[Second Edition.]

PATENT SPECIFICATION

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Complete Accepted: Oct. 27, 1931.

COMPLETE SPECIFICATION.

Process and Means for Producing Sound Motion Picture Films in Colour.

We, MULTICOLOR FILMS INCORPORATED, a corporation of the State of California, United States of America, of 201, North Occidental Boulevard, Los Angeles, California, United States of America, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

Our invention relates to colour photography and more particularly to the art of producing sound records in conjunction with colour motion-picture films in natural colour.

A method of recording sound on a strip of motion-picture film is to subject the travelling film to a focussed beam or slit of light from an exposure lamp. This beam or slit of light moves back and forth within the limits of a narrow path running lengthwise of the travelling film, or varies in intensity in accordance with the sound. The amount of exposure impressed on this path is dependent upon the volume of sound to be recorded. When developed such a film contains a sound record, the opacity of which is different at different sections, or which is in the form of a serrated sound image and is a negative sound record. A positive of this negative is then made.

In reproducing from such a positive film, a beam of light is sent through the moving sound record and the varying opacity of this record varies the intensity of that portion of the beam of light which impinges upon a light-sensitive cell such as a photo-electric or selenium cell, which action sets up audio frequency waves which are finally reproduced as sound through loud-speakers.

Heretofore it has not been possible to our knowledge to record sound in conjunction with a coloured motion-picture film with accuracy, although much work in this field has been done by ourselves and others. For instance, it has been previously suggested to dye both the images and the sound record on the film with the same dye, but we have found that the sound record when coloured with the colours of the right end of the spectrum gives inferior results as far as sound reproduction is concerned than when coloured with the colours of the blue-green end of the spectrum. We have discovered that by using chemical toning means to give the desired colours, even better sound reproduction is obtained. In our process the silver image is converted to an image composed of grains of coloured inorganic material enabling sound reproduction to be obtained equivalent to that of the known black and white.

In the present instance, our process goes forward to utilize a sound record negative, this negative being precisely the same as for black and white photography.

In both the black and white and multicolour processes the sound records are made up of a plurality of transversely extending fine lines, which occupy a space between the image areas and the adjacent perforations, the whole being called a sound track and occupying a space of approximately one-eighth of an inch on 35 mm. film. These lines vary either in length or in their relative spacing and serve to vary the intensity of the light from the excitor lamp which penetrates the sound record and hits the light sensitive cell electrically connected to the sound-reproducing mechanism.

It will be explained that in the art of producing black and white motion-pictures which are subsequently dyed the sensitized films as they are received from the manufacturer bear at one side an outline or path for the sound record, such outline or path being spaced from the image area. The sound records on such a film would be black and white and the images tinted, while by our improved process the sound records would be selectively coloured by converting the silver image to a chemically toned image.

Although we have illustrated the production of a coloured sound record on a positive film known as a double coated film, we wish it to be understood that we may also use films carrying emulsion or emulsions on one side only of a celluloid base.

The object of the present invention is to provide an improved process of and

[Price 1/-].

means for producing a coloured motion picture film having a coloured sound track thereon.

With this object in view the present invention consists in a process of preparing a coloured motion-picture film having a sound record wherein the sound record and one series of images are chemically toned to one colour value and the other series of images are treated to give a complementary colour value.

The invention also consists in a process of preparing a coloured motion-picture film having a sound record thereon comprising forming complementary colour value negatives, printing the images of each of said negatives on an emulsion of a positive, printing the sound record on an emulsion on said positive, toning blue said sound record and the images formed on the emulsion by the exposure to the red colour value negative, and toning red the images formed on the emulsion by exposure to the blue colour value negative.

The invention further consists in a coloured motion-picture film carrying a chemically toned sound record.

With reference to the accompanying drawings which illustrate one embodiment of our invention by way of example:—

Figure 1 shows two negative films, A has been exposed through a blue filter, B has been exposed through a red filter.

Figure 2 is a fragmental perspective view of a double-coated composite positive with the selectively coloured emulsions partially withdrawn from the celluloid base, and illustrating at the left the image coloured red and at the right the image and sound record coloured blue.

