(No Model.) 10 Sheets—Sheet 1.

B. S. MOLYNEUX.

ENGRAVING MACHINE.

No. 549,147. Patented Nov. 5, 1895.

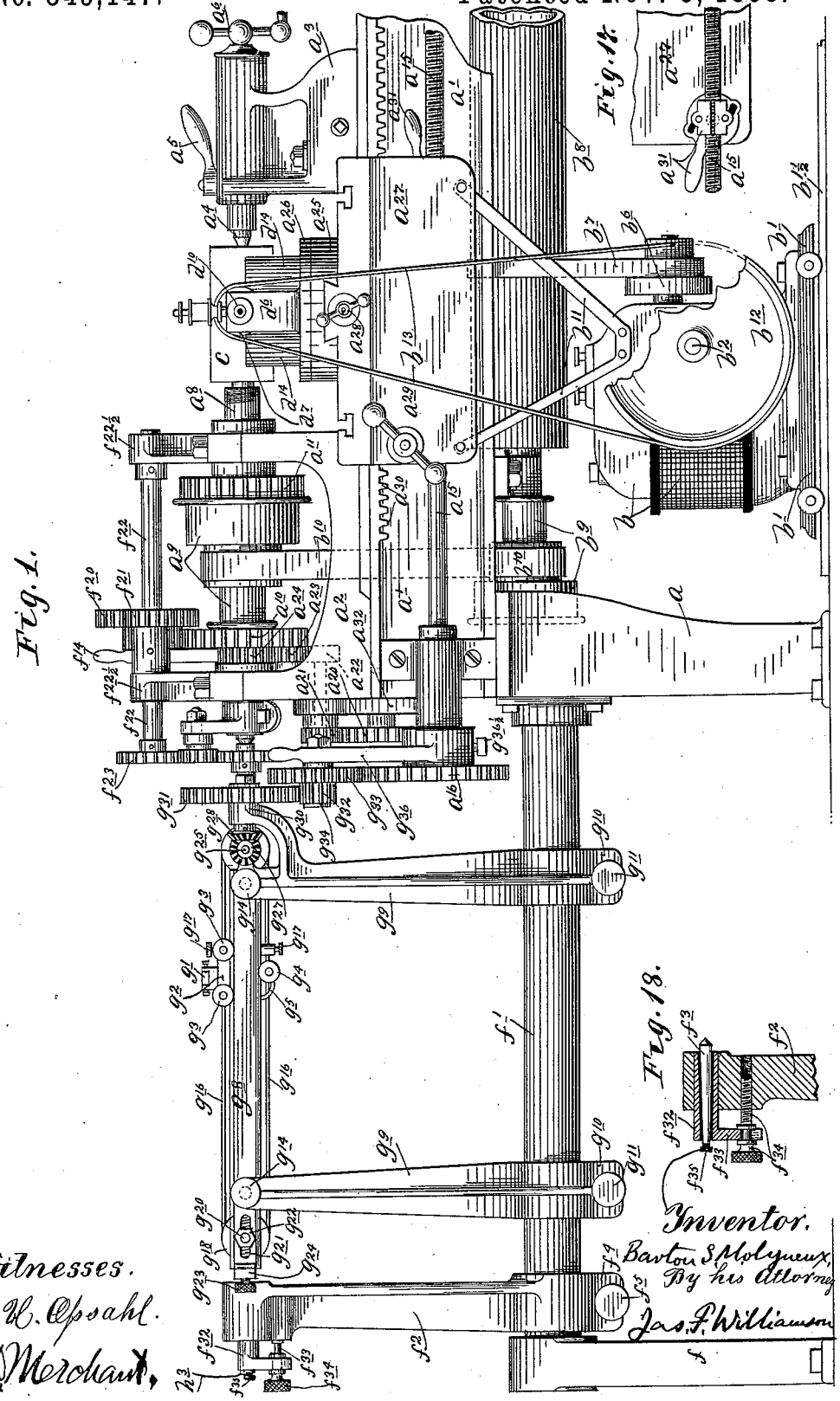

Fig. 1.

Fig. 1A.

Fig. 1B.

Witnesses.
A. W. Upsahl.
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(No Model.) 10 Sheets—Sheet 2.

B. S. MOLYNEUX.

ENGRAVING MACHINE.

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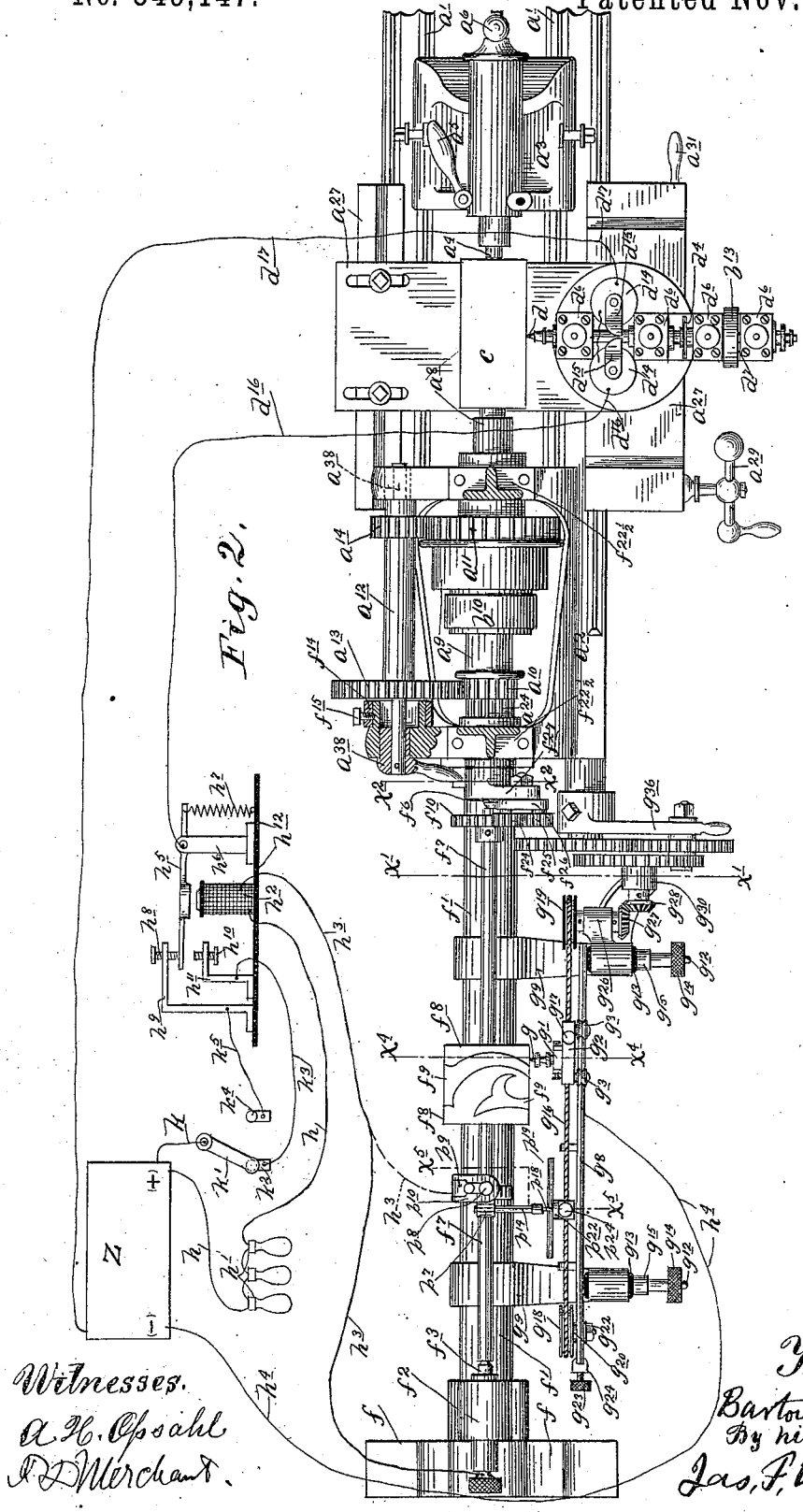

Fig. 2.

Witnesses.
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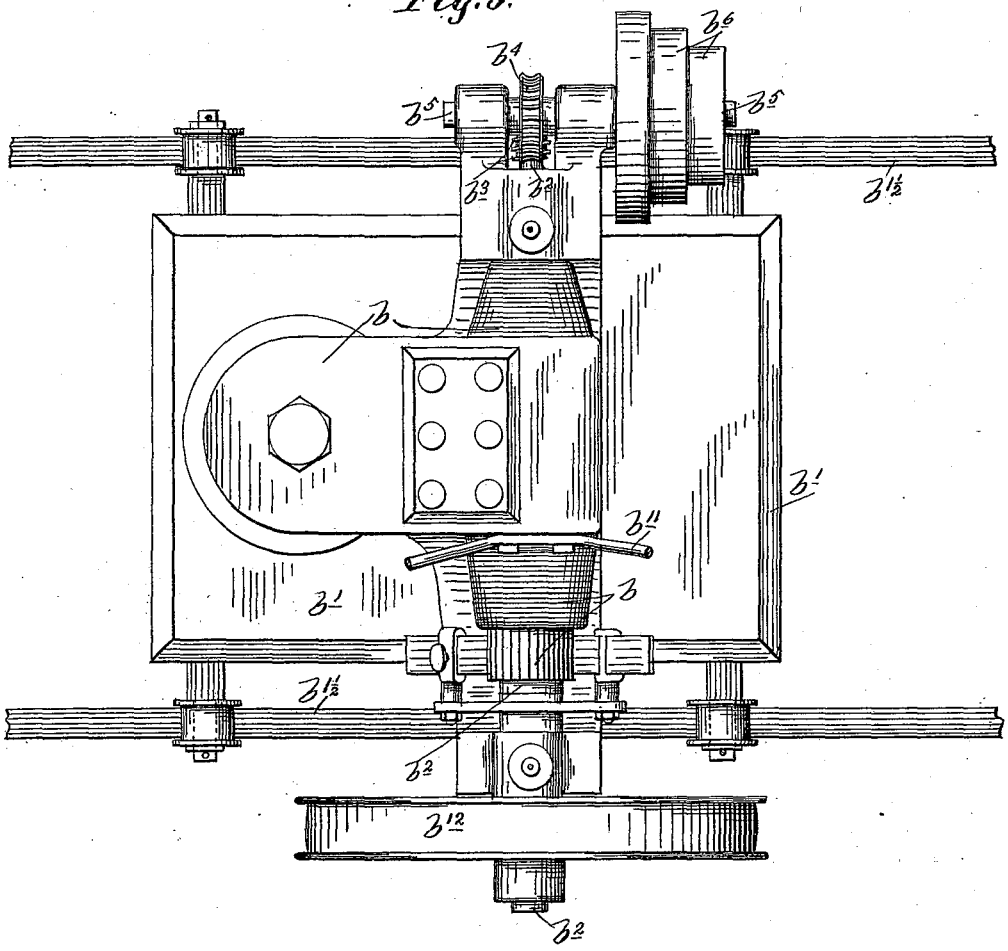
B. S. MOLYNEUX.

