

Jan. 26, 1937.

L. T. TROLAND

2,068,879

PHOTOGRAPHIC RELIEF PROCESS

Filed Sept. 9, 1933

2 Sheets-Sheet 1

Fig. 2

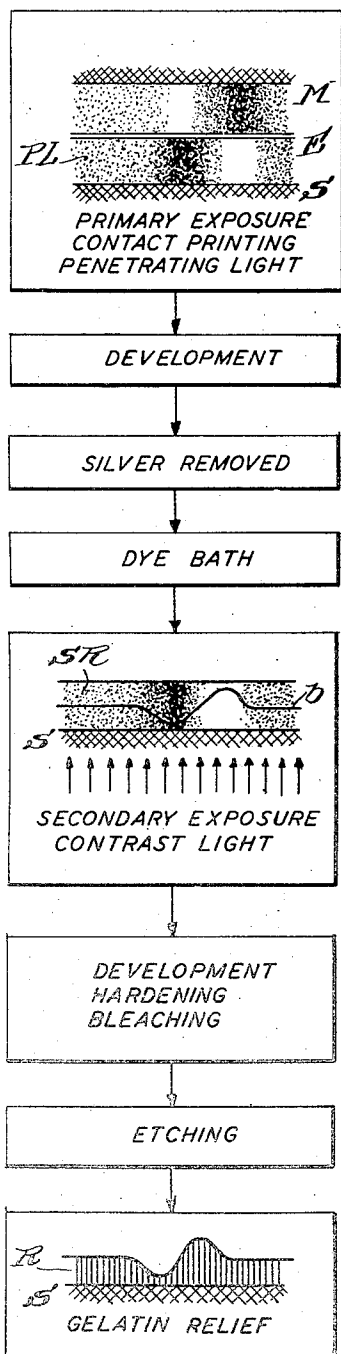
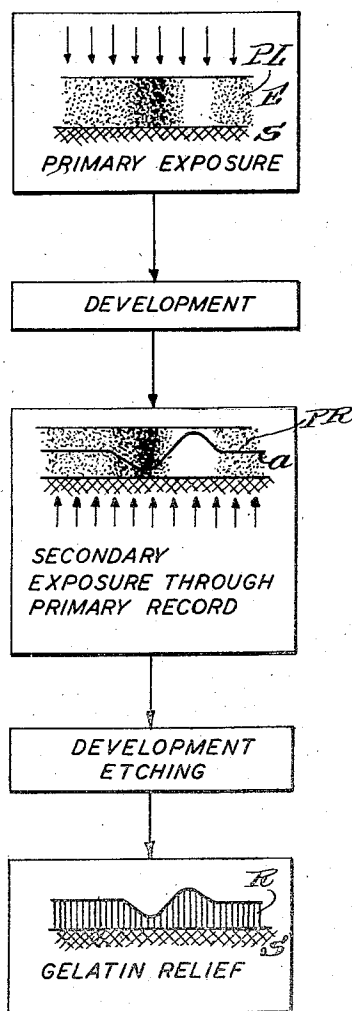


Fig. 1



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Cambridge Trust Company, Executor
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Fig. 3

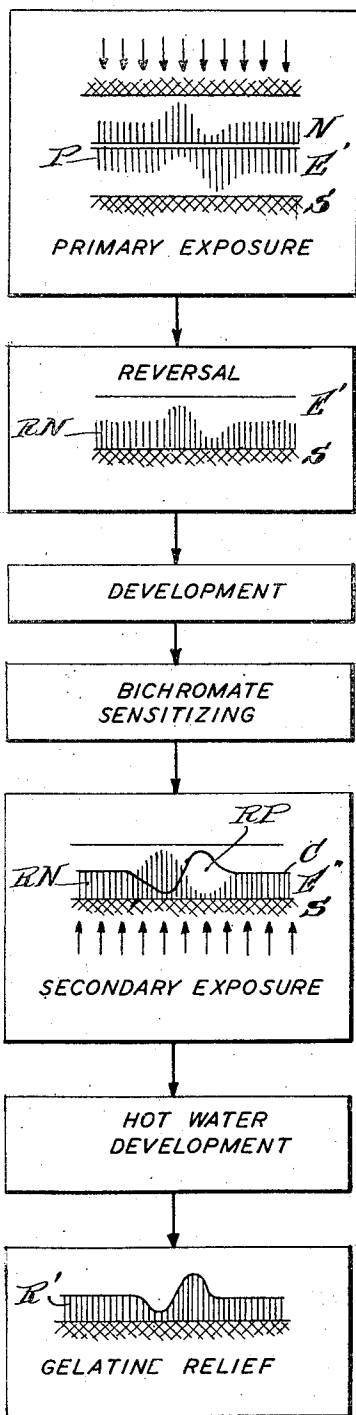
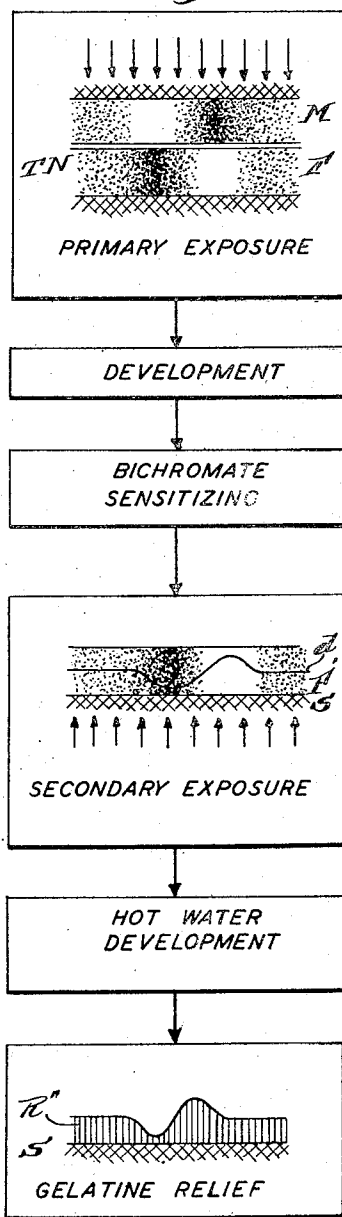


