(No Model.)

4 Sheets—Sheet 1.

R. W. BENTLEY.

RULING AND ENGRAVING MACHINE.

No. 313,648. Patented Mar. 10, 1885.

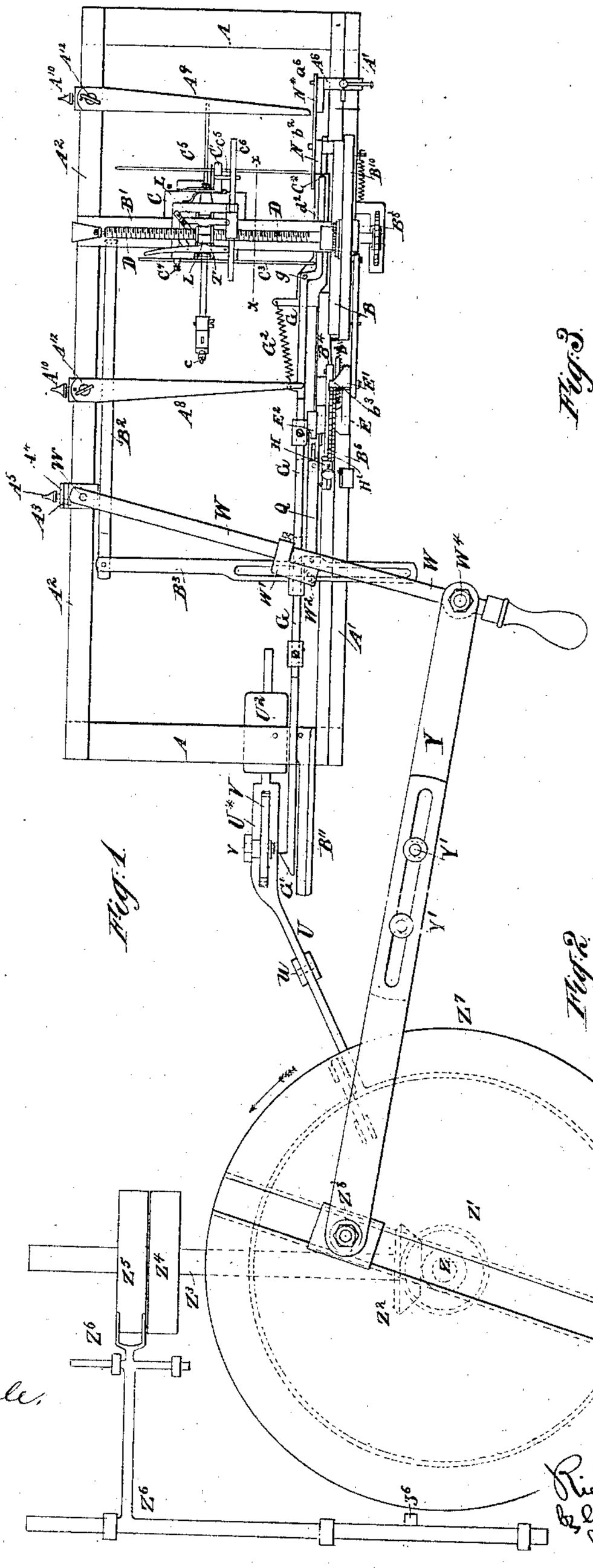

Fig. 1.

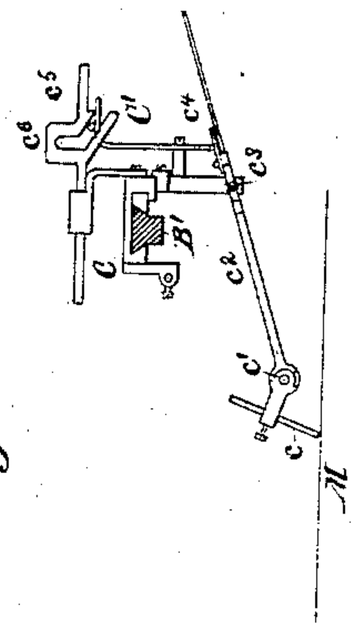

Fig. 3.

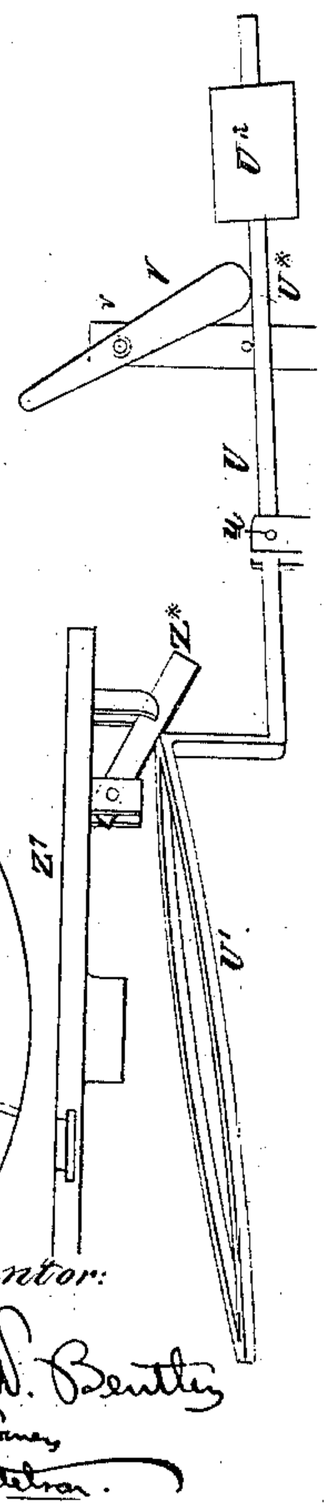

Fig. 2.

Witnesses:
Charles R. Searle.
L. E. Renwick

Inventor:
Richard W. Bentley
by his attorney
T. D. Stetson.

(No Model.) 4 Sheets—Sheet 2.

R. W. BENTLEY.

RULING AND ENGRAVING MACHINE.

No. 313,648. Patented Mar. 10, 1885.

