

## PATENT SPECIFICATION

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## PROVISIONAL SPECIFICATION.

No. 24,136, A.D. 1932.

## Improvements in or relating to Colour Photography.

We, THOMAS THORNE BAKER, a British Subject, of The Hut, Hatch End, Middlesex, and DUFAYCOLOR LIMITED, a British Company, of 19, New Bridge Street, London, E.C.4, do hereby declare the nature of this invention to be as follows:—

This invention relates to improvements in or relating to colour photography.

10 It has long been possible to produce photographic transparencies in natural colours by means of plates or films carrying a matrix, reseau or colour screen of primary colours between the support and  
15 the emulsion, exposure taking place through the matrix or colour screen after which the image was developed and reversed. Photographic transparencies in natural colours have also been produced  
20 by printing on plates or films of the same kind. Typical instances are described in Specifications Nos. 217,557 and 322,432.

So far difficulties have been encountered in making prints (i.e. photographic  
25 prints in natural colours to be viewed by reflected light) in an economical manner.

One object of the present invention is to provide a process by which colour  
30 prints in natural colours on a reflecting base, such as white paper, can be economically produced from taking films or plates of the type above referred to; and a secondary object is to provide suitable materials for carrying out the process.  
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This invention comprises a method of obtaining a photographic print in natural colours to be viewed by light reflected from a non-transparent base which consists in taking a negative through a  
40 colour screen in primary colours associated with the taking emulsion, printing from the taking film or plate on to a plurality of printing emulsions each sensitive to  
45 one of the primary colours and one of which is attached to a permanent non-transparent base, toning or dyeing each of the prints to the colour complementary to that to which the emulsion is sensitive  
50 and superposing the prints on to the print

[Price 1/-]

on the permanent non-transparent base. Conveniently the original negative on the colour screen, film or plate is reversed to form a positive and each print produced is also reversed.

According to one feature of this invention the print on the permanent non-transparent base is made on bromide paper sensitive to blue-violet light.

The process in its preferred form is a three-colour subtractive one and in addition to the print on permanent non-transparent material (e.g. the print on bromide paper sensitive to blue-violet light) two  
65 further prints are made on emulsions sensitive to red and green light respectively.

According to one form of this invention the additional emulsions carried on a suitable transparent support, (e.g. films  
70 bearing emulsions sensitive to red and green light respectively) are exposed face to face (i.e. with the emulsioned surfaces in contact) in contact with the original taking transparency and according to a  
75 further feature of this invention they are exposed through a yellow filter.

Preferably the emulsion from one print (toned as above described) is transferred to the bromide print, and the third print  
80 toned as above described and on a transparent base is secured on top of the said transferred print.

The following is a description by way of example of one method of carrying this  
85 invention into effect:—

An ordinary bromide print is made by contact printing using the natural colour positive transparency as a master, and this print is developed and reversed so that it also is a positive. This print is a  
90 "blue" separation record, as the bromide paper is by nature only sensitive to blue-violet light.

Two films are now placed emulsion-to-emulsion, one coated with a green-sensitive emulsion and the other with a red-sensitive emulsion. These two films are placed in contact with the natural colour positive transparency and are ex-  
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posed to light through a yellow filter—as a bi-pack—and then they are developed and reversed. The emulsions may conveniently be so adjusted as to cause them to give images of the gammas respectively desirable for the subsequent processes.

The green-separation picture is now used (as though it were a bromide print) in the well-known manner to make a trichromatic pink carbon print or a print such as is known under the Registered-Trade Mark “carbros”, which is developed on waxed celluloid or on any transparent temporary support.

The red-separation picture (also developed and reversed to a positive) is toned blue by a suitable and known toning solution.

The original bromide print bearing the blue-separation record is toned yellow by any suitable or known process, e.g. bleaching in a solution of lead acetate and potassium ferricyanide and converting with potassium bichromate or chromate to form a yellow image of lead chromate.

At this stage the three separate records are:—

- (1) A yellow bromide print.
- (2) A pink gelatine image on a temporary support such as celluloid, and
- (3) A blue-toned transparency on a thin celluloid or cellulose acetate base.

