July 14, 1936. J. A. BENNETT 2,047,851

MACHINE FOR REPRODUCING PRINTING PLATES FROM PICTURES

Original Filed June 25, 1932 6 Sheets-Sheet 1

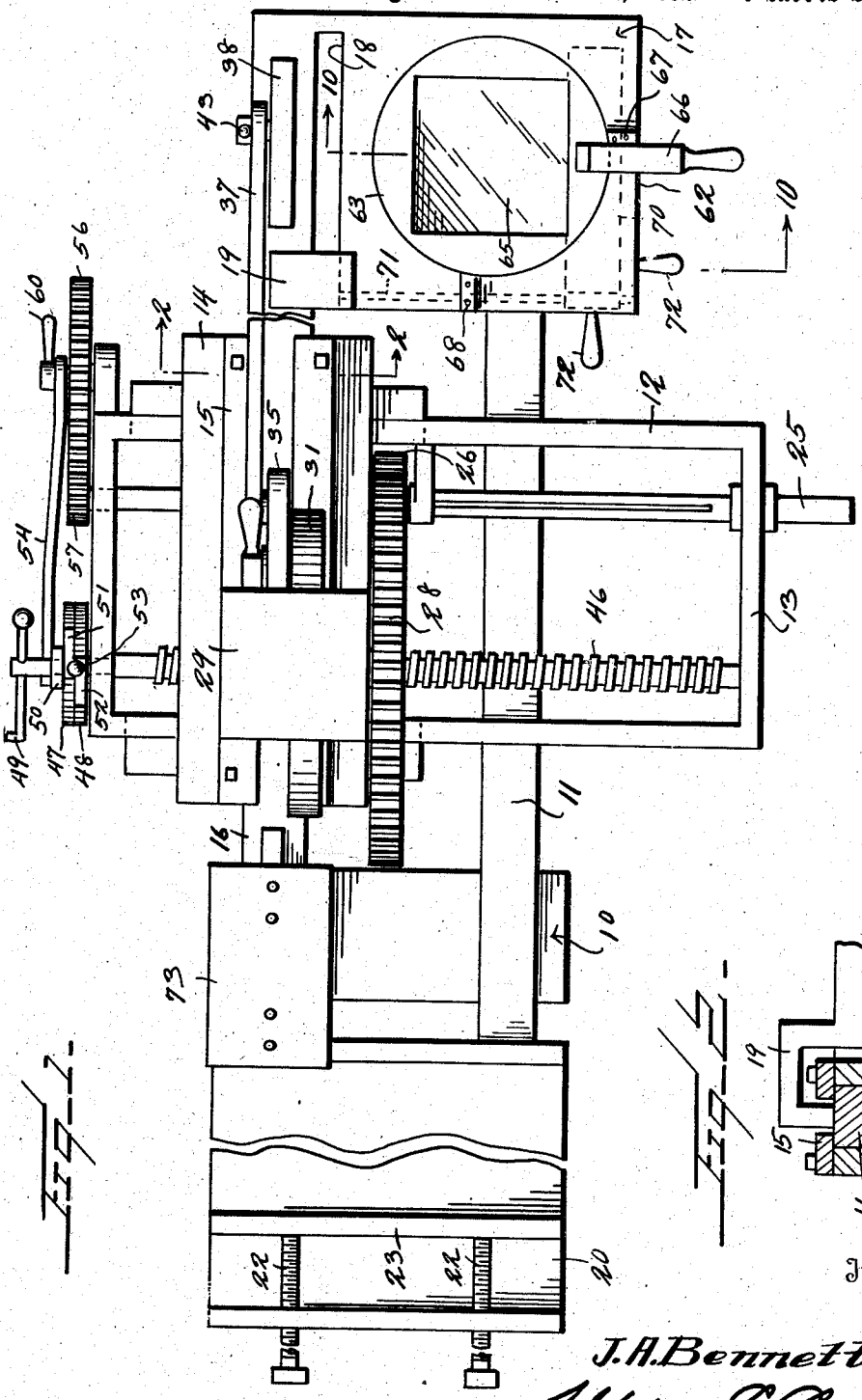


Fig. 7.

Fig. 8.

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MACHINE FOR REPRODUCING PRINTING PLATES FROM PICTURES

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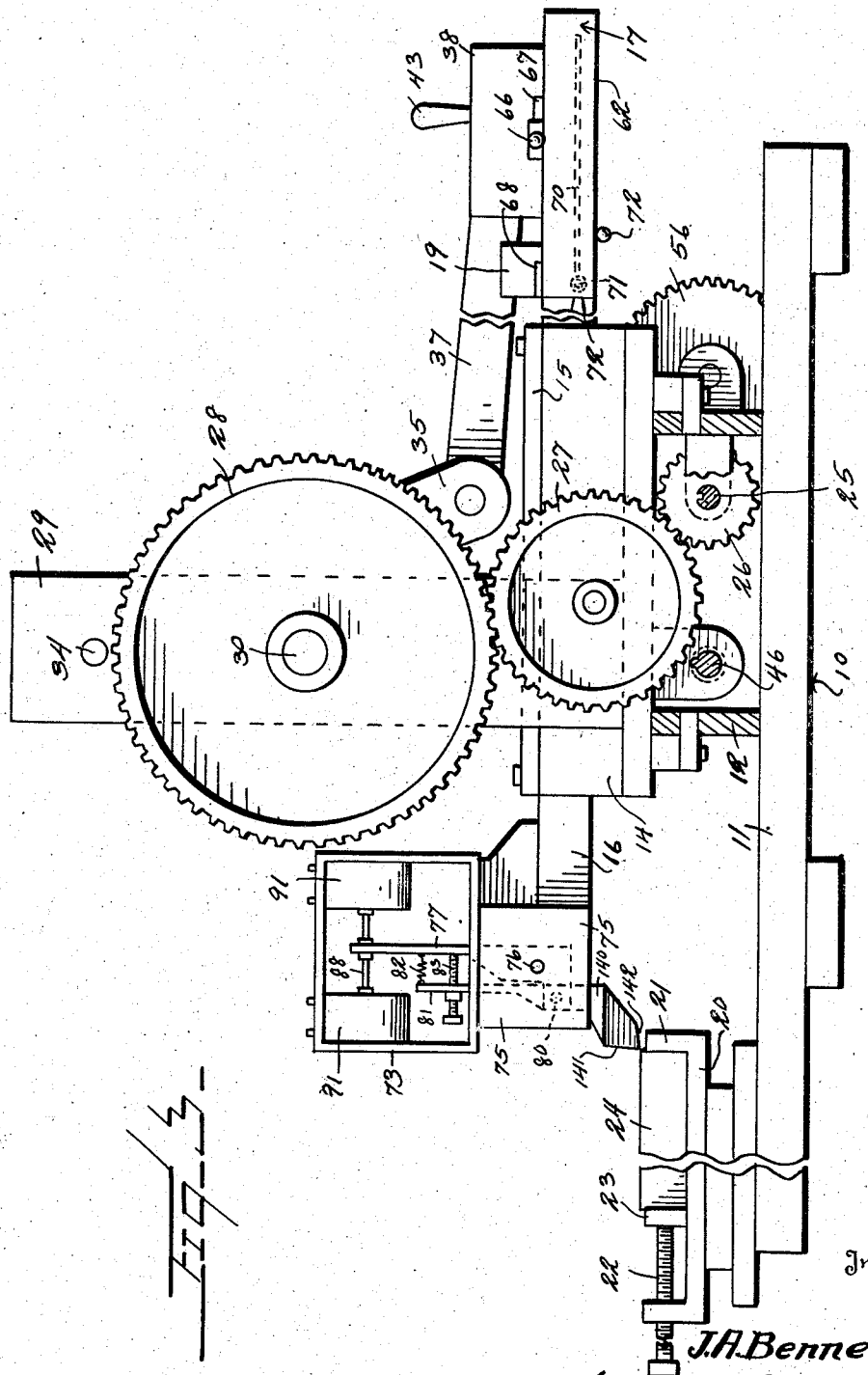


