

Dec. 26, 1939.

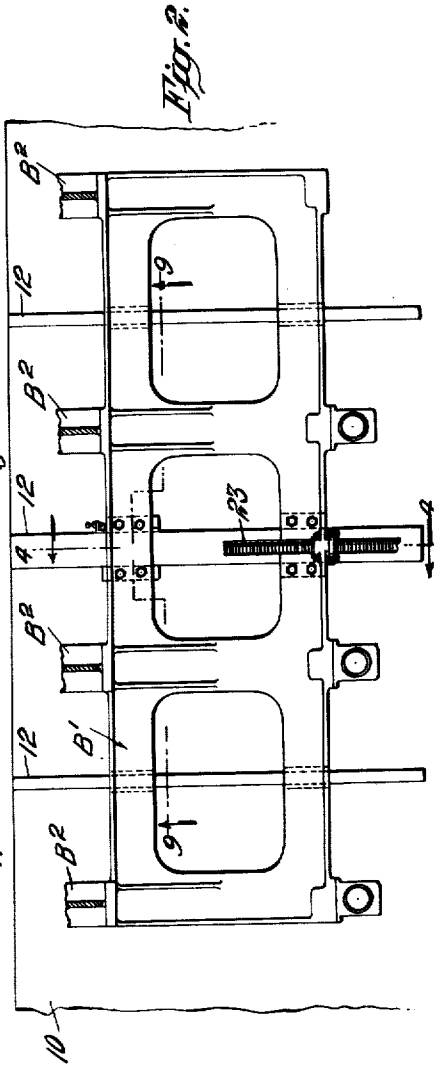
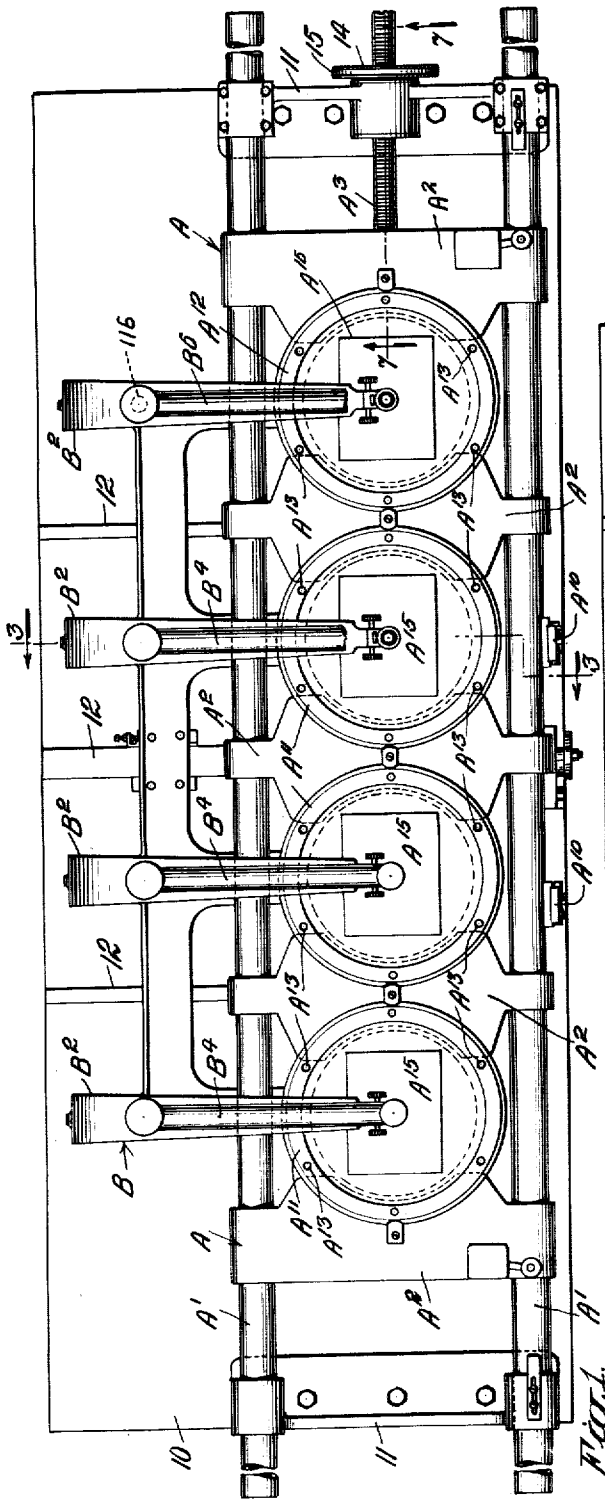
F. L. WURZBURG, JR

2,185,139

SCANNING APPARATUS

Filed April 23, 1937

4 Sheets-Sheet 1



INVENTOR
FRANCIS LEWIS WURZBURG, JR.
BY
Robert W. Bayley
ATTORNEY

Dec. 26, 1939.

