April 28, 1942. A. L. McCORMICK ET AL 2,281,075

COLOR PHOTOGRAPHY

Filed Sept. 2, 1938

Fig. 1.

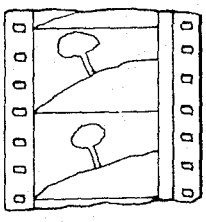


Fig. 2.

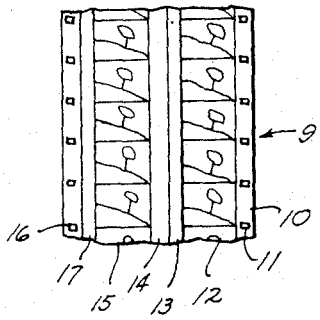


Fig. 3.

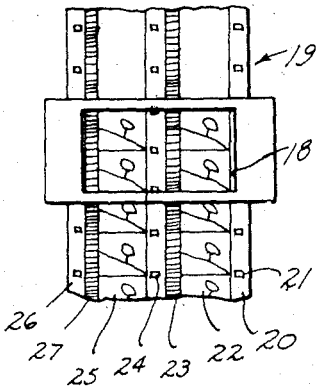


Fig. 8.

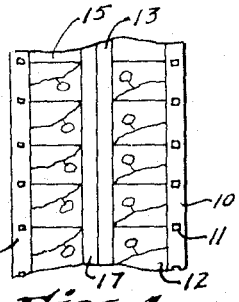


Fig. 5.

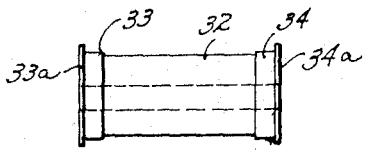


Fig. 4.

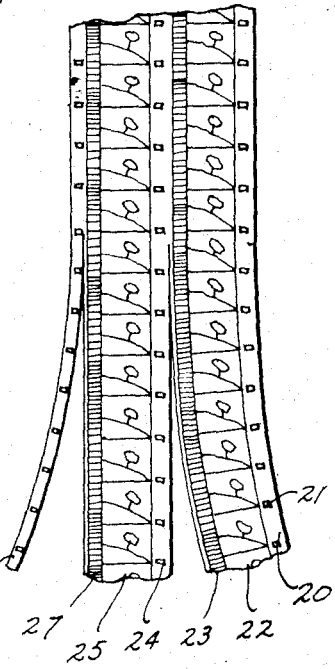


Fig. 6.

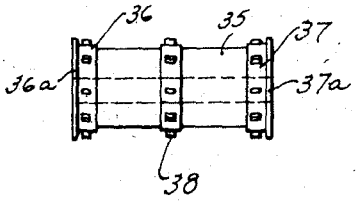
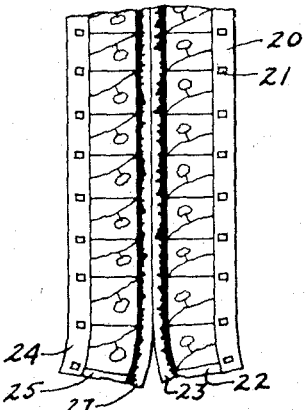


Fig. 9.



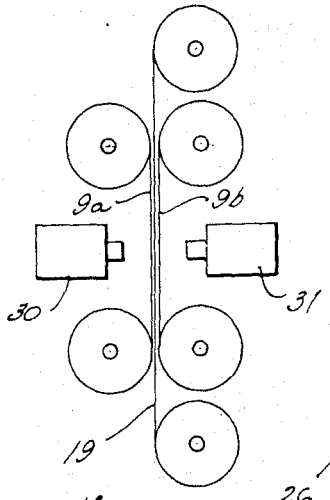


Fig. 7.

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Patented Apr. 28, 1942

2,281,075

UNITED STATES PATENT OFFICE

2,281,075

COLOR PHOTOGRAPHY

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Application September 2, 1938, Serial No. 228,126

4 Claims. (Cl. 88—16.2)

Our invention relates generally to the art of color photography, and more particularly to a novel and economical method for producing 16 mm. colored motion pictures with sound track thereon.

