PATENT SPECIFICATION

Application Date: May 2, 1934. No. 13311/34. **437,888**

Complete Specification Left: April 18, 1935.

Complete Specification Accepted: Nov. 4, 1935.

PROVISIONAL SPECIFICATION

Improvements in Printing or Reproducing Colour Photographs

We, (Dr.) GEOFFREY BOND HARRISON, a British Subject, and STANLEY DENNIS THREADGOLD, a British Subject, both of Ilford Limited, 23, Roden Street, Ilford, Essex, do hereby declare the nature of this invention to be as follows:—

This invention relates to printing or reproducing colour photographs of the multi-colour screen type. In contact printing off photographs of this type on to a multi-colour screen material, it is impossible in practice especially in cases where screens with very small multi-colour elements are used, to superimpose the master and copy sufficiently accurately to ensure exact registration of the elements of the screens of the master and copy. This is especially the case with cinematograph or other films intended for enlargement.

One of the results of this lack of registration is that colour degradation occurs in the copy since, considering for simplicity the case of a single colour element in the master—say a red element—the light transmitted by that element may not fall wholly, or even in part, on a red element of the copy. Thus this red component of the master may not be reproduced at all on the copy or may only be reproduced in part.

This invention is concerned with photographs in which the very small colour elements of the multi-colour screen are not all of the same size and shape, i.e. the area of one colour is different in shape and/or size from the area in another colour. With this type of colour screen, the aforesaid difficulty is accentuated owing to the fact that one colour area may consist of only a small part of the pattern unit. It has been proposed for instance to employ a finite number of white beams directed in different directions through the master so as to produce a corresponding number of images on the copy equal in size and shape to the corresponding elements of the original, but with a multi-colour pattern unit of the type with which this invention is concerned, this known arrangement does not ensure that the light passing through a small colour area of the master will produce a corresponding full image on the copy.

An object of the present invention is to improve the definition obtained in colour printing and the invention comprises the method of photographic contact printing with colour screens of the kind referred to according to which light rays are transmitted from a colour source which is of such multiple or extended form that the light passing through a corresponding colour area of the master is distributed on the copy material over an area which is substantially equal to that of the whole of a multi-colour pattern unit of the master or copy. In carrying out the invention a similar extended or multiple coloured light source is provided for each area of corresponding colour so as to ensure that the image produced by each colour area of the master is distributed on the copy material over substantially the area of the whole of a multi-colour pattern unit of the copy. It will be understood that in contact printing in this manner, there will always be a slight spacing or small separation of the master and copy colour screens, although the film or other supports for them may be in contact, and by suitable arrangement of the extended or multiple light source, this spacing, although small, is sufficient to effect the required distribution of light at the copy. An additional spacing may be employed if required.

In one specific example of the invention, there is employed a master and a copy having a three-colour screen in which each multi-colour element comprises a narrow red band and, alongside this band, adjacent areas of green and blue. The red band may be, for instance, one third of the total width of the unit, and the blue area may be twice the area of the green. In this case there are employed three beams of red light spaced apart in such a manner having regard to the separation of the colour screens of the master and copy that the light passing through the red area of the master is distributed on the copy over the full area of a multi-colour pattern unit of the master. In like manner three beams of

[*Price* 1/-]

green light are employed arranged at right angles to the beams of red light and so disposed that this light passing through the green area of the master is distributed on the copy across the full length of the multi-colour pattern unit of the master. In order that the light thus transmitted through the green area of the master shall be distributed sideways so as to extend across the gap between adjacent green areas, this light source may be such as to produce a diffused or less intense illumination of these parts. Since the blue portion of the colour element is the largest, a single beam of blue light is employed, and in order that a full distribution of this light shall be obtained on the copy, this light beam also has a diffused or less intense periphery. This diffusion of the green and/or blue elements may be produced if desired by providing a further set or sets of green or blue coloured elements, or by extending the original elements in one or more directions.

