

July 23, 1940.

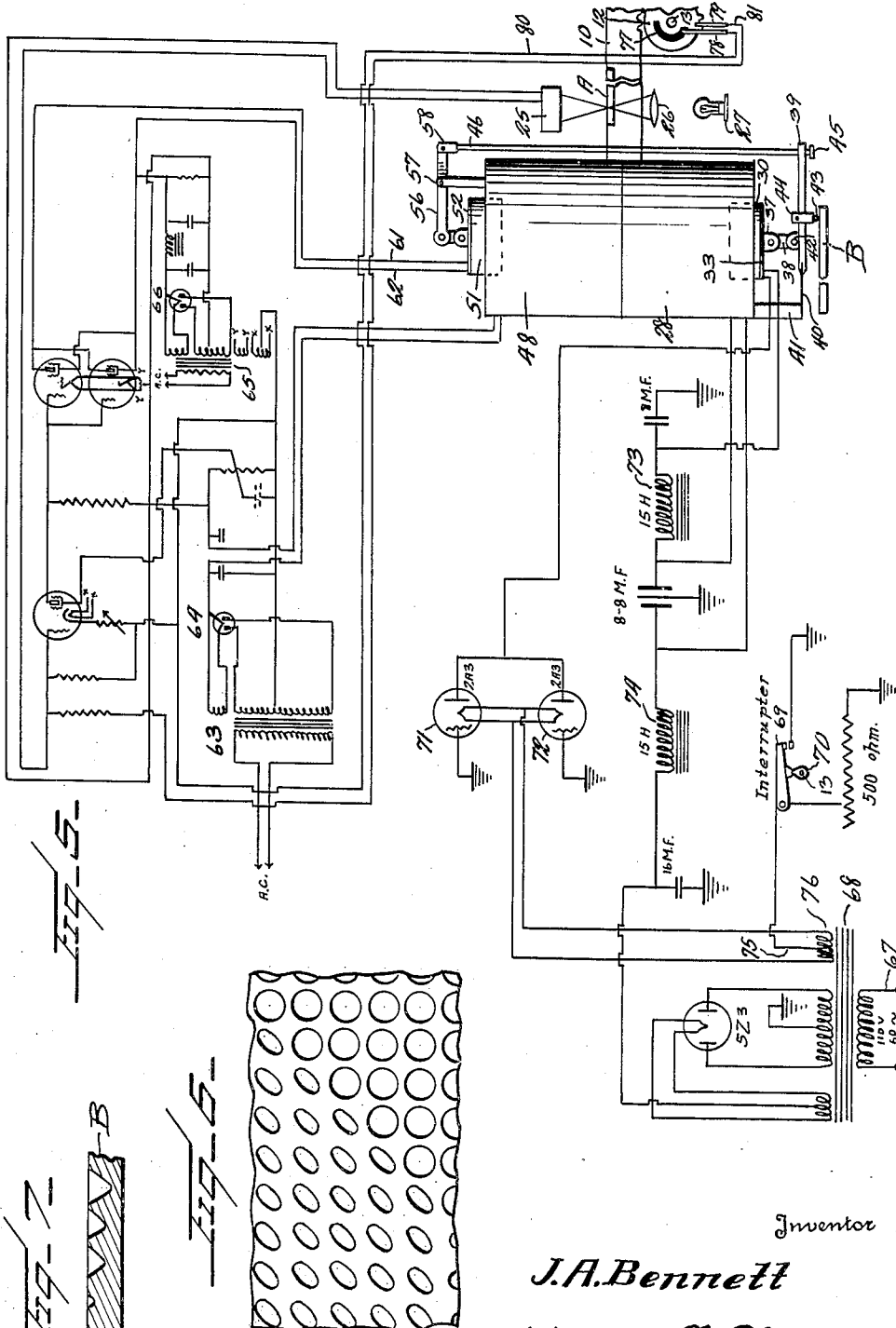
J. A. BENNETT

2,209,183

PRINTING PLATE AND METHOD OF AND APPARATUS FOR PRODUCING IT

Filed April 3, 1937

5 Sheets-Sheet 2



Inventor

J. A. Bennett

By

Watson E. Coleman

Attorney

July 23, 1940.

J. A. BENNETT

2,209,183

PRINTING PLATE AND METHOD OF AND APPARATUS FOR PRODUCING IT

Filed April 3, 1937

5 Sheets-Sheet 3

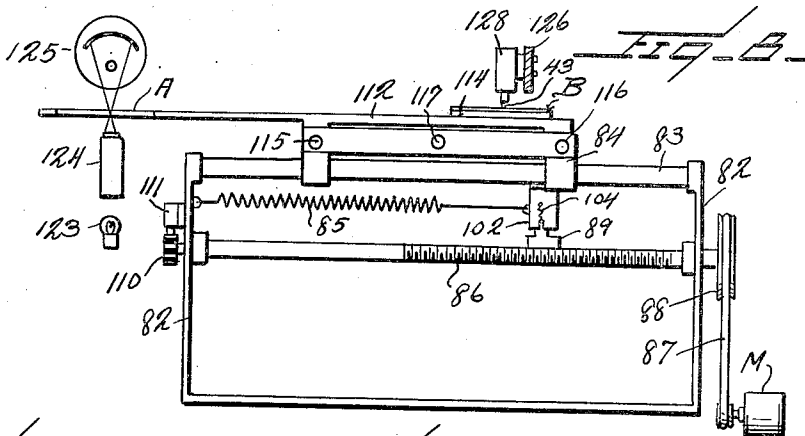
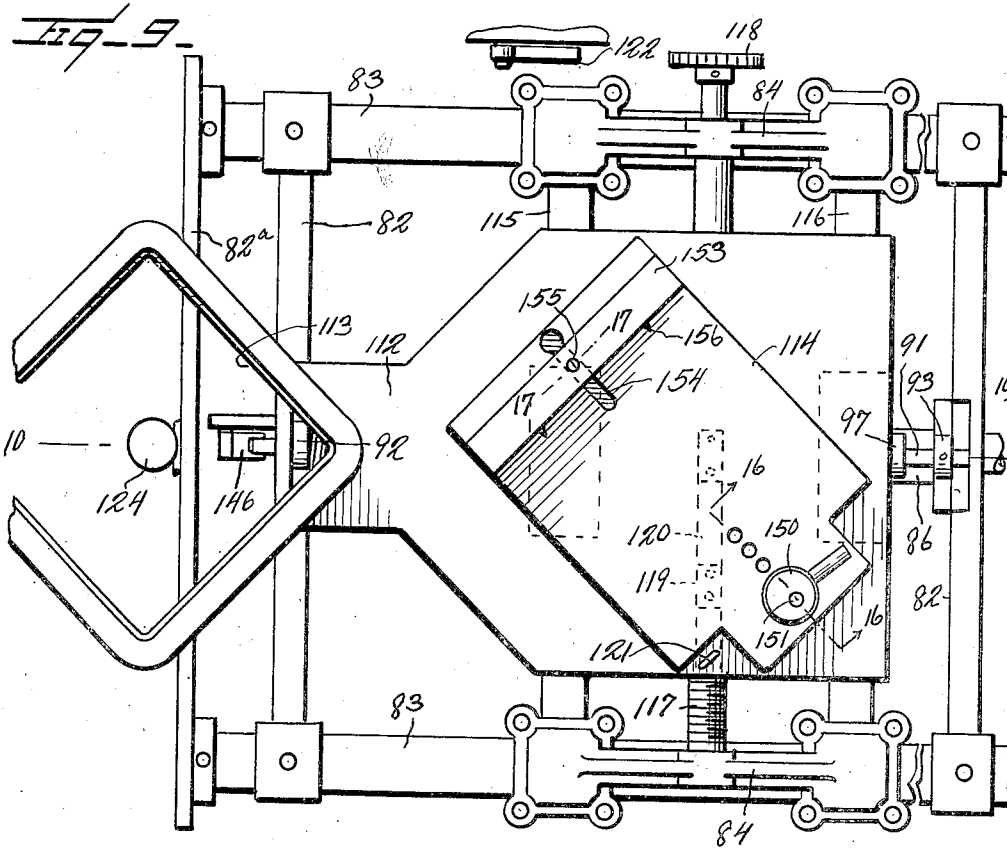


Fig. 15.

