Feb. 23, 1943. G. E. LOSIER ET AL 2,312,042

ELECTRIC CIRCUIT FOR PHOTOELECTRIC ENGRAVING MACHINES

Filed Aug. 3, 1940 2 Sheets-Sheet 1

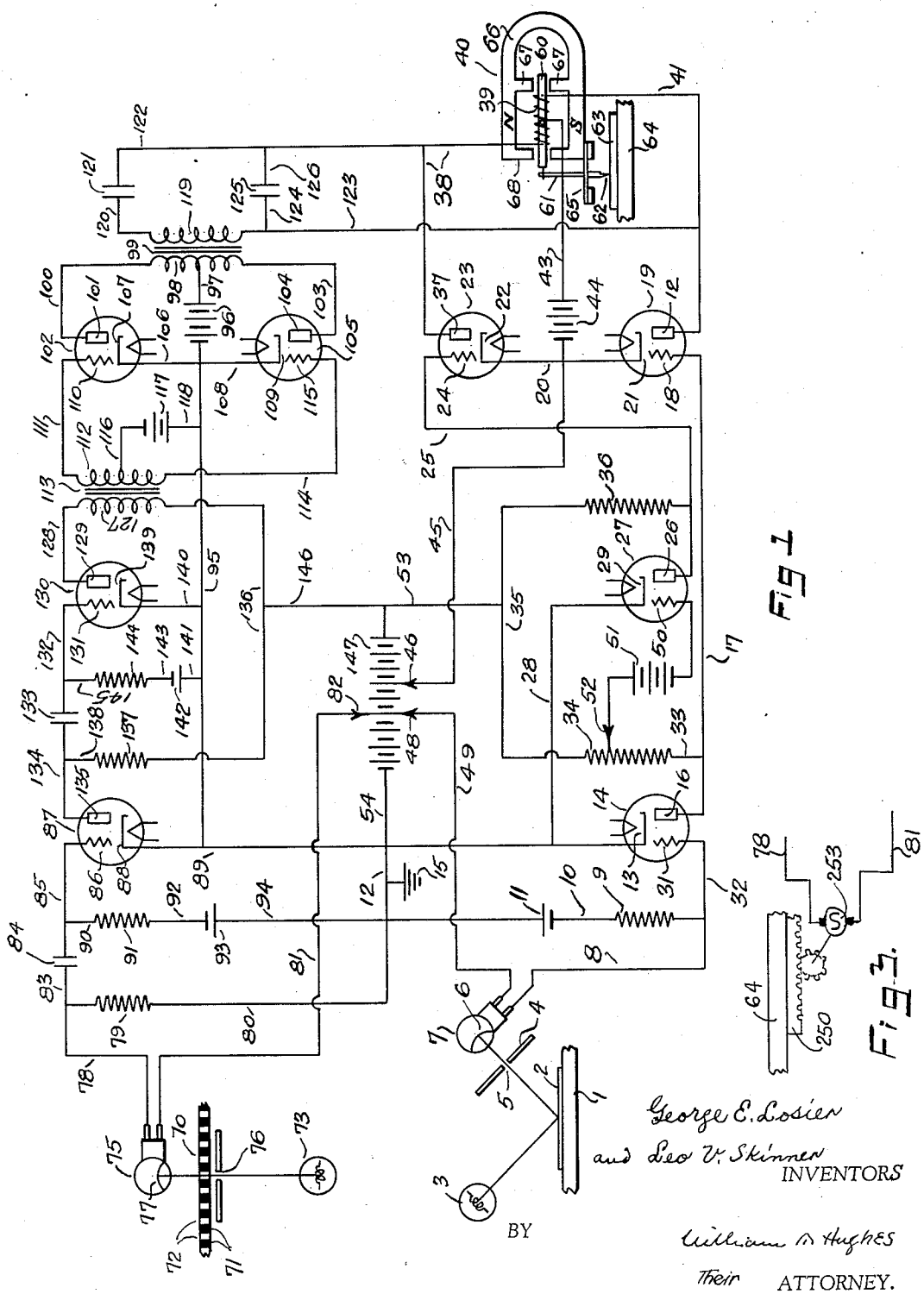


Fig 1

Fig 3.

George E. Losier
and Leo V. Skinner
INVENTORS

BY

William A. Hughes
Their ATTORNEY.

