

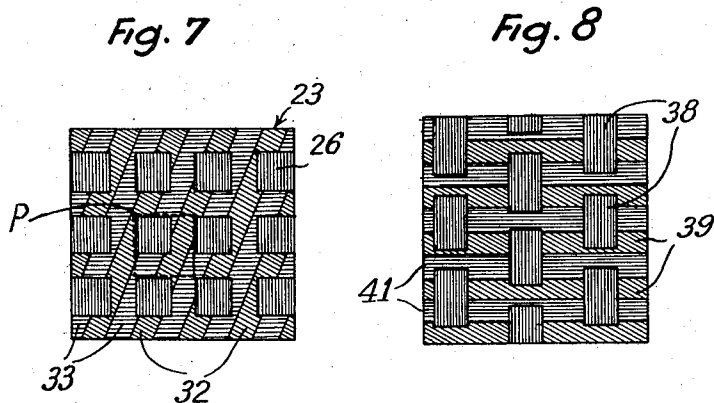
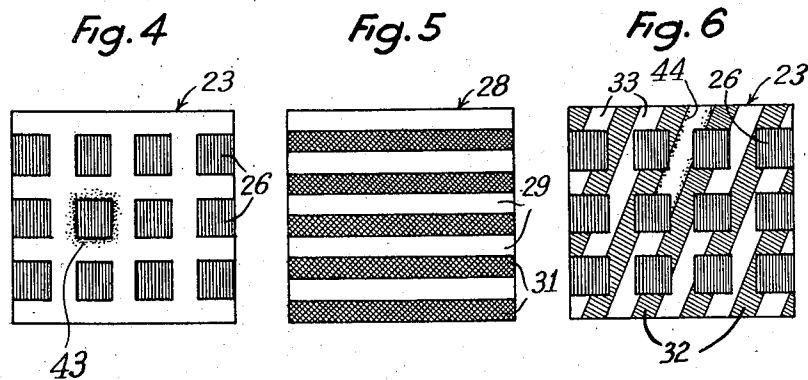
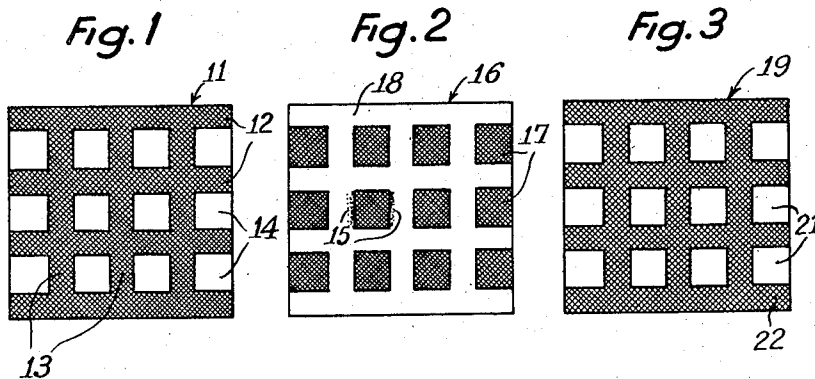
Dec. 16, 1958

G. E. CHEVALIER
PHOTOMECHANICAL METHOD FOR PREPARING MULTI-COLOR
MOSAIC CARRIERS FOR ADDITIVE COLOR
PHOTOGRAPHY AND CINEMATOGRAPHY

2,864,700

Filed Nov. 29, 1955

2 Sheets-Sheet 1



INVENTOR

Georges Emmaus Chevalier

By

George H. Harey

ATTORNEY

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2 Sheets-Sheet 2

Fig. 9

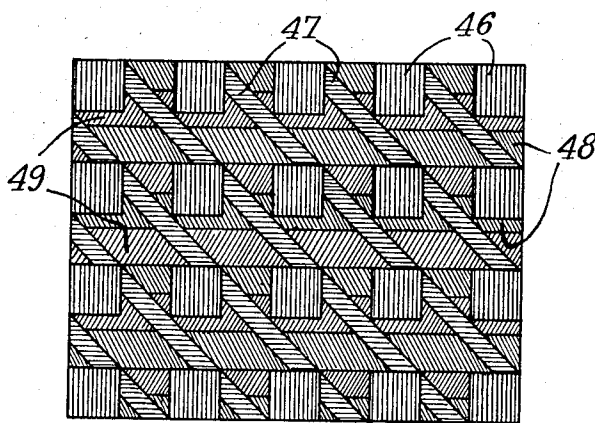


Fig. 10

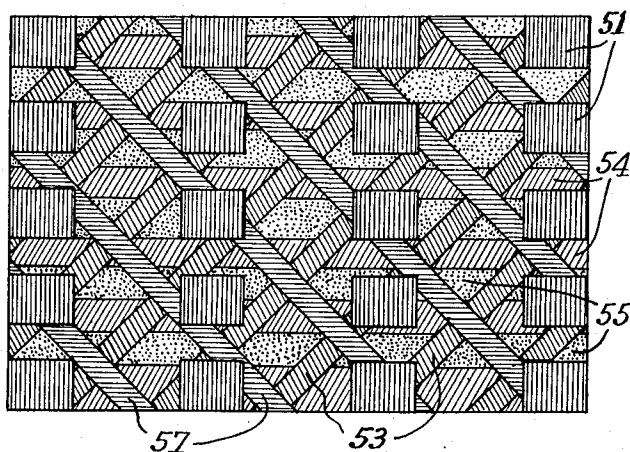
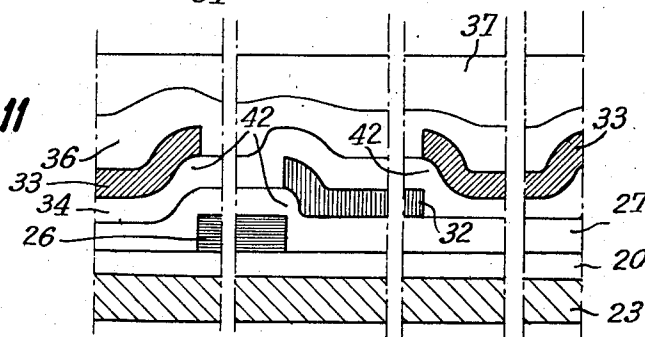


Fig. 11



INVENTOR
Georges Emmaus Chevalier
By *George Thorey*
ATTORNEY

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2,864,700

PHOTOMECHANICAL METHOD FOR PREPARING MULTICOLOR MOSAIC CARRIERS FOR ADDITIVE COLOR PHOTOGRAPHY AND CINEMATOGRAPHY

Georges Emmanus Chevalier, Paris, France, assignor to Mondiacolor, Paris, France, a corporation of France

Application November 29, 1955, Serial No. 549,755

Claims priority, application France March 17, 1951

19 Claims. (Cl. 96—35)

This invention relates to new and useful improvements in color photography by additive synthesis of multicolors and more particularly seeks to provide a carrier produced by photomechanical means that is provided with a mosaic pattern of multicolor filter screens in perfect conterminous relationship and of sufficient fineness to give true image reproduction even after the enlargement of projection.

This application is a continuation-in-part of my prior application Serial No. 223,791, filed April 30, 1951, now abandoned, for "Mosaic Carrier for Three Color Photography and Kinematography and Method for Preparing Said Carrier."