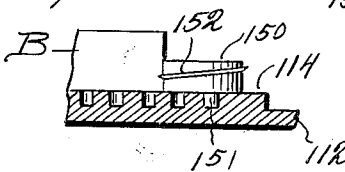
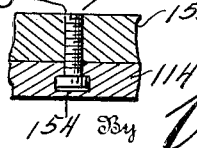


Fig. 17.



J.A. Bennett

Watson E. Coleman
Attorney

July 23, 1940.

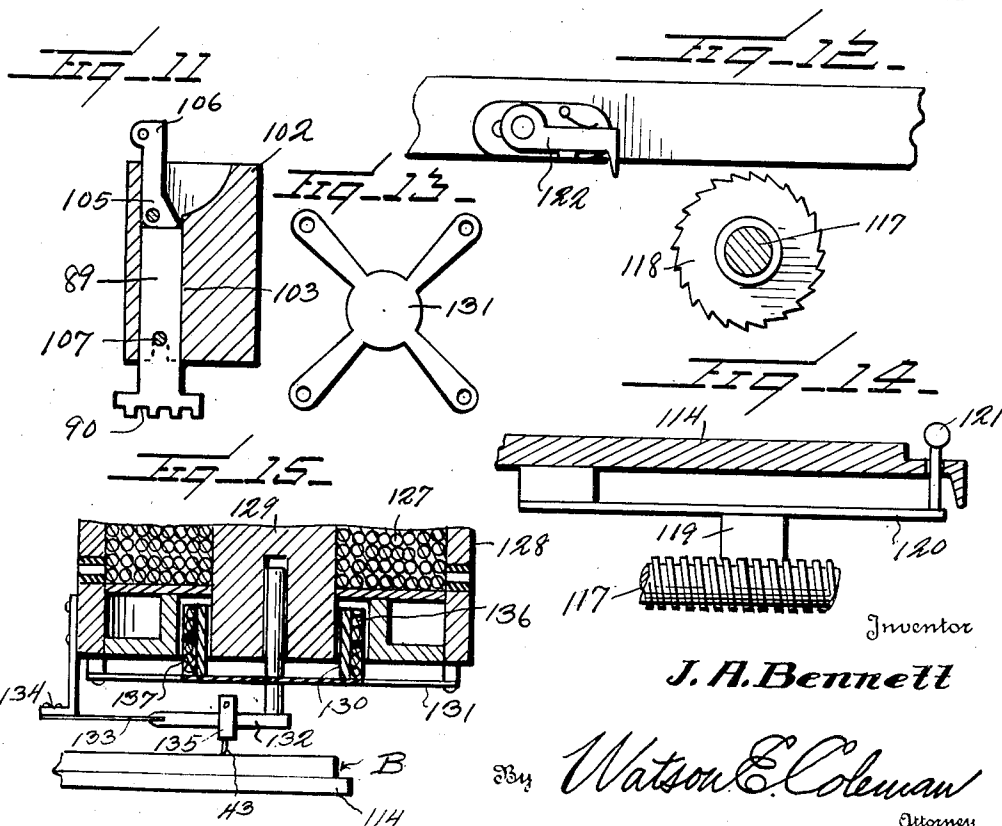
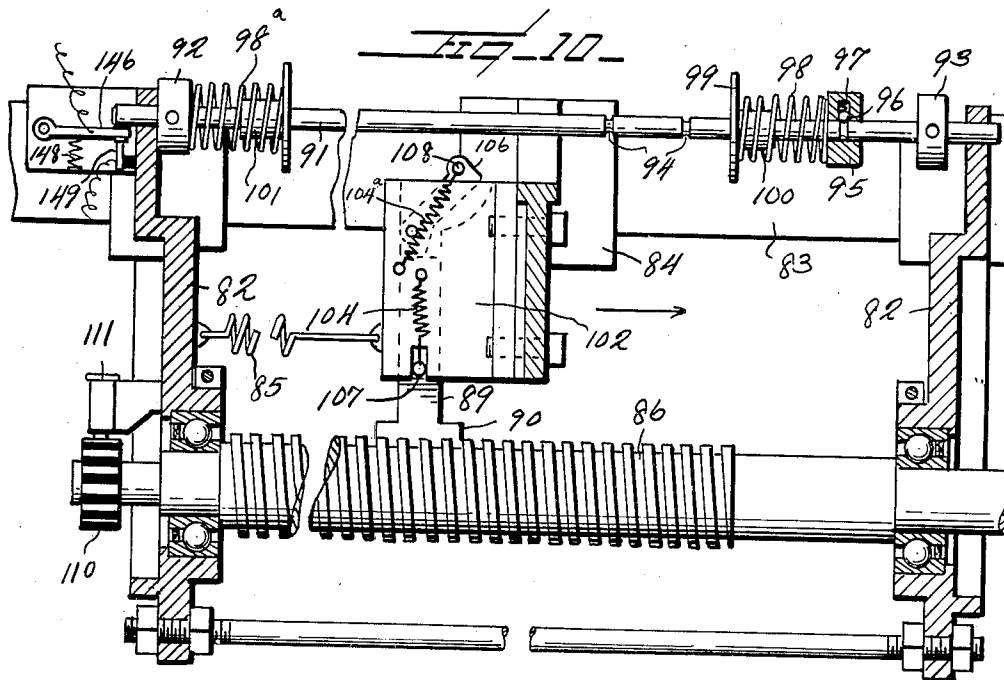
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PRINTING PLATE AND METHOD OF AND APPARATUS FOR PRODUCING IT

