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HIGH SPEED INFRARED FILM

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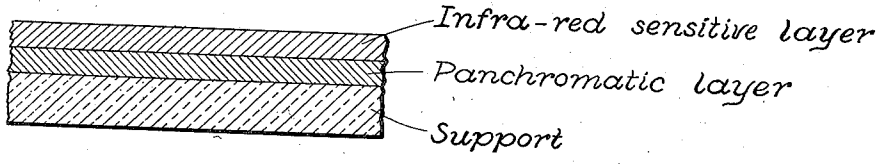

Walther Barth
Hermann H. Duerr
INVENTORS
BY Hutz and Joslin
THEIR ATTORNEYS

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HIGH SPEED INFRARED FILM

Walther Barth and Hermann H. Duerr, Binghamton, N. Y., assignors to Agfa Ansco Corporation, Binghamton, N. Y., a corporation of New York

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6 Claims. (Cl. 95—9)

The present invention relates to high speed infra-red sensitized photographic films which are particularly suitable for use in aerial photography and the like.

It is well known that pictures taken with infra-red sensitized photographic emulsions bring out details of the subject photographed rather vividly. As a matter of actual fact, in some cases it is even possible with such emulsions to photograph large areas which were not visible to the naked eye at the time of exposure. Because of this valuable property, infra-red sensitized emulsions have been recommended for use in situations where it is desirable to clearly bring out details in the pictures taken such as in aerial photography, in the taking of long distance shots and in the taking of pictures which are to appear as if they had been taken at night when actually exposure is made in bright daylight under clear skies.

The use of infra-red sensitive emulsions in these fields, however, has been to a large extent hampered by the fact that such emulsions have the disadvantageous property of being of a relatively low speed as their sensitivity is much less than that of ordinary emulsions of the panchromatic type. The difference in speed between these two types of emulsions is especially noticeable when red or yellow filters are used. Thus the art up to the present time has not been able to find an infra-red sensitizing dyestuff which is capable of imparting an intensity comparable to that obtainable with dyestuffs generally utilized for sensitizing emulsions for the orange and red part of the spectrum.

The purpose of the present invention is to overcome this speed deficiency of infra-red sensitized emulsions so as to take full advantage of the property of said emulsions to vividly reproduce details and thus render said emulsions excellently suitable for use in aerial photography and the like.

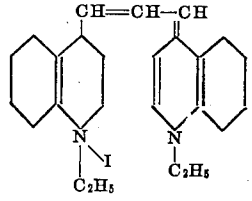
In general we effect this object by supplementing the sensitivity of the infra-red emulsion by an additional emulsion which is panchromatically sensitized. It would appear offhand that having once recognized that a panchromatic sensitized emulsion is capable of augmenting the sensitivity of an infra-red sensitized emulsion, it would be unnecessary to take any precaution with regard to the method of incorporating the sensitizing elements in the film. Thus it would appear possible to effect the desired result by sensitizing a single emulsion for both the red and infra-red portions of the spectrum. We have ascertained, however, that when using an emulsion sensitized by a mixture of panchromatic and infra-red sensitizing dyes, the sensitivity of the panchromatic sensitization is so much greater than the infra-red sensitization that the resulting image is predominantly that of the panchromatic emulsion and little or no effect is visible from the infra-red sensitization. In other words, the picture taken with such emulsions displays the characteristics of a panchromatic emulsion rather than those of an infra-red emulsion.

It would also seem that the desired result could be obtained by providing two separate emulsions sensitized panchromatically for infra-red and arranging the panchromatic sensitized emulsion over the infra-red sensitized emulsion. However, if the infra-red sensitized emulsion is the undercoating and the panchromatic sensitized emulsion the overcoating, the panchromatic sensitivity will predominate and cause the resulting picture to display the characteristics of a panchromatic emulsion, thus nullifying the property of the infra-red sensitized emulsion to bring out distinctly the details of the subject photographed.

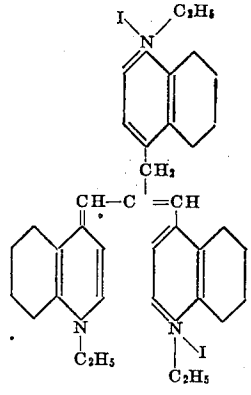
It has been discovered by us that the only way that the sensitivity of the infra-red emulsion can be augmented by a panchromatic sensitized emulsion while preserving the characteristics of the infra-red emulsion is by locating the infra-red sensitized emulsion over the panchromatic sensitized emulsion. It is possible by this method to depress the sensitivity of the panchromatic emulsion to such an extent that the resulting picture will partake predominantly of the characteristics of those produced from infra-red sensitized emulsions. The degree of sensitivity furnished by the panchromatic undercoating can be controlled by the sensitivity of this emulsion itself. Preferably, however, this is done by adjusting the thickness of the infra-red sensitive top layer. The greater the thickness of the top layer, the more depressed will be the sensitivity of the underlying panchromatic layer. The contrast of the panchromatic layer is diminished at the same time by the top coating. For best results we use an infra-red sensitized emulsion having a thickness varying from 6 to 16/μ. At such thicknesses the panchromatic emulsion will furnish just enough additional sensitivity to give the film a speed, when used with red filters, which is from 100 to 200% greater than that of the infra-red emulsion alone.

