a crank pin 62 of a crank wheel 63 on a shaft 64 driven by the gear 54 of the train above described. The crank pin 62, as clearly shown in Fig. 3, is adjustable towards and away from the center of the crank wheel 63 in order to adjust the stroke of the oscillating support 61, and such support is also made adjustable by means of the connections shown at 66, for changing the length of the rod 61, whereby the point of commencement of the stroke may be changed.

The support or carrier 43 for the needle *c* is oscillated, in a direction transversely of the axis of the work, by a pitman connection 67 with a crank pin 68 of a crank wheel 69 which is mounted on a shaft 70, carrying a spur wheel 71 which meshes with a pinion 72 on a shaft 42, and is oscillated in a direction parallel with the axis of the work by means of a pitman connection 73 with a crank pin 74 of a crank wheel 75 driven by the idler 52 through a gear wheel 76.

The needle carrier 44 is oscillated in the direction transversely to the axis of the work by a pitman connection 77 with a crank pin 78 of a crank wheel 79 on the shaft 80 driven by a gear connection 81 with the pinion 72 on the shaft 42, and is oscillated in a direction parallel with the axis of the work by a pitman connection 82 with a crank pin 83 of a crank wheel 84 driven by a gear connection 85 with the idler 52. The several crank pins to which are connected the oscillating pitmen for the various needle carriers are all made adjustable towards and away from the centers of their respective crank wheels, as shown in Fig. 3, in order that the extent of stroke and the corresponding movement of the needle carriers may be readily changed or varied. Those gear wheels of the train which are marked by arrows in Fig. 4 are also made removable from their respective shafts in order that gear wheels of varying diameters may be used for the purpose of varying the frequency of the periods of oscillation, and also the speed of rotation of the rotary needle shafts, provision in each case being made for moving the bearings of the shafts of such gear and of the respective meshing gears in the direction of the arrows to suit such changes. This is readily effected by mounting the bearing supports in slots in the supporting frame parts. Several of these adjustments are indicated in the drawing, but I have deemed it unnecessary to show them all as the arrangement in each case is a duplicate of those which I have shown.

For the purpose of simultaneously advancing and retracting the several needle points to and from the work, said points being mounted in the shafts against advancing springs 86, I provide the following means:— 87 is a three-armed lever which is pivoted at 88 to move in horizontal planes, one arm of such lever having collar portions 88^a and 88^b which engage collars 89 and 90 which are respectively arranged to slide upon the needle shafts 39 and 42. These collars 89 and 90 engage projecting pins 91 of the needle shanks, working in slots 92 of such shafts. A second arm of the lever 87^a has the connections 93 and 94 respectively with collars on the needle carriers 43 and 44. A third arm 87^b of the lever 87 projects into position for engagement with an adjustable arm 97 secured to the pawl lever 30. After the work upon each article has been completed, the pawl lever is disengaged by the stop 34, as already described, and through the action of the arm 97 connected therewith will move the lever 87 to thereby, through the means and connections described, retract the needle points *a* and *b* against their springs, and at the same time move the pivoted needle bars 43 and 44 against the springs 93^a and 94^a and carry the needles away from the work. When the pawl 29 of the lever 30 engages again with another notch 28 of the carrier 2, the lever 87 is released and the needle points *a*, *b*, *c* and *d* are returned to their former position by the action of their respective springs.

The operation of the machine as a whole will be readily understood. The articles are placed upon the tables 10 and the rotation of the carrier 2 brings the articles successively to the etching tools. At this time the etching head, or its carrier, is locked to the carrier 2 and moves with it during the time that the table 10 is making a complete revolution. The etching head is then released and returned by the action of the spring 35 or other suitable means, and shortly thereafter a second article is brought into position to be operated upon, and the described operation is repeated.