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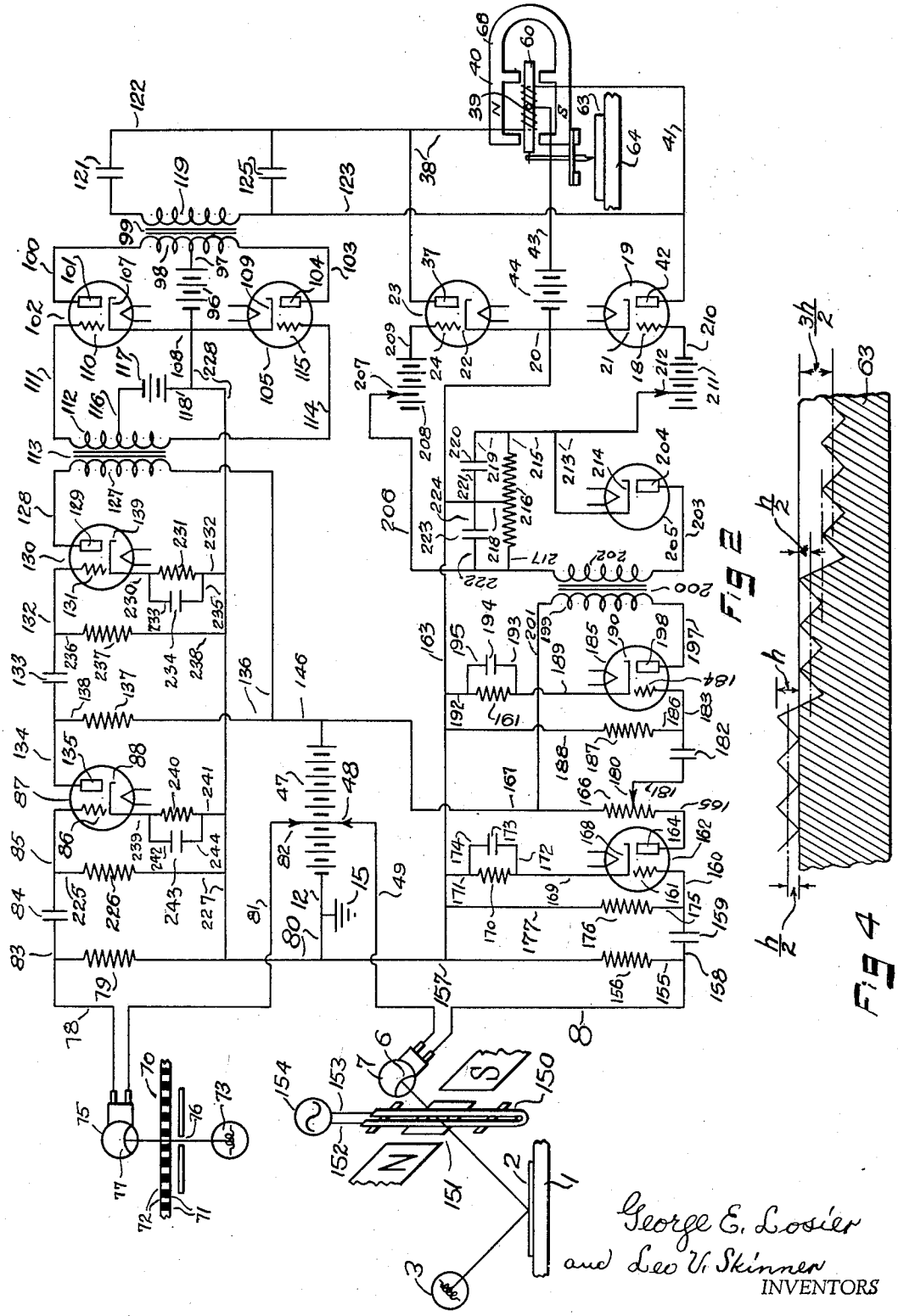


FIG 2

FIG 4

George E. Losier
and Leo V. Skinner
INVENTORS

BY

William A. Hughes
their ATTORNEY.

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2,312,042

ELECTRIC CIRCUIT FOR PHOTOELECTRIC ENGRAVING MACHINES

George E. Losier, Bloomfield, and Leo V. Skinner, Newark, N. J.

Application August 3, 1940, Serial No. 350,428

2 Claims. (Cl. 178—6.6)

The present invention relates to an electrical system for a photo-electric half-tone engraving machine of the type shown and described in Losier Patents No. 2,092,764 and 2,092,765 and to the method of operating such a machine with an electrical system shown and described herein to illustrate the present invention.

Reference is hereby made to said patents, Numbers 2,092,764 and 2,092,765 for a showing and description of a photo-electric half-tone engraving machine suitable for use in the practice of the present invention, including a cutting head which is described generally herein, reference being made also to said patents for specific disclosures of the cutting head generally described.

An object of the present invention is to provide an electrical system for a photo-electric half-tone engraving machine, which electrical system comprises two separate sources of power, one source of power for operating the cutting tool with a constant length of its reciprocating strokes whatever the depth of its entrance into the material being cut (whether for light, intermediate or dark shades of reproduction), and the other source of power for changing the mean point of the reciprocating strokes in accordance with the depth of the tools entry into the material being cut as the various tones of light and shade are being reproduced.

Reference is hereby made to Patent Number 2,032,541 issued March 3, 1936, to applicant Losier for a description of a half-tone printing plate such as can be cut with the machine and apparatus of the present invention.

