

Sept. 11, 1934.

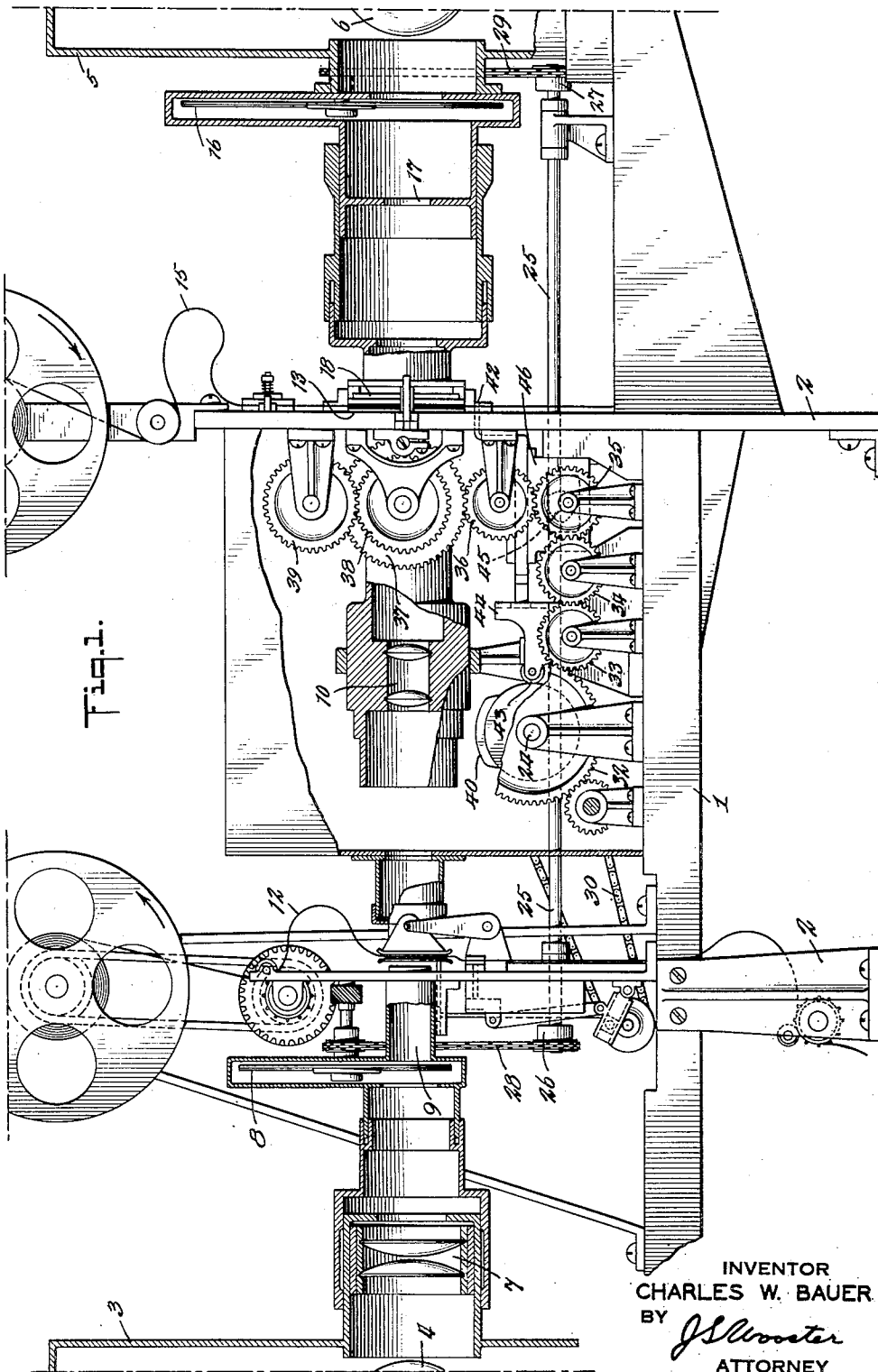
C. W. BAUER

1,972,973

APPARATUS FOR PRINTING PHOTOGRAPHS IN NATURAL COLORS

Filed June 25, 1932

6 Sheets-Sheet 1



Sept. 11, 1934.

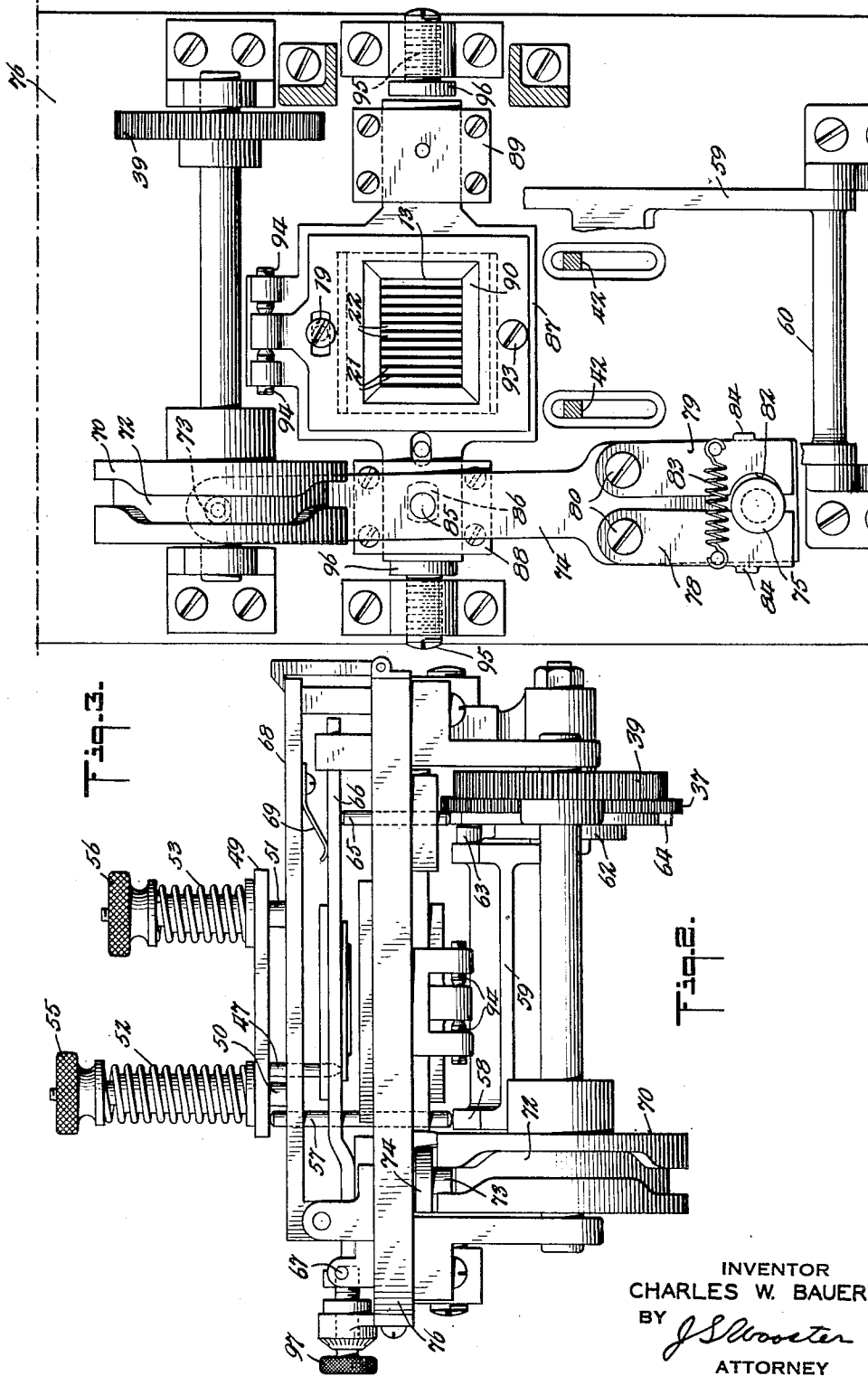
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6 Sheets-Sheet 2



Sept. 11, 1934.

