

June 9, 1925.

1,541,315

J. A. BALL ET AL

PRINTING COMPLEMENTAL PICTURES

Filed Aug. 20, 1921

4 Sheets-Sheet 1

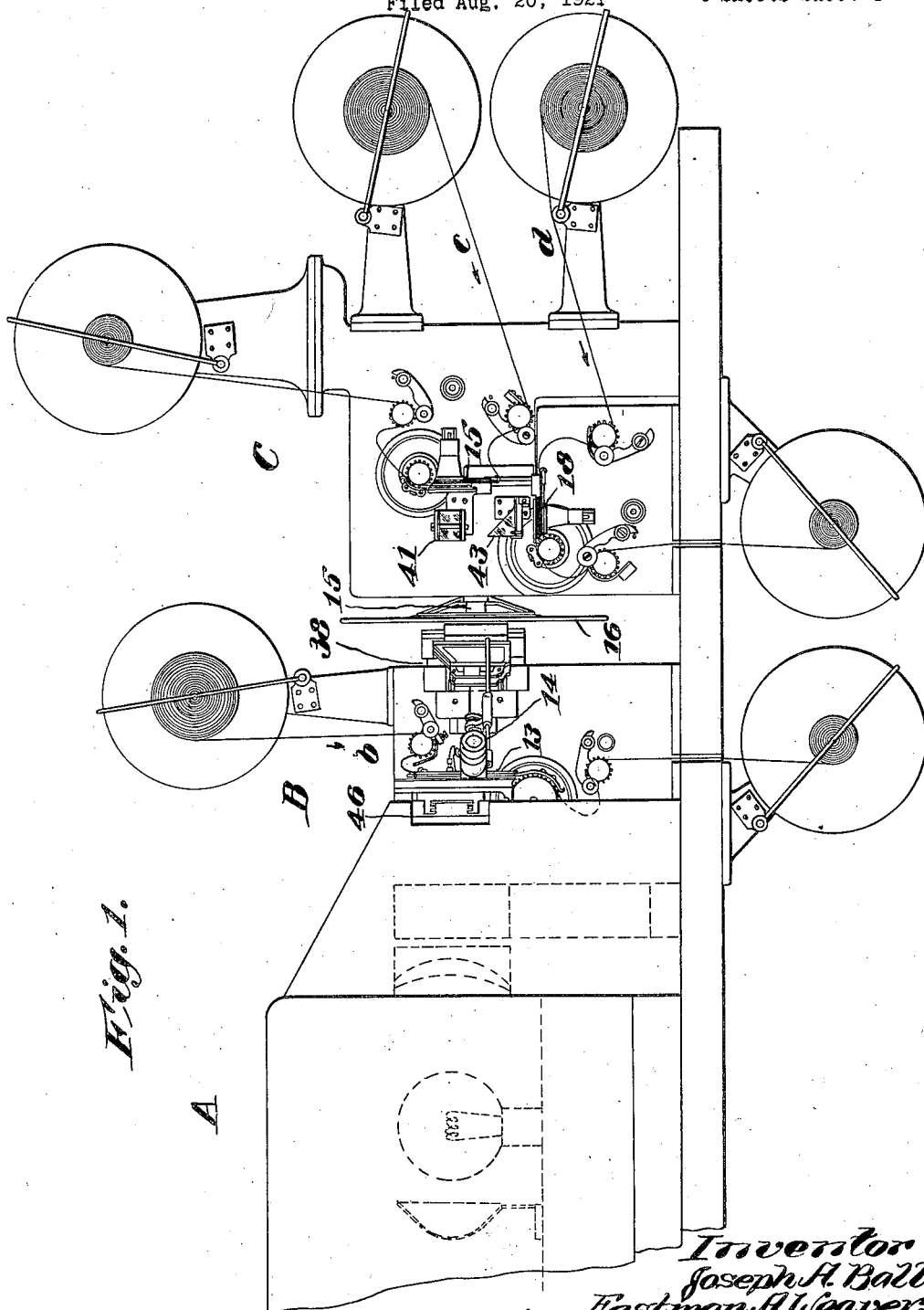


Fig. 1.