The colored films on the market today utilize subtractive methods of photography wherein generally several different layers of transparent emulsions sensitized to different colors are incorporated on a carrier, so that a multicolor composite image has the different portions thereof corresponding to the different colors formed only upon the associated emulsion layers. Thereafter, the film is generally developed through individual processes, i. e., a development for each emulsion layer.

This system has many disadvantages, only one of which is the relatively complicated and expensive developing process of the film so that the industry is constantly in search of improved processes and products.

It has been realized heretofore that the additive system of color photography represents a more direct and simpler approach to the problem, is capable of better quality, involves less complicated and less expensive developing techniques, and can produce a much more stable final image. However, the principal drawback previously to the additive system has been the coarseness of the colored screen or mosaic pattern so that the viewer tends to see the mosaic pattern, dominance of one color, and flickering (in movies). These factors are further accentuated by the normal enlargement of projection. There are other disadvantages to the prior additive systems but the lack of image resolution due to the coarseness of the filter screen is the basic problem that must first be overcome.

It will be noted that the television industry, which is not subject to this particular problem of coarseness has adopted the additive system of color reproduction for color broadcasts. Incidentally, in providing color film of the additive system for television purposes, it will be necessary that the films have a very fine mosaic pattern which will not be an obstacle for the dot sequential television system recently adopted in the United States.

It was proposed almost a century ago by Ducos du Hauron to form a mosaic filter pattern on a carrier by applying three separately colored light-sensitive layers to the carrier and exposing each layer before applying the succeeding layer through a mask so designed as to expose differently positioned portions in each layer. The unexposed areas were washed away and the exposed areas of each layer hardened with formol. Thus filter elements

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of the three primary colors, red, green and blue were built up on a carrier to create a mosaic pattern.

This system had several drawbacks, however, since it soon became apparent that the individual sensitive and colored layers of gelatin were penetrated by the light with difficulty so that the entire layer was not always exposed throughout its depth. Therefore, it was necessary to apply the mask to the rear surface of the carrier for even the first gelatin layer to make certain that the areas of contact between the carrier and gelatin were exposed because otherwise the filter elements were apt to be stripped away from the carrier during the washing step. However, the rear exposure of the first layer made the diffusing effects quite pronounced due to the depth of the carrier and thus the first layer of filter areas were not sharply defined. Moreover, it was difficult to calibrate the filter elements accurately as regards their surface area, thickness, and color intensity. Furthermore, the poor adhesion between the filter elements and the carrier meant that the washing action had to be limited which resulted in a thin film of the monochromatic dye spreading to the non-exposed areas and which remained there after limited washing so that there was a darkening of the general tone of the entire film. This lack of adherence also precluded the use of small filter elements for the first layer since it was necessary to increase the size of the elements to gain sufficient adherence. In addition, the geometrical pattern of Ducos du Hauron was formed from linear masks only so that the final pattern had long parallel lines that extended continuously through the pattern. These long lines cause for the viewer a flickering image (in movies) and a dominance of the particular color associated with the long lines. On magnification, moreover, and for the same reason, the viewer could perceive the filter pattern well before the size of the filter elements would reach the resolving power of the eye. Both the geometrical pattern of Ducos du Hauron and the lack of adhesiveness of his compounds precluded the possibility of producing individual filter elements of extremely small size that is necessary to produce a successful additive system.

It has also been proposed to add a filter screen to a carrier for an additive system by printing a carrier with the proper dyes instead of conventional inks. Such patterns have been far too coarse for satisfactory results. In addition, if the plurality of dyes are printed simultaneously, the dyes run together which cannot be tolerated. On the other hand, if the colors are printed at individual steps, there will be overlapping of and/or spaces between the individual small filter elements since it is not possible to secure perfect registry of such small elements between printing steps. Thus the overlapping areas create dark spots which allow little light to pass and tend to create a gray image. The blank spaces allow unfiltered light to pass and thus lower the color saturation.

Several attempts have been made to create an irregular filter screen consisting of a mixture of small grains in a thin layer which are individually colored with the primary colors. However, it was necessary to seal open spaces between the grains with a black medium to restrain the passage of light between the grains. If the layer is made thicker, then different colored grains overlap so that too little light is allowed to pass. In addition, the average diameter of the small grains used was never small enough to make this system successful.

Therefore, prior to this invention there has never been created a filter screen in which the multicolored individual areas are in conterminous relationship with one another and yet fine enough to be useful in a practical manner.

It is an object of this invention to provide a mosaic filter screen upon a carrier wherein the pattern of that screen may provide at least three thousand individual filter elements per square millimeter (about two million per square inch) and which may be even smaller if desired.

It is another object of this invention to provide at least three colors within the system which have approximately equal areas on the carrier and wherein each individual colored filter area is in conterminous relationship with surrounding and different color areas so that there is no overlapping of or spacing between adjacent areas.

It is a further object of this invention to create the individual filter areas by a photomechanical masking process whereby the individual surface areas can be accurately predetermined and controlled.

It is another object of this invention to create each colored group of filter areas in conterminous relationship but in such a manner that it is not necessary to closely align the masking means in each step relative to the other steps to secure proper registration.

It is also an object of this invention to arrange the individual colored filter areas in such a mosaic pattern that each area is held against displacement and flowing by the adjacent filter areas with which it is interlocked.

It is another object of this invention to provide a pattern produced by photomechanical means, in which each filter element has a longer dimension which is in a predetermined relation with the length of the pattern "period" which will be subsequently defined.

It is an additional object of this invention to secure greater adhesion of the filter areas to the base carrier or to the layers containing the filter areas previously produced, particularly so that more vigorous washing and handling of the materials may be undertaken during processing and subsequently.

It is a further object of this invention to retain and protect the monochromatic filter areas relative to the carrier and/or the other filter areas by layers of lacquer that are securely bonded to the underlying surfaces.

These and other objects of this invention will be more fully apparent with reference to the detailed description, accompanying drawings and appended claims.

In the drawings:

Fig. 1 is a plan view of an engraved glass plate which is used to form a mask in accordance with this invention;

Fig. 2 is a plan view of a negative made from the plate of Fig. 1;

Fig. 3 is a plan view of a mask made from the negative of Fig. 2;

Fig. 4 is a plan view of a carrier after exposure of a previously sensitized layer thereon with the mask of Fig. 3;

Fig. 5 is a plan view of a mask used for the exposure of further sensitized layers laid on the carrier;

Fig. 6 is a plan view of the carrier of Fig. 4 after exposure with the mask of Fig. 5;

Fig. 7 is a plan view of the carrier of Fig. 4 after a third exposure without an independent mask;

Fig. 8 is a plan view of a carrier with a modified tri-color mosaic pattern;

Fig. 9 is a plan view of a carrier with a modified mosaic pattern of four colors;

Fig. 10 is a plan view of a carrier with a modified mosaic pattern of five colors; and

Fig. 11 is an enlarged diagrammatic section taken through a carrier such as shown in Fig. 7.

Referring to the drawings in detail, this invention as illustrated is embodied on a film carrier such as triacetate cellulose which is commonly used for movie film.