It is also a feature of this invention to provide a mask having a plurality of colour filters arranged to provide the several beams of light aforesaid, and for the example described, this mask comprises three apertures with red screens spaced apart and arranged in line, three apertures with green screens also spaced apart and arranged in line at right-angles to the red screens, and a central aperture with a blue screen. The blue and green screens partly coincide and for this part a single blue-green screen may be employed. The blue and green screens of the mask have extended portions to pass less intense or diffused light or additional coloured elements are provided for the purpose above described. It will be understood that the spacing of the screens in the mask will be governed by the separation of the mask and the copy from the master. It is also a feature of this invention to provide a compound mask or screen comprising one or more unit masks each containing a number of differently coloured elements arranged and formed as described above.

In one optical arrangement, the mask is provided in front of an opal plate illuminated by a source or sources of light, or, alternatively, a lens system may be employed between the opal and the mask. The light received by the opal plate or lens system may be white light, for example a half watt light or arc light, or it may be light provided by a system such as that described in Specification No. 10375/33 (Serial No. 417,860), or any desired combination of different light sources.

Dated this 2nd day of May, 1934.

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COMPLETE SPECIFICATION

Improvements in Printing or Reproducing Colour Photographs

We, (Dr.) GEOFFREY BOND HARRISON, a British Subject, and STANLEY DENNIS THREADGOLD, a British Subject, both of Ilford Limited, 23, Roden Street, Ilford, Essex, 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 folowing statement:—

This invention relates to printing or reproducing colour photographs of the multi-colour screen type. In contact printing of photographs of this type on to a multi-colour screen material, it is impossible in practice especially in cases where screens with very small multi-colour elements are used, to superimpose the master and copy sufficiently accurately to ensure exact registration of the elements of the screens of the master and copy.

One of the results of this lack of registration is that colour degradation occurs in the copy since, considering for simplicity the case of a single colour element in the master—say a red element—the light transmitted by that element may not fall wholly, or even in part, on a red element of the copy. Thus this red component of the master may not be reproduced at all on the copy or may only be reproduced in part.

This invention is concerned with photographs in which the very small colour elements of the master multi-colour screen form regularly recurring similar pattern units but which are of non-uniform arrangement, shape or size within the unit. With this type of colour screen (hereinafter referred to as a multi-colour screen of the type described) the aforesaid difficulty is accentuated owing to the fact that one colour area may consist of only a small part of each pattern unit.

An object of the present invention is to improve the faithfulness of the colours obtained in colour printing. With this object in view the invention provides the

method of contact printing a master photograph made on multi-colour screen material of the type described on to multi-colour screen copy material which comprises the use for the printing light of a plurality of differently coloured light sources, corresponding in colour to the colours of the master screen elements and each having a spectral composition which is substantially the same as, or is within, the transmission range of the master screen elements of corresponding colour, characterised in that the effective dimensions of the source of each colour in each direction measured in a plane parallel to that of the master screen, and the distance of the source from the master screen, are so proportioned with regard to the spacing between the master and copy screens that the light from that source passed by a master screen element of corresponding colour spreads over an area on the copy screen which is substantially equal to the area of a master screen pattern unit.

Each light source may be in the form of a single undivided area but preferably the light source of each colour is subdivided into a plurality of light sources of that colour. This subdivision has the advantage that a more even illumination of the copy screen is obtained than is the case with an undivided area and it also enables the several light sources to be arranged in a small compass. In order to obtain sufficient intensity of illumination on the copy screen it is necessary to employ constituent light sources of appreciable size with the result that the light passed by each master screen unit from each constituent light source produces on the copy screen a patch of light which is of substantially uniform maximum intensity over the central area and of outwardly decreasing intensity from this central area. Near the edges of the patch the light intensity will be ineffective for printing, and this portion of the illuminated area should be neglected when considering the area of spread on the copy screen. A light source of a single undivided area will also produce a patch of illumination on the copy screen which is of ineffective intensity at the edges. The area of the light patch which is of effective photographic intensity is taken in each case as the area illuminated by light of more than half the maximum intensity.

