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METHOD AND DEVICE FOR PRODUCING INTENSIFIED COLORS OR FOR INTENSIFYING THE PERCEPTION OF COLORS

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The normal human eye has three specially remarkable fundamental perceptions the perception maxima of which lie near the spectral wave lengths 450, 550 and 650 mu, that is in those portions of the spectrum which usually are designed as blue, green and red. Light of one of said wave lengths is perceived always essentially by only one of the three fundamental perceptions of the eye, whereas the interposed portions of the spectrum each are perceived by more than one fundamental perception. For example, a light acting with equal intensity on the red and green fundamental perception produces the impression of a yellow intermediate color, even if at all none wave length of the yellow spectral portion exists in it. Similarly blue and green appear as a bluish green in which however always the red fundamental perception is simultaneously affected and thereby a whitish appearance of the blue-green is produced.

In optical glasses it is known to use neodym (accompanied mostly by some praseodym) as a component which effects an intensified perception of some colors but is not able to eliminate a very troublesome blue-green. In the electric light production, combinations of mercury vapour light and neon or lithium light have been proposed with partial success, but quite a number of colors became remarkably changed and obscure also in this case.

The invention consists primarily in decisively improving the light production or aperception thereby that from the object to be aperceived to the eye of the spectator or to the light sensitive photographic layer, as far as possible only light corresponding essentially to the aperception maxima of the eye is admitted. This may be done by either illuminating the object only by light having the maxima spectrum, or by looking onto it by a filter absorbing from the object illuminated by all colors, all other colors than the maxima colors. This method has the success of producing such an exceptionally strong intensification of all color differences and such a high intensity or saturation of all colors that very much details become visible or photographable which otherwise could not at all be perceived, and in seeing moreover a physiologically very animating impression is gained by the bright-colored sight.

This effect is attained in all practical cases, as the daylight as well as the emission of the usual artificial lamps contain light of all spectral portions, although of different intensities, and as also the objects appearing to the eye as purely colored in reality have mixed colors almost throughout. The few exceptions showing really unicolored light, as for example natrium light illuminations, are so seldom that eye glasses or photographic-filters corresponding to the invention also at night time have in the by far most cases their full effect. If, on the other hand, also the illumination is effected by light of the new composition, the sight is intensified not only with respect to the color differences but also to the entire light intensity.

The light absorbing filters according to the invention can not only be used in the form of eye glasses, but they can be realized by materials serving as admixtures or as basis or as covering window for the objects, for example by a lacquer or other transparent cover absorbing the minimum light regions situated between the maxima, or in pictures a covering glass or a background supporting the coloring matter or a color admixture may produce the mentioned effect. Useful materials for these purposes are below described.

A special adaptation of the new method for photographical multicolor negative and positive processes consists therein, that for the exposition an illumination is used which contains rays corresponding to the aperception maxima of the eye, and for the copying process an illumination is used which contains rays corresponding to the absorption maxima of the single coloring materials forming the negative or the positive produced by a conversion process. In this case an extraordinary brilliant success is attained, as not only the colors of the negative become precisely complementary and very saturated, but also the spectroscopic and sensitivity deficiencies of the light sensitive layer are corrected and made innoxious, as the negative (or conversion positive) has the most effective absorption for the rays to be absorbed.

Some examples of processes and devices according to the invention are as follows:

An illuminating device is combined of several electric discharge tubes producing an entire spectrum having interruptions between the aperception maxima. If precisely adapted discharge gases are available no filters are necessary and best economy is realised. Three tubes each emitting one maximum may be used, or one tube of two may emit two maxima.

Thus the red light component may be emitted from zinc vapor, or from neon and freed from yellow emission by a neodym glass filter. Blue and green may be emitted from mercury vapor which also by a neodym glass filter is freed from yellow rays, and in case of necessity is freed from a troublesome blue-green emission. In this case it is also possible to use mercury only for blue and thallium for green, both discharge tubes being provided with filters absorbing the undesired rays.