A

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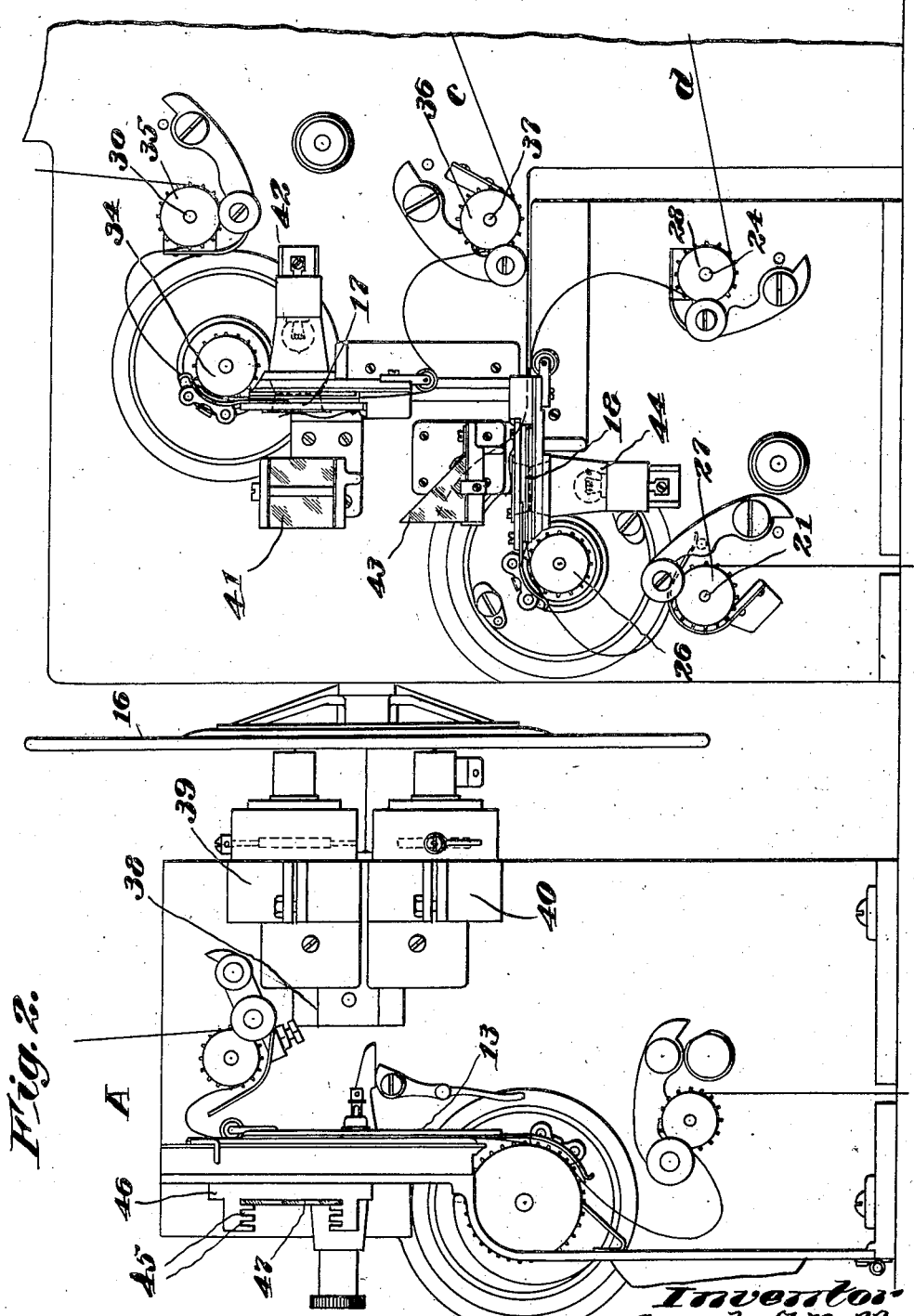


Fig. 2.

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Fig. 4.