In the accompanying drawings, showing illustrative embodiments of the power circuits of the present invention,

Figure 1 is a diagrammatical view showing one embodiment of the power circuits of the present invention, with certain directly cooperative parts from the disclosure in said U. S. Patent Number 2,092,764 shown in part and by diagrammatic representation;

Figure 2 is a diagrammatical view, similar to that of Figure 1, but showing an alternate embodiment of that part of the circuit which varies the mean position of the cutting stroke;

Figure 3 is a diagrammatic view showing an alternate embodiment of means shown in Figure 1 for generating an alternating current which, when amplified, produces constant length stroke of the cutting tool;

Figure 4 is a vertical sectional view of a half-tone printing plate indicating somewhat diagrammatically the substantially uniform length of the stroke of the cutting tool at different depths of cut and for strokes in which the tool does not enter the metal.

Referring now to Figure 1 of the drawings, the picture carrier 1 (corresponding to picture carrier 14 of Fig. 1 in said Patent Number 2,092,765) carries a picture 2 to be reproduced. A light beam from a constant source of light 3 illuminates said picture 2 and, by reflection from said picture 2, passes through a lens system (not shown) where it concentrates and from which it passes to a light stop 4 having a small opening 5. A very small portion of said light beam passes through said opening 5 and to the cathode 6 of a photo-electric cell 7. A lead 8 from said cathode 6 of said photo-electric cell 7 connects to one side of a resistor 9, the other side of which latter connects by a lead 10 to the negative side of a battery 11 the positive side of which latter connects through a lead 12 to the cathode 13 of an amplifying tube 14, with a connection to ground 15 on said lead 12 between said battery 11 and said cathode 13. The plate 16 of said amplifying tube 14 connects through a lead 17 to the grid 18 of the power tube 19. A lead 20 connects from the cathode 21 of said power tube 19 to the cathode 22 of the power tube 23. The grid 24 of said power tube 23 connects through lead 25 to the plate 26 of the amplifying tube 27, and a lead 28 connects the cathode 29 of said amplifying tube 27 to said lead 12. The grid 31 of said amplifying tube 14 connects through a lead 32 to said lead 8.

A lead 33 connects said lead 17 to one end of a resistor 34, the other end of which latter connects through a lead 35 then through a resistor 36 to said lead 25.

The plate 37 of said power tube 23 connects through a lead 38 to one end of the fixed armature coil 39 of the cutting head 40, and the other end of said armature coil 39 connects through a lead 41 to the plate 42 of said power tube 19. The mid-point of said armature coil 39 connects through a lead 43 to the positive side of a battery 44, the negative side of which connects to said lead 20.

A lead 45 connects said lead 20 to an adjustable contact 46 on a bank of batteries 47 and another adjustable contact 48 on said bank of batteries 47 connects by way of lead 49 to the anode (not shown) of said photo-electric cell 7.

The grid 50 of said amplifying tube 27 connects to the negative side of a battery 51, the positive side of which connects to an adjustable

contact 52 on said resistor 34 between the said ends thereof to which said leads 33 and 35 connect.

A lead 53 connects said lead 35 to the positive end of said bank of batteries 47, and a lead 54 connects the negative end of said bank of batteries 47 to said ground 15.

An oscillatory armature 60, mounted within said stationary armature coil 39, carries at one side of the axis thereof a bar 61 which carries at its outer end a cutting tool 62, mounted in operating relation to a plate 63 (to be cut) which is detachably fixed to and movable with the plate carrier 64. A flexible diaphragm 65, fixed at points about its center, is fixed to said bar 61 near the latter's outer end and holds said cutting tool 62 for movement in a straight line substantially vertically with respect to the surface of said plate 63 while said surface is being cut into. A permanent magnet 66 diagrammatically shown, through its two pairs of poles 67, 67 and 68, 68, provides a field which passes through said armature 60. Said cutting tool 62 is a V-shaped tool such as is described in said Losier Patent 2,032,541 to which reference is hereby made for a detailed description of said cutting tool 62 hereof (cutting tool 10 in the drawing and description of said Losier Patent Number 2,032,541).

As described in said Patent Number 2,092,765 said picture carrier 1 and said plate carrier 64 are moved synchronously in reciprocating motion.

Said plate carrier 64 carries a transparent film 70 which has opaque lines 71, 71 thereon which extend at right angles to the line of movement of said film 70 with said plate carrier 64. Said opaque lines 71, 71 are of accurate uniform width and are accurately spaced apart at a uniform distance equal to their width whereby there are left between them transparent lines 72, 72 of accurate, uniform width, accurately and uniformly spaced apart from each other by said opaque strips 71, 71. The width of each of said opaque lines 71, 71 and of transparent lines 72, 72 is accurately predetermined and made to be equal to the distance between the centers of the "dots" or printing areas of the half-tone reproduction to be cut on said plate 63.