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6 Sheets-Sheet 3

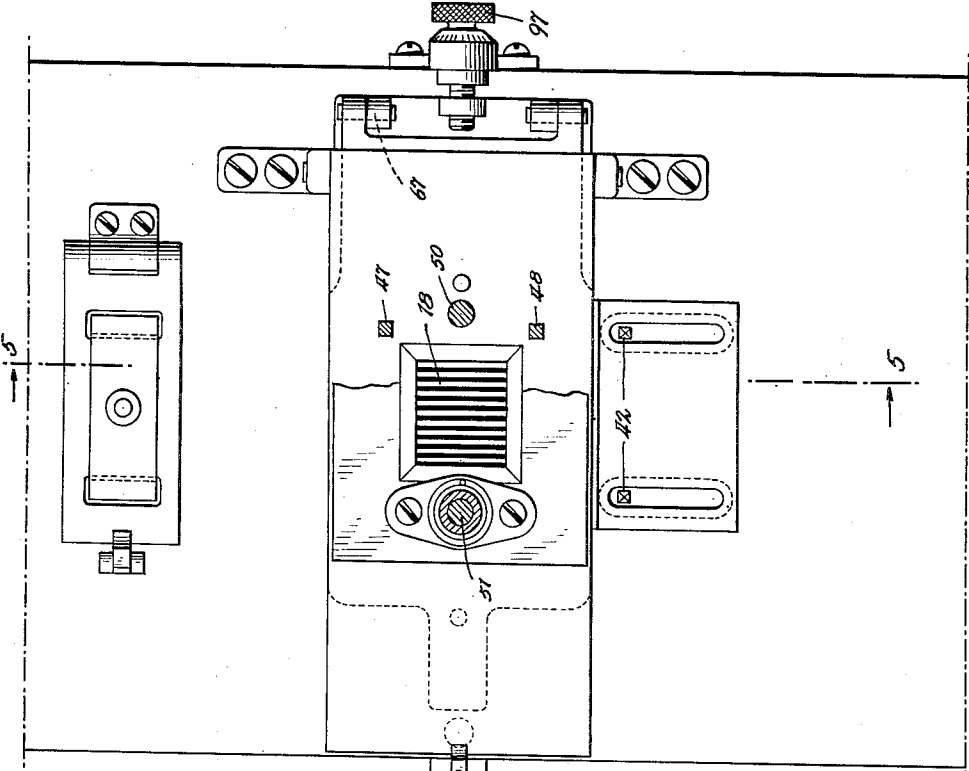


Fig. 4.

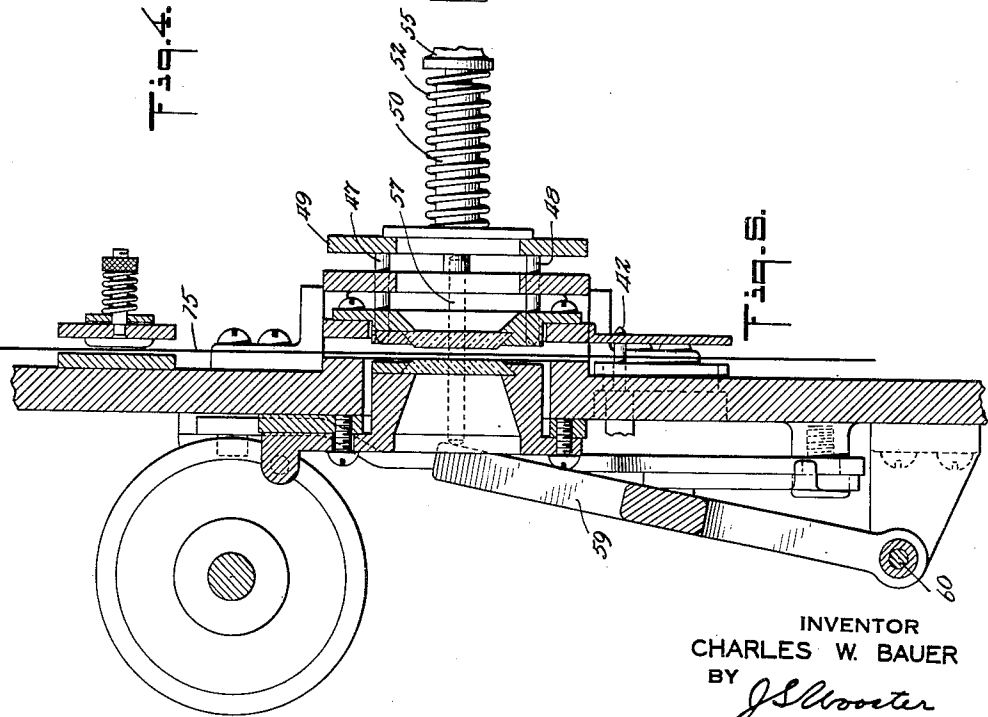


Fig. 5.