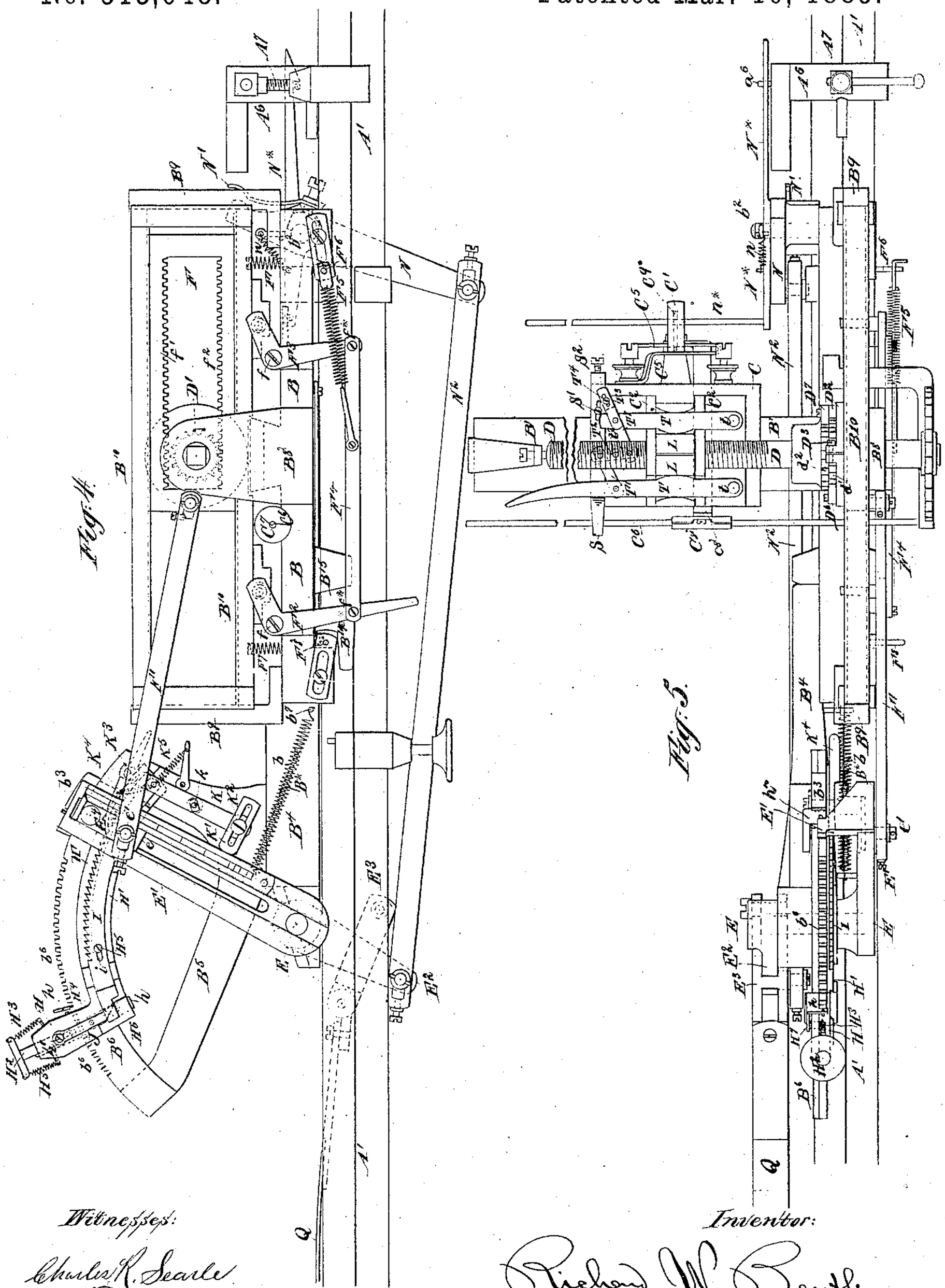

Fig. 4.

Fig. 5.

Witnesses:

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by his attorney

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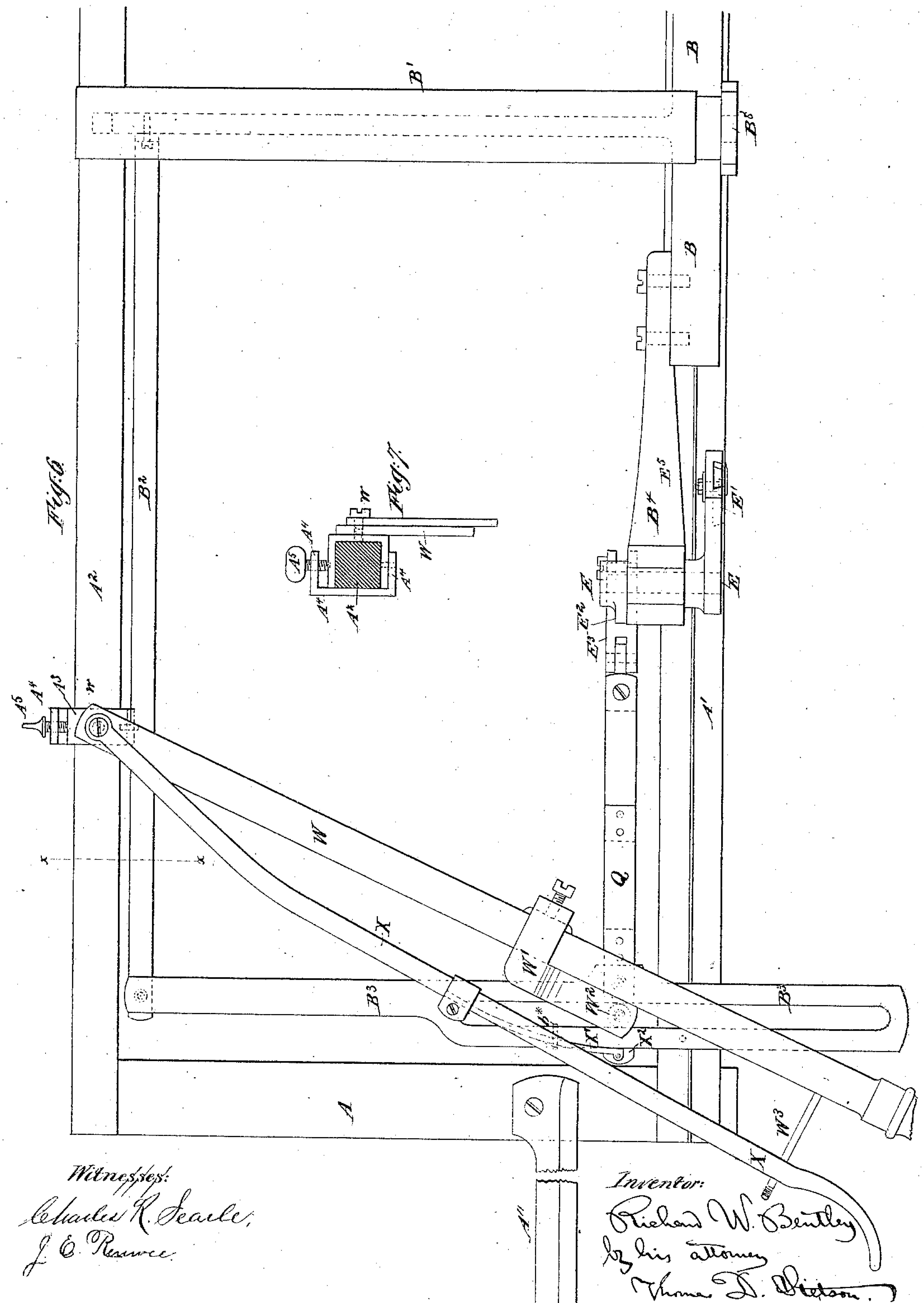
(No Model.)

4 Sheets—Sheet 3.

R. W. BENTLEY.

RULING AND ENGRAVING MACHINE.

No. 313,648. Patented Mar. 10, 1885.



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

(No Model.) 4 Sheets—Sheet 4.

R. W. BENTLEY.

RULING AND ENGRAVING MACHINE.

No. 313,648. Patented Mar. 10, 1885.

Fig. 10.

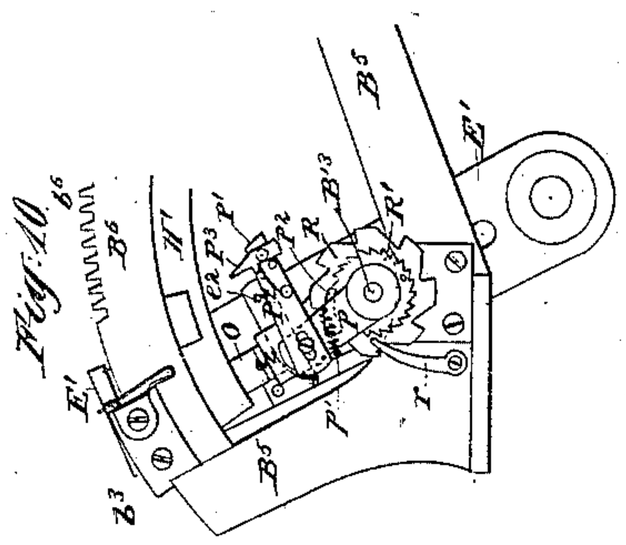


Fig. 11.