Mounted at one side of said transparent film 70 is a fixed constant source of light 73 and on the opposite side of said transparent film 70 is a fixed photo-electric cell 75 in operative relation to receive light through said transparent film 70 from said source 73, with a fixed light unit 76 parallel to said lines 71, 72 and between them and said source of light 73 and of predetermined size to admit a light beam at said transparent film 70 of a width equal to the width of said lines 71, 72.

The cathode 77 of said photo-electric cell 75 connects through a lead 78 to one side of a resistor 79 the other side of which latter connects through a lead 80 to said lead 12 and thereby to said ground 15 and through said lead 54 to the negative end of said bank of batteries 47. The anode (not shown) of said photo-electric cell 75 connects through lead 81 to an adjustable contact 82 on said bank of batteries 47.

A lead 83 from said lead 78 connects to one side of a condenser 84 and a lead 85 connects from the other side of said condenser 84 to a grid 86 of an amplifying tube 87. The cathode 88 of said amplifying tube 87 connects through a lead 89 to said lead 54 and thereby to said ground 15. A lead 90 from said lead 85 connects through a resistor 91 and thence through lead 92 to the negative side of a battery 93, the positive side of which connects through a lead 94 to said lead 12 to said ground 15.

It is to be noted that all leads connecting to said lead 12 connect both to said ground 15 and to the negative end of said bank of batteries 47.

A lead 95 from said lead 89 connects to the negative end of a battery 96, the positive end of which connects through the lead 97 to mid-point of the primary coil 98 of the output transformer 99. One end of said primary coil 98 connects through the lead 100 to the plate 101 of the power amplifying tube 102. The other end of said primary coil 98 connects through the lead 103 to the plate 104 of the power amplifying tube 105. Lead 106 connects the cathode 107 of said power amplifying tube 102 to said lead 95 and lead 108 connects the cathode 109 of said amplifying power tube 105 to said lead 95. The grid 110 of said power tube 102 connects through lead 111 to one end of the secondary coil 112 of the transformer 113, the other end of said secondary coil 112 connects through the lead 114 to a grid 115 in said power tube 105. A lead 116 connects from the mid-point of said secondary coil 112 to the negative end of the battery 117, the positive end of which connects through the lead 118 to said lead 95.

It can be seen that said transformer 113, battery 117, power tubes 102 and 105 and transformer 99 are connected in push-pull relation, the purpose of which will be hereinafter described.

One end of the secondary coil 119 of said transformer 99 connects through the lead 120, to one side of the condenser 121, the opposite side of which connects through the lead 122 to said lead 38. The other end of said transformer secondary 119 connects through the lead 123 to said lead 41. A lead 124 connects from said lead 123 to one side of a condenser 125 the other side of which connects through the lead 126 to said lead 122.

One end of the primary coil 127 of said transformer 113 connects through the lead 128 to the plate 129 of the amplifying tube 130, the grid 131 of which connects through the lead 132 to one side of a condenser 133 the other side of which connects through the lead 134 to the plate 135 of said amplifying tube 87. The other side of said primary coil 127 connects through the lead 136 to one side of a resistor 137, the other side of which connects through the lead 138 to said lead 134. The cathode 139 in said amplifying tube 130 connects through lead 140 to said lead 95. The lead 141 connects said lead 95 to the positive side of a battery 142, the negative side of which connects through the lead 143 to one end of a resistor 144, the opposite end of which connects through lead 145 to said lead 132. A lead 146 connects said lead 136 to said lead 53 and thereby to the positive side of said battery 47.

Each of said tubes 14, 19, 23, 27, 87, 102, 105 and 130 have heating filaments conventionally shown but not numbered.

Referring now to Figure 2 of the drawings, there is shown an alternative form of scanning system and amplifying circuit therefor. There is shown in Figure 2 the picture carrier 1, picture 2, constant light source 3, photo-electric cell 7 and cutting head 40 of Figure 1 together with said photo-electric cell 77, said transformer 113 and said transformer 99 with the circuit therebetween for producing the regularly timed cut-

ting stroke of said cutting head 40 somewhat as shown in Figure 1 but somewhat structurally modified as hereinafter described. Said armature coil 39 of said cutting head 40 is connected to said battery 44 and said power tubes 19 and 23 in push-pull relation as in Figure 1. But it is to be understood that either timing circuit (that of Fig. 1 or of Fig. 2) can be used with either of the scanning circuits (Fig. 1 or Fig. 2).