ENGRAVING MACHINE.

No. 549,147. Patented Nov. 5, 1895.

Fig. 3.



Witnesses.
A. H. Ashall.
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(No Model.) 10 Sheets—Sheet 4.

B. S. MOLYNEUX.

ENGRAVING MACHINE.

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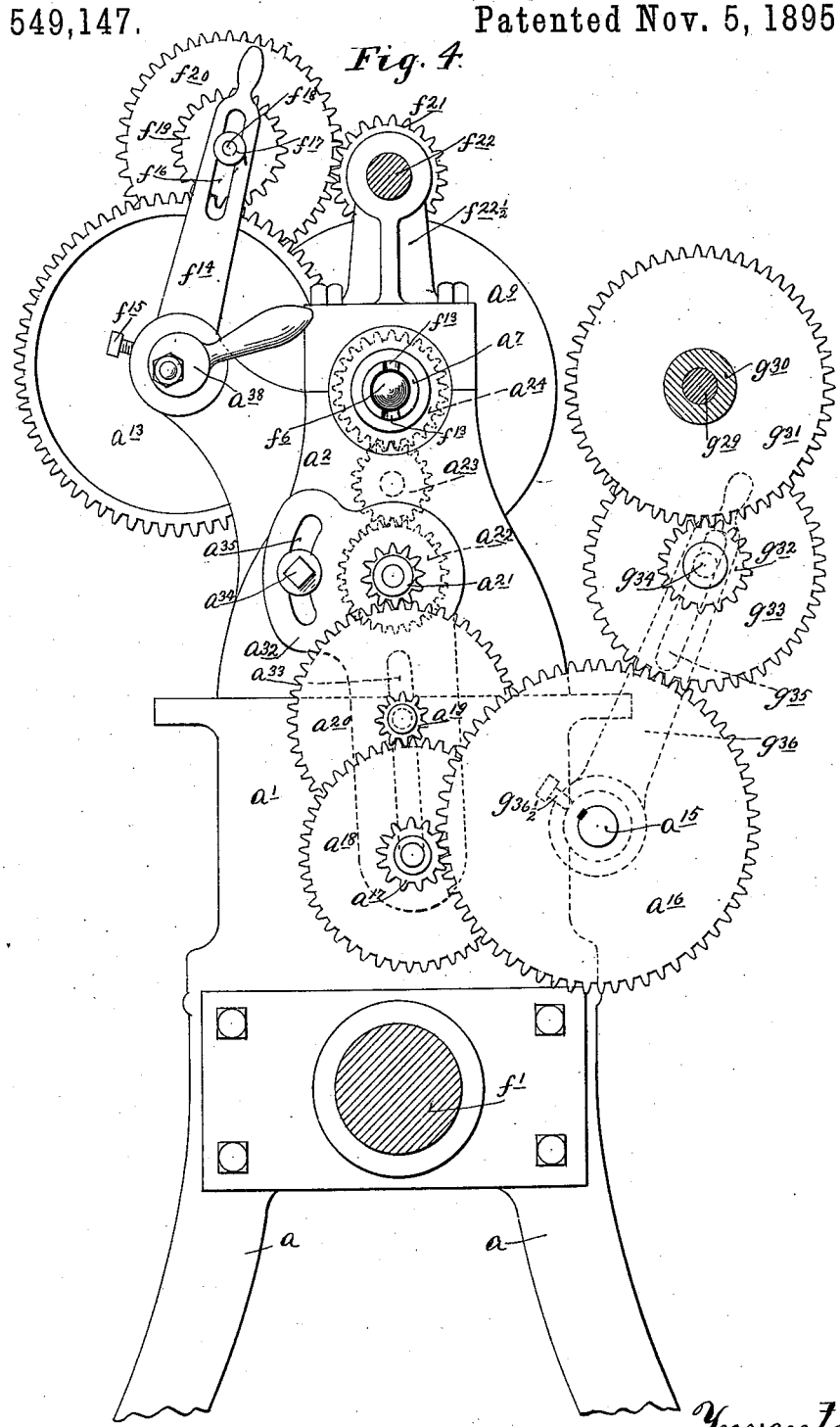
Fig. 4.



Witnesses.
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(No Model.) 10 Sheets—Sheet 5.

B. S. MOLYNEUX.

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Fig. 5.

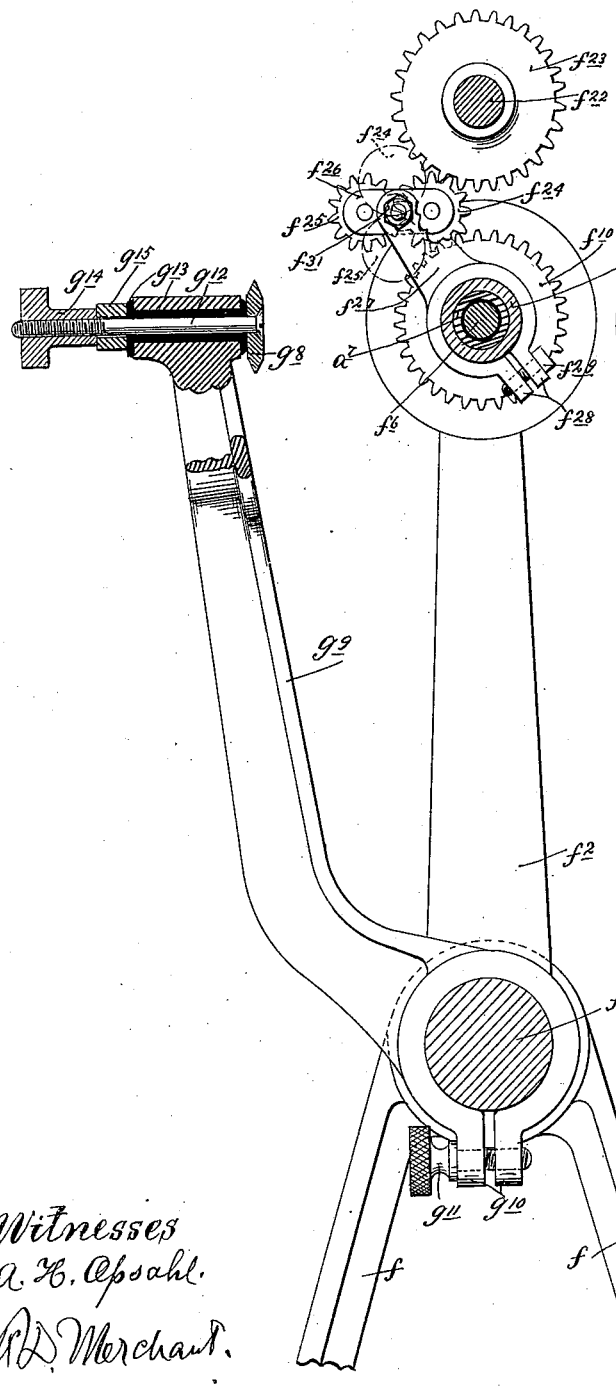
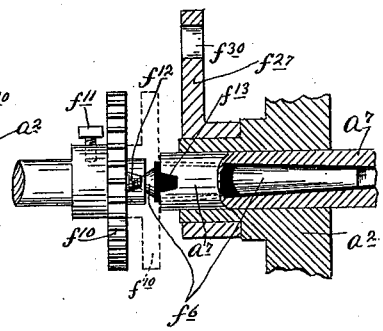


Fig. 6.



Witnesses
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(No Model.) 10 Sheets—Sheet 6.

B. S. MOLYNEUX.

ENGRAVING MACHINE.

No. 549,147. Patented Nov. 5, 1895.

Fig. 7.

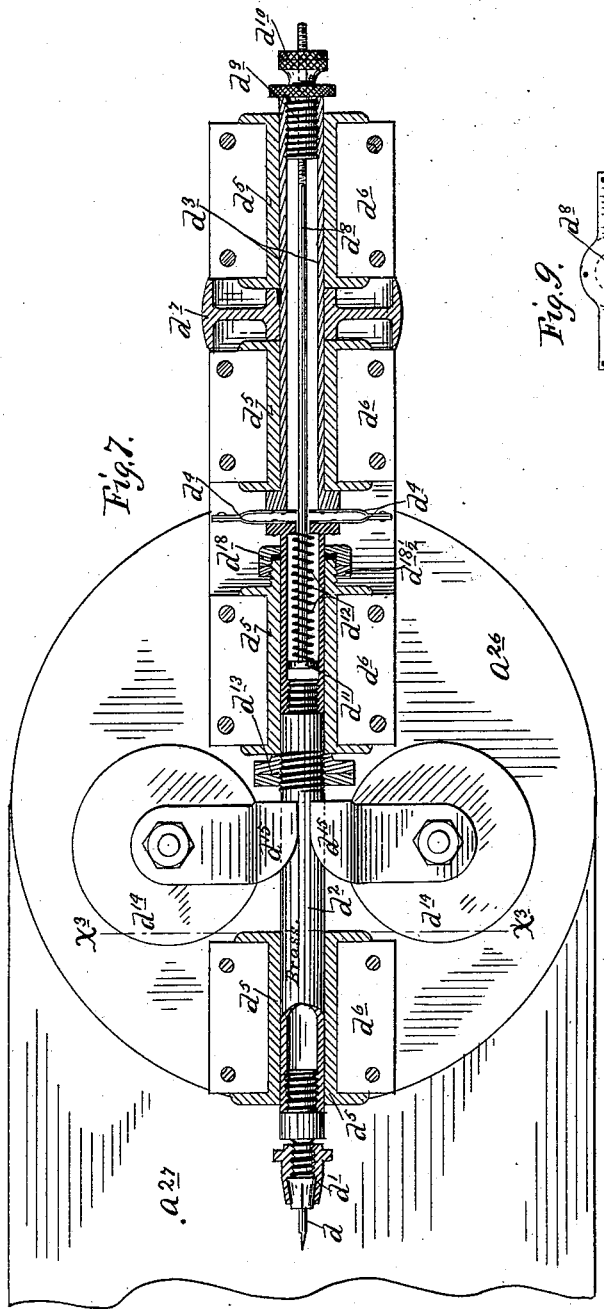


Fig. 9.