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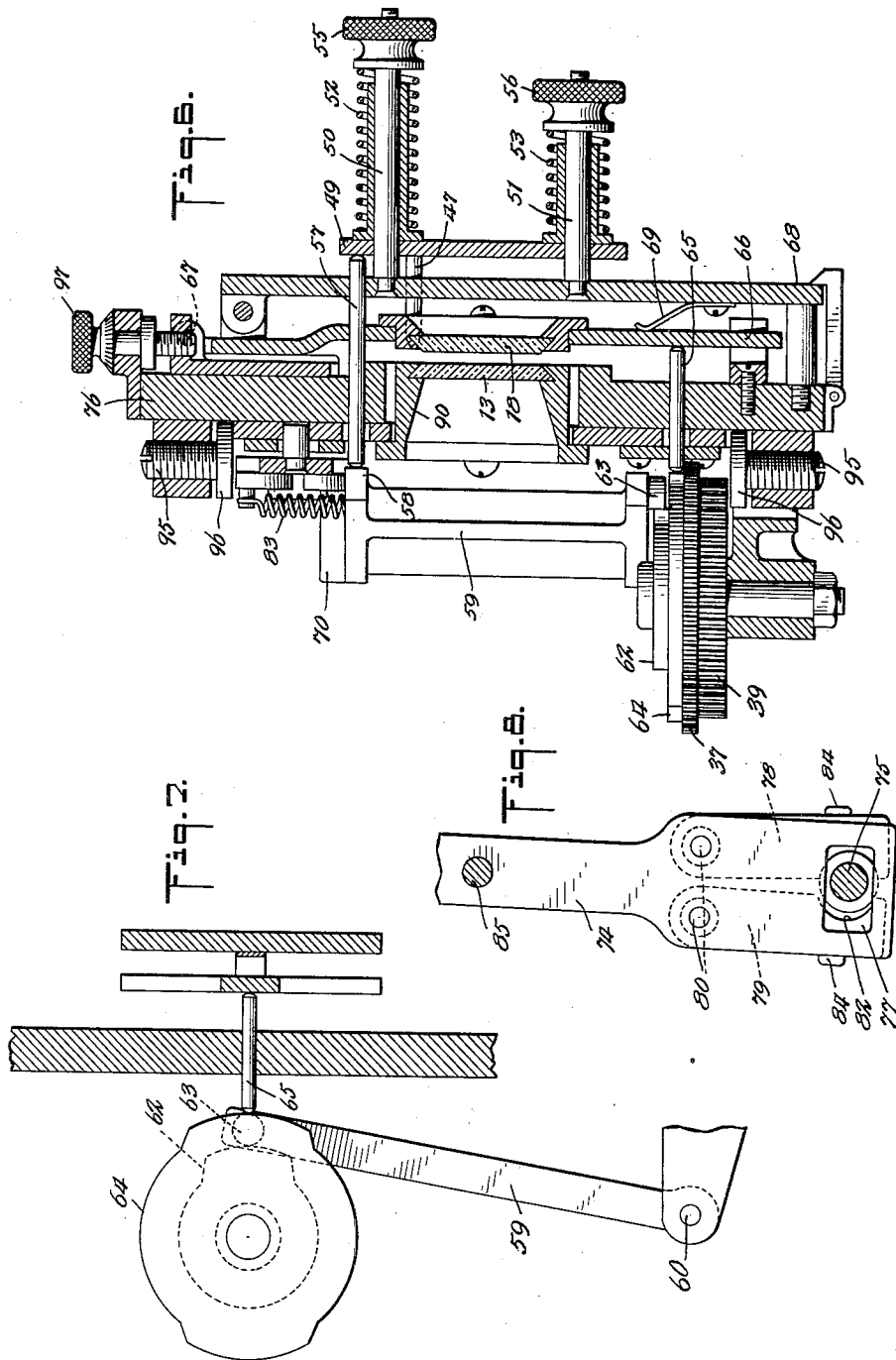
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6 Sheets-Sheet 4



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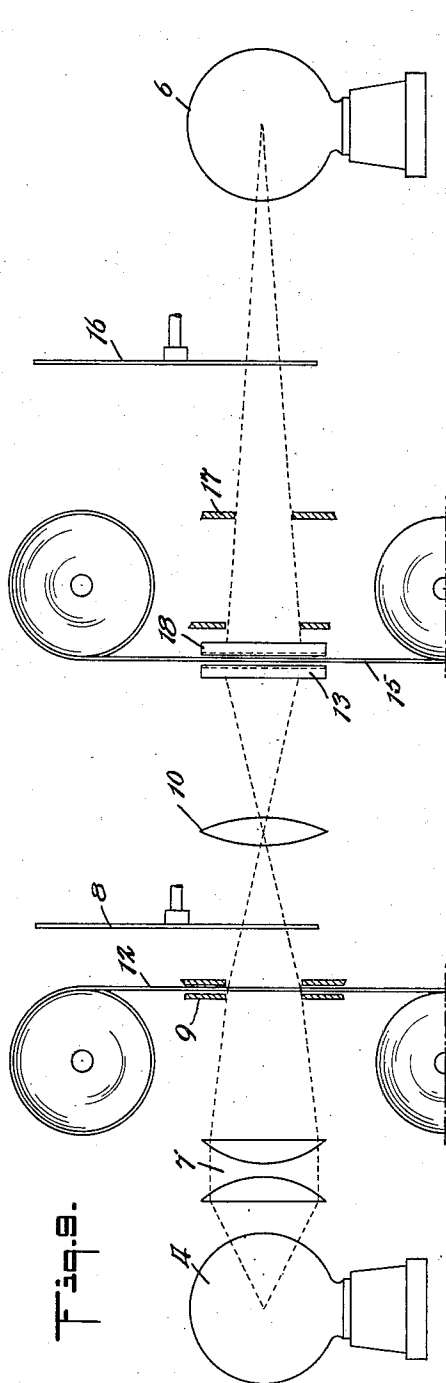
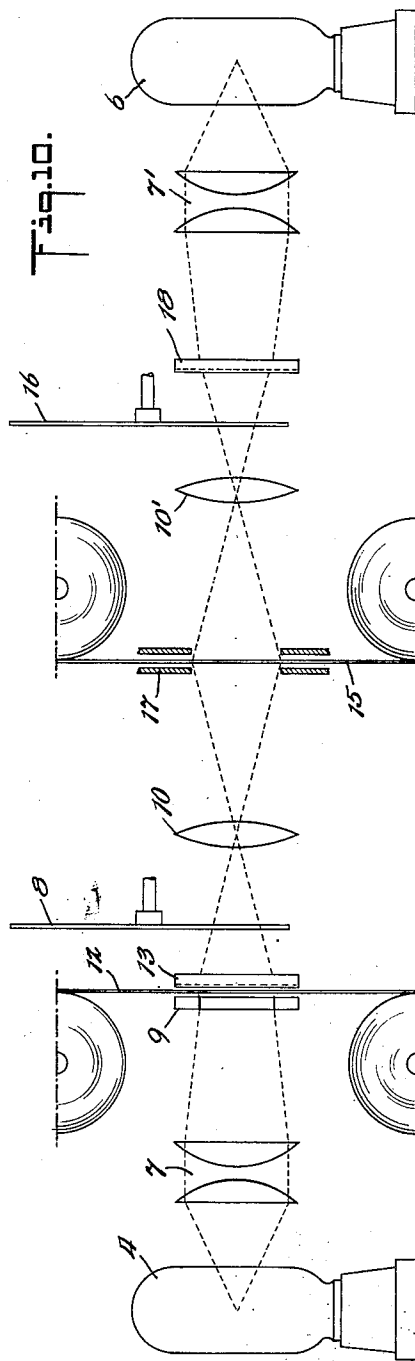
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APPARATUS FOR PRINTING PHOTOGRAPHS IN NATURAL COLORS

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6 Sheets-Sheet 5



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APPARATUS FOR PRINTING PHOTOGRAPHS IN NATURAL COLORS

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6 Sheets-Sheet 6

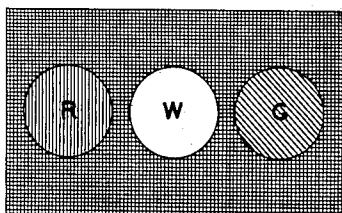


Fig. 11.

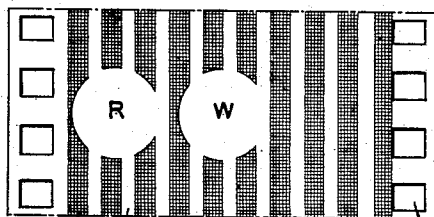


Fig. 15.

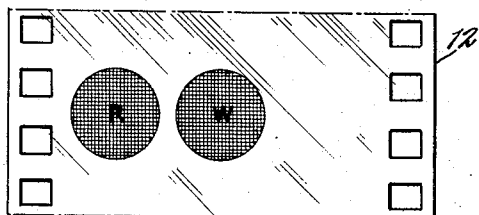


Fig. 12.

