

Oct. 10, 1950

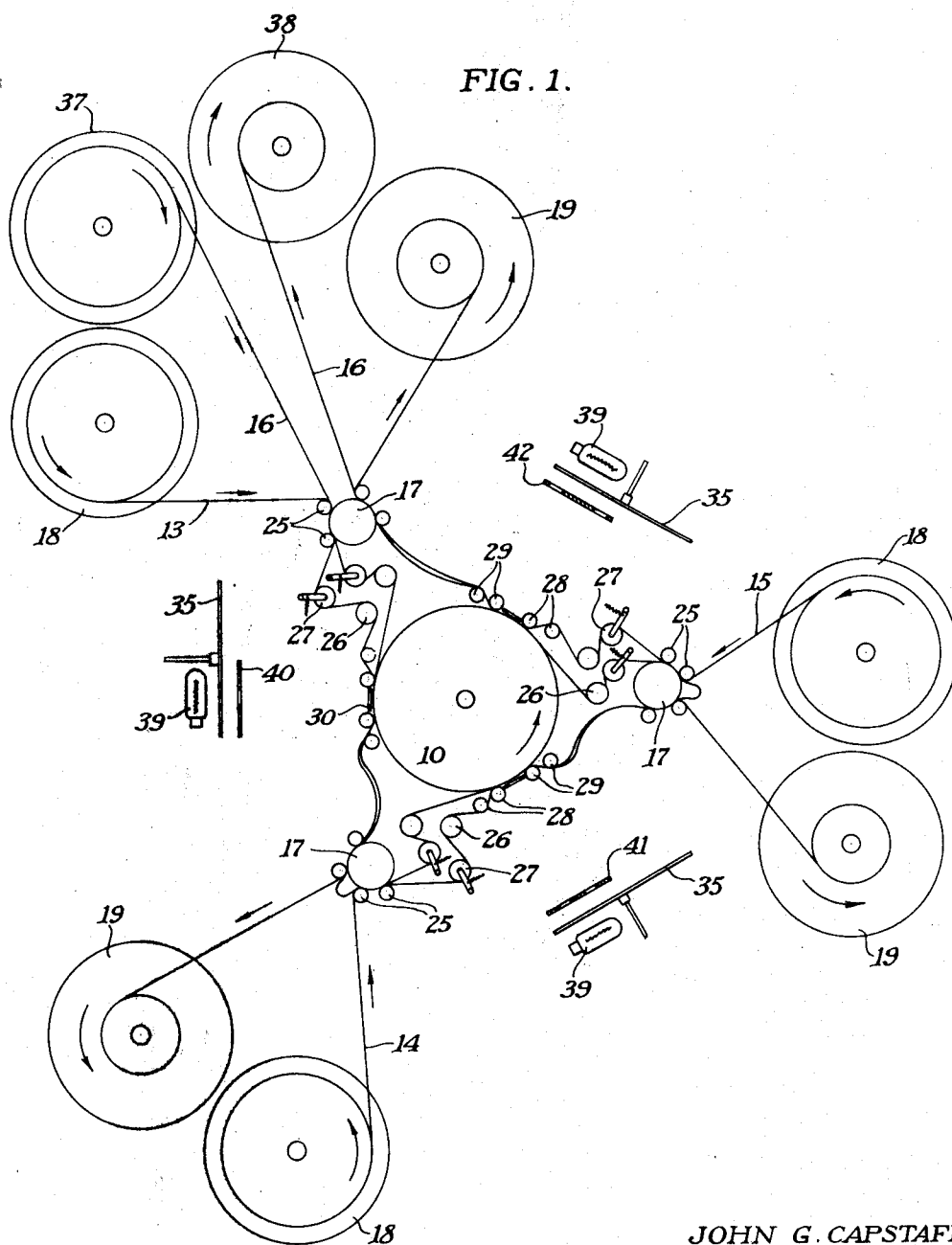
J. G. CAPSTAFF

2,525,522

TRIPLE HEAD ROTARY REGISTRY PRINTER

Filed Dec. 15, 1948

3 Sheets-Sheet 1



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INVENTOR

BY *Newton M. Perrine*
Frank R. Gollon
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Oct. 10, 1950

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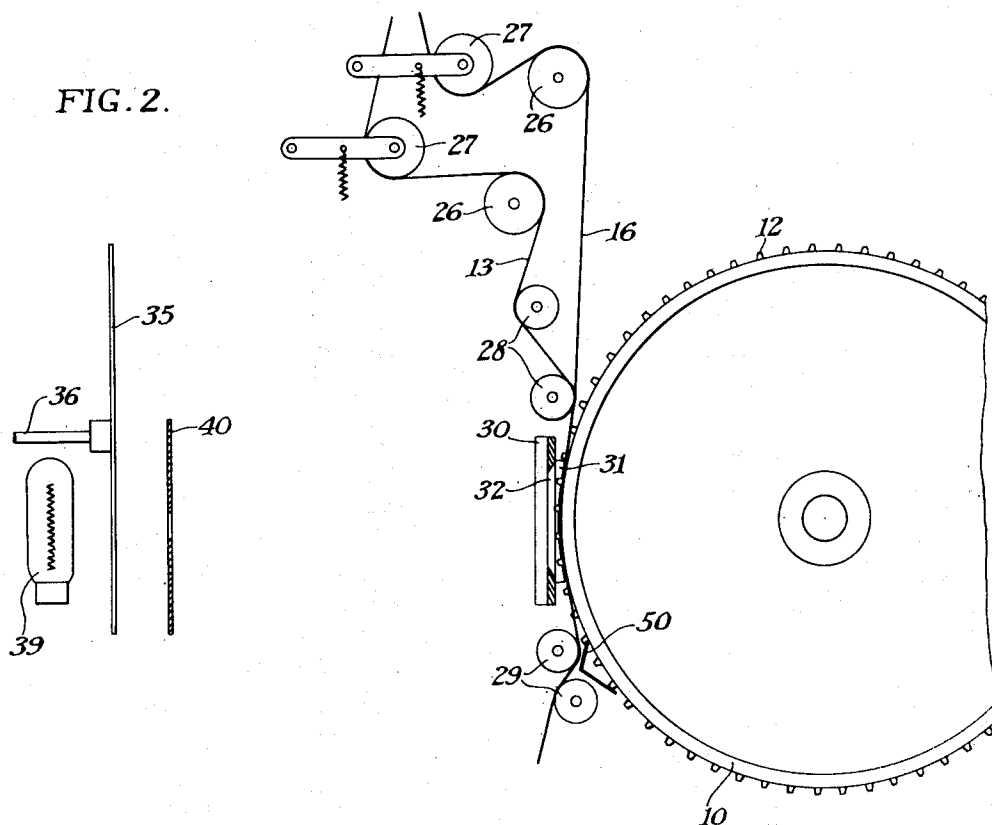
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TRIPLE HEAD ROTARY REGISTRY PRINTER

Filed Dec. 15, 1948

3 Sheets-Sheet 2

FIG. 2.



