P. D. BREWSTER.

APPARATUS FOR COLOR CINEMATOGRAPHY.

APPLICATION FILED JUNE 29, 1918. RENEWED FEB. 3, 1920.

1,359,025.

Patented Nov. 16, 1920.

4 SHEETS—SHEET 1.

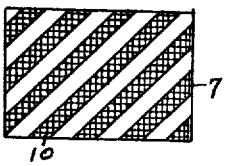

FIG. 3.

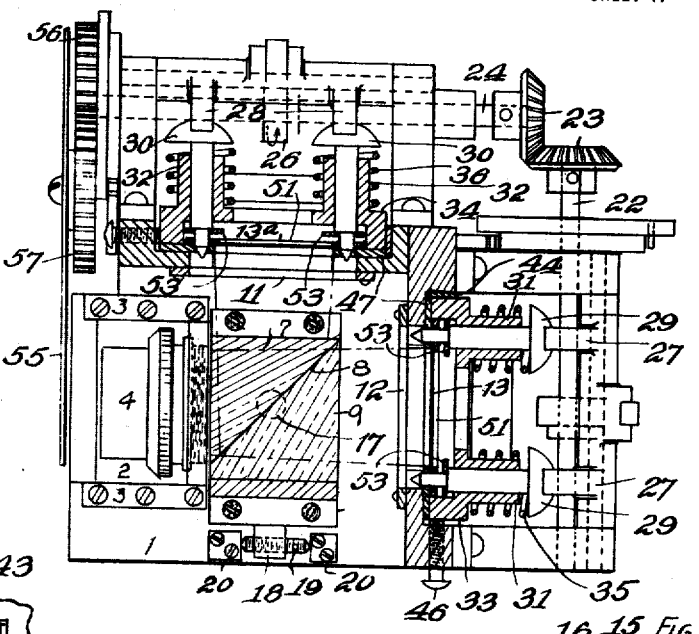

FIG. 1

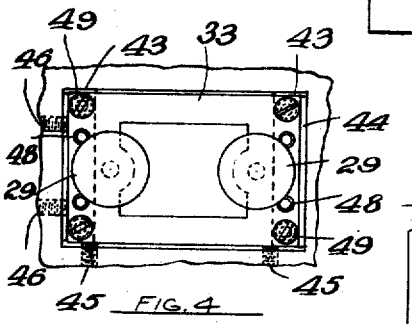

FIG. 4

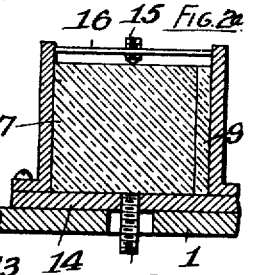

FIG. 2a

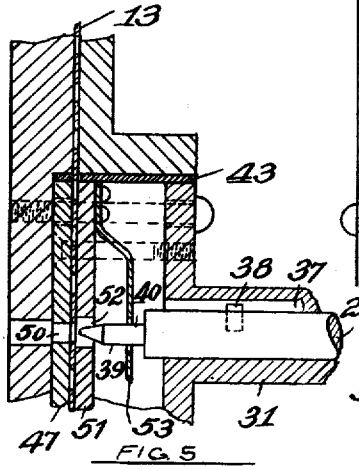

FIG. 5

FIG. 2

FIG. 6

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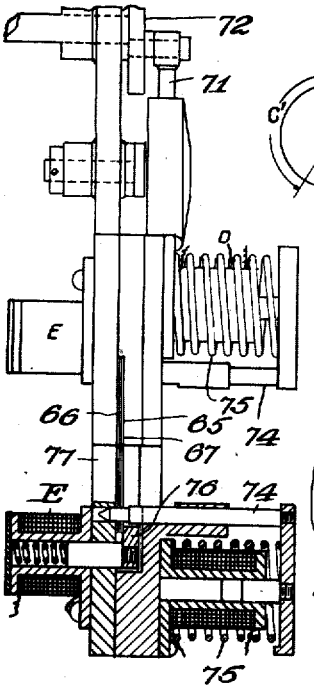


FIG. 8

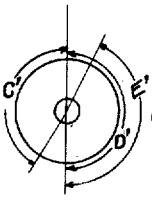


FIG. 8a

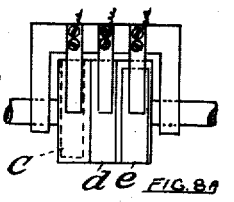
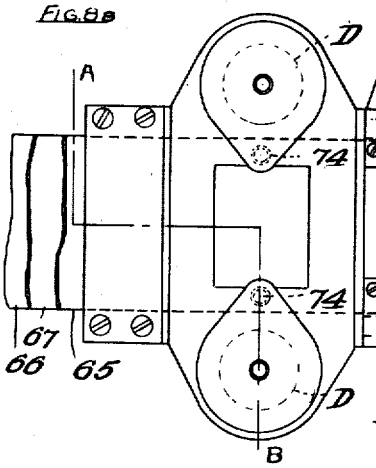