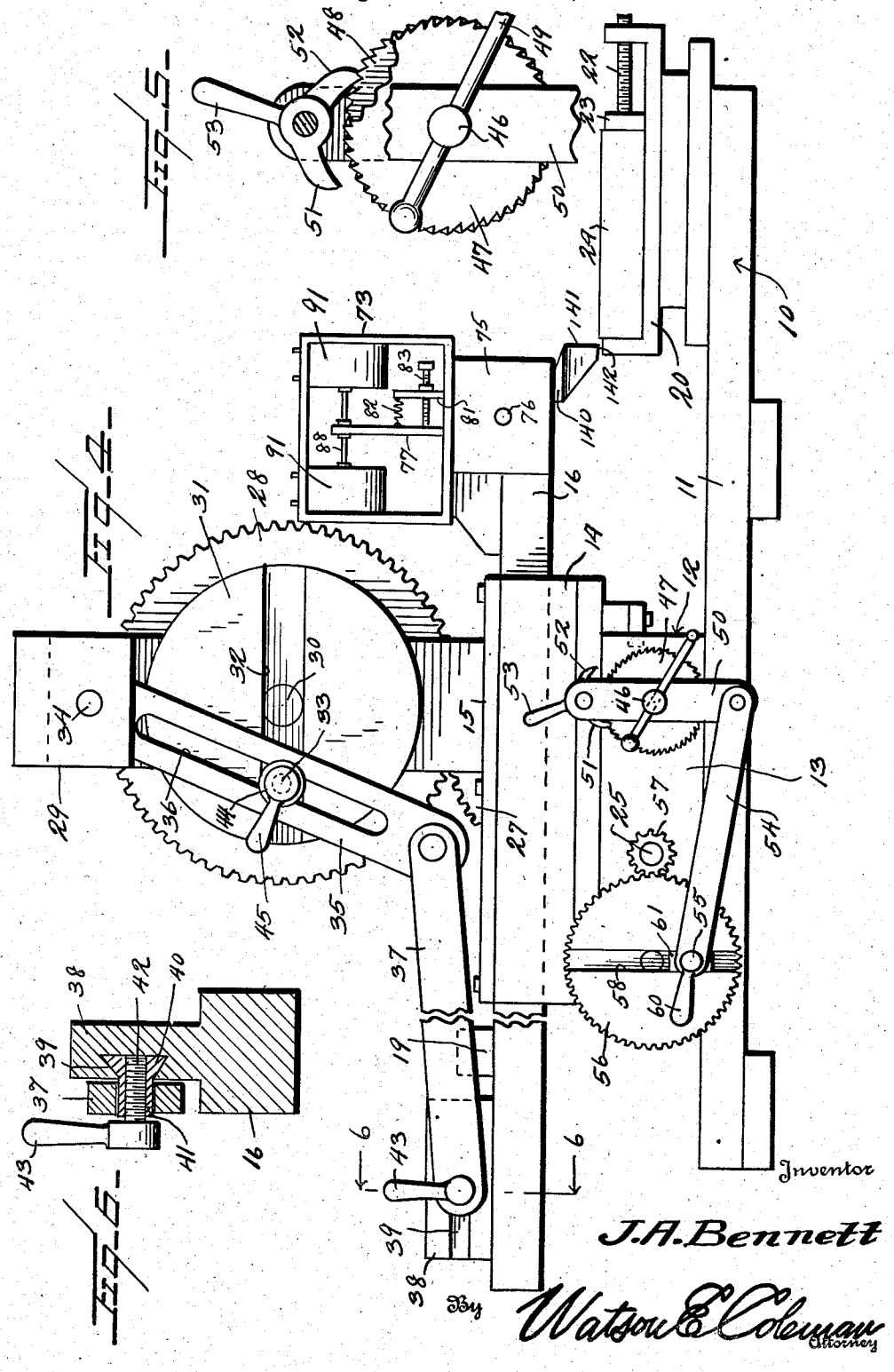
Fig. 3.

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MACHINE FOR REPRODUCING PRINTING PLATES FROM PICTURES

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MACHINE FOR REPRODUCING PRINTING PLATES FROM PICTURES

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Fig. 7.

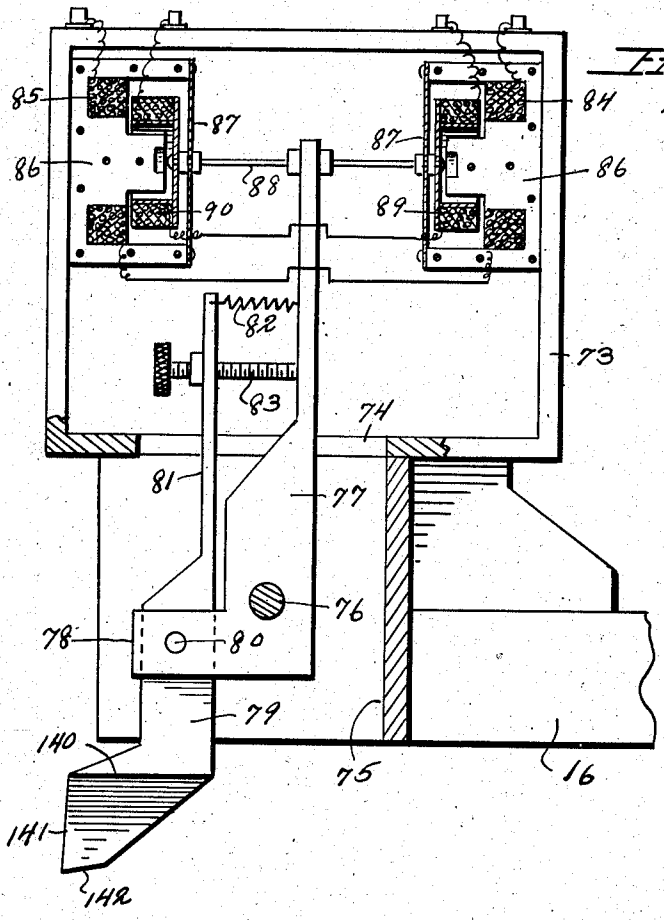


Fig. 8.

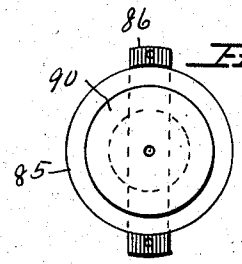


Fig. 9.

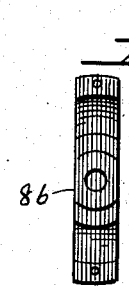
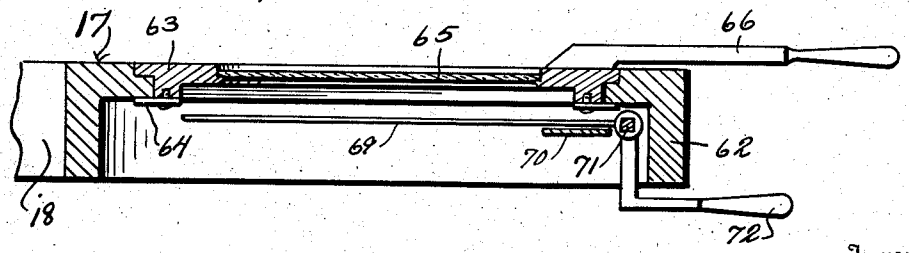


Fig. 10.