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2,525,522

TRIPLE HEAD ROTARY REGISTRY PRINTER

Filed Dec. 15, 1948

3 Sheets-Sheet 3

FIG. 3.

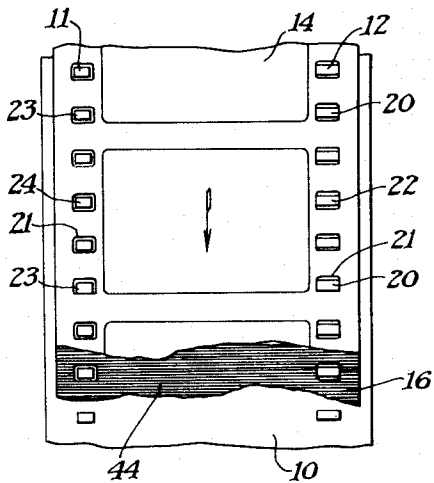


FIG. 4.

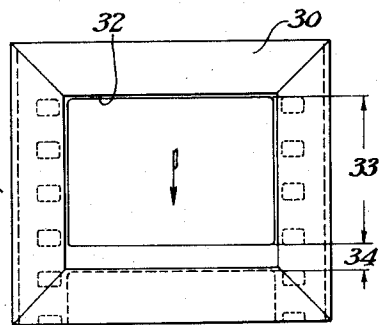


FIG. 5.

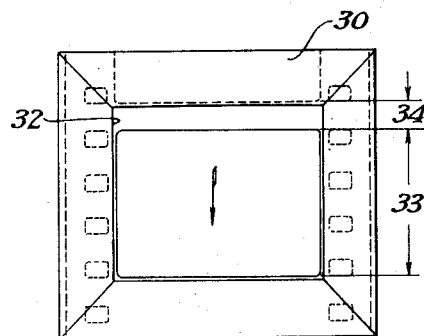


FIG. 6.

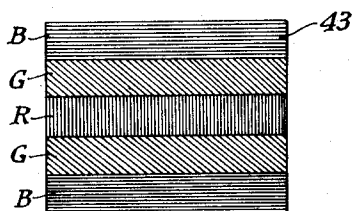


FIG. 7.

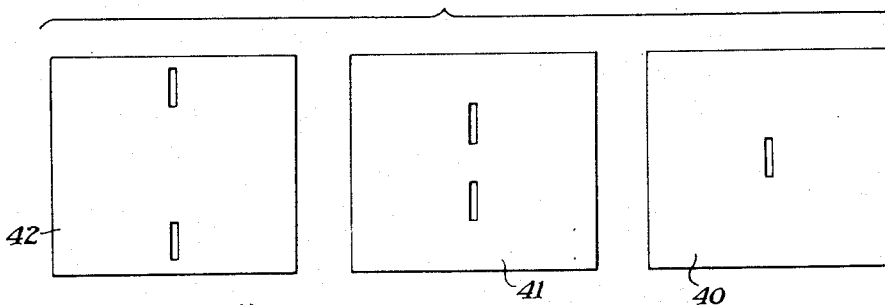
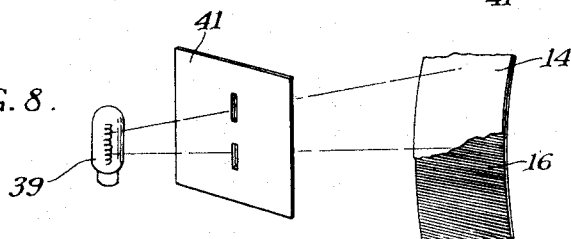


FIG. 8.



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UNITED STATES PATENT OFFICE

2,525,522

TRIPLE HEAD ROTARY REGISTRY PRINTER

John G. Capstaff, Rochester, N. Y., assignor to
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Application December 15, 1948, Serial No. 65,318

21 Claims. (Cl. 95—75)

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This invention relates to a means and method for photographic printing. More specifically, it relates to an improved printing machine for motion pictures adapted for the successive printing of a plurality of negatives or positives upon a light-sensitive film. It relates further to an improved method for the successive printing of a plurality of negatives or positives upon a sensitive film.

Printing machines having a series of apertures at each of which an exposure is made are well known in the prior art. These include apparatus in which a number of positives are printed from a single negative, those in which a sound track and a picture image are separately printed upon a sensitive film and, to a lesser extent, those in which several negatives are printed upon a sensitive film to produce a composite picture, the latter being of particular use in trick photography and color photography. The latter presents the problem of registration which is of little or no consequence in the first two and the present invention is primarily directed to the provision of means and method for the successful printing of composite photographs.

As discussed in my copending application Serial Number 716,714, filed December 17, 1946, printing machines for motion-picture film have been generally of two types, continuous and intermittent. While the former has been preferred from the standpoint of speed of operation, it offered serious difficulties in the matter of registration of the negative with the sensitive films. This is caused primarily by differences in dimensions of the negative and sensitive films and by variations in perforation size and in their spacing. This condition readily results from shrinkage occasioned by processing and aging. It is apparent that the maintaining of registration between the films during the interval of exposure to the printing beam while the films are continuously advanced through the printer is a necessity. The shifting or creeping of one film relative to the other during exposure results in prints of poor definition. This is especially objectionable in motion pictures when one considers the very considerable enlargement of the image projected upon the screen. While this condition is of serious enough consequence in the production of prints from a single negative, as in black and white photography, it is of even greater concern in any color process where prints are produced by the successive printing of a plurality of negatives upon a light-sensitive film, each negative corresponding to a particular color, such as in the len-

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ticular process or in anyone of the number of known multicolor processes. Obviously, it is of particular importance that each negative register correctly and precisely with the light-sensitive film during exposure.

Prior art devices have in general met the difficulty of holding registration during the exposure interval by resorting to the use of an intermittent feed. In such devices, the superposed films are fed intermittently to a position before the printing aperture, where they are caused to be registered both laterally and longitudinally despite variations in sizes caused by shrinkage of the film. This registration is effected by the use of pins which engage the film perforations after the films have been moved into position before the aperture. The pins are usually of such cross section that a single pin fills the superposed film perforations both laterally and longitudinally and others fill other film perforations in only one such direction to compensate for small variations in perforation spacing in the two films. The exposure is made while the films are thus fixed in position after which the pins are withdrawn and the films again advanced. Machines of this type are usually slower in operation than those of the continuous feed type and are more complicated because of the intermittent feed and reciprocating pin mechanisms. Moreover, the use of such machines especially at higher speeds entails serious risk of damage to the film perforations.