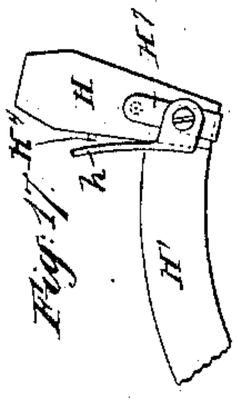


Fig. 18.

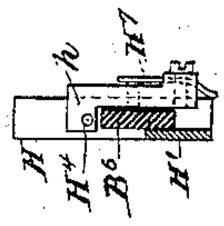


Fig. 9.

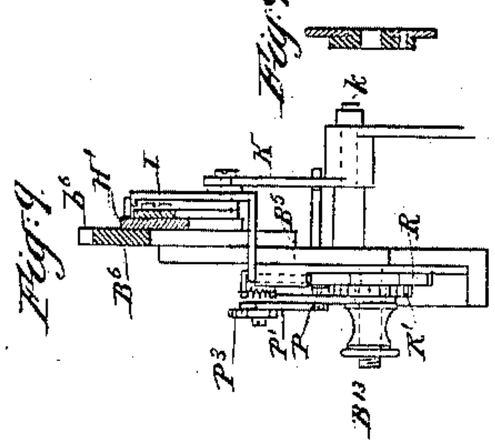


Fig. 9a.

Fig. 16.

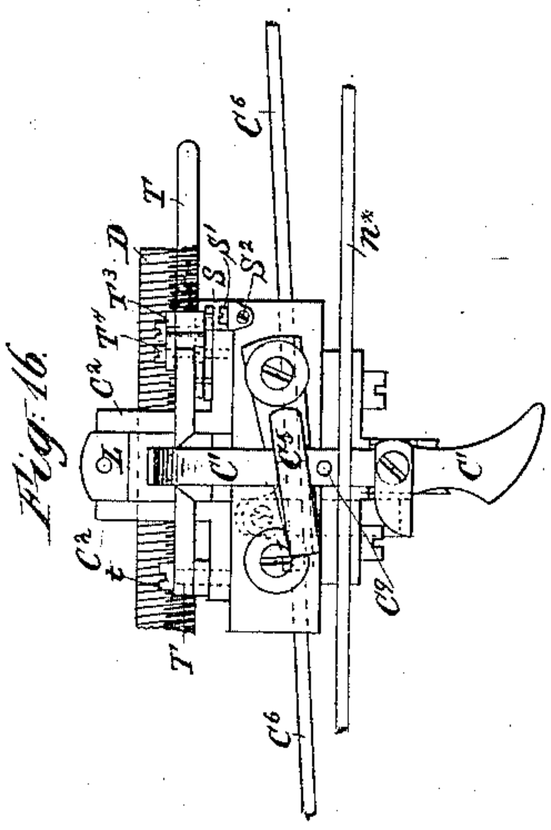


Fig. 8.

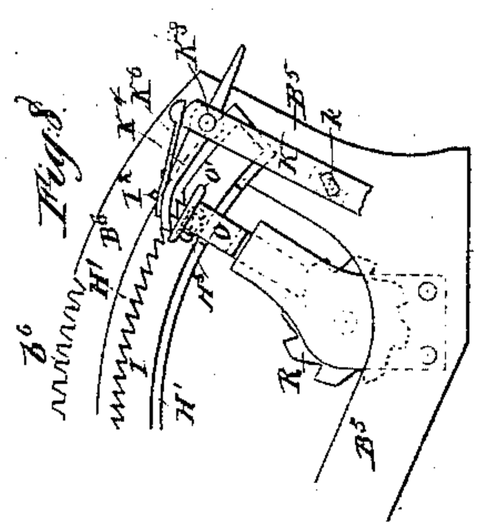


Fig. 14.

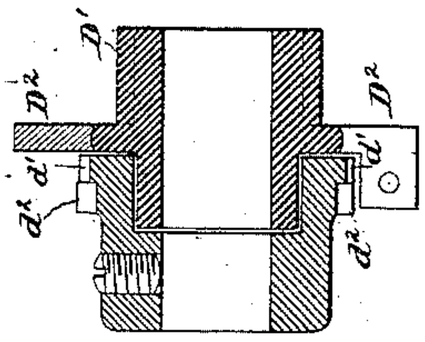


Fig. 13.

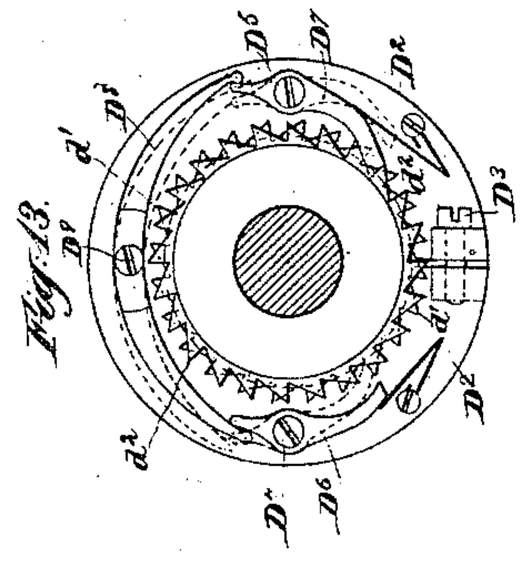


Fig. 15.

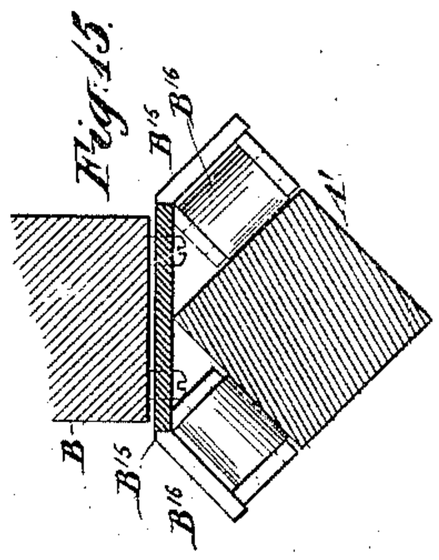


Fig. 11.

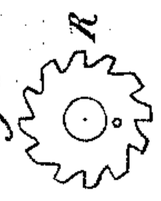
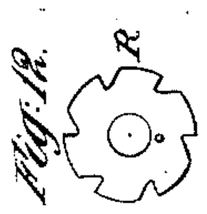


Fig. 12.



Witnesses:

Charles R. Searle.

J. E. Rennee.

Inventor:

Richard W. Bentley

by his attorneys

D. Nelson.

UNITED STATES PATENT OFFICE.

RICHARD W. BENTLEY, OF BROOKLYN, NEW YORK.

RULING AND ENGRAVING MACHINE.

SPECIFICATION forming part of Letters Patent No. 313,648, dated March 10, 1885.

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

To all whom it may concern:

Be it known that I, RICHARD W. BENTLEY, of Brooklyn, Kings county, in the State of New York, have invented certain new and useful Improvements in Ruling and Engraving Machines, of which the following is a specification.