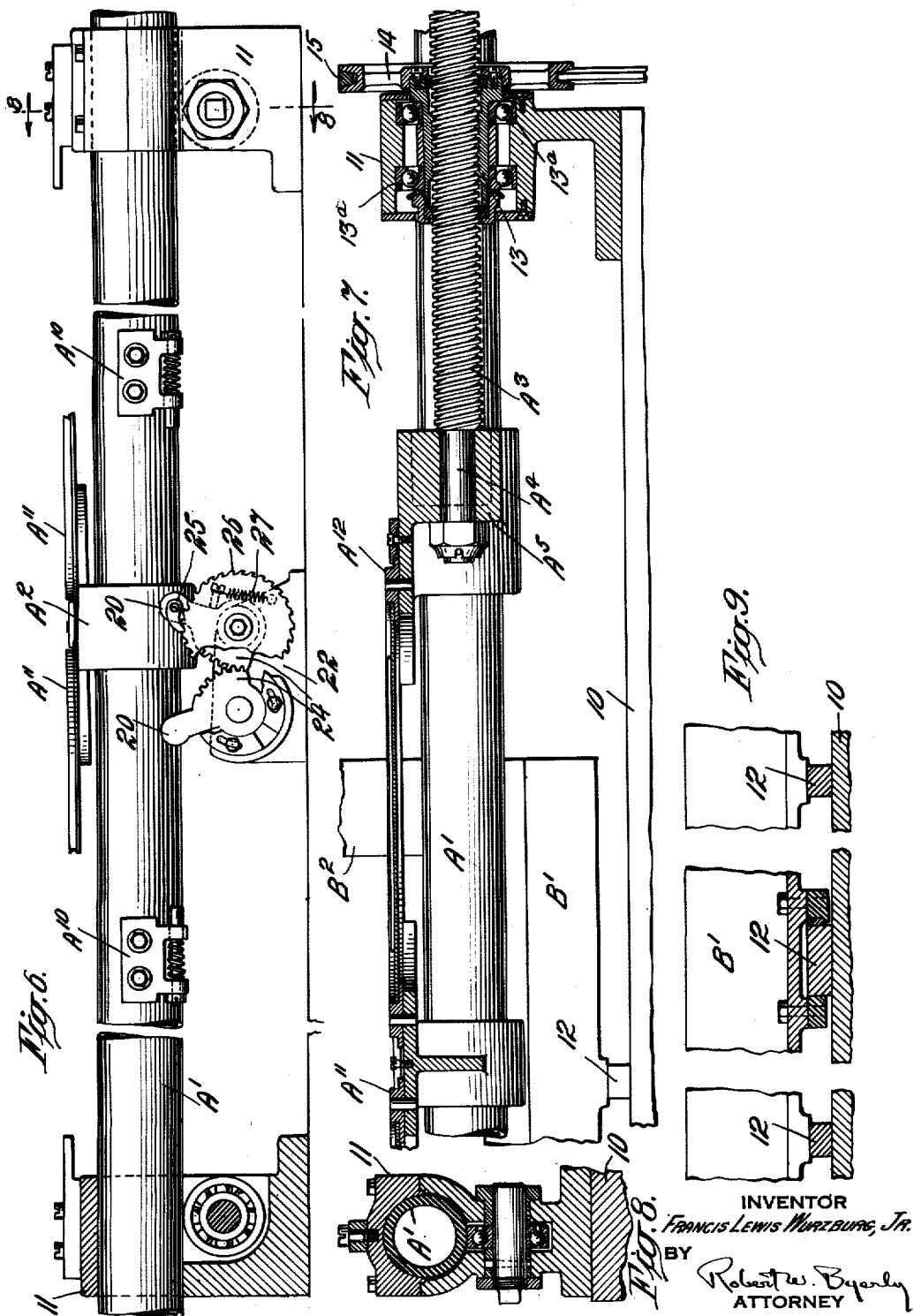
F. L. WURZBURG, JR

2,185,139

SCANNING APPARATUS

Filed April 23, 1937

4 Sheets-Sheet 3



Dec. 26, 1939.