A glass plate 11 is engraved by a small tool in a system similar to defraction gratings in parallel lines on both surfaces so that one series of lines 12 on one surface extend at right angles to the other series 13 on the other surface. When engraving said glass plate, care

should be exercised in not stripping off any small glass chip, which would detrimentally affect the optical qualities of the glass plate. This can be avoided in accordance with a method well known in the art, i. e., by coating the plate, before engraving, with a very thin alumina layer.

There is thus obtained a smooth glass plate engraved with grooves having rough-surface walls.

These grooves are then filled with an opaque substance to leave transparent window areas 14. For example, China ink may be used to fill said grooves, which offers no difficulty since after the entire surface of the plate has been coated, the ink will preferably fix itself on the rough walls of the grooves. The excess ink remaining on the polished surface of the plate will not adhere much and can be merely scratched out or scraped away.

A similar glass plate may be made by first coating both sides of the plate with an opaque material and then removing same by engraving to form continuous spaced transparent strips on both surfaces of the plate but with the strips on one surface being disposed at 90° to the strips of the other surface. Thus where the strips cross there will be transparent areas but otherwise the plate will be opaque.

It will be appreciated that the fine engraving of the glass surface necessary for successful photographic reproduction required for this invention can be done only with a continuous linear channel but by engraving on both sides of the plate at a transverse angle, it is possible to secure a pattern of very small transparent but discontinuous areas. In addition, the pattern of discontinuous areas may be greatly varied by changing the relative angles, changing the spacing, or superimposing different plates or negatives made from the plates.

The engraving of these strips has been done with a tool creating a channel of 16 microns in width. It is necessary that the channels be axially spaced 38 microns apart so that transparent window areas 14, formed by squares having sides of 22 microns, will comprise about one-third of the total area of the plate. Of course, this is an example only and various other combinations can be used, since it will be observed that the width of and the spacing between the channels can be still much smaller and as regards diffraction pattern one may have as much as 10,000 channels per millimeter. However, with the above indicated measurements, one will obtain about 70,000 areas 14 per square centimeter or 450,000 per square inch.

The plate 11 is then utilized to form by contact printing a temporary photographic negative 16 as shown in Fig. 2 which thus has opaque areas 17 which correspond to open areas 14 in the plate while the remainder 18 of the negative 16 has been unexposed and is thus transparent after developing and fixing. Due to the thickness of the glass plate, halation 15 will occur on negative 16 on two opposed sides of the opaque areas 17 corresponding to the strips 12 or 13 which were spaced from the negative sensitized layer by the thickness of the plate. Such linear halation can be easily removed during the washing step as contrasted to halation that completely encircles an area 17 and is very difficult to completely remove. A mask positive 19 as shown in Fig. 3 is then contact printed from the temporary negative and includes windows or transparent areas 21 which correspond to the opaque areas 17 of the temporary negative. The remaining area 22 of the mask is opaque. The glass plate 11 might be used as the mask but it will be preferred to use a photographic reproduction thereof in order not to damage said plate in the course of the operation.

An ordinary blank transparent carrier 23 such as a triacetate cellulose film is first coated with a layer of transparent lacquer 20 which is then coated with a layer of transparent material such as gelatin which has been sensitized as by the addition of potassium or ammonium dichromate. The sensitized gelatin is then exposed to light through the mask 19 preferably from the side op-

posed to the carrier so that a sharper image will be defined without diffusion creating halation around the edges of the image. Areas 26 are thus exposed through windows 21. The carrier is then washed in cold water to remove the remaining sensitive dichromate and subsequently washed in a solution of potassium thiocyanate (KSCN) to wash away the unexposed gelatin to thus leave only areas 26 with a layer of desensitized gelatin. The carrier is then treated with a dye which is absorbed by the exposed areas 26 and allowed to dry thereon. These dyed areas 26 thus form the first set of monochromatic filter elements and are then coated with a layer of transparent lacquer 27 which coats the entire surface of the carrier.

It is extremely important that the minute filter areas 26 maintain their positions without slipping, stripping or curling before the protective lacquer layer has dried to establish their positions. For this reason, the means employed in accordance with the invention will hereinafter be disclosed to insure that during the washing, stripping, dyeing and lacquer applying steps, the surface tension of the liquids and other forces will not adversely affect the positions of the filter elements which have no protection prior to the drying of the second lacquer layer except their adhesion to the first lacquer layer.

The carrier with the first series of monochromatic filter areas protected by a layer of lacquer is then coated again with a layer of transparent sensitized gelatin and exposed from the rear side of the carrier through mask 28 which is provided with continuous elongated spaced open windows 29 with opaque areas 31 therebetween. Mask 28 may be made by photoprinting from a glass plate in the same manner as mask 19 is made except that the glass plate is linearly engraved on one surface only. Since the remaining carrier area is to be divided in half, the open and opaque areas of the second mask are of equal width. In working with the first mask of sizes previously discussed, the glass plate for the second mask was engraved with channels 16 microns wide and spaced 16 microns apart.

It is not necessary that the second mask be definitely positioned in relation to the first filter areas 26 already on the carrier if the exposure of the second layer is made from the rear of the carrier and through the first filter areas. Such methods are well recognized by the art. For example, if the first filter areas were dyed red, a blue-green light may be used for the second exposure which will not pass through the red filters. Another method is to use a second sensitized layer that is insensitive to red so that any red light passing through the first filter areas would have no effect on the gelatin layer therebehind. Still another method and one which has been used successfully with this invention is to expose in actinic light, to decrease the intensity of light for the succeeding gelatin layers, while increasing the exposure time. Therefore, the areas to be exposed on the second gelatin layer through mask 29 will be those not masked by the filter areas 26, regardless of the relative position of the mask and first filter areas. The only relative positioning that must be considered is to insure that the elongated windows 29 and opaque areas 31 extend at an angle relative to the first filter areas 26 so that the exposed strips will not be continuous but instead will be completely interrupted periodically by the first filter areas, preferably at least at every second filter area 26 but possibly extending to every third or fourth filter area, depending somewhat on the absolute size and spacing of the elements concerned. It will be appreciated that such positioning only requires very coarse adjustments in contrast to that required if the different areas had to be perfectly matched by physical movement to secure a conterminous or abutting relationship.

This second exposure results in the mosaic pattern on the carrier 23 shown in Fig. 6 which now has exposed areas 32 in addition to filter areas 26 and the remain-

ing transparent areas 33. The unexposed portions corresponding to areas 33 and filter elements 26 are washed as before and areas 32 are dyed with a different primary color before being covered with a third layer of lacquer 34.

It will be noted that the forces which tend to displace the filter elements in the liquid medium during the stripping step or before the lacquer has dried are already less to be feared since the elements 32 are now maintained by the filter areas 26 acting as wedges, almost each second element being held in place by a first element at all four sides.

The carrier including two series of filter elements protected and isolated by layers of lacquer is again coated with a layer of sensitized gelatin and then exposed to light from the rear side without a mask since the filter elements 26 and 32 serve as a mask in a manner well known to the art as explained hereinbefore. After exposure, the gelatin layer is washed as before and the exposed portions dyed with a third primary color which results in the mosaic pattern on the carrier as shown in Fig. 7 that now includes three separate monochromatic filter areas 26, 32, and 33, all of which form small separate areas without linear continuity and which are in a perfect conterminous relationship with one another.