My improvements apply to the entire class of engraving-machines and ruling-machines which are intended to aid engravers and other artists in making great numbers of parallel straight lines at moderate distances apart. Usually in making a tint in engraving the distances apart of the lines are very small. My improvements allow them to be exactly uniform, or to be conveniently varied to indicate the shade on curved surfaces, or to grade shades on flat or other surfaces. The old method of making the graduations by means of a handle on screw-carrying division-wheel, to be turned by the operator one or more notches against the pressure of a spring underneath, is slow and requires constant and intelligent attention. It is also uncertain, as the division on the wheel into which the operator wishes the spring to fall will often be carried too far, so making an imperfect graduation. By the old method in making lines running from fine into wide spaces it is necessary to use a division-wheel divided into twenty-fourths, counting so many notches between each line made, adding a notch to the count for every line made, or every two lines, or three or six lines, &c. The space answering to one of the notches is small, but sufficient to materially impair the work if a miscount is made or the notch is carried a little too far, which very often happens. It is almost impossible to correct the mistake, and so the work is spoiled. My improvements do away with these defects. The spacing is made perfectly without fail. The counting is done away with, all being accomplished automatically by operating a lever. Even spacing or grading spacing can be done with less labor and less time than it formerly took and very much more perfectly. I apply a lever connected by a link to the reciprocating carriage which carries the stylus or marking device, and limit its motion by adjustable stops, which allow the stylus to be reciprocated to an exactly uniform extent in applying tints or shades where the same are to stop abruptly at a line. I apply a friction-brake to aid in gently arresting the motion at the termination of the movement when the lines are of varying length. The lever which operates the carriage engages therewith by means of an extension from the carriage provided with a transverse slot, in which the lever engages.

In what I esteem the most complete form of the invention the operations are all performed automatically, and the machine may be driven by power, as by a belt from a shaft driven continuously by a steam engine or other motor. A good portion of the benefits of the invention may be realized by working without power.

To facilitate the description, I will first assume that the power mechanism is disconnected. The machine as thus dismembered will be readily understood by engravers accustomed to working by the direct application of one hand to one part, and the other to another part, and by acting intelligently at the points and periods required.

I will describe the machine as applied to the production of sharp smooth lines in the ground which is applied on copper and other plates for etching.

The following is a description of what I consider the best means of carrying out the invention.

The accompanying drawings form a part of this specification.

Figure 1 is a plan view showing the parts connected for working by power. Fig. 2 is an elevation of certain portions thereof. Fig. 3 is a cross-section of a portion on the line *x x* in Fig. 1. The remaining figures are on a larger scale. Fig. 4 is a side elevation of certain parts. Fig. 5 is a plan view of the same. Fig. 6 is a plan view showing the fixed framing and supporting ways at one end of the machine, with some of the moving parts. Many important details are omitted in this figure. Among those omitted are the secondary carriage with the stylus and its immediately adjacent parts. Fig. 7 is a section on the line *x x* in Fig. 6. Fig. 8 is a side elevation of certain parts. Fig. 9 is a vertical section of the same. Fig. 9ª is a central section through a portion detached. Fig. 10 is an elevation of the back side, the reverse of Fig. 8. Figs. 11 and 12 show change-wheels which may be substituted for the correspondingly-

marked part in the other figures. Figs. 13, 14, and 15 are on a still larger scale. Fig. 13 is an end elevation of certain wheels, with a cross-section of the feed-screw on which they are mounted. Fig. 14 is a central longitudinal section through the said wheels. Fig. 15 is a vertical section, partly in elevation. Figs. 16, 17, and 18 show certain parts on the same scale as Figs. 4 to 12, inclusive. Fig. 16 is an end elevation. Fig. 17 is a side elevation, and Fig. 18 is a vertical section.

Similar letters of reference indicate corresponding parts in all the figures where they occur.

A is the fixed frame-work, certain portions of which will be designated when necessary by additional marks, as A′ A². It presents two stiffly-supported horizontal ways A′ A², adapted to support the main carriage, which gives a reciprocating motion to the tool. B is such main carriage, certain portions being designated when necessary by additional marks, as B′. It is equipped with a stout cross or T part, B′, having a nicely-finished V-groove on its under face, adapted to rest on and be guided by the way A′.

C is a secondary carriage, mounted on the main carriage B. It is adjusted transversely on B′ by turning a screw, D. An intermittent turning of this screw gives the required step-by-step feed movement to the stylus *c*, to determine the distance of the lines apart. The stylus may be of the ordinary form and presented at the ordinary angle to a plane plate of copper, steel, or other material, M, held by any suitable means at the proper distance below.

The machine is arranged to produce the mark by the movement of the carriage B and its connections to the left. During this period the stylus is down in contact with the plate M. A partial revolution is given to the screw D, so as to effect the feed movement of the stylus during the return motion. The raising and lowering of the stylus is effected by the aid of a small lever, C′, carried on the carriage C, and arranged to be operated by one finger of the attendant when working by hand.

As the machine is ordinarily worked by hand, the right hand rests on or adjacent to the carriage C, and one finger of that hand operates the lever C′. The left hand operates a long transverse lever, W, which is arranged to turn horizontally on a pivot, *w*, carried in a screw clamp or block, A³, which is secured by the aid of a clip, A⁴, and thumb-screw A⁵ in any required position on the way A². A block, W′, is secured by a pinching-screw in any required position on the lever W. It has on its under face a pin carrying a roller, W².

B² is a rigid arm extending from the part B′ parallel to and near the way A². A slotted swing-bar, B³, is pivoted loosely to B², so that it may turn horizontally. Q is an arm or link pivoted to B³. A portion is thin and elastic, allowing it to be deflected upward and downward to a considerable extent. It lies near the way A′.

B⁴ is a stout arm rigidly bolted to the part B, and constituting a bearer for a short rocking shaft, E, which is provided with a slotted arm, E′, extending upward from its front end, and an arm, E², extending downward from its inner or back end. A yoke, E³, fixed on the arm E², is knuckled to the spring-link Q. It will be understood that the link Y has not been yet connected.

The machine is worked by hand. The attendant, moving the lever W to the right, acts through the roller W² on the slotted transverse arm or swing-bar B³ and effects two important movements. One is effected through the spring-link Q, which induces a partial turning of the shaft E, so that the upright arm E′, instead of inclining to the right, inclines to the left. The other is the backward movement of the carriage B and its connections ready to commence a new line. The T-part B′ supports a bracket, B⁸, which forms a suitable bearing for the smooth or unthreaded portion of the screw D. In a horizontal guideway, B¹⁰, is mounted a double rack, F, equipped with rack-teeth *f′ f²*. It receives longitudinal motion through a link, F′, from a pin, *e′*, carried on a block, *e*, adjustable on the slotted lever E′. The upper set of rack-teeth, *f′*, are not important at this stage of the description.

On the screw D is loosely mounted a spur-gear wheel, D′, which lies within the double rack F, and is engaged by the rack-teeth *f²*. With each movement of the slotted lever E the rack F is moved, and the loose wheel D′ is turned in one direction or the other. There is a stout boss or hub firmly fixed on the screw D and equipped with ratchet-teeth *d²*. The amount of the feed motion, and consequently the distance apart of the lines engraved, depend on the extent of the longitudinal movement of the double rack F. This can be varied by increasing or diminishing the amount of the rocking motion of the shaft E, and consequently the sweep of the arm E′, by adjusting certain stops, which limit its motion. When the force of the hand applied to the lever W commences to move it to the left to effect the corresponding movement of the carriage B and its connections, the pull of the spring-link Q, aided by the force of the spiral spring *b*, causes the shaft E to perform a partial revolution, carrying the arm E′ to the right until it strikes a stop, *b³*. Then a further movement of the hand to the left induces the proper traversing of the carriage B, and the line is engraved. This movement turns the gear-wheel D′ loosely on the screw D. On the return movement of the lever W the movement to the right, the friction, and inertia of the parts, aided by the tension of the spring *b*, hold the shaft E and its connections immovably in the carriage, traversing backward therewith until near the close of the backward motion, then a new force comes into play.