F. L. WURZBURG, JR

2,185,139

SCANNING APPARATUS

Filed April 23, 1937

4 Sheets-Sheet 4

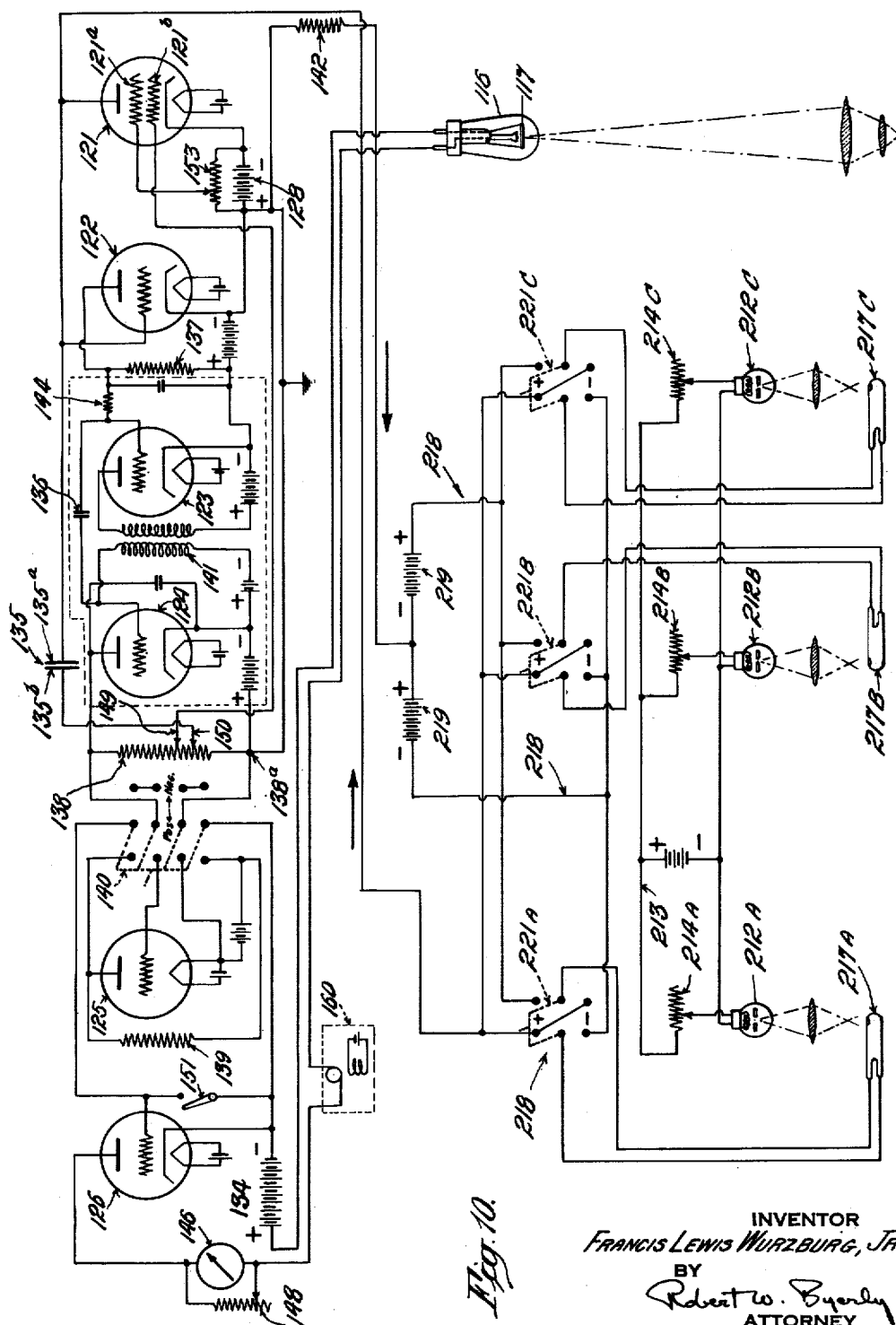


Fig. 10.

INVENTOR
FRANCIS LEWIS WURZBURG, JR.
BY
Robert W. Byerly
ATTORNEY

UNITED STATES PATENT OFFICE

2,185,139

SCANNING APPARATUS

Francis Lewis Wurzburg, Jr., Bronxville, N. Y., assignor to Interchemical Corporation, a corporation of Ohio

Application April 23, 1937, Serial No. 138,520

3 Claims. (Cl. 178—5.4)

This invention relates to electro-mechanical scanning apparatus and provides an apparatus of this character which is particularly adapted for use in making color printing plates.

5 In the co-pending application of Arthur C. Hardy, Serial No. 126,110, filed February 17, 1937 (and assigned to the assignee of the present application) on which Patent No. 2,136,340 was issued on Nov. 8, 1938, there is disclosed a method
10 in which photo-electric scanning mechanism is employed for making a contrast image of a picture on a photo-sensitive surface. This method produces superior contrast images, which are particularly advantageous for controlling the
15 etching of half-tone plates for printing. It possesses a number of other advantages. For instance, half-tone plates can be made without the use of screens, thus eliminating the screen lines in the image. However, when three or more
20 plates, for use in color printing, are made from contrast images produced by the electro-mechanical scanning method, the prints produced are apt to present moiré effects, even though no screen has been employed in the method.

25 According to the present invention, I provide an improved scanning apparatus, which avoids these moiré effects. More particularly, the apparatus provides for producing three contrast images, or color separation images, of the same
30 subject, the apparatus being so constructed that both the subject to be scanned and the photo-sensitive image surface can be readily turned through the same angle, so that the scanning lines on each of the color separation images lie
35 at an angle of, say, 60° to the scanning lines on other images. By scanning lines I mean the lines which the recording light makes in its movement over the photographic plate. More particularly, the present apparatus comprises a
40 rectilinear scanning apparatus in which both the subject to be scanned and the photographic plate can be rotated through given, equal angles.

The scanning apparatus which I have invented is of especial value when used for carrying out the method described in Arthur C. Hardy application Serial No. 121,466, filed January 21, 1937 (which has been assigned to the assignee of this application) on which Patent No. 2,165,168 was issued on July 4, 1939. In that
50 method, a color-separation image is made by the additive and subtractive combining of three master images and the combination is effected by means of an electro-mechanical scanning apparatus. When that method is carried out by means of the scanning apparatus which I have
55

invented, the combining of the three master images and the production of a contrast image to be used for engraving may be effected simultaneously in a single scanning operation.

The present scanning apparatus has a number of other important advantages which will appear from a detailed description of an illustrative apparatus embodying my invention which is shown in the accompanying drawings:

Fig. 1 is a top view of the apparatus;

Fig. 2 is a plan view of the bed plate of the carriage for the optical parts;

Fig. 3 is a transverse section of the apparatus on the line 3—3 of Fig. 1;

Fig. 4 is a transverse section on the line 4—4 of Fig. 2 showing the means for traversing the optical apparatus;

Fig. 5 is a detailed top view of one of the prisms of the optical apparatus showing the supporting tube section on the line 5—5 of Fig. 3;

Fig. 5A shows a detail of modified optical system;

Fig. 6 is a partial end elevation of the apparatus;

Fig. 7 is a partial section on the line 7—7 of Fig. 1, showing the mechanism for traversing the carrier;

Fig. 8 is a transverse section on the line 8—8 of Fig. 6;

Fig. 9 is an enlarged and broken section on the line 9—9 of Fig. 2 showing the supporting rails for the bed plate carrying the optical apparatus, and

Fig. 10 is a diagram of the electric circuits.