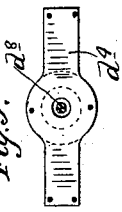
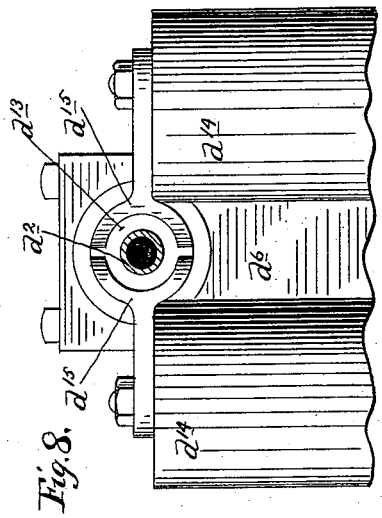


Fig. 8.



Witnesses.
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(No Model.) 10 Sheets—Sheet 7.

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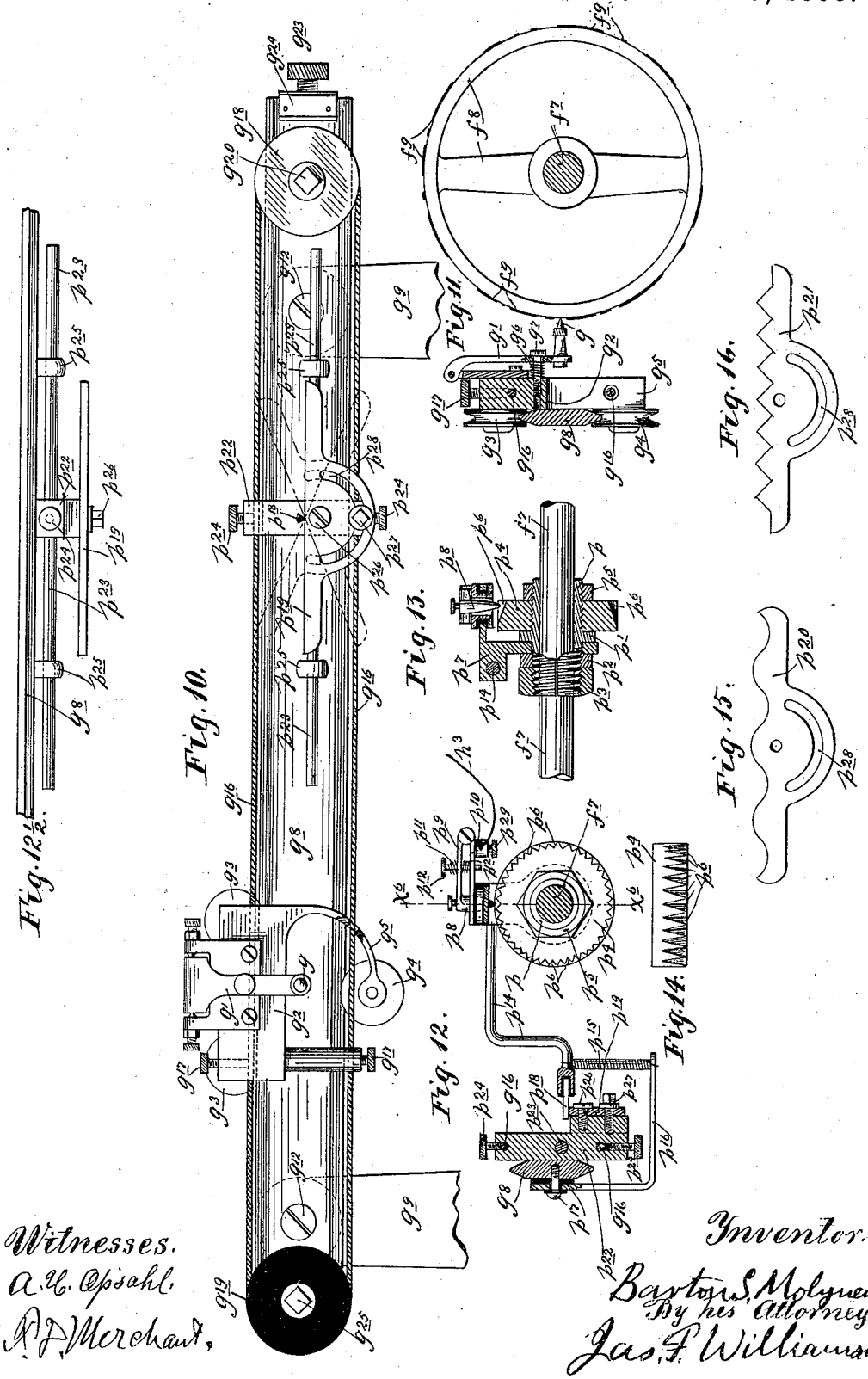

Fig. 10.

Fig. 12½.

Fig. 11.

Fig. 13.

Fig. 12.

Fig. 16.

Fig. 15.

Fig. 14.

Witnesses.
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(No Model.) 10 Sheets—Sheet 8.

B. S. MOLYNEUX.

ENGRAVING MACHINE.

No. 549,147. Patented Nov. 5, 1895.

Fig. 19.

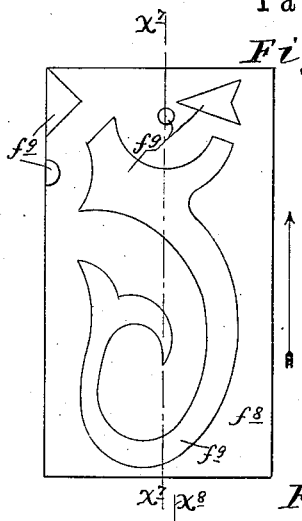


Fig. 20.

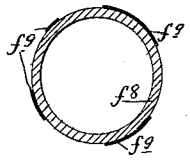


Fig. 21.

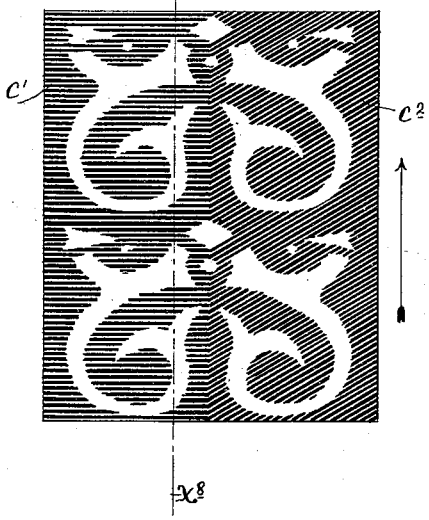
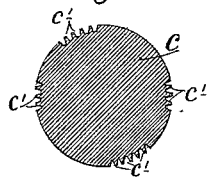


Fig. 22.



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(No Model.) 10 Sheets—Sheet 9.

B. S. MOLYNEUX.

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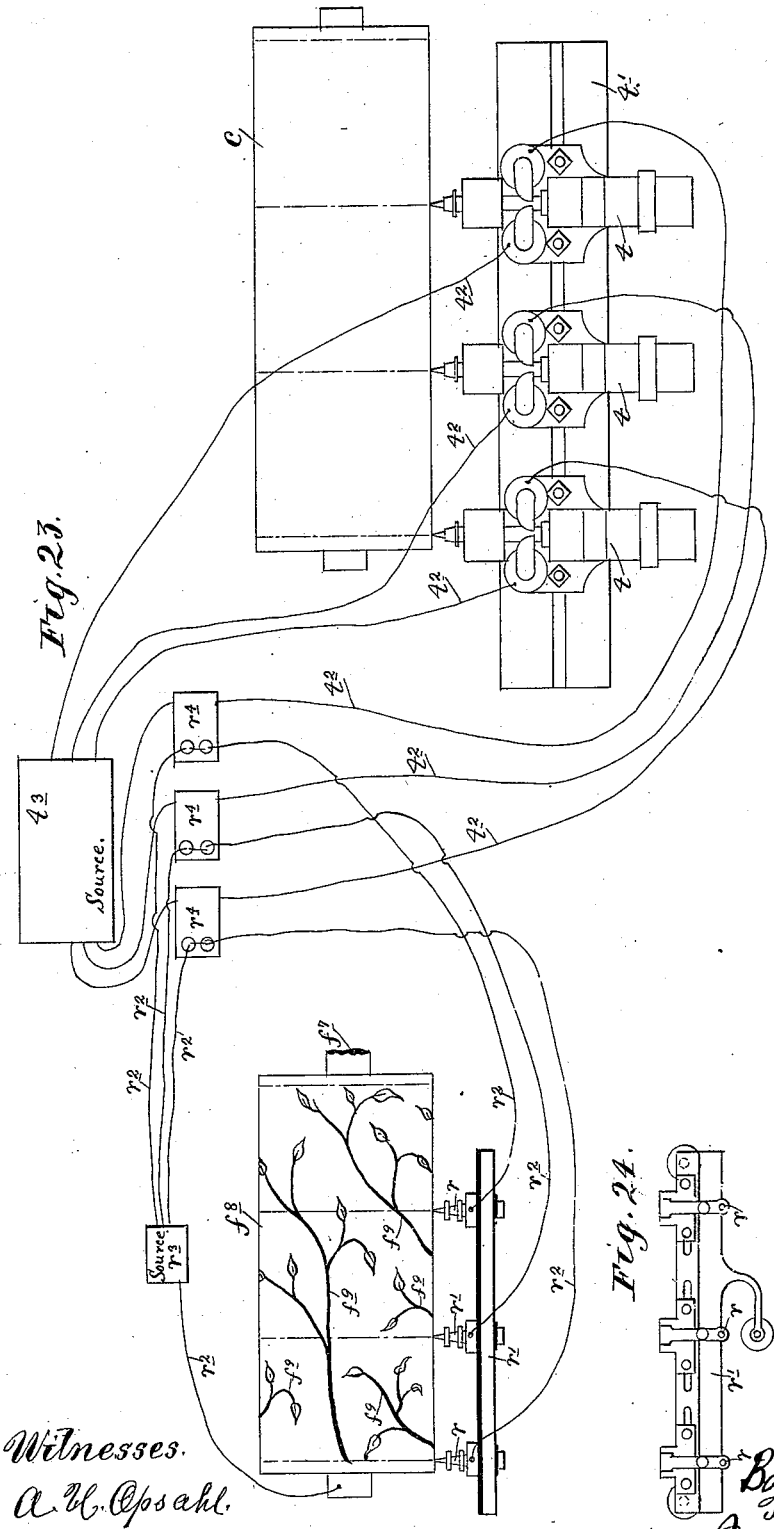

Fig. 23.

Fig. 24.