As is well-known, the standard motion picture film now used for theatrical work is 35 mm. in width, and most of the film used for amateur photography and various commercial purposes is 16 mm. in width, with some 8 mm. film being used. These three sizes have, over a period of years, become standardized and are manufactured by various film companies throughout the world. For the sake of simplicity, we will in the specification and claims speak of 35 mm. and 16 mm. films respectively, it being understood that by so doing, we refer to standard sizes, and if in the future these standard sizes should change, that the words "35 mm." and "16 mm." whenever used throughout this application are meant to include such changed sizes, so long as the general relationship between the standard sizes remains the same. Furthermore, it is to be understood that if in the future, the present standard film of 16 mm. is enlarged to 18 mm. or 19 mm. in width, whereby two 8 mm. films can be produced therefrom with an extra unused marginal strip as hereinafter set forth, that the term "35 mm." when used herein is meant to include such new type of film, and the term "16 mm." when used herein is meant to broadly include the relatively half-size films made therefrom.

In making colored photographs by the subtractive method, it is necessary to have a plurality of color-value or color-separation negatives, which are successively or simultaneously printed in register to a light sensitive film to produce a plurality of superposed positive color-value images therein, which images are subsequently selectively colored with appropriate colors to give a resulting photograph which is the combination of the superposed part images with their respective colors. In producing subtractive color prints, it is of course necessary to have two or more printing negatives (depending upon whether the process is a two-color one, or three-color one), and in ordinary 35 mm. work where the films are provided with perforations along each edge, the problem of accurately registering the plurality of negatives during the printing operation, so that all of the printed images will be exactly superimposed, has been met generally by employing a pair of registering pins adapted to be inserted in opposite perforations of the film during the printing operation. When it is desired to print a sound track on 35 mm. film, a narrow space or strip is left along one side of the film between one row of perforations and the picture area, and a suitable sound track image is printed in this space.

The foregoing method offers relatively few difficulties now in the production of 35 mm. prints in color and sound, but it has been found that this procedure cannot be applied to the production of 16 mm. or 8 mm. sound prints in color, since it has been found necessary to dispense with one row of perforations in the small size films in order to provide space for the sound track. Obviously, it is impossible to accurately register a plurality of color-value negatives during the printing operation unless at least two perforations are available for the registering operation. Due to variations in the film shrinkage and other factors, it is virtually impossible to properly register the films by using different holes in the same row of perforations, and as a consequence thereof, it has heretofore been deemed impossible to produce satisfactory colored 16 mm. or 8 mm. films in sound, since they had but one row of perforations.

It is the major object of our invention to provide a simple and efficient method for producing highly satisfactory 16 mm. and 8 mm. prints in both color and sound, which process or method as will be hereinafter disclosed is very rapid and economical.

It is also an object of our invention to provide a special film for use in our method, which greatly facilitates the operation thereof.

These and other objects and advantages of our invention will become apparent from the following description of a preferred form thereof, and from an inspection of the accompanying drawing, in which:

Fig. 1 is a plan view of a section of ordinary 35 mm. film with a developed image thereon,

Fig. 2 is a plan view of a section of one form of printing negative used in our invention,

Fig. 3 is a plan view of a section of our preferred form of positive film, showing schematically one form of printing,

Fig. 4 is a plan view of the positive film of Fig. 3, showing the final step of our system,

Fig. 5 is a plan view of a typical roller used in the film-treating equipment,

Fig. 6 is a plan view of a special type sprocket which may be used in our invention,

Fig. 7 is a diagrammatic view illustrating one

way of printing a positive from two color-value negative films,

Fig. 8 is a plan view of a modified form of printing negatives, and

Fig. 9 shows the final step in the modified form of our invention utilizing the negative of Fig. 8.

As the first step in our method, we produce a set of balanced color-value negatives by any suitable process, such for instance as the well-known bi-pack system, wherein two films are run face-to-face through a camera, and are so constructed as to record substantially complementary color-value images thereon; or by the beam-splitting system, whereby the light is divided by appropriate means and the separate beams expose separate films to produce color-separation images; or by any other suitable process, by which it is possible to produce a set of substantially complementary color-value negatives which can be used for printing in a subtractive process. For example, it is possible to produce a lenticular negative or a screen-plate negative, and then by appropriate means to produce a set of separate printing negatives from these single negatives, which printing negatives can subsequently be used in our process. The particular manner of obtaining the negatives forms no part of our invention, the only requisite being that they be color-separation negatives of proper range and quality.

In Fig. 1, we have illustrated one of a set of color-value negatives produced on 35 mm. film with standard perforations. From this set of 35 mm. negatives we preferably produce a set of 35 mm. printing negatives which have two parallel series of negative images reduced from the 35 mm. to the 16 mm. size, it being understood of course that these dimensions refer to the width of the films, and not the images. These printing negatives can be obtained by any convenient means, such for example as making lavender prints of the original negatives, and then making a pair of dupe negatives on one film by reduction printing to produce the two series of 16 mm. pictures; or if desired the reduction may be accomplished during the printing of the lavender prints to give a set of lavender prints having two parallel series of duplicate 16 mm. images thereon, which prints can subsequently be used to produce printing negatives either by contact or optical printing.