FIG. 8b



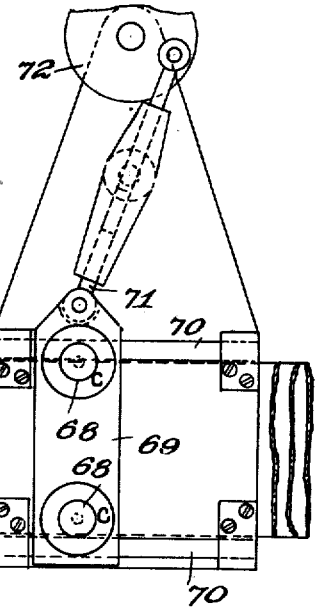


FIG. 7

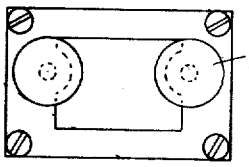


FIG. 10

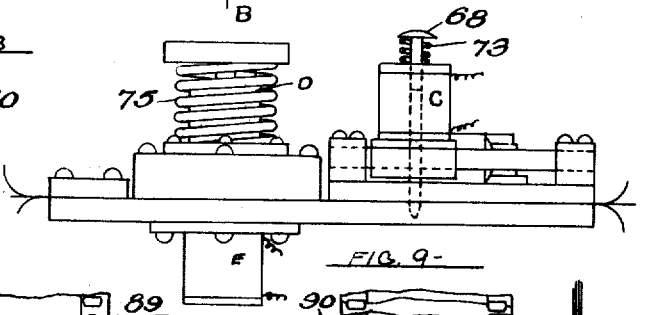


FIG. 9

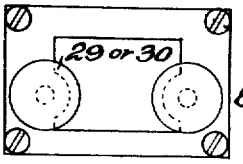


FIG. 11

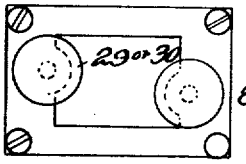


FIG. 12

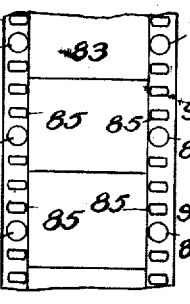


FIG. 13

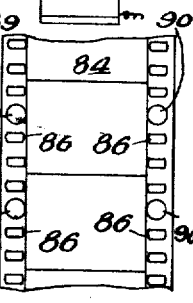


FIG. 14

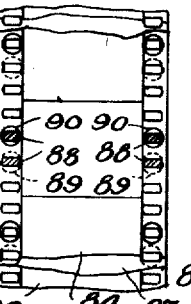


FIG. 15

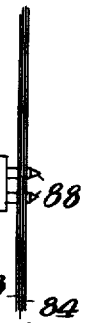


FIG. 16

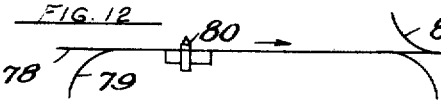


FIG. 17

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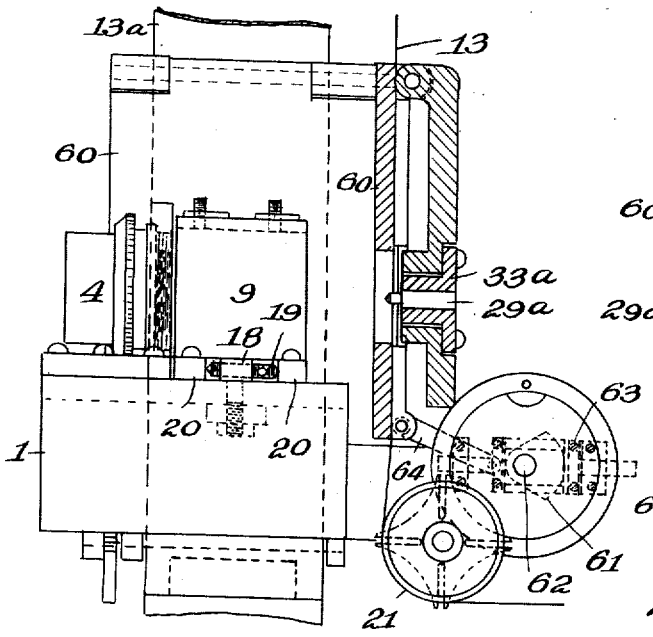

FIG. 18.

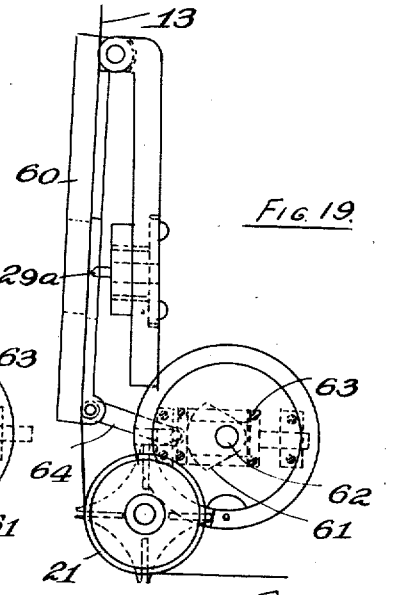

FIG. 19.

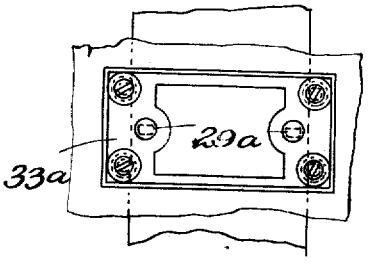

FIG. 20.

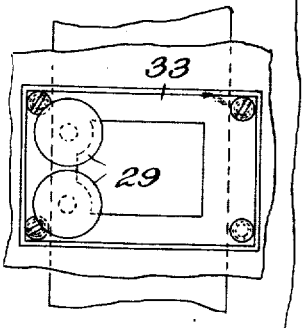

FIG. 21.