Witnesses.
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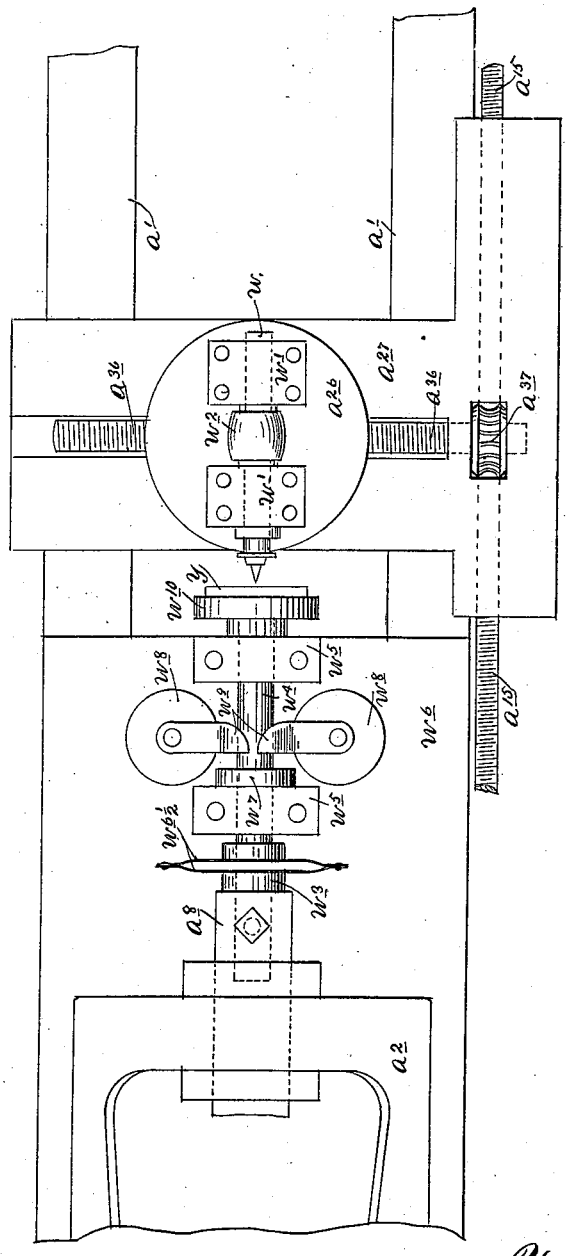
B. S. MOLYNEUX.

ENGRAVING MACHINE.

No. 549,147. Patented Nov. 5, 1895.

Fig. 25.



Witnesses.
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UNITED STATES PATENT OFFICE.

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ENGRAVING-MACHINE.

SPECIFICATION forming part of Letters Patent No. 549,147, dated November 5, 1895.

Application filed May 1, 1894. Serial No. 509,656. (No model.)

To all whom it may concern:

Be it known that I, BARTON S. MOLYNEUX, a citizen of the United States, and a resident of the city of Minneapolis, in the county of Hennepin, State of Minnesota, have invented certain new and useful Improvements in Engraving-Machines; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention has for its object to provide an efficient engraving-machine capable of a great variety and a high quality of work and of large capacity in a given unit of a time.

To these ends the invention consists of the novel devices and combinations of devices, which will be hereinafter fully described, and be defined in the claims.

It will conduce to a more ready understanding of the mechanism to note, first of all, what the machine will do. This may be briefly stated as follows:

First. Engrave on any rotated surface of any suitable material, either in cameo or intaglio, from one and the same rotated pattern for any given design and make the cut of any desired depth or the printing-surface of any desired height with a single action of the graver or drill.

Second. Produce independent of the pattern line-printing surfaces of any desired kind, whether straight, wave-like, or angular, on the background, in any desired relation to the design of the pattern.

Third. Multiply or repeat in a single circle on the design-roller as many times as desired from a single figure or section of the pattern-roller, thereby insuring absolute accuracy in the duplication of the design and in the spacing of the said duplicate designs with respect to each other circumferentially of the design-roller.

Fourth. Simultaneously produce on the design-roller several sections of a design, continuous or otherwise, which extends longitudinally of the rollers. These longitudinal sections of the design may be either joined or spaced apart from each other on the roller. In addition any design or figure of a design may be duplicated longitudinally of the design-roller from a single tracer acting on the pattern-roller.

Fifth. Any pattern can be reversed longitudinally of the design-roller. Hence in bi-symmetrical designs a half pattern will answer for the production of the whole design.

Sixth. Reverse the pattern end for end circumferentially of the design-roller.

Seventh. Produce a design of the same size or of any desired less or greater size than the pattern, either symmetrical with the pattern or varied therefrom in any of its proportions.

From the foregoing statements it will be seen that the machine is intended to cover a wide field of work, including all kinds of rotary dies, all kinds of printing and embossing rollers, and many kinds of ornamental work. The machine is, however, especially well adapted for the production of rollers suitable for calico and other prints or suitable for embossing leather, wood, metal, &c.

A general idea of the mechanism may also be had by noting the facts that the parts for engraving are constructed and arranged for attachment to and use with an ordinary lathe; that the blank roller to be engraved is held and rotated on the ordinary lathe centers or between a chuck at one end and a center at the other; that the rotary graver or drill receives its lateral feed lengthwise of the blank roller from the longitudinal or line feed of the lathe and is carried by the slide-rest, so as to be adjustable crosswise with respect to the blank roller; that the pattern is carried on a mandrel which is held between centers provided as part of the attachments, and is rotated either directly from the lathe-spindle or indirectly through multiple-speed gearing in train with the back gear of the lathe; that the tracer is mounted on a carriage which may receive motion in either direction lengthwise of the pattern-roller by clamping the same to either the upper or lower section of an endless cable, which is moved in a continuous direction from the line-feed gear of the lathe; that the to-and-fro motion of the graver or drill with respect to the blank roller to be engraved is effected by the co-operation of an electromagnet and a retracting-spring;

that the circuit for the said drill-magnet is through a relay, and the relay is controlled by a separate circuit through the tracer and pattern-roller; that the pattern-roller may be given any desired speed of rotation relative to that of the blank roller; that the tracer-carriage may be given any desired lateral feed relative to the lateral feed of the drill-carriage; that the tracer-carriage can be reversed without reversing the drill-carriage; that the pattern-roller can be reversed without reversing the blank roller, and, finally, that a circuit-breaker is mounted on the pattern-mandrel, which may be embraced in the tracer and relay circuit and be made to break the same while the tracer is in contact with the conducting-surface of the pattern-roller for controlling the drill within certain limits independent of the pattern.

With the foregoing statements in mind it is thought that the detailed description may be readily followed and understood.

The accompanying drawings illustrate my machine, like letters referring to like parts throughout.

Figure 1 is a front elevation of the machine with some parts broken away. Fig. 2 is a plan view of the same with some parts removed, others shown in section, and some parts shown in diagram-lines only. Fig. 3 is a plan view of the motor and its carriage detached. Fig. 4 is a view in left end elevation with respect to the lathe and in cross-section on the line X′ X′, of Fig. 2 in respect to part of the attachment with some parts removed. Fig. 5 is a vertical cross-section, on the line X^2 X^2 of Fig. 2, looking from the right, with some parts broken away and others removed. Fig. 6 is a detail of some of the parts shown in Fig. 5, partly in front elevation and partly in vertical section. Fig. 7 is a view of the graver or drill in position on the slide-rest, partly in plan and partly in horizontal section, with part of the slide-rest broken away. Fig. 8 is a cross-section, substantially on the line X^3 X^3 of Fig. 7, looking from the rear of the machine or from the left in Fig. 7. Fig. 9 is a detail showing one-half of the driving connection between the sections of the divided shaft which drives the graver. Fig. 10 is a view in rear elevation showing the track, tracer-carriage, cam-plate carriage for circuit-breaker, &c. Fig. 11 is a cross-section, on the line X^4 X^4 of Fig. 2, looking from the right, showing relation of tracer and pattern-roller. Fig. 12 is a cross-section, on the irregular line X^5 X^5 of Fig. 2, looking from the right, showing circuit-breaker, cam-plate carriage, &c. Fig. 12½ is a plan view of the cam-plate carriage shown in Fig. 12. Fig. 13 is a vertical section substantially on the line X^6 X^6 of Fig. 12. Fig. 14 is a plan view of the circuit-breaker disk shown in Figs. 12 and 13 detached. Figs. 15 and 16 are detail views, in plan, showing modified forms of the cam-plate shown in Figs. 10 and 12. Fig. 17, on same sheet as Fig. 1, is a detail of the clamping-nut connecting the slide-rest with the line-feed screw of the lathe. Fig. 18, on same sheet as Fig. 1, is a detail view, in section, showing the outer center and its holder for supporting the pattern-mandrel. Fig. 19 is a plan view of the pattern-roller and pattern, shown as if spread out flat. Fig. 20 is a cross-section of the pattern and pattern-roller on the line X^7 X^7 of Fig. 19. Fig. 21 is a plan view of the engraved roller, shown as if spread out flat for illustrating several different kinds of work which the machine will do. Fig. 22 is a cross-section of the engraved roller on the line X^8 X^8 of Fig. 21. Fig. 23 is a diagram view of a modification arranged for simultaneously producing several sections of a continuous or discontinuous design longitudinally of the design-roller. Fig. 24 is a front elevation of the tracer-carriage shown in Fig. 23 detached; and Fig. 25 is a plan view showing a modification in the construction and relation of the graver and blank holder.

For convenience of reference the following classification of reference-letters will be observed: a and its powers a' a^2 to denote the parts of the lathe, b and its powers for the motor, c and its powers for the blank roller and species of engraving, d and its powers for the graver, graver-shaft, &c., f and its powers for the parts pertaining to the pattern-roller, &c., g and its powers for the tracer, tracer-carriage, &c., h and its powers for the circuit-wires and parts of the relay, &c., k and its powers for the parts of the switch in the drill-circuit, p and its powers for the circuit-breaker in tracer and relay circuit, &c., r and t and powers for the modification shown in Figs. 23 and 24, w and its powers for modifications shown in Fig. 25, y for blank shown in Fig. 25, and z for the source, as shown in Fig. 2.

Lathe.—(See Figs. 1, 2, 4, 5, 6, 7, 17, and 24.) The construction and operation of lathes are of course well understood, and it will be sufficient for the purposes of this case to distinguish the standards a, bed a', head-stock a^2, tail-stock a^3, tail-center a^4, center clamp a^5, center-adjusting device a^6, live-spindle or mandrel a^7, (see Fig. 6,) chuck a^8, cone-pulley a^9, spindle-gears a^{10} a^{11}, back-gear shaft a^{12} with its gears a^{13} and a^{14}, line-feed screw a^{15} with its gear a^{16}, the line-feed reducing-gears a^{17} to a^{23}, inclusive, connecting the gear a^{16} with the spindle gear a^{24}, the compound slide-rest a^{25} a^{26} on the line-carriage a^{27}, the hand-screw a^{28} for moving the slide-rest transversely of its carriage a^{27}, the hand device a^{29}, co-operating with the rack a^{30} on the lathe-bed for moving the line-carriage a^{27} by hand, the clamping-nut a^{31} for connecting the line-feed carriage a^{27} with the line-feed screw a^{15}, the pivoted bearing-lever a^{32}, having a slot a^{33}, in which the change-gear members bers a^{17} to a^{20}, inclusive, for the line-feed are mounted, the screw-bolt a^{34}, working through

a slot g^{35} in the lever a^{32} and tapped into a seat on the head-stock for holding the said pivoted lever a^{32} and the change-gears carried thereby in whatever position they may be set, the cross-feed devices for the slide-rest, comprising the screw a^{36} and the worm-gear a^{37}, (see Fig. 24,) engaging a worm (not shown) on the line-feed screw a^{15}, and the eccentric device a^{38} on which the back-gear shaft a^{12} is mounted, for throwing the back gear into and out of action.