As above described, the etching frame can be moved towards and away from the carrier

to adapt the machine to articles of different sizes. The arm 26 can also be raised and lowered on the shaft 3, as indicated in Fig. 2 to raise or lower the plane of operation of the etching tools. Each of the needle bar supports 45 and 46, may be turned in the sockets 45^a, or 46^a to thereby raise or lower the needle bars and needles. This will be apparent from an inspection of Figs. 9 and 10, in which the support 45 is clearly shown. I also preferably provide, adjacent to the carrier 2 a brush W, in contact with which the articles turn after leaving the etching tool for removing the wax from the articles after they are etched. This may be any suitable form of brush, so positioned with respect to the table (as indicated in Fig. 1), that the etched articles, as they are carried along by the table, will be rotated in contact with its bristles.

I will now proceed to describe the modified form of machine shown in Figs. 5, 6 and 7, in which the etching head or heads are fixed and the carrier has an intermittent movement, being fixed during the period of time that each article is being worked upon. In this form the rotary carrier 2^a has its series of tables 10^a driven by gears 98, 99 and 100, the gear 100 being secured to a driving disk 101 which is carried by a sleeve 102 rotatably mounted on a fixed shaft 3^a. The gears 99 are intermediate idler gears between the gear 100 and the gears 98 on the spindles of the tables 10^a. The table or carrier 2^a is arranged to be intermittently driven by a friction roller 103 which is journaled in one arm of a bell crank lever 104. This bell crank lever has a second arm carrying a second friction roller 105 which is designed to engage the under side of the driving disk 101, and drive the same when the carrier 2^a is locked and stationary. The bell crank lever is moved from one position to the other by the action of cams 106 and 107, the cams 106 being on the under side of the table or carrier 2^a and the cams 107 being on the under side of the lower driving disk 101. A spring 108 is further provided to throw said crank past center and complete the movement begun by the cams. The roller 103 is on the shaft 109 driven by the gear wheel 110, and the roller 105 is on the shaft 111 carrying a pinion 112. Both pinions are engaged and driven by an idler gear 112^a on the axis of the bell crank lever, the gear 112^a being in turn driven by a gear 112^b on the pulley or motor shaft 112^c.

The four etching points are carried in horizontally adjustable frames 113 and are arranged to oscillate upon centers 114 and actuated by gear connections with a shaft 115 supported in bearings from an overhanging frame 116. The needle shafts are each universally jointed at 117. In this form of machine I have shown each needle shaft as having a simple vertical oscillatory motion effected by connections 118 with crank wheels 119. The shaft 115 is actuated by gear connection 120 with the sleeve 102 before referred to.

121 is a retracting lever for the needle points. The particular arrangement of the driving gears is shown in Figs. 5 and 8, and it will be understood from these figures, its arrangement being such that the four needle shafts are rotated in unison from the shaft 115. In the arrangement of gearing shown, the shaft 115 has a bevel pinion 120^a, which meshes with, and is driven by, the bevel gear 120; also spur gears 120^b, each of which drives the two spur gear wheels 120^c. Each wheel 120^c drives a pinion 120^d on one of the etcher shafts 120^e. The shaft 115 also carries pinions 115^a which drive the crank-wheels 119. Fig. 8 shows diagrammatically the arrangement of gearing for the two etchers at one end of the shaft 115; that at the opposite end is similar. This figure also indicates the manner in which spur gear wheels 120^c of different diameters may be used to vary the speed.

122 designates the top holders for the articles mounted upon standards 123 secured to the carrier 2^a.

124 is a stop lever for checking the movement of the carrier 2^a and of the driving disk 101 at the proper times, said lever having the pawls 124^a, 124^b, which are adapted to engage stop recesses 124^c and 124^d in the adjacent faces of said carrier and said driving disk under the action of a dog 125 on the arm of the bell crank lever 104 and of a spring 125^a on the frame of the machine.