Figure 2*a* is a fragmental sectional elevation of a double emulsion film slightly enlarged.

Figure 3 is a fragmental perspective view of a single-coated film with the emulsion partially withdrawn from the celluloid base and bearing the image and sound record in colour.

Figures 4 and 4*a* are diagrammatic views illustrating an apparatus for carrying out the process of my invention in the production of a coloured positive motion-picture film with a sound record.

An object having several colours is photographed from the same viewpoint upon two negative films 10 and 11 which are provided with sound tracks. Interposed between the object and one of these negative films is a transparent blue filter and between the object and the other negative film a transparent red filter. Inasmuch as the resultant sound record on the positive film is to be coloured blue, the sound is recorded on the negative exposed through the red filter, and no sound is recorded on the negative exposed through the blue filter.

The negative films are then removed from the camera and developed. An unexposed positive film 12 having a sound track is then provided having an emulsion applied to each of the opposite faces thereof. These emulsions are impregnated with a light restraining dye and this permits corresponding portions of the two developed negative films to be printed simultaneously upon opposite sides of the positive film, the negative exposed through the red filter and carrying the sound record being used to print the sound record on that side of the positive which is to be coloured blue.

When the positive film has been thus exposed, it is developed, fixed, the opaque dye washed out and the film dried. It is then ready for having the opposite faces thereof toned red and blue respectively. The image of the positive film printed from the negative which was exposed through a red filter is treated chemically to give it a blue colour. The image on the opposite side of the positive is in a similar manner treated chemically to give it a red colour. This colour positive film is now ready for use in a projecting machine. The projecting beam of light in passing through the positive film is coloured blue or red in those portions thereof which correspond respectively to the blue or red values of the object originally photographed.

The above described method of producing coloured motion-pictures by using a single film may be termed the " single film " method of projection.

In order to provide a bi-coloured film for use in the standard projection machines a positive film 12 is provided having emulsions 13 and 14 on the opposite faces of the celluloid base 15 thereof. Emulsions 13 and 14 are impregnated with an opaque dye which permits simultaneous printing of negatives 10 and 11 onto the emulsion coatings 13 and 14 on the opposite sides respectively of the film 12. The negative sound record is then by a separate operation printed on the track 18 on the positive emulsion 14 to give a positive sound record 18*a*.

Positive images 19 and 20 printed upon the layers of emulsion 13 and 14 from the blue negative and the red negative respectively are complementary to these negatives as indicated by the shading of corresponding portions of the diagrammatic view of these images in Figure 1.

The image 19 is treated so that it will be coloured red, and the image 20 is treated so that it will be coloured blue

and the sound record 18a will be likewise coloured blue. The sound track upon the negative exposed through the blue filter may be exposed to form a sound record, thus providing upon the positive film a sound record which is toned red. However, a sound record which is toned blue is found to provide superior results, probably because the desired degree of opacity is more readily obtained and it is, therefore, preferred to form the sound record upon the negative exposed through the red filter and to tone blue this sound record thus formed.

As the purpose of the positive film 12 is to project an image of the object photographed in its true colours, this will be accomplished by the passing of a projecting beam of light through the corresponding emulsions 13 and 14, with those disposed in the accurately superimposed relation in which they are printed on opposite sides of the positive film.

In the present multicolour process, as the basic colours employed in the production of the positive film are somewhat opaque, we print the sound record 18 and colour it by one of the colours used in the production of the positives. Uranium and ferric tones are more opaque than a dyed image and we find that we can record successfully a sound record with any one of the basic colours, but preferably the blue colour.

The sound record on the negative 11 is printed onto the positive film preferably by means of a continuous printer, that is, a printer which does not print step by step onto a positive film and during the printing of the sound track the portion of the film not receiving the impression of the sound record is protected from exposure by a suitable mask in the printer.

The positive film carrying the sound record 18 is now printed with the colour value images of the photographed picture. The portion of the positive film carrying the sound record 18*a* is protected in this second printing by a suitable mask in the printing aperture and, therefore, no exposure can reach it.

By the above explanation, it is clear that any object can be produced approximately in its true colours by the preparation of the positive film in the manner broadly indicated above. As previously stated, the processes at present used for the treating of the positive for colouring the images 19 and 20 have certain defects which are overcome by the process of our invention which may be carried on by the apparatus diagrammatically shown in Figures 4 and 4*a*.