Attachments for Engraving.

The motor, &c.—(See Figs. 1 and 3.) Turning now to my attachments, I provide an electric motor b, which is mounted on a carriage b', traveling on a track $b^{1\frac{1}{2}}$ parallel with the line-feed of the lathe. The armature-shaft b^2 of this motor has at its rear end a worm b^3 (only partially shown) engaging a worm-gear b^4 on a transverse shaft b^5, provided with a cone pulley b^6, which connects by belt b^7 with a drum b^8, mounted in suitable bearings fixed to the lathe-bed or standards parallel with the line-feed and provided with a cone-pulley b^9, connected by belt b^{10} with the cone-pulley a^9 of the lathe. The frame b' of the motor-carriage is connected by bracket-iron b^{11} with the line-feed carriage a^{27} of the lathe. The armature-shaft b^2 of the motor has on its forward end a large pulley b^{12}, from which through belt b^{13} the high-speed motion is obtained for operating the graver or drill shaft, as will hereinafter more fully appear. With this construction the motor will impart motion to the drum b^8 and through the same to the lathe, and under the action of the line-feed on the slide-rest carriage a^{27} the motor-carriage b' will be moved along its track, so as to keep the belts b^7 and b^{13} in line with the pulleys over which they travel.

The blank roller.—(See Figs. 1 and 2.) The cylindrical blank or roller c, upon which the design is to be engraved, is held between the center a^4 and the chuck a^8 and receives rotary motion at any desired speed from the lathe-mandrel or live-spindle a^7.

The graver, &c.—(See Figs. 1, 2, 7, 8, and 9.) The graver-tool d is held by chuck d', which is carried at the back end of a divided or sectional rotary shaft d^2 d^3. These shaft-sections d^2 d^3 are connected by a yielding driving connection d^4, which, as shown, is in the form of an elliptical spring, one leaf of which is secured to each of the shaft-sections, and both leaves of which are rigidly secured together at their joining ends. The said divided shaft d^2 d^3 is mounted and carefully fitted in boxes d^5, secured to bearing-blocks d^6, fixed to the top plate a^{26} of the compound slide-rest of the lathe, the front members of which are built outward into bracket-like form. Of the two shaft-sections the outer member d^3 is held against longitudinal movement in its bearing-boxes d^5 and is provided with a driving-pulley d^7, engaged by the motor-belt b^{13}, which extends from the pulley b^{12} on the front end of the armature-shaft b^2, and the inner shaft-section d^2 is free for longitudinal or sliding motion in its bearing-boxes d^5 to effect the necessary to-and-fro motion of the graver in respect to the blank on which it is to operate. Both shaft-sections are hollow, and within the same is disposed a spring-holder d^8 d^9 d^{10}, of which parts d^8 is a rod with a head d^{11} at its inner end and screw-threaded at its outer end, d^9 is a perforated guide-nut having screw-threaded engagement with the outer end of the shaft-section d^3, and d^{10} are thumb-nuts for adjusting the rod and holding the same against inward movement against the guide-nut d^9. Encircling the rod d^8, between its head d^{11} and the outer end of the inner shaft-section d^2, is located a coiled retracting-spring d^{12}, which tends to throw the sliding shaft-section d^2 into its outermost position and hold the same there under the reaction of the spring upon the rod d^8 against the outer end of the shaft-section d^3 as a base of resistance.

The shaft-section d^2 has fixed thereto an armature d^{13}, which is subject to the action of a pair of electromagnets d^{14}, disposed, as shown, one on each side of the shaft and provided with pole-pieces d^{15}, which extend laterally and form a divided yoke which almost completely encircles the shaft in position for rendering the magnetic forces directly effective on the armature d^{13}. Over wires d^{16} d^{17}, (see Fig. 2,) one member of which extends through a relay, which will be hereinafter noted, the said drill-magnets d^{14} may be energized from any suitable source of electricity. (Indicated at z in Fig. 2.) When the drill-magnets d^{14} are energized, the shaft-section d^2 will be thrown inward against the tension of the retracting-spring d^{12} on the rod d^8 until the outer and headed end of said shaft-section d^2 strikes a stop-nut d^{18}, which is set against a jam-nut $d^{18\frac{1}{2}}$, both of which nuts are abjustable upon the outer end of the outer box d^5, supporting the sliding shaft-section d^2. This stop-nut d^{18} will be set to permit any desired inward throw of the shaft-section d^2 under the action of the magnets and armature, according to the desired depth of the cut. The spacing between the pole-pieces d^{15} and the armature d^{13} is such that under the greatest inward throw for which the nut d^{18} may be set the armature will never strike said pole-pieces. This insures clearance for the rotary motion of the shaft without friction against the pole-pieces. With this construction for mounting and operating the graver it is obvious that the graver may be moved to and fro for the proper action on its work under the co-operation of the electromagnets and the retraction spring without any drag from the belt and pulley by which the rotary motion is imparted thereto. Otherwise stated, the graver-carrying shaft is rotatively mounted in fixed bearings, which hold the same perfectly true, with the outer or non-sliding section in the best position for receiv-

ing the high-speed rotary motion and imparting the same to the inner or sliding section, while the inner section is capable of the independent longitudinal motion in its bearings, free from the weight of and the driving drag on the outer section. The inner or sliding section may therefore be comparatively light, thus reducing the inertia to a minimum and rendering the same extremely sensitive and quick in its to-and-fro motion. The further fact that the armature d^{13} is rigid on the sliding section of the graver-shaft with the magnets and their pole-pieces arranged adjacent thereto, as described, constitutes an important improvement for insuring accuracy and rapidity of the work. The armature being carried on the rotary shaft permits the magnetic forces to be transmitted to the drill in the most direct manner possible, and hence the chance for lost motion is reduced to a minimum. The way in which the retracing-spring d^{12} is held and mounted avoids any possibility of torsional strain therefrom on the sliding shaft-section, and the yielding connection d^4, in the form of an elliptical spring, transmits the rotary motion from the non-sliding to the sliding section without rotary slippage or lost motion in a manner as positive as if the two shaft-sections were rigid with each other. The yielding connection d^4 might, however, be in the form of pivoted instead of spring-leaf sections, and yet, nevertheless, serve its purpose so far as the yielding action is concerned; but there would soon be some little lost motion in the rotary action. Taken as a whole I have found this construction and mounting for the drill-shaft to be extremely efficient for rapid and accurate work, whether the cut be shallow or deep, and that some such a construction is apparently an absolute necessity where the cut is to be deep.

The graver or drill shaft is driven at extraordinary high speed. The motor-pulley b^{12} is driven at the rate of eighteen hundred revolutions per minute, and the proportions of the motor-pulley b^{12} to the graver-shaft pulley d^7 are as seven to one. This gives a speed of twelve thousand six hundred revolutions per minute on the graver-shaft. At this speed, as I have demonstrated by actual work with this machine, I am able to engrave extremely deep-cut designs at a single action with perfectly sharp, smooth, and true marginal edges on the finished or printing surfaces. I believe myself to have been the first to have discovered the advantages and practicability of this phenomenally high speed for a drill, and as it gives an entirely different quality of work from any hitherto attained by machinery I have claimed the same as my invention in a companion case filed of even date herewith.

The pattern-roller, &c.—(See Figs. 1, 2, 4, 5, 6, and 18.) To the lathe-bed standard a and to a supplemental standard f, I rigidly secure a cylindrical support f', extending to the left of the lathe proper parallel with the lathe-spindle and in the same vertical plane therewith, but at a lower level. To the outer end of the support f', I secure a standard or stock f^2 for holding a supplemental center f^3. The stock f^2 has a divided hub, through which the support f' passes, provided with clamping-lugs f^4, fitted with a clamping-screw f^5, which construction permits the said stock f^2 to be adjustable either lengthwise of or around the cylinder f' for bringing the center f^3 accurately in line with the lathe-spindle. The lathe-spindle a^7 (see Fig. 6) has its outer end extended through its bearings on the head-stock a^2 and is fitted with another center f^6 for co-operation with the center f^3 to hold the pattern-mandrel f^7, and hence these centers f^3 f^6 may be, for convenience, called the "pattern-mandrel" centers.

The pattern-roller f^8 is rigidly secured in any suitable way to the mandrel f^7 and is composed of some suitable metal constituting a good conductor. The pattern f^9 may be in the form of paper or any other suitable non-conducting material, glued or otherwise secured to the periphery of the pattern-roller f^8.

Provision is made for imparting to the pattern-mandrel f^7 rotary motion, either at the same speed as the lathe-spindle a^7 or at any desired speed different therefrom, and especially for an increased speed. The pattern-mandrel f^7 carries at its right end a gear-wheel f^{10}, which is adjustable thereon and securable thereto in any desired adjustment by jam-screw f^{11}. The gear f^{10} has on its right face insulated clutch-lugs f^{12}, which may be made to engage with clutch-notches f^{13} on the left end of the lathe-spindle a^7, as shown in dotted lines in Fig. 6. If the gear f^{10} be thus clutched to the lathe-spindle a^7, the pattern-spindle will receive rotary motion direct from the lathe-spindle at the same speed therewith. If the gear f^{10} be thrown to the left into the position shown in full lines in Fig. 6, it may be made to engage with a multiple-speed gearing which is driven from the back gearing of the lathe. Referring especially to Figs. 1, 2, 4, 5, and 6, this multiple-speed gearing may be readily traced. On the bearing for the back-gear shaft a^{12} of the lathe is pivoted a lever-arm f^{14}, which may be secured in any angular adjustment on the said bearing by jam-screw f^{15}. In a slot f^{16} on this lever is secured by nut f^{17} a stud-shaft f^{18}, on which is loosely mounted to move with each other a pair of change-gears f^{19} f^{20}, of which the small member f^{19} engages with the back gear a^{13} of the lathe. The large member f^{20} of the said change-gears engages with a gear f^{21}, fixed to shaft f^{22}, mounted in bearing $f^{22\frac{1}{2}}$, fixed to the top of the head-stock of the lathe. The shaft f^{22} projects to the left beyond the head-stock and is provided at its outer end with a gear f^{23}, which transfers motion to the gear f^{10} on the pattern-mandrel through either one or both members of a pair of intermediate reversing-gears f^{24} f^{25}, (see Fig. 5,) carried by yoke f^{26}, secured to an arm f^{27}, which is pivoted on the bearing for the

