Nov. 3, 1953 E. J. MAKER ET AL 2,657,613

PHOTOGRAPHIC PRINTING APPARATUS

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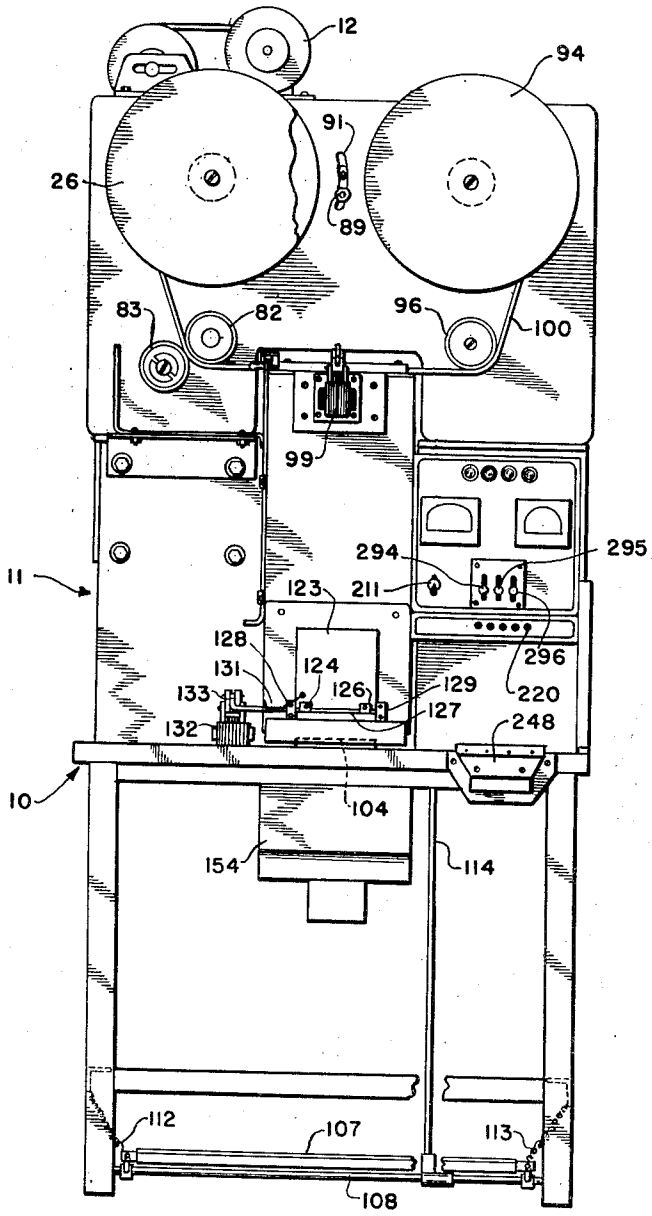


FIG. 1

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PHOTOGRAPHIC PRINTING APPARATUS

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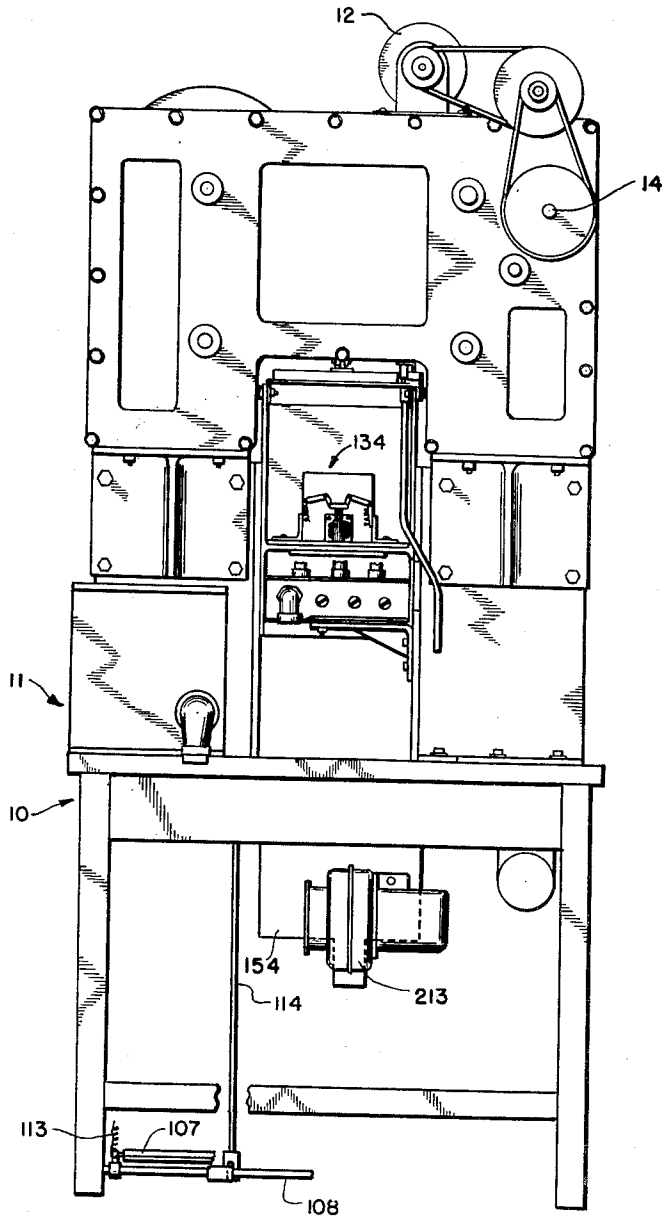


FIG. 2

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PHOTOGRAPHIC PRINTING APPARATUS

