PATENT SPECIFICATION

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COMPLETE SPECIFICATION.

Improvements in Apparatus for Color Cinematography.

I, PERCY DOUGLAS BREWSTER, of 455, Central Avenue. East Orange, New Jersey, United States of America, Manufacturer, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

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 so-called 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 pratice, 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.

According to the present invention the aforesaid defects are avoided by providing a colour cinematographic camera in which light images are recorded on two films in different planes simultaneously and which comprises devices for feeding the films step by step in synchronism with each other and registry pins co-operating with at least one selected perforation in each film after each feeding operation thereof whereby the position of the films is adjusted with respect to each other and with respect to the optical device and the respective exposure apertures. The invention relates to cameras of the kind in which a film retaining pin is adapted to register with one of the perforations in the film after the same has been fed by the feeding mechanism and during the exposure thereof.

In this connection it has previously been proposed to employ a pair of registry pins with tapered ends engaging in perforations of an ordinary single cinematograph film to register it in the aperture during exposure, said pins being actuated by means of eccentrics on the driving shaft.

In carrying out the present invention 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 ac-

[*Price* 1/-]

curate 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.

Fig. 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 position.

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

Fig. 2ª 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.

Figs. 7, 8 and 9 are rear views of registry plates, showing different arrangements of the registry plates.

The camera illustrated in Figs. 1 and 2 comprises a base 1, on which the sliding front 2 is adapted to be moved (for focussing) 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 strips 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, 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 13ª, 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, by engaging their lower limbs 27^x, 28^x, 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 the upper actuating arms, 27, 28, of the levers and press the lower limbs 27^x, 28^x, 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 per-

forations. 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 Lumiere-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 bevelled, 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 cooperate 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. 2*a*, 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 dowels 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, the 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. 7, or the next below, as in Fig. 8. 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. 7 for one film, and as in Fig. 8 for the other. Or I may have one pin below the transverse center-line and one above, as in Fig. 9, or two perforations on the same side of the film may be used, with two pins, one above the other, but in this case it is well to provide a vertical guide 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.

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.

It is within the spirit of my invention to use two lenses, one for each film, instead of a single lens as in Fig. 1.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. A colour cinematograph camera in which light images are recorded on two films in different planes simultaneously, comprising devices for feeding the films step by step for simultaneous exposure and registry pins co-operating with at least one selected perforation in each film after each feeding operation thereof to adjust the films with respect to each other, and with respect to the position of the light images in the respective exposure apertures, for the purpose specified.

2. A camera for making negative films for colour cinematography comprising optical means for producing separate images in separate focal plane areas, a film feeding mechanism for passing a pair of perforated negative films step by step through the respective focal plane areas,

registry pins co-operating with at least one selected perforation in each film after each feeding step, which registry pins are in predetermined relation to the positions of the light images projected by the said optical means, and actuating mechanism for the feeding and registering devices operating in harmony with each other.

3. A colour cinematographic camera, according to Claim 1, in which optical means produce simultaneously separate light images which images are projected through exposure apertures in plates carrying the registry pins and adapted to permit variation of the exposure location on the films relative to the position of the light images projected by said optical means.

4. A colour cinematographic camera, according to Claim 2, in which the optical images are adapted to be brought into constant position relative to their respective registry pins by adjusting means on the optical device, for the purpose specified.

5. A colour cinematographic camera, according to Claim 2, in which reciprocatory registry pins, capable of limited rotary movement co-operate with pin apertures of non-circular cross section in their path which apertures are adapted to turn the pins to a predetermined constant position after they have passed through the perforation in the films.

6. A colour cinematographic camera, according to Claim 2 in which the registry pins are reciprocatory and cooperate with pressure plates in the rear of aperture plates to press said plates upon the film after the pins have entered the perforations, so as to hold the film in a fixed position during exposure.

7. A colour cinematographic camera, according to Claim 3, in which the position of the registry pins may be adjusted laterally and vertically with respect to the corresponding light images by suitable adjusting means, for the purpose specified.

8. A colour cinematographic camera having its parts constructed, arranged and adapted to operate substantially as hereinbefore described with reference to the accompanying drawings, for the purpose specified.