The operation of this form of the invention is as follows: The carrier 2^a being rotated moves a sufficient distance to bring one of the tables 10^a into proper working relation to the etching tools. At this time one of the cams 106 engages the friction roller 103 and moves the bell crank lever 104 to bring said roller out of driving relation to the carrier 2^a and stop the motion of said carrier by allowing the top dog 124^a of the stop lever 124 to engage with one of the stop recesses 124^c in the carrier 2^a. The motion of the bell crank lever begun by the cam is completed by the spring 108 and brings the roller 105 into driving relation with the disk 101. The latter now commences to rotate, thereby rotating the table 10^a and through the gearing 120 the needle actuating shaft 115, and these movements continue until such time as the table 10^a has made a complete revolution, when the cam 107 contacts with the friction driving roller 105 and moves the bell crank lever 104 to disengage the friction roller 105, and through the action of the dog 125 on said bell crank lever depresses the stop lever 124, unlocking the carrier table 2^a and locking the lower driving disk 101 by action of the pawl 124^b. The tables 10^a and the nee-

dle actuated gearing now stop, and the throw of the bell crank lever is completed again by the spring 108 bringing the friction gear 110 again into engagement with the carrier 2^a and rotating it to bring another article to the etching tools. These operations are successively repeated, the carrier 2^a and the driving disk 101 being alternately rotated in the manner described. At each operation the needle points are alternately retracted and released by the action of the retracting levers 121, which are all actuated simultaneously by a single bell crank lever 127 on a shaft 128, the vertical member of this lever being engaged at 127^a within the upper end of the bell crank lever 104 on which the driving disks 103 and 105 are mounted.

While the specific construction and arrangement of the part in this modified form of machine are quite different from the construction and arrangement in the form first described, and while the former will form the subject-matter of separate applications, it will be seen that both forms are included within the broad scope of my invention.

The advantages of my invention result from the manner in which the articles to be etched or engraved may be automatically and successively brought to the action of the tool or tools, from the capability of the machine to produce a large number of varying designs or patterns, and from the convenience and rapidity with which the operation is effected.

Many changes may be made in the arrangement of the driving gear for the carrier, the means for actuating the needle shafts and carriers, and in the various details of construction and arrangement, without departing from the spirit and scope of my invention.

I claim:—

1. In an etching machine, a carrier for the articles to be etched, an etcher to which the articles are successively brought, and means for maintaining a fixed relation between the carrier and etcher while each article is being etched; means for imparting movement to the articles on the carrier during the time of fixed relation, and means for imparting etching movements to the etching tool in definite correlation to the movements of the articles substantially as described.

2. In an etching machine, a carrier for the articles to be etched, an etcher to which the articles are successively brought by the said carrier, and means for locking the carrier and etcher in relatively fixed relation to each other while each article is being etched; means for imparting movement to the articles on the carrier during the time of fixed relation, and means for imparting etching movements to the etching tool in definite correlation to the movements of the articles substantially as described.

3. In an etching machine, a moving carrier having means for supporting a multiplicity of articles to be etched, an etching frame and tool to which the articles are successively brought by the carrier, and means for maintaining the carrier and frame in fixed relation to each other while each article is being etched; means for imparting movement to the articles on the carrier during the time of fixed relation, and means for imparting etching movements to the etching tool in definite correlation to the movements of the articles substantially as described.

4. In an etching machine, a carrier for the articles to be etched having a plurality of supports therefor, an etching frame to which the supports are successively brought, one or more etching tools on the frame, means for imparting etching movements to the tool or tools, and means for holding the frame and carrier in fixed relation to each other while each article is being etched and for imparting a movement to the articles which is definitely correlated to the movements of the tool or tools; substantially as described.

5. In an etching machine, a carrier having a plurality of supports for articles to be etched, an etching frame to which the articles are successively brought by the said carrier and which is adjustable with respect of the carrier, and means for maintaining the carrier and frame in fixed relation to each other, while each article is being etched; means for imparting movement to the articles on the carrier during the time of fixed relation, and means for imparting etching movements to the etching tool in definite correlation to the movements of the articles substantially as described.

6. In an etching machine, a movable carrier having a plurality of supports for the articles to be etched, an etching frame adjustably supported with respect to the said carrier, one or more etching tools on the frame, means for actuating the tools, and locking means for maintaining a fixed relation between the carrier and frame while each article is being etched together with means for imparting movement to the articles which is correlated to the movement of the tool or tools; substantially as described.