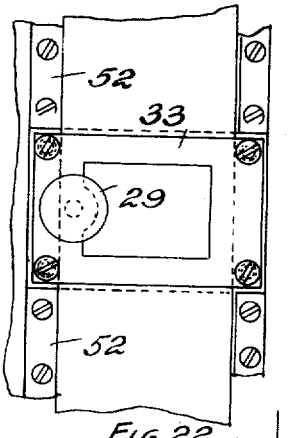

FIG. 22.

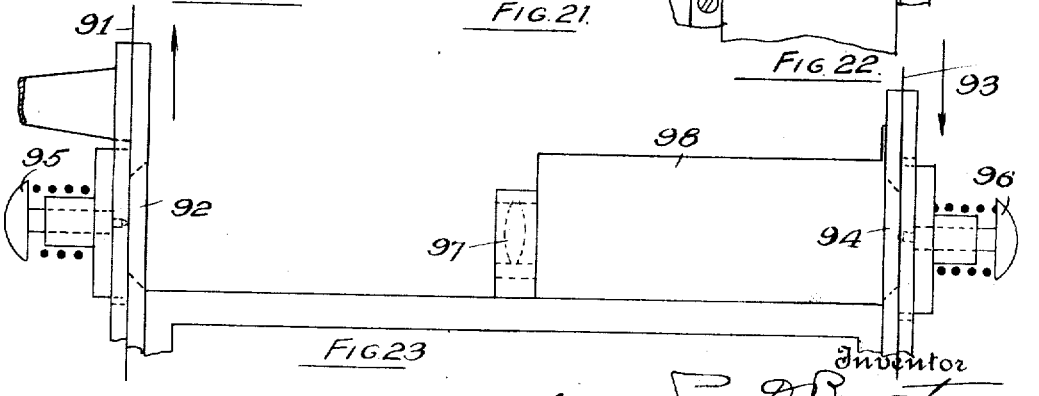

FIG. 23.

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4 SHEETS—SHEET 4.

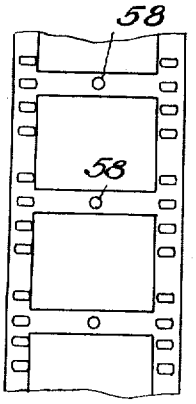

FIG. 24.

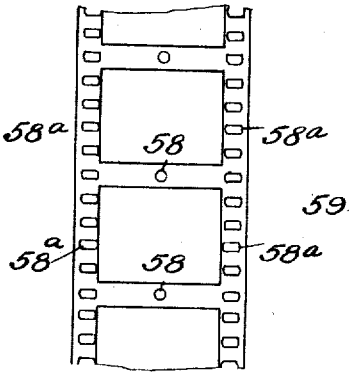

FIG. 25.

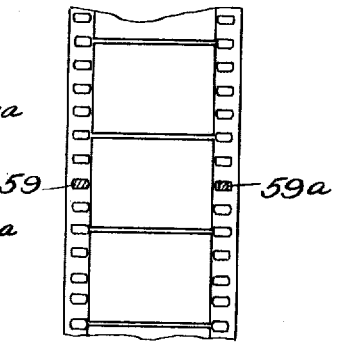

FIG. 26.

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By his Attorneys

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UNITED STATES PATENT OFFICE.

PERCY DOUGLAS BREWSTER, OF EAST ORANGE, NEW JERSEY.

APPARATUS FOR COLOR CINEMATOGRAPHY.

1,359,025. Specification of Letters Patent. Patented Nov. 16, 1920.

Application filed June 29, 1918, Serial No. 242,539. Renewed February 3, 1920. Serial No. 355,958.

To all whom it may concern:

Be it known that I, PERCY D. BREWSTER, a citizen of the United States, residing at East Orange, in the county of Essex and State of New Jersey, have invented certain new and useful Improvements in Apparatus for Color Cinematography, of which the following is a full, clear, and exact description.

In the art of color cinematography it has been proposed to make two color records, on separate negative films, for example one series of images or pictures on one of the films taken through a red filter and the other series on the other film taken through a green filter, and then by contact print the two series on the opposite sides of a positive film which is sensitized on both sides. The positive film is then developed and fixed, and the images on the two sides are stained or colored, say red on one side and green on the other, so that when the two images are projected (of course simultaneously) on the screen a unitary image in substantially natural colors will result. So far as I am aware this method, in which the color records are made on two separate films, has never been successful in practice, however attractive in theory; the reason being the difficulty, heretofore insuperable, of securing accurate enough registry of the images in printing them on the positive film. The necessity for accurate registry will be apparent when it is remembered that if the pictures are out of registry on the positive film the defect is evidenced on the screen by red and green color bands or fringes at the edges of the objects photographed.

I have therefore been led to devise my present invention, which has for its chief object to provide an improved method and apparatus whereby adequate registry can readily be attained. To this and other ends the invention consists in the novel procedure and apparatus hereinafter described.

In carrying out the invention in the preferred manner each negative picture is positioned, at the time of exposure, in a definite and fixed relation to one or more perforations, but preferably two, in each negative film. This is effected by the use of registry pins, which enter the selected perforations, say one on each side of the film, before the exposure is made, so as to locate each film in the exposure position. Usually the same perforations as were used to locate the negative images are then used to register the negative images with each other in printing the positive. I also prefer to use films perforated before exposure with the standard spacing, as I have found that the first class perforating machines now in use give highly accurate results, but it is within the spirit of my invention to use special perforations in each negative film.