Similarly incandescent lamps can be used. For example, three lamps are each provided with a filter excluding all other rays than those in near proximity to the desired aperception maximum. Blue maximum light is produced by aid of a filter of Schott glass BG 6 one mm thick or BG 12 two mm thick, red maximum light by Schott glass RG 5 two mm thick, and green by Schott glass OG 4 two mm thick combined with BG 18 two mm thick. All three lamps project their rays simultaneously onto the object, and their intensities are so regulated that the entire light appears white.

Instead of glass filters, liquid filters or solid solutions of coloring matters in gelatine or the like can be used. The organic dyestuffs give for this purpose an extraordinary ample choice, and in consequence of their (in some cases) very steep absorption curves the energy can be economically made use of.

Some light filters give the possibility of using the light of one lamp at once for two maxima. For example, acid rhodamine (rhodamine S, USA-Patents 402,436 and 425,504; Farbstofftabellen of Gustav Schultz, volume 1, Berlin 1932, Nr. 570) diluted in water or gelatine lets pass the red and blue rays at once. A second lamp or tube is then used for green maximum light.

Neodym glass (absorbing 580 mμ) and a filter containing the yellow coloring matter tartrazine (tartrazine, USA-Patent 324,630; Farbstofftabellen of Gustav Schultz, volume 1, Berlin 1932, Nr. 23) or a Schott glass OG 4 two mm thick (absorbing 500 mμ) allows to produce a light corresponding to the red and green maxima. If a second lamp is filtered to give blue light, for example by Schott glass BG 6 or BG 12, and the intensity of both lamps is brought into optical equilibrium, then also a light according to the invention is gained.

One single lighting body may produce all three maxima. Until now, a similar simplification is possible by aid of other light sources being near. For example, a mercury vapour tube is filtered so as to give the two maxima pure blue and pure green, and reddish light coming from usual road or house lamps aids to make an entire light of useful spectroscopic qualities, although in no way as good as with full use of the invention.

For aperceiving objects enlighted by daylight or other multicolor of omnicolor light, as for example from unfiltered incandescent lamps, all the above mentioned filters may be used as spectacles or the like, provided only that as far as possible only small regions of rays besides the three maxima are allowed to pass in essential quantities.

For producing the maxima colors immediately on the objects, the undesired rays about 580 mμ may be absorbed by neodym oxide (in molten glass), or neodymium nitrate or other neodym compounds soluble in water or in other usual solvents (for coverings of laquer type), for example also in gelatine, collodium or oil laquer. The undesired rays about 500 mμ may be absorbed by monobrom-fluorescein which in the group of the cosines has a specially low molecular weight. Similar other materials, as for example succinyl-fluorescein or the halides thereof may also be used, as well as other materials still to be searched by aid of spectroscopic tests.

A further example of a coloring or filtering substance for absorbing the two light minima near 490 mμ and 590 mμ is described as follows:

3 gr 6-Chlorbenzoxazol (Amer. Journal 1932, page 42, or Bulletin de la Société Chimique de France, IV, Vol. 133, page 1828) are heated to about 100° C together with 2 cm³ jodmethyl during 8 hours in a tube, then broken and washed with acetone and thereafter with water and recrystalled from absolute alcohol. The product is a 6-Chlorbenzoxazol-jodmethylate, and 2,5 gr of this product are dissolved in 20 cm³ dry pyridine and after addition of 3 cm³ ortho-formic-acid-ester heated for one hour. The crystals thereby produced are after cooling removed and recrystalled from alcohol. Thus a 5,5′ dichlor-oxacarbocyanine-jodmethylate is gained, which absorbs the light from 480 to 510 mμ and forms the first component of the entire coloring substance.