7. In an etching machine, a movable carrier having a plurality of supports for the articles to be etched, an etching frame to which the articles are successively brought by the carrier, locking means for maintaining a fixed relation between the carrier and frame, while each article is being etched and for imparting movement to the supports during such times, one or more etching tools carried by the frame, means for actuating the said tools, and means whereby said tools are actuated only when the carrier and frame are in fixed relation; substantially as described.

8. In an etching machine, a carrier having

a plurality of supports for the articles to be etched, an etching frame adjustably supported with respect to the said carrier, etching heads adjustably mounted on the said frame, and means for periodically holding the frame and carrier in fixed relation; together with means for imparting correlated movements to the etching heads and supports, substantially as described.

9. In an etching machine, a carrier having a plurality of supports for the articles to be etched, an etching frame adjustably mounted with respect to the carrier, etching heads adjustably supported in the said frame, etching needles carried by the heads, means for intermittently holding the carrier and frame in fixed relation, and actuating means for the etching needles arranged to operate only when the frame and carrier are in fixed relation and in definite relation to the movements of the articles on the carrier; substantially as described.

10. In an etching machine, a horizontally movable carrier having a plurality of vertically-movable supports for articles to be etched, an etching frame, means for intermittently locking the carrier and frame in fixed relation, and means for effecting a vertical oscillation of said supports, while the head and frame are in fixed relation; substantially as described.

11. In an etching machine, a carrier having a plurality of rotary supports for articles to be etched, an etching frame to which the articles are successively brought by the carrier, and means for intermittently locking the carrier and frame in fixed relation a plurality of etching tools carried by the heads, and means for imparting correlated movements to the tools and supports; substantially as described.

12. In an etching machine, a carrier having a plurality of vertically-movable and rotatable supports for articles to be etched, an etching frame to which the articles are successively brought by the carrier, means for intermittently locking the carrier and frame in fixed relation, and means for oscillating each support while the article thereon is being etched; substantially as described.

13. In an etching machine, a rotary carrier having a plurality of supports, an etching frame, and means for intermittently locking the carrier and frame in fixed relation an etching tool carried by said frame, and means operated by the movement of the frame for operating the tool while the carrier and frame are in fixed relation; substantially as described.

14. In an etching machine, a rotary carrier, a series of rotary supports on said carrier, an etching frame, and means for intermittently locking the carrier and frame in fixed relation an etching tool carried by said frame, and means operated by the movement of the frame for operating the tool while the carrier and frame are in fixed relation; substantially as described.

15. In an etching machine, a rotary carrier, a plurality of rotary supports mounted in the carrier, and gearing for rotating and oscillating the supports during a portion of the rotation of the carrier and for holding them stationary during the remainder of the time; substantially as described.

16. In an etching machine, etching tools a moving carrier, a plurality of rotating supports carried thereby for holding the articles to be etched by the etching tools, means for rotating the supports periodically, and a cleaning brush adjacent to the path of movement of the carrier beyond the etching tools; substantially as described.

17. In an etching machine, the combination with a movable carrier having a plurality of supports for the articles to be etched, of an etching frame, means operated by the movement of the frame for intermittently locking the carrier and frame in fixed relation, one or more etching tools carried by the frame, and means for imparting compound motion to said tool or tools; substantially as described.

18. In an etching machine, the combination with a movable carrier having a plurality of supports for articles to be etched, an etching frame to which the articles to be etched are successively brought by the carrier, and means for intermittently locking the carrier and frame in fixed relation, of one or more etching tools carried by the frame, and means for automatically advancing and retracting the tool or tools at the beginning and end, respectively, of the periods of fixed relation of the carrier and frame together with means for imparting correlated etching movements to the articles and tools; substantially as described.

19. In an etching machine, an etching tool, a movable carrier for bringing the articles to be etched to the action of the tool, a rotary support on said carrier, a holding cap for the article while on the support, a three-armed lever on one arm of which the support is carried, and cams arranged to act on the other two arms of the lever to move the holding cap; substantially as described.