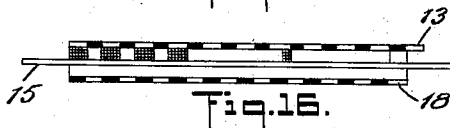


Fig. 16.

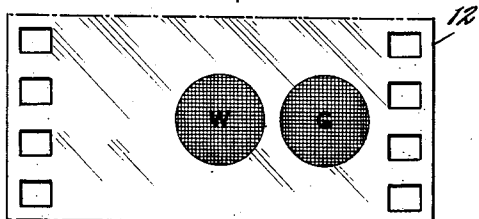


Fig. 13.

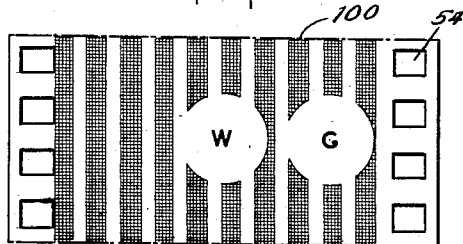


Fig. 12.

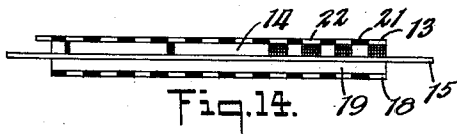


Fig. 14.

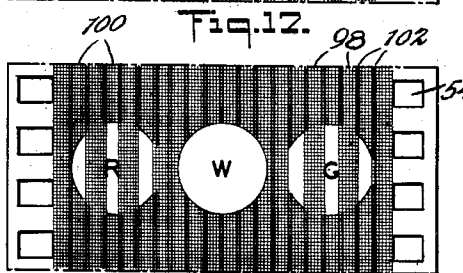


Fig. 18.



Fig. 19.

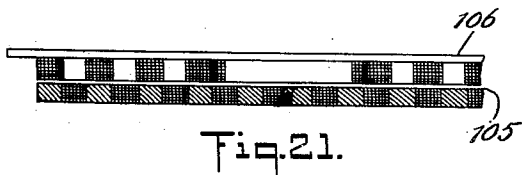


Fig. 21.

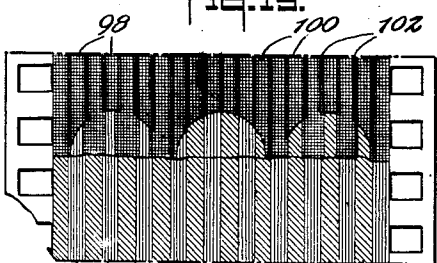


Fig. 20.

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UNITED STATES PATENT OFFICE

1,972,973

APPARATUS FOR PRINTING PHOTOGRAPHS
IN NATURAL COLORSCharles W. Bauer, Fairview, N. J., assignor of
one-half to Henry Kohlbacher, Newark, N. J.

Application June 25, 1932, Serial No. 619,305

17 Claims. (Cl. 88—24)

This invention relates to photographic printing and has for its object to provide an improved machine for making positive motion picture film reproductions in natural colors for projection.

5 The invention is chiefly concerned with the manufacture of colored positive motion picture films by what is known as the additive method, and for purposes of illustration I shall describe a machine for carrying out that method, but it
10 will be evident that with minor changes the machine may be used equally well for the reproduction of colored positive films by the subtractive method.

For many years it has been the aim of inventors
15 and research workers in the field of motion pictures to find a means by which motion pictures in natural colors could be satisfactorily and economically produced, and many workers from DuHauron down to the present day have attempted to achieve this result by what is known
20 as the additive line screen method. This method has been used successfully in the realm of still photography of inanimate objects, by making the reproductions on glass plates, but it has never
25 been successful in producing motion pictures because the physical characteristics of flexible emulsion carriers such as celluloid are very unstable mainly because of shrinkage which very seriously alters the size of the pictures.

30 The general method pursued by workers in this field was to employ a screen plate having lines of different colors and to provide a photographic emulsion sensitive to light of all colors, either on the same plate as the colored lines or on a
35 separate support, and then expose this emulsion in the camera through the lines of color, thereby getting a negative photographic record of the subject in its different color values. A duplicate print could be made from such negative on any
40 standard glass plate and this print could be brought into register with the screen plate of colored lines through which the original was recorded and a positive transparency in natural colors thereby reproduced. However, if the positive
45 print were made on an emulsion carried by a flexible support such as celluloid it would be found that after developing, fixing, washing and drying the positive print would no longer be the same size as the original negative, and the lines
50 of the positive print would not coincide with the colored lines of the screen plate or the original negative and therefore the picture would not be reproduced in its natural colors.

Attempts have also been made to apply colored
55 screen elements of linear or other design directly

to the negative, for example by applying ruled lines of color to the emulsion or to the transparent support. Workers in this field have either prepared the positive in a like manner and attempted to register the rulings and picture values
60 of the negative with the rulings of the positive, or have removed the rulings from the negative after photographing and made direct contact printing to the positive from the negative with the hope of registering the color lines with the color values after printing and developing, but
65 here again the element of shrinkage doomed these attempts to failure.

After considerable study of these problems I have devised a machine for printing multi-color value films of linear or mosaic design, which are
70 of the same length as black and white films and which can be run in any standard projector at standard speeds and without special attachments. My machine reproduces prints in lines
75 of values of the original colors in perfect register with lines of exposed and unexposed silver light sensitive emulsion which can very easily be converted into lines of color. The lines of color values and the lines of exposed and unexposed emul-
80 sion are printed in a series of rapid operations without altering the registered positions of the positive and negative films and without any shrinkage or other alteration in the size of the said positive film until all the lines are recorded
85 in their proper relationship so that subsequent alteration in the size of the positive film due to developing, etc., will not affect the true color rendering of the subject when projected on the screen.

The negative records containing the color values of the subject are photographed in any well known manner on standard color value negative film. These records may be of two or more colors but for the purpose of illustrating the invention I shall select the two colors red and green.
90 The red and green value pictures are preferably photographed simultaneously, one being photographed through a red filter and the other through a green filter, to provide a single negative
95 film with alternating red and green value images. With a suitable optical system, however, the sets of color value images may be photographed on separate films, that is, with all red values on one film and all green values on another film. In
100 the latter case the red and green value images may be transferred to a single strip of film with the red and green values alternating, and the single strip passed through my machine to make the positive, or the machine may be arranged op-
110

tically and mechanically to print the positive directly from twin negatives.

For many years there have been two well known methods of printing motion picture films both for color and for black and white work. One method is to place the negative record in contact with an unexposed light sensitive positive film and to transmit light through the negative to imprint on the light sensitive silver of the positive emulsion a latent image which is the reverse of the image of the negative. This is known as contact printing. Another method, known as optical printing, is accomplished by optically projecting the negative image through space onto the sensitive emulsion of the positive film, which gives the same result as contact printing. My machine utilizes both methods of printing. For the positive film I prefer to use a transparent support having a coating of light sensitive emulsion on both sides, the emulsion having incorporated within it a light retarding fugitive dye to prevent lateral dispersion of the rays from the printing light in the emulsion and too much penetration. I may, however, employ a positive film having a light sensitive emulsion on only one side, part of the printing operations being carried on through the transparent support and the other printing operations being carried on in direct contact with the top surface of the emulsion.