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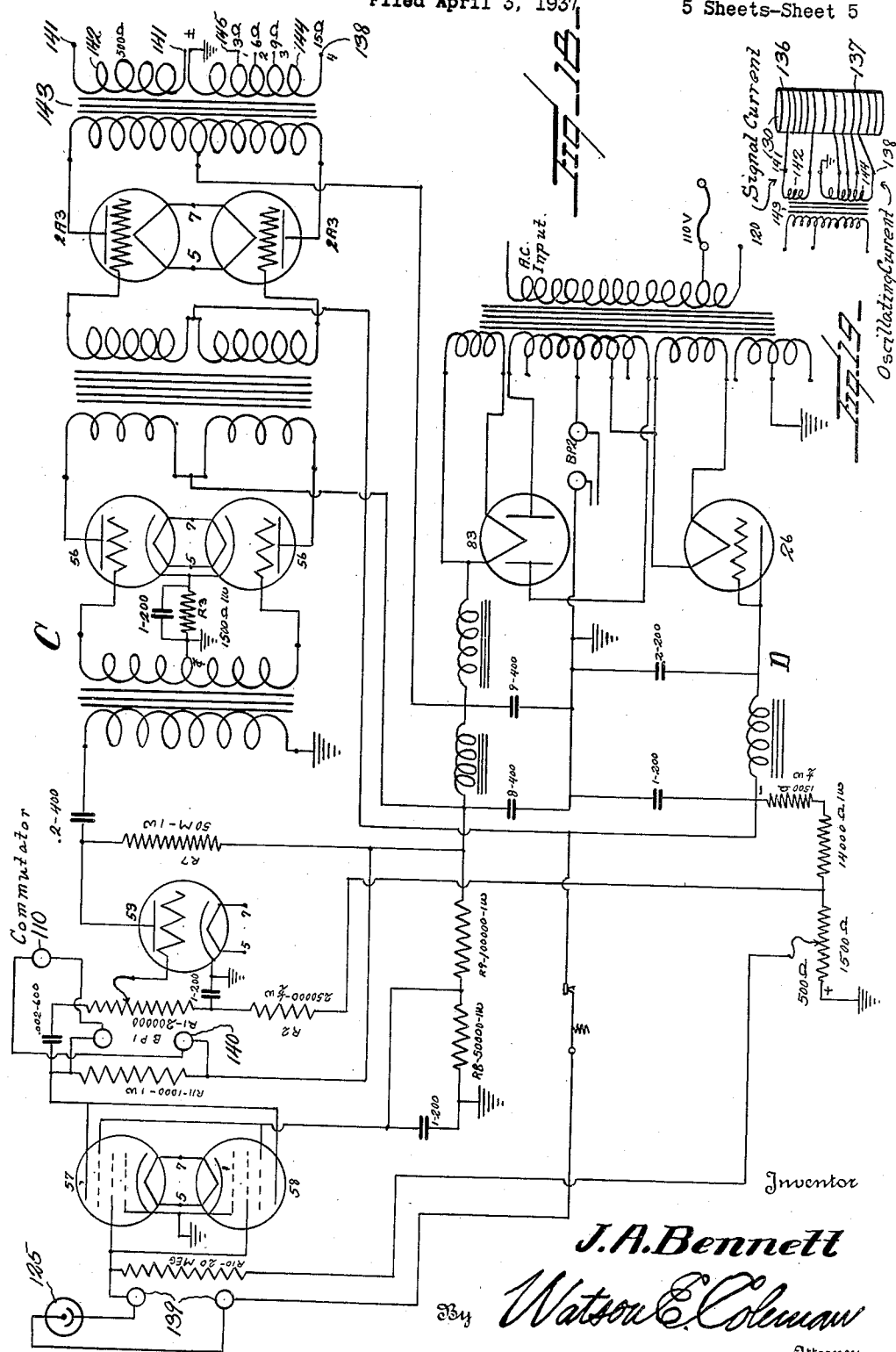
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PRINTING PLATE AND METHOD OF AND APPARATUS FOR PRODUCING IT

Filed April 3, 1937.

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UNITED STATES PATENT OFFICE

2,209,183

PRINTING PLATE AND METHOD OF AND
APPARATUS FOR PRODUCING IT

Joseph A. Bennett, Bloomington, Ind., assignor
to Automatic Engraving Machine Company,
Inc., Bloomington, Ind., a corporation of
Indiana

Application April 3, 1937, Serial No. 134,906

6 Claims. (Cl. 178—6.6)

This invention relates to the basic process for forming, other than by chemical action, the printing surface of a printing plate, to suitable mechanism for forming said surface, and to a printing plate having the surface hereinafter set forth. This invention is basic to the disclosures embodied in the copending applications, Serial No. 696,096, filed October 31, 1933, and allowed October 8, 1936, entitled "Mechanisms for producing printing plates by electric arc," and which is now Patent No. 2,079,310, dated May 4, 1937, and Serial No. 709,633, filed February 3, 1934, allowed September 17, 1936, and which is now Patent No. 2,076,220, dated April 6, 1937, and entitled "Methods of and means for producing printing plates." The last two mentioned applications disclose specifically the formation of a printing surface by the employment of an arc which produces the pits in the surface and which pits have a predetermined arrangement with relation to each other. The instant application discloses other mechanism for producing pits of this same general character in the surface of a plate to form a printing surface on the plate.

The primary invention differs from the invention disclosed in Patent No. 2,047,351 by the patent disclosing the formation of a printing surface by twice traversing said surface and by the intersections of two series of parallel lines, the lines of each series being parallel and the depth of each line varying throughout the length of the line in accordance with the pattern producing the desired surface. The basic invention common to the allowed applications before mentioned and the instant disclosure is directed fundamentally to the formation of individual pits in succession in predetermined spaced relation to each other in line formation and in a plurality of lines parallel to each other, reference herein being made to the axis or pit center, the depth of each individual pit determining its surface crater area and it being apparent that if the width of two adjacent craters each is greater than half the space between the centers, that the entire plane face of the surface being worked upon will be removed leaving a void, as it were, with respect to the original plane surface. By forming pits in this manner, but one traverse is required, thereby requiring but half the time to produce a printing surface of area equivalent to that shown in the before mentioned patent. Also, as shown in said patent and as illustrated herein, the traverse may be parallel to the edge of the plate or may be diagonal thereto or at any other desired angle, there be-

ing certain advantages obtained by the diagonal traverse insofar as the finished plate is concerned and its reproduction in printing so as to resemble the present half-tone screen reproductions now made by other processes. The basic process disclosed herein and in the two before mentioned allowed applications as outlined hereinbefore, consists essentially in scanning, as it were, a pattern and associating a pitting tool, whether of the arc pitting type or of the mechanical type, with the work, the surface of which is to be transformed into a printing surface, such scanning being of linear character and at a predetermined rate of advance or travel, successive linear travels occurring at equi-distant intervals, said lines of traverse, as it were, being parallel and the scanning interval being that preferably of the spacing between traverses, thereby resulting in a regular pattern of pits (having reference to their centers) and in this scanning, the pitting tool and the work are caused to have a movement corresponding to the scanning movement and the work and the pitting tool and caused to move relatively toward and away from each other in a line proportionate to the controlling effect obtained as a result of the scanning of the pattern.

By the aforesaid, it is to be understood that basically, it is immaterial whether the pattern be moved relative to a fixed scanning mechanism, which is the primary source of control, or whether the pattern be moved and the scanning mechanism be fixed or whether both move relative to each other. Similarly, basically, it is immaterial whether the work be moved relative to the pitting tool or the latter relative to the work or both be moved relative to each other, all, of course, in accordance with the first mentioned relative movement with respect to the pattern. Similarly, it is immaterial basically, whether the pitting tool be moved upwardly into engagement with the bottom and printing face of the work, the work being supported above the pitting tool, or whether the pitting tool moves laterally toward and away from the work, the printing face of the work being positioned other than in horizontal or vertical positions or, as shown herein, the printing face may be positioned horizontally with the pitting tool thereabove and movable approximately in a vertical direction. Whichever desired mechanical embodiment of the basic invention is employed, to utilize any one or combination of these relationships, there will result in the printing face of the work a pattern of pits, the centers of which are regularly spaced in a

straight line and in a group of lines and the relationship of the pit centers in adjacent lines is preferably that between adjacent pit centers in the same line. To produce the variation in the
 5 printing face to accord with the variation in the pattern, the variation in the controlling energy above mentioned is transmitted to the working tool or to the plate, whichever is moved towards the other in such a manner that there is produced a pit, the depth of which corresponds to
 10 the variation in the pattern.

By way of example, there is herein disclosed a mechanism differing from the disclosures of the two allowed applications before mentioned in that
 15 the formation of the pits is not obtained by the electric arc but is obtained purely by a mechanical arrangement.