It will be appreciated that it is much easier than before to hold the elements 33 in place under the effect of the liquid since these latter elements are now completely and firmly interlocked with the first and second elements.

The carrier is again treated with a fourth layer of lacquer 36 to protect the filter elements 33. A fifth layer 37 of free flowing lacquer may be positioned over the fourth layer to give a smooth surface on which a regular panchromatic emulsion layer is then coated or the emulsion may be applied directly to the fourth layer. It is possible to lay the emulsion layer on the rear of the carrier but it is preferable to not do so since greater diffusion will occur in the subsequent photographic work. Furthermore, it is desirable to use the carrier to contact the moving parts of the camera which is not possible if the emulsion is on the rear surface.

Fig. 8 shows a modified mosaic pattern in which the three series of monochromatic filter elements are 38, 39 and 41 respectively. The first filter elements 38 of this modification are rectangular instead of square and succeeding rows of elements are staggered in such a manner that it is impossible for the succeeding elongated elements 39 and 41 to be continuous unless they extend parallel to the longer sides of the rectangle. The second mask used for this pattern may be mask 28 of Fig. 5 used for the pattern of Fig. 7 but in exposing the pattern of Fig. 8, the mask will be positioned at a different angle as shown. A staggered mask necessary for exposing the first filter elements 38 may be made by superimposing two similar negatives such as that illustrated in Fig. 2, to print a mask in which the rectangular opaque areas of the negatives are offset from one another in a staggered relationship.

It will be observed however that in this modification certain second filter elements are not completely blocked at all four sides as long as the third elements have not been positioned. Moreover, the direction of the strips 39 being normal with one side of the rectangle there is no wedge action of the first elements in this pattern, such as illustrated in Fig. 7.

Fig. 9 discloses a modified pattern which includes four series of color filter screens, namely, a first series 46, a second series 47, a third series 48 and a fourth series 49.

Fig. 10 shows an additional modified pattern which includes five series of color filter screens, namely, a first series 51, a second series 52, a third series 53, a fourth series 54 and a fifth series 55.

It will be noted in both of these latter modifications that the first series of filter elements comprises a plurality of small discontinuous and rectangular areas which can be formed through a mask of the same general type as

mask 11 (shown in Fig. 1) except that the open areas 14 shown therein may be made relatively smaller, since filter screens 46 of Fig. 9 will comprise about one-fourth of the entire area and filter screens 51 of Fig. 10 will comprise about one-fifth of the entire area. The second mask to be used in either the four or five color modification will be similar to mask 28 of Fig. 5 in that it will be comprised of linearly spaced opaque and transparent areas but the dimension of the opaque areas must be widened relative to the transparent areas so as to accommodate the relative change in area of each series of filter elements. It will be necessary that the angle of the open areas of the mask which will correspond with the second series of filter screens 47 or 57 be adjusted so that filter elements 47 and 57 will be periodically completely interrupted by the associated first filter elements 46 or 51. It is not necessary that the unexposed open areas remaining after the first and second series of filter screens in these modifications be bisected by the associated first filter screens since these open areas may be bisected by any filter areas previously created. The third filter series 48 and 53 can be prepared by exposure through a linear mask also which is placed at an angle so that the exposed areas will be bisected by the second series. For the third series 48 of Fig. 9, it will be possible to use the mask 28 of Fig. 5 since it is now necessary to expose half of the remaining unscreened areas on the carrier. Mask 28 can be used similarly to form the fourth series 54 of Fig. 10. The final series 49 and 55 of both Figs. 9 and 10 will be exposed in the same manner as the final series in the three color patterns described hereinbefore, i. e., by using the prior filter screens as a mask.

The important consideration is the fact that the patterns can be created without regard to registration of the masks but only angular and therefore coarse adjustment of the masks relative to the elements already positioned for those exposures between the original and final exposure.

It will be appreciated that various patterns can be utilized as long as each series of monochromatic filter elements covers an equal portion with the other series of the total area within tolerable limits known to the industry and no single length of any of the elements greatly predominates over the period of the pattern. This period can be defined as the greatest geometrical division of the pattern that comprises at least one filter of each elementary color without comprising two filters of only one of these colors. For example, the period P of the pattern in Fig. 7 illustrated in dotted line is the largest square wherein one element 26, at least one element 32 and at least one element 33 can be found without having two elements 26.

It can be said that for an ideal pattern comprising elements of which none is longer than the side of this square, the polychrome structure is visible for an enlargement such that the dimension of this side will reach the value of the resolving power of the eye. In fact with the prior art lined patterns it is visible much earlier due to the continuous strips made still more apparent by their parallel disposition.

It is a matter of course that with the structure of the invention wherein the longest filters reach as a maximum four or five times the size of the period, the limit point where the lines become visible is practically the same as for the structure of the periods and of course the maximum ratio between the length of the longest filter and the size of the period should be given only in relation to the latter considered in an absolute manner, since the resolving power of the eye is a fixed quantity. In the present instance, this ratio is satisfactory when there are 700 periods per square millimeter. An increase of the length of the strips by modifying their angular position relatively to the general direction of the squares would not be detrimental if the number of periods per square

millimeter was simultaneously increased. In the present case however, this ratio is always lower than the greatest linear number of periods that can be found in the pattern.

In any case, to obtain the result in accordance with the invention, it is necessary in a multichromatic combination that the first monochromatic elements are formed of discontinuous elements and that the succeeding linear elements extend at such an angle relative to former series so as to be periodically completely interrupted by the former series. If the linear elements of the second and third (or more) monochromatic elements are too long between complete interruptions, i. e., even where a wavy but continuous line can be drawn along the element, the projection of a series of pictures or frames for movie purposes will create an apparent flickering image even before the long lines are sufficiently large to be perceived as such by the viewer.

In the description herein, each color series of filter elements has been described as covering that part of the total area in proportion to the total number of colors used, i. e., in the tri-color system, each color occupies one-third of the total area. This may vary quite widely before having a noticeable effect to the observer and in fact may be compensated by changing the intensity of the colors. In actual practice, if one dye is of greater intensity than the others, a deliberate compensation may be made by reducing the total relative area of the intense color. The aspect of relative areas is well known in the art so that when relative areas are used in this application or claims, it is intended to include the variances which the art would recognize as being successful.

Fig. 11 represents a diagrammatic section on a greatly enlarged and exaggerated scale of what is believed to be the relationship between the various filter elements after a unit has been completed. The relatively thick carrier 23 is completely coated with a first layer of lacquer 20. The first filter element 26 lies on the first lacquer layer and then both are covered with the second layer 27 of lacquer which, due to capillary forces is thus elevated somewhat to pass over the first filter element. The second filter element 32 is in contact with the outer surface of the second lacquer layer 27 and since the second filter element extends exactly to a point in abutting alignment (except for intervention of lacquer layer 27) with the end of first filter element 26, there is a curvature in the second element (negligible in comparison to the filter length) to correspond to the elevation in the second lacquer layer 27. This leaves a small transparent opening 42 which has somewhat less thickness than the normal layer of lacquer. The openings are repeated around the border of each individual filter element and in fact are approximately doubled in thickness at the edge between a first and third filter element. The elevation observed over the filter elements can already be implied from the fact that the second and third filters are maintained by the underlying filter elements already positioned.