It will be understood that in contact printing in this manner, there will always be a slight spacing or small separation of the master and copy colour screens, although the film or other supports for them may be in contact, and by suitable arrangement of the light sources, this spacing, although small, is sufficient to effect the required distribution of light at the copy. An additional spacing may be employed if required.

The invention includes a mask for carrying out the method described above and having a plurality of colour filters of different colours spaced apart over the surface of the mask and arranged to provide, when suitably illuminated, the several light sources aforesaid.

It has already been proposed (see Specification No. 374,891) to employ a finite number of beams of white light directed in different directions through a master multi-colour screen so as to produce a corresponding number of images on the copy screen each equal in size and shape to the corresponding elements of the original, but with a multi-colour screen of the type described, with which this invention is concerned, this known arrangement does not ensure that the light passing through a small element of the master screen will, on the copy screen spread over an area on the copy screen which is substantially equal to the area of a master screen pattern unit.

One specific example of the invention will now be described with reference to the accompanying drawings in which:—

Figure 1 is a diagram showing the relationship during printing between the mask and the master and copy screens,

Figure 2 is a greatly enlarged view of a portion of one of the multi-colour screens,

Figure 3 is a view of the mask, and

Figure 4 is a diagram showing the spread of light over the copy screen.

This example relates to the printing of photographs made on three-colour screen material of the kind consisting of parallel lines substantially uniformly coloured in one colour alternating with lines of rectangles of two different colours. A screen of this kind may be produced by the method described in British Patent Specification No. 322,432 and is illustrated to an enlarged scale in Figure 2 in which the lines 1 represent the red elements of the screen, the rectangles 2 the blue elements and the rectangles 3 the green elements. The relative proportions of the several elements are marked on the Figure and the complete pattern unit consists of a blue rectangle, a green rectangle and a length of red line corresponding to the width of these two rectangles and forms a square $1/20 \times 1/20$ mm.

The arrangement adopted during printing is shown in Figure 1 in which 4 represents an evenly illuminated opal

screen, 5 represents the mask (later described), 6 the master photograph and 7 the copy photograph. In this example the master and copy materials are arranged with their supports in contact, thus the master and copy screens (which are both of the above kind) are separated by two thicknesses of support material (in this case a total separation of 0.20 mm.) and the two photographic layers are outside the colour screens.

The mask is shown in Figure 3 and consists of an opaque portion 8 provided with a plurality of transparent coloured light filters 9, 10 and 11, the filters 9 having a light transmission similar to that of the red elements of the screen, the filters 10 having a transmission similar to that of the green elements of the screen and the filters 11 a transmission similar to that of the blue elements of the screen. The sizes of the various filters and their relative positions are marked on the Figure.

In use the mask forms the printing light source and is arranged with its plane parallel to the plane of the master and copy materials and with the length A—B of the red filters in a direction at right angles to the length of the red lines of the master screen. The mask is separated from the master screen by a distance of approximately 11.5 cms. The arrangement of the red filters of the mask and the master and copy screens and the effect of the red filters of the mask during printing is shown diagrammatically in Figure 4 in which 9 represents the red filters and 12 and 13 the master and copy screens respectively. The red elements of the screen, transparent to the red light passed by the filters 9, are shown at 14 while the blue and green elements which are opaque to the red light are shown at 15. As indicated in Figure 4 the light passed by a red element of the master screen diverges before it reaches the copy screen (due to the extended form of the red filters) and the relative dimensions of the filters and screen elements and the separations of the mask and master screen and that of the two screens are so chosen that this divergence is sufficient for the light to spread on the copy film over the full width C of a master screen pattern unit i.e. the width of one red line together with the width of one line of rectangles, in this case a total of three times the width of the red line of the master screen. In the case of the red elements it is of course only necessary to spread the light in a direction transverse of the length of the elements in order to illuminate the whole of the copy screen with red light since these elements are in the form of lines.