lathe-spindle. The arm f^{27} has clamp-lugs f^{28} and is adjustable on the said bearing and is securable thereto in any desired position by the clamp-screw f^{29}. The yoke f^{26} is pivotally secured in a slot f^{30} of said arm f^{27} by screw bolt and nut f^{31}. If the yoke f^{26} be in the position shown in full lines in Fig. 5, the single gear f^{24} will be operative to connect the gears f^{23} and f^{10} and the pattern-mandrel f^{7} will be revolved in the same direction as the lathe-spindle and the blank-roller c, which is to be engraved; but if the yoke f^{26} be thrown into the dotted-line position shown in Fig. 5 the two gears f^{24} and f^{25} will be come operative to connect the gears f^{23} and f^{10} and the pattern-mandrel f^{7} will be rotated in a direction opposite to that of the lathe-spindle and blank roller c. The movement of the mandrel-gear f^{10} toward the right, so as to engage with the lathe-spindle a^{7}, serves to throw the same out of gear with the multiple-speed gearing above noted. The gear f^{23} is of the same size as the gear f^{10} on the pattern-mandrel, and when the multiple-speed gearing is in action the pattern-mandrel f^{7} receives motion at the same speed as the gear f^{23}. The change-gears f^{19} and f^{20} may be made of any desired size relative to each other and the other members of the train from a^{13} to f^{23}, inclusive, so as to give any desired rotary speed of the pattern-mandrel f^{7} relative to that of the lathe-spindle a^{7} and the blank roller c rotated thereby. The said multiple gearing may also be thrown out of action by throwing back the lever f^{14} away from gear f^{21} or by raising the change-gears f^{19} f^{20} in the slot f^{16}, so as to throw the same out of engagement with the back gear a^{13} of the lathe.

The pattern-mandrel center f^{3} is fixed to and insulated from a chuck sleeve or holder f^{32}, (see Figs. 1 and 18,) adjustably mounted in the standard f^{2} and provided with an angularly-extended arm f^{33}, in which is fitted a thumb-screw f^{34}, which taps into a seat in the standard f^{2} for holding the center f^{3} in whatever position it may be set. The shank of the center f^{3} extends outward through the insulating-sleeve f^{32}, and is provided with a binding-screw f^{35} for the attachment of a wire forming a part of the relay-circuit, as will be hereinafter noted.

The tracer, &c.—(See Figs. 1, 2, 10, and 11.) The tracer g is carried by an arm g', pivoted to the carriage, composed of the metal body g^{2}, a pair of upper rollers g^{3}, and a single lower roller g^{4}, carried by a spring-arm g^{5}, formed integral with or secured to the body g^{2}. The tracer-arm g' is under tension from a spring g^{6} on screw-stud g^{7}, working through the arm and tapped into a seat on the carriage, which spring tends to hold the tracer in contact with the periphery of the pattern-roller f^{8}.

The tracer-carriage is mounted on a track-rail g^{8}, having beveled upper and lower edges, with which the rollers g^{3} and g^{4} engage with a clamping but yielding action from the spring-arm g^{5}, carrying the lower roller g^{4}. The said upper rollers g^{3} and lower rollers g^{4} are so spaced in respect to each other as to center the carriage on the guide-rail g^{8}. The guide-rail g^{8} is fixed to the upper ends of a pair of strong supporting-arms g^{9}, which are adjustably secured by clamp-lugs g^{10} and clamp-screws g^{11} to the fixed support f'. These arms g^{9} may therefore be adjusted into any angular position on the supporting-cylinder f' which may be required to bring the rail g^{8} and the tracer-carriage into the proper working position for any size of pattern-roller. The connection between the rail g^{8} and the arms g^{9} is made by a countersunk bolt g^{12}, (see Fig. 5,) working through an insulating-bushing g^{13} and engaged by a thumb-nut g^{14} and washer g^{15}. The track g^{8} is therefore insulated from the arms g^{9}.

An endless cable g^{16}, in the form of a cord, wire, or other suitable material, passes through longitudinal perforations both in the upper and the lower portions of the tracer-carriage body g^{2}, and either the upper or the under section of the cable may be made fast to the carriage by clamping-screws g^{17}, tapped into the carriage in position to engage and clamp the cable against the body of the carriage. The cable g^{16} is mounted on sheaves g^{18} and g^{19}, respectively, of which sheaves the outer member g^{18} is loose on a stud-bearing g^{20}, extending through a slot g^{21} (see Fig. 1) and secured from lateral movement by nut g^{22}. The stud-bolt g^{20} is tapped by a draw-bolt g^{23}, seated in block-piece g^{24}, fixed to the outer end of the rail g^{8}. This construction permits the cable g^{16} to be tightened at will. The inner sheave g^{19} is composed of insulating material and is rigidly secured to the short shaft g^{25}, mounted in the angular bearing g^{26}, formed integral with the inner member of the supporting-arms g^{9}. The said shaft g^{25} has fixed to its forward end a bevel-gear g^{27}, engaging a corresponding bevel-gear g^{28} on a short shaft g^{29}, journaled in the angular bearing g^{30}, also projecting from the inner member of the arms g^{9}. The shaft g^{29} has fixed to its right-hand end a gear g^{31}, (see Fig. 5,) engaging the small member of a pair of change-gears g^{32} g^{33}, mounted to move with each other on a stud-shaft g^{34}, removably secured in a slot g^{35} of a lever-arm g^{36}, which is pivoted on the left-hand bearing for the line-feed screw a^{15} of the lathe, and is securable thereto in any desired position by jam-screw $g^{36\frac{1}{2}}$. With this construction it is obvious that motion will be imparted to the cable g^{16} from the gear a^{16} on the line-feed screw a^{15} of the lathe, indirectly through the train of gearing g^{27} to g^{33}, inclusive. The various members of this train of gearing will be properly proportioned to give the desired feed of the cable g^{16} and the tracer-carriage secured thereto relative to the line-feed of the lathe or lateral movement of the graver d longitudinally of the blank roller c on which

it operates, and by substitution in the change-gears g^{32} g^{33} this lateral feed of the tracer-carriage may be given any rate desired relative to the line-feed of the slide-rest and graver.

From the foregoing statement it is obvious that the cable g^{16} will move in a constant direction at any desired rate of travel and that the tracer-carriage may be reversed at will by simply unclamping it from one section and clamping it to the other section of the cable. This construction is a great advantage in such a machine wherein it is desired to have the tracer operate in both directions of its lateral travel in order to obviate the large amount of slack and resulting lost motion which would be produced by reversing the train of gearing.

The circuit connections for the relay and drill magnets.—(See Fig. 2.) From one pole of any suitable supply or source z of electricity a wire h extends through a lamp-resistance or other suitable transformer h' to a relay-magnet h^2, and thence by wire h^3, either directly or indirectly, to the pattern-mandrel f^7 and roller f^8. Thence, when contact is made by the tracer g, the current can pass through the tracer and carriage to the insulated track g^8 and over return-wire h^4 back to the other pole of the source z. The wire h^3 is interchangeably applicable either directly to the mandrel f^7 by binding-screw f^{35} and center f^3 or indirectly through a circuit-breaker, which will be presently noted. The relay-armature h^5 is pivoted to post h^6 and subject to spring h^7, tending to hold its free end against an upper contact h^8 on post h^9 and away from a lower contact h^{10} on post h^{11}. All the parts of the relay are on an insulating bed-plate h^{12}. A wire k extends from one pole of the source z to a switch-button k', engaging, as shown, with switch-contact k^2, connected by wire k^3 with the relay-post h^{11}, but which switch-button may be made to engage with contact k^4, connected by wire k^5 with the relay-post h^9. From the relay-armature h^5 the wire d^{16}, hitherto noted, extends to the drill-magnets d^{14}, whence wire d^{17} returns to the other pole of the source z, as before noted. With this construction it is obvious that the relay-circuit is primarily controllable directly from the pattern and the tracer and that the relay controls the circuit through the drill-magnets d^{14}. The drill-magnet circuit is normally open at the relay, when the switch-button k' is in the position shown in the drawings in Fig. 2, and in this event the drill-magnets d^{14} will be energized when the tracer is on the metallic or conducting surface of the pattern, and the drill will be operative to produce a cameo engraving on the design-roller from a given pattern of insulating material on the pattern-roller f^8; but if the switch-button k' be thrown over, so as to connect with the contact k^4, then the drill-circuit through the magnets d^{14} will be closed at the relay-contact h^8, under the action of the spring h^7, when the relay-circuit is open, or, in other words, when the tracer is on the insulating-pattern, and in that event the drill would be operative from the same pattern as before to cut the design in intaglio on the blank roller c. The relay and switch is an advantage not only in giving this double action for cutting either in cameo or in intaglio from the same pattern, but for the further reason that the relay-circuit may be made relatively weak as compared with the drill-magnet circuit, which requires a current of considerable power. The relay-circuit in which the pattern is located being thus a weak one the sparking at the pattern and tracer will be so insignificant as to have no serious deleterious effect on the roller or pattern. From the point now reached it would be possible to trace all the actions of the drill except those which give the printing-line surfaces in the background independent of the pattern. These are controlled by the circuit-breaker above referred to, which will now be described.