Following the method well-known in the making of carbon prints, the pink print (2) is transferred upon the yellow basic print (1) which acts as the final support. The blue print (3) is then squeegeed upon the combination of prints (1) and (2) thus forming a three-colour natural print of the original natural colour transparency.

In this way it is possible to make natural colour prints from coloured transparencies at a very small cost and with great accuracy of colour rendering.

In a modification of this invention prints in approximation to natural colours may comprise only two superimposed prints each of which is printed by direct contact with a transparency in natural colours. In that case, naturally the colour sensitiveness of the printing emulsions is suitably chosen as well as the colour of the filter through which the superimposed print is exposed. It will also be understood that the original colour transparency might embody a two-colour screen.

Dated this 29th day of August, 1932.  
BOULF, WADE & TENNANT,  
111 & 112, Hatton Garden, London,  
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Chartered Patent Agents.

#### PROVISIONAL SPECIFICATION.

No. 17,733, A.D. 1933.

#### Improvements in or relating to Colour Photography.

We, THOMAS THORNE BAKER, a British Subject, of The Hut, Hatch End, Middlesex, and DUFAYCOLOR LIMITED, a British Company, of 19, New Bridge Street, London, E.C.4, do hereby declare the nature of this invention to be as follows:—

This invention consists in improvements in or relating to colour photography, and is cognate with or a modification of that described in co-pending Application No. 24,136/32. Various methods of obtaining photographic prints in natural colours to be viewed by light reflected from a non-transparent base have been proposed (see for example co-pending Application No. 24,136/32) in which two or more elemental prints are prepared from a single negative having a colour screen associated therewith and are subsequently assembled on a common base. In order, however, that such methods shall be easy to carry out it is necessary to ascertain accurately the exposure required to be given for

each elemental print in order that the assembled print may have the correct colour values. One object of the present invention is to provide a method of ascertaining the exposure necessary for each elemental print. Further objects are to provide an improved method of printing the elemental prints and of assembling them on a common base.

The invention provides in the method of obtaining a photographic print in natural colours to be viewed by light reflected from a non-transparent base to which it is attached which comprises taking an original transparency through a colour screen associated with the taking emulsion, and preparing from the original a series of elemental prints each corresponding to one of the colour separation records formed on the original by the colours of the screen, the steps of measuring the density of the original by means of a beam of light passing through the original onto a photo-electric cell and

from this density estimating the time of exposure necessary for the several elemental prints.

In the preferred form of the invention each elemental print is made with light of colour containing one of the colours of the screen but containing substantially no component of colour transmitted by any of the remaining colours of the screen.

The invention also includes the method of obtaining a photographic print wherein one of the elemental prints, which is made on a base which forms the permanent non-transparent base of the final print, is coloured (e.g. by toning) to the colour complementary to that of the colour separation record to which it corresponds, a pigmental gelatine or like coloured transferable print is prepared from the second elemental print in the colour complementary to that of the separation record to which the print corresponds and is superposed on the first elemental print, and the third elemental print which is separable from its base is coloured (e.g. by toning) to the colour complementary to that of the separation record to which it corresponds and is also superposed on the first print and its base thus removed. Conveniently the negative transparency may be reversed to form a positive transparency and each elemental print is also reversed to form a positive.

The following is a description, by way of example, of one way of carrying the invention into effect, together with several modifications thereof.

A master natural colour positive transparency is prepared by reversing a negative picture formed on a film having a colour screen with red, green and blue elements. Three holes are punched through the film each near a corner of the film. These holes are carefully spaced apart and may, for example, be punched simultaneously with a triple punch. The transparency is then placed in a printing frame having a hinged back of the well known type. The front of the frame consists of a piece of glass of size suited to the picture to be printed and a flat L shaped border of wood of the same thickness as the glass. This border carries three ivory pins which are spaced to engage with the holes in the film and accurately hold the film in position.

Three pieces of bromide paper, one sensitive to blue, one sensitive to green and one to red light, and all on paper having the same expansion on wetting are punched with the same punch as was used for the original transparency. These pieces of paper are each, in turn, placed in the printing frame with the perforations in engagement with the pins and

exposure through the original transparency is made.