Generally speaking, I have provided mechanism whereby a pitting tool is rapidly reciprocated
 20 toward and from the face of the printing plate over the entire area of the plate so as to subject all portions of the plate, except those portions which are to print black for relief printing, to the successive pitting action of the tool. On those
 25 portions of the plate intended to print solid black for relief printing, the tool will not touch the plate or at least will not penetrate it. On those portions of the plate which are intended to print white for relief printing, the pits will overlap or intersect each other so that all of this portion of
 30 the plate will be cut away, while on those portions of the plate from which varying gradations of tone are to be printed, the pits will vary in width according to the relative proportions of
 35 white or dark tones to be printed therefrom. The tool is reciprocated very rapidly as it moves over the face of the plate. The means for reciprocating the tool, tends, if the stroke of the tool is not modified, to give the tool a maximum width of
 40 cut, that is, to produce a pit of maximum surface area, and if such pits of maximum surface area are disposed close enough together, the pits will overlap so that, as before explained, this portion of the plate would print white because of the
 45 entire cutting away of the surface. In order to provide, however, for the variations in the light and shade or tone of the picture, the pits in some places must be small in surface area and in other places the pits must be relatively large in surface
 50 area. To this end, I provide means controlled by variations of light passing from the pattern being reproduced to a light sensitive scanning element and these variations in turn control a motor or dynamic head which controls the depth
 55 to which the tool penetrates the metal and, because of the fact that the tool is V-shaped in cross-section, this variation in depth will cause also a variation in the width of the pit or recess. Thus, assuming that a negative is being used as a
 60 pattern, the light passing through the thin portions of the negative will act upon the motor to so limit the depth of the cutting tool that it can only pit the plate very slightly, if at all, so that this portion of the engraved plate so slightly recessed or having pits dug into its surface which
 65 are shallow and relatively narrow, will give a black effect or dark effect when printed, and when the light passes through a dense portion of the negative, the penetration of the tool will not be
 70 so limited and the reciprocations of the tool will cause a series of pits to be dug into the surface of the plate which will be relatively wide, long and deep, so that that portion of the surface of the plate remaining between the pits will be rela-
 75 tively small in area and this portion of the plate

will print a very light tone. The effect, therefore, that is produced by printing from the plate engraved in the manner stated, is very similar to the acid etched half-tone and the mechanism which I have devised requires that the plate be
 5 cut only once and the dot formation which is left between the pits provides an adequate bearing surface for the ink rollers. Furthermore, this instant mechanism cuts down the time necessary to be used in making the plates and secures the
 10 desired results most effectively.

A better understanding of the basic process will be obtained by reference to Patent No. 2,076,220, dated April 6, 1937, and to the following specific description of the specific mechanism directed to
 15 one mechanical embodiment suitable for carrying out this process.

The drawings illustrate one embodiment of the "mechanical" type of mechanism suitable for mechanically pitting the printing plate as distinguished from pitting the plate by means of the
 20 electric arc shown in the before mentioned co-pending applications.

In the drawings:

Fig. 1 is a diagrammatic side elevation of the
 25 machine constructed in accordance with my invention, the casing of the twin dynamic heads being broken away and the cores of these heads being in section.

Fig. 2 is a fragmentary section showing the
 30 manner in which the ram which carries the tool and dynamic heads is traversed laterally.

Fig. 3 is a front elevation of the engraving tool used.

Fig. 4 is a side elevation thereof.

Fig. 5 is a wiring diagram for my improved machine.

Fig. 6 is a diagrammatic plan view on a greatly enlarged scale of a portion of a plate to show the general arrangement and general shape of the pits formed in the plate to imitate a half-
 40 tone.

Fig. 7 is a sectional view through a plate of this character to show the variations in the depth and widths of the pits.

Fig. 8 is a general side elevation, largely diagrammatic, of another form of my machine.

Fig. 9 is a fragmentary top plan view.

Fig. 10 is a longitudinal vertical section on the line 10—10 of Fig. 9.

Fig. 11 is a vertical section of the drive clutch.

Fig. 12 is a fragmentary elevation of a part of the frame, with pawl, the shaft for the ratchet wheel being in section.

Fig. 13 is a top plan view of the armature supporting spider.

Fig. 14 is a fragmentary section through the table, showing the cross-feed in elevation.

Fig. 15 is a fragmentary vertical section through the dynamic motor, the cutter being in elevation.

Fig. 16 is a section on the line 16—16 of Fig. 9.

Fig. 17 is a section on the line 17—17 of Fig. 9.

Fig. 18 is a diagram of the electrical connections to the dynamic motor, the photo-cell and the interrupter.

Fig. 19 is a diagrammatic elevation of the armature coils.

Fig. 20 is an elevation of the cutting head showing a planing tool carried thereby in advance of the engraving tool.

Fig. 21 is a fragmentary side elevation of the planing tool, the support therefor being partly broken away.

Fig. 22 is a fragmentary elevation of the plate engaging end of the cutting tool.

Referring to these drawings and particularly to Fig. 1, 10 designates a ram which is to be reciprocated under power toward the left hand in Fig. 1 and retracted by a spring 11 toward the left in Fig. 1. This ram is caused to travel toward the left in Fig. 1 by means of the interrupted gear wheel 12 mounted upon a motor shaft 13 and rotating in the direction of the arrow. It will be obvious that as this gear wheel is rotated, its teeth will engage the rack teeth 14 on the ram 10 and force the ram with the cutting tool toward the left in Fig. 1, and that as soon as the teeth on the gear wheel have passed the ram, the ram will be retracted by the spring 11, the cutting tool doing no cutting during this retractive movement. This ram is mounted for lateral traversing movement and to this end is illustrated diagrammatically as being disposed within a guide 15, this guide guiding the ram for longitudinal movement, and this guide in turn being mounted in transverse guides 16 carried by the frame of the machine so that the guide or support 15 can be laterally shifted. To this end, as shown in Fig. 2, I provide the support 15 with a downwardly extending portion 17 screw-threaded to engage screw-threads on a shaft 18. This shaft 18, as shown in Fig. 1, carries upon it the ratchet wheel 19, and loosely mounted upon this shaft is the arm 20 carrying a pawl 21 engaging the teeth on the ratchet wheel 19. A spring 22 urges the arm 20 in a direction such that the pawl 21 will ride over the teeth on the ratchet wheel 19, and a pin or light projection 23 on the ram 10 acts to force the arm 20 in the opposite direction. An adjustable limiting stop 24 limits the movement of the arm 20 in the counterclockwise direction or retractile movement and determines the amount of oscillation of arm 20 and, therefore, the subsequent amount of cross feed travel by arm 20, pawl 21 and ratchet in the rearward movement of the ram 10.

It will be seen that upon a forward stroke of the ram 10, the upper end of the arm 20 will move toward the left in Fig. 1, the pawl riding over the ratchet teeth of the wheel 19, and that as soon as the teeth on pinion 12 have escaped from the teeth 14, the ram will be retracted by the spring 11 to a degree permitted by the stop 24, and that this will cause a definite rotation of the shaft 18, and through the screw threads thereon will cause a definite lateral movement or traverse of the carriage or ram 10. Thus, after each forward stroke of the ram, the ram is traversed or indexed a certain very slight distance laterally.

In Figure 1, A designates the pattern, negative or picture which is to be reproduced upon the printing plate B. This pattern is carried by the ram 10 either directly or indirectly so that it moves with the ram, and disposed immediately above the pattern A is a light sensitive element which may be a photoelectric cell and which is disposed within the casing 25. Disposed below the path of travel of the picture A or pattern is a lens 26 and disposed below the lens is a source of light 27 which is focused by the lens upon the surface of the pattern. In Fig. 1, the pattern A is supposed to be a photographic negative so that the light from the source 27 passes through this negative to the cell 25, and the light is modulated by the variations in the light and shade of the pattern itself. I do not wish to be limited to this, however, as it is obvious that light may be thrown

down upon the face of the pattern and be reflected up to the light sensitive element or photoelectric cell. I have not illustrated this because this feature is well known.

Before describing electrical connections to the dynamic head or power head, I will describe the head itself.