Filed Jan. 29, 1947 8 Sheets-Sheet 3

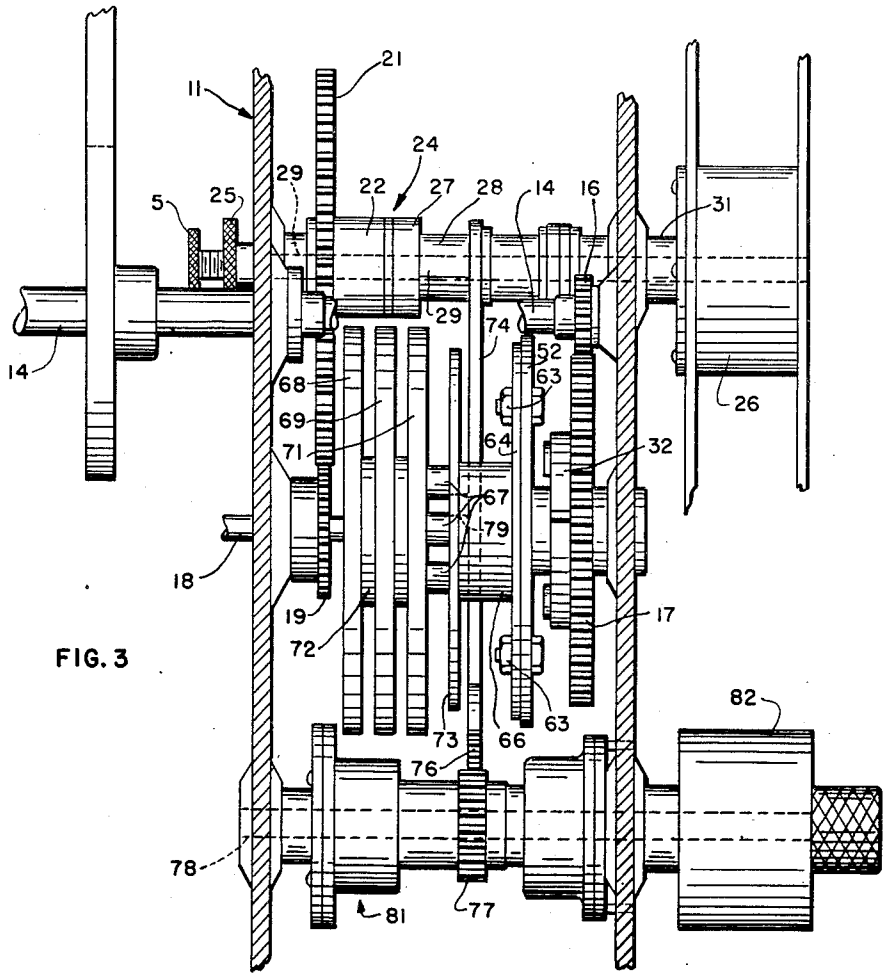


FIG. 3

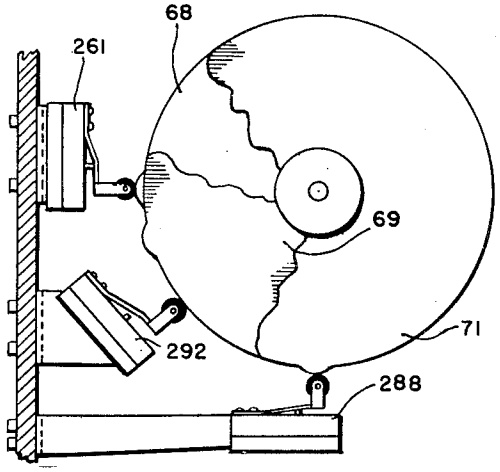


FIG. 4

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PHOTOGRAPHIC PRINTING APPARATUS

Filed Jan. 29, 1947 8 Sheets-Sheet 4

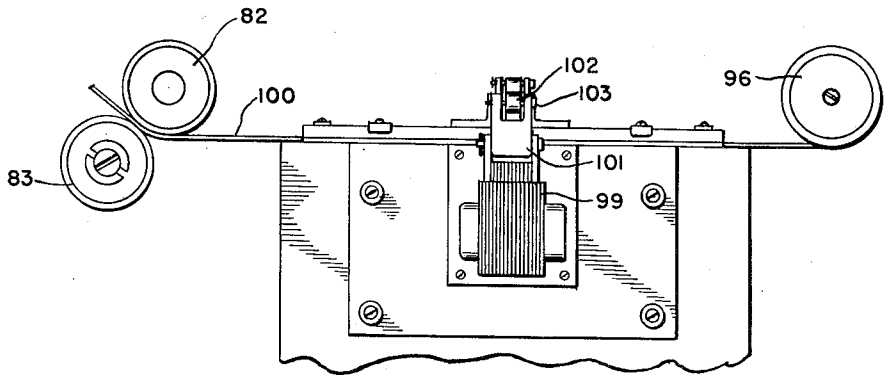


FIG. 5

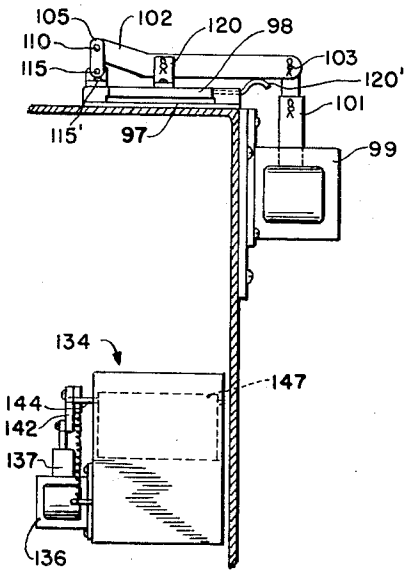


FIG. 6

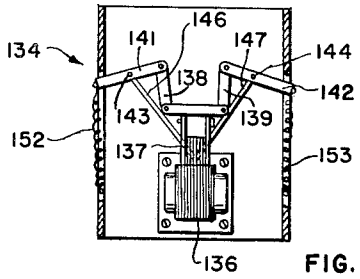


FIG. 7

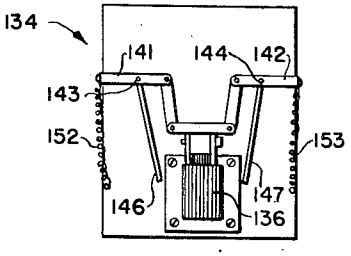


FIG. 8

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PHOTOGRAPHIC PRINTING APPARATUS

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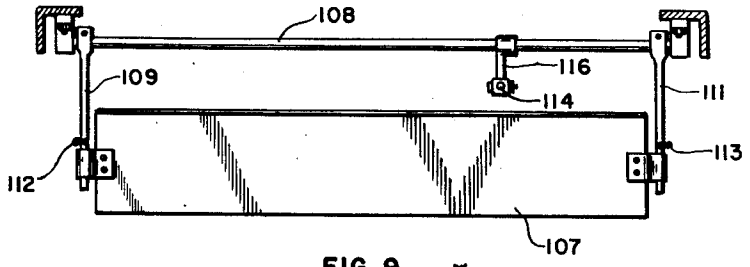


FIG. 9

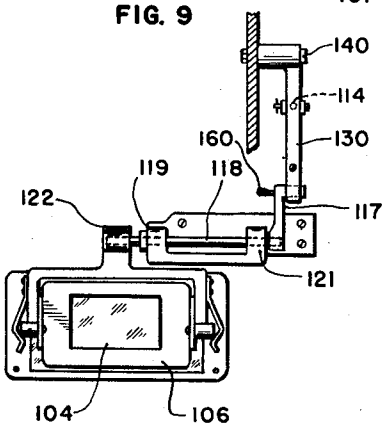


FIG. 10

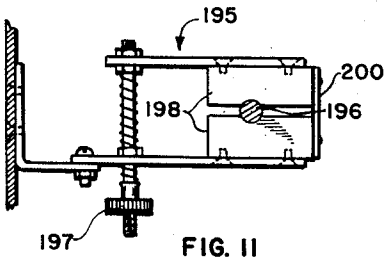


FIG. 11

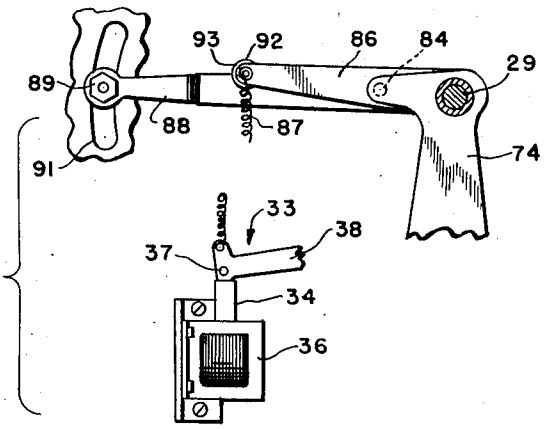


FIG. 12

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PHOTOGRAPHIC PRINTING APPARATUS