Referring to the accompanying drawings, in which the preferred embodiment of the invention is illustrated,

Figure 1 is a sectional plan view of the camera (omitting the usual light-tight casing and the film-feeding mechanism) showing the registry pins in their advanced positions.

Fig. 2 is a side view of the parts shown in Fig. 1, partly in vertical section.

Fig. 2^a is a cross section of the light-splitting device on a plane at right angles to the optical axis of the lens, illustrating a method of tilting the device to raise or lower one of the images.

Fig. 3 is an elevational view of the reflecting and transmitting surface of the light-splitting device by which part of the light from the lens is transmitted to one of the negative films and part reflected to the other.

Fig. 4 is a rear view of one of the registry plates and its pair of registry pins.

Fig. 5 is a detail section, on a larger scale, showing one of the registry pins about to enter the selected perforation in the negative film.

Fig. 6 is a detail front view, on the same scale as Fig. 5, showing the pointed end of one of the registry pins, in its registry plate.

Fig. 7 is a diagrammatic plan view of the more important parts of the printing machine that I prefer to use.

Fig. 8 is an end view, partly in section on line A—B of Fig. 7.

Fig. 8^A is a plan view of the commutator which controls the printing solenoids.

Fig. 8^B is a diagram representing the timing of the solenoids.

Fig. 9 is a side view of the parts shown in Fig. 7.

Figs. 10, 11 and 12 are rear views of registry plates, showing different arrangements of the registry plates.

Figs. 13 and 14 show portions of two negative films which have been specially perforated.

Fig. 15 shows three films—two negatives with a positive between—registered together for printing.

Fig. 16 is a side view of the films in Fig. 15, showing the double registry pins.

Fig. 17 is a diagram illustrating a printer which images are printed on one side of the positive after the corresponding images on the other negative have been printed on the other side.

Fig. 18 is a side elevation, partly in section, of a camera in which the registry pins are stationary and the film is moved into engagement with them.

Fig. 19 is a side view of the registry mechanism of Fig. 18, showing the films disengaged from the registry pins.

Fig. 20 is a rear view of the registry plate used in the camera illustrated in Figs. 18 and 19, showing the ends of the registry pins in dotted lines.

Fig. 21 is a rear view of a registry plate with two registry pins, one above the other.

Fig. 22 is a rear view of a registry plate having a single registry pin.

Fig. 23 is a diagrammatic side view of an "optical" printer, for printing by optical projection of the images from the negative films upon the positive film.

Fig. 24 shows a negative film with certain of the usual perforations omitted and special perforations provided between the successive images.

Fig. 25 shows the same film after it has been re-perforated to supply the omitted perforations.

Fig. 26 shows the same film as positioned in the printer, with the special registry pins employed.

The camera illustrated in Figs. 1 and 2 comprises a base 1, on which the sliding front 2 is adapted to be moved (for focusing) between guides 3, 3, by the rack and pinion 5, 6. The lens 4 is carried by the front 2.

The light from the lens enters the splitting prism 7—9, composed of two triangular prisms having their inclined faces 8 cemented together. One of these surfaces is partially silvered, as for example in bands or stripes 10, Fig. 3, so that incident rays striking the silvered portions will be reflected at right angles and pass thence through the filter 11, preferably green, to the "green" film, not shown, while rays striking the unsilvered portion of surface 8 are transmitted and pass through the filter 12, preferably red, to the "red" film 13, Fig. 2. Preferably the prisms used are of the 45° type, but in any case the surfaces from which the rays emerge should be perpendicular to the axial rays and the films should be perpendicular to the same rays. The films used may both be panchromatic, or one may be specially sensitized for the green group of rays, as for example by pinaverdol, and the other for the red group, as by pinacyanol. If the films are specially sensitized I sometimes prefer to use in front of the "green" film 13^a, Fig. 1, a yellow filter, such as the standard K_2 or K_3 which will sufficiently reduce the action of blue and violet rays on the film. Such a filter is "faster" than any green filter that I know of and thus permits shorter exposures to be made.

The splitting prisms are held firmly on their base 14, Figs. 2 and 2^a, by means of screws 15 in the upper spring clips 16. The base is mounted on a vertical pivot 17 the axis of which is in the plane of the reflecting and transmitting surface 8. The prisms can therefore be rotatively adjusted to shift the reflected image laterally on the film. To make this adjustment easily and accurately the base 14 is provided on one side with a lug (Fig. 1) having a capstan screw 19 working between two stops 20 on the camera bed 1.

By the optical system described above, two separate light-images of the object to be photographed are produced in predetermined areas or parts of two separate focal planes, preferably at right angles to each other.

The two films are fed intermittently through their film gates (which embrace the above-mentioned focal plane areas) by any suitable mechanism, as for example a Lumiere or a Geneva movement, one of the latter type being illustrated in connection with the film 13, which is advanced by the sprocket 21. The shaft 22, which is the main driving shaft, rotated manually by means of any convenient mechanism, is connected by bevel gears 23 to shaft 24 which actuates the feeding mechanism (not shown) for the other film.

The cams 25, 26, are mounted on shafts 22, 24, respectively, and are arranged to actuate the rocker arms or levers 27, 28, at the proper times. The registry pins 29, 29, 30, 30, are mounted in guides 31, 31, 32, 32, carried by the registry plates 33, 34, to reciprocate in paths perpendicular to the films. Coil springs 35, 36, urge the pins outwardly against their actuating arms 27, 28, and press the latter firmly against the cams.