In order to obtain sufficient speed in the negative film it is necessary to provide the colour screen with the colours having slightly overlapping wave-lengths. The bromide prints should, however, each correspond only to that portion of the negative associated with the elements of one of the colours of the screen, and it is therefore necessary to use in printing light which will be transmitted by those colour elements but which does not contain any component that will be transmitted by the elements of any of the other colours of the screen.

The time of exposure necessary for the prints is found by measuring the overall density of the transparency. A beam of light of standard intensity is passed through the transparency onto a photoelectric cell which is connected to a galvanometer which gives a reading corresponding to the density of the transparency. The time of exposure for each print corresponding to this reading may then be read off a graph which has been prepared from experiments, or the galvanometer may be calibrated to give the times direct. The ratios of the times of exposure for the three prints depend on the ratios of the colours in the screen, on the sensitivity of the papers and on the exposure and development conditions. In one case the time of exposure for the print on blue sensitive paper when divided by two for the print on green sensitive paper and four for the print on red sensitive paper gave satisfactory results.

The prints are then developed and reversed to form positives. The development conditions should be chosen to give the characteristic curves and gammas of each print as nearly the same as possible.

The print on blue sensitive paper is toned yellow to form one elemental print which forms the common base upon which the picture is combined.

The print on green sensitive bromide paper after soaking in water for sufficient time to ensure the maximum stretch (which may amount to 1 or 2 m.m. in the length of a half-plate print on ordinary paper) is next placed face upwards on a registering board. This registering board is of flat wood and has three ivory pins similar to those on the printing frame but spaced apart at a distance corresponding to the holes in the stretched paper. A presser bar fitting over two of the pins is also provided for holding the paper in position.

A pink elemental print is next made from the print on green sensitive bromide paper using pink pigment paper known

under the Registered Trade Mark "Carbro". This pigment paper which is preferably on a backing of the same paper as was used for the bromide prints in order to obtain the same stretch on wetting is punched (while dry) with the above-mentioned triple punch. The paper is thoroughly wetted and is then sensitised in the known manner and placed face downwards onto the "green" print on the registering board with the holes in the wet paper in engagement with the pins. The two papers are squeegeed together and allowed to react together, under a weight, for four and a half minutes. They are then removed from the board together and separated. Any surplus sensitiser is then removed from the pigment by two washings of one minute each in water and one in equal quantities of methylated spirits and water.

The elemental print on blue sensitive paper, now toned yellow, which has been left wet or resoaked is now placed face upwards on the registering board and the pink elemental print (still in position on its backing and not yet developed) is placed in contact therewith. Registration is effected solely by means of the pins on the board engaging with the holes in the respective prints. The two prints are squeegeed together and allowed to rest for ten minutes under a weight. They are then placed in water at 103° F. to develop the pink print and the backing is stripped from that print. There is left at this stage therefore a yellow elemental print and a pink elemental print permanently superposed thereon.

The bromide paper used for the third

print (i.e. that sensitive to red light) is made on a known type of paper in which a thin layer of readily soluble gelatine is placed between the emulsion and the paper backing. The image in this case is toned blue to form the third elemental print.

The above combined yellow and pink print is next placed face upwards and still wet on the registering board and the wet blue print placed face downwards thereon and squeegeed. Registration in this case also is obtained by means of the pins on the board engaging with the holes in the respective prints. The combined prints are next placed in warm water (130° F.) to dissolve the above gelatine layer and the backing stripped from the blue print leaving the three elemental prints in register on a common base, and forming a picture in colour.

In one modification of the above example the third print (i.e. that sensitive to red light) is made on thin celluloid and after toning is stuck down on the yellow and pink prints. The celluloid backing in this case is not stripped off.

In a second modification the red and blue elemental prints are made by exposing, under the transparency and through a deep yellow filter, a film coated on one side with a green sensitive emulsion, and on the other side a red sensitive emulsion. The images are developed and dye-toned the correct colour and then cemented upon the yellow print.

Dated this 21st day of June, 1933.

BOULT, WADE & TENNANT,  
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## COMPLETE SPECIFICATION.

### Improvements in or relating to Colour Photography.

We, THOMAS THORNE BAKER, a British Subject, of The Hut, Hatch End, Middlesex, and DUFAYCOLOR LIMITED, a British Company, of 19, New Bridge Street, London, E.C.4, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to improvements in or relating to colour photography.