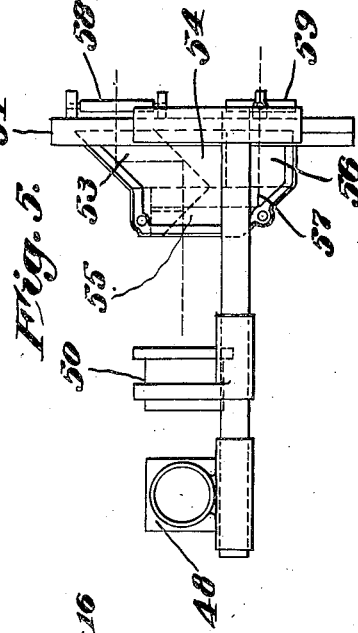
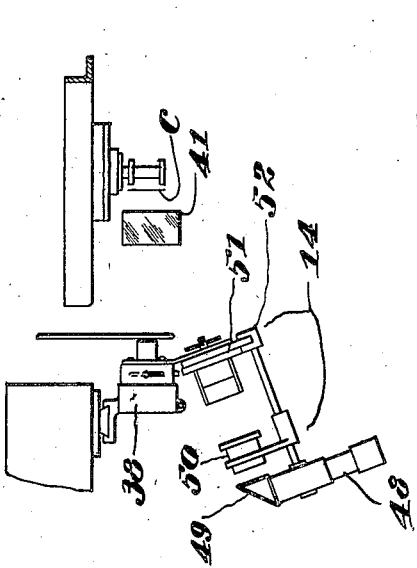
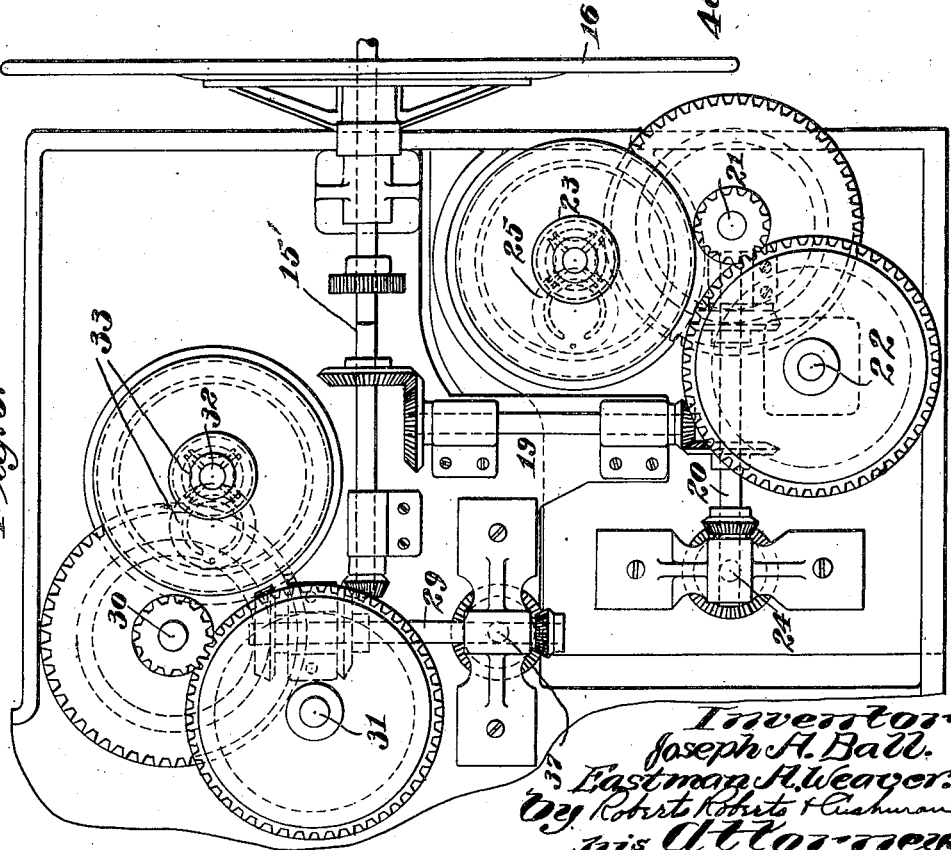


Fig. 3.