In Figure 2 the ends of a metallic ribbon loop 150 of a light valve 151, mounted between said picture 2 and said photo-electric cell 7, and connected respectively by the leads 152, 153 to the terminals of the alternating current generator 154 so that when current from the latter passes through said metallic ribbon loop 150 the latter opens and closes in regular timed movement, synchronous with the current from said generator 154, so that when said current is at a maximum in one direction the loop is closed and shuts off the light from said constant source 3 and when said current is at a maximum in the opposite direction said metallic ribbon loop 150 is open to a maximum position and lets a maximum amount of light, reflected by a scanned point on said picture 2, pass from said constant source 3 to said photo-electric cell 7. Between the maximum open position of said metallic ribbon loop 150 and its closed position the resistance of said photo electric cell 7 varies with a pulsating characteristic. When a dark portion of said picture 2 is being scanned said pulsating characteristic will have a very small amplitude, and when a high-light portion of said picture 2 is being scanned said pulsating characteristic will have a much greater amplitude. The effect of this variation is characteristic on said cutting head 66 will be hereinafter described. Also for purposes hereinafter described the current from said alternating current generator 154 is of a frequency several unit multiples of the frequency of the regularly timed cutting stroke circuit described above for Figure 1 and hereinafter described for Figure 2 in a somewhat modified alternate form. Said alternative current generator 154 can be a vacuum tube oscillator or a rotating armature generator or other equivalent and in Figure 2 is conventionally shown.

As in the circuit of Figure 1, said lead 49 connects the anode (not shown) of said photo-electric cell 7 to said adjustable contact 48 on said battery 47. Said lead 8 connects said cathode 6, through lead 155, to one end of a resistor 156, the other end of which connects through the lead 157 to said lead 80 and thereby to said ground 15 and to the grounded side of said battery 47. Said lead 8 also connects through a lead 158 to one side of a condenser 159 the other side of which connects through a lead 160 to the grid 161 of the amplifying tube 162. A lead 163 connects said lead 157 to said lead 20 and to the negative side of said battery 44. The plate 164 of said amplifying tube 162 connects through a lead 165 to one side of a resistor 166 the other side of which connects through a lead 167 to the positive side of said battery 47. The cathode 168 of said amplifying tube 162 connects through lead 169 to one side of a resistor 170, the other side of which connects through lead 171 to said lead 163. A lead 172 connects one end of said resistor 170 to one side of a condenser 173, the other side of which connects through a lead 174 to the other side of said resistor 170.

A lead 175 connects from said lead 160 to one side of a resistor 176 the other side of which connects through a lead 177 to said lead 163.

An adjustable contact 180 on said resistor 166 connects through a lead 181 to one side of a condenser 182, the other side of which connects through a lead 183 to the grid 184 of the amplifying tube 185. A lead 186 connects said lead 183 to one side of the resistor 187, the other side of which connects through the lead 188 to said lead 163. A lead 189 connects the cathode 190 of said amplifying tube 185 to one side of a resistor 191, the other side of which connects through a lead 192 to said lead 163. A lead 193 connects from one side of said resistor 191 to one side of a condenser 194 the other side of which connects through a lead 195 to the other side of said resistor 191.

A lead 197 connects the plate 198 of said amplifying tube 185 to the one end of primary coil 199 of the transformer 200 the other end of which connects through the lead 201 to said lead 167.

One end of the secondary coil 202 of said transformer 200 connects through a lead 203 to the plate 204 of the detector tube 205, and the other end of said secondary coil 202 connects through a lead 206 to an adjustable contact 207 on a battery 208, the positive side of which connects through a lead 209 to said grid 24 of said power tube 23. The said grid 18 of said power tube 19 connects through a lead 210 to the negative side of a battery 211 and an adjustable contact 212 on said battery 211 connects through a lead 213 to the cathode 214 of said detector tube 205. As in Figure 1, said lead 20 connects said cathode 21 of said power tube 19 to said cathode 22 of said power tube 23.

A lead 215 connects said lead 213 to one end of a resistor 216 the other end of which connects through a lead 217 to said lead 206. A lead 218 connects the mid-point of said resistor 216 to said lead 163. A lead 219 connects said lead 215 to one side of a condenser 220, the other side of which connects through the lead 221 to said lead 218. A lead 222 connects said lead 206 to one side of a condenser 223, the other side of which connects through a lead 224 to said lead 218.

As in Figure 1, said plates 37 and 42, of said power tube 23 and 19, respectively connect through leads 38 and 41, respectively, to opposite ends of said armature coil 39, and said lead 43 connects the mid-point of said armature coil 39 to the positive end of said battery 44.

Also as in Figure 1, said cathode 77 of said photo-electric cell 75 connects successively through said lead 78, resistor 79 and lead 80 to said ground 15 and said lead 81 connects said anode (not shown) of photo-electric cell 75 to said adjustable contact 82 on said battery 47. Said lead 78 connects successively through lead 83, condenser 84 and lead 85 to said grid 86 of said amplifying tube 87.

A lead 225 connects from said lead 85 to one side of a resistor 226 the other side of which connects through a lead 227 to said lead 80. A lead 228 connects said lead 227 to the negative side of said battery 96, the positive side of which connects through the lead 97 to the mid-point of said primary coil 98 of said transformer 99. Said lead 100 connects one side of said primary coil 98 to said plate 101 of said power tube 102 and said lead 103 connects the other end of said primary coil 98 to said plate 104 of said power tube 105. Said lead 108 connects said cathode 107 of said power tube 102 to said cathode 109 of said

power tube 105, and, therebetween, connects to said lead 228.