This apparatus includes a fresh positive feed reel 16, a blue negative feed reel 21, a red negative feed reel 22, a printing device 23, negative rewinding reels 24 and 25, a series of tanks 26, 27, 28 and 29, a blue toning tank 30, a series of treating tanks 31, 32, 33, 34, 35, 36 and 37, a drier 38, and a positive film winding reel 39. Air jet pipes 40 are mounted adjacent to the film as it passes between the tank 29 and the blue toning tank 30. This apparatus is operated in the following manner to carry out our method of producing a double-coated positive colour film with a sound record.

A supply of fresh double-coated film 12 is provided upon the reel 16 and as the film is advanced through the apparatus, this fresh film is drawn from the reel 16 and passed through the printing device 23 between the blue and red negatives which are unwound from the reels 21 and 22, respectively. After the positive 12 has been printed, the negatives 10 and 11 are wound upon the reels 24 and 25, respectively. The printed positive film then passes through a bath of developer which will give the image a soft tone in the tank 26 and after that through a stop bath formed by a weak solution of acetic acid which is placed in the tank 27. The printing and developing of the positive 12 is carried on in a dark room but the remainder of the process may be conducted in the light.

Leaving the tank 27, the film 12 passes through a fixing solution in the tank 28 after which the film passes through a water wash in the tank 29. Leaving the tank 29, the film 12 is practically dried by jets of air blowing at high velocity from the pipe 40 disposed close to the film. The film then passes through the blue toning tank 30 which converts the positive silver image 20, which was printed from the red negative 11, into a blue image.

One formula for the blue toning bath is as follows:—

Iron ammonium alum -	2.5 grams.
Potassium citrate - -	2 grams.
Ammonium oxalate sat. sol. - - -	10 grams.
Hydrochloric acid (Sp. Gr. 1.18) - -	5 cc.
Potassium ferricyanide -	2 grams.
Distilled water - -	1000 cc.

The tank 30 may be of any suitable construction which restricts the application of the treating liquid to only one side of the positive film.

After leaving tank 30 the positive film 12 is run through a water wash for approximately four minutes in tanks 31, 32 and 33, and then into tank 34 where it is treated with a uranium solution. The formula for the uranium solution is as follows:—

Potassium oxalate	12 grams.
Uranyl nitrate	32 grams.
Potassium ferricyanide	9 grams.
Hydrochloric acid (Sp. Gr. 1.18)	32 ccs.
Distilled water	4000 ccs.

The uranium toning treatment chemically converts the image 19 from a silver image to an opaque image consisting of silver ferrocyanide and uranyl ferrocyanide. The colour of the image is changed from black to colours ranging from brownish yellow to red, depending upon the concentration of the uranium solution and the time of treatment. In order to produce a satisfactory red colour value image, the film 12 requires from six to eight minutes in the uranium solution.

The film is then given a water wash in tank 35 which removes the surplus of the dye. The film is then run through a hypo solution in tank 36. Before entering the hypo solution the images are usually opaque. The film usually requires from two to four minutes in this hypo solution to completely convert the silver ferrocyanide thereby removing all traces of cloudiness from the images. The film is then washed in tank 37 after which it passes through the drier 38 and is wound onto take-up reel 39.

Owing to the complete transformation of the positive silver image 20 to a blue image in the tank 30, this side of the film is entirely unaffected by the uranium bath so that the film 12 when wound upon the reel 39 has the opposite images thereof perfectly coloured to produce a projected image of the original in its natural colours.

It is important in sound recording on film that the silver record be of a density that certain parts of the silver prevent the rays from the exciter lamp from penetrating the sound record or impression. This is easily accomplished with a black and white result, but with colour most coloured objects are quite transparent. This is particularly so with a dye-toned image. With regard to a silver image that is chemically toned, a much greater opacity is obtained and a still greater density is possible by the addition of more concentrated hydrochloric acid to the toning bath. Such treated film will give a sound reproduction equal to black and white.