I have disclosed in my copending application Serial Number 716,714 a continuous printer in which the teeth of the printing sprocket are so dimensioned and spaced and a shutter so synchronized with the rotation of the sprocket that but a single tooth in each row of sprocket teeth drives the superposed films past the printing aperture during the exposure interval. In this manner no slippage of the films upon the sprocket can occur during the exposure, the films being permitted to adjust their position relative to each other and to the sprocket while the driving force of the sprocket is transferred from one pair of teeth to a second during the interval when the printing beam is occluded. The present invention is directed to the adaptation of such a mechanism to a triple head printer in which a plurality of exposures are made along the periphery of a printing sprocket. To further insure like registration of corresponding frames of the several negatives or positives upon the light-sensitive film, the printing machine embodying the present invention causes identical sprocket teeth to reg-

ister corresponding portions of the negatives or positives with the light-sensitive film at the several printing stations. This precludes variations in the registration of any one of the negatives or positives with the sensitive film which may be caused by defects inherent in the size and spacing of the sprocket teeth, such, for example, as the misalignment of corresponding teeth in the opposed rows.

In addition I have adapted my machine to the printing of lenticular film from a plurality of separation negatives or positives by the use of printing masks as will be hereinafter described.

It is, therefore, an object of the present invention to provide an improved machine for the successive printing of a plurality of negatives or positives in which the films are moved continuously and in which the difficulties resulting from unequal shrinkage of the films are effectively overcome.

It is a further object of this invention to provide improved means which prevent film creep in a continuous printer at a plurality of printing stations during the periods of exposure of the films.

It is a still further object of this invention to provide a continuous printer which is especially adapted for the printing of a plurality of negatives or positives upon a light-sensitive film because of the improved characteristics of the machine in maintaining precise and identical registration between each corresponding frame of each negative or positive and the sensitive film at the printing apertures during each exposure interval.

It is a still further object of this invention to provide an improved printing machine adapted to the printing of lenticular film from a series of separation negatives or positives.

It is a still further object of this invention to provide an improved method of continuous printing of a plurality of negatives or positives upon a light-sensitive film wherein precise and identical registration of each corresponding frame of each negative or positive with the sensitive film is insured during the exposure interval at the several printing apertures.

Other objects and advantages of the invention will become apparent from the following description taken in connection with the accompanying drawings, and it will be understood that many changes may be made in the details of construction, arrangement of parts and in the method shown and described without departing from the spirit of the invention as expressed in the accompanying claims. I, therefore, do not wish to be limited to the exact details shown and described as the preferred form only has been shown by way of illustration.

In the drawings:

Fig. 1 is a schematic view of a triple head rotary registry printer embodying the present invention;

Fig. 2 is an enlarged schematic view illustrating the arrangement of elements of the apparatus relative to a single printing station;

Fig. 3 is a partial view taken along the edge of the printing sprocket;

Figs. 4 and 5 illustrate, respectively, the positions of the films relative to a printing aperture at the beginning and end of an exposure interval;

Fig. 6 is a diagrammatic view of the type of multicolor filter intended for the projection of the lenticular film printed by means of the disclosed printing machine;

Fig. 7 illustrates the series of printing masks used in the apparatus for the printing of lenticular film from separation negatives or positives; and

Fig. 8 is a perspective view showing diagrammatically the use of a mask in the lenticular printing operation.

The triple head rotary registry printer, embodying the present invention, shown in Fig. 1 comprises the sprocket 10 which has two rows 11 and 12 of teeth along its peripheral edge. A plurality of negative films 13, 14 and 15 (or positive films as the case may be) and a light-sensitive film 16 are advanced through the printer by the rotation of the sprocket 10. The sensitive film may be either non-lenticular or lenticular, having transverse lenticulations 44 thereon as shown in Fig. 3, as will be later discussed. Each negative is successively brought into superposed engagement with the light-sensitive film 16 upon the printing sprocket 10 at one of the plurality of printing stations which are positioned on the periphery of the sprocket. Auxiliary sprockets 17, whose rotation is synchronized with that of the sprocket 10, are provided to draw each of the negatives 13, 14 and 15 from its respective supply reels 18 and to simultaneously lead these negatives from the printing stations to their respective take-up reels 19. Each auxiliary sprocket, as noted in Fig. 1, serves the dual purpose of leading one negative from its supply reel to the printing sprocket and leading a second negative from the printing sprocket to its take-up reel. In addition, the auxiliary sprockets function as a drive for the light-sensitive film at stations intermediate the printing stations, leading the sensitive film from its supply reel 37 prior to the first of the printing operations and leading that film to its take-up reel 38 after the last of the exposures has been made. To maintain the several films in engagement with the auxiliary sprockets 17, a series of small rollers 25 cooperate with each of said sprockets as noted in Fig. 1.

In the row of teeth 12 on the printing sprocket 10 every fourth tooth 20 is a film-locating tooth. After entering the superposed film perforations 21, as will be described below, this tooth engages the leading edge as well as the major portion of two sides of the perforations. It may here be noted that the present invention is directed particularly to use with the square-type or Eastman-type of perforation, the straight sides of the film perforations being obviously necessary for the satisfactory functioning of the printer as will be apparent from the following description. The tooth 20 is not of sufficient size to contact the trailing edge in addition to the leading edge of the film perforations. Since it is the latter edge only which need be engaged to drive the films, it is preferable to shorten the teeth 20 in this particular direction, i. e. the thickness, in order that they may readily fit all film perforations despite small variations in the height thereof and in the pitch resulting from shrinkage. Between every pair of film-locating teeth 20 there is a series of three teeth 22 which are so dimensioned and positioned on the sprocket that they touch only the sides of the film perforations and neither the leading nor trailing edges thereof. The teeth 22 serve only to position the films laterally. In row 11 every fourth tooth 23, as in row 12, is relatively thicker than the others in the row. The tooth 23 corresponds to the tooth 20 in that it engages the leading edge of the perforations of the superposed films and together with it functions to advance the films

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through the printer. Unlike the teeth in row 12, tooth 23 is of smaller width than that of the film perforations and is so located on the sprocket that it does not engage either of the side walls of the film perforations. Like tooth 20, however, the tooth 23 does not contact the trailing edge of the film perforations. Between every pair of teeth 23 in row 11 there are provided three teeth 24 which do not engage any of the walls of the film perforations. These teeth are merely dummies and may be omitted entirely. Their retention or omission will depend upon manufacturing considerations. Actually each consecutive pair of teeth, which are intended to engage the leading edge of the film perforations, are so spaced that their forward or leading edges are separated by a distance slightly in excess of four times the pitch of film perforations. With the limited engagement that each pair of films make with the printing sprocket as will be described below, this will insure that only one pair of teeth will drive any pair of films at all times even though somewhat more than four teeth are simultaneously inserted in one row of film perforations.

The printing sprocket edge which mounts the teeth comprises a solid uninterrupted surface extending between the two rows of teeth as seen in Fig. 3, providing a rigid support for the films as they travel over the sprocket. This also assists in precluding relative movement between the films during the exposure intervals, the support being provided at the points at which it will be most effective, i. e., at the several printing stations. The peripheral surface of the sprocket 10 is preferably a dull black to preclude reflections therefrom.