The film is made up according to the usual method of coating gelatino-silver-halide emulsions containing sensitizing dyes on a film base

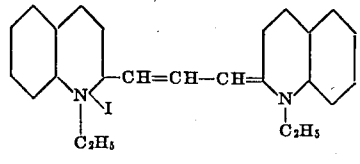
such as nitro- or acetyl cellulose. For sensitizing the infra-red emulsion, we may employ dyestuffs usual for this purpose such as bis-[1-ethyl-quinoline(4)]-trimethinecyanine iodide having the following structure



and sold under the trade name Rubrocyanin, bis-[1-ethyl-quinoline(4)] - β - (1'-ethyl-1'-iodo-quinoline-4'-methylene) - trimethinecyanine iodide having the following structure



and sold under the trade name Allocyanin or other infra- red sensitizing dyes. Similarly the dyestuffs ordinarily employed for sensitizing emulsions in the red portion of the spectrum such as bis-[1-ethyl-quinoline(2)]-trimethinecyanine iodide having the following structure



and sold under the trade name Pinacyanol or other sensitizing dyes for the red portion of the spectrum may be utilized for the panchromatic emulsion.

In forming the image, the panchromatic layer, because of its greater sensitivity, registers the darker parts of the subject, as well as the brighter parts. However, due to the very flat gradation caused by the top layer, acting in a sense as a light restraining layer, the image registered is relatively flat. The top layer, because of its very steep gradation, superimposes an image on the first layer, especially in the brighter parts of the subject, which is of high contrast but which does not destroy the darker parts of the image formed in the panchromatic layer. The result is a satisfactory image having the contrasty characteristics of the infra-red and at the same time still showing registration of the dark portions of the subject due to the greater sensitivity of the panchromatic layer.

In practice it has been found advantageous to make the panchromatic layer inherently flat in gradation in its red sensitized region by restricting the amount of panchromatic sensitizer. For example, the maximum sensitivity and maximum gradation of an emulsion sensitized with Pinacyanol may be obtained by using 15 to 20 mg. Pinacyanol per one liter of emulsion. By using, for instance, only 4 to 8 mg. of this sensitizing dye per one liter of emulsion, the gradation of the resulting emulsion in the red region is decidedly flatter.

The top infra-red layer further depresses the gradation of the panchromatic layer so that there is deliberately provided in the film a panchromatic layer of very flat gradation, that is, substantially below maximum gradation, which registers the total image in very flat gradation. Upon this image is then superimposed the contrasty image characteristic of the infra-red layer, the final image retaining the flat registration of the darker parts of the subject provided by the sensitive panchromatic layer.

Our invention will be further explained by reference to the following specific examples when taken with the accompanying self-explanatory drawing of a section through a film according to the present invention. It is to be understood, however, that our invention is not restricted to these specific examples but that the examples are submitted for illustrative purposes only.

Example 1

A film is constructed with a base of acetyl cellulose, a gelatino-silver halide emulsion panchromatically sensitized with Pinacyanol on said base and a gelatino-silver halide emulsion sensitized to infra-red by means of Rubrocyanin on said panchromatic emulsion. The infra-red sensitized layer is cast to a thickness of 10–12/μ. The quantity of dyestuff to gelatine in the panchromatic emulsion is about 60 mg. of dyestuff per kilogram of gelatine whereas in the outer emulsion the quantity of dyestuff to gelatine is about 10 mg. per kg. of gelatine.

Example 2

The film is constructed in the same way except that the outer emulsion is sensitized to infra-red by means of Allocyanin.

Films of this construction after exposure may be developed and printed in the usual manner. Due to the presence of the panchromatically sensitized layer, the films have a speed which fits them for use in fields such as aerial photography which require films of speeds as high as 1/75 of a second. Despite this high speed, the films nevertheless are possessed of the valuable haze-cutting characteristics so peculiar to infra-red sensitized films.

What we claim is:

1. A high speed infra-red film comprising a base, a colorless panchromatic sensitized emulsion on said base and a colorless infra-red sensitized emulsion on said panchromatic sensitized emulsion.

2. A high speed infra-red film comprising a base, a colorless panchromatic sensitized emulsion on said base and a colorless infra-red sensitized emulsion on said panchromatic sensitized emulsion, said infra-red emulsion having a thickness of from 6 to 16/μ.

3. A high speed infra-red film comprising a base, a colorless gelatino-silver halide emulsion on said base sensitized panchromatically with bis - [1-ethyl-quinoline(2)] - trimethinecyanine iodide and a colorless gelatino-silver halide emulsion on said first emulsion sensitized to infra-red with bis-[1-ethyl - quinoline(4)] - trimethinecyanine iodide.

4. A film as in claim 2 wherein the panchro-

matic emulsion is sensitized with bis-[1-ethyl-quinoline(2)]-trimethinecyanine iodide and the infra-red emulsion with bis-[1-ethyl-quinoline(4)]-trimethinecyanine iodide.

5. A high speed infra-red film comprising a base, a colorless panchromatic sensitized emulsion on said base which is inherently flat in gradation in its red sensitized region and a colorless infra-red sensitized emulsion on said panchromatic sensitized emulsion.

6. A film as defined in claim 5 wherein the panchromatic emulsion contains from 4 to 8 mg. of sensitizing dye per liter of gelatine.

WALTHER BARTH.
HERMANN H. DUERR.