A⁶ is a rigid stop fixed in an adjustable po-

sition on the rail A′ by a screw, A⁷. A lever, N, provided with a spring, N′, to soften its action, is mounted on a stud, b^2, on the T-piece B. At the termination of the backward motion of the carriage the upper arm of this lever, cushioned by its spring N′, strikes this stop A⁶ and causes a turning of the lever. The lower arm of this lever is connected by a link, N², to the arm E². The hand-lever W must be worked with sufficient force at this juncture to turn the shaft E against the force of the spring *b* and overcome the resistance due to the inertia and friction of the several parts, and also the tension of the spring B′, and turn the arm E′ to the left, giving a corresponding motion to the double rack F and turning the wheel D′ and the screw D, with which it is rigidly connected by the pawls D⁶ D⁷, to effect the required feed motion of the carriage C and its connections. An adjustable stop limits the motion of the arm F′, and consequently the extent of the turning of the screw. This requires elaborate description.

B⁶ is an arc, of metal, mounted by means of arms or framing B⁵ on the extension-arm B⁴ from the carriage B, and traversing with it. It is concentric with the shaft E, and is toothed, as indicated by b^6, the teeth being properly spaced to make each induce an absolutely equal change in the extent of motion of the screw D. H′ is an arc or curved piece of metal mounted movably on the arc B⁶, attached to and carrying a radial arm, H, which performs the important function of an adjustable stop to limit the movement of the arm E′ to the left. It is secured firmly in the desired position on the arc B⁶ by means of a dog, H², urged downward and inward by springs H³. On raising this dog H² the arm H, with the entire arc H′, may be shifted at will to the right or left, and on allowing the dog to engage between the proper teeth the stop is held firmly. A spring, *h*, is mounted on the arm H, and insures a soft and gentle contact of the parts. A short stud, H⁴, is provided on the side of H, which stud serves as the direct means of receiving the impact of the arm E′. The spring is perforated to allow the gentle impact to be received directly. There are some kinds of work in which it is desired to change the spacing between the lines engraved at certain determined intervals. I provide mechanism by which, after one or two or any other given small number of lines have been engraved at a certain distance apart, the position of the stop H will be changed, and consequently the distance of the engraved lines apart will be increased automatically.

I is a ratchet-arc mounted on the front face of the arc H′, to which it is loosely secured by screws H⁵, inserted in slots *i*. These slots are of sufficient length to allow a little movement of the arc I to the right and left on the arc H′. The ratchet-arc I acts in each movement to the left against a toggle-lever, J, which latter is pivoted to the dog H² at a point, *h*′, the pivot extending through a slot in the stop-arm H. The lower end of J is rounded and adapted to slide smoothly on the inclined plane H⁶. Whenever these parts are liberated the tension of the springs H³, depressing the dog H², forces the toggle-lever J upon the inclined plane H⁶ and causes J to be deflected to the right with sufficient force to move the ratchet-arc I to the right, and the dog H², then allowed to sink, engages and holds the stop H firmly.

K is a lever pivoted at *k* to the arc B⁶, or, rather, to one of the arms B⁵ rigidly connecting such arc with the arm B⁴ on the carriage B. Its lower end carries a slotted adjustable cross-piece, K′, secured by a screw, K². Its upper end carries, by a loose pivot, K³, a lever, K⁴, one arm of which serves as a pawl to engage in the teeth on the periphery of the ratchet-arc I. A spring, K⁵, urges the upper end of K to the right. Near the termination of each movement of the arm E′ to the right it strikes the cross-piece K′, and, acting forcibly thereon, turns the lever K, urging the upper end, and consequently the pawl K⁴, to the left. This, when the pawl K⁴ is allowed to act, moves the ratchet-arc I to the left, and thus slides the toggle-lever J up the incline H⁶ and lifts the dog H². Then, continuing its movement a little farther, it shifts the stop H and its entire train of connections to the left. When the lever E′ again swings to the left, it liberates the lever K, which by the force of its spring K⁵ is restored to its original position, allowing the ratchet-arc I and its connections to move to the right, and consequently the dog H² to engage in the new notch. The parts being so adjusted that a sufficient movement of the lever K will be induced, the stop H will be shifted one notch or some other number of notches after each line is engraved, thus correspondingly increasing the width apart of the several lines as they are successively engraved. In general practice it is desired to shift only one notch at a time, and the parts are so adjusted. Whenever it is desired to throw this mechanism entirely out of use, a hooked swing-arm, K⁶, (shown in Fig. 8,) mounted on the upper edge or back of the pawl-lever K⁴, can be turned to one side, so as to catch on a pin, I², set in the upper edge of the arc H′, and hold the pawl-lever K⁴ permanently out of use. Thus conditioned, the stop H′ may be shifted into any position desired by raising the dog H² by hand and shifting the stop by force of the hand applied in either direction.

It may frequently happen that an automatic increase in the width of the spaces between the lines is desired which shall be less rapid than that above provided for. I attain this by making two, three, or other number of lines uniformly spaced, then automatically increasing the space, and then correspondingly making a number of lines uniformly spaced, and so on. This is effected by automatically lifting the pawl K⁴ and holding it during two or three or other number of movements, then allowing it to act once, and then holding it up

again during a similar number of movements. Figs. 8 to 12 show this mechanism.

O is a slide having a broad or T head, O′, presented under one edge of the acting end of the pawl K^4.

R is a coarsely-notched wheel turning on a stud, B^{13}, mounted on the framing or arm B^5, carried on the carriage B. A ratchet-wheel, R′, is fixed to one face of the wheel R. Its teeth receive a pawl, P^2, from a swinging lever, P, which is free to turn on the same center stud, B^{13}, and carries on a rigidly-connected arm, P′, a dog, P^3. This dog is urged into the upright position by a spring, P^4, the arm P is urged into contact with a stop, p', and the pawl P^2 engages with the teeth of the wheel R′. A spring, r, fixed on the carriage, holds the wheel R in any position in which it is turned. The coarse notches in the wheel R are adapted to receive the lower end of the slide O when they are presented thereto. The more or less broad spaces on the wheel R between the several notches hold up the slide O when they are presented thereto. A pin, e^2, on the inner or back face of the arm E′ sweeps across the point of the hinged dog P^3. At each movement of the arm E′ in one direction it engages with P^3 and moves the lever P, causing its connections to turn; but this motion is only to a small extent, because the pin e^2 soon slips off the dog P^3, and the rest of the movement of E′ produces no effect. On the return movement of E′ the pin e^2 moves idly across the hinged dog P^3, the latter swinging by the yielding of its spring P^4 to allow it to pass without effect. These parts are so adjusted that as each line is produced the wheel R′ turns one notch, correspondingly turning the coarsely-notched wheel R. When the latter presents a notch to receive the slide O, this slide sinks, and after the next line the pawl K^4 is allowed to act and shift the stop H one notch. Then the further turning of the wheel R lifts and holds up the slide O, causing the pawl K^4 to be held up, and to perform its vibrations idly during the execution of three or some other number of lines, which are thus uniformly spaced. Then the sinking of the slide O into the next notch allows the pawl to again act and increase the spaces between the lines, and so on.

I provide several differently-toothed wheels R, which by slight labor may be substituted one for another to accommodate different kinds of work.

It is important to preserve the elaborate mechanism just described from being subjected to wear in executing ordinary uniformly-spaced lines, and yet to vary the width of the spaces between the lines. I can effect this by shifting the point of connection of the link F′ to the slotted arm E′. The pin e' is mounted in a block, E^4, which can be shifted toward and from the axis of E. The slot is sufficiently long to allow all the range which is usually required. The block is held in the required position by a nut, E^5, at the back.