To provide the necessary back pressure for maintaining good contact between the leading edges of the film perforations and the corresponding edges of the driving teeth 20 and 23, a pair of rollers for each film is interposed between the auxiliary sprocket 17 and the printing sprocket 10. The axis of one roller 26 of each pair is fixed whereas the other 27 is spring biased, as illustrated in Figs. 1 and 2. Instead of spring biasing one of said rollers any other form of tensioning means may obviously be employed such as a gravity biased roller. For the above-described teeth to function properly each pair of films can have only limited engagement with the sprocket 10. A pair of rollers 28 is employed to lead each pair of films into such engagement, a second pair 29 serve as stripping means. The rollers 28 and 29 are so positioned relative to each other and to the printing apertures that each pair of superposed films must necessarily have only limited engagement with the sprocket. This relationship is clearly illustrated in Fig. 2. In addition to the stripping rollers 29 a deflector element 50 is interposed between the rollers 29 which serves as a supplementary stripper to facilitate threading of the films or their leaders into the machine prior to its operation.

A printing gate 30 is located between each pair of rollers 28 and the stripping rollers 29. It includes spaced pressure shoes 31 which bear upon the superposed films along the edges beyond the perforations to provide the necessary pressure against the films. The gate 30 includes the aperture 32, the height of which is equal to the height 33 of a picture frame plus the distance 34 between frames. By locating the printing aperture 32 adjacent to the drive means, which precludes relative slip between the superposed films

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during exposure as will be explained below, the possibility of relative motion between the films occurring at some other point in the travel of the films coinciding with the location of the printing aperture is thereby eliminated. Thus in the present invention, no long or unsupported lengths of film exist between the registering drive means and the printing aperture. The existence of such a condition could well result, despite the elimination of film creep at the drive, in relative motion of the films at the printing aperture caused, for example, by vibration of the unsupported lengths of film. Although I have disclosed the use of a printing gate to determine the dimensions of the printing beam impinging upon the superposed films, it is apparent that such an element may be omitted and the size of the beam determined optically as by projecting a beam having the desired cross section.

Since the printing sprocket 10 moves at a constant speed, the printing operation occurs while the films are moving. The exposure interval is synchronized with the sprocket so that the exposure occurs while the films move a distance equal to the distance 34 between picture frames. It should be noted that 35 mm. motion picture negatives have considerably wider frame lines, that is, a greater distance between adjacent frames, since the advent of the sound track. The exposure is controlled by the shutter 35 which rotates upon shaft 36, the rotation of the latter being synchronized with that of the sprocket 10. The exposure begins when the picture frame occupies the position relative to the printing aperture indicated in Fig. 4. It is completed when this same picture frame has advanced to the position indicated in Fig. 5. During this interval only two teeth 20 and 23, one in each of the two rows, have engaged leading edges of the superposed film perforations to drive the films past the printing aperture. At the same time the teeth in row 12 have all served to register the films laterally despite possible variations in the dimensions between the two rows of perforations in the superposed negative and sensitive films. The shutter closes as the films advance beyond the position indicated in Fig. 5 and remains closed until the following picture frame has advanced to the position shown in Fig. 4, at which time the shutter again opens. During this relatively longer period of non-exposure, the pair of teeth which has been in engagement with the leading edges of the film perforations 21 reach a point where they begin to recede from the perforations with the rotation of the sprocket 10 and the operation of the stripper rollers 29 as may be observed in Fig. 2. At the same time, the following pair of teeth 20 and 23 have entered the film perforations and presently engage the leading edges of the perforations to serve as the motive force for driving the films. The pitch or distance between the sprocket teeth is intentionally made slightly greater than the normal pitch of the film perforations as noted above. Therefore, slippage between the films and between the films and sprocket will occur, but by virtue of the arrangement and dimensioning of the sprocket teeth, above described, no slippage or creep takes place during the printing exposure. It occurs entirely during the dark interval when one pair of driving teeth are substituted for another pair as the driving force for the superposed films.

After passing by the first printing gate 30, the superposed films are stripped from the

sprocket 10 by the stripper 29 and travel to the next auxiliary sprocket 17. From the latter, the negative is led to the takeup reel 19 while the sensitive film passes about the sprocket 17 to a point where a second negative is engaged by the sprocket which draws it from a supply reel 18. This second negative and sensitive film then proceed over a series of rollers to a second printing station on the sprocket 10, the various mechanical elements by which this is accomplished being a duplicate of those described above. Similarly, the printing gate, sprocket teeth, stripping rollers, synchronized shutter are all duplicated at this second station. After the exposure of the second negative, the films proceed to the next auxiliary sprocket and the preceding operations are all repeated with the exposure of a third negative at a third printing station. Obviously, while the present invention is described as embodied in a triple head printer, any plurality of printing stations may be provided upon the periphery of the printing sprocket by duplicating the previously described elements. After the final printing exposure the final negative and the sensitive films are led to the first of the auxiliary sprockets 17 which drives the two films to their respective takeup reels, as may be clearly seen in Fig. 1.

Since misalignment of some of the corresponding driving teeth in the opposed rows of sprocket teeth may well result in variations of registration between corresponding frames of the several negatives and the sensitive film, another precaution that is observed is to provide that identical sprocket teeth register corresponding frames of the several negatives with the sensitive film at the several printing stations. This is accomplished by so positioning the various rollers and auxiliary sprocket between consecutive printing stations that the sensitive film is caused to move between printing stations in loops of such length that any one portion of the sensitive film is driven and registered by identical sprocket teeth at each of the printing stations. This film loop will be approximately equal in length to one and one-third the circumference of the printing sprocket and the sprocket will make one and one-third revolutions between the successive exposures of corresponding frames of the several negatives. Thus, the printing machine, herein disclosed, not only insures that there will be no relative motion between the negative and sensitive films during the printing exposure but causes each negative to be identically registered with the sensitive film.

It is clearly apparent that the above-described printing machine is well adapted for the making of color prints from a series of separation negatives or positives or for the printing of composite pictures from several negatives or positives as in so-called trick photography. I have further adapted it to the printing of lenticular films from a series of separation negatives (or positives as the case may be) on ordinary, non-lenticular film. I have done this by locating a printing mask between each printing aperture and the illuminating means. The size and location of the aperture or apertures in said masks 40, 41 and 42 and the position thereof relative to the lenticular film to be printed upon is dependent upon the multicolor filter 43 which will be employed in the projection of the film and the location of that filter or its virtual image relative to the film. The location of the virtual image will of course be dependent upon the particular