Also as in Fig. 1 said lead 111 connects said grid 110 of said power tube 102 to one end of said secondary coil 112 of said transformer 113, the other end of which connects through said lead 114 to said grid 115 of said power tube 105. The said lead 116 connects the mid-point of said secondary coil 112 to the negative side of said battery 117, the positive side of which connects through lead 118 to said lead 228.

As in Fig. 1, said secondary coil 119 of said transformer 99 connects through said leads 122 and 123, respectively, to said leads 38 and 41, with said condensers 121 and 125 in series and in parallel, respectively. Said amplifying tube 130 is connected in series between one side of said primary coil 127 of said transformer 113, through said leads 128, 132 and 134, with said condenser 133 in series between said grid 131 of said amplifying tube 130 and said plate 135 of said amplifying tube 87. The other side of said primary coil 127 connects through said lead 136 to the positive end of said battery 47. Said resistor 137 and lead 138 are connected as shown in Fig. 1.

Said cathode 139 of said amplifying tube 130 connects successively through lead 230, resistor 231 and lead 232 to said lead 228, with lead 233, condenser 234 and lead 235 connecting successively from one side of said resistor 231 to the other side thereof.

Lead 236, resistor 237 and lead 238 connect successively from said lead 132 to said lead 228.

Said cathode 88 of said ampifying tube 87 connects successively through lead 239, resistor 240, and lead 241 to said lead 228, with lead 242, condenser 243 and lead 244 connecting successively from one side of said resistor 240 to the other side thereof.

As in the tubes of Figure 1, said tubes 162, 185, 205, 19, 23, 105, 102, 130 and 87 have heating filaments conventionally shown but not numbered and without showing the necessary source of heating current.

In Figure 3 is shown alternative means for producing a regularly varying current in the system connected to said leads 78 and 81, and this alternative means includes a rack 250 fixed to and movable with said plate carrier 64, a pinion 251 in operated engagement and relation to said rack 250, a shaft 252 which is driven by said pinion 251 and which drives a current generator 253 which produces a current similar to that supplied to said leads 78 and 81 in the system of Figure 1 as above described.

The following is a description of the use and operation of the apparatus of Figure 1 for scanning a picture and using an effect of the scanning operation to produce a machine cut half-tone printing plate.

Said plate 63, to be cut to make a half-tone printing plate, is placed on said plate carrier 64 and fixed thereon in a suitable manner not shown and said picture 2, to be reproduced, is fixedly mounted on said picture carrier 1 in a suitable manner not shown.

Said plate carrier 64 and said picture carrier 1 are set in synchronous reciprocating (or rotating) motion by means not shown herein but shown in said Patents Numbers 2,092,764 and 2,092,765 to which reference is hereby made.

With said plate carrier 64, said transparent film 70 will reciprocate between said fixed light slit 76 and said photo-electric cell 75 and interrupt the beam of light passing from said constant source of light 73 through said light slit 76 to said photo-electric cell 75, whereby the resistance of said photo-electric cell 75 is repeatedly and regularly varied between a minimum value and a maximum value. As a result of this regularly repeated variation in the resistance of said photo-electric cell 75, the current passing therethrough from said battery 47 by way of said leads 78, 80 and 81 and said resistor 79 will vary in a similar manner and the shape of the current-time curve or graph will be substantially saw-tooth.

It can be seen that a regularly varying current will be flowing through said resistor 79 and that there will be a voltage drop across the terminals of said resistor 79 whose value varies regularly and proportionally to the value of said current.

Now, said cathode 88, being heated by the tube filament, will supply a stream of electrons which are attracted to said plate 135 because of the latter's positive potential with respect to said cathode 88 as determined by the connection of said plate 135 through said resistor 137 to the positive side of said battery 47 and the connection of said cathode 88 to the negative side of said battery 47, as above described.

It will also be seen that battery 93 will produce a predetermined potential between said cathode 88 and said grid 86 in which said grid 86 is negative with respect to said cathode 88 and that the regularly repeated variations in the voltage drop across said resistor 79 will produce a proportional regularly and repeatedly varying voltage between each of the plates of said condenser 84 and said ground 15 with the result that there will be a regular variation in the voltage between said cathode 88 and said grid 86 and a consequent regular variation in the quantity of electrons flowing from said cathode 88 to said plate 135.

Said tube 87 being an amplifying tube, as above set forth, it will be seen that the regularly repeated voltage drop across resistor 79 will be reproduced and amplified in the voltage drop across said resistor 137. This voltage drop across said resistor 137 will produce a proportional regularly and repeatedly varying voltage between each condenser plate of said condenser 133 and said ground 15, with the result that there will be a regular variation in the voltage between said cathode 139 and said grid 131 and a consequent regular variation in the quantity of electrons flowing from said cathode 139 to said plate 129 of said amplifying tube 130. Said grid 131 is kept at a predetermined potential with respect to said cathode 139 by the voltage impressed by said battery 142 through said resistor 141.