My machine has a film moving and registering mechanism, source of light and optical projection system for the negative film, a film moving and registering mechanism and source of light for the positive film, and a pair of screen plates arranged on opposite sides of the positive film. The screen plates preferably consist of black lines and transparent spaces alternating with each other, although screen plates of mosaic or other design may be used as well. One of the screen plates preferably has the black lines and clear spaces equally proportioned, while the other has the same number of lines per inch as the first screen plate but has its black lines narrower than its clear spaces. The screen plate of unequal proportions is preferably arranged between the negative film and the positive film, while the screen plate of equal proportions is arranged between the other side of the positive film and its source of light.

In the preferred form of the invention the screen plate of equal proportions is arranged to exert pressure on the positive film and against the other screen plate on the opposite side of the positive film, and is so arranged that this pressure may be released when desired to permit the positive film to be moved in a longitudinal direction and to permit shifting the other screen plate. The screen plate of unequal proportions is attached to suitable guides which permit it to be displaced from side to side automatically in synchronism with the printing operations. The screen plate of equal proportions, which I shall call the positive screen plate, is used to print lines on the emulsion on one side of the positive film, which lines are dyed alternate red and green after the printing operation is finished. The other or negative screen plate is used in printing the two color value negative records onto the opposite emulsion of the positive film in alternating lines of red and green color values.

Each source of light is provided with a rotating shutter consisting of opaque blades and clear spaces suitably arranged between the light source and the light-sensitive positive film. The shutter which intercepts the light between the negative

and positive films has two blades, one for each color value picture of the negative. The other shutter, which intercepts the light to the opposite side of the positive film, is of the so-called single blade type. Both shutters have separately adjustable blades for altering exposure or balancing values as desired. The negative film is run through the machine at twice the speed of the positive film since it is necessary to project two negative image frames to complete the color value records of one positive image frame. The film moving mechanisms, rotating shutters, screen plate control mechanism and all other moving parts are coordinated and operated in synchronism in a manner hereinafter described.

In the operation of the machine one frame of the negative film, say a frame containing a red value image, is first exposed to light and the image is projected upon the picture surface of the positive film through the clear spaces of the screen plate of unequal proportions. Since the black lines of the screen plate will not transmit light it is apparent that only parts of the red record will be imprinted on the light sensitive emulsion of the positive film in a series of lines alternating with a series of lines of unexposed light sensitive emulsion in the same picture area. Then, while the positive film and the screen plate of equal proportions are still held in the same position, the screen plate of unequal proportions is displaced laterally so that the black lines of said screen plate will be centrally located in the previously exposed red record. However, as the black lines of the screen plate are not as wide as the clear spaces through which the red record was printed, the red record will be almost, but not entirely, covered by the said black lines, and the red record will therefore be susceptible to further printing at both edges of the lines of the red value record. While the positive film and the screen plate of equal proportions are thus held stationary, and while the screen plate of unequal proportions is thus displaced laterally, the negative film is moved in a longitudinal direction to bring the corresponding green value picture of the pair into position for printing.

Light is then passed through the negative and through the clear spaces of the laterally displaced screen plate, and a record of the green values is photographically printed on the previously unexposed emulsion of the positive film. In this way the color values are printed in lines next to and partially overlapping the aforementioned lines of the red record, thus giving records of both the red and green values alternating with each other and with double exposed or black subdividing lines of both values in register in one frame of a single picture area. At or about the same time as the record of the green value negative image is being imprinted on the positive film, light is permitted to pass through the clear spaces of the screen plate of equal proportions at the opposite side of the positive film. This screen plate is so placed as to print a record of lines only on the emulsion opposite to the emulsion which has received the record of the red and green values.

After one frame of the positive film is printed in the manner described, the pressure on the screen plate of equal proportions is released, the screen plate of unequal proportions is again displaced laterally to its original position, and the negative and positive films are both moved longitudinally the distance of one frame, and the

printing operation is repeated. In this way the machine prints a complete record in perfect register of both the red and green value images alternating with each other and alternating with double exposed subdividing lines on one side of the positive film, and on the opposite side of the same film it prints lines of exposed red sensitive silver emulsion in register with the red value record and alternate lines of soft unexposed silver emulsion in register with the green value record. These lines of exposed light sensitive silver emulsion are subsequently dyed one color, for example red, while the alternate lines of soft unexposed silver emulsion are dyed the other color, such as green, as described in a copending application of Bauer and Kohlbacher, Serial No. 616,592, filed June 11, 1932.

The invention will be described in connection with the accompanying drawings, in which:

Fig. 1 is a longitudinal section of a machine embodying the invention;

Fig. 2 is a plan view of the positive printing mechanism;

Fig. 3 shows the mechanism for shifting the negative screen plate;

Fig. 4 is an end view showing the positive screen plate;

Fig. 5 is a vertical section on the line 5—5 of Fig. 4;

Fig. 6 is a transverse section of Fig. 2;

Fig. 7 is a detail of the mechanism for releasing the pressure on the positive screen plate;

Fig. 8 is a detail of the mechanism for shifting the negative screen plate;

Fig. 9 is a diagrammatic view of a suitable optical system;

Fig. 10 is a diagrammatic view of a modified optical system;

Fig. 11 is a diagrammatic view of an object photographed on the negative;

Fig. 12 is a red color value negative;

Fig. 13 is a green color value negative;

Fig. 14 shows the position of the positive film and the screen plates during printing of the red color values;

Fig. 15 is the picture surface of the positive film showing only the red color values;

Fig. 16 shows the position of the positive film and the screen plates during printing of the green color values;

Fig. 17 is the picture surface of the positive film showing only the green color values;

Fig. 18 is the picture surface of the positive film showing both the red and green color values;

Fig. 19 is a view similar to Fig. 16 and illustrates the printing of the black and white screen lines on the back of the positive film;

Fig. 20 is the printed positive cut away to show both front and back;

Fig. 21 shows a positive film having light sensitive emulsion on only one side of the transparent support.

The machine shown in Fig. 1 has a base 1 mounted on standards 2, casing 3 containing light source 4 at one end of the machine, and casing 5 containing light source 6 at the other end of the machine.

The negative projecting mechanism has condenser lenses 7 and a two-bladed shutter 8 having separately adjustable auxiliary blades for increasing or decreasing the period of time of the exposure of light to negative aperture 9 to and through projection lens 10. The lens 10 in turn projects the negative images of negative film 12 to and through the transparent spaces of glass

screen plate 13 onto emulsion 14 on the front or picture surface of positive film 15.

The printing mechanism at the other end of the machine has a single blade shutter 16 provided with an adjustable auxiliary blade for increasing or decreasing the period of time of the exposure of light to positive aperture 17. In this way light from source 6 is transmitted to and through the transparent spaces of glass screen plate 18 onto emulsion 19 on the back of positive film 15.

Screen plate 13, which I call the negative screen plate, has black lines 21 and transparent spaces 22 alternating with each other, and in this screen plate the black lines are narrower than the transparent spaces. Screen plate 18, which I call the positive screen plate, has alternating black lines and transparent spaces of equal width. I have used a positive screen plate having four hundred black lines and four hundred clear spaces to the inch, and a negative screen plate having the same number of lines per inch but with clear spaces 22 twice the width of black lines 21. These screen plates are best shown in Figs. 3, 4, 14, 16 and 19 in which the lines and spaces are greatly enlarged for the sake of clearness.