Filed Jan. 29, 1947 8 Sheets-Sheet 6

FIG. 15

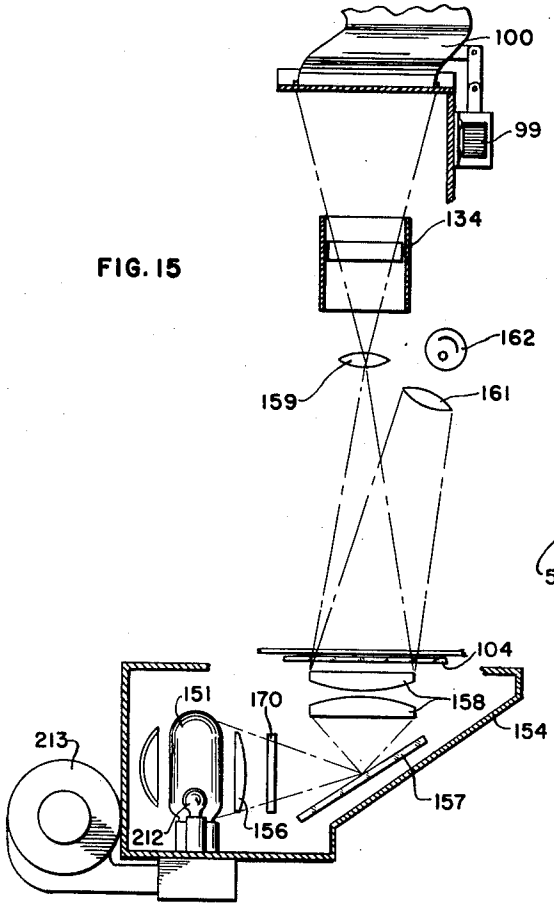


FIG. 19

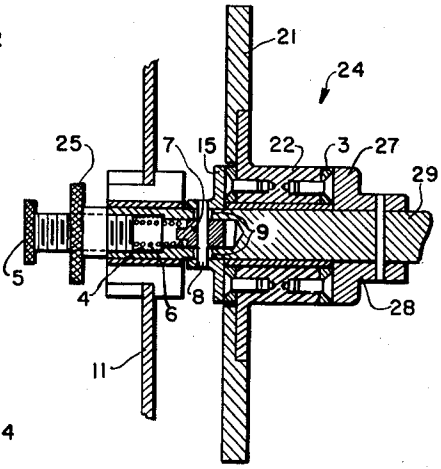


FIG. 13

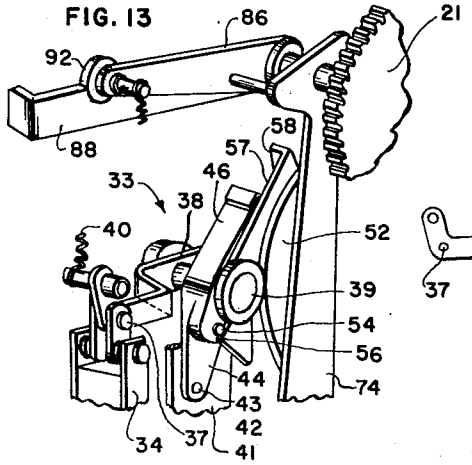
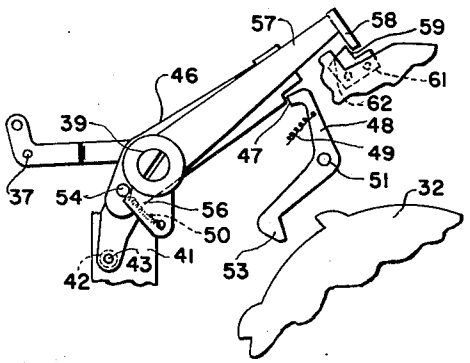


FIG. 14



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PHOTOGRAPHIC PRINTING APPARATUS

Filed Jan. 29, 1947 8 Sheets-Sheet 7

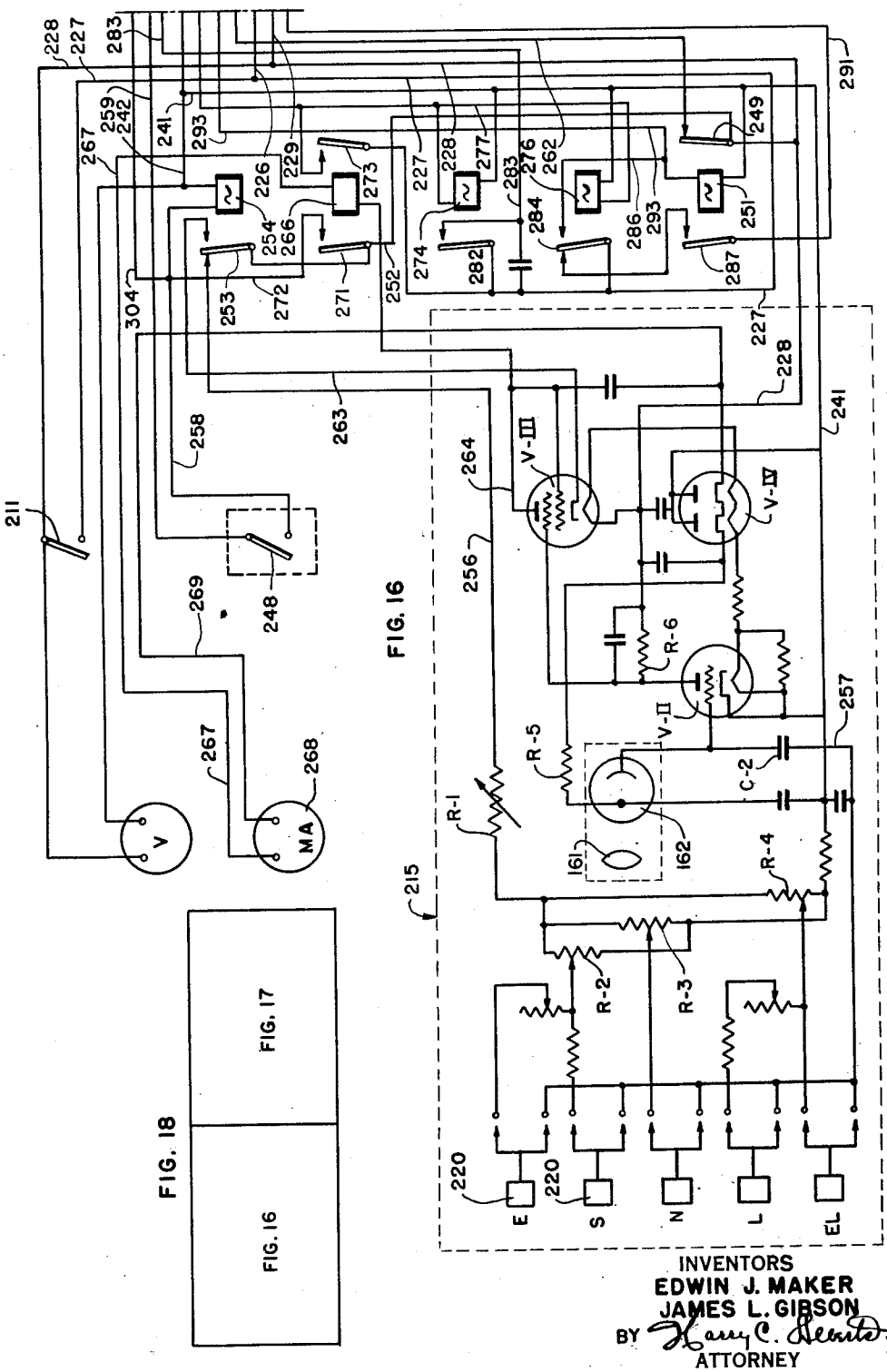


FIG. 16

FIG. 18

FIG. 17

FIG. 16

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PHOTOGRAPHIC PRINTING APPARATUS