Theoretically such a filter screen as described herein should pass $33\frac{1}{3}\%$ of the light striking the screen if the filter elements are composed of the primary colors, red, green and blue. Practically, the total $33\frac{1}{3}\%$ are allowed to pass through. It may be that the transparent passages 42 contribute to facilitate the passage of light. Owing to their smallness, this does not affect the apparent quality of the image either in regard to true color or to double images, as will be seen hereinafter.

It is important that the first exposure be made through mask 19 from the surface of the sensitized layer since this gives excellent definition without diffusion effects which otherwise tend to cause halation around the areas 26 as noted at 43 on Fig. 4. When such halation occurs on all four sides to encircle the exposed areas, the halation is not completely removed by the subsequent stripping of the unexposed sensitized layer and will subsequently cause local darkening of the final picture since

the dyes subsequently deposited will be superimposed thereon. If the glass plate of Fig. 1 is used directly as the mask and laid on the sensitized surface, there will be some halation easily removed during the stripping step, along two opposed sides of the area 26 in the same manner as discussed in the making of negative 16.

It is necessary in the second and third exposure steps to expose from the rear of the carrier. In the third step there is no appreciable halation since the first and second filter elements serve as the mask and they are only separated from the third sensitized layer by thin layers of lacquer. In the second step there is apt to be halation, however, along the elongated sides of areas 32 as shown at 44 in Fig. 6. Since filter elements 26 serve as masks for the short sides of areas 32, there is no appreciable halation at that point. However, since this halation extends in only one linear direction, it is removed by the subsequent vigorous stripping of the unexposed areas 33.

The sensitized layers are exposed before dyeing to insure that the light will act uniformly throughout the surface and depth of the layer. Such a method makes it possible to adjust the intensity and saturation of the final colors by changing the intensity and saturation of the dye, time of application, etc. Moreover, this method insures more secure bonding of the exposed areas to the underlying surfaces which is extremely important to this invention.

It has been found that after the dyeing of each layer of monochromatic filter elements, there tends to remain, even after rinsing, a molecular film of the dye over the areas previously stripped, which film is sufficient to create grey images throughout the final mosaic pattern due to superimposed complementary colors. It is necessary to forcibly separate the excess dye from the unexposed areas and this is preferably done by directing vigorous air blasts in the direction parallel to the longest side of the particular areas being operated on until the carrier is dry. It is believed that such air-blasting of the carrier until dry tends to remove the molecular film from unexposed areas and decreases the tendency of the dye to spread from the exposed areas towards the stripped areas, since the force of the air moves the dye along the longitudinal axis of the exposed areas.

Although acidic or basic dyes may be used in the present process, it is highly desirable to use acidic dyes which are more durable and have better tone. Various suitable wetting agents may be added to the dyes to insure a thorough penetration of the dye into the desensitized areas. It is necessary to increase the depth of the sensitized layer to secure desirable tones with the basic dyes which, among other things, increases the undesirable diffusion effects.

Various colors and numbers of colors may be used in this invention but the basic system is a tricolor arrangement of the three primary colors, red, green and blue. A four-color system such as red, green, violet-blue and orange-yellow could be used also.

It is desirable of course that the adhesion of the carrier, the three monochromatic filter layers, and the three lacquer layers be very secure so that the individual structures will remain bonded during the manufacture and processing of the finished product and further that there will be subsequently no mechanical separation of the various layers which will create optical and mechanical difficulties.

Finally, while the structure hereinabove described makes it possible, in opposition to the lined patterns, to mutually interlock the filter elements and to maintain them in position, it remains however that any reduction of the surface of the filter elements will subsequently involve some decrease of their adhesion and an increase of the capillary forces tending to bring together two adjoining filter elements. After first improving the cohesion of the filter elements, and thus making possible a reduction of their size, their surface can be still further de-

creased only in increasing their adhesion (adherence per surface unit).

Thus the problem of adhesion, maintenance of transparency, and maintenance of the position of the dyes must be given special consideration. Although other means may be used to protect and maintain the position of the filter elements a lacquer coating is the most desirable.

A lacquer that has been found successful includes in solution a small amount of the primary material of the sensitive layers and a solvent for the carrier, although the isolating medium of the lacquer will be different from the carrier. Thus if a triacetate cellulose carrier supports a sensitized gelatin to form the filter elements, the lacquer for the first layer will contain gelatin, a gelatin solvent such as acetic acid, a solvent for triacetate such as acetone, an isolating material such as nitrocellulose and solvent therefor such as a mixture of acetone and methyl alcohol. A mixture of butyl alcohol and butyl acetate may be added also. Benzene may be added in varying amounts to control the drying time and viscosity of the lacquer. The butyl acetate and methyl alcohol impart absolute clearness to the solution by suppressing the tendency of gelatin to precipitate as a colloidal gel. Such a lacquer as this will provide a strong bond between the triacetate carrier and the nitrocellulose isolating medium since there is a slight dissolving of the carrier surface. It is important that there be a slight but only slight dissolving of the triacetate surface so that the lacquer will strictly adhere thereto and be almost a continuation thereof but yet it is necessary that there be no distortion of the triacetate surface which would otherwise cause optical deficiencies. Therefore, the dissolving action of the lacquer must be closely controlled. This may be done, for example, by changing the relative amounts of the strong solvent acetone and the weaker solvents butyl and methyl alcohol. In addition, it is important that a gelatin base be incorporated onto the triacetate surface so that the subsequent first layer of monochromatic filter elements which are comprised mostly of gelatin will strongly adhere to the carrier. If the filter elements are laid directly on the triacetate carrier without an intervening layer of lacquer containing gelatin there is much less adhesion and thus the filter elements cannot be subject to vigorous action to remove any halation and/or color film that may be present outside the definitely defined edges of the filter elements.

Moreover, the solubility of gelatin by the lacquer after the first layer must be controlled since it is desirable to slightly dissolve the gelatin that was within the prior lacquer layers and the prior filter elements to create a stronger bond but such dissolving must not be sufficient to optically distort any surfaces or allow the dyes to spread out of their respective filter areas. Since the lacquer is nearly saturated with respect to gelatin, the solubility for additional gelatin can thus be controlled. In addition, the drying time and viscosity of the lacquer serves to control the amount of dissolving possible by the various solvents and also the degree of flowing of the lacquer over the relatively uneven surfaces created by the filter elements. Such lacquers must not, of course, affect the transparency of the final product.

The various layers of lacquer will be somewhat different since each may have peculiar conditions to meet. The first layer which is applied directly to the carrier primarily to lay down a layer of gelatin need not be concerned with prior gelatin on the carrier, uneven surface, or dyes absorbed by the gelatin filter elements. The drying time and viscosity of the first layer is not important relative to the other layers so the solvents need not be as carefully selected and in fact benzene will generally be omitted since it serves to increase the drying time and make the lacquer less viscous.

The second lacquer layer covers the first lacquer layer and the first series of filter elements. The lacquer for the second layer will contain some benzene to increase

the fluidity and drying time to allow the lacquer to closely coat the irregular filter elements but the lacquer must be so adjusted that it will dry quickly enough to prevent the first filter elements from sliding and clustering together under the effect of the liquid since only the adherence of the filter elements to the first lacquer layer maintains their isolated positions.