The tool controlling mechanism is constituted by twin motors or dynamic heads, one for the purpose of constantly reciprocating the engraving tool and the other for variably limiting the extent of this reciprocation. Mounted upon the end of the ram 10 are two conjoined casings, one of these casings being designated 28. Within this casing 28 is disposed the field coil 29 through the center of which passes the core 30. The casing 28 extends below the field coil 29 and is formed to provide an inwardly extending portion 30 and an upwardly extending portion 31. This last named flange 31 with the protruding portion of the core defines an annular chamber within which is located the armature coil 32. Extending across this armature coil is the plate or cross bar 33 and connected to or extending through this plate 33 is the guide 34 which extends up into and fits within an axial recess 35 formed in the core. This recess 35 constitutes a guide giving a rectilinear movement to the armature 33. A spring 36 attached to the flange 30 urges the armature upward toward the core. Attached to the armature or forming part of the guide 34 itself is a clevis 37 to which a shackle 38 is pivotally attached. The tool carrying bar 39 is connected at one end by a leaf spring 40 to a supporting block 41 extending downward from the casing 28, this spring acting as a pivotal connection upon which the tool carrying bar 39 will swing. The tool carrying bar carries a clevis 42 which also pivotally engages the shackle 38 and thus the tool carrying bar is shackled to the armature so that a rectilinear movement of the armature 33 can be translated into a very slight arcuate movement of the tool carrying bar around the point of attachment of the spring 40 to the block 41. The tool 43, which is shown in Fig. 3, is mounted in a tool holder 44 of any suitable character and may be held in place by a set screw or other suitable means, and this tool holder 44 is adjustable upon the bar 39. I have heretofore referred to the tool as being V-shaped in cross-section. This is not strictly accurate for, as illustrated in Fig. 3, the tool is, more properly speaking, U-shaped in front elevation, the cutting portion of the tool, as shown in Fig. 4 being tapered to a sharp edge and being disposed at a slight angle to the shank of the tool.

For the purpose of limiting the downward movement of the tool, I provide a limiting stop 45 carried by a vertically disposed rod 46, this rod being reciprocable within the guide or guides 47. This rod is reciprocated to a greater or less extent depending upon the light and shade of the pattern A by means of a second dynamic head or motor enclosed within a casing 48. This comprises the field coil 49, the core 50 and the armature coil 51, the armature 52 and the spring 53 substantially as heretofore described for the lower dynamic head. The core 50 is provided with the bore 54 and the armature carries a guide pin 55 operating within this bore. The armature is shackled to a lever 56 which is pivoted upon a fulcrum 57 and which is pivotally connected at 58 to the upper end of the rod 46. An adjustable stop 59 is mounted upon the rod 46, the stop being held in position by a set screw

or equivalent device. The two heads are separately energized, as will be more fully described hereinafter, and is illustrated in diagram in Fig. 5, but both heads operate on the same general principle, that is, for instance, the coil 29 is connected by conductors to a source of field coil current while the floating armature 32 is connected by conductors to a power unit. The construction is such that when a surge of current passes through the field coils 29, the current through the armature coils will be of reverse polarity and the armature will be forced downward, causing the tool 43 to dig into the metallic plate B. The current through the armature coil is being constantly and uniformly interrupted and, therefore, a constant oscillation will be given to the bar 39 and to the tool carried thereby so that as the ram moves across the face of the plate B, a series of evenly spaced pits will be cut into the plate, these pits being extremely close together, the closeness of the pits depending entirely upon the screen tone which is being imitated.

As before explained, if these pits were all of the same depth and extent, a uniform tone would be printed by the plate, but the penetration of the tool 43 and the consequent depth and width of the pits is varied by and in accordance with the variations in the light falling upon the sensitive element 25 due to the modulations of light and shade in the pattern. These modulations of light and shade are transmitted electrically to the upper dynamic head to cause greater or less repulsion of the armature 51 and a greater or less depression of the rod 46 and the stop 45. When this rod is fully depressed, the tool 43 can penetrate to its maximum depth, that is, the depth indicated by line $x-x$ of Fig. 3. When the rod 46 is fully raised, the tool cannot penetrate the metal at all and thus it will be seen that the penetration of the tool and the consequent depth and area of the pits cut out will be determined by the elevation or depression of the stop 45 and this by the amount of repulsion between the field coils 49 and the armature coil 51 and armature 52, as will appear more fully hereinafter.

As illustrated in Fig. 1 diagrammatically, the plate B is supported within a holder or clamp 60 held firmly from any longitudinal or transverse movement. It is to be understood that the showing in Fig. 1 is purely diagrammatic and only shows those essentials of the operating mechanism which are necessary to indicate the operation of the machine, and it is to be understood that the actual mechanism except as defined in the appended claims, may be modified in many ways without departing from the spirit of the invention.

As shown by the wiring diagram shown in Fig. 5, the photoelectric cell 25 is connected with the floating armature 51 through an amplifying system by the wires 61 and 62, so that the varying current received from the phototron will be amplified and endeavors to correspondingly affect the floating armature 51. Any suitable amplifying system may be used and I have here illustrated a direct coupled amplifying system. I have also illustrated the field coils 49 as being connected to a source of alternating current through a power transformer designated 63, the alternating current thus produced being rectified by the rectifier 64. I have illustrated the electronic valve amplifying system as being supplied with current from an AC source through a

power transformer 65 having therein a rectifier 66. I do not wish to be limited to this, however. This is the same wiring as is shown in my application, Serial No. 696,096, filed October 31, 1933. The circuit which acts to reciprocate or oscillate the engraving tool 43 is also shown in Fig. 5. In this diagram, the current is obtained from a 60 cycle 110-volt power line 67, a transformer 68 with taps to provide filament voltages, and a power rectifier to provide a rectified current for the field coils 29 is used. An interrupter designated 69, which interrupter is operated by means of a cam 70 is used to cause the grids of the tubes 71 and 72 to be shorted out at each interruption, causing a surging current that flows to the armature coil 32, thus driving the tool 43 downward into the metal of the plate. These armatures 32 and 33 are supported in the magnet field of the field coil and when more current is supplied to the armature 32, it moves out of the magnetic field and causes the tool to be forced into the metal plate to thereby make a pit in the plate, as heretofore described. The pair of tubes 71 and 72 are in parallel, the plates of these tubes being directly connected on one side to the armature coil 32 and the other side of this coil is connected to a series of resistors 73 and 74. The cam 70 is mounted on the shaft 13 which is the driving shaft for the machine or is connected by gearing to any constantly operated shaft on the machine. By doing this, the interruption of the current occurs at definite intervals dependent entirely upon the speed of the machine. If the motor slows down due to line loss or lag, the machine, of course, slows down and, therefore, the speed of rotation of cam 70 is less, and inasmuch as the speed of the ram is less and the pits will be disposed a definite distance apart. If, on the other hand, the motor speeds up, the machine moves faster, the cam moves faster and the interrupter moves more rapidly, but again the spacing of the pits on the plate is the same as when the machine is moving slower.

It will be seen from Fig. 5 that one side of the interrupter 69 is grounded while the other end of the interrupter is connected to the middle tap 75 of the secondary 76 of the transformer. It will be seen that the frequency generated is entirely dependent upon the speed of the opening and closing of the interrupter which in turn affects the grids of the two tubes 71 and 72, which are disposed in parallel.

In Figs. 6 and 7, I have illustrated, rather diagrammatically the shape of the pits formed by the cutting tool 43 and the manner in which larger or smaller pits are formed. It will be understood that it is the face of the plate between these pits that constitutes the inked surface of the plate while the pits themselves constitute the light surface of the plate so that the spaces between the pits are equivalent to the dots of a half-tone while the pits themselves are equivalent to the spaces around the dots of a half-tone.

By Fig. 7, it will be seen that the width of any pit varies with its depth; that the deeper the pit, the greater is its width, and the smaller the pit, the less its width. This is due to the use of the peculiarly shaped cutting tool, shown in Figs. 3 and 4.