Filed Jan. 29, 1947 8 Sheets-Sheet 8

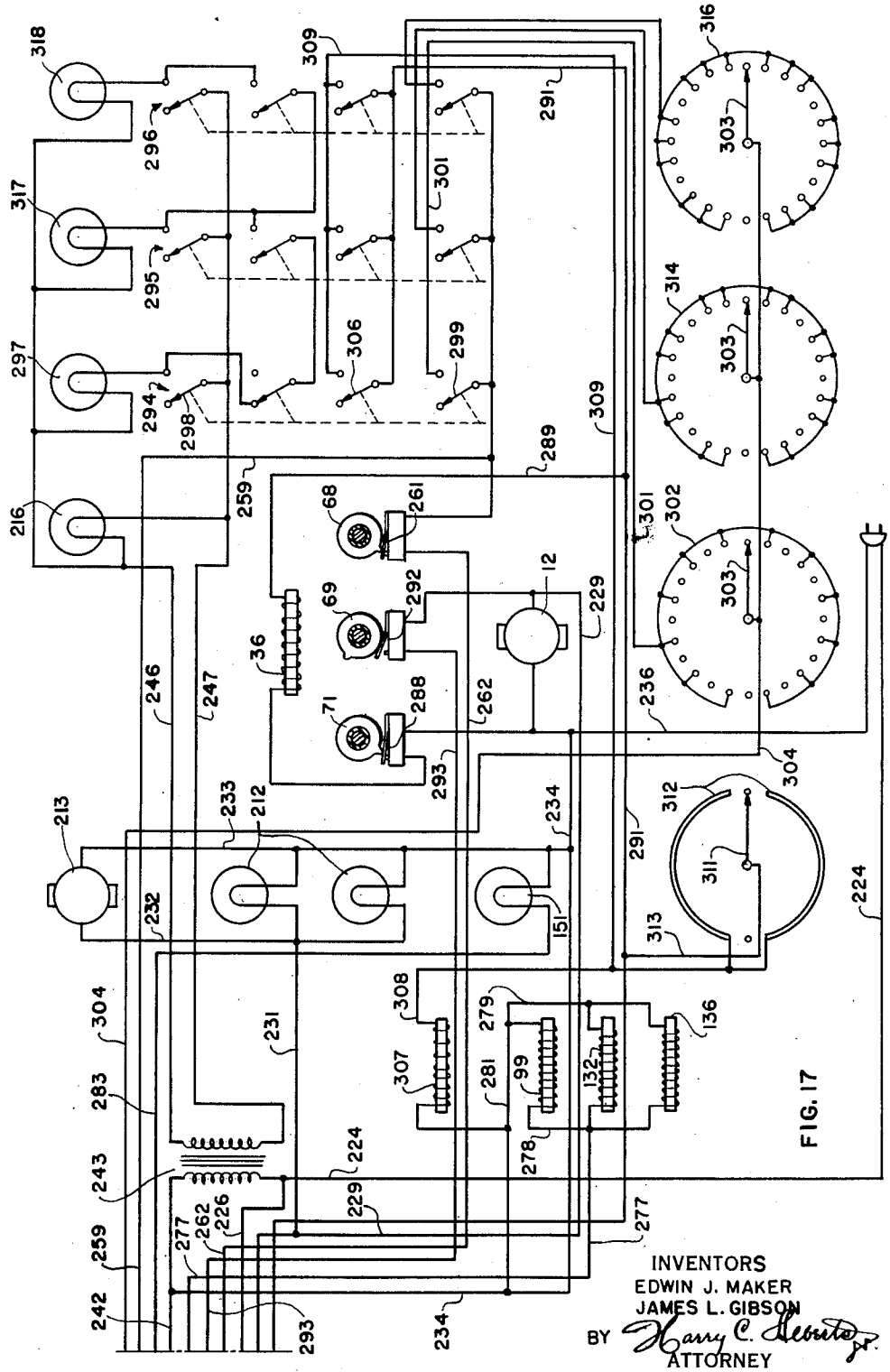


FIG. 17

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Patented Nov. 3, 1953

2,657,613

UNITED STATES PATENT OFFICE

2,657,613

PHOTOGRAPHIC PRINTING APPARATUS

Edwin J. Maker and James L. Gibson, Chicago, Ill., assignors to Walgreen Co., Chicago, Ill., a corporation of Illinois

Application January 29, 1947, Serial No. 725,049

5 Claims. (Cl. 88—24)

1

This invention relates to photography and particularly to a photographic printing apparatus for automatically making prints from negatives, although certain features thereof may be employed with equal advantage for other purposes.

It contemplates more especially the provision of an improved and more efficiently operated photographic printing apparatus wherein properly exposed prints may be reproduced from negatives on a high production basis.

In the photographic art it is customary, in making prints from negatives, to use a grade of contrast paper which is consistent with the type of negative from which a print is to be made. For example, if the negative to be printed is flat or weak, a relatively hard grade of paper is used for printing and, conversely, if the negative is hard or "contrasty," a relatively soft grade of paper is used for printing. By the present invention it is proposed to provide a photographic printing apparatus equipped with an electrically controlled means which includes a plurality of resistance control circuits as representative of a difference in the relationship between the principal subject and the average mean density of the background. The resistance control circuits are in reality a series of electrical paths or branches which are part of a main circuit, one of which may be chosen for operation. More specifically, each of said resistance control circuits would be provided with a switch, selectable by the judgment of an operator and indicative of the relationship between the principal subject and the background and for the purposes of control, these electronic circuits having arbitrarily been divided into five exposure control groups; namely, extra short, short, normal, long and extra long. The operation of a chosen control switch selects the resistance circuit most desirable for the negative being printed and thereby establishes an initial control for the time of printing exposure. But the time of printing exposure is controlled by the average light transmission characteristics of the negative itself. With the arrangement just outlined above, only a single grade of paper is employed for printing purposes, compensation for principal subject area relationship to background of the negative being made by the electrical control means mentioned above.

One object of the present invention is to provide a photographic printing apparatus for automatically making prints from negatives.

Another object of the invention is to provide in an automatic printing apparatus a plurality of controls, one of which may be selected for operation dependent upon the light transmission characteristics of the negative from which a print is to be made.

2

Still another object of the invention is to provide in a photographic printing apparatus a plurality of control means for establishing an initial control for the time of printing exposure, one of which may be selected for operation dependent upon the light transmission characteristics of the negative to be printed, and further control means directly responsive to the light transmission characteristics of the negative itself for finally determining the time of printing exposure.

An additional object of the present invention is to provide in a photographic printing apparatus means for obtaining an integration of the light transmission characteristics of a negative and utilizing said integration to control the time of printing exposure.

A further object of the invention is the use of an out-of-focus image of a negative as a timing control medium for print exposure.

A still further object of the invention is to provide in a photographic printing apparatus, means for automatically reproducing a predetermined number of positive prints.

Still a further object of the invention is to provide in a photographic printing apparatus an adjustable feed means for feeding a predetermined length of printing paper.

An additional object of this invention is to provide a photographic apparatus which integrates the negative and determines the proper exposure, electronically, and at the completion of the exposure cycle, automatically and electronically cuts off the printing light and engages the necessary mechanism for advancing the photo paper a predetermined amount necessary for additional prints, and at the completion of the feeding of the photo paper, resets the electronic timer preparatory for the next exposure.

A further object of this invention is to provide electronically controlled means for interlocking the mechanical and electrical operations in such a fashion that double exposures on a single sheet of printing paper are impossible.

Another object of this invention is to provide an electro-mechanical control means for a photographic printing apparatus operable by switch means which initiate an exposure operation, automatically terminates the period of print exposure, and feeds a new section of print paper into printing position.

A still further object of this invention is to provide suitable adjustments for presetting the timer control elements to produce comparable results on photo paper of different exposure time characteristics.

Other objects, features and advantages, while not specifically set out above, will appear as the invention is described in detail.

As previously mentioned, the photographic printing apparatus is equipped with a plurality of control circuits selectable according to the transmission characteristics of a negative being printed at a particular time. These resistance control circuits are associated with a capacitor whose discharge rate determines the time of printing exposure. Prior to the selection of a particular circuit, the operator judges the transmission characteristics of the negative by placing the negative over a judging glass. A proper control switch is then depressed which is effective in conditioning the chosen circuit for operation. An alternating current control relay is first operated by manually depressing the operating switch and its operation enables a direct current relay to be operated by means of an electronic circuit. Operation of the direct current relay provides a locking circuit for the control relay and operates a printing light relay and transfer relay. In addition thereto, operation of the direct current relay is effective in causing the energization of a solenoid which operates a platen to hold the printing paper in a fixed position during the exposure period. A judging shutter solenoid is also under the control of the direct current relay and insures the closing of the judging shutter prior to the operation of the printing light in order to prevent glare in the eyes of the operator. Further, the direct current relay controls the operation of the printing light which is situated in a compartment under the table of the machine and this light is transmitted by an optical system and suitable mirrors through the negative by another optical system, whereby the enlarged image of the negative is projected on the sensitive surface of the photo paper. Further, the direct current relay controls the operation of a light shutter interposed between the projection lens and the sensitive paper, opening this shutter at the same instant the light is turned on to maximum brilliance. Operation of the transfer relay effects the operation of a clutch control relay. The clutch, however, does not operate until the termination of the exposure period.