In the third lacquer layer, the benzene (and fluidity) is increased since the surface to be covered is now more uneven than before but the second filter elements which are now being covered are interlocked in position by the first filter elements in addition to adhering to the second lacquer layer.

The fourth lacquer layer (if five are used) contains no gelatin since no filter elements of gelatin are to be placed thereon. This layer will be more free flowing than the third layer because the third filter elements are interlocked in position by both the prior first and second elements. Moreover, the surface being covered thereby is now very irregular. The fifth layer (or fourth if it is last) contains gelatin because it will be covered by a panchromatic emulsion which generally contains a gelatino-bromide substance. The fifth layer will also be relatively free-flowing.

Thus, the lacquers contain acetic acid, as a solvent, particularly for prior layers, gelatin as a bonding agent, nitrocellulose as the isolating medium and lacquer body, and various solvents for the nitrocellulose. The butyl acetate acts particularly to prevent gelatin precipitation and as a mild solvent. It is of course essential that the gelatin be perfectly transparent.

It is desirable that the lacquer be acidic to be compatible with the acid fast dyes to be used. Thus, acetic acid in the above example serves as a gelatin solvent and also to create an acid medium.

If the base carrier is nitrocellulose, then the lacquer will contain triacetate cellulose and solvents therefor instead of nitrocellulose and its primary solvents.

The bond obtained throughout the entire unit by this invention is sufficient to withstand the vigorous treatment such as air blasting and heat to which the unit must be exposed. Moreover, there will be no local separation of the various layers during mechanical treatments that would cause spots, particularly on magnification.

If gelatin is used for the sensitized layer, it has also been found that potassium thiocyanate is an excellent solvent for selectively removing the unexposed gelatin. The unexposed potassium dichromate generally used for sensitizing the gelatin is first washed away with cold water and then the unexposed gelatin removed in a bath of KSCN. The time required for such stripping step varies with the concentration of the bath.

It has been found that to manufacture film it is advisable to operate at a well determined hygrometric degree, for example between 55 and 70° and preferably about 63°, and at a temperature comprised between 15 and 30° C., preferably 23° C.

Once the film has been completed and the gelatino-bromide exposed through the pattern, it is necessary that the exposed areas of the panchromatic layer be transparent and therefore required to reverse the black and white aspects of the image.

If the film is developed as an ordinary film, there is obtained a negative the colors of which are reversed, but it is then possible to obtain a positive print on sensitized paper. The latter may also comprise a mosaic pattern and it will be found that satisfactory results are obtained by contact printing without it being necessary to accurately position both of the patterns in relation to each other. It may be that the window areas 42 partially make up for the defective superposition of the two patterns and restore the correct distribution of the colors without however producing diffusion effects.

It is not intended to limit this invention to any theoretical concepts expressed herein but only to the disclosed

methods and articles produced thereby as defined in the claims.

Example

The following detailed example will illustrate the manufacture of a movie film in accordance with this invention.

The operations are conducted at a temperature of 23° C. and hygrometric degree of 63°.

An ordinary triacetate cellulose carrier as used for 35 mm. movie films was first coated with a lacquer solution containing 0.25 g. of gelatin, 3 cc. glacial acetic acid to dissolve the gelatin, 20 cc. of methyl alcohol, 20 cc. of acetone, 1.0 g. of nitrocellulose, 30 cc. of butyl alcohol and 30 cc. of butyl acetate. This lacquer is applied directly to the triacetate carrier and evaporates slowly enough so that it may smoothly spread over the entire surface.

The first layer of gelatin which has been sensitized by the addition of potassium dichromate ($K_2Cr_2O_7$) is then laid down on the first layer of lacquer and exposed to light through the mask 19 shown in Fig. 3 which is placed on the surface of the gelatin. Any light may, of course, be used for this first exposure which may be done by a photoprint machine or a similar device. The mask is removed and the film first washed with water which removes the unexposed $K_2Cr_2O_7$. The film is then washed in 8% KSCN which removes the unexposed gelatin and thus leaves on the triacetate carrier a pattern of discontinuous areas of exposed gelatin such as shown in Fig. 4. The carrier is then treated in the following dyeing acid bath:

1% diazol red "Lumière" 8B50
0.05% diazol orange "Lumière" 3R
0.5% acetic acid
0.5% of a solution at 20% of "Kodak" wetting agent T

The carrier is then rinsed but it has been found that such rinsing invariably leaves a molecular film of the dye over the unexposed areas which reduces the color tone of the final film. Therefore, the film is dried by strong air blasts which are directed generally parallel to the elongated open areas between the filter elements.

Another layer of lacquer is now laid down to cover, protect and maintain the positions of the filter elements 26. The second lacquer solution contains 0.25 g. gelatin, 2 cc. glacial acetic acid, 20 cc. methyl alcohol, 16 cc. acetone, 20 cc. butyl alcohol, 10 cc. butyl acetate, 2.25 g. nitrocellulose and 30 cc. benzene.

Another layer of gelatin which has been sensitized with $K_2Cr_2O_7$ is now laid over the second layer of lacquer. The mask of Fig. 5 is then laid on the back of the triacetate carrier, that is, the surface of the carrier away from the layers of lacquer and gelatin and an exposure made through the mask as before with actinic light of less intensity than before and one which will not be effective through the filter areas 26. The mask 28 which includes simply linearly extending and spaced opaque and transparent areas must be positioned relative to the first filter elements 26 only to the degree that the linear elements 29 and 31 will not extend continuously within the open areas between the filter elements 26 but will be blocked, i. e. completely interrupted periodically by the first filter elements as shown in Fig. 6. Thus, the exposure through the mask 28 and the filter elements 26 which serve as a mask results in the exposure of areas 32 on the second gelatin layer as can be seen in Fig. 6.

There may also be halation along the elongated sides of areas 32 due to the spacing between the mask 28 and the second gelatin layer which is created primarily by the carrier 23 but also by the first two lacquer layers. There is no halation along the short ends of the areas 32 which are blocked by the former filter areas 26 since that part of the masking is caused by the filter elements 26 which are separated from the second sensitive gelatin layer by only the second layer of lacquer which is relatively thin. The layer is washed again as before so that

all the gelatin is removed, except the exposed areas 32. The latter are then dyed in the following acid bath:

0.25% superfine 5° A. S. bright acid blue
0.135% extra metaline yellow
0.025% acetic acid
0.5% "Kodak" wetting agent T at 20%

The film is then rinsed and air blasted as before except that the air blasts are not directed along the longitudinal axes of the filter elements 32. There is no need, and in fact it is not desirable, to direct the air blasts in any other direction. The second layer of filter elements which are now dyed green is then covered with a third lacquer layer which contains in solution 0.2 g. gelatin, 2 cc. glacial acetic acid, 20 cc. methyl alcohol, 3 cc. acetone, 20 cc. butyl alcohol, 2 cc. butyl acetate, 1.5 g. nitrocellulose and 53 cc. benzene.