In Figure 3 we have shown a single-coated film 41 bearing an image 42 and a sound record 43 in colour, the sound record being toned one of the colours used in the production of the image 42. This single-coated film may be formed either with two separate layers of emulsion on one side of the base, or merely by providing upon one side of the base a single emulsion thick enough to accommodate two images thereon. One image is formed in the upper or outer stratum of the emulsion and one image is formed on the lower or inner stratum. Such a film is printed from the two colour value negatives in the same manner as a double-coated positive is printed one image being printed to the face of the emulsion and one image through the base, the latter image being printed on the inner half of the emulsion. The red image is printed on the outer emulsion, and the blue image and the sound record are printed on the inner or lower emulsion. Both images are developed and dried and the film is immersed in a mordant, either copper or iodine compounds being preferred. The film is immersed in the mordant just long enough to mordant the outer image and is then immersed in a bath of red dye and then washed. The film is then immersed in a blue toning bath as described relative to the double-coated film, and this bath does not affect the outer image but tones the inner image and the sound record blue.

A formula for the copper mordant is

Copper sulphate	7 grams.
Potassium citrate	56 grams.
Potassium ferricyanide	6 grams.
Water	1000 ccs.

A formula for the iodide mordant is

Iodine	3 grams.
Potassium iodide	25 grams.
Acetic acid	4 cc.
Water	2000 cc.

Any of the basic red dyes can be used, depending upon the particular type of red which it is desired to impart to the images upon the positive.

It is to be understood that the production of the sound records is not confined to 35 mm. but can be used for 16 mm. or wide width films.

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

1. A process of preparing a coloured motion-picture film having a sound record, wherein the sound record and one series of images are chemically toned to one colour value and the other series of images are treated to give a complementary colour value.

2. A process of preparing a coloured motion picture film having a sound record thereon comprising forming complementary colour value negatives, printing the images of each of said negatives on an emulsion of a positive, printing the sound record on an emulsion on said positive, toning blue said sound record and the

images formed on the emulsion by the exposure to the red colour value negative, and toning red the images formed on the emulsion by exposure to the blue colour value negative.

3. A process as claimed in Claim 2 in which one of the negatives is exposed through a blue filter and the other is exposed through a red filter.

4. A process as claimed in Claim 1 in which the image on one side of the positive is toned blue, and the image on the opposite side is chemically toned to give it a red colour value.

5. A process as claimed in Claim 1 in which the sound track is toned blue.

6. A coloured motion-picture film carrying a chemically toned sound record.

7. A coloured motion-picture film as claimed in Claim 6 in which the sound record and the image on the same side of the film are toned blue and the image on the other side of the film is coloured red.

8. A process of preparing a coloured motion picture film bearing a chemically toned sound record substantially as described and illustrated with reference to the accompanying drawings.

9. A coloured motion picture film bearing a chemically toned sound record substantially as described with reference to the accompanying drawings.

Dated this 27th day of May, 1930.

MARKS & CLERK.

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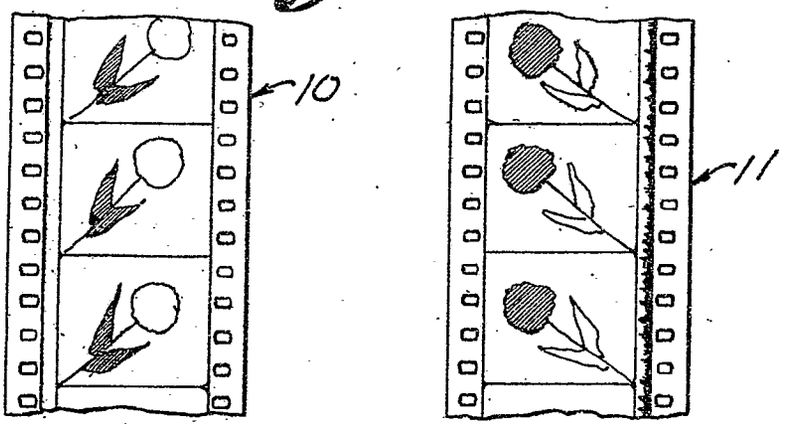
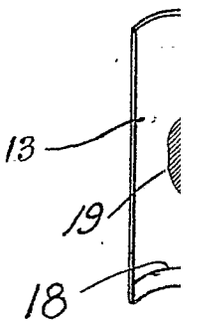
[Wt. 8002A.—50/12/1934.