In our preferred form of printing negatives, we have a row of 16 mm. type perforations along each edge of the stock as indicated in Fig. 2. As previously mentioned, two parallel duplicate series of 16 mm. size images are produced on this film, their position being as follows. One row of perforations indicated by the numeral **11** is located in the usual manner for 16 mm. films, i. e., closely adjacent to the outer edge of the film. Adjoining this row of perforations is one series of 16 mm. picture images indicated by the numeral **12**. Inside of this row of images is a space **13** large enough to receive a 16 mm. type sound track; said perforations, series of picture images, and sound track space occupying exactly 16 mm. of the width of said film. Immediately adjacent the sound track area **13** is a blank strip **14** equal in width to the strip occupied by the perforations **11**. Immediately adjoining this is a second series **15** of picture images of 16 mm. film size. Adjacent the other side of the picture strip **15** is a blank strip **17** equal in width to the strip **13**, i. e., 16 mm. sound track width, the outer edge of this strip being exactly 32 mm. from the first-mentioned edge of the film. In the remaining 3 mm. strip on the edge of the film is a row of 16 mm. type perforations **16** similar to the perforations **11** first mentioned. Thus it will be seen that we have produced a printing negative having two parallel series of duplicate 16 mm. type picture images thereon with spaces left for a sound track for each series of picture images, there being a row of 16 mm. type perforations on each edge of the film which can be used for registering in the printing operation.

Referring now to Fig. 3, wherein is illustrated a strip of positive film adapted to receive the images from the negatives of Fig. 2, the numeral **20** indicates a space along one edge corresponding in size to strip **10** of the printing negatives, and provided with a series of 16 mm. type perforations **21**, corresponding to the perforations **11** of the printing negatives. The positive film is preferably also provided with a series of perforations **24** in a strip area corresponding to strip **14** of the printing negatives, and a series of perforations **26** along its other edge, corresponding with perforations **16** of the printing negatives, the perforations in the positive being of the same size and spaced the same as the perforations in the negatives. The images carried by the printing negatives are printed on to their appropriate picture areas **22** and **25** on the positive stock corresponding to the areas **12** and **15** of the negatives, and an appropriate sound track is printed in the areas **23** and **27** which correspond in width to sound track areas **13** and **17** of the printing negatives. The printing of the picture images is preferably accomplished by contact printing with an over-sized aperture such as indicated by numeral **18**, which, as will be seen, is double length so as to simultaneously accommodate two successive frames in each row of picture images, that is to say, during each printing light exposure, two consecutive frames of each series of negatives are printed at the same time, thus doubling the ordinary speed of printing, and since two separate 16 mm. prints are made simultaneously, the speed of printing is again doubled, so that our method of printing is four times as fast as conventional methods. It is to be understood, of course, that we may use positive stock having an emulsion layer on one or both sides for producing the colored prints, the printing operation being the same in either case.

The picture and sound track images may then be developed and the picture images colored in any suitable manner, it being understood of course that the order of steps employed forms no part of our invention, and that it is immaterial whether the sound tracks or the pictures are printed first, or whether both picture images are printed at the same time or consecutively. Likewise, the sound tracks may be colored or left black and white as desired. In other words, our invention contemplates the use of various types of color processes, and may readily be adapted to any of them, so long as the ultimate result is two duplicate or substantially duplicate parallel series of 16 mm. picture images in color, each accompanied by a sound track of suitable nature, these two series of pictures including their sound tracks occupying 32 mm. of the 35 mm. strip of film, leaving a 3 mm. protective strip along one edge of the film which may carry the perforations **26** therein.

In Fig. 7, we have illustrated diagrammatically one means of printing a positive film from a set of printing negatives. The numerals **9***a* and **9***b* indicate the printing negatives, and the numeral **19** indicates the positive stock receiving

the prints from the printing negatives. A pair of lamp houses **30** and **31** are shown as being oppositely disposed, so as to simultaneously print the negatives **9***a* and **9***b* to the positive stock **19**. It is to be understood of course that this is merely illustrative of one suitable method of performing the printing operation.