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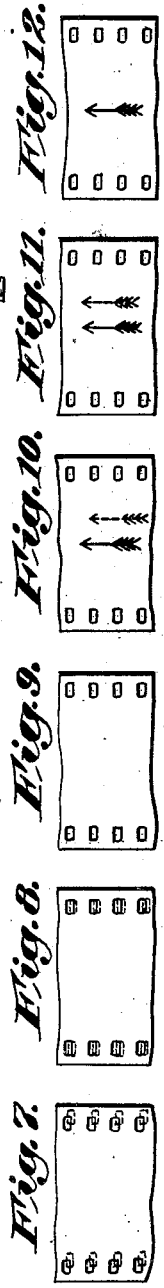
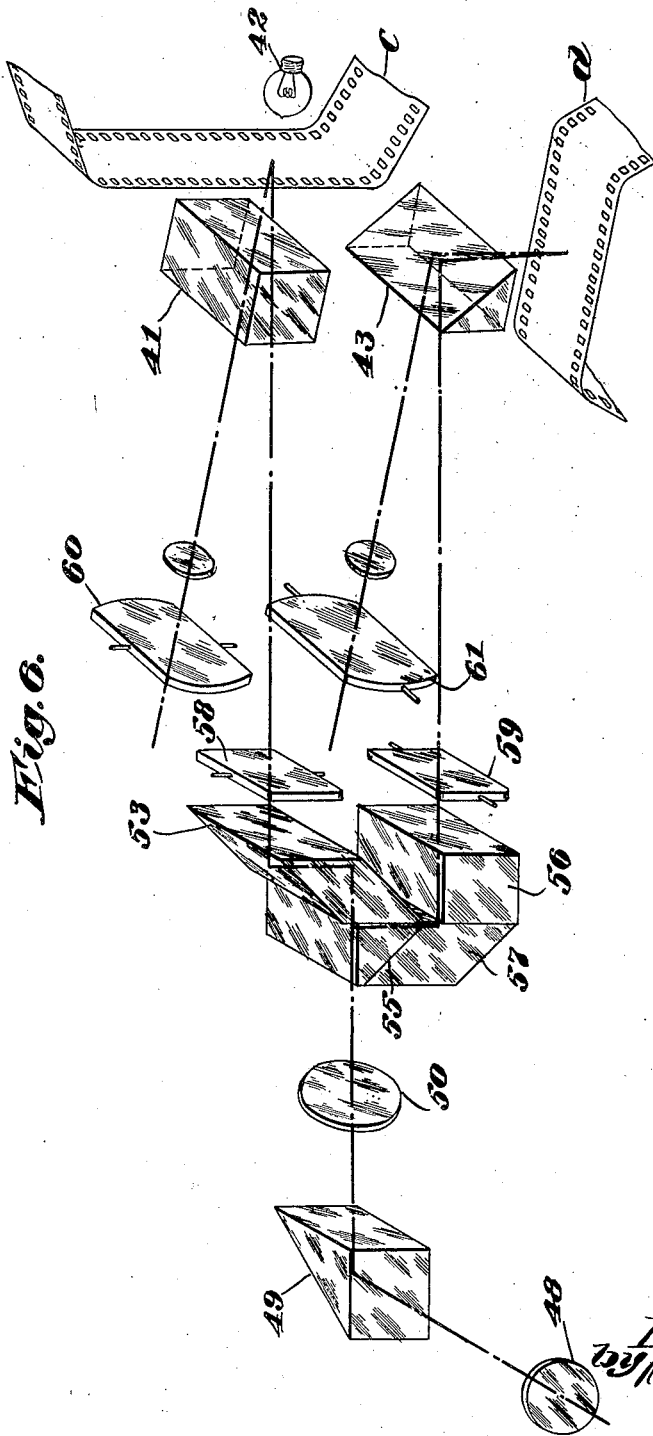
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4 Sheets-Sheet 4



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UNITED STATES PATENT OFFICE.

JOSEPH A. BALL, OF WOLLASTON, AND EASTMAN A. WEAVER, OF BROOKLINE, MASSACHUSETTS, ASSIGNORS, BY MESNE ASSIGNMENTS, TO TECHNICOLOR MOTION PICTURE CORPORATION, OF BOSTON, MASSACHUSETTS, A CORPORATION OF MAINE.

PRINTING COMPLEMENTAL PICTURES.

Application filed August 20, 1921. Serial No. 493,824.

To all whom it may concern:

Be it known that JOSEPH A. BALL and EASTMAN A. WEAVER, citizens of the United States of America, and residents of Wollaston and Brookline, respectively, in the counties of Norfolk and Suffolk, respectively, and State of Massachusetts, have invented new and useful Improvements in Printing Complementary Pictures, of which the following is a specification.

This invention relates to the art of making cinematographic films and more specifically those films used in producing colored motion pictures by combining in their projected form a plurality of complementary images of different color values.