When the operating switch is depressed, it closes a predetermined resistance circuit and places it in circuit across a condenser which at this time becomes charged. Above and off center from the main light rays passing through the negative is a lense so positioned that it picks up an image of the negative to be printed and projects an out-of-focus image on the cathode of a photo-electric cell with which it is associated. The result of this positioning of the lens is the throwing of an out-of-focus image upon the cathode which is an integration of the light conducting characteristics of the negative. The advantage of this out-of-focus image is important since it causes a blending together of the light transmitting characteristics of various parts of the negative. On the other hand, if the lens where in focus, a sharp image would impinge upon the light sensitive cell and negatives having areas of lesser density than other areas, such areas being capable of transmitting greater quantities of light, could impinge upon a portion of the cathode whose sensitivity to light would be conceivably more sensitive than other sections of the cathode, thus providing an unreliable control medium. The control medium thus obtained is utilized in the final determination of the time of printing exposure. The cathode of the photocell becomes conductive in proportion to the intensity of the light as determined by the aforementioned integration which, in turn, determines the discharge rate of the capacitor previously identified, over the selected resistance circuit.

Discharge of the condenser operates suitable control means which extinguish the printing light, release the platen, close the light shutter and open the judging shutter. It further enables the operation of a single revolution clutch associated with a mechanical photo paper feed mechanism. Means are also provided for automatically reproducing a predetermined number of prints by causing a recycle of operations according to the number of prints desired.

The invention may be more readily comprehended by reference to the detailed description which follows when read in conjunction with the drawings in which:

Figure 1 is a front elevational view of the printing apparatus,

Figure 2 is a rear elevational view of the photographic printing apparatus,

Figure 3 is an enlarged detailed left end view of the main operating mechanisms of the apparatus,

Figure 4 is an enlarged detailed view of the cam switches utilized in the present invention,

Figure 5 is an enlarged detailed plan view of the platen for holding the printing paper,

Figure 6 is a left end view showing the platen and the light shutter,

Figures 7 and 8 are detailed views of the light shutter showing the closed and open positions, respectively,

Figure 9 is a detailed plan view of the treadle used for operating the negative holding mask.

Figure 10 is a detailed plan view illustrating particularly the negative holding mask,

Figure 11 is a detailed view of the drag brake used in conjunction with the printing paper supply reel,

Figure 12 is a detailed view showing portions of the adjustable paper feed and the clutch operating mechanisms.

Figure 13 is a fragmentary perspective view of the single revolution clutch used in the present invention,

Figure 14 is a detailed view of a portion of the clutch mechanism,

Figure 15 is a schematic illustration of the light projection system used in the present invention,

Figures 16 and 17 are circuit diagrams of the proposed invention.

Figure 18 shows the arrangement of the circuit comprising Figures 16 and 17,

Figure 19 is a detailed view of the friction clutch adjusting mechanism.

Referring now to the drawings, the invention will be described in detail. In Figure 1, numeral 10 represents a stand upon which is mounted a vertically extending framework or housing which is indicated generally at 11. On top of the frame (as best illustrated in Figure 2) is mounted a motor 12 which, by means of a suitable belt and pulley arrangement, drives shaft 14 in a clockwise direction, as shown in the same view. Shaft 14 carries at its front end (as best shown in Figure 3) driving gear 16, which drives the large gear 17 fast to shaft 18. To the rear of shaft 18 is attached a gear 19 which is in mesh with the large gear 21 and drives the latter gear in a counterclockwise direction, as viewed from the front of the machine. Gear 21, by means of its hub 22, is rotatable about shaft 29 and through the instrumentality of a friction slip clutch 24,

drives the paper take up reel 26. This is accomplished as the friction clutch 24 drives the collar 27, whose reduced portion 28 is attached to shaft 29, to the other end of which is connected, by means of hub 31, the take up reel 26.

In Figure 19 is shown a clutch adjusting mechanism for the friction clutch 24 for varying the friction between friction plate 3 and collar 27. Shaft 29 is internally threaded at 4 and receives the adjusting screw 5 which presses against coil spring 6. Coil spring 6 in turn presses against slide 7 which carries a pin 8 which moves in the diametrically opposite slots 9 of shaft 29. The ends of pin 8 are made fast to collar 15 which moves with gear 21 and hub 22. It is apparent then, that by turning the adjusting screw 5, the pressure between plate 3 and collar 27 may be varied and screw 5 may be held in adjusted position by a lock nut 25.

Carried on shaft 18 near the front of the apparatus is a ratchet wheel 32 which constitutes the driving part of a clutch indicated generally as 33 in Figures 12, 13 and 14. The clutch 33 is controlled from the plunger 34 of clutch solenoid 36. Pivotally attached to the plunger 34 at 37 is a bell crank lever 38 which, in turn, is movable about the pivot 39. The downwardly extending arm 41 of the bell crank lever 33 is provided with a slot 42 near its lower end, through which projects a pin 43, carried by the lower arm 44 of clutch stop lever 46, which is also pivoted at 39. A shoulder 47 formed at the free end of the clutch stop lever 46 is normally positioned (in the rest position of the clutch) to hold a latch pawl 48 in a clockwise position against the action of retractile spring 49. The latch pawl 48 is mounted at 51 on the relatively large circular plate 52 and the foregoing action of stop lever 46 on the latch pawl 48 is effective in maintaining the hooked shaped portion 53 out of engagement with the constantly rotating ratchet 32 previously identified. The stop lever 46 carries a pin 54, designed to engage the shoulder 56 of latching lever 57, which is also pivoted on the axis 39 and connected to lever 46 by spring 50. Latching lever 57 includes a hooked end 58 normally in engagement with shoulder 59 of block 61 which is secured to the plate 52. The purpose of latching lever 57 is to constrain plate 52 from clockwise rotation.

It can now be seen that, as the plunger 34 moves downwardly upon the energization of solenoid 36, bell crank lever 38 is pivoted in a counterclockwise direction. This causes the slot 42 to engage the pin 43 of stop lever 46, rotating the stop lever 46 likewise in a counterclockwise direction and removing the shoulder 47 from blocking engagement with the pawl 48, which is now free to pivot at 51 in a counterclockwise direction under the influence of spring 49 to cause its hooked end 53 to engage the next passing tooth of ratchet 32. The just described action causes the rotation of the plate 52 and its assemblage. It further can be seen that as stop lever 46 moves counterclockwise, its pin 54 will have engaged shoulder 56 of latching lever 57 to also pivot the latter lever in a counterclockwise direction to remove its hooked end 58 from engagement with shoulder 59 of block 61. As the plate 52 nears the end of a single revolution, solenoid 36 will have become deenergized and stop arm 46 and latching lever 57 will be urged to their original positions by spring 49. Thus, shoulder 47 will again engage latching pawl 48 and the hooked end 58 of stop lever 57 will ride up the cam surface 62 of block 61 and again become latched upon the shoulder 59. A more detailed description of the operation of a clutch of this type may be found in the patent of R. F. Morrison, No. 2,144,076.