In Fig. **4**, we show a strip of finished film carrying two series of developed and colored 16 mm. picture images each with its own sound track, the various film areas being indicated by numerals as in Fig. 3. For example: strip **20** is provided with a series of perforations **21** adjacent to picture area **22** which has sound track **23** on its other side. Next comes the strip carrying perforations **24** adjacent to picture **25** with its corresponding sound track **27**, these various elements all together again occupying 32 mm. of the film width. The 3 mm. strip left on the other edge of the film carries a row of perforations **26** as before. Fig. 4 illustrates the final step in our system which comprises removing the 3 mm. strip **26** with its perforations and then slitting the remaining 32 mm. film down the middle between sound track **23** and the perforations **24** to give two separate and complete 16 mm. positive prints in color and sound, it being noted that the two prints are duplicates of each other. It will be understood of course that the sequence of operations in the final step of our process is immaterial, it making no difference whether the film is slit between the track **23** and perforations **24** before, after, or during the slitting or removal of the strip **26**.

In Fig. 5, we have illustrated a typical film roller used in cameras and film treating machines comprising a spool portion **32** with raised shoulders **33** and **34** on each end thereof, each shoulder being provided with a flange **33***a* and **34***a* as indicated.

While we have described our preferred form of positive film as being provided with three rows of perforations, it will be understood of course that only two rows are necessary for properly registering the films. We have found that by providing the perforations on opposite edges of the film, we are enabled to obtain accurate registry during the printing operation, and that it is usually not necessary to use the perforations **24**, it being understood that if it is desired to use the perforations **24** as additional means for registering the films, similar perforations would be provided in the strip **14** of the printing negative **9**. In this case, a sprocket such as illustrated in Fig. 6 is preferably employed which has a spool portion **35** provided with raised shoulders **36** and **37** on its opposite ends, each of said shoulders being provided with sprocket teeth. A substantially centrally disposed shoulder **38** is also provided on the spool portion **35** and has suitable teeth corresponding to the teeth on shoulders **36** and **37**, the position of shoulder **38** being such as to mesh with the perforations **24** and **14** of the films. As mentioned, we find that usually it is not necessary to provide this additional precautionary means. However, it is sometimes highly desirable to employ rollers of this type in the developing and processing machines, particularly if long lengths of film are to be pulled therethrough, it having been our experience that the three-point pull on the film during processing reduces the strain on the individual perforations considerably.

As will be readily understood, so far as the printing operation goes any two of the three sets or rows of perforations will suffice, although we prefer to employ the outside rows as illustrated. However, if for any reason, it is not desired to perforate the strip **26**, the printing negatives may be provided with perforations **14**, corresponding to perforations **24** in the positive stock and the printing operation can be carried on by registering the perforations **11** and **14** with perforations **21** and **24**. Likewise, it is possible but not particularly advantageous to provide the series of perforations **24**, and not supply the perforations **21** until after the films have been processed.

By using 35 mm. stock for producing the 16 mm. films, we overcome several disadvantages which are encountered in processing 16 mm. film strips. In the first place, 16 mm. film because of its narrow width has more of a tendency to stretch and become distorted which makes registry more difficult. Secondly, as previously mentioned, it is impossible to accurately register color negatives with only the one set of perforations present on 16 mm. sound films. Thirdly, all 16 mm. stock is made with an acetate base instead of the nitrate base usually used for 35 mm. stock, which is much more difficult to handle in the laboratory because of its tendency to curl and stretch. Even 35 mm. "safety" (acetate) stock is difficult to process, and when the width of the film is reduced to 16 mm., it becomes virtually impossible to float it across a solution as is necessary in many color processes.

Also by leaving the 3 mm. strip along one edge of the film, we obtain a number of distinct advantages. In the first place, an area is provided for an auxiliary set of perforations, which as mentioned is our preferred means of registering the films during printing. Secondly, without the 3 mm. strip, the sound track image comes out to the very edge of the film, and during the printing and processing thereof, the edge of the film is bound to rub against the flanges **33***a* and **34***a* of the rollers of the machine and **36***a* and **37***a* of the sprockets. This rubbing will very often result in chipping small portions of the emulsion away from the base which of course produces defects in the sound track. Furthermore, if double-coated stock is used, i. e., film having a light sensitive emulsion on each side of the base, it is obviously impossible to run the film through a developing or coloring machine without ruining the sound track, since when the emulsion is dampened, it has a tendency to stick to the rollers and without the protective strip **26**, the sound track **27** would be riding over one of the shoulders **33** or **34** of the rollers or **36** or **37** of the sprocket, and would also rub against any surfaces such as tracks or guides provided in the printer. However, by providing the 3 mm. protective strip on the outside edge of the film, this condition is entirely obviated and the entire picture and sound track area of the film is thoroughly protected.