Fig. 4



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UNITED STATES PATENT OFFICE

2,068,879

PHOTOGRAPHIC RELIEF PROCESS

Leonard T. Troland, deceased, late of Cambridge, Mass., by Cambridge Trust Company, executor, Cambridge, Mass., assignor to Technicolor Motion Picture Corporation, Hollywood, Calif., a corporation of Maine

Application September 9, 1933, Serial No. 688,805

4 Claims. (Cl. 95—5.6)

The present invention relates to photography, and particularly to the making of gelatine reliefs which can be dyed, (the dye being taken up in conformity with the pattern of the relief representing a record) and used in that state, or for transferring the dye, and with it the record, to another gelatine layer, by means of the so-called imbibition printing.

Heretofore, such reliefs have, for example, been made by exposing through its support a silver haloid emulsion containing a light restraining dye, or a colloid layer made sensitive with a chromium compound. The exposed portion of the silver emulsion can be hardened in some manner, for example with a hardening developer, and/or in a hardening and bleaching bath, whereas a chromium emulsion is hardened by the exposure itself. In either case, the thickness of the exposed emulsion layer varies in accordance with the strength of the exposure light, and by removing the unexposed portion of the emulsion at the outer emulsion surface, a record bearing gelatine relief can be obtained. Among other disadvantages, these and similar methods require exposure through the support and therefore copying from the negative records with the aid of projection printers involving certain difficulties well known in the art. It has therefore been proposed to print upon a silver haloid emulsion from the front or entrant side, and to obtain a record near the support by means of the well known so-called reversal process which involves development of the exposed outer portions of the emulsion with a non-hardening developer, re-exposing the emulsion to uniform light, thereby exhausting the silver haloid contents thereof, developing and hardening these not yet developed but re-exposed portions of the gelatine and removing the outer, unhardened portion, so that the inner portion remains, constituting a relief which inversely corresponds to the record obtained with the first exposure.

In contradistinction to this known method, the relief process according to the present invention proposes in its main aspect not merely an auxiliary over-all exposure of undeveloped gelatine, but an auxiliary exposure of a sensitive emulsion through a record obtained with a primary exposure and contained in the emulsion itself.

It is one important feature of the invention that it permits, due to this peculiar procedure, a better control of the final record, since it provides two record controlled exposures by which the photographic characteristics of the final relief record can be controlled, and, if desired, changed

and corrected. Another object is to provide a process resulting in gelatine reliefs of especially fine grain due to an auxiliary exposure controlled by a record not containing the larger grains or particles of its silver emulsion.

In another aspect, the invention in one of its modifications permits, in addition to some or all of the herein named objects, the commercial utilization of chromate emulsions for relief making, which emulsions could heretofore not be employed to advantage due to their extremely low sensitivity to light, making it impracticable to use such emulsions for the printing of motion picture records by ordinary means.

In still another aspect, the invention permits the use of an emulsion not containing a light restraining dye for the initial record imparting exposures, and therefore a much quicker and therefore more economical printing.

These and other objects and advantages of the invention will be apparent from the following explanation of its general aspect as well as of several embodiments thereof illustrating its genus. The description refers to drawings in which:

Fig. 1 is a diagrammatic flow chart of the general aspect of the invention;

Fig. 2 is a similar chart of one embodiment of the invention; and

Figs. 3 and 4 are such charts illustrating another embodiment in two different modifications.