Cam shaft 24 is driven by hand or by any suitable source of power. Shaft 25 extends lengthwise of the machine and is driven from cam shaft 24 through suitable right-angle spiral gears. Shaft 25 has sprockets 26 and 27, the former driving chain 28 which operates shutter 8, and the latter driving chain 29 which operates shutter 16. Shutters 8 and 16 are thus rotated in unison and in proper timed relation.

The mechanism for intermittently moving and registering negative film 12 may be of any standard type. That shown in Fig. 1 is a modification of the well-known "Moy" movement, and is driven by chain 30 through a suitable sprocket on cam shaft 24. This mechanism operates at twice the speed of the mechanism which drives the positive film because it is necessary to project two negative image frames to complete the color value records of one positive image frame.

Cam shaft 24 carries gear 32 which drives a chain of seven gears numbered from 33 to 39 inclusive and shown in Fig. 1. Cam 40 on cam shaft 24 operates the forward or engaging motion of feeding pins 42 which transport positive film 15 past the printing aperture. These pins are disengaged from the film by the tension of suitable springs which hold roller 43 of slidable actuating block 44 in contact with cam 40. Up and down motion of feeder pins 42 is effected by the action of harmonic cam 45 on the shaft which carries gear 35. The pins slide in vertically movable block 46 and cam 45 raises and lowers the block.

Positive film 15 is properly located at the printing aperture by dowel pins 47 and 48 best shown in Fig. 5. These pins are carried by plate 49 which is slidably mounted on shafts 50 and 51. Coil springs 52 and 53 surround the respective shafts 50 and 51 and tend to force plate 49 toward the left as viewed in Figs. 5 and 6 to engage pins 47 and 48 in perforations 54 which are provided in the edges of positive film 15 as shown in Figs. 15, etc. The pressure of these springs may be varied by adjusting nuts 55 and 56.

Pins 47 and 48 are disengaged from the positive film by push rod 57 which is actuated by lug 58 on the upper end of cross bar 59 which is pivoted to the framework at 60. Bar 59 is moved by cam 62 on the shaft which carries gears 37 and 38, 150

cam 62 engaging roller 63 on the edge of the bar opposite lug 58. Hence, when cam 62 strikes roller 63 push rod 57 moves plate 49 to the right as viewed in Figs. 5 and 6, thus disengaging locating pins 47 and 48 from positive film 15 against the pressure of springs 52 and 53. When cam 62 passes off roller 63 the springs force plate 49 and pins 47 and 48 to the left in Figs. 5 and 6 until the pins enter the perforations 54 in the positive film and properly locate the film at the printing aperture.

Perforations in the edges of positive and negative films are at present obtainable in two different shapes and sizes. The general practice is to provide the negative film with what is known as the Bell and Howell perforation of one shape and size and the positive film with so-called square hole perforations of a different shape and size. These or any other type of perforation may be used in my machine since I locate the negative and positive films independently of each other and it is only necessary to use locating pins of the proper shape and size to fill the perforations of the respective films.

Cam 64 operates push rod 65 which releases the pressure of positive screen plate 18 from positive film 15 and from negative screen plate 13. Cam 64 is carried by the same shaft as cam 62. Screen plate 18 is mounted in frame 66 which has one end hinged at 67 to supporting plate 68 as shown in Figs. 2 and 6. Plate 68 carries leaf springs 69 which press the lower end of frame 66 against push rod 65 and thus press screen plate 18 against positive film 15 and screen plate 13 during the printing operation. When cam 64 forces push rod 65 to the right, as viewed in Fig. 6, it releases the pressure of frame 66 and screen plate 18 and permits screen plate 13 to be shifted laterally in a manner presently to be described.

The mechanism for shifting screen plate 13 includes cam 70 which is carried by the same shaft as gear 39 and is rotated by said gear as shown in Figs. 2 and 3. This cam has a groove 72 containing roller 73 which is attached to one end of lever 74. The lower end of lever 74 is pivoted to pin 75 as best shown in Figs. 3 and 8. Pin 75 is rigidly secured to upright frame 76 of the positive mechanism and extends through an elongated slot 77 in the lower end of lever 74. The pivoted end of lever 74 has a pair of movable plates 78 and 79 which are pivoted to the lever by bolts 80 and have semi-circular grooves 82 engaging pin 75. Plates 78 and 79 are held together by spring 83 and the plates have fingers or stops 84 adapted to engage the edges of lever 74 to limit the pressure of the grooved portions 82 of plates 78 and 79 on pin 75.

Pin 85 is carried by lever 74, about midway between its ends, and this pin passes through an elongated slot 86 in stationary guide 88 and engages a sliding member 87 which is slidably supported by guides 88 and 89. Member 87 is arranged at right angles to shifting lever 74 and carries a frame 90 which holds negative screen plate 13 as shown in Figs. 3 and 6. Frame 90 is secured to member 87 by means of screws 91 and 93 and, by loosening screw 91, frame 90 may be adjusted by means of micrometer thread adjusting screws 94 to bring negative screen plate 13 into proper vertical alignment with positive screen plate 18.

Micrometer thread adjusting screws 95 are mounted adjacent the extreme ends of sliding member 87 and these screws have heads 96 large

enough to contact with and serve as stops for sliding member 87. The object of stops 96 is to determine the relative positions of the black lines and transparent spaces of screen plates 13 and 18. Groove 72 of cam 70 is arranged to impart to sliding member 87 through lever 74 more lateral motion than is necessary to displace negative screen plate 13 the required distance of one line, and this excess movement of lever 74 is compensated by spring tensioned plates 78 and 79 which allow freedom of motion to the lower end of lever 74 but still insure the pivotal action necessary to slide the member 87 in a lateral direction without undue strain.

In describing the operation of the machine it is assumed that the negative consists of red and green values alternating with each other on a single strip of film 12 and that the red and green values are arranged in pairs on the film. The original object or scene shown in Fig. 11 has a red section R, a green section G and a white section W on a black background. Fig. 12 shows a negative frame of this scene taken through a red filter and Fig. 13 shows the other frame of the pair taken through a green filter.

In starting the printing operation the machine is first adjusted by hand to bring the negative screen plate 13 into what I call the "left-hand" position with the black lines 21 of screen plate 13 in perfect alignment and in register with the black lines of positive screen plate 18 as shown in Fig. 14. Adjustment of negative screen plate 13 is effected by micrometer screws 94 and 95 as previously described, and adjustment of positive screen plate 18 is effected by micrometer screw 97 as shown in Fig. 6.

A red value picture of negative film 12 is then located at the negative aperture 9 by suitable locating pins, and positive film 15 is placed between screen plates 13 and 18 and held at the printing aperture by locating pins 47 and 48 with emulsion 14 adjacent screen plate 13 and emulsion 19 adjacent screen plate 18. Lamps 4 and 6 are next turned on, but, as the blade of shutter 16 will at this time be interposed between lamp 6 and positive film 15 there will be no exposure of light to the positive film. However, as one of the clear spaces in shutter 8 will now be in position to allow free passage of light from lamp 4 to negative film 12, the red value negative image will be illuminated and said image will be projected optically to and through the transparent spaces 22 of screen plate 13 and photographically printed on the light sensitive positive film. Since black lines 12 of screen plate 13 will not transmit light, only parts of the red record will be imprinted on the light sensitive emulsion 14 in a series of black lines 98 alternating with a series of lines 99 of unexposed light sensitive emulsion in the same picture area as shown in Fig. 15. As yet there has been no exposure in emulsion 19 on the opposite side of the positive film.