It is, of course, necessary to entirely cut out the action of the armature coil 51 so as to lift the stop and prevent the tool from touching the face of the plate upon the reverse movement of the ram 10. To this end, I may provide the wheel 75

12 with an arcuate insulating segment designated 77 and shown in Fig. 1 and disposed opposite to the toothed portion of the wheel. This wheel 12 may constitute a conductor, and contacting the wheel 12 are the two contacts 78 and 79, which are connected to the amplifying system by conductors 80, as shown in Fig. 5. When the two contact fingers both rest upon the metal gear 93, the circuit is completed, which causes the tool to be entirely lifted and held lifted while the ram 10 moves to the right in Fig. 1. When one of the contact fingers 78, for instance, reaches the segment 77, the circuit is broken and the tool is then lowered so that it can operate under the control of the picture, as before described. Obviously, the structure might be readily modified so as to cut upon either the forward or rearward stroke of the ram, if desired. In the construction illustrated, the lateral traverse of the ram and of the cutting tool with the negative or pattern A is secured upon the travel of the ram to the right in Fig. 1.

Attention is particularly called to the fact that the current through the armature 30 is being constantly interrupted at definite intervals by the interrupter 69 which is operated by the cam 70, this cam being driven from and in accordance with the speed of the machine itself. By this means, I can secure, as heretofore stated, a definite and regular spacing of the pits across the face of the plate without regard to the speed of the machine and this is extremely important.

This mechanism in actual practice has been found to produce plates in which the gradations of tone are very delicate and comparable with the gradations in tone in a photograph or half-tone. While I have illustrated this machine as reproducing a pattern which is carried by the same ram, which carries the tool, I wish it distinctly understood that the impulses which operate the dynamic relay 43 and which, therefore, move the stop 45, may be transmitted by radio from a distant point where the pattern is being scanned by a photoelectric cell such as the cell 25 or other light sensitive element associated with a pattern which is relatively traversed with regard to the pinpoint of light projected through the pattern onto the sensitive element. Thus, the wiring for such construction will be obvious to those skilled in the art, a system of this general character being shown in my Patent No. 2,047,851, granted July 14, 1936.

A preferred form of this invention is illustrated in Figs. 8 to 13, the structure disclosed in these latter figures being simpler, cheaper, more effective and more economical in operation than the structure shown in Figs. 1 to 7.

In this form of my invention, the plate to be engraved and the pattern or picture to be reproduced are both mounted upon a reciprocable carriage which in one sense is the equivalent of the ram previously described, and the cutting head is held immovable as regards any traversing action either longitudinally or transversely, in other words, the cutting head instead of moving over the plate, is stationary, and the plate moves beneath the cutting head. Another and very important difference between the construction now to be described and the construction previously described resides in the fact that the cutting head carries but one dynamic motor for the tool, which operates not only to reciprocate the tool rapidly into and out of the metal plate which is being engraved, but also acts to vary the depth of the cut or projection of the tool into the metal,

thus doing away with the two dynamic motors shown in Figs. 1 to 7.

In Figs. 8 to 10, I have illustrated a supporting frame which may be of any suitable character and which includes the upright transversely extending members 32 supporting the parallel rails 33. On these rails travels the carriage 84 which supports the plate B which is being engraved and the negative or pattern A or picture to be reproduced. This carriage is urged in one direction by the spring 85. For the purpose of traversing the carriage longitudinally in a direction reverse to the action of the spring 85, I provide a screw 86 which is constantly driven in one direction by a motor M shown as connected by a belt 87 to a pulley 88 on the shaft 86. Mounted on the carriage is a vertically movable element 89 carrying at its lower end a half nut or its equivalent designated 90. The element 89 with the half nut constitutes a clutch and is automatically shifted into or out of engagement with the threads of the shaft 86 by means which will be later described. It suffices at present to say that the clutch 89 is automatically raised out of engagement with the threads on shaft 86 upon the completion of the forward stroke of the carriage and automatically lowered into engagement with said threads at the beginning of the power or forward stroke of the carriage.

Slidably mounted in the uprights 82 of the frame is a longitudinally extending rod 91. Extending parallel to the path of movement of the carriage and carried by the rod are the two adjustable stops 92 and 93, each held on the rod 91 by a set screw, these stops being adjustable to permit a slight longitudinal movement of the rod through the uprights 82. The rod 91 is formed adjacent one end with a plurality of circumferentially extending grooves 94 equidistantly spaced from each other at intervals of, for example, an inch. Coacting with these grooves is a stop collar 95 slidable upon the rod and having in a recess in the stop collar a dent 96 projected outward by a spring 97, the spring being strong enough to hold the stop 95 in adjusted position but permitting the shifting of the stop by hand. The stop carries a coiled laterally extending compression spring 98 which bears against the flange 99 of a cushioning sleeve 100. The sleeve is normally held projected by the spring. At the opposite end of the rod is a like flanged cushioning sleeve 101 urged outward by a spring 98^a which bears against the stop 92.

Mounted on the carriage is a depending casing 102 having therein a vertical guide slot 103 (see Fig. 11). The shank of the clutch member 89 extends up into this slot and is urged upward therein by a contractile spring 104. Pivoted within the upper end of this slot is a cam 105 having an upwardly extending arm 106. When the arm 106 is upright, the flat lower face of the cam bears against the upper end of the shank 89. When the arm is tilted to the right as in Fig. 10, the cam will act to depress the shank 89 to carry the half nut 90 into engagement with the screw 86. A spring 104^a is connected to a pin 108 projecting laterally outward from the upper end of the arm 106. The pin 107 operates within a slot 109. It will be obvious now that these springs act to lift the clutch member 103, and to hold the cam 105 in either its upright or its tilted position in an obvious manner.

It will be noted that the flanges of the stop collars 100 and 101 are in the path of movement

of the arm 106, hence when the carriage is nearing the end of its idle stroke under the action of the spring 85, the upper end of the arm will strike the stop collar 101 which will tilt the arm 106 to the right as in Fig. 10, lowering the half nut 90 into engagement with the screw-threaded shaft 86. This causes a movement of the carriage toward the right in Fig. 10, until the arm 106 strikes the stop collar 100, when the arm 106 will be again shifted to its upright position, thus permitting the spring 104 to lift the nut 90 from its engagement with the screw-threaded shaft which in turn permits the spring 85 to retract the carriage to its initial point. The collars 100 and 101 and the springs 98 and 98a also act as cushions so that there will be no jar due to the stoppage of the carriage on either of its strokes.

Also mounted upon the screw shaft 86 is a commutator or interrupter 110 carrying any desired number of metallic segments. Carried by the frame and supported by the adjacent upright 82 is a brush 111 coacting with the segments of the interrupter. The purpose of the interrupter is exactly the same as the purpose of the interrupter 69 shown in Fig. 5.

The carriage 84 supports a transversely shiftable negative and printing block supporting table 112 formed with a recessed seat 113 for a negative or pattern to be reproduced, this seat being disposed with its corners in line with the path of travel of the carriage so that the picture on the negative is at an angle of approximately 45° to the path of travel. The table also carries a support or seat 114 for the Linotype metal block B for example, which seat may have the form of a more or less rectangular boss upon which the block B may be disposed and clamped firmly in place. The particular clamping means, which is illustrated, will be later described, it being understood that any convenient clamping means may be used.

The table 112 is mounted upon the carriage for longitudinal movement therewith and for independent transverse movement relative to the carriage. To this end, the table is supported by the transversely extending rails 115 and 116, and this table must be traversed or cross-fed transversely one step upon each rearward or idle movement of the carriage. To this end, I mount upon the carriage below the table the cross-feed or traversing screw 117 carrying a ratchet wheel 118 at one end and engaging with a half nut 119 depending beneath the table. The half nut 119 is supported by a spring 120 disposed beneath the table, as shown in Fig. 14, and extending up through the table is a handle 121. When the handle is lifted, the attached half nut 119 is lifted from the cross-feed screw 117 and the table then may be shifted by hand to its initial position, thus I have provided a feed screw for feeding the table laterally in one direction and manually operable means for quickly shifting the table in the opposite direction to its initial position. Carried by the supporting frame in the path of movement of the ratchet wheel 118 is a pawl 122 (see Fig. 9) and on the backward stroke of the carriage under the action of its spring 85, this pawl engages the ratchet wheel 118 and turns it a predetermined distance shifting the table one step laterally preparatory to the next power stroke. Obviously this shifting movement could occur at the end of the power stroke or at the end of the idle stroke.