One way of producing such pictures is by the well-known kodachrome process in which the complementary pictures are printed from two master positives in registry upon opposite sides of double-coated stock. To register the pictures on the double-coated stock accurately and uniformly it is essential that the pictures of each of the master positives bear precisely the same relation to their sprocket holes respectively as the corresponding complementary pictures of the other master positives bear to their sprocket holes respectively.

Another way of producing such pictures is to make two positive films, giving each a different color treatment, and then cementing or otherwise attaching these two films to each other with the complementary images in registry. Since the films must be assembled with the sprocket holes in registry, it is obvious that the images must be similarly positioned upon the films relative to the sprocket holes or registration of the images when the films are joined together will be impossible. An extremely high degree of accuracy is necessary during the printing operation to insure that the images are made in exactly corresponding positions upon the films. As the image upon a cinematographic film is magnified about 200 times when it is projected upon the screen, even the most minute displacement of the images relative to each other will produce objectionable color fringes upon the picture.

In its broader aspect the invention com-

prises an improved method and apparatus for positioning images in spaced relation in exactly corresponding positions relative to common identifying marks or objects. More specifically the invention comprises an improved method and means for printing cinematographic films by which complementary images are to be projected simultaneously and in exact registry to form a complete picture, together with means associated with a film printing machine for viewing two spaced images in superposition regardless of whether such images change periodically or not, and means for shifting the images relative to each other, or the film spaces upon which the images are projected, in order that the images may be positioned in exactly corresponding position upon the film spaces relatively to the sprocket holes or other registering means associated therewith.

For a clearer understanding of the invention, attention is directed to the embodiment shown in the accompanying drawings, in which,—

Fig. 1 is an elevational view of a machine embodying the features of the invention;

Fig. 2 is an enlarged view of the projecting and printing portions of the machine;

Fig. 3 is a view of the driving means of the printing portion of the machine viewed from the opposite side of Fig. 2;

Fig. 4 is a plan view of the viewing instrument and the associated parts of the machine;

Fig. 5 is a side elevation of the viewing instrument;

Fig. 6 is a diagrammatic view of the various optical paths involved in the printing portion of the machine, including those to the viewing instrument; and

Figs. 7 to 12 are diagrammatic views illustrating the appearance of two films through the viewing instrument during the process of adjustment.

The particular embodiment of the invention chosen for the purpose of illustration is shown completely in Fig. 1 and comprises the lamp chamber A, the projection apparatus B and the printing apparatus C. The lamp chamber includes the usual lamp, re-

flector, condensing lens and filter usually found in devices of this kind, all of which are indicated by broken lines. The projection apparatus comprises the usual mechanism for carrying the negative film *b* through the film-gate 13 in which the film is intermittently stopped while the beams from the lamp chamber project the images for printing. While the complemental pictures may be projected from separate negatives to the same or separate positives, in the illustration they are simultaneously projected from a single negative to separate positives, the images of each complemental pair of negatives being spaced apart sufficiently to permit them to be projected along optical paths which are separated enough to accommodate the necessary optical elements. At 14 is shown the viewing means which will be explained in more detail hereinafter.

Upon the shaft 15, which connects the driving mechanism of the projecting apparatus B and of the printing apparatus C and keeps them in synchronism, is mounted the shutter 16 which intercepts the printing light during each intermittent advance of the films. The printing apparatus C includes the feeding mechanism for the two positive films *c* and *d*, the former of which is fed upwardly through the film-gate 17 in which the film *c* lies in a plane parallel to the negative film *b*. The positive film *d* is fed through film-gate 18 in a plane transverse to that of film-gate 17 and consequently to that of the negative film *b*. The driving mechanism for the films in the printing apparatus C, shown in detail in Fig. 3, comprises the main drive shaft 15' geared to vertical shaft 19 which in turn transmits the driving impulse to shafts 20, 21, 22, 23 and 24. Upon shaft 23 is mounted a star wheel cooperating with the pin wheel 25 as a Geneva movement to intermittently drive the film take-up wheel 26 (Fig. 2). Sprocket drums 27 and 28 mounted on shafts 21 and 24 respectively are driven continuously.

Main shaft 15 is likewise connected by gearing to vertical shaft 29 which transmits the drive in turn to shafts 37, 30, 31 and 32. Upon shaft 32 is mounted a star wheel contacting with pin wheel 33 of another Geneva movement for intermittently operating the feed sprocket 34 for positive film *c* (Fig. 2). Sprockets 35 and 36 for the same film mounted on shafts 30 and 37 are driven continuously.