Immediately after the above exposure shutter 8 rotates until one of its blades intercepts the passage of light to the negative film, and at this time the negative film is fed upward the distance of one frame to bring the companion green value picture of the pair into position at the negative aperture 9 previously occupied by the red value picture. While this action is taking place one lift of cam 64 operates push rod 65 and thereby releases the pressure of screen plate 18 from the positive film and from screen plate 13. Cam 70 now shifts the upper end of lever 74 to the right, as viewed in Fig. 3, and, since lever 74 actuates

sliding member 87 which carries screen plate 13, it will be evident that screen plate 13 will be laterally displaced to the right as viewed in Figs. 3 and 16. Sliding member 87 comes to rest against right-hand stop 96, it being understood that stops 96 are properly adjusted before starting the printing operation. Cam 64 now releases push rod 65, allowing springs 69 to press screen plate 18 against the positive film and screen plate 13.

The relative positions of the lines in the two screen plates will now be altered to the extent of one line so that the black lines of screen plate 18 will now register with the transparent spaces 22 of screen plate 13, and black lines 21 of screen plate 13 will be aligned with the previously printed lines 98 in emulsion 14 containing the latent image of the red values. However, in the embodiment here disclosed the black lines 21 of screen plate 13 are not as wide as the transparent spaces 22 through which the red record was printed, so that black lines 21 will not quite cover the edges of the previously printed red record lines 98 on the positive film and these edges will therefore be susceptible to further printing.

With screen plate 13 shifted in the above manner the second clear space of rotating shutter 8 comes into a position where light from lamp 4 is transmitted through negative film 12. This time the light will be transmitted through a green value negative picture, and this green value picture will be optically projected through the transparent spaces 22 of screen plate 13, thereby photographically printing a latent image of the green values on the previously unexposed portions 99 of emulsion 14 in the form of a series of lines 100 as shown in Fig. 17. Since black lines 21 of screen plate 13 do not quite cover the edges of previously printed red record lines 98 at this time it will be seen that green value lines 100 will slightly overlap red value lines 98 so as to form fine double exposed or black dividing lines 102 which separate the red color value images 98 from the green color value images 100 as shown in Fig. 18. The black dividing lines 102 may be of any suitable width, for example they may be about one-tenth the width of the color value lines.

At the time the record of the green value negative image is being imprinted on the positive film the shutter 16, rotating in unison with shutter 8, will be in a position which permits light from lamp 6 to pass through the transparent spaces of positive screen plate 18 onto the light sensitive silver emulsion 19 of the positive film which up to this time has received no exposure. The light passing through these transparent spaces will form lines 103 of exposed silver emulsion in register with the red value lines 98, and alternating lines 104 of soft unexposed silver emulsion in register with the green value lines 100 as best shown in Fig. 20. Having thus performed all the printing operations necessary for a complete and accurate record of the red and green color values in lines perfectly registered with lines of exposed and unexposed emulsion in one frame of the positive film, without disturbing the original location of the positive film, the machine continues to print the succeeding frames in the following manner.

As shutters 8 and 16 continue to rotate, their opaque blades will intercept the rays from lamps 4 and 6. Cam 40 now pushes film feeding pins 42 into engagement with perforations 54 of the positive film, and cam 62 actuates push rod 57 through cross bar 59, thus forcing dowel plate 49 to the right as viewed in Figs. 5 and 6 and thereby disengaging dowel pins 47 and 48 from

perforations 54 of the positive film. Cam 64 operates push rod 65 which releases the pressure of screen plate 18 on positive film 15 and screen plate 13, and screen plate 13 is restored to its first position by the action of cam 70. Harmonic cam 45 actuates feeding pins 42, thus moving positive film 15 downward the distance of one frame. Negative film 12 is fed upward the distance of one frame, thereby bringing the next red value picture into position at aperture 9 where it is located by suitable pins. Cams 40, 62 and 64 then release feeding pins 42, dowel plate 49 and positive screen plate 18, respectively, thereby completing the cycle of operations which is then repeated in the manner previously described.

Fig. 9 shows a combined optical and contact printing system which is similar to that shown in Fig. 1 except that negative shutter 8 is arranged between negative aperture 9 and objective lens 10 instead of being between condenser lenses 7 and negative aperture 9 as in Fig. 1. In the optical printing system of Fig. 10 negative screen plate 13 is located adjacent negative film 12 while positive screen plate 18 is located between auxiliary condenser lenses 7' and objective lens 10' on the positive side of the apparatus. In other respects the operation is the same as previously described.

It will be understood that the positive film bearing the completely printed and correctly registered record is subsequently developed, fixed, washed and dried in the usual manner, and that alternate exposed lines 103 and unexposed lines 104 in emulsion 19 are dyed in any suitable manner such as disclosed in the above mentioned Bauer and Kohlbacher application. It will also be understood that instead of positive film 15 I may use a positive film having a light sensitive emulsion or separate emulsions 105 on only one side of a transparent support 106 as shown in Fig. 21. In such case the printing of the color value images is carried on through transparent support 106, with the aid of screen plate 13, while the printing of the lines is carried on through screen plate 18 which is placed between the light source and the outer surface of the emulsion remote from the transparent support.

It will be evident that the invention is capable of various modifications and adaptations not specifically described but included within the scope of the appended claims.

The invention claimed is:

1. In a photographic printing machine, a pair of screen plates, means for feeding a strip of film between said screen plates, means for clamping said strip in printing position between said screen plates, means for releasing said strip, and means for shifting one of said screen plates laterally of said strip.

2. In a photographic printing machine, a pair of screen plates, means for feeding a strip of film between said screen plates, means for exerting pressure on one screen plate to force same against the other screen plate, means for releasing said pressure, and means for shifting one of said screen plates laterally of said strip.

3. In a photographic printing machine, a slidable screen plate and a hinged screen plate, means for feeding a strip of film between said screen plates, a spring pressing said hinged screen plate against said strip, means for releasing the spring pressure on said hinged screen plate, and means for sliding the other screen plate laterally of said strip.

4. In a photographic printing machine, a pair

of screen plates having alternating opaque areas and transparent spaces, means for feeding a strip of film between said screen plates, means for adjusting said screen plates to align their opaque areas, means for exerting pressure on one screen plate to force same against the other screen plate, and means for shifting said other screen plate laterally of said strip.

5. In a photographic printing machine, a pair of screen plates, means for feeding a perforated strip of film between said screen plates, reciprocating pins for locating said strip in printing position, means for pressing one screen plate against the other, means for releasing the pressure on said screen plate, means for moving the other screen plate laterally of said film, and means for actuating said strip feeding means, reciprocating pins and screen plate moving and releasing means in synchronism.

6. In a photographic printing machine, a negative screen plate and a positive screen plate, means for feeding a perforated strip of positive film between said screen plates, reciprocating pins for locating said strip in proper printing position between said screen plates, means for exerting pressure on said positive screen plate to force same against said strip and said negative screen plate, a push rod acting on said positive screen plate to release said pressure, a shifting lever for moving said negative screen plate laterally of said strip, adjustable stops limiting the lateral movement of said negative screen plate, and means for actuating said strip feeding means, reciprocating pins, push rod and shifting lever in synchronism.