Plate 52 is connected, by means of bolts 63 (Figure 3), to a plate 64 carried by collar 66 which is freely mounted about the shaft 18. By means of bushings 67 (three of which are shown in Figure 3) and suitable fastening means (not shown), switch cams 68, 69 and 71 carried on hub 72, and paper feed cam 73 are mounted for rotation with collar 66. Pivotally mounted about the shaft 29 is a lever 74, which carries at its lower end a gear segment 76 in mesh with gear 77 mounted on shaft 78. Lever 74 carries a follower 79 which is in contact with the periphery of paper feed cam 73. Gear 77, by means of a one way clutch 81 (details of which are not shown) drives a pressure feed roller 82 in a clockwise direction as viewed from the front of the apparatus in Figure 1. It is now obvious that, as the clutch 33 is released, cam 73, by means of a high part thereof, will engage follower 79 to cause rotation of pressure feed roller 82 as indicated, to feed the paper on to the take up reel 26, since the paper is fed between pressure feed roller 82 and a fixed pressure roller 83. Normally, the pressure maintained on the printing paper 100 between the rollers 82 and 83 is sufficient to hold take up reel 26 from rotation as the clutch 24 is caused to slip at this time. However, as a section of paper is advanced as explained, take up reel 26 will rotate to take up the slack in the printing paper caused by the feeding operation of the pressure feed roller 82.

The means for adjusting the feed mechanism to feed a predetermined amount of printing paper will now be explained with particular reference to Figure 12. By means of pin 84, lever 74 is connected to lever 86 and is pivoted therewith about the shaft 29. A spring 87 normally tends to hold lever 74 in a counterclockwise position as viewed in Figure 12. To adjust the stroke of lever 74, there is mounted also about the shaft 29, adjacent to lever 86, an adjustable lever 88. The position of lever 88 about the shaft 29 may be adjusted by means of a nut and bolt connection 89 which may be moved to any desired position in slot 91 formed on the framework 11 of the apparatus. Lever 86, by means of a fiber roller 92, carried at the free end thereof, tends to follow a notch 93 of adjustable lever 88. This action will determine the initial starting position of the stroke and therefore will determine the amount of paper fed. It is obvious that, if nut and bolt connection 89 is moved to a higher position in the slot 91, less paper will be fed whereas, if it is moved to a lower position in slot 91, more paper will be fed.

As the paper passes from the supply reel 94, it moves below a guide roller 96 (Figure 1) to the guideway 97 of printing platen 98 which is under the control of platen solenoid 99. When the solenoid 99 becomes energized, its plunger 101 moves downwardly to also carry lever 102 pivotally mounted thereto at 103 in a downward direction. Lever 102 is pivotally mounted at 110 to link 105 pivotally supported at 115 on clevis 115' and connected to platen 98 by link 120. The operation of the solenoid is properly timed to hold the paper in a fixed position during the exposure period. At the termination of the exposure period, solenoid 99 becomes deenergized and platen 98 is moved upwardly to free the printing paper for the feeding operation. A flat spring 120 is placed

under the lever 102 which at the moment solenoid 99 is deenergized, raises the platen 98 upwardly.

At the start of the printing operation, the operator places the negative to be printed over a judging glass 104 (Figure 10) through which light is transmitted by judging lights to be hereinafter identified. Operation of the judging light mask 106 will now be explained. When the operator desires to place a negative beneath the mask 106, treadle 107 (Figure 9), which is connected to a shaft 108 by means of rods 109 and 111, is operated downwardly against the tension of springs 112 and 113 respectively connected to rods 109 and 111. This moves the long rod 114, mounted for movement with shaft 108 by means of bracket 116, in a downward direction and further causes a lever 130 pivoted at 140 to the framework of the apparatus and connected to the upper end of rod 114, to also move downwardly and to press against a rocker arm 117 to rotate shaft 118 in the bearings 119 and 121. Mask 106 is fixedly secured at 122 to the shaft 118 and by the aforementioned action is caused to move upwardly enabling the operator to place the negative beneath the mask 106. The operator now removes his foot and the mask is returned to its original position by a spring 160, and the foot pedal is raised by springs 112 and 113.

At the front of the apparatus is located a judging shutter 123 attached by brackets 124 and 126 to a shaft 127 pivoted at 128 and 129 and urged to an outward position normally by a coil spring 131. With the shutter in its outward position, the operator may look over the top of the shutter to the judging glass 104 to determine the light transmission characteristics of a particular negative. However, on operation of the apparatus, a solenoid 132 which is suitably connected to bent over arm 133 of shaft 127 by a linkage not shown is energized, causing the shutter to pivot toward the rear of the apparatus, thereby closing it and preventing glare in the eyes of the operator from the printing light to be hereinafter identified.

By particular reference now to Figures 6, 7 and 8, operation of the printing light shutter 134 will now be explained. When solenoid 136 is energized, its plunger 137 moves downwardly, causing links 138 and 139 to be also moved in a downward direction. This pivots links 141 and 142 in opposite directions and causes pivotal rotation of their respective shafts 143 and 144. Fixed to shafts 143 and 144 are their respective flaps 146 and 147 which, when solenoid 136 is energized (as in Figure 8), move in opposite directions permitting light transmitted from printing light 151 through optical system 159 to strike sensitized paper 100. When the links 141 and 142 were caused to pivot as explained, they moved against the tension of associated springs 152 and 153 which cause flaps 146 and 147 to assume their original overlapping positions (Figure 7) upon deenergization of solenoid 136. It should be pointed out that the shafts 143 and 144 (Figure 6) extend out from the enclosure of the printing light shutter 134 and that links 141 and 142 are mounted to the rear at the outside of the shutter enclosure itself.

Mounted within the printing light compartment 154 is the printing light 151 previously referred to, lens 156, mirror 157, condensing lenses 158 and heat absorbing glass 170. Also mounted on the apparatus, by means not shown, is a lens 159 which is positioned below the light shutter 134. Above and at the right side of the judging glass 104, as viewed from the rear of the apparatus is mounted a lens 161 which is in a position to throw an out-of-focus image of the negative onto the cathode of a photoelectric cell 162.

A drag brake 195 (Figure 11) is provided on shaft 196, which carries printing paper supply reel 94, to maintain tension on the printing paper 100. It is adjustable by means of a knurled member 197 to vary the constriction of block sections 198 of the brake about shaft 196 to thereby vary the retarding pressure. Sections 198 are connected together by a spring plate 200.

Referring now particularly to Figures 16 and 17, the description of the circuit operation will now be undertaken. To initiate the operation of the apparatus, a main switch 211 is first operated which establishes a circuit for the judging lights 212 (only one of which is shown in Figure 15), the blower 213, paper feed motor 12, timer section 215 and pilot light 216. It might be well to mention at the outset the functions of the parts just enumerated. The judging lights 212 comprise two lamps mounted within the compartment 154 and are for the purpose of enabling the operator to view the light transmission characteristics of a negative from which a print is to be made and to accordingly select the proper control switch 220. The blower 213 is obviously provided for the purpose of preventing overheating in the printing light compartment 154. The motor 12 furnishes power for the cams involved in the mechanism which are controlled by the single revolution clutch 33. The timer section 215 which is in reality an electronic circuit controls the time interval for which a particular print will be exposed to light transmitted from the printing light 151 through a negative. Illumination of pilot light 216 is an indication to the operator that the main switch 211 has been operated.

The circuit for the judging lights 212 and the blower 213 is as follows: from A. C. lead 224, over the conductors 226 and 227, through main switch 211, over conductors 228, 229 and 231, through obvious parallel circuits 232 and 233, over the conductor 234 to the A. C. line 236. The motor 12 is operated by the following circuit: from the circuit extending from the conductor 234, to conductor 229 as previously described, through the motor 12 to the A. C. line 236. The circuit extending to the timer 215 is made as follows: from the circuit previously described, extending over conductor 228 and over conductors 241, 242 and 234 to A. C. line 236. The circuit for the pilot light 216 is as follows: from A. C. lead 224, through the primary winding of transformer 243, over conductors 242 and 234 to A. C. lead 236. This sets up a current in the secondary of the transformer 243 and an obvious resulting circuit on leads 246 and 247 extending to pilot light 216.