(A) Fig. 1. (B)





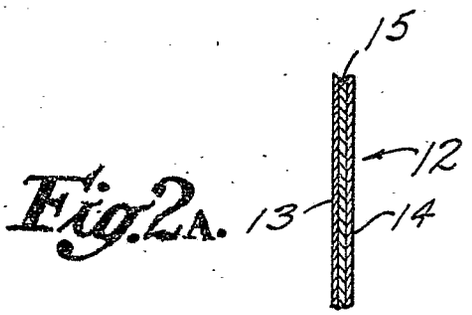


Fig. 2a.

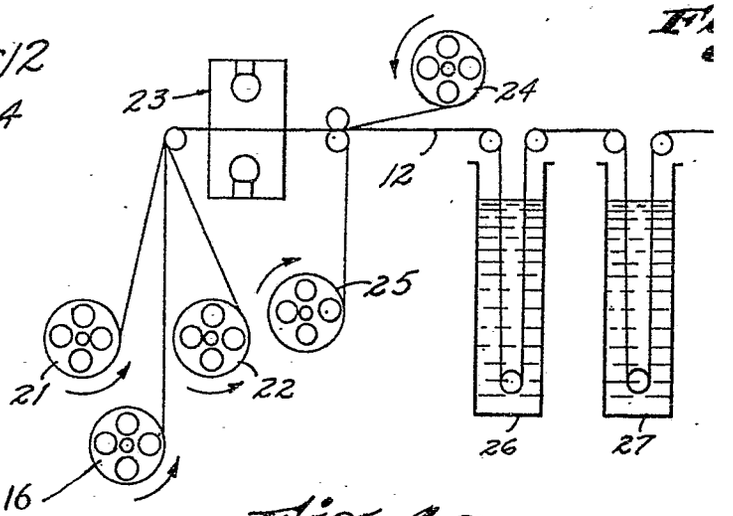


Fig. 4a.

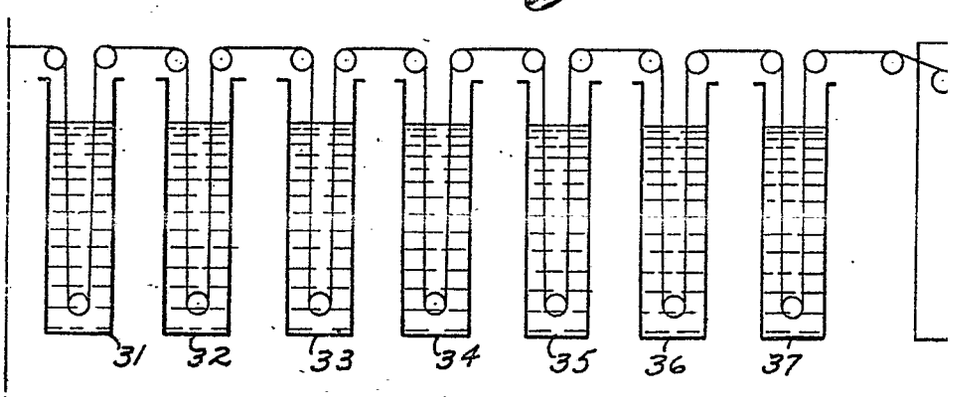


Fig. 2.

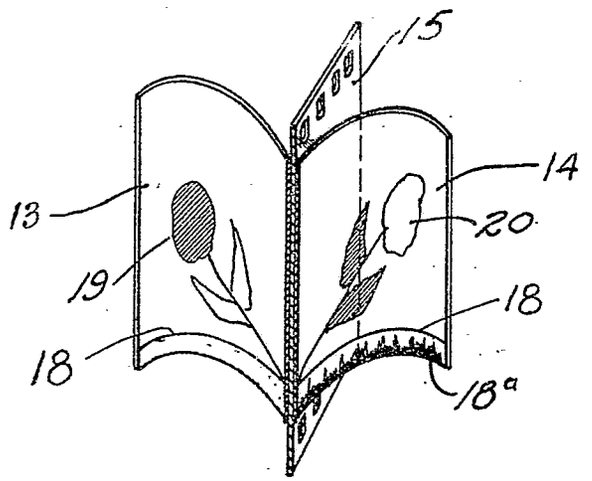


Fig. 3.