projection lens to be used. Let us assume that the multicolor filter to be used in projecting the film is the five band type disclosed in my Patent No. 2,210,881, granted August 13, 1940. This is schematically illustrated in Fig. 6 of the present application showing the central red band R, the contiguous green bands G, and the outer blue bands B. The length of each mask aperture corresponding to one of the filter bands will be approximately equal to the width of that band or rather the width of the virtual image thereof. The width of each mask aperture is sufficiently small to minimize the parallax errors resulting from the separation of the emulsion layer of the negative from that of the sensitive film occasioned by the interposed lenticular layer. The mask 40 employed to print the separation negative corresponding to the red contains a single, centrally located aperture of a length approximately equal to the width of the red band of the multicolor filter to be used in projecting the film or rather the width of the virtual image of the band. Similarly, the mask 41 to be used in printing the "green" negative has a pair of apertures whose position and length correspond to the green bands of the filter and the third mask 42 for the blue has apertures whose position and length correspond to the blue filter bands. These masks are illustrated in Fig. 7. By positioning these masks at a distance from the lenticular film which corresponds to the distance of the multicolor filter (or its virtual image) from the lenticular film when the latter is projected, the configuration and direction of each printing beam which records a particular color upon the lenticular film will correspond to the configuration and direction of the beam which is projected through the lenticular film and the particular color band of the filter to project that color. The use of similar masks in the printing of lenticular film from separation negatives on non-lenticular film and the theory relating thereto is disclosed at length in United States Patent No. 1,968,145, granted to G. Heymer, July 31, 1934. I have illustrated the application of the present invention to the printing of lenticular film having transverse lenticulations thereon, but it is obvious that with a rearrangement or rotation of the printing masks the printer is equally adapted to the printing of lenticular film with longitudinal lenticulations.

While I have disclosed a separate shutter 35 and a separate lamp 39 for each of the printing stations, it is apparent that a single source of illumination might be used together with a system of mirrors and/or prisms to direct a printing beam to each of the printing apertures. Similarly, a single shutter might be employed to simultaneously expose the films at all the printing stations. While I have shown neither reflector nor condenser system in the disclosed printer, these may be employed in the conventional manner. It must be noted, however, that in the lenticular application the use of a condenser system will require the repositioning of the several printing masks in order that the distance and position of the image of the mask aperture or apertures correspond to the distance and position of the corresponding filter area of the multicolor filter, or its virtual image, which will be used to project the lenticular film.

It is apparent that the present invention is applicable to printers employing a printing sprocket having a single row of teeth, this row of teeth being similar to row 12. In such an arrangement

every fourth tooth alone makes successive contact with the leading edges of the superposed film perforations at each printing station to drive the films during the exposure interval, the intermediate teeth serving only to assist in registering the films laterally. It is also apparent that instead of making the teeth 20 and 23 thicker than the intermediate teeth in their respective rows in order that the teeth 20 and 23 may alone make contact with the leading edges of the film perforations during the exposure interval, the same end may be reached by controlling the longitudinal spacing of the teeth on the sprocket. Thus, by causing every fourth tooth to be spaced slightly ahead of the position it would otherwise occupy, such teeth could be made to alone successively engage the leading edges of the film perforations as required to preclude slippage during exposure.

From the foregoing description, it will be apparent that I have provided means and method for obtaining all of the objects and advantages of this invention.

What I claim and desire to secure by Letters Patent of the United States is:

1. In a printing machine for use with continuously moving strips of film having perforations along an edge thereof, a printing sprocket for simultaneously advancing a plurality of negative or positive films and a light-sensitive film, a plurality of printing stations located on the periphery of the sprocket for successively printing each of the plurality of films upon the light-sensitive film, means for guiding one of said plurality of films and the light-sensitive film into superposed engagement upon the sprocket at each printing station and a film stripper for removing the films from the sprocket just beyond each station, said guide means and film stripper being so positioned relative to each other and to the sprocket that each pair of superposed films has only limited engagement with the sprocket at the printing station, shutter and illuminating means adapted to intermittently expose the superposed films at the several printing stations, said printing sprocket having a row of teeth along its peripheral edge, the teeth being of a width substantially equal to the width of the film perforations and being of such relative thickness and the shutter means being so synchronized with the rotation of the sprocket that the leading edge of only one tooth in said row contacts the aligned edges of the perforations of the superposed films during the exposure interval at each printing station.

2. In a printing machine for use with continuously moving strips of film having perforations along an edge thereof, a printing sprocket for simultaneously advancing a plurality of negative or positive films and a light-sensitive film, a plurality of printing stations located on the periphery of the sprocket for successively printing each of the plurality of films upon the light-sensitive film, means for guiding one of said plurality of films and the light-sensitive film into superposed engagement upon the sprocket at each printing station and a film stripper for removing the films from the sprocket just beyond each printing station, said guide means and film stripper being so positioned relative to each other and to the sprocket that each pair of superposed films has only limited engagement with the sprocket at the printing station, shutter and illuminating means adapted to intermittently expose the superposed films at the several printing stations, said printing sprocket having a row of

teeth along its peripheral edge, the teeth being of a width substantially equal to the width of the film perforations and of a thickness less than the height of the perforations and being so relatively spaced and the shutter means being so synchronized with the rotation of the sprocket that each superposed pair of films is driven by the leading edge of a single tooth in said row at each printing station during the exposure interval.

3. In a printing machine for use with continuously moving strips of film having perforations along the edges thereof, a printing sprocket for simultaneously advancing a plurality of negative or positive films and a light-sensitive film, a plurality of printing stations located on the periphery of the sprocket for successively printing each of the plurality of films upon the light-sensitive film, means for guiding one of said plurality of films and the light-sensitive film into superposed engagement upon the sprocket at each printing station and a film stripper for removing the films from the sprocket just beyond each station, said guide means and film stripper being so positioned relative to each other and to the sprocket that each pair of superposed films has only limited engagement with the sprocket at the printing station, shutter and illuminating means adapted to intermittently expose the superposed films at the several printing stations, said printing sprocket having two rows of teeth along its peripheral edge, a plurality of teeth in one row being of a width substantially equal to the width of the film perforations, the teeth in the second row being of less width than the width of the film perforations, the teeth in each row being of such relative thickness and the shutter means being so synchronized with the rotation of the sprocket that the leading edge of only one tooth in each row contacts the aligned edges of the perforations of the superposed films during the exposure interval at each printing station.

4. In a printing machine for use with continuously moving strips of film having perforations along the edges thereof, a printing sprocket for simultaneously advancing a plurality of negative or positive films and a light-sensitive film, a plurality of printing stations located on the periphery of the sprocket for successively printing each of the plurality of films upon the light-sensitive film, means for guiding one of said plurality of films and the light-sensitive film into superposed engagement upon the sprocket at each printing station and a film stripper for removing the films from the sprocket just beyond each station, said guide means and film stripper being so positioned relative to each other and to the sprocket that each pair of superposed films has only limited engagement with the sprocket at the printing station, shutter and illuminating means adapted to intermittently expose the superposed films at the several printing stations, said printing sprocket having two rows of teeth along its peripheral edge, a plurality of teeth in one row being of a width substantially equal to the width of the film perforations, the teeth in the second row being of less width than the width of the film perforations, the teeth in each row being of a thickness less than the height of the perforations and being so longitudinally spaced in each row and the shutter means being so synchronized with the rotation of the sprocket that the leading edge of a single tooth in each row drives the superposed pair of films at each printing station during the exposure interval.