As shown in Figure 3 the blue and green filters 10 and 11 of the mask are arranged at the corners of rectangles having sides parallel to the length A—B of the red filters. The effect of this arrangement during printing is similar to that described for the red elements in that the light transmitted by a blue or green element of the master screen is spread on the copy screen over the full width of a pattern unit of the master screen but in this case, due to the rectangular arrangement of the filters, the spreading action takes place in each direction so that the light from each blue or green element is spread over an area on the copy screen equal to the area of a full pattern unit of the master screen.

The proportions to be employed for the light sources depend in each case upon (a) the size and shape of the several colour elements of a pattern unit of the master screen, (b) the distance between the master and copy screens, and (c) the distance of the mask from the master screen.

It is found that the size and shape of the individual filter areas of a subdivided filter for a given colour can be altered within small limits without substantial variation in the results obtained provided that the "geometrical centre" of each constituent area is unchanged relative to the "geometrical centre" of any other constituent areas of the same colour and it is the distance between the geometrical centres of the filter areas of one particular colour which should be considered in determining the effective dimensions of subdivided filters of that colour. If the filter areas are altered for any colour (for example if the areas are enlarged to give a larger proportion of light of that colour) then this change must be made symmetrically for all the areas of that particular colour, if the effectiveness of the mask is to be unchanged.

In order that the effect of each light source may be restricted to the master screen elements to which that source is appropriate the filters used in the filter mask should be chosen so that, as far as is practicable having regard to the necessary balance of the exposures given by the differently coloured lights and to the filters which are practically available, light transmitted by any one of the mask filters is transmitted only by the equivalent coloured elements in the master screen and copy screen.

It is to be understood that in order to obtain the best results as to colour effects in the copy and to reduce the effects of lack of registration the important consideration is that for each colour the light

from the source of that colour passed by a master screen element of corresponding colour should spread over an area on the copy screen substantially equal in size to the area of a master screen pattern unit. In practice various factors arise which have not been considered in detail here for the sake of simplicity and which make it necessary to deviate slightly from the simple theoretical proportions of the light sources and their distance from the screens in order to obtain the desired spread of the light. These deviations, which are small, are best found by trial and error for example by making adjustments in the sizes of the filters or in the distance of the filters from the master screen until the desired spread of the light is obtained as shown by the production of the best colour effects in the copy.

Variations may be required, for example, because the screen elements may be found each to be situated on a slightly curved surface of the support material which acts as a lens and which may be formed by the particular method of production of the screen. Other variations from the theoretical conditions may be necessary to allow for irregularities in the proportions or form of the screen elements.

In Figure 3 the mask is shown as having blue filter areas of somewhat larger dimensions than the green filters. This is necessary because the usual forms of artificial printing lights are deficient in blue and the patch of blue light of effective printing intensity produced on the copy screen might not otherwise reach the required dimensions and also because it is necessary in practice to employ larger filter areas in order to obtain the correct proportion of blue light even at the expense of producing an area of spread of the blue light which slightly exceeds the best spread obtained from theoretical considerations. This excess of spread of the blue light, due to the enlarged size of the individual filter areas, will however be small compared with the total spread produced by the separation of the areas themselves and will not represent a departure from the total area of spread of more than about 10 to 15% of that spread. In the example using the mask shown in Figure 3 the difference in spread of blue and green lights of effective intensity is considerably less than 10%.

In the example described above the master and copy screens are separated by two thicknesses of support material but if the screens should be so arranged that only one thickness of support material separates them (i.e. a separation of 0.10 mm.) then the mask having the proportions given should be only approximately 5.75 cms. away from the master screen—together with an allowance for the thickness of one emulsion layer which must also be between the two screens.