It has long been possible to produce photographic transparencies in natural colours by means of plates or films carrying a matrix, reseau or colour screen of primary colours between the support and the emulsion, exposure taking place

through the matrix or colour screen after which the image was developed and reversed. Photographic transparencies in natural colours have also been produced by printing on plates or films of the same kind. Typical instances are described in Specifications Nos. 217,557 and 322,432.

So far difficulties have been encountered in making colour prints (i.e. photographic prints in natural colours to be viewed by reflected light) in an economical manner.

One object of the present invention is to provide a process by which colour prints in natural colours on a reflecting base, such as white paper, can be economically produced from taking films or plates of the type above referred to.

This invention provides the method of producing a composite coloured print from a master colour-screen record (i.e. a negative or a positive transparency) having two or more part images of the subject produced by the selective action of the screen colours which comprises the steps of preparing from said record two photographic prints corresponding respectively to two of the said part images and one being on a light reflecting base (e.g. paper) to constitute the base of the final print, changing (e.g. by toning) this print to a colour complementary to that primary colour to which it is appropriate, and making from the other of the photographic prints an undeveloped gelatine print pigmented in a colour complementary to the primary colour to which it is appropriate superposing this gelatine print in register on the print on the light reflecting base and then developing it.

It has already been proposed in Specifications Nos. 175,003 and 198,745, to produce photographs in two or three colours by obtaining a single coloured positive or print from a separate colour record negative by a carbon printing process and one or more single coloured positives or prints from a further separate colour record negative or negatives by a bromide printing process and superposing these prints in register to form a finished multi-coloured photograph or picture. In these prior proposals the carbon print was developed before superposition on the bromide prints and the superposition was effected by a double transfer of one of the prints. According to the present invention, which relates to the production of prints from colour screen negatives, the carbon print is developed after it has been superposed on one of the bromide prints and the transfer may, accordingly, be effected by single transfer.

The master colour screen film or plate employed in this invention may be a negative, and positive photographic prints may be produced direct but conveniently the master colour screen film or plate is a positive and each photographic print produced is reversed to form a positive.

When the invention is applied to a three-colour process, three photographic prints are made and the partial image on the third print is changed to a colour complementary to that of the primary screen colour to which it is appropriate and the print is also superposed in register on the print on the paper or like base. This third print may be on a transparent base which forms a protective face for the finished print or it may be separable from its base and this base may be stripped from the print after it has been

superposed in register on the print on the paper or like base.

In order that the above method may be easy to carry out in practice it is necessary to ascertain accurately the exposure required to be given for each photographic print in order that the assembled print may have the correct colour values, and it is a feature of the present invention that the density of the master colour screen record may be measured by means of a beam of light passing through the master record onto a photo-electric cell and the several photographic prints may be exposed to a degree determined from this density.

In the preferred form of the invention each photographic print is made with light of colour containing one of the colours of the screen but containing substantially no component of colour transmitted by any of the remaining colours of the screen.

The following is a description, by way of example, of one way of carrying the invention into effect, together with several modifications thereof.

A master natural colour positive transparency is prepared by reversing a negative picture formed on a film having a colour screen with red, green and blue elements. Two holes are punched through the film symmetrically placed each near a corner at the top of the film. These holes are carefully spaced apart and may, for example, be punched simultaneously with a double punch. The transparency is then placed in a printing frame having a hinged back of the well-known type. The front of the frame consists of a piece of glass of size suited to the picture to be printed and a flat border of wood of the same thickness as the glass. This border carries two ivory pins which are spaced to engage with the holes in the film and accurately hold the film in position.

Three pieces of bromide paper, one sensitive to blue, one sensitive to green and one to red light, and all on paper having the same expansion on wetting are punched, using a triple punch, with three holes each near a corner, and two adapted to be closely engaged by the pins in the printing frame. These pieces of paper are each, in turn, placed in the printing frame with the perforations in engagement with the pins and exposure through the original transparency is made using light of colour corresponding to the colour of the screen to which the emulsion is sensitive thus forming, after development and reversal, three photographic prints each of which is a black and white record of one of the part images formed on the

original transparency by the colours of the screen.