A third layer of gelatin which has been sensitized with $K_2Cr_2O_7$ is then coated over the third lacquer layer. This layer is now exposed from the rear side of the carrier without any mask and an actinic light of relatively low intensity so that the prior filter elements will now serve as a complete mask and thus completely eliminate any problem of mask alignment and also of halation since the mask is now relatively close to the sensitized layer, i. e., there is no intervention of the carrier. After the third layer is washed and the unexposed gelatin dissolved the third group of filter elements 33 are then treated with the following acid bath:

0.125% surfine 50 A. S. bright acid blue
0.4% foulon S. A. B. violet
0.05% acetic acid
0.25% "Kodak" wetting agent T at 40%

The dyeing baths bear the references employed by the firm "Francolor."

Air blasts are directed after rinsing in the same direction as the previous air blasts since filter elements 32 and 33 are parallel to one another.

The dyed filter elements 33 are then covered with a fourth layer 36 of lacquer to completely cover the filter screens. The solution for the fourth layer contains 1 cc. glacial acetic acid, 20 cc. methyl alcohol, 3 cc. acetone, 20 cc. butyl alcohol, 2 cc. butyl acetate, 1.5 g. nitrocellulose and 53 cc. of benzene.

After the fourth layer is dried, a fifth and a final layer 37 containing 0.35 g. gelatin, 3 cc. glacial acetic acid, 20 cc. of methyl alcohol, 3 cc. acetone, 20 cc. butyl alcohol, 2 cc. butyl acetate, 1.5 g. nitrocellulose, and 53 cc. benzene. This is relatively fluid and slow drying so that an even surface is formed.

The fifth layer is covered with a panchromatic emulsion containing gelatino-bromide, at which time the film is ready for ordinary exposure for taking pictures. For photographic purposes the panchromatic layer could be applied to the rear side of the carrier but for practical purposes it is necessary to retain the rear side of the carrier to contact various moving parts in the camera which would otherwise tend to physically damage the panchromatic layer which would result in poor photographic results.

After exposure of this film through a regular camera only a regular black and white image is formed on the emulsion layer 37 and this will be developed in the same manner as regular black and white images are developed without regard to the filter screen which is spaced between the carrier and the panchromatic emulsion since the filter screen is completely protected by the lacquer.

If a diapositive transparency film is desired, the image will be reversed in the following manner:

The film is developed in a regular genol hydroquinone developer for black and white images, and subsequently whitened in a potassium bichromate bath. In this whitening bath the exposed areas where the silver grains have

collected become transparent in proportion to the light received.

The film is then exposed again to light, developed for the second time and then fixed in hyposulphite. The image is reversed and there is obtained the final transparent positive image.

If a positive image on white paper is desired, the development by inversion is no longer necessary since a regular development for black and white film will produce a negative the colors of which in each point are complementary to the natural colors. It is then sufficient to form by contact printing a positive image on a regular sensitized paper comprising a similar pattern.

It will be observed that with the masks defined at the beginning of this description, 700 periods per square millimeter are obtained, i. e., roughly about 1600 separate geometrical divisions with the pattern of Fig. 7. However, a pattern should not be characterized by its absolute number of filter elements, and the contours of the colored surfaces of the image should be taken also in consideration. These dividing lines in effect practically never correspond to the drawing of the pattern and it results therefrom that for instance the same blue filter may be covered with two colored areas, one green-blue, and the other violet, and consequently that a single monochrome geometrical division of the pattern may act as two filters at least. In the same manner a period receiving a green-blue light has three or four active filter elements. A single period may thus comprise more than three separate filter elements.

The average number of filter elements per square millimeter should be thus estimated in view of above observations, since for a same number of geometrical divisions, a pattern comprising for instance long parallel monochrome strips divides less the image than an imbricated pattern such as described in the invention.

Though approximately, it may be said that patterns of 700 periods per square millimeter above described comprise as an average four filters per period, i. e., about 3,000 separate filter elements per square millimeter.

It will be noted that rounds could be obtained with the first masks instead of squares. This can be done in positioning the masks not in a contacting position, i. e., the sensitized layers of the masks (Fig. 2) being in contact with the layer to be exposed but at a certain distance (substantially the thickness of the support) from the last cited layer.

In effect, diffusion effects for squares are more pronounced in the middle of the edges of the squares than in the angles and this causes a curvature of each of the sides which finally results in a round.

I claim:

1. A photomechanical method for preparing a mosaic filter screen pattern on a transparent carrier for additive multicolor photography comprising, covering the front surface of said carrier with a first colorless light sensitive colloidal layer, exposing said first layer from the front surface thereof through a first opaque mask having a pattern of spaced minute light-permeable areas of similar shape and size, said areas aligned in parallel equally spaced straight rows, removing the unexposed portions of said first colloidal layer, dyeing said exposed portions of said first layer with a first color to obtain a first series of monochrome filter screens, applying additional colorless light sensitive colloidal layers on the same side of said carrier as said first layer to obtain additional series of filter screens, exposing each of said additional layers before application of the succeeding additional layers, said additional exposures being made from the rear surface of said carrier through said first filter screens, any prior additional filter screens and an additional mask having parallel opaque strips separated by light permeable strips, said permeable strips being positioned at an angle relative to any prior filter screens that each elongated

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permeable strip is completely interrupted periodically by said prior filter screens, said additional exposures affecting only those portions of the associated additional layers not in alignment with said prior filter screens and said opaque strips of said associated additional masks, removing the unexposed portions of each additional layer after its exposure and before application of a subsequent layer, dyeing the exposed portions of each of said additional layer with an additional distinctive color after removal of the associated unexposed portion and before application of a subsequent layer to obtain an associated additional series of monochrome filter screens, covering said additional series of monochrome filter screens with a final colorless light sensitive colloidal layer, exposing said final layer from the rear surface of said carrier through the prior filter screens under conditions affecting only the portions of said final layer not in alignment with the prior filter screens, removing the unexposed portions of said final colloidal layer, and dyeing said exposed portions of said final layer with a final distinctive color to obtain a final series of monochrome filter screens, each said series of monochrome filter screens covering approximately an equal area.

2. A photomechanical method for preparing a mosaic filter screen pattern on a transparent carrier for additive tri-color photography comprising, covering the front surface of said carrier with a first colorless light sensitive colloidal layer, exposing said first layer from the front surface thereof through a first opaque mask having a pattern of spaced minute light-permeable areas of similar shape and size, said areas aligned in parallel equally spaced straight rows, the total extent of said areas being approximately equal to one-third the extent of the carrier, removing the unexposed portions of said colloidal layer, dyeing said remaining exposed portions of said first layer with a first color to obtain a first series of monochrome filter screens, covering said first monochrome filter screens with a second colorless light sensitive colloidal layer, exposing said second layer from the rear surface of said carrier through said first filter screens and a second mask having parallel opaque strips separated by light permeable strips, the extent of said opaque and light permeable strips being approximately equal, the width of said strips being less than the longest dimension of said first filter screens, said strips being positioned at an angle relative to said first filter screens so that each elongated strip is completely interrupted periodically across its longitudinal axis by said first filter screens, said exposure of said second layer affecting only those portions not in alignment with said opaque strips and said first filter screens, removing the unexposed portions of said second colloidal layer, dyeing said remaining exposed portions of said second layer with a second color to obtain a second series of monochrome filter screens, covering said first and second monochrome filter screens with a third colorless light sensitive colloidal layer, exposing said third layer from the rear surface of said carrier through said first and second filter screens under conditions affecting only the portions of said third layer not in alignment with either of said first or second filter screens, removing the unexposed portions of said third colloidal layer, and dyeing said remaining exposed portions of said third layer with a third color to obtain a third series of monochrome filter screens.