5. In a printing machine for use with continu-

ously moving strips of film having perforations along an edge thereof, a printing sprocket for simultaneously advancing a plurality of negative or positive films and a light-sensitive film, a plurality of printing stations located on the periphery of the sprocket for successively printing each of the plurality of films upon the light-sensitive film, a plurality of auxiliary sprockets synchronized with the printing sprocket, each adapted to lead one of said plurality of films from its supply reel to the printing sprocket and a second one of said plurality of films from the printing sprocket to its takeup reel and to drive the light-sensitive film at stations intermediate the printing stations, film tensioning means between each auxiliary and printing sprocket for tensioning the films, means for guiding a pair of films into superposed engagement upon the sprocket at each printing station and a film stripper for removing the films from the sprocket just beyond each station, said guide means and film stripper being so positioned relative to each other and to the printing sprocket that each pair of superposed films has only limited engagement with the sprocket at the printing station, shutter and illuminating means adapted to intermittently expose the superposed films at the several printing stations, said printing sprocket having a row of teeth along its peripheral edge, the teeth being of a width substantially equal to the width of the film perforations and being of such relative thickness and the shutter means being so synchronized with the rotation of the sprocket that the leading edge of only one tooth in said row contacts the aligned edges of the perforations of the superposed films during the exposure interval at each printing station.

6. In a printing machine for use with continuously moving strips of film having perforations along the edges thereof, a printing sprocket for simultaneously advancing a plurality of negative or positive films and a light-sensitive film, a plurality of printing stations located on the periphery of the sprocket for successively printing each of the plurality of films upon the light-sensitive film, a plurality of auxiliary sprockets synchronized with the printing sprocket, each adapted to lead one of said plurality of films from its supply reel to the printing sprocket and a second one of said plurality of films from the printing sprocket to its takeup reel and to drive the light-sensitive film at stations intermediate the printing stations, film tensioning means between each auxiliary and printing sprocket for tensioning the films, means for guiding a pair of films into superposed engagement upon the sprocket at each printing station and a film stripper for removing the films from the sprocket just beyond each station, said guide means and film stripper being so positioned relative to each other and to the printing sprocket that each pair of superposed films has only limited engagement with the sprocket at the printing station, shutter and illuminating means adapted to intermittently expose the superposed films at the several printing stations, said printing sprocket having two rows of teeth along its peripheral edge, a plurality of teeth in one row being of a width substantially equal to the width of the film perforations, the teeth in the second row being of less width than the width of the film perforations, the teeth in each row being of a thickness less than the height of the perforations and being so longitudinally spaced in each row and the shutter means being so synchronized with the rotation of the sprocket

that the leading edge of a single tooth in each row drives the superposed pair of films at each printing station during the exposure interval.

7. In a printing machine for use with continuously moving strips of films having perforations along an edge thereof, a printing sprocket for simultaneously advancing a plurality of negative or positive films and a light-sensitive film, a plurality of printing stations located on the periphery of the sprocket for successively printing each of the plurality of films upon the light-sensitive film, a plurality of auxiliary sprockets synchronized with the printing sprocket each adapted to lead one of said plurality of films from its supply reel to the printing sprocket and a second one of said plurality of films from the printing sprocket to its takeup reel and to drive the light-sensitive film at stations intermediate the printing stations, film tensioning means between each auxiliary and printing sprocket for tensioning the films, means for guiding a pair of films into superposed engagement upon the sprocket at each printing station and a film stripper for removing the films from the sprocket just beyond each station, said guide means and film stripper being so positioned relative to each other and to the printing sprocket that each pair of superposed films has only limited engagement with the sprocket, a printing aperture, a shutter and source of illumination at each printing station, said aperture being positioned adjacent to the films at the point at which they are in engagement with the printing sprocket, said printing sprocket having a row of teeth along its peripheral edge, the teeth being of a width substantially equal to the width of the film perforations and of a thickness less than the height of the perforations and being so relatively spaced and each shutter being so synchronized with the rotation of the sprocket that each superposed pair of films is driven by the leading edge of a single tooth in said row at each printing station during the exposure interval.

8. In a printing machine for use with continuously moving strips of film having perforations along the edges thereof, a printing sprocket for simultaneously advancing a plurality of negative or positive films and a light-sensitive film, a plurality of printing stations located on the periphery of the sprocket for successively printing each of the plurality of films upon the light-sensitive film, a plurality of auxiliary sprockets synchronized with the printing sprocket each adapted to lead one of said plurality of films from its supply reel to the printing sprocket and a second one of said plurality of films from the printing sprocket to its takeup reel and to drive the light-sensitive film at stations intermediate the printing stations, film tensioning means between each auxiliary and printing sprocket for tensioning the films, means for guiding a pair of films into superposed engagement upon the sprocket at each printing station and a film stripper for removing the films from the sprocket just beyond each station, said guide means and film stripper being so positioned relative to each other and to the printing sprocket that each pair of superposed films has only limited engagement with the sprocket, a printing aperture, a shutter and source of illumination at each printing station, said aperture being positioned adjacent to the films at the point at which they are in engagement with the printing sprocket, said printing sprocket having two rows of teeth along its peripheral edge, a plurality of teeth in one row being

of a width substantially equal to the width of the film perforations, the teeth in said one row being of a thickness less than the height of the perforations, each shutter being so synchronized with the rotation of the sprocket and the leading edges of said one row of teeth being so spaced that but one such edge contacts and drives the aligned edges of the perforations of the superposed films during the exposure interval at each printing station, the teeth in the second row being of less width and of a smaller thickness than the corresponding dimensions of the film perforations, such teeth having leading edges which are aligned with those of the teeth of the first row which contact and drive the superposed films during the exposure intervals.

9. In a printing machine for use with continuously moving strips of film having perforations along an edge thereof, a printing sprocket for simultaneously advancing a plurality of negative or positive films and a light-sensitive film, a plurality of printing stations located on the periphery of the sprocket for successively printing each of the plurality of films upon the light-sensitive film, a plurality of auxiliary sprockets synchronized with the printing sprocket, each adapted to lead one of said plurality of films from its supply reel to the printing sprocket and a second one of said plurality of films from the printing sprocket to its takeup reel and to drive the light-sensitive film at stations intermediate the printing stations, biased rollers between each auxiliary and printing sprocket for tensioning the films, means for guiding a pair of films into superposed engagement upon the sprocket at each printing station and a film stripper for removing the films from the sprocket just beyond each station, said guide means and film stripper being so positioned relative to each other and to the printing sprocket that each pair of superposed films has only limited engagement with the sprocket, a printing aperture, a shutter and source of illumination for each printing station, said aperture having a height equal to the height of a picture frame plus the distance between frames and being positioned adjacent to the films at the point at which they are in engagement with the printing sprocket, said printing sprocket having a substantially solid peripheral surface for supporting the engaged films and having a row of teeth along said edge, the teeth being of a width substantially equal to the width of the film perforations and being of such relative thickness and each shutter being so synchronized with the rotation of the sprocket that the leading edge of only one tooth in said row contacts the aligned edges of the perforations of each pair of superposed films during the exposure interval at each printing station.