It is frequently useful to be able to change the position of the carriage C on the carriage B to a great extent rapidly. To accommodate this I engage the carriage C with the screw D by means of a nut which is formed in two halves or semi-nuts, L L. These are mounted in parallel ways C^2 C^2 on the carriage C, and are controlled by levers T T, which are pivoted on the carriage C at t t, and are connected by links T′ T′ to a short intermediate lever, T^2, which turns on a pivot, t^2. One of the levers T is extended to form a convenient handle, by acting on which both levers, and consequently the semi-nuts L L, can be moved apart to let go of the screw-threads. Thus conditioned the carriage C may be moved by any sufficient force the whole width of the machine, or to any less extent which may be desired. Then by a proper movement of the levers T the semi-nuts L L are again closed together and engage firmly and reliably with the threads of D.

S is a spring-catch fixed firmly on the carriage C by means of the pinching-screw S′, which stands in a slot and allows it to be shifted considerably to the right or left.

S^2 is a set-screw, by turning which, when the screw S′ is a little slackened, the spring S may be set to the right as little as may be required. This spring holds one, and consequently by the connections both, the levers T in the position of engagement with the screw D.

It is important to preserve the perfection of the threads of the screw D and of the semi-nuts L L and maintain as accurate a condition of centering of the adjustment as possible. It may happen from various causes that as the work wears the nut tends to get slightly out of line with the screw to the right or left. To correct this, I provide an adjustable connection of one of the links T′ to its corresponding lever T. To effect this on so short a link as T′, I extend one of them past its proper lever T, and thence, making an offset forward, extend it back again to the proper lever, making this backward extension by a separate piece, which is slotted. This return-piece T^3 is adjustable by shifting it on the connecting-screw T^4. When the semi-nut, operated by the back extension, T^3, takes hold sooner and tighter than the other semi-nut, I shift this connection to lengthen this link. If it does not take hold soon enough, I shorten this link. The spring-catch S may require adjustment after each such change in the adjustable link T^3.

X^2 is a brake-block mounted on a stout spring, X′, carried on a horizontal lever, X, which stands nearly parallel to the lever W and turns on the same pivot w. Its near end is supported by an arm, W^3, from the lever W, and is formed to allow it to be easily operated by a finger of the hand which is operating the lever W.

It is frequently desirable to control the action of the lever W very accurately at and near the termination of some or all of the en-

graved lines, particularly where there are lines of varying length. In such case the attendant moves the lever W boldly until the line is nearly completed, and then, acting on the lever X, urging it toward the lever W, he applies the friction brake-block X^2 forcibly to the side of the cross-lever or hinged bar B^3, and generates a friction, which rapidly extinguishes the momentum of the parts and brings all to rest. My experiments indicate that practice will give great facility in thus operating. If it happens that the movement is arrested too early, the compression on the lever X is relaxed and tightened intermittently a few times, while a gentle force is applied to the lever W, and the movement of the lever W, and consequently the engraving of the lines, is completed by a series of short and diminishing steps.

I will now describe the provisions for working the lever W and its connections by power. This is effected through the adjustable link or connecting rod Y, which is formed in two parts, slotted and united by bolts Y', as shown, so as to allow a considerable range of adjustment in the link.

Z is an upright shaft equipped with a beveled gear-wheel, Z', which receives motion from a corresponding beveled gear-wheel, Z^2, carried on a shaft, Z^3, which latter is equipped with fast and loose pulleys Z^4 Z^5, allowing it to be stopped or to be turned uniformly by a belt from a steam-engine or other suitable power when desired. The belt is controlled by a shipper, Z^6.

Z^7 is a sufficiently large horizontal wheel carried on the upper end of the shaft Z, and having one or more radial slots holding an adjustable block carrying a pin, Z^8. The link Y connects with the pin Z^8 at one end and with a pin, W^4, mounted on the lever W, at the other end. The pin Z^8, carried around by the wheel Z^7, communicates the proper motion through the link Y. If it be desired to increase the range of motion of the lever W, the block, and consequently the pin Z^8, is shifted on the wheel Z^7.

The attendant can at any moment stop the machine by moving the shipper Z^6 to shift the belt upon the loose pulley Z^5, as will be readily understood.

I provide means for automatically stopping the operation when the engraving has proceeded to a certain point.

Z* is a short lever suspended on the under side of the wheel Z with liberty to drop into the inclined position shown in Fig. 1, except as it is held up by the smooth ring U', carried on a lever, U, which latter turns on a fixed center, *u*, and is partially balanced by a weight, U^2. A widened portion, U*, is adapted to receive the rounded end of a lever, V, mounted on a fixed pivot, *v*. An arm from this lever V extends upward, and is the medium for receiving the action from the machine when the engraving has progressed to the proper line.

C^3 is a horizontal arm extending to an adjustable distance out from the carriage C, controlled by a pinching screw, C^4. This arm is allowed to project to a just sufficient extent, according to the breadth which is to be engraved. The feed motion of the carriage C is always toward the operator when running by power. Until the arm C^3 strikes something the work will continue.

G is a horizontal lever, adjustable lengthwise, turning on a fixed vertical pivot or pintle, *g*, carried on the carriage B. The long arm of this lever G is provided with a beveled hook, G'. The short arm has a notch on its under face, which engages with a spring-catch, C*. So long as this lever G remains in the position shown the engraving action of the machine will continue; but so soon as the carriage C, and consequently the stylus *c*, have traversed to the proper extent the arm C^3 will press against the lever G and disengage it from its spring-catch C^5 and leave it free to be turned by its spring G^2. This moves its hook G', so that as it is reciprocated by the carriage B it travels in a new path, ready to engage with the lever V. Immediately on the commencement of the return motion of the stylus *c* the hook G' brings the lever V into the upright position, and by the action of the lower end of V upon U* raises the ring U', and consequently the short lever Z*. With the lever Z* in this position the rotation brings the latter strongly into contact with a projection, z^6, from the shipper Z^6 and moves the shipper and stops the machine. My experiments indicate that this will occur with certainty before the return movement of the carriage B is completed.

I will now proceed to describe the function of the set of ratchet-teeth *f'*.

I have heretofore described the horizontal guideway B^{10} as carried always at a uniform height on the carriage B. It is capable of being raised and lowered, guided between uprights B^9.

F^2 F^3 are bell-crank levers turning on pivots *f f*, carried on the carriage B. The lower ends of these levers are connected by a link, F^4, and are subject to the force of a spring, F^5, having its abutment in a pin, F^6, carried on the carriage B. The lateral arms of these levers F^2 F^3 support the guideway B^{10}. The back face of one lever, F^2, is recessed, to engage with gentle force on a spring-arm, B^{14}, extending down from the carriage B.

F^7 F^7 are spiral springs arranged to serve between the carriage B and the guideway B^{10}, aiding to partially support the latter.

So long as the parts are in the position represented the lower rack, f^2, is effective and the screw D is turned in the direction to feed the tool-carrier from the operator. When the feed is to be in the opposite direction, the attendant disengages the spring F^5 from its pin F^6, and, after turning the levers F^2 F^3 to lower the guideway B^{10}, shifts the position of the spring F^5 so that it extends in a nearly-opposite direction to that shown and engages it on the

pin F^8. Now, its tension urges the levers F^2 F^3 in the opposite direction to that shown, and holds the upper set of teeth, f', in the proper gentle engagement with the teeth of the wheel D'. A corresponding adjustment of another part is required. The extended bearing or sleeve of the wheel D' carries a clip-ring, D^2, which is compressed tightly thereon by a screw, D^3, so as to serve as a unit therewith. Pins D^4 D^5 in one face of the ring D^2 carry pawls D^6 D^7, each urged by a spring into engagement with one of the ratchets d' d^2. These pawls are controlled by a curved lever, D^8, adjustable on the pin D^9. This lever D^8 should turn with considerable friction; but it may be adjusted by a forcible action of the thumb or finger, so as to raise the pawl D^6 out of action and allow the opposite pawl, D^7, freedom to play. As shown by the dotted lines in Fig. 13, the stylus will be fed toward the operator. By turning the lever D^8 into the position shown in strong lines in Fig. 13 and turning the lever F^2 to lower the double rack F, so that the rack-teeth f' will be engaged with the gear-wheel D', the stylus will feed in the opposite direction, the feed movement being effected as at present during the return movement.