Inventor

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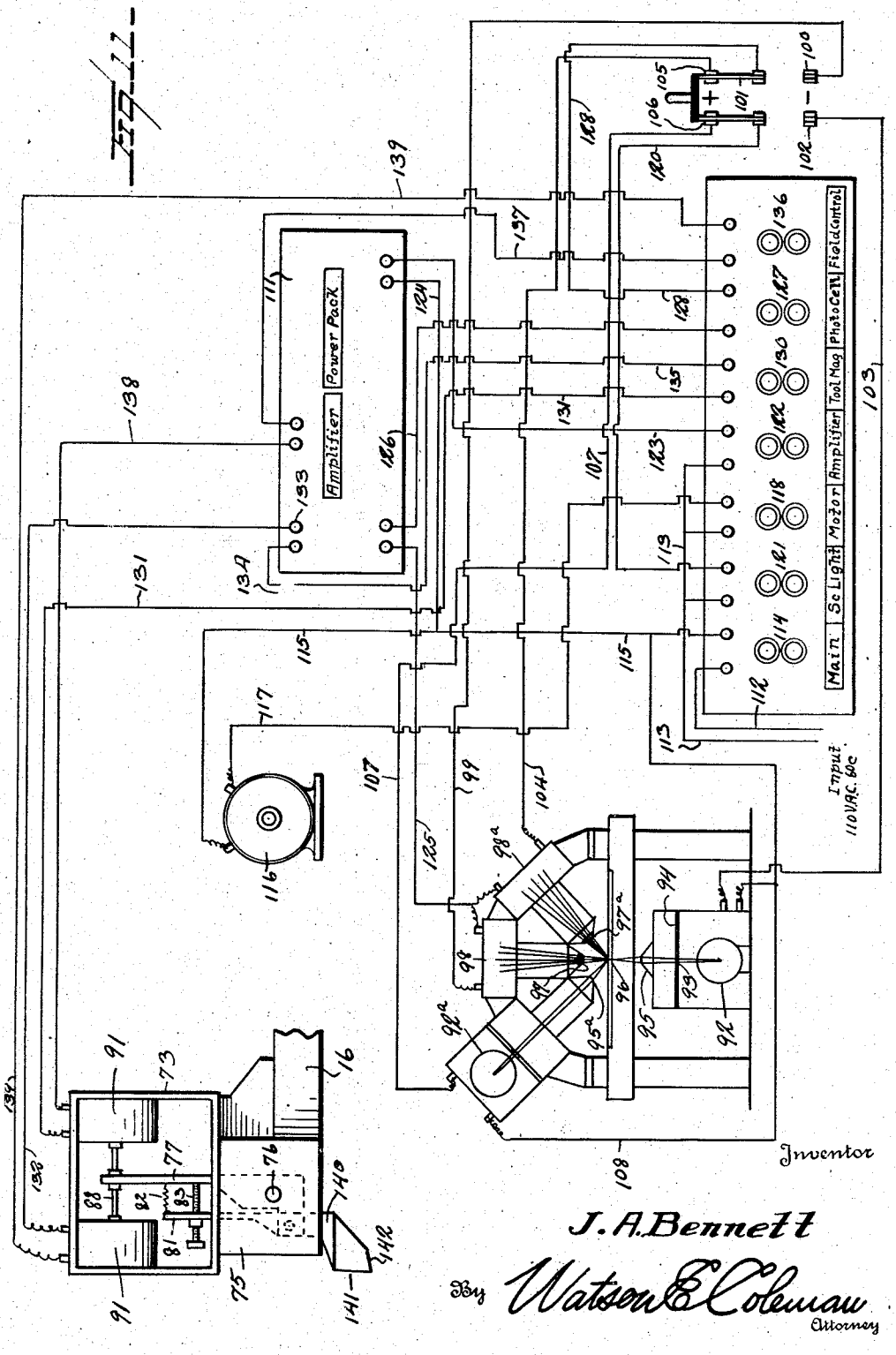
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MACHINE FOR REPRODUCING PRINTING PLATES FROM PICTURES

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MACHINE FOR REPRODUCING PRINTING PLATES FROM PICTURES

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Fig. 12.

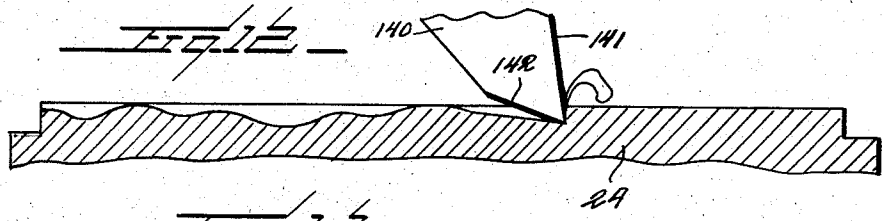


Fig. 13.

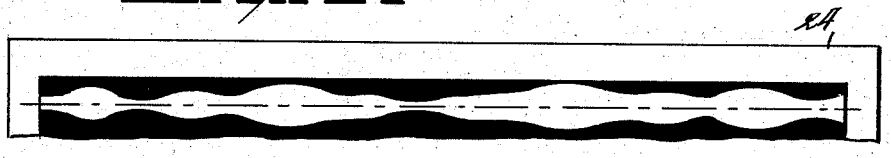


Fig. 14.

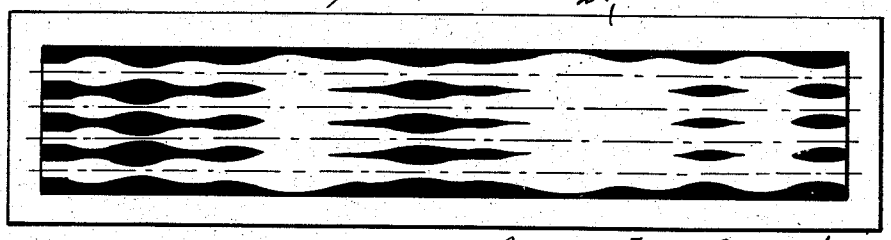


Fig. 16.

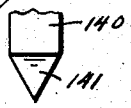


Fig. 17.

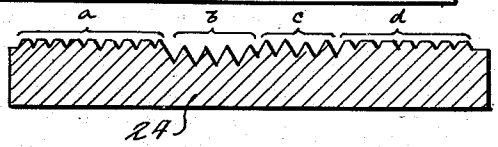


Fig. 18.

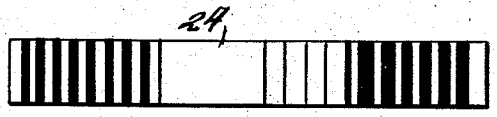


Fig. 15.