7. In a photographic printing machine, a negative screen plate and an adjacent positive screen plate having one end hinged and the other end free, means for feeding a perforated strip of positive film between said screen plates, reciprocating pins for locating said strip in proper printing position between said screen plates, a spring pressing said positive screen plate against said strip and said negative screen plate, a push rod acting on the free end of said positive screen plate to release said spring pressure, a shifting lever having a flexible pivotal support at one end and having means for moving said negative screen plate laterally of said strip, adjustable stops limiting the lateral movement of said negative screen plate, and a power shaft having means for actuating said strip feeding means, reciprocating pins, push rod and shifting lever in synchronism.

8. A machine for printing a positive film having two strata of light sensitive emulsion from a negative film containing alternating families of color value images, comprising means for feeding the negative film a plurality of predetermined lengths and for independently feeding the positive film one length, a negative screen plate between said films having alternating black areas and transparent spaces, a positive screen plate at the opposite side of the positive film having alternating black areas and transparent spaces, means for independently locating said films in proper printing position with respect to said screen plates, means for shifting said negative screen plate laterally of said positive film, means for exposing one side of said positive film to light through said negative screen plate and said negative film, means for exposing the other side of said positive film to light through said positive screen plate, and means for actuating said film feeding means, film locating means, screen plate

shifting means and exposing means in synchronism.

9. A machine for printing a positive film having two strata of light sensitive emulsion from a negative film containing alternating families of color value images, comprising means for feeding the negative film a plurality of predetermined lengths and for independently feeding the positive film one length, a negative screen plate between said films having a series of alternating black areas and transparent spaces, a positive screen plate at the opposite side of the positive film having a series of alternating black areas and transparent spaces, means for independently locating said films in proper printing position with respect to said screen plates, means for adjusting said screen plates to register the black areas of one with the black areas of the other, a shifting lever for moving said negative screen plate laterally of said positive film, stops limiting the lateral movement of said negative screen plate to a distance equal to one space, means for exposing one side of said positive film to light through said negative screen plate and said negative film, and means for exposing the other side of said positive film to light through said positive screen plate.

10. A machine for printing a positive film having two strata of light sensitive emulsion from a negative film containing alternating families of color value images, comprising means for feeding the negative film a plurality of predetermined lengths and for independently feeding the positive film one length, a negative screen plate between said films having a series of alternating black lines and transparent spaces, a positive screen plate at the opposite side of the positive film having a series of alternating black lines and transparent spaces, means for independently locating said films in proper printing position with respect to said screen plates, means for adjusting said screen plates to register the lines and spaces of one with the lines and spaces of the other, a shifting lever for moving said negative screen plate laterally of said positive film, stops limiting the lateral movement of said negative screen plate to a distance equal to one line, means for exposing one side of said positive film to light through said negative screen plate and said negative film, means for exposing the other side of said positive film to light through said positive screen plate, and means for actuating said film feeding means, film locating means, shifting lever and exposing means in synchronism.

11. A machine for printing a positive film having two strata of light sensitive emulsion from a negative film containing alternating families of color value images, comprising means for feeding the negative film a plurality of predetermined lengths and for independently feeding the positive film one length, a negative screen plate between said films having alternating black areas and transparent spaces, a positive screen plate at the opposite side of the positive film having alternating black areas and transparent spaces, means for aligning the black areas of the respective screen plates, means for independently locating said films in proper printing position with respect to said screen plates, means exerting pressure on said positive screen plate to force same against said negative screen plate, means for releasing said pressure, and means for shifting said negative screen plate laterally of said positive film.

12. A machine for printing a positive film

having two strata of light sensitive emulsion from a negative film containing alternating families of color value images, comprising means for feeding the negative film a plurality of predetermined lengths and for independently feeding the positive film one length, a negative screen plate between said films having a series of alternating black lines and wider transparent spaces, a positive screen plate on the opposite side of the positive film having alternating black lines and transparent spaces of equal width, means for adjusting said screen plates to bring the respective black lines into alignment, means for independently locating said films in proper printing position with respect to said screen plates, means for pressing said positive film plate against said negative screen plate, means for releasing said positive screen plate, and means for shifting said negative screen plate laterally of said positive film.

13. A machine for printing a perforated positive film having two strata of light sensitive emulsion from a perforated negative film containing alternating families of color value images, comprising means for feeding the negative film a plurality of predetermined lengths and for independently feeding the positive film one length, a negative screen plate between said films having a series of alternating black areas and transparent spaces, a hinged positive screen plate at the opposite side of the positive film having a series of alternating black areas and transparent spaces, reciprocating pins for independently locating said films in proper printing position with respect to said screen plates, means for adjusting said screen plates to register the black areas and transparent spaces, means for exerting pressure on said positive screen plate to force same against said positive film and said negative screen plate, means for releasing the pressure on said positive screen plate, a shifting lever for moving said negative screen plate laterally of said positive film, stops limiting the lateral movement of said negative screen plate to a distance sufficient to register its black areas with the transparent spaces of said positive screen plate, means for exposing one side of said positive film to light through said negative screen plate and said negative film, means for exposing the other side of said positive film to light through said positive screen plate, and means for actuating said film feeding means, reciprocating pins, pressure releasing means, shifting lever and exposing means in synchronism.

14. A machine for printing a plurality of picture images alternating with each other in one stratum and on the same focal plane of emulsion in one picture area of a positive film having two strata of light sensitive emulsion, comprising means for optically projecting the images from the negatives through and in combination with a movable screen plate of alternating narrow

opaque lines and wider transparent spaces, in contact with the positive film so that the lines of the screen plate and the negative images will be on the same printing plane for perfect definition, said screen plate having the clear spaces wider than the opaque lines to cause double printing at the edges of the lines of the images to form black area which separate the individual images, said positive film being rigidly registered at one setting to receive the impressions from the negatives to prevent errors of spacing.

15. A machine for printing a plurality of picture images alternating with each other and subdivided by black areas in one stratum and on the same focal plane of an emulsion in one picture area of a positive film having two strata of light sensitive emulsion on opposite sides of a support, comprising means for optically projecting the images from the negatives through and in combination with a movable screen plate of alternating black lines and wider transparent spaces in contact with the emulsion on one side of the positive film and simultaneously printing black and white lines only with the aid of a fixed screen plate of equal proportions in contact with the emulsion on the opposite side of the film, said black and white lines being printed in one emulsion so as to register with the picture images printed in the opposite emulsion.

16. A machine for printing positive film having two strata of light sensitive emulsion from families of negative color value images, comprising means for projecting separate negative images through a movable screen plate in contact with and on separate areas in the same stratum of one emulsion and simultaneously printing a design record only, in the other stratum of emulsion in register with one set of positive color value images in the first stratum, the said positive film being rigidly registered in one position for all printing operations to prevent errors of spacing and registration.

17. A machine for printing a positive film having two strata of light sensitive emulsion from a negative film of alternating families of color value images, comprising means for feeding the negative film a plurality of predetermined lengths while holding the positive film in register in one position for successive printings and for independently feeding the positive film one length, means for printing by projection one negative image upon alternating areas of one stratum of said emulsion, means for projecting a companion negative image upon intermediate areas of the same emulsion and double printing at the edges of the images on the same focal plane and in the same stratum of emulsion, and means for simultaneously printing a design record only in the other stratum of the said emulsion in register with the color value positive images.

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