Said tube 130 being an amplifying tube, as above set forth, it will be seen that the regularly repeated voltage drop across said resistor 137 will be reproduced and amplified in the voltage drop across said primary coil 127 of said transformer 113, said primary coil 127 being included in the circuit which comprises the said primary coil 127, said plate 129, said cathode 139, said battery 47 and the various leads completing said circuit.

It can be seen then that said voltage variations in said primary coil 127 will induce corresponding voltage variations between said lead 111 and said lead 114 of said secondary coil 112, one half of which, at any given instant, is between said lead 111 and said lead 116 and the other half of which is between said lead 116 and said

lead 114. Said battery 117 having its negative side connected to said lead 116 and its positive side connected to said lead 118, said grid 110 of said power amplifying tube 102 and said grid 115 of said power amplifying tube 105 will be kept at predetermined potential variations with respect to said cathode 107 and said cathode 109, respectively, because, when there is no voltage drop across said secondary coil 112, said battery 117 will place a fixed voltage between said grid 110 and said cathode 107 and between said grid 115 and said cathode 109.

Also, when there is no voltage drop across said secondary 112, said cathodes 107 and 109 being heated, the current from said battery 96 through said lead 97 will divide equally between the halves of said primary coil 98 of said transformer 99, but when there is a varying voltage drop across said secondary 112 the currents flowing through said halves of said primary coil 98 will vary in opposite relation so that when current in one half is increasing the current in the other half is decreasing, and vice versa, according to the phase of the voltage in said secondary coil 112, with the result that there will be produced a regularly varying voltage drop across said primary coil 98 which is an amplified reproduction of the varying voltage drop across said secondary coil 112 and of the varying voltage drop across said resistor 79. This varying voltage drop across said primary coil 98 is reproduced in said secondary coil 119 and transmitted to said armature coil 39 whereby said armature 60 is actuated on its axis with an oscillatory movement which is regularly timed with and by the interruptions by said transparent film 70 of the beam of light from said constant source 73 to said photo-electric cell 75, so that said cutting tool 62 is caused to have a regularly reciprocating stroke of constant length.

Said condenser 125 is of such a value that the circuit comprising said secondary coil 119, condenser 121, armature coil 39 and condenser 125 will be tuned to resonance with the regularly repeated variations in voltage drop across said secondary coil 119 and corresponding regularly repeated variations in current flow through said armature coil 39.

The function of said condenser 121 is to prevent any direct current from said battery 44 from passing through said secondary 120 of said transformer 99.

As hereinafter described, said cutting tool 62, during its movement with a regularly reciprocating stroke of constant length, is controlled so that the lower limit of its reciprocating stroke is varied in accordance with the lights and shades of a picture 2 being scanned on said picture carrier 1.

Said picture 2 being moved with a reciprocating motion synchronous with the motion of said plate 63 and said transparent film 70, the light passing from said constant source 3 to said cathode 6 will vary in accordance with the variations in light and shade of said picture 2 and thereby cause corresponding variations in the internal resistance of said photo-electric cell 7 and in turn cause variations in the amount of current flowing from said battery 47 through said resistor 9 and thereby variations in the voltage drop across said resistor 9 which are impressed between said grid 31 and cathode 13 of said amplifying tube 14. Said battery 11 keeps said grid 31 at the proper operating potential with respect to said cathode 13. Said variations in potential between said grid 31 and cathode 13 are reproduced and amplified in the voltage drop across said resistor 34 due to the current flowing from said battery 47 through said resistor 34, plate 16 and cathode 13. Said variations in potential across said resistor 34 are impressed between said grid 18 and cathode 21 of said power amplifying tube 19 and are reproduced and amplified in the current flowing from said battery 44 through one-half of said armature coil 39 and thence from said plate 42 to said cathode 21.

Said battery 51 keeps said grid 50 of said amplifying tube 27 at the proper operating potential with respect to said cathode 29 by overcoming the difference between the voltage drop in that part of said resistor 34 between said adjustable contact 52 and lead 35, caused by current flowing from said battery 47, plus the voltage of said battery 47, with an additional voltage sufficient to keep said tube 14 operating at its proper grid potential. The potential between said lead 35 and said adjustable contact 52 is a fraction of the total voltage across said resistor 34 and varies in accordance with variations in said total voltage across said resistor 34 and is impressed between said grid 50 and said cathode 29. The variations in voltage impressed between said grid 50 and cathode 29 are reproduced and amplified in the current flowing from said battery 47 through resistor 36 and said plate 26 to said cathode 29.

In a similar manner, the voltage drop across said resistor 36 is impressed between said grid 24 and cathode 22 of said power amplifying tube 23 and is predetermined to be equal at any instant to but opposite in phase to said voltage drop impressed between said grid 18 and said cathode 21 so that said power tubes 19 and 23 operate in push-pull relation.