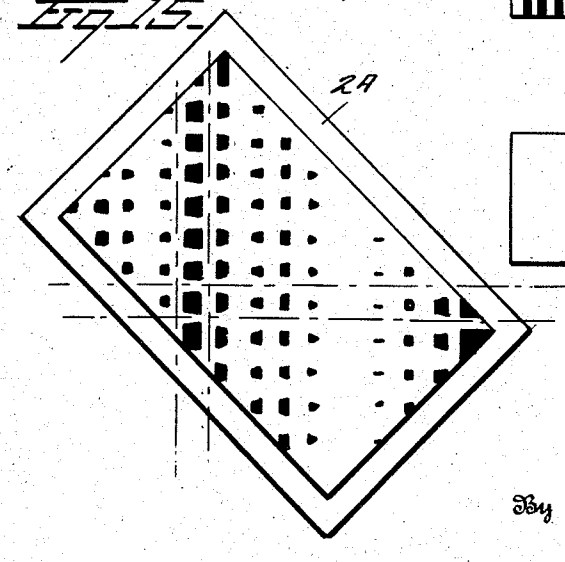
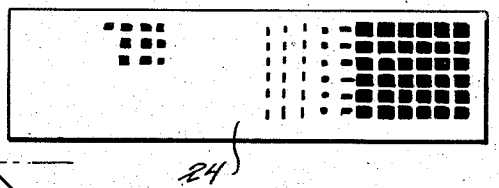


Fig. 19.



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Patented July 14, 1936 2,047,851

UNITED STATES PATENT OFFICE

2,047,851

MACHINE FOR REPRODUCING PRINTING PLATES FROM PICTURES

Joseph A. Bennett, Bloomington, Ind., assignor of forty-five per cent to Joseph W. Piercy, Bloomington, Ind.

Application June 25, 1932, Serial No. 619,716
Renewed September 24, 1935

8 Claims. (Cl. 178—5)

This invention relates to machines for automatically engraving printing plates and particularly to means for engraving a plate in correspondence with variations of the light responsive element such as a phototron either affected by radio waves induced from a distance or affected by variations of light passing through a negative or reflected from a positive.

A black and white print is formed of masses of black and masses of white. In a half tone plate, the picture is photographed on the plate through a screen which breaks it up into dots more or less closely associated, the dots being fine and wide apart when the tone or shadow is light and closer and coarser where the plate is darker. In a half tone plate, however, there is no full and positive black nor any full and positive white except where the plate is routed out.

The general object of my invention is to provide an engraving machine of the character stated which will reproduce upon a printed plate masses of pure black, masses of pure white and intermediate tones grading by fine degrees into the pure black or into the pure white.

A further object is to produce an engraving machine of this character which will automatically duplicate exactly in black and white and intermediate tones the picture which is being reproduced, whether this picture be in the form of a negative or a positive.

A further object is to provide a machine of this character in which the engraving tool is moved back and forth across the plate in successive, parallel closely approximating lines, the tool being depressed into the metal of the plate being produced to a greater or less extent to thus cut wider or narrower "white" lines in the plate, that is, cut lines which will constantly vary more or less in width and further provide a machine of this character wherein the picture being reproduced and the reproduced plate are rotatable through 90°, or any other angle desired, so that after lines have been cut on the plate in one direction, a second set of lines constantly varying in width may be cut on the plate at a right angle to the first-named set to thus cause the surface of the plate, in the intermediate tones thereof at least, to be cut into dots, that portion of the surface which is to print solid black being entirely uncut and that portion of the surface which is to print solid white being cut away.

A further object is to provide a mechanism of this character wherein the engraving tool is raised or depressed by means of a solenoid, this solenoid being operatively connected with a light responsive element which will cause the solenoid to vary its action upon the armature of the solenoid in consonance with variations in the amount of light passing through or reflected from the negative or positive picture being reproduced.

A further object is to provide means in the same machine whereby either a negative or a positive may be reproduced by the use of two light sensitive elements, one of which receives light rays transmitted entirely through the picture and the other of which receives light rays reflected from the face of the picture.

Another object is to provide power operated means for reciprocating the cutter of an engraving tool and light responsive means for controlling the depth and, therefore, the width of cut made.

A further object is to use in connection with the tool controlling solenoid and with the light responsive element amplifying means so that the relatively slight variations in the light responsive element may be translated into relatively large variations in the magnetism exerted by the solenoid.

Other and more specific objects will appear more fully hereinafter.

My invention is illustrated in the accompanying drawings, wherein:—

Figure 1 is a top plan view of the engraving machine itself without the electrical connections;

Figure 2 is a fragmentary section on the line 2—2 of Figure 1;

Figure 3 is a side elevation of the mechanism shown in Figure 1;

Figure 4 is also a side elevation but looking toward the side opposite to that shown in Figure 3;

Figure 5 is a deflected view of the transverse feed ratchet;

Figure 6 is a section on the line 6—6 of Figure 4;

Figure 7 is a vertical sectional view through the tool head showing the solenoid in section, the tool being shown in elevation;

Figure 8 is a face view of one of the armatures showing the diaphragm removed;

Figure 9 is a face view of the laminated core of the field magnets;

Figure 10 is a section on the line 10—10 of Figure 1;

Figure 11 is an electrical diagram showing the connections between the light responsive element, the amplifier and the solenoid which operates the engraving tool;

Figure 12 is a very greatly enlarged diagrammatic section showing the manner in which the cutter operates upon the metal plate;

Figure 13 is a top plan view of a portion of a printing plate showing a single line cut therein;

Figure 14 is a like view to Figure 13 but showing a printing plate with a plurality of longitudinal lines cut therein varying constantly in their width and showing how the lines will intersect each other to leave black and white spaces;

Figure 15 shows diagrammatically a surface of a printing plate in which the cuts are disposed at right angles to each other to form dots;

Figure 16 is a fragmentary front elevation of the forward face of the cutting tool;

Figure 17 is a transverse section through a printing plate after it is cut showing the manner in which the white and black spaces are formed by the cuts;

Figure 18 is a top plan view of the plate shown in Figure 17 to illustrate the manner in which this plate shown in Figure 17 will print;

Figure 19 is a face view of a portion of a plate showing the manner in which the plate shown in Figure 17 will print after it has been cut at right angles to the line shown in Figure 18.

Referring to Figures 1, 3, and 4, 10 designates a base or supporting frame comprising generally speaking two supporting bars 11 which may be in turn supported upon any suitable bed, table or other structure. Mounted upon these bars 11 is a rectangular frame 12 having the end members 13. This frame has vertical walls as shown best in Figure 3. This frame is fixed upon the beams or bars 11. Supported upon the frame 12 is the longitudinally extending guide 14 grooved upon its upper face and having the detachable overhanging rails or flanges 15 which are bolted to this guide 14. Operating through the guide 14, which guide is attached in any suitable manner to the frame 12 is a reciprocating bar 16 held in place by the rails or flanges 15 so that it has true rectilinear motion. Carried upon one end of this bar is a picture supporting frame or table designated generally 17, the details of which will be later described. This picture supporting table is longitudinally slotted as at 18 so that the table may move longitudinally into overlapping relation to guide 14. A bridge 19 as shown in Figure 2 connects the table 17 at the inner end of the slot 18 with the bar 16. It will be seen from Figure 1, however, that the bar 16 is formed integral with the table 17 though I do not wish to be limited to this. The beams 11 at their ends opposite the picture supporting bed 17 support a plate supporting bed generally designated 20 which is flanged upon one edge as at 21 and which carries the clamp screws 22 and the adjustable wall 23 mounted upon these screws so that this wall 23 may be shifted toward or from the wall 21 and thus clamp a printing plate between the walls 21 and 23 and hold the printing plate firmly in place while it is being engraved. This printing plate is designated 24 in Figure 3.