Supported below the negative seat is a lamp

123 and a lens system 124 shown as mounted on a frame member 82a, which concentrates the light from the lamp as a small spot of light on the negative. This lens system is, of course, fixed and the negative moves back and forth and laterally with relation to the spot of light. Disposed immediately above the negative carried by the table is a photoelectric cell 125 upon which the light passing through the negative or picture is received. Supported on the frame of the machine as upon the bar 126, is the cutter operating mechanism, the cutter thereof being, of course, disposed in engagement with the type metal block B. The cutter operating mechanism includes as the essential element a dynamic head or motor such as previously described. This in the present preferred example of my invention consists of a single field coil 127 disposed within an exterior wall 128 and having a core 129. Operating over the lower end of the projecting core is an armature consisting of a tubular core 130 and certain windings, this armature being in some respects like the armature previously described and shown in Fig. 1 of the drawings. This armature is supported, however, by a resilient spider 131. The armature engages one end of a tool bar 132, the other end of this tool bar being supported by a leaf spring 133 held in place by an outwardly projecting lug 134 on the exterior casing of the field magnet. This spring 133 constitutes a resilient support or hinge for the tool bar 132. Mounted upon this tool bar is the tool holder 135 which is adjustable along the tool bar in any suitable manner. The tool 43 is of the same character as previously described and shown in Figs. 3 and 4. There is no mechanical stop for this armature or rather for the cutter, as is illustrated at 45 in Fig. 1. The coil of the armature is formed as two coils 136 and 137 (see Fig. 19). The coil 136 receives pattern current, that is, current which is varied by the light and shade of the pattern or picture, while the coil 137 receives oscillating current, that is, current which is constantly interrupted but which is of constant strength. The current is interrupted by the rotation of the commutator or interrupter 110. This continually interrupted current would, if not modulated, cause a constant reciprocation of the cutter and this would dig or cut a series of pits in the metal plate B of a constant depth and, therefore, of a constant diameter, as previously explained. The oscillating current in coil 137, however, is modulated by the coil 136 whose current varies with the light and shade of the pattern, in other words, with variations in the density of the negative and the consequent variation in the amount of light falling at successive instants upon the photoelectric cell. The variations of current passing through coil 136 act as a variable "stop" restraining the movement of the armature under the action of the oscillating current in coil 137, because the passage of current through the coil 136 strengthens the magnetic field of this coil and, therefore, restrains the armature from vibrating.

In the wiring diagram, Fig. 18, C designates, as a whole, a transformer-coupled amplifier system and D a power pack for energizing the field coil of the dynamic head or motor. The conducting wire from the field coil is connected to the terminal 138. The photoelectric cell 125 is electrically connected to the input terminals 139. The commutator 110 and its brush are connected to the terminals 140. The terminals of the pattern coil 136 are connected to the terminals 141 75

of the secondary coil 142 of transformer 143 (see Fig. 19). The other secondary coil 144 of this transformer is grounded at one end and at the other connected by one or the other of the several taps 145 to the coil 137. It is not believed necessary to describe the amplifying system C or the power rectifier D in detail, as this is largely conventional structure and clearly understandable by anyone skilled in the art.

As before remarked, the commutator is connected to the terminals 140. The current interrupted by the commutator effects the oscillation of the reciprocating armature that controls the tool action. The frequency in the pattern coil 136 is so low, due to the smoothing and balancing effect of the tube and transformer arrangement by the introduction of direct current from the power pack into the transformers coupled in the amplifying system, that the interrupter or commutator does not affect the signals from the photo cell. Frequency in the oscillating coil 137 is determined directly by the commutator and is calibrated in relation to the movement of the plate B under the cutting device so that a certain number of oscillations occur per linear inch of movement.

It is, of course, necessary to break the flow of current through the apparatus upon the reverse movement of the carriage and to this end, I provide the switch 146, (see Fig. 10) this switch being disposed in the path of movement of the end of the rod 91. The end of the rod 91 is beveled at 147. The switch blade is designated 148 and this switch blade is urged upward by a spring 148 and away from the contact 149. At the end of the power stroke, the carriage shifts the rod 91 to the right in Fig. 10, and the extremity 147 of the rod rides off of the switch blade so that the electrical circuit through the main line of current flow is broken. The carriage is then returned by the spring 25 and when the carriage reaches the end of its idle stroke, the stop 92 is forced over towards the left in Fig. 10, as previously described, and this causes the rod 91 to shift to the left and the beveled end 147 rides over the top of the switch blade, closing the circuit through the main line, and once more electrical energy is conducted through the electrical system.

While I do not wish to be limited to any particular means for clamping the printing plate upon its seat, I have shown for this purpose an eccentric 150 having a handle whereby it may be rotated and having a pivot stud 151. This eccentric is formed on its periphery (see Fig. 16) with a slightly inclined spiral rib 152 which is sharp-edged. Also mounted upon the printing plate seat is a transversely extending abutment 153 mounted for movement from or toward the eccentric by means of the slot 154, there being an adjusting screw 155 extending into this slot. The inner face of this abutment member 153 is provided with prongs 156 which engage with the side edges of the printing plate. By this means, the printing plate may be readily clamped in place. The plate seat is formed with a row of perforations 157 in anyone of which the stud 151 may be inserted. Thus the clamp may be shifted to accommodate larger or smaller plates, and it is obvious that the abutment clamp 153 may also be shifted. The purpose of having the spiral sharp-edged rib 152 upon the eccentric is not only to clamp the plate, but to force the plate down against its seat upon a rotation of the clamp in one direction and raise the plate up from its seat

to permit it to be readily removed upon a rotation of the clamp in the other direction.

The surface of the plate which is to be engraved should be conditioned so as to be perfectly smooth and have all roughnesses or irregularities effaced. To this end, I have mounted in conjunction with the engraving tool 43, a planing attachment. This attachment includes a planing tool 158, supported upon the casing supporting the dynamic head and the pitting tool, this planing tool 158 being disposed in advance of the pitting tool so that upon each forward stroke of the plate with relation to the engraving tool, the planing tool will plane the surface of the plate. To the end that the planing tool may ride freely over the face of plate B on the idle stroke of the plate or engraving tool, tool 158 is shown as mounted on a pivoted arm 159 which swings upward when the dynamic head moves reversely to the arrow, Figure 1, which occurs simultaneously with the indexing movement, the direction of which is indicated by the arrow in Figure 20, but swings downward against an abutment 160 when moved in the direction of the arrow, Figure 21. I have not illustrated the planing tool in Figures 1, 8 and 15, as it would tend to confuse these figures. By providing a planing tool, it is possible to take plates which have already been engraved and re-use these plates, as the planing tool will pass over the previously engraved surface of the plate and cut away this previously treated surface to provide a new surface upon which the new engraving or pitting may be formed. I, therefore, secure a nearly coincident conditioning of the surface of the plate and successive pitting thereof at one operation. The printing plate does not have to be conditioned in one machine and then engraved in another.