B^{15} is a carriage introduced under the T-piece B, and equipped with two oppositely-inclined anti-friction rollers, B^{16} B^{16}. These are adjusted to press on the correspondingly-inclined surfaces of the way A' and relieve the carriage from a great portion of the friction to which it would otherwise be subject; but it is important not to set these rolls so as to take all the load. The proper steadiness of the stylus *c* requires that the carriage shall bear directly on the way A' with a portion of its weight.

I have not deemed it necessary to represent the provisions for holding the plate M. It will be understood that a firm table is employed, of any ordinary or suitable character. It may be adjustable in height. I propose to engrave plates of different thicknesses, composed of any ordinary or suitable material. I can, by using a suitable tool adapted to act directly on the material, engrave accurately-spaced smooth parallel lines on blocks of box-wood or other suitable wood. I can, by the use of a diamond in the stylus *c*, engrave lines on lithographic stone.

H^7 is a friction-spring secured on the inner face of the adjustable stop H, and exerting a considerable pressure on the back face of the arc B^6. It holds the parts H and B^6 together with some force, but not so as to prevent the stop H from being shifted by the mechanism described.

The stylus or tool *c*, which effects the engraving or marking on the plate M, may be changed to various angles by adjusting its holder at a joint, *c'*. (See Fig. 3.) The lever c^2 is pivoted to the carriage C at the point c^3. The extension of the lever c^2 beyond the axis c^3 presents a sufficiently broad bearing-surface, c^4, which receives the cam-shaped lower end of the lever C', (see Figs. 1 and 3,) which turns on a pivot, c^3, carried on the carriage C. The stylus may be raised and lowered by acting on this lever C' directly by hand. I provide an arm, c^5, on the upper end of the lever C', which is received in an inclined slot in a slide, c^6, which is mounted with liberty to slide endwise in the carriage C, all as shown in Figs. 1 and 3. Two arms, A^8 and A^9, are secured in adjustable positions on the back rail or way, A^2, by means of thumb-screws A^{10}. At each movement of the carriage B and its connections to the left one end of the slide c^6 is struck against the stop A^8, causing the slide c^6 to move in its keeper on the carriage C in the direction to the right. The movement raises the arm c^5, thereby tilting the upper end of the lever C' from the operator and moving the lower end of the same lever, which is cam-shaped, toward the operator. This movement, by the action of the cam-shaped lower end of the lever C' on the bearing-surface c^4, depresses that portion of the lever c^2 and causes said lever to turn on the center c^3, thereby raising the opposite end and the stylus *c*. The parts hold this relation to each other during the whole return movement of the carriage B and its connections to the right; but at the extreme end of the movement to the right the slide c^6 strikes the stop A^9 and moves the slide c^6 again in its keeper or seat on the carriage C. The movement this time is in the direction to rock the lever C' in the opposite direction, causing its cam-shaped lower end to liberate the bearing c^4. This allows the lever c^2 to rock by gravity and lower the stylus *c* down into contact with the plate M. The parts remain in this position during the whole movement of the carriage B and its connections to the left, which is the effective portion of its movement. The stylus *c* describes a smooth straight line on the plate during the whole of the movement of the carriage to the left. At the termination of its movement in this direction the slide c^6 again strikes the arm A^8, and the stylus *c* is again lifted, and so on.

C^5 is a folded piece of hard brass or other suitable material secured on the carriage C, and embracing the lever C', as shown in Figs. 1, 5, and 16. It clasps on the lever C' with gentle force, so as by its friction to hold it in any of the several positions in which it may be left by the action of the slide c^6. In working by hand this spring serves the same function, holding the lever C' in the right position to hold the stylus up during the return motion, and holding the lever C' out of use and allowing the stylus to rest on the plate M during the effective movement.

C^6 is a rod carrying a button, C^7, which serves in raising and lowering the tool by hand when the machine is by proper changes in the other parts conditioned for engraving by the movement of the tool to the right. It is embraced by a clamp, C^8, carried on an arm, c^8, which is rigidly connected to the le-

ver C′. The clamp C⁸ embraces the rod C⁶ with sufficient force to allow a gentle force impressed on the rod C⁶ to rock the lever C′ in one direction and the other. The brake-block X² and its connections should be shifted forward or backward on the brake-lever X, according as the roller W² and its connections are shifted forward and backward on the lever W. The brake-block should be kept adjacent to the roller W².

When I am engraving long lines, and the carriage B and its connections make the extreme movement to the left, the end of the arm B² and the slotted cross-lever B³ can move to the left considerably beyond the ends of the ways A′ A². I provide an arm, A¹¹, to support the parts when in this extreme position. The roller *b**, mounted on the under side of the slotted cross-lever B³, runs on the extension A¹¹ and makes a nearly frictionless support.

B* is a spring inclosed within the principal spring *b*. Under ordinary conditions a single spring, *b*, is sufficient to compel the proper movement of the lever E′ to the right; but whenever, by reason of the adjusting of the pin *e′* to a lower position, or if, for any other reason, it is found that the lever E′ is too easily shifted over to the left, I engage both springs *b* and B* on the pin *b*⁷. Graduations are indicated on the face of the arm E′. This may be accompanied by designated figures or marks. They aid in adjusting the height of the block carrying the connection *e′* for the link F′. When the stop H is adjusted so as to allow the fullest vibration of the arm E′, the adjusting of the pin *e′* up and down in the slot to any given graduation will cause the machine to produce lines of any given fraction of an inch apart.

When the mechanism is operated for varying the spaces between the lines, I set the block carrying the pin *e′* in its highest position, so that the index or pointer on the block stands at the extreme upper end of the graduated scale.

N* is a lever, which is important in some conditions when making lines automatically varied. One end is hook-formed and beveled, as shown in Fig. 4. When the carriage B and its connections move to the right, this hook end passes over a pin, *a*⁶, on the adjustable stop A⁶. The shoulder of the hook moves considerably past this pin. On the return movement the carriage is moved to the left until this hook strikes the pin *a*⁶, thus giving warning to the operator, who has until this period held up the tool or stylus. Then, when this position of the parts is attained, the operator lowers the stylus into contact with the plate M, at the same time lifts the hook and allows the stylus to commence to engrave its line. The hook is worked automatically, being engaged by gravity, aided by a spring, *n*, and disengaged simultaneously by the lowering of the stylus through the pin *c*⁹, carried on the lever C′, which acts on a lateral arm, *n**, on the lever N*. This avoids an irregularity in the commencement of the lines which would otherwise be likely to occur when the distances between the lines are being changed by the means above described.

I find that there is under some circumstances an objectionable concussion and jarring when the arm E′ strikes the stop B³. I introduce a spring, *h*², attached to the stop B³, arranged so that it deadens the force of the slight blow, and yet allows the arm E′ to come certainly into contact with the stop B³ at each forward motion of the carriage B.

A¹² is a thumb-screw, by which the arms A⁸ A⁹ may be shifted at their junction with the stops A¹⁰. I have shown A⁸ A⁹ standing parallel to each other and extending directly across the path of the stylus. The lines engraved will correspondingly commence and stop and the area covered by the engraved lines will be rectangular; but I can change the position to various other angles by slacking the screw A¹², with the effect to induce the starting and stopping of the lines correspondingly.

Modifications may be made in the forms and proportions of the details without sacrificing the advantages or departing from the principles of the invention.

Parts of the invention may be used without the whole.