A modified system for producing two 16 mm. prints at on time from a single strip of positive stock is illustrated in Figs. 8 and 9. In this form of our invention, we likewise prefer to first produce a set of 35 mm. color-separation negatives in any suitable manner, but instead of using them to product a set of 35 mm. printing negatives such as shown in Fig. 2, we produce a set of 32 mm. printing negatives such as shown in Fig. 8. By inverting one series of 16 mm. images in the printing operation, we are enabled to place the two sound tracks together on the inside of

the stock and to eliminate the necessity of the 3 mm. strip 26 along one edge of the positive. However, as will be seen in Figs. 8 and 9, we nevertheless have a row of perforations along each edge of the film, so that accurate registry can be had as previously explained.

In Fig. 9, we have illustrated the final step of our system which is the same as illustrated in Fig. 4, except that but one slitting operation is necessary. In this figure, we have shown the films as having a variable area sound track whereas in Fig. 4, a variable density track is illustrated. The same numerals have been used in these figures as in the figures which illustrate the first form of our invention, it being noted that the two series of 16 mm. pictures and tracks are reversed with respect to each other. By thus placing the perforations of each of the 16 mm. films on the outside edge of the positive step, we again provide protection for the emulsions when the films are being processed. It will also be understood that this modified form of our invention can be used to produce 8 mm. sound prints in color from 16 mm. stock, so long as sufficient precautions are taken to prevent curling and breaking of the film. However, in making 8 mm. sound prints in color, we prefer to produce four of them at once on 35 or 32 mm. stock, as previously described.

It will be understood of course that if it is desired to produce the printing negatives directly by exposure in a suitable camera, that this procedure may of course be followed, such being easily accomplished by providing a pair of lenses, or a beam-splitting apparatus in the camera adapted to expose the two portions of the film simultaneously to produce duplicate or substantially duplicate 16 mm. images direct. However, our experience has shown that much better photography can be accomplished if the pictures are originally photographed in the 35 mm. size, and subsequently reduced to the 16 mm. size.

Thus it will be seen that we have provided a system of producing 16 mm. colored motion pictures with sound tracks thereon by utilizing double width stock throughout, which makes it possible to secure accurate registry of the images during printing, and to protect the emulsions during printing and processing, thus insuring pictures of high quality in every regard.

It is to be understood that when in the claims, we speak of double width films, the term is meant to include both 32 mm. and 35 mm. films.

We claim as our invention:

1. The method of producing a plurality of reduced size motion picture prints in color and sound which includes: producing a set of 35 mm. negatives having a series of color-value images thereon; producing from said set of negatives a plurality of series of reduced size positive images in color on a single 35 mm. film strip having two sets of perforations therein; producing a plurality of reduced size sound tracks on said film strip, said picture and sound images all together occupying but 32 mm. of said film; and slitting said film longitudinally to produce a plurality of strips of reduced size picture images in color and sound which are duplicates of each other.

2. The method of producing a plurality of reduced size motion picture prints in color and sound which includes: producing a set of 35 mm. negatives having a series of color-value images thereon; producing from said set of negatives a plurality of series of reduced size positive images in color on a single 35 mm. film strip having two sets of perforations therein, at least one set thereof being of reduced size to correspond with the reduced size of said images; producing a plurality of reduced size sound tracks on said film strip, said picture and sound images all together occupying but 32 mm. of said film; removing said unused 3 mm. strip; and slitting said film longitudinally to produce a plurality of film strips each having a series of reduced size picture images in color and a sound track thereon.

3. The method of producing a plurality of reduced size motion picture prints in color and sound which includes: producing a set of 35 mm. negatives having a series of color-value images thereon; producing from said set of negatives a plurality of series of reduced size positive images in color on a single 35 mm. film strip having two sets of perforations therein, at least one set thereof being of reduced size to correspond with the reduced size of said images, and located along one edge of said film; producing a plurality of reduced size sound tracks on said film strip, said picture and sound images alternating across said film, there being an area for perforations between each composite reduced sound and picture strip; and slitting said film to produce a plurality of film strips each having a set of perforations, a series of reduced size picture images in color, and a sound track thereon.

4. A 35 mm. motion picture film strip which includes a plurality of series of reduced size picture images in color and sound tracks, said series being duplicates of one another, and a set of perforations for each combined series of picture and sound images, all of said series and sets occupying but 32 mm. of said film strip.

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