The cams 25, 26 are preferably so timed that as soon as the films have been fed down one image space the registry pins are advanced into their respective perforations. In general it is desirable that the pins enter perforations which are as near as possible to the centers of the respective exposure spaces or areas on the films, and I therefore prefer to have the pins in the lines

passing horizontally through the points where the axial rays strike the films; the feeding mechanism being constructed so that when the films come to rest a pair of perforations on each film will be opposite the respective registry pins. The feed-mechanism should also maintain the usual loop or slack in the films above the film gates, to permit the films in the film gates to be shifted slightly downwardly or sidewise by the registry pins, and the lower sprockets should be set to leave the centers of the registry perforations (which are entered by the registry pins) slightly above the axis of the pins so that the latter will not be required to raise the film, which, as will be readily understood, is held down by the sprocket and hence cannot move upwardly.

In the claw type of feeding mechanism the claws leave the film at the end of their downward stroke and the film is therefore free. I prefer the Geneva type, however, for the reason that the feeding movement requires only about one-sixth of the revolution of the driving shaft as against a third, more or less, in the Lumière-claw type; thus affording ample time for the operation of the registry pins without reducing the period devoted to exposure of the films.

One of the registry pins is illustrated in detail in Figs. 5 and 6. As there shown, each pin comprises a round shank fitting its guide (designated by 31 in Fig. 5), which has an interior guide groove 37 to receive the stud 38 carried by the shank. As shown in Fig. 5, the front portion of the pin is shaped to fit the perforations in the film, and to facilitate its entry into the perforations its point is beveled, preferably with a longer bevel on the underside to give adequate camming effect downward when the film comes to rest (after the operation of the feed mechanism) with the center of the perforation above the axis of the pin.

The pin should advance with its flat surfaces 39, 40, Figs. 5 and 6, truly parallel to the "flats" of the film perforation, in order to avoid possible distortion or other injury to the edges of the perforation; or the pin should be capable of slight rotary movement so as to adjust itself to the perforation. For this reason I prefer to have the pin shank round and make the stud 38 slightly smaller than its keyway 37. The pin is thus maintained in such position that the flat of its taper will engage the flat of the perforation and, if the pin and perforation are not exactly registered, will cam the pin rotatively until the flats make even contact throughout. The pin itself is then rotated to its normal position (that is, to the position which it occupies during the exposure period) by the closely fitting pin-aperture 50, Fig. 5, hereafter more fully described, thereby shifting the film in the film gate to the exposure position. Preferably the registry pins are from .001 to .002 of an inch smaller than the perforations.

From the foregoing it will be seen that before exposure each film is positioned by two selected registry perforations, and that in consequence the images produced by the exposures bear each a definite fixed relation to the registry perforations. In practice the pins for one of the films are carefully set. The relation thus established between the images on that film and the corresponding registry perforations is taken as a standard, and the corresponding relation on the other film is adjusted to conform thereto. My invention contemplates several ways of effecting this adjustment, for example by an optical method, so to speak, in which the image is shifted horizontally or vertically, or in both directions, or by a mechanical method, in which the registry pins which coöperate with one of the films are shifted, or by a combination of both methods.

In the optical method of adjustment illustrated herein the reflected image is shifted laterally in either direction to any desired extent by turning the light-splitting device on its vertical axis by means of the screw 19, as already described. To raise or lower the reflected image one side or the other of the light-splitting device is raised by placing under it one or more shims, not shown. Or screws, as 42, Fig. 2ª, can be provided in the base 14 at each side to raise or lower one side or the other as may be desired. In the mechanical method I prefer to effect the vertical adjustment of the registry pins to raise or lower the registry perforations or shift them laterally relatively to the image in the focal plane by the use of shims 43, 44, and screws 45, 46, Figs. 2, 4 and 5. In practice my procedure has been to make a series of negative pictures on the films and superpose the two films, face to face, registering them by means of pins through the registry perforations. Taking the position of the images on one film relative to the registry perforations as the standard, I measure the vertical and horizontal errors, if any, in the other by means of a microscope in thousandths of an inch, and then substitute for the shims used others of proper thickness to correct the errors. Quick and accurate results are obtained by this method.

The aperture plates 47, Figs. 1, 2 and 5, behind which the films travel, are secured directly to the guide plates 33, 34 (so as to be shifted with the latter when they are adjusted), by means of a dowel 48 and screws 49, Fig. 4, and are provided at each side with

pin-apertures 50, Fig. 5, to receive the registry pins. The apertures preferably fit the pins closely.

The pressure plates 51, Figs. 1, 2 and 5, hold the films snugly against the rear surfaces of the aperture plates 47 while the exposures are being made, the registry pins extending through the relatively large openings 52. As the pins advance, the shoulders on the pins meet the springs 53 and by their pressure on the latter press the plates 51 upon the back of the films. At one end, say the top, springs may be fixed to the pressure plates but at the other end are preferably held loosely by the screws, see 54, Fig. 2, to permit free flexure of the springs without cramping the pins.

The shutter 55, Fig. 1, operating in front of the lens to expose and obscure the films, is actuated from shaft 24 by means of the gears 56, 57, in harmony with the movement of the films.

From the foregoing the operation of the camera will be readily understood. The parts being in the position shown in Figs. 1 and 2, the shutter uncovers the lens to make the exposures and then covers it again. The cams 25, 26, rotating in the direction of the arrows and operating through the levers 27, 28, now permit the springs 35, 36 to retract the registry pins 29, 30, thereby releasing the film, after which the lower feed sprockets draw the film down through the space of one picture. The cams then advance registry pins again, which "justify" the films and through the medium of the pressure plates 51 hold them firmly in position, thus bringing the parts again to the positions shown in Figs. 1 and 2, and completing the cycle.