Mounted upon the opposite end of the reciprocating bar 16, that is, the end opposite the picture support is a cutter which traverses the surface of the plate 24 to be engraved and which is controlled as will be later stated.

The means for reciprocating this sliding bar 16 with its picture table and with its cutter includes a shaft 25 as shown in Figure 1 which passes through and is carried by the frame 12. To this shaft is splined a pinion 26 (see Figure 3) which meshes with an intermediate gear 27 which in turn meshes with the gear wheel 28. The ratio between the gears 26 and 28 is one to four. It will be understood that the guide 14 is adapted to be traversed across the upper surface of the frame 12 once for each complete reciprocation of the cutter carrying bar 12 and it is for this reason that the pinion 26 is splined upon the power shaft 25. The gear wheel 28 is mounted upon a vertical post or support 29 extending upward from the guide 14. Mounted upon the shaft 30 of the gear wheel 28 as shown in Figure 4 is a disk 31 provided with a diametrical undercut groove 32. Disposed within this groove is an outwardly projecting pin 33. This pin is adjustable along the groove as will be later stated.

Pivotally mounted upon the upright or post 29 by a pivot 34 is an arm 35 which is longitudinally slotted at 36. The pin 33 passes loosely through this slot so that as the disk 31 rotates the arm 35 will be oscillated upon its pivotal center 34.

Pivotally connected to the extremity of this arm 35 is a link 37 which in turn is pivotally connected in the manner shown in Figure 6 to the picture supporting end of the reciprocating bar 16. To this end, this bar 16 is provided with the upwardly extending lug or flange 38 which is formed upon one side face with the undercut slot 39.

Disposed within this slot is the flared end 40 of a pin 41 as shown in Figure 6, which pin passes through an aperture in the link 37. The pin is centrally screw-threaded and extending through this pin 41 is the clamping screw 42 having a handle 43 so that when this screw is turned inward, the flared base 40 of the pin 41 will be clamped within the slot 39 in any adjusted position. When on the other hand the screw 42 is turned upward, the pin 41 may be adjusted along the slot 39 and then reclamped. Identically the same construction is used for holding the pin 33 clamped in any desired position within the slot 32, this pin being provided with adjusting screw, the head of which is designated 44, which head is provided with a handle 45.

It will be seen that the pin 33 may thus be adjusted nearer to or further from the center of rotation of the disk 31 so that the throw of the arm 35, the link 37 and, therefore, the range of reciprocation of the bar 16 may be regulated to fit the machine for operating on pictures of various dimensions. It will be obvious now that as the disk 31 is rotated, the cutter carrying bar 12 will be reciprocated, carrying its cutter back and forth over the plate and, as shown in Figure 3, the form of the cutter is such that it will cut into the plate and cut a line in the face thereof upon a movement of the tool from right to left in Figure 3 and that it will do no cutting upon the return stroke.

For the purpose of giving a transverse traverse to the carriage which comprises the guides 14 and the bar 16 and the parts supported thereon, I provide as illustrated in Figure 1, the traversing screw 46 shown best in Figure 1. This screw is mounted in the ends of the frame 12 and at one end carries upon it the two reversely notched ratchet wheels 47 and 48.

The shaft also carries upon it the handle 49 whereby the screw shaft 46 may be rotated by hand to retract the carriage to its initial position when desired.

Also mounted upon the ratchet end of the shaft 46, as shown best in Figures 4 and 5 is an oscillating arm 50 carrying pivoted upon its upper end the double pawls 51 and 52, these double pawls being provided with the integral handle 53 whereby the pawls may be thrown from one position to the other or held in an intermediate position, if desired, these pawls coacting respectively with the ratchets 47 and 48. The arm 50 is oscillated by means of the link 54 which engages with a pin 55 projecting from a gear wheel 56, this gear wheel being driven by a pinion 57 mounted upon the shaft 25 shown in Figure 1. The face of the gear wheel 56 is diagrammatically

slotted at 58, this slot being undercut in the same manner as are the slots 32 and 39 and the pin 55 being constructed in the same manner as the pins shown in Figure 6 so that upon turning the handle 60, the base 61 of the pin will be jammed or clamped within the slot 58, this structure permitting the pin to be shifted nearer to or further from the center of motion of the gear wheel 56 or entirely across the gear wheel. By shifting this pin in this manner, a greater or less rotative movement may be communicated to the feed screw 46 so that the step by step traversing movement of the cutter or engraving tool across the face of the plate will be very slight or relatively coarse.

It will be noted from this mechanism that a single traverse step is made upon the return movement of the tool carrying bar 16 to its initial position which for purposes of illustration may be considered to be in the right hand upper corner of the plate 24.

Thus the engraving tool moves in one direction along the plate to the full length of the stroke for which it is adjusted and is then retracted and when it is retracted, it is given a lateral movement of one step and then again engraves a line across the face of the plate and so on.

I will now describe the picture supporting means designated generally 17 which is shown in detailed section in Figure 10. The picture supporting frame, as it may be called, is designated 62 in Figure 10. Mounted in the rabbeted face of this frame 62 is a circular picture supporting frame 63 held in place upon the frame 62 by the projecting members 64 which in turn are held in place by screws. Any suitable means to this end may be used. The frame 63 supports a plate of glass 65 if a negative is to be reproduced.

For the purpose of rotating the frame 63 through 90°, I provide the handle 66 attached to the frame 63 and adapted to engage the right angularly positioned stops 67 and 68. Operating beneath the frame 63 are the framing or masking plates 69 and 70 disposed at right angles to each other and movable upon rods 71 also disposed at right angles to each other, each masking plate having a handle 72 whereby it may be shifted to cut off those portions of the plate through which light is not to pass. Any suitable masking means may be used, however.

The tool or cutter controlling head is shown particularly in Figures 3 and 7. Mounted upon the bar 16 is a frame 73, this frame having an opening 74 in its lower member, the frame being supported upon an approximately U-shaped element 75 which is attached to or forms part of the bar 16. The frame and the member 75 are rigidly connected to the bar 16 under any circumstances so that there can be no play.

Pivotally mounted in the side walls of the member 75 upon a pivot pin 76 is a lever 77, the lower end of which is angularly extended as at 78 in a direction toward the plate holder or clamp. This lever 77 may be bifurcated or otherwise formed at its lower end to pivotally support the engraving tool or cutter 79. The pivot pin for this purpose is designated 80. The tool or cutter has an extension 81 extending upward parallel to the lever 77, the extremity of this extension being connected to the lever 77 by a tension spring 82. An adjusting screw 83 passes through the extension 81 and engages against the lever 77 so that the angle of the cutter with relation to the lever 77 and with relation to the work may be adjusted.

The tool controlling mechanism comprises the field magnets 84 and 85 connected in series and wound upon the laminated iron cores 86. These cores support metallic elastic diaphragms 87 which are connected by a rod 88 to the upper end of the tool operating lever 77 in any suitable manner so as to move therewith. It is to be understood at this point that the total movement of the upper end of the lever 77 is relatively slight. The field coils 84 and 85 are wired in series so that the polarity from left to right in Figure 7 is NSNS. Mounted upon the rod 88 outward of the diaphragms 87 are the armature coils 89 and 90. These are wired in series so that the polarity from left to right is SNSN. The field coils 84 and 85 are uniformly and constantly energized while the machine is in operation. The armature coils, however, are varyingly energized from zero to maximum depending upon the amount of light which passes through or is reflected from the picture on the picture supporting frame 17, which light is directed upon a phototronic cell and affects an amplifier mechanism which in turn controls the passage of current to the armature coils.