Said picture 2, plate 63 and transparent film 70 being in synchronous motion, the regularly timed interruptions of light beam falling on said photo-electric cell 75 caused by said transparent film 70 will cause said armature 60 and said cutting tool 62 to have a regular up and down motion of a predetermined and constant amplitude or distance, and the variations of light and shade of said picture 2 will cause corresponding variations in the value or strength of the light passing from said constant source 3 to said photo-electric cell 7 and thereby will cause said armature 60 and said cutting tool 62 to have a varying up and down motion of amplitude or distance corresponding to the said variations in the light and shade of said picture 2. The resultant of said regular up and down motion and of said varying up and down motion of said cutting tool 62 is shown diagrammatically in Figure 4 of the drawings which shows the path taken by said cutting tool 62 in making cuts in a plate 63 when said picture 2 is being scanned. As indicated by Figure 4, said cutting tool 62 will have a regular up and down motion of a stroke of predetermined length and frequency (or speed) and at the same time will move further into or completely out of said plate 63 in accordance with the degrees of light and shade of said picture 2, whereby said plate 63 is fashioned or cut into a half-tone printing plate having a regular screen of predetermined distance between lines as described in said Losier Patent Number 2,032,541 to which reference is hereby made.

The operation of the apparatus shown in Figure 2 is similar to that of Figure 1 except that that part of the electrical system which is be-

tween said photo-electric cell 7 and said push-pull system which includes said power tubes 19 and 23 is arranged to do away with the aperiodic amplifying or direct coupling connections between the several stages of the amplification system and provides an independent and easier means for adjusting each stage of amplification. Said grid 161 of said tube 162 is kept at the correct bias with respect to said cathode 168 by means of said resistor 170 and by-pass condenser 173. Said resistor 166, through said adjustable contact 180 serves as a gain control for said tube 185. In like manner said resistor 191 and condenser 194 serve to keep said cathode 190 of said tube 185 at the correct bias with respect to said grid 184, and as the potential of said grid 184 varies a similar potential variation but of amplified magnitude is generated across said secondary coil 202 of said transformer 200 and the current from said secondary coil 202 is transmitted by means of said detector tube 205 to the push-pull system which includes said power tubes 19 and 23. Said batteries 208 and 211 and said resistor 166 are adjusted so that when a dark area is being scanned by said photoelectric cell 7 the current in said power tube 23 is at a maximum and the current in said tube 19 is at a minimum and when a light area is being scanned by said photoelectric cell 7 the current in said power tube 23 is at a minimum and the current in said power tube 19 is at a maximum. Since the plate current for said power tubes 19 and 23 is supplied by said battery 44 through said armature coil 39 the position of said armature 60 will be controlled by the lights and shades in the picture being scanned by said photoelectric cell 7, and any remaining carrier frequency current that is not eliminated by said condensers 220 and 223 will be by-passed around said armature coil 39 by said condenser 125.

Having thus described our invention, what we claim and desire to protect by Letters Patent is:

1. In apparatus for cutting screen-effect printing plates and having a cutting head comprising a tool holder, an armature in operative relation to move said tool holder and an electro-magnetic coil in operative relation to actuate said armature, a plate carrier in operative relation to the position of a tool in said tool-holder, and means for producing relative movement between said plate carrier and said cutting head, in combination, means comprising a photo-sensitive cell adapted to scan a picture to be reproduced and electrical connection from said photo-sensitive cell to said electro-magnetic coil including means for connection to a source of power whereby variations in the conductivity of said photo-sensitive cell can cause corresponding variations in an electric current passing through said electro-magnetic coil; means for producing synchronous relative movement between said plate carrier and said cutting head and between said scanning means and a picture to be scanned; and means for causing the oscillation of said armature and tool-holder at a regular rate of speed through a path of oscillation having a constant length comprising a second photo-sensitive cell, electrical connection from said second photo-sensitive cell to said electro-magnetic coil including means for connection to a source of current, and means, in operated relation to said means for producing synchronous relative movement, for producing repeated and regularly timed changes in the conductivity of said second photo-sensitive cell alternately between a predetermined higher value and a predetermined lower value.

2. In apparatus for cutting screen-effect printing plates and having a cutting head comprising a tool holder, an armature in operative relation to move said tool holder and an electro-magnetic coil in operative relation to actuate said armature, in combination means comprising a photo-sensitive cell adapted to scan a picture to be reproduced and electrical connection from said photo-sensitive cell to said electro-magnetic coil including means for connection to a source of power whereby variations in the conductivity of said photo-sensitive cell can cause corresponding variations in an electric current passing through said electro-magnetic coil and thereby to vary the position of said tool-holder; and means for causing the oscillation of said armature and tool-holder at a regular rate of speed through a path of oscillation having a constant length comprising a second photo-sensitive cell, electrical connections from said second photo-sensitive cell to said electro-magnetic coil including means for connection to a source of current, and means for producing repeated and regularly timed changes in the conductivity of said second photo-sensitive cell alternately between a predetermined higher value and a predetermined lower value.

GEORGE E. LOSIER.
LEO V. SKINNER.