The apparatus illustrated consists of a picture carrier A and an optical carrier B slidably mounted for straight line movement in directions at right angles to one another. The picture carrier has a frame consisting of two rods A1 secured together by cross-pieces A2 and slidably mounted in standards 11 secured to the table 10. The optical carriage B consists of a bed plate B1 located below and partly under the picture carriage A and a number of U-shaped arms B2, extending over the picture carriage A. The bed plate B1 of the optical carriage is slidably mounted on rails 12 which are secured to the table 10 and extend at right angles to the rods A1 of the picture carriage.

Automatic means are provided for reciprocating the picture carriage in the direction of the rods A1 and for giving the optical carriage a short movement in a rearward direction along the rails 12 at the end of each traversing movement of the picture carriage. These means pro-

vide for movement of the picture carriage at a uniform rate throughout its traversing movements in each direction.

The means for moving the picture carriage include a worm A3 having an unthreaded end A4 fixed in a detent A5 on one of the cross-pieces A2. The worm A3 meshes with an internally threaded nut 13 which is rotatably mounted in one of the standards 11 by means of bearings 13a, which are arranged to take the thrust in both directions. Nut 13 may be driven from a constant speed, reversing motor (not shown), connected to the picture carriage A in any suitable, conventional manner for reversing the motor at each end of the travel of the carriage. In the form of apparatus shown in Fig. 7, the nut 13 is secured to a pulley 14 which is driven from the motor by belt 15. However, suitable gearing may be employed instead.

The means for moving the optical carriage B are actuated by the movement of the picture carriage A. At the end of each traversing movement of the picture carriage A, one or the other of two adjustable stops A10 (Fig. 6) strikes one or the other of two arms 20, one of which is rotatably mounted on a shaft 21 journaled in a standard 22 at the front of the table and carrying a worm 23 meshing with a nut B3 carried by the bed plate B1 of the optical carriage. The arms 20 are connected by gear segments 24 and one of them carries a pawl 25 engaging a ratchet 26 fixed on the shaft 21. The arms 20 are normally held in the position shown in Fig. 5 by a spring 27, but, when either of them is struck by one of the stops A10, the pawl turns the ratchet to cause a slight rotation of the shaft 21 and a small rearward movement of the optical carriage B.

As shown in Fig. 1, the picture carriage A has four circular picture-supporting tables A11, which may comprise metal rims and glass centers. These tables are set in arcuate recesses in the cross-pieces of the carriage A. Each table has six equally spaced holes A13 formed in its rim, any diametrically opposite pair of these holes being adapted to engage cooperating pins mounted on the cross-bars of the carriage. At least one of the tables, and, in the form shown, for use in the method described in Patent No. 2,165,168, each of the three tables at the left supports a continuous-tone transparency A15 which is adapted to be scanned. The table at the right, in Fig. 1, supports a photo-sensitive film or plate A16. The transparencies and the photo-sensitive film are all of the same size and shape.

As best shown in Fig. 3, at least one of the arms B2 of the optical carriage B, and, in the form shown, each of the three arms B2 at the left in Fig. 1, carries an optical system including a lamp 212, a tube B4, a prism B7 and a vertical lens system B8, for directing light of fixed intensity through a small, sharply defined area of the transparency located beneath the lens system. Instead of employing the tube B4 and the prism B7, an electric lamp 212X, having a small filament, may be mounted directly above the lens system B8 as shown in Fig. 5A. Beneath each of the transparencies there is mounted, an optical carriage B, a photo-electric cell 217. In the optical system of the right-hand table in Fig. 1, there is mounted, in place of the lamp 212, a recording lamp 116, hereafter described, for forming the image on the photo-sensitive film or plate. Obviously, no photo-electric cell is used beneath this right-hand table.

When three transparencies are to be employed

for making a composite or master image, for color work, these may be prepared as described in aforesaid Patent No. 2,165,168. In this case, an electrical circuit is provided, also as described in said application, for adding or subtracting the tones in the transparencies which represent the color values to be combined in making the master image on the photo-sensitive film or plate A16. This circuit is shown in the lower part of Fig. 10.

Three scanning lights 212A, 212B and 212C are connected in parallel in a circuit 213. Connected with the three lights are three rheostats 214A, 214B and 214C which control the intensity of the three lights. Suitable dials (not shown) are provided for indicating the setting of the rheostats.

The three photo-electric cells 217A, 217B and 217C are connected in parallel in an electric circuit 218 containing a source of electro-motive force 219. These photo-electric cells are connected into the circuit 218 through three reversing switches 221A, 221B and 221C, which may be set so as to oppose the current passing through any one photo-electric cell to that passing through the others. The symbols "+" and "-" are indicated on the switches. When all three switches are thrown to the "+" position, the currents through all three of the photo-electric cells are passed through the circuit 218 in the same direction (that is, the direction indicated by the arrows on Fig. 10), so that they are added. The throwing of any one of the switches to the "-" position opposes the current controlled by this switch to the current flowing through the switches which are in the "+" positions. As the separate current through each photo-cell varies proportionately to the amount of light falling upon that photo-cell and the resultant current in the circuit 218 is the algebraic sum of the separate currents through the cells, the variations in the resultant current are proportional to the sum of the variations in the transparency of the images controlling the photo-cells whose switches are in the "+" position less the corresponding variations in the transparency of the image controlling the photo-cell whose switch is in the "-" position; or, if two of the switches are in the "-" position, the variations in the resultant current are proportional to the variations in the transparency of the image controlling the photo-cell whose switch is in the "+" position less the sum of the corresponding variations in the transparency of the images controlling the photo-cells whose switches are in the "-" position. This resultant current in the circuit 218 is employed to flash the lamp 116 which forms the image on the photo-sensitive surface A16 (Fig. 1).