These armature coils are energized from zero to maximum which is sufficient to cause the required maximum movement of the diaphragms 87 which in turn act upon the lever 77 to shift the cutting tool 79 vertically, a maximum amount of .004 inch. The maximum energization of the armature coils raises the armature tool so that it will just clear the surface of the plate. The normal position of the cutting tool when the armature coils are not energized is .004" below the surface of the plate. The maximum energization of the armature coil raises the cutting tool so that it will just clear the surface of the plate. Varying degrees of energization of the armature coils will cause the cutting tool to vary correspondingly within this range. Thus assuming that a negative is being used upon the table and a beam of light is passing through the negative, then when a transparent portion of a negative is scanned, which transparent portion, of course, represents a solid black portion of the picture, the tool is raised and the metal is not cut away, thus causing this portion of the plate to print as a solid black. When, however, the scanning beam is obstructed by a dense portion of the negative, the weakened scanning beam which passes through the negative creates a correspondingly weaker energization of the phototronic cell and the armature coils with the result that the tool is not raised so much and the metal is cut away from the surface of the plate so that this portion will not print. Varying degrees of energization of the armature coils will thus cause the cutting tool 79 to vary correspondingly in its vertical position within the range of its shifting. As shown in Figures 4 and 11, the field coils and magnets are contained within a casing 91 carried by the frame 73.

As illustrated in Figure 11, which as before remarked, is purely diagrammatic, a beam of light is discharged from a scanning light 92 of any suitable character up through an aperture 93 in a diaphragm 94 and through a lens 95 which comes to a focus on the negative 96. After passing through the negative, the beam passes upward through a lens 97 which directs it on to a light-sensitive element of known character carried within the phototronic cell 98. From one side of this cell extends the conductor 99 which leads to one pole or contact 100 of a double-

throw switch, the blades of which are designated 101. Associated with this switch is the switch contact 102 which is connected by a conductor 103 to the scanning lamp 92.

It will, of course, be understood that the scanning lamp 98 is held in a fixed position relative to the negative supported upon the table 17 and that the negative is movable in two directions beneath the scanning lamp by the mechanism heretofore described and that as the negative is moved longitudinally by the disk gear 31, the arm 35 and the link 37, the light striking the lens 97 and entering the phototronic cell will be constantly varied in consonance with variations in the light and the shade or density or thinness of the negative. This photoelectric cell is connected to amplifying means which in turn is electrically connected to the armature of the tool controlling solenoids. When the switch 101 is thrown into engagement with the contacts 100 and 102, the lamp 92 and the electric cell 98 will be connected to a source of current.

Under some circumstances, it is desirable that a positive be used in place of a negative and under these circumstances, the light must be cast downward upon the surface of the positive and be reflected to the photoelectric cell. I illustrate this arrangement in Figure 11 wherein the lamp 92*a* which is the same as the lamp 92 is so disposed that the light beam coming from it is focused by means of the lens 95*a* upon the negative at one point and that this pencil of rays is reflected from the negative through the lens 97*a* into the photoelectric cell 98*a*. This cell is connected on one side by a wire 104 to the switch contact 105 of a double throw switch while the opposite contact 106 on the positive side of the switch is connected by the conductor 107 to the lamp 92*a*, the other pole of this lamp being connected by the conductor 108 to a conductor 115 extending to the push button switch 114 on the controlling panel. One electrode of each of the photoelectric cells 98 and 98*a* is connected, as before described, to the switch 101, the other electrode of each of these cells being connected by a wire 125 to the input of the ordinary radio amplifier 111.

It will be understood that the double-throw switch 101 is designed for the purpose, in one position, of cutting in the lamp 92 and the photoelectric cell 98 and cutting out the lamp 92*a* and the photoelectric cell 98*a* and in its other position cutting in the lamp 92*a* and the photoelectric cell 98*a* and cutting out lamp 92 and the cell 98.

The wiring from the source of current to the amplifier, to the motor, the scanning lights and the wiring controlling the armature magnets, the photocell and the feed magnets is illustrated diagramatically in Figure 11.

The current is received by the wire 112 and returned to the source of current by the wire 113. These wires 112 and 113 are preferably connected with a source of sixty cycle alternating current at 110 volts. The wire 112 extends to the binding screw of a push button control switch 114 which is the main switch and from the other binding screw of this switch extends a wire 115. This wire connects with the wire 108 leading to the lamps 92 and 92*a*. This wire 115 also connects to one side of the motor 116 which operates the driving shaft 25, the other side of this motor being connected by a conductor 117 to a binding screw of the motor controlling switch 118, the other binding screw of this switch being connected to the return wire 113. The return wire from the scanning light 92*a* is designated 107, this wire extending to the contact 106 of the switch 101, one of the blades of this switch being connected by a wire 120 to the push button switch 121 which in turn is connected to the line wire 113. The scanning light 92 is connected on one side to the wire 108 and on the other side, as before stated, by the wire 103 to the contact 102.

The amplifier is controlled by a push button switch 122, one binding screw of which is connected to the wire 113, the other binding screw being connected by a conductor 123 to the input of the amplifier, the amplifier being connected in circuit with the wire 115 by the wire 124. Each of the photoelectric cells 98 and 98*a* are connected to the amplifier by the conductor 125 and then connected by a wire 126 to one of the binding screws of a push button switch 127 which controls the photocell, the other binding screw of this switch being connected by a wire 128 to one of the switch blades 101. The armature magnets are controlled by a push button switch 130, one binding screw of which is connected by the wire 131 to one of the armature magnets.

This magnet is connected in series with the opposed armature magnet which in turn is connected by the wire 132, to the radio amplifier at 133, which in turn is connected by the wire 134 to the tool magnet switch 130 by the wire 135. The field coils are controlled by the push button switch 136 connected on one side by the wire 137 to the output of the amplifier which is connected by the wire 138 to one of the field magnets which is connected in circuit with the other field magnet, the last magnet being connected by the wire 139 to the other binding post of the field controlling push button switch 136. It will thus be seen that the entire mechanism may be cut off from connection with the source of power by operating the main switch 114, that either of the scanning lights may be cut out or cut in by operating the switch 121 that the motor may be cut in or cut out by operating the switch 118, that the amplifier may be controlled by the switch 122, the tool magnet controlled by the switch 130, the photocell controlled by switch 127 and the field magnets controlled by the switch 136 and that the switch 101 in one position connects the lamp 92 to the source of current and at the same time connects the photoelectric cell 98 to the source of current or when in the other position connects the lamp 92*a* to the source of current and the photo cell 98*a* to the source of current.

It will be obvious, of course, that many changes might be made in the wiring without in any way departing from the spirit of the invention and that the wiring diagram in Figure 11 is merely given to shown one manner in which the various parts may be wired.

The particular shape of the cutting tool or engraving tool 79 is best shown by reference to Figures 7, 12, and 16.