Two beams of light issue from film-gate 13 and pass through the lens assembly 38 which comprises upper lens 39 for the upper beam of light and lower lens 40 for the lower beam, the two lenses being arranged to be adjusted vertically and horizontally. The beam of light extending through lens 39 is projected through square prism 41

upon the portion of positive film *c* which is exposed in film-gate 17. The lower beam issuing from lens assembly 40 enters a total deflecting prism 43 which deflects it downwardly upon the portion of positive film *d* exposed in film-gate 18 and reverses the image projected by the beam. Directly behind film-gates 17 and 18 are lamps 42 and 44 enclosed in suitable housings.

This arrangement constitutes a complete assembly for projecting the complemental images from the negative film *b* to the positive films *c* and *d*. The optical path of the square prism 41 is the same as the optical path of the total reflecting prism 43 so that there are no unbalanced distortions in the complemental positives. Since the use of colored light in printing affords more accurate contrast gradients so that the resultant pictures do not appear too green in the shadows or too red in the high lights (when red and green are the colors chosen as the hues of the respective positives) as described in Patent No. 1,283,087, granted Oct. 28, 1918, arrangements are made for the insertion of color screens before the projecting beams from the lamp chamber, a simple means being slots 45 in frame 46 attached to gate member 13 for the insertion of color screens such as 47.

The means for viewing the projected images in order to provide for the adjustment of the same in corresponding positions upon the positive films comprises the viewing mechanism 14, the position of which in relation to the rest of the machine is shown in Fig. 1 and the details of which are shown in Figs. 4, 5 and 6. This instrument comprises an eye piece 48, a total reflecting prism 49, objective lens 50, and the beam collecting assembly 51, all of which are mounted upon a bracket arm 52 attached to the lens assembly 38. The beam collecting assembly 51 is adapted to gather two beams of light, one from the opening in film-gate 17, the other from the opening in film-gate 18. These two beams enter the beam collecting assembly in parallelism and are there united coaxially and reflected through the objective lens 50, through the total reflecting prism 49 and thence to the eye piece 48 so that the images thus brought together may be viewed in superposition by the operator of the machine. The means within the beam collecting assembly for producing this result comprise the elements shown in detail in Figs. 5 and 6. The upper beam enters a diamond shaped reflecting prism 53 and is deflected downwardly from its upper surface to its lower surface which is backed by air space 54. By the lower face of the prism 53 the beam is deflected through a light dividing screen or grid 55 of any suitable type, for example that shown in the patent to Comstock No. 1,231,710, granted

July 3, 1917, half of the beam being reflected and lost.

The lower beam passes through the rectangular prism 56, then enters the diamond shaped prism 57, and is then reflected by the lower surface thereof directly upward to the light-dividing grid 55 from which half the beam is reflected coaxially with the upper beam toward the objective lens 50, the other half of the beam penetrating through the grid 55, and being lost.

In the path of the upper beam the registering glass 58 is mounted upon a vertical pivot. In the path of the lower beam a similar registering glass 59 is mounted upon a horizontal pivot. Lenses 39 and 40 which project the beams from the lamp chamber A are likewise provided with similar registering glasses, one mounted on a vertical pivot 60 for the upper beam of light and the other mounted on a horizontal pivot 61 for the lower beam of light. These registering glasses are preferably in the form of plane sheets of glass which shift the light beams laterally without changing their directions as disclosed in Patent No. 1,208,490, granted December 12, 1916.

After a negative film *b* has been threaded through the projector B and blank positive films *c* and *d* have been threaded through their respective film-gates, the lamps 42 and 44 are turned on. Upon looking through the viewing apparatus the sprocket holes of the two positive films will appear in registry as shown in Fig. 9 if the apparatus is made with great precision. However, in apparatus made with only practical limits of precision, the sprocket holes will probably appear out of registry as shown for example in Fig. 7, where the full lines represent the sprocket holes of one positive and the dotted lines represent the sprocket holes of the other positive. By rotating the registering glasses 58 and 59, the sprocket holes may be brought into exact registry. For example, if the upper glass 58 is properly adjusted, the sprocket holes of the two films are brought into exact transverse register as shown in Fig. 8; and then by rotating the registering glass 59 the sprocket holes may be brought into exact longitudinal register as shown in Fig. 9. The adjustment of registering glasses 58 and 59 thus compensates for any slight inaccuracy in the construction and alignment of parts. After the registering glasses 58 and 59 have been properly adjusted, they need not be further adjusted except in case the parts have to be disassembled and then reassembled, or in case there is some slight relative movement of the parts due to slippage or wear.