10. In a printing machine for use with continuously moving strips of film having perforations along the edges thereof, a printing sprocket for simultaneously advancing a plurality of negative or positive films and a light-sensitive film, a plurality of printing stations located on the periphery of the sprocket for successively printing each of the plurality of films upon the light-sensitive film, a plurality of auxiliary sprockets synchronized with the printing sprocket, each adapted to lead one of said plurality of films from its supply reel to the printing sprocket and a second one of said plurality of films from the printing sprocket to its takeup reel and to drive the light-sensitive film at stations intermediate the printing stations, biased rollers between each auxiliary and printing sprocket for tensioning

the films, means for guiding a pair of films into superposed engagement upon the sprocket at each printing station and a film stripper for removing the films from the sprocket just beyond each station, said guide means and film stripper being so positioned relative to each other and to the printing sprocket that each pair of superposed films has only limited engagement with the sprocket, a printing aperture, a shutter and source of illumination for each printing station, said aperture having a height equal to the height of a picture frame plus the distance between frames and being positioned adjacent to the films at the point at which they are in engagement with the printing sprocket, said printing sprocket having a substantially solid peripheral surface for supporting the engaged films and having two rows of teeth along said edge, a plurality of teeth in one row being of a width substantially equal to the width of the film perforations, the teeth in the second row being of less width than the width of the film perforations, the teeth in each row being of such thickness and so longitudinally spaced and each shutter being so synchronized with the rotation of the sprocket that the leading edge of a single tooth in each row drives the superposed pair of films at each printing station during the exposure interval.

11. In a printing machine for use with continuously moving strips of film having perforations along an edge thereof, a printing sprocket for simultaneously advancing a plurality of negative or positive films and a light-sensitive film, said sprocket having a row of teeth along its peripheral edge, a plurality of printing stations located on the periphery of the sprocket for successively printing each of the plurality of films upon the light-sensitive film, a plurality of auxiliary sprockets synchronized with the printing sprocket, each adapted to lead one of said plurality of films from its supply reel to the printing sprocket and a second one of said plurality of films from the printing sprocket to its takeup reel and to drive the light-sensitive film at stations intermediate the printing stations, means for guiding a pair of films into superposed engagement upon the printing sprocket at each printing station, a film stripper for removing the films from the sprocket just beyond each station, and shutter and illuminating means adapted to intermittently expose the films at the several printing stations.

12. In an apparatus for printing on lenticular film from color separation negatives or positives, said films having perforations along an edge thereof, a printing sprocket for simultaneously advancing a plurality of negative or positive films and a lenticular film, a plurality of printing stations located on the periphery of the sprocket for successively printing each of the plurality of films upon the lenticular film, means for guiding one of said plurality of films and the lenticular film into superposed engagement upon the sprocket at each printing station and a film stripper for removing the films from the sprocket just beyond each station, said guide means and film stripper being so positioned relative to each other and to the sprocket that each pair of superposed films has only limited engagement with the sprocket at the printing station, shutter and illuminating means adapted to intermittently expose the films at the several printing stations, a printing mask having an opening therein between each printing station and the illuminating means and at a distance and position relative to the films corre-

sponding to the distance and position of the filter area of the multicolor filter, or its virtual image, to be used in projecting the lenticular film, which filter area has the color corresponding to the film to be printed, said printing sprocket having a row of teeth along its peripheral edge, the teeth being of a width substantially equal to the width of the film perforations and being of such thickness and so longitudinally spaced and the shutter means being so synchronized with the rotation of the sprocket that the leading edge of a single tooth in said row drives the superposed pair of films at each printing station during the exposure interval.

13. In an apparatus for printing on lenticular film from color separation negatives or positives, said films having perforations along the edges thereof, a printing sprocket for simultaneously advancing a plurality of negative or positive films and a lenticular film, a plurality of printing stations located on the periphery of the sprocket for successively printing each of the plurality of films upon the lenticular film, means for guiding one of said plurality of films and the lenticular film into superposed engagement upon the sprocket at each printing station and a film stripper for removing the films from the sprocket just beyond each station, said guide means and film stripper being so positioned relative to each other and to the sprocket that each pair of superposed films has only limited engagement with the sprocket at the printing station, shutter and illuminating means adapted to intermittently expose the films at the several printing stations, a printing mask having an opening therein between each printing station and the illuminating means and at a distance and position relative to the films corresponding to the distance and position of the filter area of the multicolor filter, or its virtual image, to be used in projecting the lenticular film, which filter area has the color corresponding to the film to be printed, said printing sprocket having two rows of teeth along its peripheral edge, a plurality of teeth in one row being of a width substantially equal to the width of the film perforations, the teeth in the second row being of less width than the width of the film perforations, the teeth in each row being of such thickness and so longitudinally spaced and the shutter means being so synchronized with the rotation of the sprocket that the leading edge of a single tooth in each row drives the superposed pair of films at each printing station during the exposure interval.

14. In an apparatus for printing on lenticular film from color separation negatives or positives, said films having perforations along an edge thereof, a printing sprocket for simultaneously advancing a plurality of negative or positive films and a lenticular film, a plurality of printing stations located on the periphery of the sprocket for successively printing each of the plurality of films upon the lenticular film, means for guiding one of said plurality of films and the lenticular film into superposed engagement upon the sprocket at each printing station and a film stripper for removing the films from the sprocket just beyond each station, said guide means and film stripper being so positioned relative to each other and to the sprocket that each pair of superposed films has only limited engagement with the sprocket at the printing station, means for illuminating each pair of films from a distance and position corresponding to the distance and position of the filter area of the multicolor filter, or its virtual image, to be used in projecting the lenticular film, which

filter area has the color corresponding to the film to be printed, shutter means for intermittently intercepting the illumination directed to each printing station, said printing sprocket having a row of teeth along its peripheral edge, the teeth being of a width substantially equal to the width of the film perforations and being of such thickness and so longitudinally spaced and the shutter means being so synchronized with the rotation of the sprocket that the leading edge of a single tooth in said row drives the superposed pair of films at each printing station during the exposure interval.

15. In an apparatus for printing on lenticular film from color separation negatives or positives, said films having perforations along the edges thereof, a printing sprocket for simultaneously advancing a plurality of negative or positive films and a lenticular film, a plurality of printing stations located on the periphery of the sprocket for successively printing each of the plurality of films upon the lenticular film, means for guiding one of said plurality of films and the lenticular film into superposed engagement upon the sprocket at each printing station and a film stripper for removing the films from the sprocket just beyond each station, said guide means and film stripper being so positioned relative to each other and to the sprocket that each pair of superposed films has only limited engagement with the sprocket at the printing station, means for illuminating each pair of films from a distance and position corresponding to the distance and position of the filter area of the multicolor filter, or its virtual image, to be used in projecting the lenticular film, which filter area has the color corresponding to the film to be printed, shutter means for intermittently intercepting the illumination directed to each printing station, said printing sprocket having two rows of teeth along its peripheral edge, a plurality of teeth in one row being of a width substantially equal to the width of the film perforations, the teeth in the second row being of less width than the width of the film perforations, the teeth in each row being of such thickness and so longitudinally spaced and the shutter means being so synchronized with the rotation of the sprocket that the leading edge of a single tooth in each row drives the superposed pair of films at each printing station during the exposure interval.