It will be understood that instead of employing the variable recording lamp 116, a fixed light provided with a suitable light valve, or similar inertialess recording device may be used, as an equivalent.

When recording lamp 116 is used, it illuminates a shield 117 containing a long narrow slit or aperture. A lens system B8 focuses an image of the slit on a recording film A16. The lamp is a gas-discharge lamp having no afterglow. The length of the image of the slit is equal to the distance that the optical carriage B is moved rearward each time carriage A reaches one end of its travel, so that, as the mechanism operates, the image of the slit scans the entire area of the recording film without any overlap. The length of the image of the slit on the recording film determines the width of the elemental areas of the contrast image pro-

duced on the recording film. In this connection, it should be noted that the elemental areas are all of the same width. The lengths of the elemental areas are determined by the time length of the cycle of the recording lamp 116; and the proportion of black and white which each elemental area contains is determined by the time during which the recording lamp 116 is lighted and the time periods during which it is extinguished during one cycle. These time periods are controlled by the light passing through the originals to the photo-electric cells 217 by means of inter-connecting electric circuits between the photo-electric cells 217 and the recording lamp 116.

This may be accomplished to particular advantage by means of the electrical circuit described in Patent No. 2,136,340, mentioned above.

The interconnected electric circuits, as shown in Fig. 10, include a photo-cell circuit which charges a condenser 135, a constant current circuit which discharges the condenser 135, a trigger circuit actuated by the voltage across the condenser 135, and a control circuit for the recording lamp 116 actuated by the trigger circuit. The circuits are so interconnected that the condenser 135 is alternately charged and discharged in a cycle controlled by the resultant current in the circuit 218 and controlling the cycle of the recording lamp 116 and thus the length and character of the elemental areas of the contrast image.

The photo-cell circuit contains the circuit 218 and a resistance 142, and is connected to the plate 135a of the condenser so that a positive potential is built up on this plate when the current flows in the circuit 218 in the direction of the arrow. The current or rate of charge of this condenser in this circuit is proportional to the resultant current in circuit in 218.

The discharging circuit is connected to the plate 135a of the condenser and contains a source of electro-motive force 128 opposed to the source of electro-motive force 219 in the photo-cell circuit. The discharging circuit also contains means for maintaining the flow of current constant and means for stopping and starting the flow of current. These means consist of a vacuum tube 121 whose plate circuit constitutes a part of the discharging circuit. The tube 121 contains a grid 121a maintained at a constant potential and holding the flow of current in the plate circuit at a constant value greater than the greatest resultant current in the photo-cell resultant circuit. While greater than the current in the photo-cell circuit, the discharging current should be of the same order as that in the photo-cell circuit which requires that the tube 121 be operated at very low voltage. The strength of the discharging current may be regulated by a potentiometer 153 connected to the grid 121a and spanning the source of electro-motive force 128. The tube 121 also contains a control grid 121b which permits the plate current to flow when it is neutral with respect to the cathode of the tube and cuts off the flow of current when it is at a certain negative bias with respect to the cathode of the tube. This grid is connected by a variable tap 149 to the resistor 138 of the trigger circuit hereinafter described. When the current is flowing in the discharging circuit, it reduces the positive charge on the plate 135a, because the current in this circuit is greater than the resultant current in the photo-cell circuit by which it is opposed.

In addition to the charging and discharging circuits connected to the plate 135a of the con-

denser, a means for varying the condenser charge is connected with its other plate 135b. This means is the resistor 138 to which the plate 135b is connected by a variable tap 150 so that the existence of a voltage drop in the resistor 138 applies a negative potential to the plate 135b equal to the voltage drop between the high end 138a of the resistor 138 and the variable tap 150, while the absence of a voltage drop in the resistor 138 eliminates this negative charge on the plate 135b of the condenser.

The trigger circuit is actuated by the voltage across the condenser 135 in such manner as to cause a drop in potential in the resistor 138 only when the condenser voltage is below a predetermined value (which, for convenience, I shall term "the trigger value"). The trigger circuit includes a vacuum tube 122 whose grid is connected to the plate 135a of the condenser and whose plate circuit is connected to cause a flow of current through a resistor 137. The resistor 137 is connected through an oscillator and detector (enclosed in dotted lines in Fig. 10) to the resistor 138. The operation of this oscillator and detector (hereinafter described in detail) is such that it causes a flow of uni-directional current through the resistor 138 only when the flow of current through the resistor 137 is such as occurs in the plate circuit of the tube 122 when its grid is below the trigger value.