Further (according to British Patent 344,409, Imperial Chem. Ind. Ltd., London) 0,43 gr raw 2′-ω-acetanilido-vinyl-benzthiazol-jodethylate are cooked with 0,3 gr chinaldine-jodethylate and 2 cm³ dry pyridine during 25 minutes. Green crystals are therefrom produced by cooling and after separation recrystalled from alcohol. They are an 1,1′-diethyl-2-chinoline-2-thiazol-carbocyaninjodide, which absorbs the light from 580 to 600 mμ.

Both described substances are dissolved in acetone, the first at a grade of 0,25% and the second 0,02%, and about 50 gr of each solution are added to 400 gr acetyl cellulose (Kahlbaum) and 2400 gr acetone under slight heating. This product is then fused on a glass plate for serving as a light filter according to the invention. Its separate constituents and other coloring matter produced under similar views may also be used for coloring any objeets or photographic layers or for painting pictures.

Where a color basis is to be got from only two colors, for example a fabric having differently colored chain and stay filaments, one series of said filaments may be green so as to absorb the whole spectrum excepted 510 to 570 mμ, and the other series may be red so as to absorb the whole spectrum between 490 and 590 mμ.

For example the stays may be colored by rhodamine and the chains by patent blue mixed with tartrazine or any other coloring means reflecting only between 510 and 570 mμ.

In the use for making photographic multicolor pictures, the new method consists in illuminating the object by a light corresponding to the aperception maxima of the eye. The negative thus produced, is with special preciseness complementary to the colors of the object. If said negative consists, as usual, of three color layers representing red, green and blue respectively, or also if separate negatives each containing one of said layers are produced, the positive copying process is effected by a light containing mainly rays of that spectroscopic portions which correspond to the absorption maxima of the single colors of the three color negative. This may be effected by light mixed in the above mentioned way, or the different lights may be applied after each other.

In case a single color of a negative has an absorption spectrum which is very different from the sensitiveness spectrum of the appertaining (complementary) single color portions of the positive, it is often advantageous to make the positive by aid of light rays which do not precisely correspond to the absorption maximum of the negative color but to a relative maximum of absorption. This relative maximum of absorption is a combination of the absolute maximum of absorption and of a complementary maximum of sensitiveness in such way that with relation to the sensitiveness of the positive layer the best absorption in the negative layer is attained. This means that the light elements to be absorbed are specially completely absorbed, as the light rays used nearly correspond to the absorption maximum and at once to the sensitiveness minimum of the layer for the undesired color.

A practical example is as follows: a multicolor object is illuminated by a light mixed from mercury vapor and neon discharge and filtered by neodym glass, and photographed either on three single color negatives or on a combined three color negative of the Kodachrome or Agfacolor type, similar to that described for example in German patent 257,160. This negative may then be converted into a positive by usual exposing (without fixation), developing by a special developer whose oxides chemically produce the colors from the different constituents of the layers, and freed from silver. The positive thus gained has a special brilliance as all its portions specially well correspond to the aperception maxima of the human eye. This brilliance can still be augmented by illuminating this picture by a light corresponding to that used for the exposure.

On the other hand, the negative, instead of being converted into a positive, may be completed to a complementary color negative by being developed by the said special developer. This brilliant color negative, in contradistinction to the known negatives of the mentioned type, which are not able for positive reproduction, is very well adapted to be copied, as its colors are already purified and higher saturated. Now, a copying light is composed of that spectral portions which correspond to the absorption maxima of the single color elements of the negative, eventually with a deviation towards that color group which are the least sensitive for the complementary troublesome color of the positive color to be reproduced. In this way from the complementary negative, a positive is gained which by the double correction of the spectroscopic deficiencies of the coloring and sensitizing matters is free from the detrimental incorrectnesses arising without the use of the invention. Also this positive still gains when contemplated in light according to the invention.

In the same way it is also possible to copy a negative from a positive produced by conversion from a negative, or a positive by conversion of the first mentioned negative.

In all cases, objects being at rest can be photographed also by subsequent application of the single maximum lights instead of by the simultaneously applied mixed lights. The same is true for copying the positives.

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