After the glasses 58 and 59 have been properly adjusted, the lamps 42 and 44 are turned out and the lamp in the projector A is turned on, thus throwing a pair of com-

plemental images on the two films *c* and *d* respectively. Ordinarily, the two images would not appear in registry but would appear as shown in Fig. 10. By adjustment of the registering glasses 60 and 61 in the optical paths between the respective negatives and positives, the positive images may be brought into exact registry. For example, by rotating the glass 61 the images may be brought into exact longitudinal registry as shown in Fig. 11; and then by rotating the glass 60 the images may be brought into exact transverse registry as shown in Fig. 12.

With both the images and the sprocket holes in exact registry, as shown in Fig. 12, each image bears the same relation or has the same position relative to its sprocket holes as the other image bears to its sprocket holes. Consequently, in subsequently registering the images, as for example when gluing the two positives together, the images will be in exact registry if the sprocket holes are exactly registered, the same individual sprocket holes being employed to register the films in the subsequent operation as are used to register the images in the printing operation.

After the images of the first pair of complementary images have been registered as aforesaid, the machine is started and as the negative and positive films are fed through the machine, the operator continuously observes the images projected on the positive films through the viewing apparatus, and by manipulating the glasses 60 and 61 any tendency toward variation in the relative positions of the positives may be counteracted. Thus the positive images are formed in exactly the same relation to their respective sprocket holes notwithstanding variations in the positions of the negative images relative to their sprocket holes.

Accurate registration of the complementary images is facilitated by displaying the respective images of each complementary pair in different colors, preferably in the colors which they represent. This may be accomplished by inserting color screens in the branched paths of the viewing apparatus, e. g. a red screen in the path of the image representing the red aspect of the object field and a green screen in the path of the image representing the green aspect of the object field. By employing colored glass in the registering devices 58 and 59 these devices may constitute the color screens. This also aids in registering the sprocket holes or other registering means in the preliminary adjustment of the viewing apparatus.

By exposing the negative film so that the figures of the subjects extend transversely of the film rather than lengthwise, the positive films may be arranged to run in a parallel plane but in a direction transverse

to that of the negative film and still have the figures extending lengthwise of the positive films for use in the ordinary motion picture projecting machines. By such an arrangement it would be unnecessary to arrange the positive films transversely to one another as shown in the present device.

We claim:

1. The method of printing complemental pictures on non-superposed sensitized printing spaces in uniform relationship to associated registering means which comprises simultaneously projecting the images on said spaces, and viewing both the images and the associated registering means in superposition.

2. The method of printing complemental pictures on non-superposed sensitized printing spaces in uniform relationship to associated registering means which comprises simultaneously projecting the images on said spaces, and viewing both the images and the associated registering means in superposition, and adjusting the position of the images until they appear in exact registry.

3. The method of photographic printing which comprises making successive simultaneous exposures upon a plurality of film spaces each having associated therewith registering means, viewing in superposed relation the images so projected, and maintaining the respective fields of exposure correspondingly positioned upon the film spaces relatively to the registering means corresponding to the images being printed.

4. The method of photographic printing which comprises projecting an image of one color value upon a film space in a certain relationship to its registering means, simultaneously projecting a similar image of another color value upon a second film space accurately in the same relationship to its registering means, and determining said relationship by viewing the images so projected in superposed relation.

5. The method of photographic printing which comprises recurrently making two exposures simultaneously from the same picture film upon two films accurately in the same relationship to their registering means respectively, and maintaining successive images correspondingly positioned upon the two blank films by viewing the images in superposed relation and adjusting the relationship between the projected images and the blank films.

6. The method of photographic printing which comprises making two exposures simultaneously from the same picture film upon two blank films, viewing the images so projected in superposed relation and adjusting the direction of the beams of light so that the exposures will be correspondingly positioned upon the blank films relatively to their registering openings respectively.

7. The method of continuously printing successive sets of complemental pictures on non-superposed picture spaces in uniform relationship to associated registering means respectively which comprises determining said relationship by viewing both the images and the registering means through an optical system and maintaining the relationship by adjusting the course of the printing light.