The prints on blue and green sensitive paper are each made with the emulsion in contact with the emulsion of the master transparency but for the third print the master transparency is turned over in the frame so that the print is made in reversed position. This is necessary in order that when the composite print is assembled all the partial prints may be in register.

In order to obtain sufficient speed in the negative film it is necessary to provide the colour screen with the colours having slightly overlapping wave-lengths. The bromide prints should, however, for true colour rendering each be a separation record of only that portion of the negative associated with the elements of one of the colours of the screen, and it is therefore necessary to use in printing, light which will be transmitted by those colour elements but which does not contain any component that will be transmitted by the elements of any of the other colours of the screen.

The time of exposure necessary for the prints is found by measuring the overall density of the transparency. A beam of light of standard intensity is passed through the transparency onto a photo-electric cell which is connected to a galvanometer which gives a reading corresponding to the density of the transparency. The time of exposure for each print corresponding to this reading may then be read off a graph which has been prepared from experiments, or the galvanometer may be calibrated to give the times directly. The ratios of the times of exposure for the three prints depend on the ratios of the total light transmission of each of the colours in the screen, on the sensitivity of the papers and on the exposure and development conditions. In one case the time of exposure for the print on blue sensitive paper when divided by two for the print on green sensitive paper and four for the print on red sensitive paper gave satisfactory results.

The prints are then developed and reversed to form positives. The development conditions should be chosen to give the characteristic curves and gammas of the prints as nearly the same as possible.

The photographic print on blue sensitive paper is next toned yellow to form one elemental print which forms the common base upon which the picture is combined.

A suitable method of toning the print is to bleach it in a solution of lead acetate and potassium ferricvanide and then to convert with potassium bichromate or

chromate to a yellow image of lead chromate.

The print on green sensitive bromide paper after soaking in water for sufficient time to ensure the maximum stretch (which may amount to 1 or 2 mm. in the length of a half-plate print on ordinary paper) is next placed face upwards on a registering board. This registering board is of flat wood and has three ivory pins adapted to engage closely the holes in the stretched paper. A presser bar fitting over two of the pins is also provided for holding the paper in position.

A pink elemental print is next made from the photographic print on green sensitive bromide paper using pink pigment paper known under the Registered Trade Mark "Carbro". This pigment paper which is preferably on a backing of the same paper as was used for the bromide prints in order to obtain the same stretch on wetting, is punched (while dry) with the above-mentioned triple punch. The paper is thoroughly wetted and is then sensitized in the known manner and placed face downwards on the "green" print on the registering board with the holes in the wet paper in engagement with the pins. The two papers are squeegeed together and allowed to react together, under a weight, for four and a half minutes. They are then removed from the board together and separated. Any surplus sensitiser (which might affect the tone of the print to which the pigmented gelatine is to be applied) is then removed from the pigment by two washings of one minute each in water and one in equal quantities of methylated spirits and water.

The print on blue sensitive paper, now toned yellow, which has been left wet or resoaked is now placed face upwards on the registering board and the pink elemental print (still in position on its backing and not yet developed) is placed in contact therewith. Registration is effected solely by means of the pins on the board engaging with the holes in the respective prints. The two prints are squeegeed together and allowed to rest for ten minutes under a weight. They are then placed in water at 103° F. to develop the pink print and the backing is stripped from that print. There is left at this stage therefore a yellow elemental print and a pink elemental print permanently superposed thereon.

The bromide paper used for the third photographic print (i.e. that sensitive to red light) is made on known type of stripping paper for example that in which a thin layer of readily soluble gelatine is placed between the emulsion and the

paper backing. The image in this case is toned blue (e.g. by bleaching with ferro-cyanide and toning with iron alum) to form the third elemental print.

5 The above combined yellow and pink print is next placed face upwards and still wet on the registering board and the wet blue print placed face downwards thereon and squeegeed. Registration in this case  
10 also is obtained by means of the pins on the board engaging with the holes in the respective prints (the holes in the third print being arranged to engage with the pins when the print is face downwards).  
15 The combined prints are next placed in warm water (130° F.) to dissolve the above gelatine layer and the backing stripped from the blue print leaving the three elemental prints in register on a common base, and forming a picture in colour.