The advantages of the mechanism shown in Figs. 8 to 18 over what is shown in the prior figures is that this preferred mechanism eliminates one dynamic head and its armature and secures the same benefit from one as is attained by two dynamic heads and armatures in the construction illustrated in Figs. 1 to 7. Furthermore, the mechanism shown in Figs. 8 to 18 secures a more faithful reproduction of the picture pattern by the elimination of variables which are due to hinge joints, links, pivots, etc., which are necessary in the other construction. In the preferable construction also, the cutter and dynamic head are fixed and thus the weight carried and moved is reduced. It does away also with the necessity of flexible cables or trolleys, and the mechanism secures a more rigid mount for the cutter. By using the pattern coil 136 for the armature as a means of varying the depth of stroke of the cutter, I secure much more accurate and sensitive action than by the structure illustrated in Figs. 1 to 7. In these former figures, there are two units working against each other whereas in the preferred construction, the two units work together. The use of a screw feed as a means for longitudinally moving the carriage not only secures a much more even and smoother action but reduces friction to a very great extent and altogether about three hundred parts in actual practice are eliminated by the construction shown in Figs. 8 to 18, while the efficiency of the machine is increased from fifty to sixty percent.

Throughout the claims, it is to be understood that the light sensitive element may scan the pattern either by a movement of the pattern past the light sensitive element or a movement of the light sensitive element past the pattern, and

that the tool may scan the work either by a movement of the work past the tool or the tool over the work.

Furthermore, it is to be understood that by the term "carriage" used in the claims, I include not only a ram or like element, such as shown in Fig. 1, but the table supporting element, as shown in Figs. 8, 9 and 10.

Herein for clearness and simplicity, the process, apparatus and plate description have been referred to primarily on the bases of "relief printing". However, it is expressly intended the foregoing is merely an example thereof for the finished plate, if used for intaglio printing, as is well understood in the printing art would under such circumstances have the pits filled with ink, and the smooth surface portion of the pitted plate wiped clear thereof. Thus, the pits for intaglio printing would print black or a gradation thereof whereas for relief printing, the pits would insure no printing but the printing ink would be accepted from the ink covered flat and unpitted surface.

While the invention has been described in considerable detail in the foregoing specification and certain specific modifications thereof have been described in even greater detail herein, and other embodiments have been illustrated and described in the before mentioned copending applications, but not claimed therein, all said modifications and embodiments, and such other modifications and embodiments as will readily suggest themselves to persons skilled in this art are all considered to be within the broad scope of this invention, reference being had to the appended claims for the statutory definition thereof.

What is claimed is:

1. A mechanism, including two electro-dynamic motors each having a field coil and a floating armature coil, each field coil being connected to a source of current of constant voltage, means for interrupting the current through the armature coil of one motor to thereby cause the reciprocation of the armature thereof, an element operatively connected to and reciprocated by said armature, means for supplying current to the armature of the other motor, controlled means for varying the voltage of said current to thus variably reciprocate the last named armature, and an element shifted by the last named armature and controlling the amplitude of movement of the first named element.

2. A machine for engraving a printing plate, including supporting members, a motor driven screw mounted within the supporting members and constantly driven in one direction, longitudinally extending rails mounted on the supporting members, a carriage mounted upon the rails for longitudinal movement, a screw engaging clutch mounted upon the carriage and including a depressible element having threads engageable with the threads on the screw, means urging the element upward out of engagement with the screw, a rod mounted in the supporting members and extending parallel to the screw, stops adjustably mounted upon the rod, means for depressing the screw engaging member, including a cam having an arm engageable by one of said stops upon a full stroke of the carriage in one direction to rock the cam and permit the disengagement of the threaded member from the screw, the opposite stop engaging said arm upon a reverse stroke of the carriage to depress the threaded member into engagement with the screw, and means for urging the carriage in its reverse movement after

the threaded member has been disengaged from the screw.

3. A machine for engraving a printing plate, including supporting members, a motor driven screw mounted within the supporting members and constantly driven in one direction, longitudinally extending rails mounted on the supporting members, a carriage mounted upon the rails for longitudinal movement, a screw engaging clutch mounted upon the carriage and including a depressible element having threads engageable with the threads on the screw, means urging the element upward out of engagement with the screw, a rod mounted in the supporting members and extending parallel to the screw, the rod having a pair of stops, one of said stops being adjustable toward or from the other, sleeves loosely mounted upon the rod and having flanges, a cushioning spring disposed between the flange of each sleeve and the corresponding stop, means for depressing the screw engaging member, including a cam having an arm, the upper end of the arm being disposed to contact the flanges of said sleeves, the arm being turned to a position to release said screw engaging member and permit its upward movement when the arm strikes one flange, said arm when engaging the opposed flange being turned to a position to depress the screw engaging member, and means for retracting the carriage upon the release of the screw engaging member from the screw.

4. A printing plate engraving machine, including spaced supporting members, a motor driven screw mounted in said supporting members and extending longitudinally of the machine, rails carried by the supporting members, a carriage movable longitudinally upon said rails, a clutch disposed between said carriage and the screw and engageable with the screw to shift the carriage in one direction, means for lifting said clutch member when the carriage has moved a full stroke in one direction and including cushioning means at opposite ends of the stroke of the carriage, means for retracting the carriage, and means for again engaging the clutch with the screw threaded member at the end of its retractive stroke.

5. A plate engraving machine, including spaced supporting members, a screw mounted therein, a carriage operatively mounted upon the supporting members for movement parallel with the screw, a rod extending parallel to the screw and mounted in the supporting members, stop collars adjustably mounted upon said rod and spaced from each other a distance less than the distance between the supporting members whereby the rod may have a slight longitudinal play, a stop collar adjustably mounted upon the rod and between the first two stop collars, a spring surrounding the rod and abutting at one end against the last named stop collar, a sleeve having a flange engaged by the other end of the spring, a second sleeve opposed to the first named sleeve and having a flange and a spring disposed between the last named sleeve and bearing against the adjacent stop collar, the clutch including a shiftable member adapted to engage at opposite ends of its stroke with said flanges on the sleeves and constructed and arranged to release said clutch upon engagement with one of said flanges and to shift the clutch into engagement with the screw upon the engagement of said member with the other flange, and means for causing the retraction of said carriage upon the release of the clutch upon the screw.

6. A machine for engraving printing plates, in-

cluding supporting means, longitudinally extending rails carried by the supporting means, a carriage mounted upon said rails for longitudinal movement, the carriage including transverse rails, 5
a table mounted upon the transverse rails, the table having a pattern receiving element and a work holding element, a transversely extending screw carried by the carriage and having a ratchet wheel at one end, means normally engaging the 10
table with said screw, said means being manually releasable from the screw, a pawl disposed in the path of movement of the ratchet wheel whereby the traversing screw is turned to traverse the table across the carriage upon each reciprocation 15
of the table, means for reciprocating the table, including a motor driven screw extending parallel to the path of movement of the carriage, a clutch between the carriage and the last named screw, means for releasing the clutch upon the full 20
stroke of the carriage in one direction, means for retracting the carriage when the clutch is released from the screw, means at the end of the full stroke of the carriage in a reverse direction acting to engage the clutch with the screw, a light 25
sensitive cell supported above the path of move-

ment of the pattern holder, a source of light therefor, an engraving tool supported above the work on said table, a dynamic motor having a field coil, an armature and an armature coil carried thereby, the armature operatively supporting 5
said tool for vibrating movement toward or from the work, means for connecting the field coil to a source of current, means mounted upon the screw for intermittently interrupting the current 10
as the screw rotates, the armature coil being formed in two sections, radio amplifying means connected between the light sensitive element and one of said sections for varying the current in 15
said last named section of the coil by and in accordance with variations in the light and shade value of the pattern, radio amplifying means 20
causing oscillating current in the other section of the armature coil, means actuated operatively by the carriage when it has reached its full stroke in one direction for flow of current through the 25
field and armature coils during the reverse stroke of the carriage, and means causing the flow of current when the carriage has reached its full stroke in a reverse direction.

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