As previously stated, I prefer to arrange the registry pins at the horizontal or transverse center-line of the image space, as in Figs. 2 and 4, but they may be positioned to enter other pairs, as for example the next pair above, as in Fig. 10, or the next below, as in Fig. 11. I also prefer to use corresponding pairs of perforations in the two films, but modern perforating machines are so accurate in operation that the error between their successive perforation is, I have found in practice, entirely negligible, and it is therefore practicable to use different perforations in the two films. For example, I may arrange the registry pins as in Fig. 10 for one film, and as in Fig. 11 for the other. Or I may have one pin below the transverse center-line and one above, as in Fig. 12, or two perforations on the same side of the film may be used, with two pins, one above the other, as 29, Fig. 21. Indeed I may use only one pin as in Fig. 22, but in thise case it is well to provide a vertical guide 52 on one side of the film above and below the guide plates, against which guides the film is lightly pressed, to prevent side play or "weave." In fact, with film perforated accurately any perforations may be used, but they should be near the picture space so as to avoid or minimize the effects of shrinkage in development. Still another method is illustrated in Fig. 25. In the film there shown every fifth perforation on each side is omitted but perforations 58 between the spaces for the pictures are provided for the registry pin or pins, which are of course correspondingly arranged in the camera. These intermediate perforations may be of the standard shape and size, or they may be round as shown. In using such a film in a camera employing sprockets to advance the film every fifth tooth on each side of the sprockets is omitted. After developing, fixing and drying, the film is re-perforated to supply the missing perforations, as at 58^a, in Fig. 25, using the intermediate perforations 58 as guides for the pilot pins in the perforator, and preferably using these new perforations, 58^a, for registry in printing.

Inasmuch as developed and fixed film is found, after drying, to have shrunk about one per cent. of its original length I prefer to have the perforations in the undeveloped negative one per cent. farther apart (vertically) than in the unprinted positive, so that in printing the latter (after the negative film has shrunk) the perforations in the two negatives and the positive will match exactly.

If the film has been supersensitized for one or more colors by means of a dye both after perforating, I prefer to use in the camera registry pins of the type illustrated in Fig. 26. Here the pin 59 on one side of the film is shaped to fill the perforation, vertically and horizontally; while on the other side the pin 59^a fills the perforation vertically but not horizontally, to prevent any slight bending of the film in its own plane.

In the camera illustrated in Figs. 18 to 21 inclusive, the registry pins, as 29^a, are not reciprocated but are stationary and the films are slipped on and off the pins, the entire film for a suitable distance above and below the pins being swung clear of the pins before it is fed down for the next exposure. For this purpose the films, as 13, 13^a, fed down step-by-step by the feed sprockets, pass through swinging film gates 60, pivoted at the top. The cam 61, fixed on the shaft 62 (corresponding to shaft 22 in Figs. 1 and 2), works in and reciprocates a frame 63 which is connected to bottom of the film gate by a link 64. It will be understood that similar feeding mechanism, with a similar cam, frame and link, is provided in conjunction with the other film gate. The parts being in the position shown in Fig. 18, the shutter (not shown) makes the exposure. The cams then advance the frames, which

swing the film gates forwardly, carrying the films off the registry pins. The feed sprockets now draw the films down one picture space and come to rest, after which the cams retract the film gates and bring the next registry perforations in the films into engagement with the pins, thus completing the cycle and leaving the films accurately positioned for the next exposure. As in the other cameras illustrated, the light splitting device is adjustable to correct the relative positions of the images in the focal planes by the optical method described, and the registry or guide plates, as 33^a, are adjustable vertically and horizontally (preferably by the use of shims, not shown) to make the correction by the mechanical method.

For printing the positive films I prefer to use the printer illustrated in Figs. 7, 8 and 9. The red color record negative 65, the green color record negative 66, and the positive 67 between the two, are fed together step-by-step, one picture space at a time, through the film gate and past the exposure opening on each side, by the feed pins 68, which are fixed in a crosshead 69 mounted to be reciprocated lengthwise of the films on rails 70 by a sliding and oscillating link 71 connected to the crank disk 72. The feed pins are withdrawn from the films by springs 73, Fig. 9, and are passed into the film perforations by solenoids C, the fields of which act upon the iron outer portions of the pins, the inner portions of the pins being made of brass or other non-magnetic metal. After the films have been fed forward and the feed pins withdrawn (through the deënergization of the solenoids) the registry pins 74, which have been held in their outer positions by the springs 75, are advanced by the solenoids D, the fields of which attract the iron cores, into registry perforations in the films. The perforations used in negatives for registering the two are preferably the same perforations as were used in the camera, but if the films were perforated with sufficient accuracy other perforations may be used in the printer. The apertured pressure plate, part of which is shown at 76, Fig. 8, is next drawn in by the solenoids E, thereby pressing the three films snugly together upon the plate 77. The exposure is now made, after which the operations described are repeated until the printing is complete. The solenoids C, D, E are energized and deënergized under the control of the timing commutator, Fig. 8^A, by means of the respective contacts or segments c, d, e. The timing is determined by the length of the contacts, and is represented in the diagram, Fig. 8^B, by the respective angles C', D', E'.