20 In one modification of the above example the third print (i.e. that sensitive to red light) is made on a thin celluloid backing and after toning is stuck down on the yellow and pink prints. The celluloid backing in this case is not stripped off.

25 In a second modification two sensitised films are placed emulsion to emulsion one coated with an emulsion sensitive only to green and one with an emulsion sensitive only to red and exposure is made in contact with the master transparency (as a bi-pack) using a deep yellow filter. The dyes used for this filter is the ammonium salt of aurophenin, or uranin. The images are developed and reversed and are used in the place of the photographic  
30 prints on green and red sensitive paper in the above example to form a pink "Carbro" print and a blue print which are superposed on the print toned yellow as described above.

35 It will be appreciated that if the emulsions used for the photographic prints are each particularly sensitive to one of the colours transmitted by the screen, ordinary white light containing all the colours of the screen may be used for printing.  
40 In this case the photographic prints each form (after development and reversal) due to the selective action of the emulsion an approximate reproduction in black and white of one of the part records formed on the original transparency by the colours of the screen. A composite print in approximately the colours of the original  
45 may then be produced from these photographic prints in the manner described above.

50 In a further modification of the above-described example in which each photographic print is made with light of a particular colour, all three photographic  
55 prints are produced simultaneously. Three images of the original transparency are simultaneously produced by means of a known optical device and are focussed side-by-side on paper or film coated with panchromatic emulsion. A colour filter corresponding to one of the colours of the screen is interposed in the beam of light forming each image so as to produce on the paper the three different colour separation records required.  
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When it is desired to prepare a number of composite coloured prints from one positive transparency it may be preferred to prepare negatives of the part images on colour sensitive films using the requisite separation filters. The ordinary black and white photographic prints on bromide or like paper may then be produced from these negatives in the usual way.

85 It will be understood that although the invention has been specifically described in relation to a three-colour process it is not limited to such a process but may be applied to a two- or four-colour process. For example, the master record may have a two-colour screen and the composite print may consist of a toned bromide print and a pigmented gelatine print superposed.

90 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:—

95 1. A method of producing a composite coloured print from a master colour-screen record (i.e. a negative or a positive transparency) having two or more part images of the subject produced by the selective action of the screen colours which comprises the steps of preparing from said record two photographic prints corresponding respectively to two of the said part images and one being on a light reflecting base (e.g. paper) to constitute the base of the final print, changing (e.g. by toning) this print to a colour complementary to that primary colour to which it is appropriate, and making from the other of the photographic prints an undeveloped gelatine print pigmented in a colour complementary to the primary colour to which it is appropriate superposing this gelatine print in register on the print on the light reflecting base and then developing it.

100 105 110 115 120 125 130  
2. The method according to claim 1 wherein three photographic prints are made and the partial image on the third print is changed to a colour complementary to that of the primary screen colour to which it is appropriate and wherein the print is separable from its base which base is stripped off after the

print has been superposed in register on the print on the paper or like base.

3. The method according to claim 1 or claim 2 wherein the density of the master colour screen record is measured by means of a beam of light passing through the master colour screen record onto a photo-electric cell and the photographic prints are exposed to a degree determined from this density.

4. The method according to any one of the preceding claims wherein each photographic print is made on an emulsion sensitive only to light of substantially that colour of the screen of which the print is to be a separation record.

5. The method according to any one of the preceding claims wherein each photographic print is made with light of colour containing one of the colours of the screen but containing substantially no component of colour transmitted by any of the remaining colours of the screen.

6. The method according to any one of claims 1 to 3 wherein two or more of the photographic prints are simultaneously exposed in superposed position.

7. The method according to any one of claims 1 to 5, wherein the photographic prints are made on bromide paper.

8. The method according to any one of the preceding Claims wherein registration of the assembled prints is obtained by perforating or notching in similar manner the base on which each photographic or transferable print is made, preparing each print in similar position in relation to the notches or perforations on its base and assembling the prints with the notches or perforations engaged by correspondingly arranged projections.

9. A method of producing a print in natural colours to be viewed by light reflected from a non-transparent base substantially as described.

10. A print in natural colours on a non-transparent reflecting base when produced by the method according to any one of the preceding Claims.

Dated this 24th day of July, 1933.

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