3. A photomechanical method for preparing a mosaic filter screen pattern as claimed in claim 2 wherein a separate layer of lacquer is coated on the front of said carrier prior to each light sensitive colloidal layer and subsequent to the third light sensitive colloidal layer.

4. A photomechanical method for preparing a mosaic filter screen pattern as claimed in claim 3 wherein said colors are red, green and blue.

5. A photomechanical method for preparing a mosaic filter screen pattern as claimed in claim 3 wherein said

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colloidal layers are sensitized with a compound selected from the group consisting of ammonium dichromate and potassium dichromate.

6. A photomechanical method for preparing a mosaic filter screen pattern as claimed in claim 3 wherein said colloidal layers are gelatin.

7. A photomechanical method for preparing a mosaic filter screen pattern as claimed in claim 6 wherein the unexposed portions of said gelatin layers are removed by washing with potassium thiocyanate.

8. A photomechanical method for preparing a mosaic filter pattern as claimed in claim 3 wherein said first mask is formed by obtaining a photographic positive from a transparent plate, said plate being engraved to form parallel channels on each surface at transverse angles to the other surface, and said channels being filled with an opaque substance.

9. A photomechanical method for preparing a mosaic filter pattern as claimed in claim 8 wherein said second mask is formed by obtaining a photographic print from a second transparent plate, said second plate being engraved on one surface to form parallel channels, and said channels being filled with an opaque substance.

10. A photomechanical method for preparing a mosaic filter pattern as claimed in claim 9 wherein said channels in said first plate have a width of about 22 microns and said channels in said second plate have a width of about 16 microns.

11. A photomechanical method for preparing a mosaic filter screen as claimed in claim 3 wherein said first mask is formed by creating a positive from superimposing two negatives, each said negative having rectangular opaque areas in horizontal and vertical alignment, said negatives being superimposed with their opaque areas separated and staggered from the opaque areas of the other so that said mask has staggered and open areas corresponding to the combined opaque areas of said negatives.

12. A photomechanical method for preparing a mosaic filter screen as claimed in claim 3 wherein said first series of monochrome filter screens are rectangular.

13. A photomechanical method for preparing a mosaic filter screen pattern as claimed in claim 3 wherein the lacquer for the first layer contains an isolating material, the colloidal material of said light sensitive layers, solvents for said materials, and a solvent for the carrier, the solvent for said carrier creating a strong bond between said carrier and first lacquer layer but being insufficient to alter the optical characteristics of the carrier surface; and the lacquer for the other layers contains said isolating material, said colloidal material and solvents for said materials, said solvents for said materials creating a strong bond between any two contacting lacquer layers but being insufficient to alter the optical characteristics of the surface of the prior contacting layer, said solvent for said colloidal material also creating a strong bond between said filter screens and the associated covering lacquer layer but being insufficient to alter the optical characteristics of the surface of said filter screens.

14. A photomechanical method for preparing a mosaic filter screen pattern as claimed in claim 13 wherein said carrier is cellulose triacetate, said colloidal material is gelatin, and said isolating material is nitrocellulose.

15. A photomechanical method for preparing a mosaic filter screen pattern as claimed in claim 14 wherein said solvents include acetic acid, methyl alcohol, acetone, butyl alcohol and butyl acetate.

16. A photomechanical method for preparing a mosaic carrier for three-color photography and cinematography of the additive type, comprising exposing a colorless light sensitive colloidal layer carried by a transparent support through a first mask laid over the front surface of said sensitive layer, said mask being opaque except for a large number of spaced minute light-permeable areas of similar shape and size, arranged in parallel equally spaced rows with the areas in each row equally spaced, the total sur-

face of said areas being substantially equal to one-third of the surface of the mask, removing the unexposed portion of said layer to obtain on the support very small sized colloidal elements corresponding to the light permeable areas of the mask, dyeing said colloidal elements in one of the primary colors, covering the monochrome screen thus obtained by means of a second colorless light sensitive colloidal layer, positioning on said support a second mask having parallel opaque strips separated by light permeable strips of equal area as said opaque strips, the width of said strips being equal to a value less than the maximum dimension of the light permeable areas of the first mask, arranging the second mask with its strips at such an angle to the rows of colloidal elements that each of the strips is completely interrupted by one element in at least each other row, exposing said second layer through the rear of the first color layer of colloidal elements and through the second mask under such conditions as to impress only areas of the second layer that are not corresponding to the color elements of the first layer and the opaque strips in the second mask, removing the unexposed portions of said second layer to obtain very small colloidal elements corresponding to the impressed areas, dyeing said last mentioned colloidal elements in a second primary color, covering the two colored screens thus obtained by a third colorless light sensitive colloidal layer, exposing said third layer through the rear of the already obtained two color screens under such conditions as to impress only the areas of the third layer that are not corresponding to said two color screens, removing the unexposed portions of said third layer to obtain colloidal elements corresponding to the impressed areas of the third layer, and dyeing said colloidal elements in said third layer in a third primary color.

17. The photomechanical method of claim 16 wherein the dyed colloidal elements of each layer are covered with an insulating layer after dyeing.

18. The photomechanical method of claim 17 wherein the light permeable areas of the first mask are rectangular and the areas of each row are staggered relative to the areas in adjacent rows.

19. A photomechanical method for preparing a mosaic carrier for three-color photography and cinematography of the additive type, comprising laying a first light sensitive layer on a transparent blank carrier, laying on said light sensitive layer a first mask, opaque except for a large number of spaced minute light-permeable areas of similar shape and size, arranged in parallel equally spaced rows with the areas in each row equally spaced, the total surface of said areas being substantially equal to one-third of the surface of the mask, exposing the first light

sensitive layer through said mask, removing the unexposed portions of said first layer, dyeing the exposed elements corresponding to the permeable areas of said first mask in a first primary color, coating said first color elements with a first layer of transparent varnish, laying a second light sensitive layer over the first layer of varnish, positioning behind the carrier a second mask having parallel opaque strips separated by light permeable strips being equal in width to said opaque strips, the width of said strips being less than the maximum dimension of the light permeable areas of the first mask, arranging the second mask with its strips at such an angle to the rows of the first exposed elements that each of the strips is completely interrupted by one first element in at least every other row, exposing the second sensitive layer through said second mask under such conditions as to impress only areas of the second layer that are not corresponding to the color elements of the first layer and the opaque strips of the second mask, removing the unexposed portions of said second layer, dyeing the exposed parts of the second sensitive layer in a second primary color, coating said second color elements with a second layer of varnish, coating the second layer of varnish with a third light sensitive layer, exposing said third light sensitive layer from the rear of the carrier under such conditions as to impress said third layer only at areas not corresponding to the first and second color elements, removing the unexposed portions of said third layer, dyeing the exposed parts of the third layer to form the third color elements which lie between the second color elements and the first color elements, coating said third color elements with a third layer of varnish, and covering the whole three-color carrier obtained with a panchromatic emulsion.

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