At this point the operator now selects and operates one of the control switches 220 in accordance with her judgment of the light transmission characteristics of the negative from which a print is to be made, and then operates switch 248. After the operation of a selected control switch 220 but prior to the operation of switch 248, capacitor C–2 is charged, due to the halfway rectifying action of tube V–II over the following path: from A. C. current extending to conductor 228 as previously described, through contact tongue 253 of relay 254, over conductor 256, through a variable resistor R–I, through parallel resistances R–II, R–III and R–IV and through one of the obvious circuit paths estab-

lished by the closure of one of the control switches 220, over conductor 257 to one side of the capacitor C–2, thence, from the other side of the capacitor C–2, to the grid of tube V–11, to the cathode of the same tube, and to the conductor 241 which is associated with the opposite side of the A. C. power source, as was previously mentioned in connection with the conditioning circuit for the timer 216. It might be mentioned that the control switches are of the type wherein one is always depressed, and the depression of a different control switch releases the one which was previously operated. Thus, for all practical purposes, one control switch will always be depressed and the capacitor C–2 may charge prior to the depression of the next control switch, it being understood that the rate of discharge of capacitor C–2 is the controlling factor in determining the time of printing exposure. While resistance values are not herein given, it will be appreciated, for example, that the values will be such that upon operation of the extra short negative control switch the chosen circuit will be one conducive to a relatively quick exposure, while on the other hand operation of the extra long negative control switch is one which conditions a resistance circuit which tends to prolong the discharge rate of capacitor C–2. Final determination of the printing exposure time, of course, is determined by the negative itself as previously explained. It is believed that the individual resistance circuits obtained by operating particular switches 220 are self evident and need not be individually traced.

When the switch 248 is closed, A. C. relay 254 becomes energized over the following circuit: From A. C. lead 236, over conductor 234, over conductor 242, through the winding of A. C. relay 254, over conductor 258, through the switch 148, over conductor 259, through cam switch 261 (now closed), over conductor 262, through contact tongue 249 of A. C. relay 251, over conductor 228, through main switch 211, over conductor 227 and conductor 226 to A. C. lead 224.

Operation of A. C. relay 254 breaks the previously described charging circuit for capacitor C–2, which extended through contact tongue 253 as it now moves to its attracted position. Attraction of tongue 253 by A. C. relay 254 closes a circuit leading to the cathode of tube V–111 as follows: from the circuit previously described as extending from contact tongue 253, over conductor 263 to the cathode of tube V–111. This enables direct current to flow in the plate circuit of tube V–111, due to the rectifying action of tube V–1V over the following path: from lead 264, through the winding of direct current relay 266, which now becomes energized, over conductor 267, through milliammeter 268 of conductor 269 which is maintained positive with respect to lead 264 due to the action of rectifier tube V–1V.

When D. C. relay 266 becomes energized, it attracts its armature tongue 271 to provide a locking circuit for A. C. relay 254 as follows: from the A. C. current previously described as extending through conductor 252, through closed tongue 271, over conductor 272, through the winding of A. C. relay 254 and over conductors 242 and 234 to A. C. lead 236. Operation of D. C. relay 266 causes it to also attract its contact tongue 273 which establishes circuits for the A. C. relays 274 and 276 as follows: from A. C. lead 224, over conductors 226 and 227, through closed contact tongue 273, over conductor 277, through the windings of A. C. relays 274 and 276 in parallel to conductor 241, and thence over conductors 242 and 234 to A. C. lead 236. The energization of D. C. relay 266 and closure of its contact tongue 273 further enables the operation of platen solenoid 99, the judging shutter solenoid 132 and light shutter solenoid 136 as follows: from the circuit just described extending through contact tongue 273, over conductor 277 to the parallel lead 278, thence through the respective windings of the solenoids to lead 279, over conductors 281 and 234 to A. C. lead 236. Thus, at this time, the platen 98 firmly holds the printing paper 100 for the printing operation, the printing light shutter 134 is opened and the judging shutter 123 is closed preventing glare in the eyes of the operator when the printing light 151 becomes illuminated as will immediately hereinafter be described.

As A. C. relay 274 operates, a circuit is made for the printing light 151 as follows: from A. C. current extending to lead 227, as already described, through closed armature tongue 282 to A. C. relay 274, over conductor 283, through printing light 151 and over conductor 234 to A. C. lead 236.

When A. C. relay 276 operates, it causes the energization of A. C. ratchet relay 251 over the following path: from lead 227, through closed contact tongue 284, over conductor 286, through the winding of A. C. ratchet relay 251 and over conductors 241 and 234 to lead 236. This ratchet relay 251 is of the type wherein one energization closes associated contacts by means of a cam rotatable with a ratchet which is stepped as the relay is energized, the cam being provided with alternate high and low portions. After a single energization, the switching position is maintained until the relay is again operated and its contact tongues are returned to their original positions. In each cycle of operation, A. C. relay 251 is energized twice as will appear from the ensuing description.

Now as relay 251 is operated, contact tongue 249 is opened, breaking the original operated circuit path for relay 254 and tongue 287 is closed preparing a circuit path for the operation of clutch solenoid 36 over conductors 289 and 291 through closed contact tongue 287, through contact tongue 284 (when it moves away from A. C. relay 276 as will later be described) and over conductors 227 and 226 to A. C. lead line 224.

The cathode of the photo cell 162 at this time receives an out-of-focus image through the lens 161 (Figure 15) which is an integration of the density of the negative from which the print is being made, and current now flows from the anode which is maintained positive by the current received through resistor R–5 by the action of rectifier tube V–1V of the photo cell 162 to its cathode and causes capacitor C–2 to discharge. The time of discharge of capacitor C–2 is dependent on the resistor circuit associated with the particular control switch selected and the average density of the negative which controls current flow to the cathode of tube 162. It should be mentioned that the out-of-focus image projected upon the cathode of the photo cell 162 is also more advantageous than a focused image for the reason that light might be concentrated at a single point on the cathode and different sections of the cathode may have varying electronic discharge characteristics. It is believed that the various possible resistance circuits through the control switches 220 are readily

traceable. It is evident then, that depression of a particular switch 220 sets up a resistance discharge circuit for capacitor C–2 different than the unselected switches 220.

When capacitor C–2 discharges to a certain point, the grid bias provided on tube V–11 is reduced to a point which enables current to flow in the plate circuit of tube V–11. When this occurs, there is a voltage drop across resistor R–6 which controls the grid of tube V–111. This weakens the current flow in the plate circuit of tube V–111 to an extent which results in the deenergization of D. C. relay 266.

Upon deenergization of D. C. relay 266, the locking circuit for relay 254 is broken as tongue 271 returns to its unattracted position thereby again closing the charging circuit for timer section 215 extending over conductor 256, readying the charging circuit for capacitor C–2 for the next operating cycle of the apparatus. Release of relay 266 further results in the deenergization of relays 274 and 276 and solenoids 99, 132 and 136 and tongue 273 is opened. Thus, at this point, the platen is released, the judging shutter is once more opened, and the light shutter is closed. When relay 274 becomes deenergized, the printing light 151 is extinguished as contact tongue 282 is opened.

As relay 276 is released, the previously described circuit for clutch solenoid 36 is made as tongue 284 falls back to its unattracted position. The switch operating cams 68, 69 and 71 are thus at this time released for rotation and in addition the cam 73 functions to operate the adjustable paper feed mechanism. As cam 71 rotates, switch 288 is opened, insuring that stop lever 46 will be in a position to disengage pawl 48 from ratchet 32 as it completes a single revolution.