The circuit-breaker.—(See Figs. 2, 10, and 12 to 16.) On the pattern-mandrel f^7 is mounted an externally-screw-threaded sleeve p having a central collar p'. One end of this sleeve is split and fitted with a jam-nut p^2 and a tapered clamping-nut p^3, by which the sleeve is rigidly secured to the mandrel f^7 in any desired position. On the right end of the sleeve p is fitted a screw-threaded metallic disk p^4, which is clamped in position against the collar p' by jam-nut p^5. This disk p^4 has cut from its periphery a series of **V**-shaped notches p^6, which construction leaves the disk with a continuous peripheral surface at one side and a broken peripheral surface at the other composed of a series of **V**-shaped points separated by the air-spaces produced by the notches p^6. On the sleeve p, between the collar p' and the jam-nut p^2, is pivoted an angular headed block p^7, the angular portion of which overhangs the disk p^4. A contact-piece p^8, mounted in an arm p^9, is pivoted to an arm p^{10}, extending rearward from block p^7. A pair of springs p^{11} on an adjusting-screw p^{12}, extending through the arm p^9 and tapped into the arm p^{10}, yieldingly holds the contact in proper position with respect to the disk p^4. To the block p^7 is rigidly attached an angular rod p^{14}, connected by spring p^{15} to the rear end of an angular bracket p^{16}, fixed to and insulated from the track-rail g^8, as shown at p^{17}, Fig. 12. At its outer end the arm p^{14} has fixed thereto and insulated therefrom a finger p^{18}, which is of angular form in cross-section, with its sharp or knife edge downward in position to traverse the upper edge of any one of a series interchangeable cam-plates p^{19}, p^{20}, or p^{21}, which are securable to and angularly adjustable on what may be called a "cam-plate" carriage composed of an angular block p^{22} and rod p^{23}. The cable g^{16} passes through the block p^{22}, and either section thereof may be clamped to

the block p^{22} by clamping-screws p^{23} for motion in either direction in the same way as the tracer-carriage is secured to the cable. The guide-rod p^{23} extends both ways from the carriage body or block p^{22} and works through guide-keepers p^{25}, fixed to the rear face of the track-rail g^8. This rod p^{23} and keepers p^{25} serve to insure a straight-line movement of the cam-plate carriage when clamped to and moved with the cable g^{16}. One of the cam-plates p^{19} p^{20}, &c., is pivoted to the angular part of the carriage-block p^{22} by screw-bolt p^{26}, and locked in any desired angular adjustment thereon by a jam-bolt p^{27} working through a curved slot p^{28} in the cam-plate and tapped into a seat on the carriage-block p^{22}. The arm p^{10}, carrying the pivoted contact p^8, has a binding-screw p^{29} for the attachment of the wire h^3 of the relay-circuit, and thereby embracing the circuit-breaker in the tracer and relay-circuit whenever so desired, as shown in Fig. 2 of the drawings. By turning the jam-nut p^5 and the disk p^4 on the sleeve p the said disk may be adjusted laterally with respect to the contact p^8, so as to cause the contact p^8 either to ride over the continuous peripheral portion of the disk p^4 or on the broken portion thereof. If the contact p^8 rides on the continuous portion of the disk p^4, the circuit will not be broken at that point, or, in other words, the circuit-breaker will be inoperative in respect to any action on the drill. If, however, the disk p^4 be so set that the contact p^8 rides over the broken peripheral portion of the disk p^4, then the circuit will be broken whenever the contact p^8 is over one of the notches p^6. Owing to the shape of the notches p^6 and the corresponding raised portions of the periphery of the said disk p^4, it is of course obvious that the contact will be broken at the said notches for a greater or less length of time, according to whether the contact p^8 is riding near the outer or near the inner portions of the same. The action of the drill d under the control of the tracer g may therefore be intercepted for a greater or less length of time while the tracer g is in contact with the metallic or conducting surface of the pattern-roller f^8, and thereby printing-line surfaces may be produced in the background on the engraved roller. Without the cam-plates p^{19} p^{20}, &c., these background lines would, however, all be straight and parallel with the axis of the design-roller; but with the addition of the said cam-plates and the rocking connections therefrom to the block p^7 it is possible to make these background printing-lines take any desired angle to the axis of the design-roller and to be of various shapes. Any number of said cam-plates p^{19} p^{20}, &c., may be provided to afford diversity of cam-surfaces on their upper edges and corresponding diversity in the background lines on the design. The effect of the cam-plates p^{19} p^{20}, &c., may be readily understood by noting that they may be set to rock the block p^7 and contact p^8 on the sleeve p under the travel of the cam-plate carriage p^{22} p^{23} and the action of the spring p^{15}, so as to make the contact between p^8 and the disk p^4 successively earlier or later with respect to the rotation of the disk or successively earlier and then successively later or always at the same time, according to the form of the cam-plate and its angular position with respect to the line of its travel. If the straight-edged cam-plate p^{19} be employed, for example, these lines will be straight, but may be made to run either parallel with the axis of the engraved roller or at any desired angle thereto in either direction, according to how the cam-plate may be set. If the plate p^{19} be set as shown in full lines in Fig. 10, for example, the lines in the background of the engraving will be parallel with the axis of the roller, as shown at c' in Fig. 21; but if said plate be set in either of the dotted-line positions shown in said Fig. 10 the lines will still be straight and parallel with each other, but will extend at an angle to the axis of the roller or diagonally across the periphery of the same, as shown at c^2 in Fig. 21. If the curved plate p^{20} be substituted for the cam-plate p^{19}, wave lines will be produced on the engraving, and if the cam-plate p^{21} be substituted zigzag lines will be produced. The action to produce said background lines above noted may perhaps be rendered still more distinct by considering some concrete examples. Suppose the straight-edge cam-plate p^{19} to be employed and to be secured with its straight edge horizontal or parallel with the axis of the pattern-cylinder. Then when the said cam-plate is moved under the finger p^{18} in the lateral feed movement the contact p^8 will not be rocked on the disk p^4, but will be held in a constant position without any rotary motion, and inasmuch as the disk p^4 will receive one rotation or more in relation to the said contact p^8, either in exactly the same time or in an exact factor of the same time as the rotation of the work or blank cylinder, the breaks in the circuit controlling the graver, occurring by the contact p^8 coming over the notches p^6, will occur at exactly corresponding times in successive rotations. Hence the accumulating cuts and accumulating raised or uncut surfaces on the work-cylinder effected on the successive rotations will line with each other laterally or join to form straight lines parallel with the axis of the blank roller. But suppose, again, that the straight-edge cam-plate p^{19} be set on a downward incline forward. Then under the lateral feed movement thereof the said finger p^{18} will be moved upward, thereby rocking the contact p^8 backward on the disk p^4 and causing a given point on the said disk p^4 to come under the said contact p^8 sooner than it would have done had it not been for this action of said cam-plate and sooner or in less time than the corresponding complete rotation of the blank roller. Hence this variation on successive revolutions will cause the corresponding successive cuts and raised surfaces on the

work-cylinder, under the action of the graver, to adjoin and form lines which will advance circumferentially of the cylinder or run at an angle to the axis thereof. If the same cam-plate p^{19} had been used and inclined backward, the same result would have followed on the work-cylinder with the exception that the lines would run at an angle in the opposite direction. Hence it must be obvious that the cam-plate p^{20} will produce the curved or wave lines and the cam-plate p^{21} zigzag lines, as hitherto stated, inasmuch as they may be regarded simply as combinations of two or more inclined plates into one.

Of course it has been assumed in the foregoing statements that the reader recalls that the graver is primarily controlled from the pattern and, as shown, would cut when the tracer is on the metallic surface of the pattern-roller f^8 except when prevented from so doing by the breaking of the circuit from the coaction of the disk p^4 and contact p^8. It is also assumed that the reader has fully in mind the fact that the pattern-roller and the work-roller receive rotary motion from the lathe either at the same or any desired multiple speeds by means already heretofore fully described.

Any number of the cam-plates p^{19} p^{20} p^{21}, &c., may of course be provided to afford the requisite range or diversity for producing any kind of background printing-line surfaces desired on the design-roller. The circuit-breaker for producing these background printing-lines has been shown and described for connection in the relay and tracer circuit; but it will of course be understood that it might be in the drill-circuit or anywhere in either circuit, so long as the disk p^4 could receive the properly-timed rotary motion and the contact p^8 the properly-timed rocking motion from the traveling cam-plates p^{19} p^{20}, &c., or substitutes for the same. The location and arrangement shown are, however, the most convenient and desirable for obtaining all the necessary motions.

General operation.—With the exception of the modifications shown in Figs. 23 to 25, which will be hereinafter noted, all the parts of the machine have now been specified, and the general operation is probably clear from the introductory statements and the detailed description. It may, however, add distinctness to briefly note the relations which must be established for the several kinds of work. Let it be recalled that the drill operates under the control of the tracer and pattern; that the rotary motions of the pattern-roller and design-roller may be identical or in any ratio desired; that the lateral feeds of the tracer-carriage and drill-carriage may be identical or in any ratio desired; that the pattern-roller may be reversed without reversing the design-roller; that the tracer-carriage may be reversed without reversing the drill-carriage; that both the tracer-carriage and the drill-carriage may be adjusted crosswise with respect to their respective rollers; that the circuit-breaker may be connected in or cut out of the tracer and relay circuit, and that the switch may be shifted to change the action of the drill from cameo to intaglio.

With the foregoing statements distinctly in mind it must be obvious that, with pattern-roller and design-roller of the same diameter and under equal rotary motions of the rollers and equal lateral feed motions of the tracer and drill, the design will be produced identical with the pattern in all of its proportions. A like result will follow if the lateral feeds be identical and the rotary motions be proportionate to the diameters of the pattern and design rollers.

If the diameter of the design-roller be greater than that of the pattern-roller and the speeds and feeds be identical, then the design will be lengthened circumferentially of the design-roller, and vice versa.

By multiplying the rotary speed of the pattern-roller relative to the design-roller any number of circumferential duplications may be made with the one tracer and drill from a single figure or section of the pattern, insuring absolute accuracy of duplication, as hitherto noted.

If the rotary motions be in the proper ratio for identical dimensions of pattern and design circumferentially, the lateral dimensions of the design lengthwise of the design-roller may be varied at will by varying the relative feeds of the tracer and drill carriages.

By reversing the travel of the tracer-carriage without reversing the drill-carriage any bisymmetrical design may be produced from a half-pattern, such as the diamond shown in Fig. 21 from the half-diamond shown in Fig. 19.

By reversing the pattern-roller without reversing the design-roller, or vice versa, the design will be reversed end for end circumferentially of the design-roller as compared with the pattern.

By connecting in the circuit-breaker p^4 p^8, &c., the printing-lines hitherto noted may be produced in the background in any desired relation to the pattern, and by varying the stroke of the drill its cut may be made light or deep, as desired.

Modifications: Simultaneous longitudinal sections.—(See Figs. 23 and 24.) If it be desired to produce simultaneously several different longitudinal sections of a design, the construction shown in diagram in Figs. 23 and 24 would be employed. In the said figure three tracers r are shown as adjustably mounted on the common carriage r', and three drills t are shown as mounted for independent adjustment on the slide-rest t' of the lathe. Each tracer has separate circuit connections r^2 from a common source r^3 through the magnet of a separate relay r^4. Both the carriage r' and the slide-rest t' may be given their respective feed movements in the manner shown and above described in connection with the

preferred form of my single machine. Each drill has separate circuit connections t^2 from a common source t^3 through the armature and post of the relay r^4 in the same way as was shown for the single tracer and drill in Fig. 2. The tracer-carriage r' would receive a lateral feed from the cable g^{16} and the drill-slide t' would receive its lateral motion from the line-feed of the lathe, both as in the principal views. Hence it is obvious that each tracer will control its corresponding drill, and that the several tracers will operate simultaneously over adjacent longitudinal sections of the pattern-holder f^8, and that the three drills will operate upon three corresponding adjacent segments of the blank roller c. Hence the three sections of the design will be simultaneously produced on the blank roller c and will be joined to form the continuous design corresponding to the continuous pattern w, shown on the pattern-roller f^8.