16. In an apparatus for printing on lenticular film from color separation negatives or positives, said films having perforations along an edge thereof, a printing sprocket for simultaneously advancing a plurality of negative or positive films and a lenticular film, a plurality of printing stations located on the periphery of the sprocket for successively printing each of the plurality of films upon the lenticular film, a plurality of auxiliary sprockets synchronized with the printing sprocket, each adapted to lead one of said plurality of films from its supply reel to the printing sprocket and a second one of said plurality of films from the printing sprocket to its takeup reel and to drive the lenticular film at stations intermediate the printing stations, film tensioning means between each auxiliary and printing sprocket for tensioning films, means for guiding one of said plurality of films and the lenticular film into superposed engagement upon the sprocket at each printing station and a film stripper for removing the films from the sprocket just beyond each station, said guide means and film stripper being so positioned relative to each

other and to the printing sprocket that each pair of superposed films has only limited engagement with the sprocket at the printing station, means for illuminating each pair of films from a distance and position corresponding to the distance and position of the filter area of the multi-color filter, or its virtual image, to be used in projecting the lenticular film, which filter area has the color corresponding to the film to be printed, shutter means for intermittently intercepting the illumination directed to each printing station, said printing sprocket having a row of teeth along its peripheral edge, the teeth being of a width substantially equal to the width of the film perforations and being of such thickness and so longitudinally spaced and the shutter means being so synchronized with the rotation of the sprocket that the leading edge of a single tooth in said row drives the superposed pair of films at each printing station during the exposure interval.

17. In an apparatus for printing on lenticular film from color separation negatives or positives, said films having perforations along the edges thereof, a printing sprocket for simultaneously advancing a plurality of negative or positive films and a lenticular film, a plurality of printing stations located on the periphery of the sprocket for successively printing each of the plurality of films upon the lenticular film, a plurality of auxiliary sprockets synchronized with the printing sprocket, each adapted to lead one of said plurality of films from its supply reel to the printing sprocket and a second one of said plurality of films from the printing sprocket to its takeup reel and to drive the lenticular film at stations intermediate the printing stations, film tensioning means between each auxiliary and printing sprocket for tensioning the films, means for guiding one of said plurality of films and the lenticular films into superposed engagement upon the sprocket at each printing station and a film stripper for removing the films from the sprocket just beyond each station, said guide means and film stripper being so positioned relative to each other and to the printing sprocket that each pair of superposed films has only limited engagement with the sprocket at the printing station, a shutter and source of illumination for each printing station, a printing aperture having a height equal to the height of a picture frame plus the distance between frames positioned adjacent to the films at the point at which they are in superposed engagement with the printing sprocket, a printing mask having an opening therein between each printing aperture and source of illumination and at a distance and position relative to the films corresponding to the distance and position of the filter area of the multi-color filter, or its virtual image, to be used in projecting the lenticular film, which filter area has the color corresponding to the film to be printed, said printing sprocket having two rows of teeth along its peripheral edge, a plurality of teeth in one row being of a width substantially equal to the width of the film perforations, the teeth in the second row being of less width than the width of the film perforations, the teeth in each row being of such thickness and longitudinally spaced and each shutter being so synchronized with the rotation of the sprocket that the leading edge of a single tooth in each row drives the superposed pair of films at each printing station during the exposure interval.

18. In an apparatus for printing on lenticular

film from color separation negatives or positives, a printing sprocket for simultaneously advancing a plurality of negative or positive films and a lenticular film, a plurality of printing stations located on the periphery of the sprocket for successively printing each of the plurality of films upon the lenticular film, a plurality of auxiliary sprockets synchronized with the printing sprocket, each adapted to lead one of said plurality of films from its supply reel to the printing sprocket and a second one of said plurality of films from the printing sprocket to its takeup reel and to drive the lenticular film at stations intermediate the printing stations, means for guiding one of said plurality of films and the lenticular film into superposed engagement upon the printing sprocket at each printing station, means on said sprocket for registering each pair of superposed films at a printing station, a film stripper for removing the films from the sprocket beyond each station, and means for illuminating each pair of films at a printing station from a distance and position corresponding to the distance and position of the filter area of the multicolor filter, or its virtual image, to be used in projecting the lenticular film, which filter area has the color corresponding to the film to be printed.

19. In an apparatus for printing on lenticular film from color separation negatives or positives, a printing sprocket for simultaneously advancing a plurality of negative or positive films and a lenticular film, a plurality of printing stations located on the periphery of the sprocket for successively printing each of the plurality of films upon the lenticular film, a plurality of auxiliary sprockets synchronized with the printing sprocket, each adapted to lead one of said plurality of films from its supply reel to the printing sprocket and a second one of said plurality of films from the printing sprocket to its takeup reel and to drive the lenticular film at stations intermediate the printing stations, means for guiding one of said plurality of films and the lenticular film into superposed engagement upon the printing sprocket at each printing station, means on said sprocket for registering each pair of superposed films at a printing station, a film stripper for removing the films from the sprocket beyond each station, a shutter and source of illumination for each printing station, a printing mask having an opening therein between each printing station and source of illumination and at a distance and position relative to the films corresponding to the distance and position of the filter area of the multicolor filter, or its virtual image, to be used in projecting the lenticular film, which filter area has the color corresponding to the film to be printed.

20. The process of successively printing each of a plurality of strip negative or positive films upon a light-sensitive film strip comprising advancing a light-sensitive film about a printing sprocket causing it to intermittently engage said sprocket at each of a plurality of stations, simultaneously advancing each of said plurality of strip films into superposed engagement with the light-sensitive film at a different station, causing said light-sensitive film to move in loops of sufficient length prior to engaging said sprocket at each station subsequent to the first whereby any single portion of the light-sensitive film is driven by an identical portion of the sprocket past each station, and exposing said sensitive film at each of said stations.

21. The process of successively printing each

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of a plurality of perforated strip negative or positive films upon a perforated light-sensitive film strip comprising advancing the sensitive film about a printing sprocket causing it to intermittently engage said sprocket at each of a plurality of stations, simultaneously advancing each of said plurality of strip films into superposed engagement with the sensitive film at a different station, causing said sensitive film to move in loops of sufficient length prior to engaging said sprocket at each station subsequent to the first whereby any single portion of the sensitive film is driven by identical sprocket teeth past each station, and exposing said sensitive film at each of said stations.

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