Cam switch 261 is opened prior to the closure of cam switch 292 and as the latter switch is closed, a circuit is made for the operation of ratchet relay 251 as follows: from A. C. line 236, over conductors 242 and 241, through the winding of ratchet relay 251, over conductor 293, through closed contact 292, over conductors 229 and 228, through main switch 211 and over conductors 227 and 226 to A. C. line 224. Thus, at this time, ratchet relay 251 is operated to its originally described position and contact tongue 249 moves to its unattracted position to provide once more the original energizing circuit path for A. C. relay 254. Simultaneously with the closure of contact tongue 249, contact tongue 287 which leads to the clutch solenoid 36, is opened. Just at the end of the revolution of the cams, cam switches 261 and 288 are again closed and the machine is ready for another cycle of operations.

Thus far the invention has been described in connection with the making of a single print. The means for reproducing multiple exposures for 2, 3 or 4 prints will now be described. In Figure 17 is shown three gang switches 294, 295 and 296 which respectively act as control means for the purpose of making two, three or four positive prints. Assuming now that it is desired to make two positive prints, gang switch 294 is closed. This results in the formation of an obvious circuit for indicating lamp 297 extending over the leads 246 and 247 since, at this time, contact 298 is closed. Closure of contact 299 is effective in establishing the following circuit: from A. C. line 224, over conductors 226 and 227, through the main switch 211, over conductor 228, through closed contact 249, over conductor 262, through closed cam switch 261, through closed contact 299, over conductors 301 and 302, then through wiper 303, conductor 304 to relay 254, conductors 242, 234 and to A. C. line 236. The closing of switch 299 also establishes a circuit through conductors 301 and 302. To initiate the multiple exposure, switch 248 is closed and the circuit operates in the first cycle of operation as for single exposures. However, the second printing operation will take place automatically as brush 303 moves from a dead contact to one that is wired, closing the circuit just described above and operating relay 254 as it was previously operated by switch 248, thereby automatically initiating a repeat operation.

The stepping of the brushes 303 will now be explained. When switch 306 of gang switch 294 was closed, the following circuit was made which placed the stepping solenoid 307 in series with the clutch solenoid 36; from A. C. line 236, over conductors 234 and 281, through the winding of stepping solenoid 307, over conductors 308 and 309, through closed contact 306, over conductor 291, to the previously described circuit extending to contact tongue 287 of ratchet relay 251. When brush 311 is stepped to the commutator ring 312, the circuit just described will by-pass contact 306 of gang switch 294 as conductor 308 will connect with conductor 291 over short lead 313.

Thus, on each operation of clutch solenoid 36, stepping solenoid 307 will also be operated and brushes 303 will be moved to a new position and when the next dead contact is encountered by brush 303 of bank 302, the repeat operation will cease. Brush 303 may continue to be stepped as the printer is operated without effect until the neutral position is reached where it will automatically stop. Of course, as is well known in this type of switch, the brushes 303 are mounted on the same shaft as brush 311 and will rotate therewith.

It is believed that the operation of gang switches 295 and 296 and their respective contact banks 314 and 316 is obvious from the foregoing description. When switch 295 is operated, lamps 297 and 317 will be illuminated. When switch 296 is operated, lamps 297, 317 and 318 will be illuminated. It should be pointed out again, for the sake of clarity, that since cam switch 261 is closed just at the end of a revolution of the cam sleeve, when brush 303 associated with a contact bank being used is on a wired contact, it will function just as if switch 248 were reoperated to accomplish another printing cycle of operation.

It will be understood that in the present invention, negatives to be printed will first be developed by a suitable process and further that the chosen grade of printing paper will be one which works most harmoniously with the herein described automatic printing apparatus. It should be further pointed out that the above described invention has particular application wherein prints are made from a developed roll of negative film and that the operator may successively advance the individual negatives of a roll of film past the judging glass 104.

While there has been illustrated and described a preferred embodiment of this invention, it must be understood that the invention is capable of considerable variation and modification without departing from the spirit of the invention. Therefore, the invention should not be limited to the precise details of construction set forth, but should extend to such variations and modifica-

tions as come within the scope of the appended claims.

What is claimed is:

1. In combination, apparatus for the automatic control of exposure in photographic printing apparatus, a printing paper, printing paper feeding means for intermittently advancing the printing paper in predetermined sections, a negative to be printed on sections of said printing paper, a first optical system for reproducing on said printing paper exposed by an image derived from said negative, a second optical system for producing an out-of-focus image of said negative, means controlled by said out-of-focus image for governing the period of printing exposure provided by said first mentioned optical system, a plurality of control means for producing multiple exposures of the same negative, means for selecting one of said control means for synchronous timed operation to thereby effect the printing of a predetermined number of positive prints, and means responsive upon the termination of the individual exposure periods to operate said feeding means for advancing a section of said printing paper into printing position.

2. In combination, apparatus for the automatic control of exposure in photographic printing apparatus, a printing paper, printing paper feeding means to intermittently advance said paper in sections in the path of said first optical system, a negative to be printed, a first optical system for reproducing on said printing paper an image exposed by and derived from said negative, a second optical system for producing an out-of-focus image of said negative, means controlled by said out-of-focus image for governing the time of printing exposure, and a plurality of individually selectable control means for automatically effecting a predetermined number of recycles of synchronized operation of said printing exposure means according to the control means selected, thereby producing a predetermined number of positive prints from the same negative responsive to the initial actuation of a particular selectable control means.

3. In combination, apparatus for the automatic control of exposure in photographic printing apparatus, a negative to be printed, a printing paper, a lamp for passing light through said negative to said printing paper, a normally closed light shutter for controlling the passage of light from said lamp through said negative to said printing paper, a normally open judging shutter for viewing the condition of said negative, an electrical control means including switch means, means operative upon the operation of said switch means for automatically closing said judging shutters, illuminating said light and opening said light shutter, means responsive to the average light transmitting characteristics of the out-of-focus image produced by said negative itself for closing said light shutter, extinguishing said light and opening said judging shutter, and paper feeding means responsive to said last named means for advancing a new section of said paper into printing position for a succeeding printing operation.

4. In combination, apparatus for the automatic control of exposure in photographic printing apparatus, a negative to be printed, a printing paper, a first optical system including a lamp for passing light through said negative to said printing paper for reproducing on said printing paper exposed by an image derived from said negative, a normally open judging shutter in the path of the lamp in said first optical system for viewing the condition of said negative, an electrical control means including switch means, means operative upon the operation of said switch means for automatically closing said judging shutter, illuminating said light and opening said light shutter, a second optical system for producing an out-of-focus image of said negative, a normally closed light shutter in the path of said second optical system for controlling the passage of light from said lamp through said negative to said printing paper, means responsive to the average light transmitting characteristics of the out-of-focus image produced by said negative itself for closing said light shutter, extinguishing said light and opening said judging shutter, and paper feeding means responsive to said last named means for advancing a new section of said paper into printing position for a succeeding printing operation.

5. In combination, apparatus for the automatic control of exposure in photographic printing apparatus, a negative to be printed, a printing paper, a first optical system including a lamp for passing light through said negative to said printing paper for reproducing on said printing paper exposed by an image derived from said negative, a normally open judging shutter in the path of the lamp in said first optical system for viewing the condition of said negative, an electrical control means including switch means, means operative upon the operation of said switch means for automatically closing said judging shutter, illuminating said light and opening said light shutter, a second optical system for producing an out-of-focus image of said negative, a normally closed light shutter in the path of said second optical system for controlling the passage of light from said lamp through said negative to said printing paper, means responsive to the average light transmitting characteristics of the out-of-focus image produced by said negative itself for closing said light shutter, extinguishing said light and opening said judging shutter, paper feeding means responsive to said last named means for advancing a new section of said paper into printing position for a succeeding printing operation, a plurality of selectable control means for automatically producing multiple exposures of the same negative, and means for selecting one of said control means for synchronized timed operation of said printing exposure means and said feeding means.

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