In its general aspect, the method according to the invention involves the following steps illustrated in Fig. 1. To a customary silver haloid emulsion E on support S is in some way imparted a latent record PL indicated in Fig. 1 by stippling to various densities and herein referred to as primary record. Although this record is indicated in Fig. 1 as uniformly penetrating the entire emulsion (presupposing a theoretically transparent emulsion made up of grains of varying sensitivity), it will be understood that in actual practice this latent record may be more or less concentrated towards one emulsion surface.

The latent primary record is then developed and the emulsion, which is maintained sensitive by utilizing its remaining sensitivity or by re-sensitizing, thereupon subjected to an auxiliary exposure through the support, the penetration of this second exposure being controlled by the primary record PR and reaching to depths indicated by line a. The second exposure is controlled, and restricted to the emulsion strata towards the support by using emulsions and exposure light of contrasting colors, in a manner well known in itself for obtaining concentrated

records. The emulsion is then again developed, the gelatine portion between the support and line α hardened, and the remaining outer and unhardened gelatine portion removed or "etched" off by known means, whereupon a gelatine relief R remains which is inverse of the primary record PR, that is, a positive if PR was a negative, or vice versa. The relief can now be further utilized in well known manner, as previously indicated. In actual practice, this procedure can be carried out in various ways, some of which will now be described in detail.

According to the embodiment outlined in Fig. 2, an undyed silver emulsion E is exposed by contact printing to a master positive M, this primary exposure providing a latent record PL. Preferably, the exposure is made with light that is not strongly absorbed by the emulsion, such as green or yellow light, herein also referred to as penetrating light in contradistinction to contrast light. The emulsion E is then developed with a non-hardening, for example, a metal developer, preferably to a high gamma. It will be evident that this procedure exposes and eliminates from further activity all larger and therefore high sensitive grains practically throughout the emulsion, and produces a record substantially extending through the entire depth of the emulsion and mainly made up by silver grains whose size varies according to the record pattern, the parts which received the highest exposure having the greatest number of exposure affected and developed grains.

The developed silver is then removed, as for example, with the following well known bleaching bath:

	cc.
Potassium bichromate.....	6
Sulphuric acid.....	4
Water	1000

This solution is then washed out, or neutralized with a suitable alkali. The film, always retained in the dark room, is then preferably dyed with a dye, as for example xylene yellow (Colour Index #639) which increases its absorption of actinic rays. The emulsion is then exposed, through the support, to uniform light preferably of contrasting color, as violet, the hues of light restraining dye and secondary exposure light being regulated to produce a secondary record SR of desired density and thickness. It is evident that the effect of the secondary exposure light, controlled, in the sense of being limited and determined, by the remaining record made up of unaffected silver haloid grains and by the restraining dye, will be an exposure of the grains substantially between the support and line b , the larger grains being already eliminated as pointed out above.

The film is now again developed, preferably to a high degree (in order to reduce all exposed grains between line b and support) and with a hardening developer (for example, according to Patent No. 1,535,700 to L. T. Troland, of April 25, 1925), fixed, washed, and bleached in one of the solutions well known for this purpose, for example:

	cc.
Potassium bichromate.....	6
Hydrochloric acid.....	10
Water	1000

Thereupon, the unhardened gelatine A intermediate line b and the outer emulsion surface is dissolved with water of approximately 140° F.,

and the film dried, the remaining relief R representing the gradations of the original negative from which master positive M was made.

It will now be apparent, that this process permits flexible control of the gamma at two points, namely during the exposure to the master positive, and by means of adjusting the light absorption during the secondary exposure. Further, as already pointed out, the secondary image has a fine grain structure due to the fact that the primary exposure eliminates the larger, more sensitive grains, leaving the smaller ones to form the relief image. Still further, it will now also be apparent that the photographic speed of the primary exposure of the undyed emulsion, in a printing machine, can be much greater, and the process therefore cheaper, than with the commonly used initially dyed emulsions, the duration of the secondary exposure being of course immaterial since it merely involves exposure to uniform light.

It will be further noted that this process is not appreciably affected by variations in emulsion thickness, since the altitude or maximum light of the final relief is primarily determined by the secondary, and not the primary exposure; providing that, as above described, the light of the primary exposure is not substantially absorbed within the emulsion.

However, it may sometimes be advantageous to permit a certain restricted amount of light absorption during the primary exposure with the effect that the primary record is more pronounced (especially over the regions receiving only a small amount of light) towards the entrant side of the emulsion, with the result that the gamma in the higher density regions of the finished relief becomes steeper, or in other words, the characteristic H and D curve more concave upwardly. This effect will be easily understood by considering that a certain light absorption during the making of record PL will leave the medium-to no-exposure parts somewhat recessed from the support, moving the corresponding parts of line b towards the entrant surface, and therefore causing the upper density or high relief parts of the final relief to be exaggerated in comparison to the lower density or shallow parts thereof.