20. In an etching machine, the combination with a rotary carrier having a plurality of supports or chucks, of an etching frame, a movable support for the frame, and means for intermittently locking the support to the carrier an etching tool on the carrier, and gearing actuated by the movement of the frame with the carrier for operating the tool; substantially as described.

21. In an etching machine, the combination with a rotary carrier having a plurality of chucks or supports, of an etching frame, a movable support for the frame, means for

intermittently locking the support and the carrier and for releasing the same and returning the support and frame to initial position an etching tool on the carrier, and gearing actuated by the movement of the frame with the carrier for operating the tool; substantially as described.

22. In an etching machine, the combination with a rotary carrier having a plurality of supports or chucks, of an etching frame etching tools mounted thereon, a swinging support for the frame, means for intermittently connecting the carrier and support for common movement, and means for releasing and returning the support and frame to initial position together with means operated by the forward movement of the frame for operating the etching tools; substantially as described.

23. In an etching machine, the combination with a rotary carrier having a plurality of chucks or supports, of an etching frame, a movable support for the frame, means for intermittently connecting the support and carrier for common movement, and means for overcoming the inertia of the support and frame prior to such connection; substantially as described.

24. In an etching machine, the combination with a rotary carrier having a plurality of supports or chucks, of an etching frame supporting arm pivoted on the axis of rotation of the carrier, an etching frame on said arm means for periodically connecting the arm and carrier for common movement, and spring means for overcoming the inertia of the arm prior to such connection; substantially as described.

25. In an etching machine, the combination with a rotary carrier having a plurality of supports or chucks, of an etching frame supporting arm adapted for periodical movement with the carrier, means for automatically locking the arm to the carrier and for automatically releasing the same an etching frame on the arm, and means for returning the arm to initial position after its release; substantially as described.

26. In an etching machine, the combination with a movable carrier having a plurality of supports or chucks, of an etching frame supporting arm arranged to be moved periodically with the carrier, one or more etching tools carried by the frame, devices for connecting and disconnecting the arm and carrier, and means controlled by such devices for advancing and retracting the etching tool or tools together with an etching frame carried by the said arm; substantially as described.

27. In an etching machine, the combination with a rotary carrier having a plurality of supports or chucks, of an etching frame support, an etching frame on said support means for periodically connecting and disconnecting the support and carrier, an etching tool or tools on the support, and gearing for actuating the tool or tools and actuated by the movement of the support with the carrier; substantially as described.

28. In an etching machine, an etching tool, and means for oscillating the tool in two directions at an angle to each other; substantially as described.

29. An etching machine having an etching tool, means for oscillating the tool in two directions at an angle to each other, and means for varying the position of the tool with respect to the work; substantially as described.

30. In an etching machine, an etching tool, means for oscillating the tool in two directions at an angle to each other, and means for varying the period or periods of oscillation; substantially as described.

31. In an etching machine, an etching tool, means for oscillating the tool in two directions, at an angle to each other, and means for varying the amplitude of one or both oscillating movements; substantially as described.

32. In an etching machine, an etching tool, means for oscillating the tool in two directions at an angle to each other, and means whereby the period and amplitude of either or both oscillating movements may be varied; substantially as described.

33. In an etching machine, a plurality of etching tools, means for oscillating one of said tools in two directions at an angle to each other, and means for rotating and oscillating one or more of the other tools; substantially as described.

34. In an etching machine, the combination with a support or chuck for the article to be etched, and means for reciprocating the support relatively to an etching tool, of an etching tool, and means for oscillating such tool in two directions at an angle to each other; substantially as described.

35. In an etching machine, the combination with a support or chuck for the work, and means for rotating and reciprocating the support, of a plurality of etching tools, means for oscillating one or more of the tools in two directions at angles to each other, and means for imparting rotary and oscillating movements to the other tools; substantially as described.

36. In an etching machine, an etching tool, a holder therefor, and means for moving the holder to oscillate the tool both transversely and parallel to the axis of the work; substantially as described.

In testimony whereof, I have hereunto set my hand.

FRANK L. O. WADSWORTH.

Witnesses:
GEO. B. BLEMING,
GEO. H. PARMELEE.