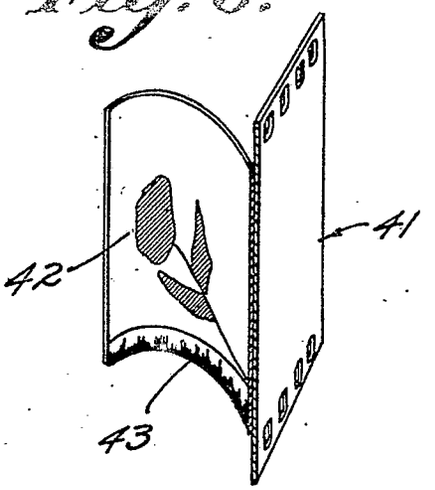
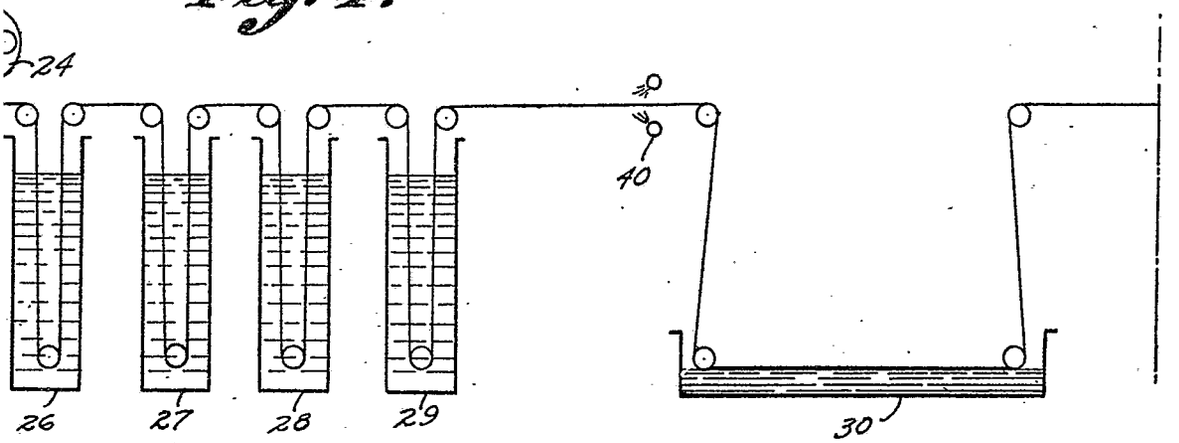
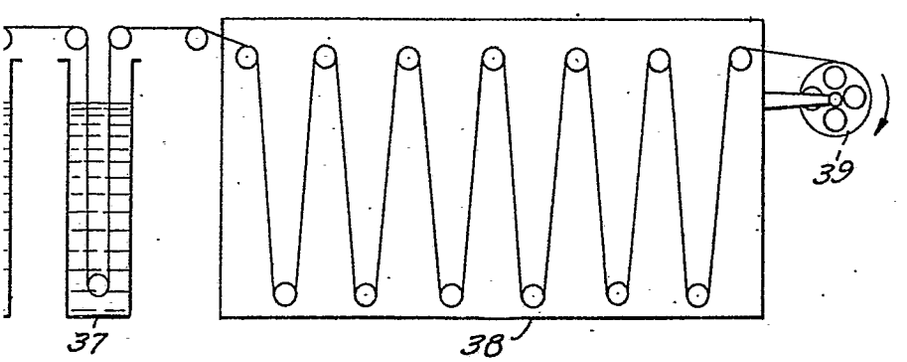


Fig. 4.



2.