The control circuit for the recording lamp 116 is connected to the resistor 138 of the trigger circuit, and serves to keep the recording lamp 116 lighted only when there is a drop in potential in the resistor 138 or only when there is no drop in potential across this resistor, according to the setting of a reversing switch 140. The control circuit includes a source of electro-motive force 134, the recording lamp 116, and the plate circuit of the tube 126. Current flows in this circuit only when the grid of the tube 126 is neutral. The grid of the tube 126 is connected directly to the low end of the resistor 138 when the reversing switch is in the position marked "Neg." on Fig. 10, so that current flows through the recording lamp 116 only when there is no potential drop in the resistor 138. This results in making a negative contrast image of a positive subject. When the switch 140 is thrown to the position marked "Pos." in Fig. 10, the grid circuit of the tube 126 is connected across a resistor 139 in the plate circuit of a tube 125 whose grid is then connected to the low end of the resistor 138. In this case, the current in the plate circuit of the tube 126 and the recording lamp 116 flows only when there is no current in the plate circuit of the tube 125, that is, when there is a potential drop in the resistor 138. In this case, a positive contrast image is made.

The operation of the interconnected circuits which have been described is cyclic and may conveniently be described by beginning at the end of the discharge of the condenser 135. At this time, there is a potential drop in the resistor 138, as the condenser voltage is below the trigger value; if the reversing switch is in the positive position, the recording lamp is on and no current is flowing in the discharge circuit which includes the plate circuit of the tube 121. The condenser, therefore, becomes charged by the current flowing through the photo-cell circuit, and the charge continues to increase until it reaches the trigger value. At this point, the trigger circuit operates to stop the flow of current in the resistor 138 eliminating the potential drop in this resistor.

The elimination of the potential drop in the resistor 138 causes three effects: (1) It increases the charge of the condenser by a predetermined value depending upon the setting of the variable tap 150. (2) It eliminates the negative bias on the control grid 121b of the tube 121 and starts the flow of current in the discharge circuit. (3) It operates the control circuit to extinguish the recording lamp 116. After these three effects of the elimination of the voltage drop in the resistor 138, which take place simultaneously, the condenser voltage decreases, since the current in the discharging circuit is greater than the current in the photo-electric circuit which is opposing it. The discharge of the condenser continues until its voltage reaches the trigger value. The trigger circuit then starts a flow of current through the resistor 138, causing a potential drop in this resistor. The potential drop in the resistor 138 has three effects: (1) It decreases the charge in the condenser by the same amount as this charge was increased by the elimination of the voltage drop in the resistor 138. (2) It produces a negative bias on the control grid 121b of the tube 121 sufficient to stop the flow of current in the discharge circuit. (3) It lights the recording light 116. This completes the cycle and the charging of the condenser by the current in the photo-cell circuit begins again.

To facilitate the description of the operation of the interconnected circuits which have been described, their operation will first be described on the assumption that the switch 221A is in "+" position and the switches 221B and 221C are open, so that the current in the circuit 218 is simply the current through the photo-cell 217A. Under these circumstances the rate at which the condenser is charged is proportional to the amount of light reaching the photo-cell 217A, as this determines the strength of the current in the photo-cell circuit. The rate at which the condenser is discharged is an inverse function of the amount of light reaching the photo-cell, since the photo-cell current opposes the constant current in the discharging circuit. The amount of time required for the discharging and charging of the condenser depends upon the discharging and charging rates and upon a fixed capacity of the condenser and the fixed voltage by which the condenser voltage is raised above and dropped below the trigger value by the voltage drop in the resistor 138 applied to the plate 135b of the condenser through the variable tap 150. Since the time for charging and discharging of the condenser determines the length of the black and white portions of each elemental area of the contrast image, the device which has been described operates to produce a positive contrast image when the switch 140 is in "Pos." position.

When a dark-tone area of the original is between the scanning lamp and the photo-cell, the photo-cell current is weak, so that the charging of the condenser to the trigger value takes a long period of time making a long black area on the contrast image, and the discharge of the condenser is rapid making a short white area. Because of the slowness of the charging, the whole cycle is long, and consequently the elemental area is long.

When a light-tone area of the original lies between the scanning lamp and the photo-cell, the photo-cell current is large, charging the condenser rapidly and opposing the discharging current so that the discharge is slow. This also re-

sults in a long cycle producing a long elemental area which, in this case, contains a long white area and a short black area.

When a middle-tone of the original is between the scanning lamp and the photo-cell, the current in the photo-cell circuit is approximately half the current in the discharge circuit, so that both the charging and discharging of the condenser are comparatively rapid, giving a short cycle producing a short elemental area which is half black and half white.

No black area of the contrast image can be less than a predetermined length, which is determined by the time required for the maximum photo-cell current to charge the condenser to the trigger value. At the same time, no white area can be less than a predetermined length, which is determined by the time required for the constant current in the discharge circuit to discharge the condenser when the photo-cell current is at its lowest value.

Adjustments may be made to determine the size of the elemental areas in the middle tones and the minimum sizes of the black and white areas as desired in the making of contrast images for etching printing plates. Best results are secured when the discharging current is made equal to the maximum photo-cell current plus the minimum photo-cell current. This or other desired adjustment of the discharging current may be made as follows:

The proportion of black area in the contrast image is indicated by a milliammeter 146 which is connected in the recording lamp circuit and provided with a variable shunt 148 which is adjusted so that the milliammeter reads 100 when the recording light 116 is lighted without interruption, a condition which may be attained by closing the switch 151 to maintain a constant potential on the grid of tube 126. The switch 151 is then opened and the indications of the milliammeter 146 are then used as a guide in adjusting the photo-cell current and the discharging current. The adjustment is made after a positive continuous-tone image A15 has been placed on one of tables in Fig. 1. The darkest tone of this image is moved between the scanning lamp 212A and the photo-cell 217A with the reversing switch 140 in positive position. The strength of the photo-cell current is then adjusted by adjusting the brightness of the scanning lamp 212A, for example by a rheostat 214A, until the reading of the milliammeter 146 equals the percentage of black area desired to represent the darkest tone of the original, for example 95%. The lightest portion of the continuous-tone original is then moved between the scanning lamp 212A and the photo-cell 217A, and the discharging current is adjusted by means of the potentiometer 153 until the reading of the milliammeter 146 is equal to the percentage of black desired to represent the lightest tone of the original, for example 5%. It is desirable to select the percentages so that 100 minus the percentage selected for the darkest tone equals the percentage selected for the lightest tone, as this results in making the discharging current equal to the sum of the maximum and minimum photo-cell currents. After the relation of the minimum size white and black areas to the size of the elemental area has been adjusted in this manner, the size of the elemental areas is adjusted by varying the position of the variable tap 150 on the resistor 138 to control the frequency of the charging and discharging of the

cycle of the condenser 135. The adjustment is most desirably such as makes the elemental areas in the middle tones about equal in size to the elemental areas of an ordinary half-tone contrast image used for the sort of plate for which the contrast image made on the apparatus is to be used.

A further feature of the apparatus illustrated consists in a means for indicating the total amount of black area in a contrast image produced by the apparatus. This is of value since it enables a printer using a plate made from such an image to know the area of the printed plate which must be covered with ink without the experimentation necessary to determine this as in using ordinary printing plates. The means for indicating the total black area consists of an ampere hour meter 160 connected in the circuit of a recording lamp 116. The number of ampere hours indicated by this meter during the making of a positive contrast image on the apparatus, when divided by the number of ampere hours which would be required to burn the recording lamp 116 for the same length of time gives the proportion of black area in the contrast image.

In describing the operation of the device, I have referred to placing a positive continuous-tone image on the table and producing a positive contrast image when the reversing switch 140 is in "Pos." position and a negative contrast image when the reversing switch 140 is in "Neg." position. It should, of course, be understood that, if desired, a negative continuous-tone image may be placed upon the table and that, in this case, a positive contrast image will be obtained by placing the reversing switch 140 in the "Neg." position and a negative contrast image by placing the reversing switch 140 in the "Pos." position.

The operation of the oscillator and detector enclosed in dotted line in Fig. 10 is as follows:

When sufficient current flows through resistor 137, the grid of tube 123 is held at a negative potential sufficient to prevent a current in the plate circuit of this tube. When the current through resistor 137 decreases, there is a corresponding increase in the potential of the grid of tube 123. This causes the plate current of this tube to increase. The plate current flows through the primary of transformer 141. This induces a voltage in the secondary of the transformer which causes the grid of tube 123 to become more positive by virtue of the potential induced on one plate of condenser 136. This results in a further increase in the plate current and a correspondingly further increase in the grid voltage until saturation conditions are attained. At this point, the current through the primary of transformer 141 becomes momentarily constant and the secondary voltage drops to zero. This causes a decrease in the potential of the grid of tube 123, which produces a corresponding reduction in the current through the primary of transformer 141. This induces in the secondary of the transformer a voltage of the opposite sign and tends to make the grid of tube 123 even more negative. This process continues until the grid of tube 123 becomes so negative that the plate current ceases. Current then flows through the resistor 144 in such a direction as to again cause the potential of the grid of tube 123 to increase. These oscillations continue so long as the voltage drop across resistor 137 biases

the grid of tube 123 above the cut-off potential of this tube.

Tube 124 is operated as a detector, its grid being biased normally slightly below the cut-off potential. During one-half of the oscillation period of tube 123, the voltage induced in the secondary of transformer 141 causes the grid of tube 124 to become positive allowing current to flow in the plate circuit through the resistor 138. Since the oscillations of tube 123 are at a radio frequency, the oscillations of this tube result in a pulsating uni-directional through resistor 138 which to all intent and purpose may be regarded and treated as a direct current. It is obvious to one skilled in the art that this oscillator and detector might be replaced by a direct current amplifier containing an odd number of stages.

From this description of the operation of the circuits when only one photo-electric cell is connected and from the description of the circuit 218 on page 2, it is apparent that, when the three photo-cells are placed in operation by closing all the switches 221A, 221B and 221C with one or more of them in the "+" position and one or more of them in the "-" position, the operation of the circuits will be the same except that the charging of the condenser 135 will be controlled by the resultant current in the circuit 218 which is the algebraic sum of the separate currents through the photo-cells and is, therefore, proportional to an additive and subtractive combination of the point-to-point variation in density of the three master images placed on the three tables over the three photo-cells 217A, 217B and 217C.

In using the present apparatus, it is merely necessary to place one or more pictures to be scanned on the appropriate tables above one or more of the photo-electric cells 217A, 217B, 217C, adjust the electrical circuits, and start the reciprocating mechanism to produce the image on the right-hand table in Fig. 1. This image, when made by the use of the radio frequency circuit last described, includes a large number of minute elemental areas faithfully representing the light-tone, middle-tone, and dark-tone portions of a continuous-tone original, and is particularly adapted for making half-tone printing plates. Moreover, when three master images are combined to make a color-separation image, from which superior color printing plates are produced. However, it will be understood that mechanical features of the present invention are useful and advantageous in connection with other types of scanning devices. The arrangement of the parts shown in Fig. 5 is not essential as other forms of scanning apparatus, including those designed to scan an opaque original, may be used in carrying out my invention.