8. The method of continuously printing successive sets of complemental pictures on separate films in the same accurate relationship to their respective registering means which comprises simultaneously projecting the images of a complemental set upon the separate films respectively, determining said relationship by viewing both the pictures and the registering means through an optical system and maintaining the relationship by adjusting the course of the printing light.

9. The method of printing complemental pictures on non-superposed picture spaces in uniform relationship to associated registering means respectively which comprises viewing both the images and the registering means along a branched optical path to present the images and registering means in apparent superposed relationship, and shifting certain of the viewed objects until both the registering means and the images respectively appear in exact superposition along said branched path.

10. The method of simultaneously printing complemental pictures in non-superposed spaces on film stock which comprises projecting the pictures to the aforesaid spaces, viewing the spaces and the associated registering means along a branched path which makes the registering means appear in exact registration, and then shifting the pictures relatively to each other until they appear in exact registration along the branched path, whereby each picture will bear exactly the same relation to its registering means as each complemental picture bears to its registering means.

11. The method of simultaneously printing complemental pictures in non-superposed spaces on film stock which comprises projecting the pictures to the aforesaid spaces, viewing the spaces and the associated registering means along a branched path which presents the registering means in exact registration, and then producing a relative shift between the pictures, and registering means until each picture bears the same relation to its registering means as each other picture to its registering means, whereupon the pictures will appear in exact registration along said path.

12. Apparatus for registering complemental pictures in non-superposed picture spaces comprising means having a branched optical path for viewing the pictures in ap-

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parent superposition, and means for shifting the pictures until they appear in exact superposition along said path.

13. Apparatus for printing complementary pictures in non-superposed spaces on film stock comprising means for positioning said stock by engagement with openings in the film, an optical viewing system for viewing said spaces and associated openings in superposition, and means for effecting relative shifting between the pictures and film until both the pictures and the associated openings appear in exact registration.

14. In a machine for simultaneously printing images upon separate picture spaces, a viewing instrument comprising means for conducting beams of light from the images in parallelism and for uniting the beams coaxially so that the images may be viewed in superposition.

15. In a machine for simultaneously printing complementary images upon separate picture spaces, a viewing instrument comprising means for conducting beams of light from the images in parallelism and for uniting the beams coaxially so that the images may be viewed in superposition, and means for shifting the images upon the picture spaces so that the images will be viewed in exact superposition.

16. In a machine for simultaneously printing complementary images upon separate picture spaces, a viewing instrument comprising means for directing beams of light from the images in parallelism and for uniting the beams coaxially so that the images may be viewed in superposition, and means to color the respective images differently whereby failure of exact registry of the images is indicated by color fringes.

17. The method of registering complementary pictures in non-superposed picture spaces which comprises viewing the pictures along a branched optical path which presents the pictures in apparent superposed relationship and shifting the pictures until they appear in exact superposition along said path.

18. The method of forming pictures which comprises simultaneously projecting two images upon different objects, viewing the images so projected in superposition and

adjusting the course of the beams of light to cause the latter to direct the images into corresponding positions upon the objects. 55

19. The method of photographic printing which comprises making two exposures simultaneously from the same picture film upon two blank films, viewing the images so projected in superposed relation and adjusting the course of the beams of light so that the exposures will be correspondingly positioned upon the blank films. 60

20. The method of photographic printing which comprises recurrently making two exposures simultaneously from the same negative film upon two positive films, viewing the images so projected in superposed relation, adjusting the course of the beams of light so that the exposures will be correspondingly positioned upon the positive films, and keeping the images so projected correspondingly positioned upon the two films. 65

21. The method of photographic printing which comprises projecting an image of one color value upon a film space simultaneously projecting a similar image of another color value upon a second film space and viewing the images so projected in superposed relation. 70

22. The method of photographic printing which comprises making successive simultaneous exposures upon pairs of film spaces, viewing in superposed relation the images of the pairs so projected, and maintaining the fields of exposure correspondingly positioned upon the series of film spaces. 85

23. The method of photographic printing which comprises projecting images simultaneously upon separate areas, viewing the images in superposed relation, and adjusting the position of the images until they appear in exact registry. 90

24. The photographic method which includes simultaneously projecting two images upon separate sensitized areas, and concomitantly viewing the images in superposition. 95

Signed by us at Boston, Mass., this 18th day of August, 1921. 100

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