Again in the example described above the mask is placed directly in front of a diffusing medium illuminated by a source or sources of light but in an alternative arrangement a lens system may be employed instead of a diffusing medium. The light received by the diffusing medium or lens system may be white light, for example from a half watt light or an arc light, or it may be light provided by a system such as that described in British Patent Specification No. 417,860 or any desired combination of different light sources.

In cases where two differently coloured filters partly coincide on the mask a filter (e.g. a blue-green filter) having a transmission combining both colours may be employed over the area of coincidence. Thus for example if it is desired to enlarge the constituent blue and green filter areas in the mask shown in Figure 3 without enlarging the mask as a whole the blue and green areas may overlap to a small extent and in this case the overlapping portions may be constituted by a blue-green filter.

It is to be understood that although the invention is only concerned with master photographs made on multi-colour screen material of the type described, it is immaterial what form of copy screen be employed in carrying out the invention.

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. The method of contact printing a master photograph made on multi-colour screen material of the type described on to multi-colour screen copy material which comprises the use for the printing light of a plurality of differently coloured light sources, corresponding in colour to the colours of the master screen elements and each having a spectral composition which is substantially the same as, or is within, the transmission range of the master screen elements of corresponding colour, characterised in that the effective dimensions of the source of each colour in each direction measured in a plane parallel to that of the master screen, and the distance of the source from the master screen, are so proportioned with regard to the spacing between the master and copy screens that the light from that source passed by a master screen element

of corresponding colour spreads over an area on the copy screen which is substantially equal to the area of a master screen pattern unit.

2. The method of photographic contact printing a master photograph made on three-colour screen material of the kind consisting of parallel lines substantially uniformly coloured in one colour alternating with lines of rectangles of two different colours on to multi-colour screen copy material which comprises the use for the printing light of three differently coloured light sources corresponding in colour to the colours of the master screen elements and each having a spectral composition which is substantially the same as, or is within, the transmission range of the master screen elements of corresponding colour, characterised in that the light sources are so proportioned with regard to the spacing between the master and copy screens that:—

(a) The light source of colour corresponding to the uniformly coloured lines has an effective length transverse to the direction of the lines of the master screen and is located at such a distance from the screen, that the light passed by a line of the master screen spreads over an area of the copy screen having a width approximately the width of a pattern unit of the master screen measured in a direction transverse to the lines thereof, and

(b) The light sources of colours corresponding to the rectangles are of such effective dimensions and are located at such distances from the master screen that the light passed by a rectangle of the master screen spreads over an area on the copy screen approximately equal in length and breadth to the area of a pattern unit of the master screen.

3. The method of photographic printing as claimed in claim 1 or claim 2 wherein the light source of each colour is subdivided into a plurality of light sources of that colour.

4. A mask for use in carrying out the method according to any one of the preceding claims and having a plurality of colour filters of different colours spaced apart over the surface of the mask and arranged to provide, when suitably illuminated, the several light sources aforesaid.

5. The method of contact printing multi-coloured screen photographs substantially as described with reference to the accompanying drawings.

6. A mask for use in contact printing multi-colour screen photographs substantially as described with reference to Figure 3 of the accompanying drawings.

Dated this 18th day of April, 1935.

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Chartered Patent Agents.

Leamington Spa: Printed for His Majesty's Stationery Office, by the Courier Press.—1935.

Fig. 1.

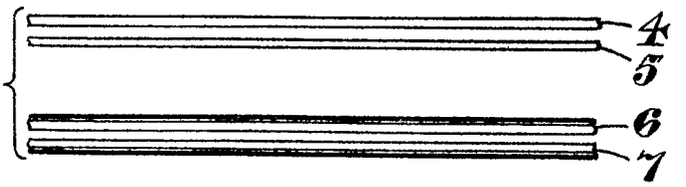


Fig. 2.