I can, by disconnecting the link or connecting-rod Y, operate by hand, as first described. I can, if any work requires it, carry two or more tools by a single motion of the carriage. I can, by an obvious reversing of the conditions, engrave by moving the plate in contact with a stationary cutter or stylus.

I have shown a bracket supporting the farther end of the feed screw D. This can be varied.

By suitable modifications of this machinery I can engrave on box-wood so as to produce parallel lines at uniform or varying distances thereon the same as on other material. The modifications necessary to adapt this to the wood-engraving machines need not be detailed, but will be obvious to those skilled in the art. The principles apply in the same manner.

I claim as my invention—

1. The segment B⁶, differentially notched, in combination with a variably-rotating rocking shaft, E, connecting-link F′, rack *f′*, and gear-wheel D′, as means for operating the feed-screw controlling the spaces between the lines in an engraving-machine, as herein specified.

2. The movable stop H and locking key or dog H², in combination with the differentially-notched segment B⁶, variably-rotating rocking shaft E, connecting-link F′, rack *f′*, and gear-wheel D′, as means for operating the feed-screw controlling the spaces between the lines in an engraving-machine, as herein specified.

3. In an engraving-machine, the toggle-lever or lifting-link J, in combination with the dog H², stop H, rocking arm E′, and sliding segment I, with its inclined plane I′, and mechan-

ism, substantially as specified, for moving the segment I to a limited extent by a movement of the arm E′, all substantially as herein specified.

4. In an engraving-machine, the vibrating lever N, connecting-link N^2, shaft E, with its arms E′ E^2, connection F′, rack f', and pinion D′, carrying one or more pawls, and ratchet-wheel H′, combined and arranged as herein specified.

5. In an engraving-machine, the adjustable split ring D^2, carrying a pawl, D^6, in combination with the feed-wheel D′ and gear-screw D, and with means, as f', and suitable connections to the arm E′, for giving a variable reversely-rotating intermittent motion to D′, as herein specified.

6. The double-rack slide F, with its two sets of teeth, f' and f^2, and means for reciprocating it to variable extents, as specified, in combination with the two pawls D^6 and D^7, double ratchet-wheel D′, and feed screw D, as herein specified.

7. The levers F^2 F^3, connecting-link F^4, and means, as F^5, for holding them in position, in combination with each other and with the gear-wheel D′, feed-screw D, and means, as F′ and its connections, for inducing reciprocating motions in the rack-frame F, with its two racks f' f^2, as herein specified.

8. In an engraving-machine, the rack-frame F, with its two racks, f' f^2, and means for reciprocating it to variable extents, in combination with the levers F^2 F^3, connecting-link F^4, and supporting or partially-supporting springs F^7, as herein specified.

9. In an engraving-machine, the reversible spring F^5 and its reversing-studs F^6 F^8, in combination with the double rack F, with its two sets of rack-teeth f' f^2, and reciprocating mechanism E′ and its connections, and with the feed-screw D, and means, as E′, for transmitting variable motion, as herein specified.

10. In an engraving mechanism, the extension-piece B^4 on the carriage B, in combination with the notched segment B^6 b^6, and its connecting-frame B^5, and with the rocking shaft E and its connections, adapted to serve substantially as herein specified.

11. In an engraving-machine the lever K, adjustable motion-piece K′ and ratchet K^4, in combination with the arm E′, and means for vibrating the latter to variable extents, and with the notched segment B^6, sliding toothed segment I, toggle or lifting link J, dog H′, and adjustable stop H, arranged for joint operation as herein specified.

12. In an engraving-machine, the carriage B, operating-lever W, turning on an adjustable center, *w*, roller W^2, and slotted swing-bar B^3, pivoted on an arm, B^2, from the carriage B, in combination with each other and with a link, Q, variably-oscillating shaft E, with its arms E′ E^2, and connections therefrom to the feed-screw D, arranged to give by the vibration of W both the reciprocating motion of the carriage and the variable feed motion of the tool, as herein specified.

13. In an engraving-machine, the combination, with the reciprocating carriage B, vibrating arm E′, and means, as W and its connections, for giving a reciprocating motion to said carriage, of the screw D, having variable feed motion, as herein specified.

14. In an engraving-machine, the double stop A^6, in combination with the reciprocating carriage B and lever N, as herein specified.

15. In an engraving-machine, the continuously-rotated shaft Z, carrying a crank-pin, Z^8, in combination with the connecting-rod of adjustable length, as shown, and with the lever W and suitably-connected mechanism, as shown, for reciprocating the carriage B and raising and lowering the stylus and effecting the feed movement of the carriage C and its attachments, substantially as herein specified.

16. The longitudinal hook-lever G′, carried on the carriage B, in combination with the adjustable rod carried on the carriage C, and with the lever V and its connections, arranged to stop the action so soon as the engraving has progressed to the required distance, as herein specified.

17. In an engraving-machine actuated by power, the obliquely-slotted slide c^6, carried on the carriage C, in combination with the transverse adjustable arms or stops A^8 A^9, the lever C′, and suitable connections, c^2 c^4, to stylus *c*, arranged to effect the raising and lowering of the latter at the proper period, as herein specified.

18. In an engraving-machine, the brake-block X^2, carried on the lever X and arranged to serve with the lever W and its connections for aiding to arrest the motion of the stylus and its carrying parts, as herein specified.

19. In an engraving-machine, the pair of semi-nuts, in combination with the carriage B C and feed-screw D, arranged to serve as herein specified.

20. In an engraving-machine, the carriage B and extension B′, in combination with the feed-screw D and means for operating it, the carriage C and stylus *c*, and a pair of semi-nuts, L L, capable of being connected and disconnected at will, as herein specified.

21. In an engraving-machine, a pair of semi-nuts, L L, operating-levers T T, and links T′ T′ to a single operating part, T^2, in combination with an adjustable return-arm connected to one of the said links, arranged to allow the positions and motions of the semi-nuts to be varied, as herein specified.

22. In an engraving-machine, the rollers B^{16} B^{16} and carriage B^{15}, in combination with the way A′ and carriage B, to relieve the carriage of a portion of the friction, while leaving a sufficient direct bearing to maintain steadiness, as herein specified.

23. In an engraving-machine as described, the combination, with the carriage, the lever

N, and stops A^6, of the cushioning-spring, as N′, adapted to soften the concussion, while not disturbing the certainty of the action of the stop, as herein specified.

24. In an engraving-machine, the friction-spring H^7, in combination with the arc B^6, carried on the main carriage, and with the stop H and arc H′, and mechanism, as shown, for automatically shifting the latter, as herein specified.

25. In an engraving-machine, the spring C^5, in combination with the lever C′ and its connection c^2 to the stylus *c*, arranged to offer a gentle friction to hold the stylus in the raised and lowered position alternately, as herein specified.

26. In an engraving-machine, the hook-stop, N*, in combination with the carriage B, and mechanism, as shown, for effecting the traversing movement, raising and lowering the stylus *c* and imparting the feed, arranged to arrest the carriage at a certain point in each traverse and allow the stylus to descend with certainty at the point to commence the lines uniformly, as herein specified.

27. In an engraving-machine, the lever C′, clamp C^8, and operating-rod C^6, in combination with the carriage B C, and mechanism, as shown, for allowing the tool-lifting to be properly effected for right-hand working, as herein specified.

28. In an engraving-machine, the supporting roller or wheel *b**, in combination with the lever B^3 and its connections to the carriage B and with the framing A, having an extension, A^{11}, adapted to serve as a track for said wheel, as herein specified.

In testimony whereof I have hereunto set my hand, at New York city, N. Y., this 4th day of September, 1884, in the presence of two subscribing witnesses.

RICHARD W. BENTLEY.

Witnesses:
CHARLES R. SEARLE,
M. F. BOYLE.