The lower end of the cutter is extended forwardly at 140 and the forward face 141 of the cutter as shown in Figure 16 is triangular in form to provide a cutting edge which is V-shaped in cross section. This cutting tool is, therefore, a straight line cutting tool, that is, it cuts by being forced forward in a straight line plowing through the metal in the manner shown in Figure 12 and casting out the metal which is being cut in the form of a thread ahead of the tool, thus leaving no ragged edges nor any detritus in the

cut. The lower edge of the cutter is extended upward and rearward as at 142 at a slight angle and then extended upward and rearward to the heel of the cutter at a sharper angle. Figure 12 shows the manner in which the cutter plows through the metal of the plate 24. As the amount of light reaching the photoelectric cell varies, the lever 77 is shifted in one direction or the other, thus forcing the cutting tool deeper into the metal or less deeply. The depth of cut has, of course, no bearing upon the completed plate but because of the shape of the cutter, it follows that the deeper the cut, the wider will be the cut and the narrower the cut the shallower the cut will be. This is shown clearly in Figure 13 which shows a top plan view of a cut made in consonance with the variations in depth of the cutter shown in Figure 12. The cutter travels longitudinally of the plate and entirely across the plate. When the stroke in one direction has been completed, the cutter moves back to the right hand edge of the plate and is traversed downward, that is, transversely across the plate one step by means of the action of the feed screw 46. The cutter then travels longitudinally of the plate again making a second cut parallel to the first. If the cut is a wide one, that is, if the cutter is forced deeply into the metal, a second cut will intersect either entirely or at intervals with the first named cut. If the cut is relatively shallow and, therefore, relatively narrow, the cuts may not intersect at all. If the cuts intersect along their entire extent, the metal will be entirely cut away from the face of the plate and as a consequence, this portion of the plate will print white.

If, on the other hand, the cutting tool is raised entirely from the face of the plate, this portion of the plate will print black. If the cuts are relatively shallow and relatively narrow and extend parallel to each other, the plate will print as a series of white lines on a black ground or black lines on a white ground as shown in Figures 17 and 18 and if the plate with its white or black parallel lines or cuts is turned at right angles and cut, the plate will print a series of dots of varying degrees of area with varying spaces between the dots as shown diagrammatically in Figure 19 or as shown in Figure 15 where the lines or cuts have been drawn not parallel to the side and end edges of the plate but an angle of 45° to these side and end edges. If the plate has been formed with the parallel cuts shown in Figures 13 and 14 which intersect each other so that elongated white and black spaces would be printed and if then the plate be turned at right angles and a series of cuts made, it will be obvious that the black spaces on the print made from the plate will be formed as dots, squares, triangles, etc., of varying degrees of area so that the entire surface of the plate will show masses of white, masses of black and intermediate tones formed of dots which may be diamond-shaped, rectangular, triangular or have any other form which when printed will give what is known as a half-tone effect. Only the tones will vary infinitely. Figure 17 shows diagrammatically in cross section the manner in which a plate will be grooved or cut to print as shown in Figure 18. Figure 19 shows how a print made from a plate as illustrated in Figure 17 will print if it be again cut at right angles to the direction of cut shown in Figure 17, breaking the surface of the plate into a series of larger or smaller dots of varying area and possibly of varying shape.

In Figure 17, it is assumed that the depth of the cuts *a* is .002", that the cuts designated *b* overlap .001" below the surface of the plate so that this portion of the plate will print white and that these cuts have a depth of .004" below the surface of the plate and that cuts *c* have a depth of .003" while the cuts *d* have approximately a depth of .001". The deepest cuts made where it is desired that this portion of the plate print white are .004". Depth of the cuts will, therefore, vary from zero which is the surface of the plate to .004" and the width of the cuts will vary as the depth. By adjusting the slide 61 within the groove 58 of the traverse controlling gear 56, the lines per inch may run from 50 lines per inch to 160 lines per inch which will give a separation between the lines ranging from .02" to .0055, thus securing reproductions which may be either used for news print, "antique" or any other of the usual five classifications of paper stock. It is to be understood, of course, that the angle of the face 141 of the cutting tool is also to be changed for cutting different lines per inch, this angle being capable of being changed by adjusting the screw 83.

The general operation of this mechanism is as follows:—The negative is placed in the plate holder and framed by the masks. The plate to be cut is placed within the clamp or vise 20 in a position properly related to the position of the negative (or positive). The plate may be a stereotype plate, a zinc or copper plate or of any other suitable character. If a stereotype plate, it will either be cast in a stereotype box to type high (.918") or the conventional shell-cast height and mounted on a wooden base. Copper or zinc plates may be mounted in a similar manner. The negative or positive and the plate to be engraved are positioned so as to be in direct relation.

The angle of the tool point is adjusted to secure the proper depth and the ratchet of the worm screw 46 is set to give the proper spacing of cuts per inch to compare with screen lines per inch. Electric circuits are closed and the machine set in motion. The bar 12 constitutes a ram. This ram moves forward and the plate holder attached to the rear end of the ram moves likewise. The negative (if a negative is used) moves between the scanning beam and the photocell and the tool is thrown in operation by the variations of the light energy acting on the photocell, the tool varying in its depth of cut according to the density of negative. Where there are light parts in the negative, the tool rises and does not cut into the surface of the plate, thereby leaving the inking surfaces on the plate. The length of stroke is, of course, adjusted by adjusting the pin 33 with relation to the center of motion of the disk 31 and thus the ram moves forward the desired stroke length, in conformity with the size of the plate being engraved. At the end of the stroke, the tool point will, of course, rise and as the ram moves backward with the tool point raised, the traverse movement takes place and positions the ram and the tool point for the next succeeding forward stroke. Another forward cut is then made and this is repeated until the plate has been entirely engraved. Since the negative holder and the tool holder are synchronized for both forward and traverse movement, because of the

fact that the negative holder is mounted upon the ram, the negative will pass over the scanning beam in a series of parallel lines and the tool will pass over the plate in a series of parallel lines. When the cuts have been completed in one direction, the machine is stopped and the plate is turned 90° and the negative 90°.

While I have shown mechanism wherein the plate and negative are turned by hand through 90°, it will be understood, of course, that automatic means might be provided for this purpose. The machine is placed in motion again and the same procedure is followed so that the second series of cuts made will be at right angles or at any other desired angle to the first series of cuts and the completed plate will have the appearance of the screen lines of a half tone but with an advantage over the ordinary half tone, that solid blacks on the negative will appear as solid blacks on the plate or rather on the print therefrom, solid whites will appear as solid white on the print and there will be an infinity of intermediate tones. This operation is labor saving for the reason that the cut can be made directly from a negative and the range of possibilities is so great as to meet the requirements of any particular paper stock which will take a screen from 50 lines per inch to 175 lines per inch. Furthermore, since it is impossible to produce total white with the ordinary photochemical process used in making half tones, my machine has advantages in that it may be so adjusted as to cut out the surface of the plate without routing procedure now used.

While I have before referred to the use of a negative from which the plate may be engraved, it is also obvious from what has gone before that a positive may be used and the light be reflected from the surface of the positive and by "positive", I do not wish to confine myself to the use of a photographic positive but my machine may be used to reproduce any picture from which the light may be reflected, or any picture through which the light may be transmitted may be used as a negative.

The engraved plate is made on a flat surface and this plate can be immediately removed from my machine and placed on the press ready to be inked and printed. This machine will reproduce a printing plate directly from a negative or positive, will produce a half tone which is superior to the half tone produced by the photochemical methods in that it will produce both solid black and solid white and will give a clearer plate than by any other method known to me. It will reproduce any screen or tone block that is desired and any straight line effect or any solid white or solid black decorative design upon a border of solid black or solid white.

While in the above description I have referred more particularly to the use of this machine for the purpose of producing an engraved plate from a negative or positive, which negative or positive is mounted upon the ram 12, it is also obvious that radio waves controlled by a light beam transmitted through or from a picture and a long distance away may be transmitted through space in the same manner as used for radio communication and be received by the amplifier which will vary the current passing through the armature of the cutting tool controller and that thus an engraving may be made by my machine receiving its impulses, as they may be termed, from a long distance.