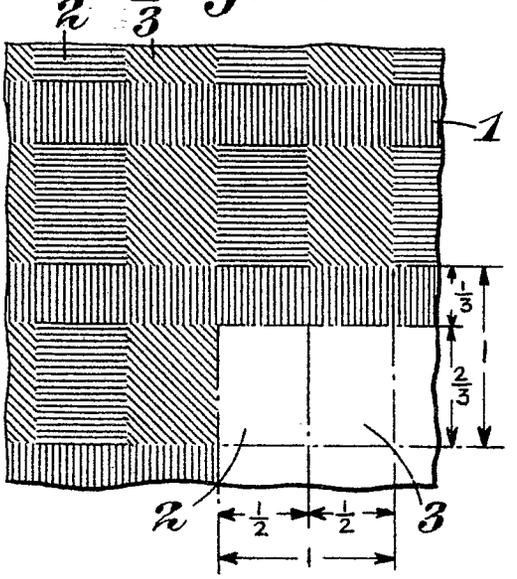


Fig. 4.

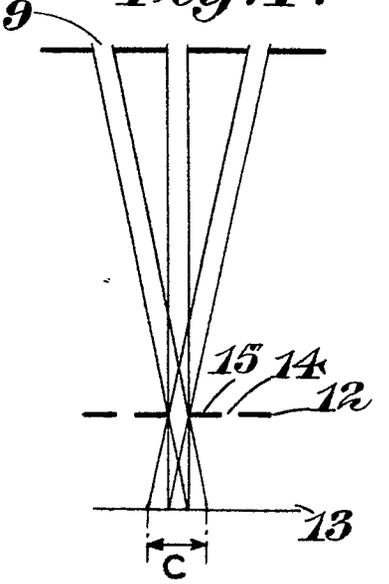
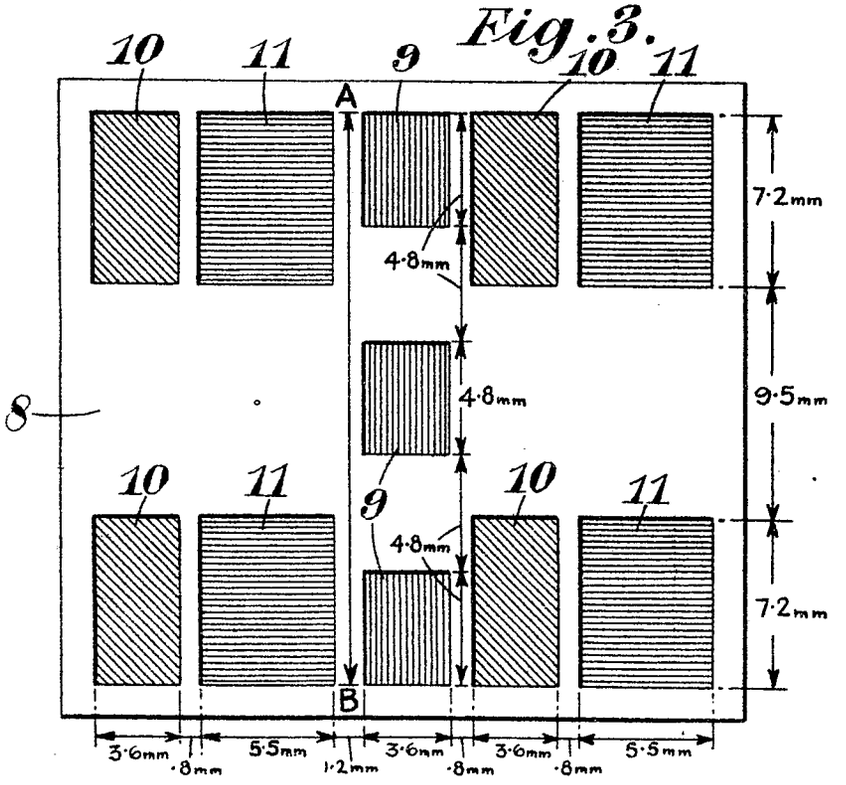


Fig. 3.



Malby & Sons, Photo-Lith.