Dated this 18th day of July, 1919.

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SHEET 1

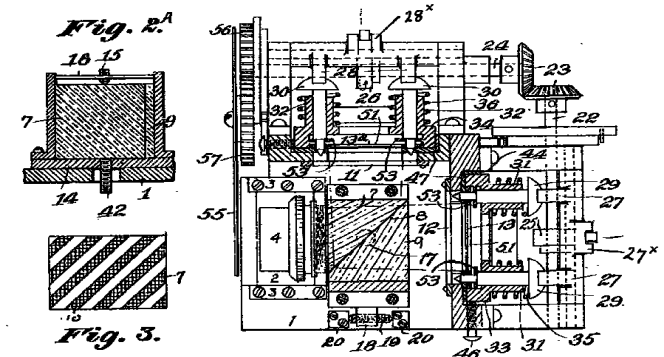


Fig. 1.

Fig. 2.

Fig. 2A.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.

SHEET 2

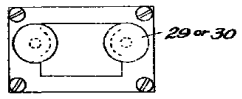


Fig. 7.

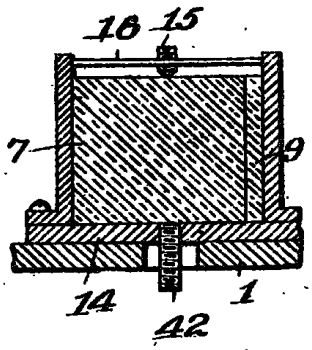
Fig. 8.

Fig. 9.

Maiby & Sons Photo Litho

[This Drawing is a reproduction of the Original on a reduced scale.]

Fig. 2A.



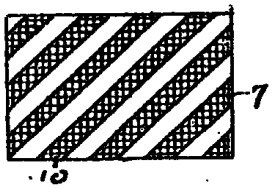


Fig. 3.

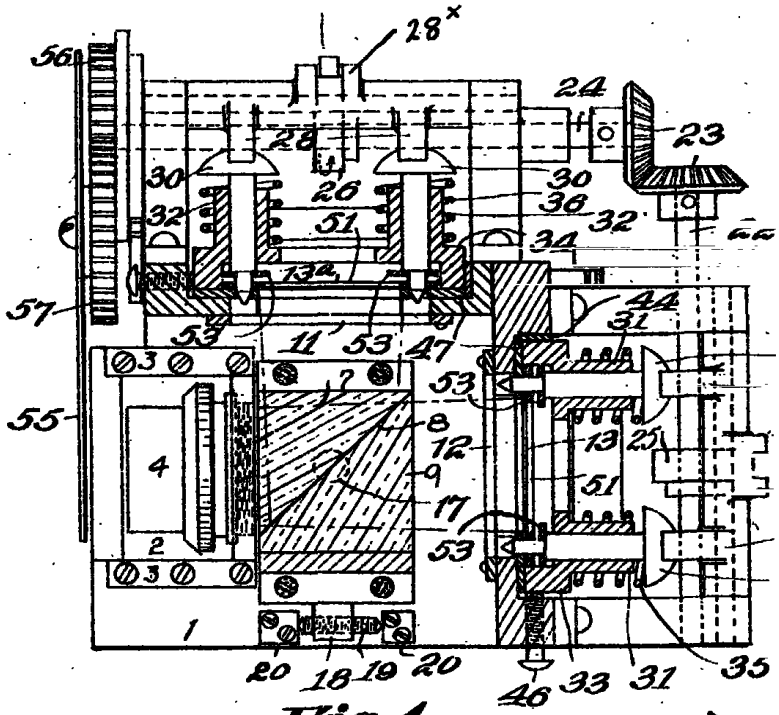


Fig. 1.

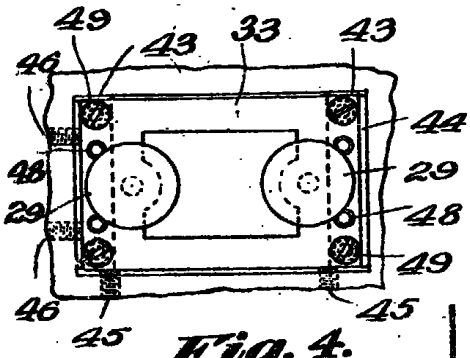


Fig. 4.