Attention is called particularly to the electromagnetic means whereby the variations in the current are translated into vertical movement of the engraving tool. It will be seen that in my construction, the armature coils are submitted both to attraction and repulsion, one field magnet attracting while the other field magnet repulses and that thus a particularly strong action is secured upon the engraving tool to vary its depth of cut.

I claim:—

1. A machine for reproducing a picture by engraving upon the surface of a plate including a ram held from vertical movement but being longitudinally movable, a vertically movable engraving tool mounted upon one end of the ram, a picture support mounted upon the other end of the ram, power operated means for reciprocating said ram, the tool and the picture support, means operating upon each stroke of the ram to cause a lateral traverse of the ram whereby to engrave the plate in a series of successive parallel lines, and means for varying the vertical position of the tool with reference to the plate in consonance with variations in light and shade of the picture comprising a dynamic armature operatively connected to the tool and including armature coils, field magnets associated with the armature coils, means for supplying a constant current to the field magnets, and means for varying the current passing through the armature coils including a light responsive element fixed with relation to the picture support, a scanning light associated with the cell and picture support and a radio amplifier amplifying the variations of current passing through the cell and transmitting said fluctuating current to the armature coils.

2. In a machine for reproducing pictures by engraving upon the surface of a plate, a cutting head, a lever pivoted upon said head, an engraving tool mounted upon said lever and oscillated thereby to raise or lower the tool, opposed field coils carried by the head, means for constantly energizing said coils, armature coils coacting with and opposed to the field coils, elastic diaphragms carried on the head, means rigidly connecting the diaphragms and the armature coils to said lever, and means for passing current through the armature coils.

3. In an engraving machine, a cutter head, a lever mounted upon the cutter head and having an angular portion extending horizontally from the lever below the pivot thereof, an engraving tool pivoted upon said angular portion for adjustment in a vertical plane, a screw passing through the upper end of the engraving tool and bearing against said lever, a spring urging the upper end of the engraving tool toward the lever, and means for oscillating said lever comprising constantly energized field coils, armature coils disposed between the field coils and connected in series with each other, a rod connecting the armature coils to each other and to the upper end of the lever, and yielding means resisting movement of the lever from a normal position.

4. In an engraving machine, a cutter head, a lever pivoted thereon for oscillation in a vertical plane, a cutter carried by the lever and depressed or raised by the oscillations thereof, means for oscillating the lever comprising constantly energized field magnets carried on the head, each having a field coil and a core, armature coils opposed to the field coils, a rod connecting the ar-

mature coils rigidly to the upper end of the lever, the armature coils being connected in series with each other and with the source of current, resilient diaphragms carried on the head resisting movement of the armature coils and lever from a medial position, the armature coils having their like poles confronting each other, one of the field coils having a like pole opposed to the pole of the contiguous armature coil, the other field coil having its unlike pole opposed to the contiguous pole of the armature coil whereby to secure repulsion between one armature coil and the corresponding field magnet and an attraction between the other armature coil and the corresponding field magnet.

5. A machine for reproducing a picture by engraving upon the surface of a plate including a ram, guides within which the ram is reciprocatable, a vertically movable straight line engraving tool carried upon one end of the ram, a picture support carried upon the other end of the ram, means for reciprocating the ram, means for adjusting the length of such reciprocation, means actuated upon each stroke of the ram to cause a transverse movement of the ram, the picture support and the engraving tool, manually controlled means for regulating the degree of transverse movement of the ram under the action of said last named means, the picture support being mounted on the ram for rotative movement through an angle of 90°, means for supporting the plate beneath the engraving tool, said means permitting the plate to be turned through an angle of 90°, a scanning light disposed in conjunction with the picture support, a light-sensitive element receiving light from the picture, electromagnetic means for vertically shifting the tool carried upon said ram, and including a dynamic armature operatively connected with the tool to vertically shift the tool and means for causing the light-sensitive element to vary the current passing through said electro-magnetic means in consonance with variations in the light received upon said light sensitive element from the picture.

6. A machine for reproducing a picture by engraving upon the surface of a plate including a reciprocatable ram, a guide therefor, a tool head holding member on one end of the ram, a picture support carried on the other end of the ram and having means whereby a picture supported thereon may be rotated from one position to another, means for operating the ram comprising a diametrically slotted disk, power operated means for rotating said disk, an arm pivoted above the disk and having a longitudinally extending slot, a pin passing through said slot and adjustable along the slot of the disk to any desired position nearer to or further from the center thereof, a link pivoted to said arm and adjustably connected to the ram for adjustment into a plurality of positions longitudinally of the ram, a shaft extending at right angles to the ram, a frame within which the shaft is carried and operatively connected to the ram to move therewith, a screw shaft carried by said frame and having screw-threaded engagement with the ram, a double ratchet wheel carried upon the screw shaft, a lever mounted upon the shaft and freely oscillatable thereon and carrying a double pawl adapted in one position to engage one of said ratchet wheels and in another position to engage the other of the ratchet wheels, manually operable means connected to the screw shaft for reversely turning it, means for operating said pawl carrying lever comprising a gear wheel having a diametrically slotted face, a link pivoted to the pawl carrying lever at one end and at its other end adjustably connected to the slotted face of the gear wheel for movement nearer to or further from the axial center thereof, and means operatively connected to the power shaft for rotating said last named gear wheel.

7. A machine for reproducing a picture by engraving upon the surface of a plate including a reciprocatable ram, horizontal guides in which the ram moves, the guides preventing vertical movement of the ram, an engraving tool operatively carried upon one end of the ram, a picture support operatively carried upon the other end of the ram for longitudinal movement therewith, the cutting tool being movable perpendicularly with relation to the surface of the plate to be engraved, means for supporting a plate to be engraved beneath the cutting tool, electro-magnetic means for shifting the engraving tool vertically, a scanning light directed upon the picture, a light-sensitive element receiving light from the picture, means causing the scanning light to vary the amount of current in the electro-magnetic means to thus vary the position of the engraving tool in correspondence with variations in the light and shade of the picture, means for reciprocating the ram, said means being adjustable to vary the amount of stroke, means for adjusting the ram longitudinally with relation to the reciprocating means, means for giving a step by step transverse movement to the ram one step for each stroke of the ram, said means being adjustable to vary the amount of this transverse movement, and means for initially adjusting the amount of penetration of the cutting tool into the plate.

8. In a machine for reproducing a picture by engraving upon the surface of a plate, a reciprocating ram, a lever mounted upon one end of the ram for pivotal movement in a vertical plane, the lever having an angular extension, an engraving tool having its lower end V-shaped in cross section and pivoted to the angular extension of the lever and extending above said pivot, an adjusting screw passing through the upper end of the tool and bearing against the lever, a spring urging the upper end of the tool toward the edge of the lever, a rod carried upon the upper end of the lever and extending in the plane of motion of the lever, opposed armature coils mounted upon the edge of the rod and having their like poles confronting each other, field magnet coils disposed outward of the armature magnets, cores therefor, picture controlled means for varying the current passing through the armature coils, means for constantly energizing the field coils, the pole of one field coil being unlike the adjacent pole of the adjacent armature coil, the other field coil and the opposed armature coil having their like poles adjacent each other, the coils of the armature being connected in series, and metallic elastic diaphragms mounted on the cores of the field coils and connected to the armature coils and the lever and yieldingly holding the armature coils and the lever in a medial position.

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