Of course it will be understood that if it be desired to engrave several disjointed sections of a design on the blank roller c the same may be done by properly setting the drills t on the slide-rest t' with respect to each other and the design-roller c. It is of course obvious that if it be desired to duplicate a single design longitudinally of the design-roller c several of the drills t would be employed and controlled from a single tracer operating on a single pattern on the pattern-roller f^8. These multiplying features of this machine, taken together with the high-speed action of the drill, give large capacity at comparatively low cost.

Modification of drill and blank shafts.—(See Fig. 25.) Of course it will be understood that modifications might be made in the construction of many parts of the mechanism without departing from the spirit of my invention. For example, having regard to the necessary to-and-fro motion for bringing the drill and the blank into and out of engagement with each other, as required to make the cut, it would be possible in some classes of work to have the drill carried on a non-sliding shaft and the blank or work carried on a sliding shaft, and for facilitating this sliding movement the said shaft might be divided. Such a modification is shown in Fig. 25, where the drill d is carried by the shaft w, which is rotatively mounted but held against sliding movement in the bearings w', fixed to the upper or turn-table section a^{26} of the compound slide-rest of the lathe and provided with the driving-pulley w^2 for imparting the rotary motion thereto. The slide-rest section a^{26} is turned on the section a^{25} so as to stand parallel with the lathe-centers. One section w^3 of the divided work-shaft w^3 w^4 is secured in the lathe-chuck a^8 and the other section w^4 is mounted for rotary and sliding movement in the bearings w^5, which are fixed to a plate w^6, secured to the lathe-bed. The shaft-sections w^3 w^4 are connected by the yielding connection $w^{6\frac{1}{2}}$. The section w^4 is provided with an armature w^7, subject to the magnets w^8, with their pole-pieces w^9 partially spanning the shaft, all substantially in the same relation as to the drill-shaft in the other views. The blank y is held by a chuck w^{10} on the shaft-section w^4.

A spring which in practice would be substantially like that shown as applied to the sliding member of the drill-shaft in the other views would be employed for co-operation with the electromagnet and armature to effect the to-and-fro motion of the work-shaft section w^4; but in Fig. 17, for purpose of illustration merely, a flat spring w^{11} is shown as attached to a post w^{12}, fixed to the bed w^6 and tending to throw the shaft-section w^4 into its outermost position.

The slide-rest on which the drill-shaft is mounted would receive its lateral motion from the cross-feed of the lathe shown as composed of the screw a^{36} and worm-gear a^{37}, engaging on threads of the line feed-shaft a^{15}.

The drill-shaft would receive its necessary lateral feed with respect to the blank y from the cross-feed devices a^{36} a^{37}, operative on the slide-rest a^{25} a^{26}, as hitherto noted.

The construction shown in this modification, Fig. 25, is well adapted for engraving light work, such as buttons, various kinds of jewelry, &c.

In conclusion it may be noted that the accompanying drawings, with the exception of Figs. 23 to 25, inclusive, were taken from a full-sized working machine, and that all statements of fact herein contained, except those relative to Figs. 23 to 25, inclusive, are based upon the said working machine.

What I claim, and desire to secure by Letters Patent of the United States, is as follows:

1. The combination with a cooperating cutter and blank holder, of a divided rotary shaft, one section of which is held against longitudinal motion and the other of which is free for longitudinal motion and carries one of said cooperating elements, and an elliptical spring connecting said shaft sections for driving the sliding section from and permitting the longitudinal motion thereof independent of the non-sliding section, substantially as described.

2. The combination with a cutter and a blank holder, of a rotary shaft, carrying one of said elements, mounted with freedom for longitudinal motion in its bearings, and an armature fixed to said shaft and subject to an electro magnet, for imparting sliding motion to said shaft, substantially as described.

3. The combination with a cooperating cutter and blank holder, of a divided rotary shaft having one section held against longitudinal motion and the other free for longitudinal movement and carrying one of said cooperating elements, an armature fixed to said sliding shaft section, and an electro magnet cooperating with said armature against a re-

tracting spring, for imparting the to-and-fro motion to said sliding shaft section, substantially as described.

4. The combination with a cooperating cutter and blank holder, of a divided rotary shaft, one section of which is held against longitudinal motion and the other of which is free for longitudinal motion and carries one of said cooperating elements, a yielding driving connection between said sections, an armature fixed to said sliding shaft section, an electro magnet cooperating with said armature against a retracting spring, and an adjustable stop, for limiting the inward throw of said sliding motion, substantially as described.

5. The combination with a cooperating cutter and blank-holder, of the hollow sectional rotary shaft, one section of which is held against longitudinal motion and the other of which is free for sliding motion and carries one of said cooperating elements, a retracting spring for said sliding shaft section and a spring holder disposed within said shaft section with the holder extending to the exterior of said non-sliding section and provided with means for adjustably holding the same against the outer end of said non-sliding section, substantially as described.

6. In an engraving machine, the combination with a tracer, of rotary pattern and blank holders, the rotary divided drill shaft, with one section held against longitudinal motion and the other free for sliding motion, a yielding driving connection uniting said shaft sections, the armature on said sliding section, the electro magnet cooperating with said armature against a retracting spring, and a circuit for said magnet controlled by said tracer and pattern, substantially as described.

7. The combination with the divided rotary shaft having the non-sliding and the sliding section, of the armature fixed to the sliding section, and the drill magnets disposed one on each side of the shaft and provided with pole-pieces extended to form a divided yoke nearly but not completely encircling said shaft adjacent to said armature, substantially as and for the purposes set forth.

8. The combination with the non-sliding hollow shaft section d^3 having the driving pulley d^7, of the sliding hollow shaft section d^2 having the drill chuck d' and the armature d^{13} secured thereto, the yielding driving connection d^4 uniting said sections, the electro magnets d^{14} with their pole pieces d^{15} extended to form a divided yoke nearly encircling the shaft, the spring d^{12} and spring holder d^8, &c., and the adjustable stop d^{18}, all arranged and operating substantially as described.

9. In an engraving machine, the combination with a drill tracer, pattern holder and blank holder, of an electric device for throwing the drill and blank toward or from each other, or vice versa, a circuit for said electric device controlled primarily by said tracer and pattern, and an automatic circuit breaker operative to break said circuit independent of the tracer and pattern, for producing line printing surfaces in the background of the design independent of the pattern, substantially as described.

10. In an engraving machine, embracing a drill controlling circuit, the combination with an automatic circuit breaker, operative to break said drill circuit independent of the tracer and pattern, of devices for variably timing the action of said circuit breaker relative to the movements of the blank to be engraved, for producing background printing lines in the design, independent of the pattern, of any desired form and extending in any desired direction, in respect to the pattern design, substantially as described.

11. In an engraving machine, embracing a drill controlling circuit, an automatic circuit breaker, for breaking said circuit independent of the pattern, comprising a rotary conducting disk with non-conducting spaces or surfaces alternating with the conducting surfaces thereof and a cooperating contact point, substantially as described.

12. The automatic circuit breaker, for the purposes stated, comprising the rotary disk or body having on one section thereof, a circumferentially continuous conducting surface and on another and adjacent section thereof, a series of non-conducting **V**-shaped notches or non-conducting surfaces alternating with reversely **V**-shaped conducting surfaces of said disk and a contact point cooperating with said disk, with one of said cooperating parts mounted for lateral adjustment, in respect to the other, for varying the duration of each contact or vice versa, substantially as described.

13. The automatic circuit breaker, for the purposes stated, comprising the rotary disk or body having non-conducting spaces or surfaces alternating with conducting surfaces circumferentially thereof, a cooperating contact point movable circumferentially of the disk and a laterally movable cam-plate for moving said contact point to vary the timing of the circuit breaking action relative to the rotation of said disk, substantially as described.

14. The combination with the circuit breaker disk and contact point, of a laterally movable cam-plate carriage and a series of interchangeable cam-plates, for cooperation with a spring to move said point forward and backward over said disk, to vary the timing of the circuit breaking action relative to the rotation of said disk and consequently the character of the background printing lines produced by the drill, substantially as described.

15. The combination with the circuit breaker disk p^4, contact p^8, and the pivoted block p^7, of a laterally movable cam-plate carriage and a rod or connection p^{14} subject to the action of the cam-plate on said carriage and to a

spring p^{15}, for rocking said block and contact, substantially as and for the purposes set forth.

16. The combination with the circuit breaker disk p^4 and contact point p^8, of the laterally movable cam plate carriage and the interchangeable cam-plates securable to said carriage parallel with or at any desired angle to the line of its travel, substantially as and for the purpose set forth.

17. In an engraving machine, the combination with a pattern holder, of an endless cable moving in a constant direction and a tracer carriage securable to either section of said cable, for effecting the lateral feed of the tracer in either direction, and reversing the same, at will, without slack or lost motion, substantially as described.

18. In an engraving machine, the combination with a pattern holder, of an endless cable moving in a constant direction, a tracer carriage, a rigid track for said carriage, and clamps for securing said carriage to either section of said cable, substantially as and for the purposes set forth.

19. The combination with the tracer carriage and track of the endless cable running in a continuous direction, to either section of which the tracer carriage is securable, and the cam-plate carriage also securable to either section of said cable, for effecting its lateral feed in either direction, substantially as described.

20. The combination with the endless cable g^{16}, of the cam-plate carriage composed of the body portion p^{22} and rod portion p^{23} and the guide keepers p^{25} secured to some fixed support and engaging said rod, substantially as and for the purpose set forth.

21. The combination with the lathe and rotary drill mounted on the slide rest thereof, of the electric motor mounted on a carriage movable with the line feed carriage of the lathe, a belt drive from the motor armature shaft to said drill shaft, and a belt drive from a countershaft on the motor to a countershaft drum parallel with the line feed of the lathe, for driving the same, whereby the belts from said motor will always be central with respect to their pulleys.

22. The combination with a lathe of attachments for engraving, comprising the rotary drill on the slide-rest of the lathe and receiving its lateral feed from the line feed of the lathe, the tracer carriage, the endless traveling cable for moving said tracer carriage, and a train of gear for driving said cable from the rotary motion of the lathe line feed screw, substantially as described.

23. In an engraving machine, the combination with a rotary pattern roller and a rotary design roller, of several tracers on a common carriage operating on different longitudinal sections of the pattern-roller, several magnet controlled drills on a common carriage operating on different longitudinal sections of the design roller, and corresponding distinct circuits for said several drill magnets controlled by the several corresponding tracers, substantially as described, for simultaneously producing several longitudinal sections of a design on the design roller.

24. In an engraving machine, the combination with a rotary pattern and design blank, of a laterally movable tracer carriage and a tracer carried thereby, a laterally movable tool carriage, and a tool carried thereby, and a variable feed mechanism between said carriages, comprising as one of its elements, a reversing device; whereby said carriage may be given any desired relative feed movements, either in the same or in different directions, substantially as described.

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

BARTON S. MOLYNEUX.

Witnesses:
JAS. F. WILLIAMSON,
FRANK D. MERCHANT.