In Fig. 17 is illustrated diagrammatically a method of printing in which the two negative images are not printed on the positive simultaneously but instead one image of the pair is printed, on one side of the positive, and later the other image of the pair is printed on the other side in registry with the first. In this figure 78 represents the positive film. 79 is one negative film, say the red color record, registered with the positive by registry pins, of which one is shown at 80. 81 is the other negative, registered by pins 82 to print the other image of a pair that was previously printed at the position indicated by the pin 80. Preferably, in each case the pins 82 coöperate with the same perforations (in the positive) that were entered by pins 80.

Figs. 13 and 14 illustrate a pair of negative films made simultaneously in a camera in which the registry pins were not located in the same relative positions and hence did not enter corresponding perforations in the two films. In the films 83 and 84 shown, the registry or "master" perforations 85 were entered by registry pins located as in Fig. 11, while registry or "master" perforations 86 were entered by pins located as in Fig. 10. Films so registered in the camera are preferably printed on the positive 87 by means of double registry pins 88, Figs. 15 and 16. To prevent the edges of the registry perforations on each film from interfering with the pin that registers the other film, in printing, the adjacent perforations, 89 in film 83, and 90 in film 84, are enlarged, as shown, so that the pins 88, Fig. 15, can pass into the proper registry perforations.

The films may also be printed by optical projection, as for example by means of the apparatus illustrated diagramatically in Fig. 23. In the apparatus shown, the positive film 91 (one of the color record negatives made according to my invention) is fed upwardly step-by-step through the film gate 92 and the negative film 93 is fed downwardly step-by-step through the film gate 94. At each step the two films are registered by registry pins 95, 96, actuated by mechanism like that illustrated in the camera, Figs. 1 and 2. A suitable projecting lens 97 projects the rays from the negative 93 through the light-tight housing 98 to form the image on the positive film 91. A suitable shutter, not shown, is provided to cut off the light while the films are in motion and are being registered. The feed mechanisms may be like that shown in Fig. 2. After the series of images is printed on one side, the positive is turned over and run through again, with the other color record negative to receive the other images of each pair or group.

It is within the spirit of my invention to use two lenses, one for each film, instead of a single lens as in Figs. 1 and 18. Also the two exposures (to make an image pair

or group) may be made one after the other instead of simultaneously. In place of exposing two negative films, a single film of double width may be used and the images made side by side. After exposure the negative can be split lengthwise to form two separated color records, if desired, or its images can be printed on the two sides of the positive without splitting the negative in two. For three-color cinematography three separate negative films may be used.

It is to be understood that the invention is not limited to the specific details herein illustrated and described but can be practised in other ways and embodied in other forms without departure from its spirit as defined by the following claims:

I claim:

1. In a camera for making negative films for color cinematography, in combination, optical means for producing separate images in separate focal plane areas; intermittently operating film-feeding mechanism for passing a pair of perforated negative films step by step through the respective focal plane areas and permitting the films to be shifted in their own planes after the feed mechanism comes to rest; film-shifting devices adapted to coöperate with at least one selected perforation in each film at each step and operating independently of the feed mechanism after each feeding operation thereof, to shift the films in the respective focal planes to positions in which the selected perforations are in predetermined relation to the positions of the light-images projected by the said optical means; and means for actuating the feed mechanism and the film-shifting devices in harmony with each other.

2. In a camera for making negative films for color cinematography, in combination, optical means for producing separate images in focal planes at an angle to each other; a pair of film gates having exposure apertures; mechanism for feeding two films step by step through the respective film gates and permitting the films to be shifted in their own planes after the feed mechanisms come to rest; adjusting means coöperating with said optical means to shift at least one of the images in its focal plane; film-shifting means coöperating with at least one selected perforation in each film in the respective focal plane independently of the feed mechanism at each step to shift the films to positions in which each selected perforation has a predetermined positional relation to the respective image projected by the optical means; and mechanism for actuating the film-shifting means after each operation of the feed mechanism.

3. In a camera for making negative films for color cinematography, in combination, a pair of film gates arranged at an angle to each other and having exposure-aperture plates; optical means for projecting optical images through the exposure apertures in said plates; mechanism for feeding two perforated films step by step through the respective film gates; registry pins adjacent to the aperture plates to coöperate with selected perforations in the films and thereby shift the films horizontally and vertically in their respective focal planes at each step independently of the feed mechanism; and means for shifting the registry pins and aperture-plates in planes parallel with the film gates to vary the exposure-location of the films relative to the respective images projected by said optical means.

4. In a color cinematographic camera adapted to make two negative color-records simultaneously on two separate films, the combination of two film gates arranged at an angle to each other and each having an exposure aperture, means for feeding the two films intermittently through the film gates step by step and permitting the films to be shifted in their own planes after each step, optical means to project similar optical images through the two said apertures and record on the two films images of the same object by action of light of different colors, tapered registry pins adapted to enter at least one selected perforation in each of the said films near the respective exposure aperture and shift the selected perforation in each film at every step to a constant position, and means for shifting one of the optical images relatively to the respective registry pin so that the separate photographic images produced on the two films will be exactly similarly positioned in relation to the respective selected perforations.

5. In a color cinematographic camera, in combination, a pair of film gates arranged at an angle to each other and having exposure apertures; means for feeding a pair of perforated negative films through the film gates step by step past the exposure apertures; a pair of reciprocatory registry pins adjacent one of the film gates to coöperate with a selected pair of perforations in the film to shift the latter in its own plane independently of the feeding means; a pair of registry pins adjacent to the other film gate to coöperate with a selected pair of perforations in the film to shift the latter in its own plane independently of the feeding means; means for shifting one pair of pins in a plane parallel with the exposure aperture in the respective film gate to locate such pins in the same relative position as the other pins: optical means for projecting separate optical images of the same object through the exposure apertures and in constant position relative to each other; and mechanism for actuating the registry pins after each operation of the film-feeding mechanism.