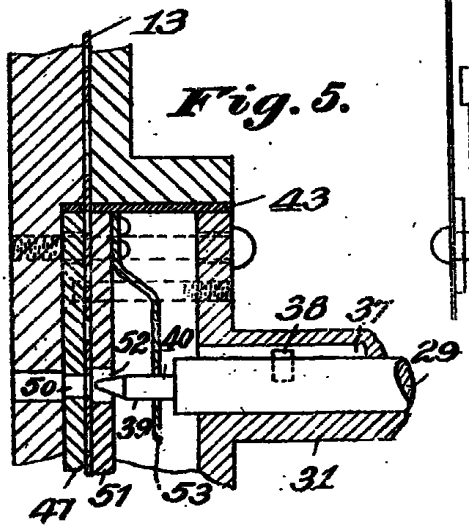


Fig. 5.

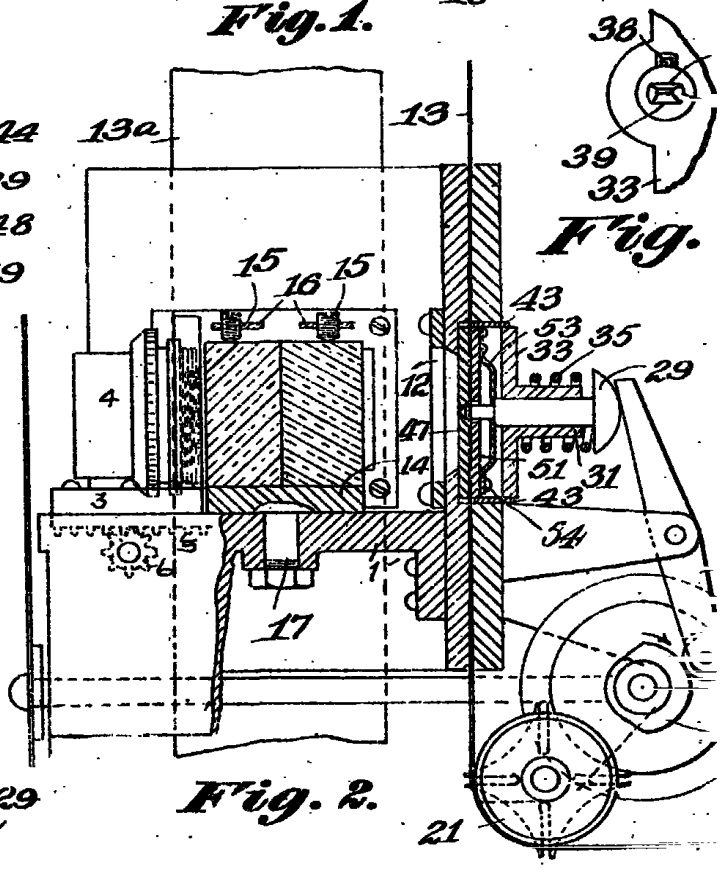


Fig. 2.

Fig.

SHEET 1.

SHEET 2.

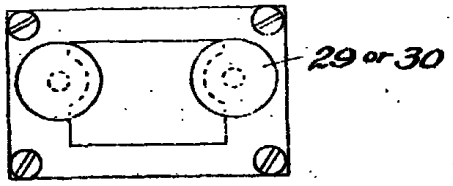


Fig. 7.

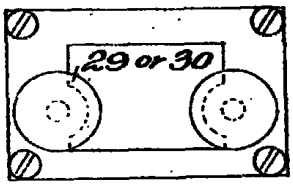


Fig. 8.

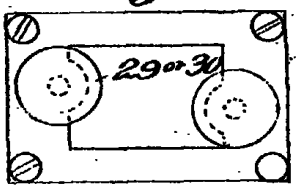


Fig. 9.

Malby & Sons, Photo-Litho