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(A) Fig. 1. (B)

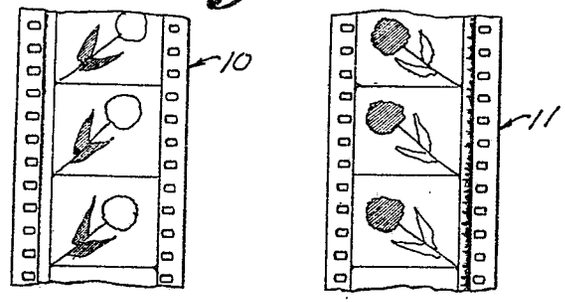


Fig. 2.

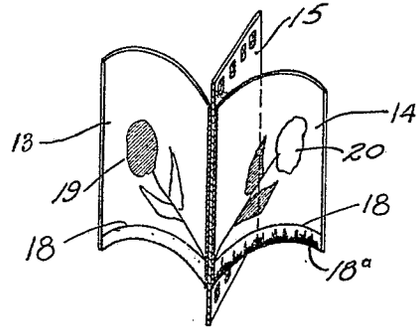


Fig. 3.

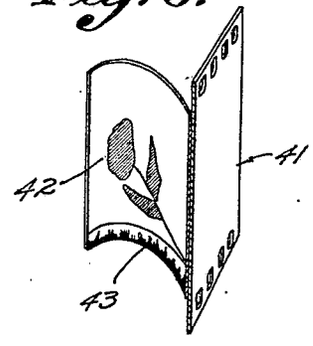


Fig. 2a.

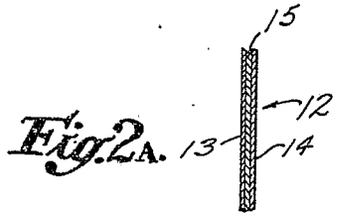


Fig. 4.

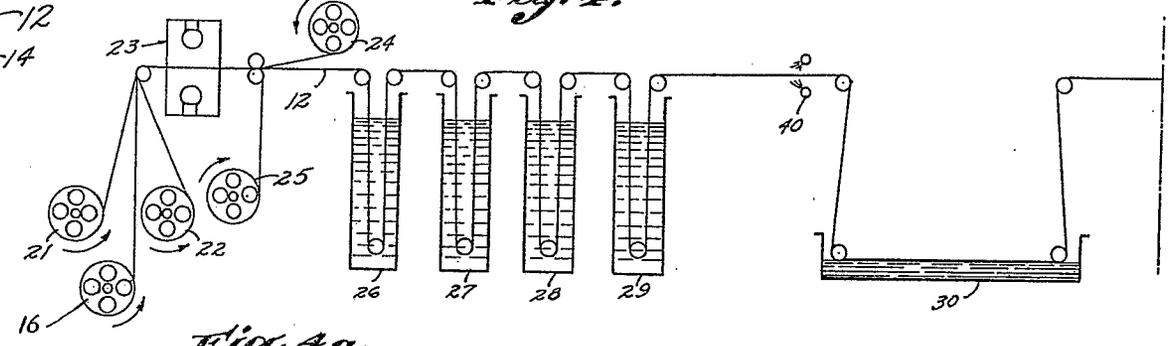
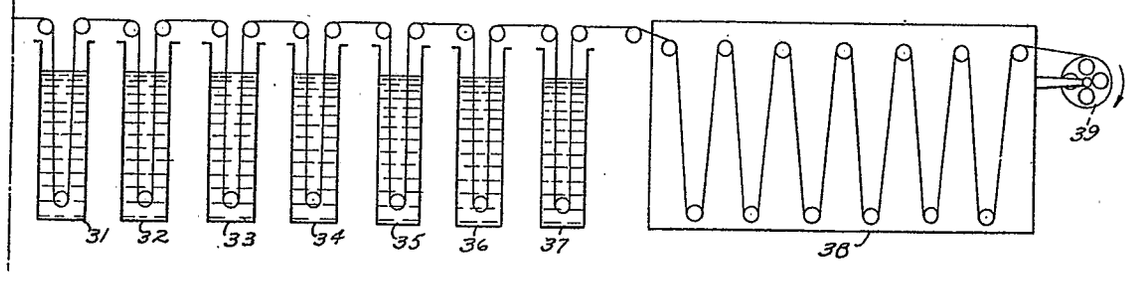


Fig. 4a.



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