6. In a color cinematographic camera, in

combination, a film gate having an exposure aperture; means for feeding through the film gate step by step past the exposure aperture a perforated negative film having non-circular perforations; a reciprocatory registry pin, adapted to fit closely each perforation of a series of non-circular perforations in the film, and capable of slight rotary movement to accommodate itself to the position of the film; means coöperating with the pin after it has entered the perforation to rotate the pin to a constant position and thereby shift the film to a correspondingly constant position; and means for actuating the registry pin after each operation of the feeding mechanism.

7. In a color cinematographic camera for making negative images on perforated negative films, having non-circular perforations, in combination, step-by-step film-feeding mechanism; reciprocatory registry pins adapted to fit the non-circular perforations and capable of limited rotary movement whereby to accommodate themselves to the positions of the perforations; means having apertures in the path of the pins to receive the pins after they have entered the perforations and rotate the pins each to a predetermined constant position; and means for actuating the pins after each operation of the feeding mechanism.

8. In a color cinematographic camera, in combination, a film gate having an exposure aperture and adjacent thereto a pin-aperture of non-circular cross-section; a tapered registry pin capable of limited rotation; arranged to move into and out of the pin-aperture and be rotated thereby to a constant position; means for feeding step by step through the film gate a negative film, having non-circular perforations adapted to receive the registry pin whereby the rotation of the registry pin by the pin-aperture will shift the film in its own plane; and mechanism for actuating the registry pin after each operation of the feeding means.

9. In a color cinematographic camera, in combination, an exposure-aperture plate; a pressure plate in rear of the aperture plate and spaced therefrom to permit the film to pass between the two plates; a pair of reciprocatory registry pins of non-circular shape movable through non-circular perforations in the film and into and out of the pin-apertures; and means enabling the pins to press the pressure plate upon the film after the pins have entered the perforations and thereby hold the film in a fixed position during exposure.

10. In a color cinematographic camera, in combination, a film gate having an exposure aperture, means for feeding a perforated film step by step through the film gate past the exposure aperture, means operating after each feeding movement of the film to shift the latter to a predetermined constant position relative to the exposure aperture; and a device actuated by said means at each operation of the latter, to hold the film in said constant position during exposure.

11. In a color cinematographic camera, in combination, a film gate having an exposure aperture and a non-circular pin-aperture adjacent thereto; means for feeding step by step through the film gate a negative film having non-circular perforations; a pair of reciprocatory registry pins of non-circular cross section movable through perforations in the film; a pressure plate having spring members in the path of the shoulders on the registry pins for actuation by the latter to press the plate against the film and hold the latter in a fixed position during exposure; and mechanism for actuating the registry pins after each operation of the feeding means.

12. In a color cinematographic camera, in combination, a film gate having an exposure aperture and a pair of pin-apertures in its front, and equipped with a pair of rearwardly extending pin-guides; a pair of reciprocatory non-circular registry pins in said guides, adapted to coöperate with non-circular perforations in a film fed through the film gate step by step and each having a shank capable of limited rotary movement in its respective guide; the pins and pin-apertures coöperating to rotate the pins to a constant position after they have passed through the perforations in the film; and means for actuating the pins intermittently.

13. In a color cinematographic camera, in combination, a film gate having an exposure-aperture plate and a pair of pin-apertures in its front; a rear carrier-plate having a pair of pin-guides alined with the said pin-apertures; registry pins mounted to reciprocate in the pin-guides and enter the pin apertures after passing through perforations in a film fed step by step through the film gate, to shift the film at each step to a constant position; and means for shifting the rear carrier plate, and the exposure-aperture plate simultaneously in their own planes to vary at will the aforesaid constant position of the film.

14. In a color cinematographic camera, in combination, a film gate having an exposure aperture in its front and an opening in its rear; a carrier plate in the rear opening and having a pair of pin guides; reciprocatory registry pins in the guides, to coöperate with perforations in a film fed step by step through the film gate and shift the film at each step to a predetermined constant position; one or more shims between the carrier plate and the edge of the said rear opening; and screw means for pressing the carrier plate against the shims.

15. In a color cinematographic camera, in

combination, a film gate having an exposure aperture in its front; a carrier plate having pin guides perpendicular to the plane of exposure aperture; mechanism for feeding a perforated film step by step through the film gate and permitting movement of the film in its own plane after the feed mechanism has come to rest; reciprocatory registry pins in the pin guides to coöperate with selected perforations in the film after each step and shift the film to a constant position; and means for shifting the said carrier plate in its own plane to vary at will the location of the said constant position with respect to the exposure aperture.

16. In a color cinematographic camera, in combination, optical means for projecting a light-image of an object in a predetermined focal-plane area; mechanism for feeding a perforated film step by step through said focal-plane area and leaving the film free to be shifted in the focal-plane after each step; a pair of reciprocatory registry pins adapted to coöperate with selected perforations in the film after each step independently of the feed mechanism to shift the film in the focal plane to a constant position therein; and means for shifting the registry pins in a plane parallel with the focal-plane to vary at will the location of said constant position with respect to the said focal-plane area.

In testimony whereof I hereunto affix my signature.

PERCY DOUGLAS BREWSTER.