In the use of my apparatus, for making images for the three-color process, one image is made with the tables in the positions shown, after which the tables are turned 60° and locked in place, and the second image is made. The tables are then turned another 60°, and the third image is made. It will be appreciated that the tables may be rotated through other angles, for instance 30° in each case. In making a set of color-separation contrast images from a set of continuous-tone color-separation originals, the rotation of the tables serves to locate the scanning lines in the images at large angles to one another. A set of printing plates made from these images does not produce moiré effects. Moreover, the apparatus is so constructed that the adjustments

can be readily and quickly made, while the scanning is accomplished by a rectilinear movement.

What I claim is:

1. In an electro-mechanical scanning apparatus, a flat transparent member adapted to support a picture to be scanned, a photo-sensitive plate, a frame for supporting said picture and plate in the same plane and in a plurality of positions at fixed, equal angles to a line joining their centers, a scanning lamp and a photo-electric cell at opposite sides of said transparent member, a recording lamp adjacent said plate, a U-shaped frame for supporting said lamps and cell, means for reciprocating one of said frames at a uniform rate of motion, and means for causing a step-by-step movement of the other frame at each reversal of movement of the reciprocated frame.
2. An electro-mechanical scanning apparatus for producing a composite contrast image from a plurality of continuous-tone master images, comprising a reciprocating carriage, tables for supporting the master images on said carriage, a table for supporting a photographic plate on said carriage, a scanning lamp and a photo-electric cell associated with each of said master image supports, a circuit connecting said photo-electric cells so as to produce a resultant current equal

to the algebraic sum of the separate currents through the cells, a recording light associated with said photographic plate carriage, a circuit connecting said resultant current with said recording light and arranged to light and extinguish said light for periods corresponding in length to variations in said resultant current, and means for making corresponding angular adjustments of said master image tables and said photographic plate tables.

3. In an electro-mechanical scanning apparatus, a flat, transparent member adapted to support a picture to be scanned, a photo-sensitive plate, a reciprocatably mounted carriage supporting said transparent member and said plate, a scanning lamp and a photo-electric cell at opposite sides of said transparent member, a recording lamp at one side of said plate, a U-shaped frame having arms extending at opposite sides of the first frame and mounted for reciprocatory movement at right angles to the movement of the first frame, means for reciprocating one of said frames at a uniform rate of motion, and means for causing a step-by-step movement of the other frame at each reversal of movement of the reciprocated frame.

FRANCIS LEWIS WURZBURG, JR.

CERTIFICATE OF CORRECTION.

Patent No. 2,185,139.

December 26, 1939.

FRANCIS LEWIS WURZBURG, JR.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 2, first column, line 67, for "an optical" read on optical; page 3, first column, lines 52 and 53, for "photo-cell resultant circuit. While greater than the current" read photo-cell circuit. While greater than the resultant current; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 13th day of February, A. D. 1940.

(Seal)

Henry Van Arsdale,
Acting Commissioner of Patents.

can be readily and quickly made, while the scanning is accomplished by a rectilinear movement.

What I claim is:

1. In an electro-mechanical scanning apparatus, a flat transparent member adapted to support a picture to be scanned, a photo-sensitive plate, a frame for supporting said picture and plate in the same plane and in a plurality of positions at fixed, equal angles to a line joining their centers, a scanning lamp and a photo-electric cell at opposite sides of said transparent member, a recording lamp adjacent said plate, a U-shaped frame for supporting said lamps and cell, means for reciprocating one of said frames at a uniform rate of motion, and means for causing a step-by-step movement of the other frame at each reversal of movement of the reciprocated frame.
2. An electro-mechanical scanning apparatus for producing a composite contrast image from a plurality of continuous-tone master images, comprising a reciprocating carriage, tables for supporting the master images on said carriage, a table for supporting a photographic plate on said carriage, a scanning lamp and a photo-electric cell associated with each of said master image supports, a circuit connecting said photo-electric cells so as to produce a resultant current equal

to the algebraic sum of the separate currents through the cells, a recording light associated with said photographic plate carriage, a circuit connecting said resultant current with said recording light and arranged to light and extinguish said light for periods corresponding in length to variations in said resultant current, and means for making corresponding angular adjustments of said master image tables and said photographic plate tables.

3. In an electro-mechanical scanning apparatus, a flat, transparent member adapted to support a picture to be scanned, a photo-sensitive plate, a reciprocatably mounted carriage supporting said transparent member and said plate, a scanning lamp and a photo-electric cell at opposite sides of said transparent member, a recording lamp at one side of said plate, a U-shaped frame having arms extending at opposite sides of the first frame and mounted for reciprocatory movement at right angles to the movement of the first frame, means for reciprocating one of said frames at a uniform rate of motion, and means for causing a step-by-step movement of the other frame at each reversal of movement of the reciprocated frame.

FRANCIS LEWIS WURZBURG, JR.

CERTIFICATE OF CORRECTION.

Patent No. 2,185,139.

December 26, 1939.

FRANCIS LEWIS WURZBURG, JR.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 2, first column, line 67, for "an optical" read on optical; page 3, first column, lines 52 and 53, for "photo-cell resultant circuit. While greater than the current" read photo-cell circuit. While greater than the resultant current; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 13th day of February, A. D. 1940.

(Seal)

Henry Van Arsdale,
Acting Commissioner of Patents.