Still further, it is evident that very thin emulsions of approximately the thickness of the highest parts of the finished relief can be used, resulting in an appreciable saving in emulsion material and a minimum of definition loss due to halation in the primary exposure.

The modification illustrated in Fig. 3 utilizes for purposes of the invention certain features of the well known so-called bichromate relief processes. In carrying out this embodiment, a positive record P may be made in emulsion E' from a negative N by contact printing, as shown in Fig. 3, where varying record densities are indicated by the varying thickness of the silver record, as, for example, obtained by using emulsions with strongly light restraining dyes. By any of the well known reversal methods, emulsion E' is then provided with a negative silver record RN, record RN being substantially the complement to positive record P. The same result could of course be obtained directly by printing this negative silver record through the support, if under the given circumstances the projecting printing thereby involved is less onerous than the reversal process.

The emulsion E' is then impregnated with a bichromate solution, for example, potassium bichromate, according to any one of the many well

known methods for making light sensitive bichromate emulsions. Preferably, the potassium bichromate bath is for the present purpose made rather more alkaline than normal, by adding some ammonia or other alkali. The emulsion E'' containing silver record RN, and rendered light sensitive throughout its thickness, is then exposed to uniform light through the support. The record RN controls this exposure, and where the bichromate gelatine is exposed to this light, it is rendered insoluble according to well known principles. Hence, the region RP between line C and the support is hardened by the uniform secondary exposure light controlled by record RN. The film is then treated with hot water in the usual manner, dissolving the unexposed and therefore unhardened gelatine portions between line C and the outer surface, the result being a gelatine relief R' representing a positive record. It should be especially noted that this procedure obviates the difficulty connected with all bichromate processes, namely the fact that bichromated gelatine is relatively slow in its exposure reaction to light, wherefore it has been heretofore impracticable to use it in motion picture printing of the usual type. With the new method, the secondary exposure can be made to any convenient light source without restrictions concerning registration and time such as are imposed by motion picture printing machines.

As already mentioned, the process introduces a new principle in the formation of a gelatine relief according to which the production of the relief depends primarily upon absorption of light by the picture image contained within the gelatine layer itself, rather than by a general absorption of light in the film layer. It follows, therefore, that the contrast of the gelatine relief image is directly determined by that of the silver image, although this contrast can be reduced in linear proportions, that is, undistorted, by increasing the concentration of the bichromate, using relatively short-wave printing light, and by other well known methods.

It will now be evident that, instead of using for the primary exposure dyed emulsions and contrast light, as assumed for the process according to Fig. 3, undyed emulsions and penetrating exposure light of substantially emulsion color can be used similar as described in connection with Fig. 2. In this case, the process has the form as illustrated in Fig. 4, which will now be understood without detailed explanation. In this figure, M is a master positive and F' an undyed emulsion receiving a primary exposure to penetrating light resulting in a primary latent record TN representing a negative.

Record TN is then developed, sensitized with bichromate, if desired dyed with a light restraining dye and resensitized emulsion F' subjected to the secondary exposure through the primary record. The secondary exposure being effective between support and line d, the result of development in water is a relief R, representing a positive corresponding to master positive M.

It will now be understood that the new process lends itself to many modifications making use of one or the other of the many techniques known in the photographic art for obtaining relief yielding records, the novel basic idea being always the relief formation through light absorption by the picture record, contained within the emulsion itself in effect near the emulsion side from which the secondary exposure light enters,

rather than by a general absorption of light in the film layer. With this procedure, the contrast of the gelatine relief is directly determined by that of the primary image, and not inversely as in the case of the customary reversal processes where the primary record is substantially near the emulsion side opposite to the surface whence the secondary exposure light enters.

It will also be evident to those skilled in the art that the herein described embodiments of the invention are not restricted to exposures either penetrating essentially the entire emulsion or to exposures substantially limited to the surface regions of the emulsion, but that the exposures may, and practically always will have both characteristics mixed, since these extreme types are more or less theoretical and can not be perfectly obtained in actual practice. However, the exposures will have the one, or the other character to a smaller or larger degree, which may be controlled depending upon the prevailing circumstances and the desired character of the final relief record.

It should be understood that the present disclosure is for the purpose of illustration only, and that this invention includes all modifications and equivalents which fall within the scope of the appended claims.

What is claimed is:

1. The method of photographically producing gelatine reliefs which comprises the exposure of a silver haloid emulsion with light to which said emulsion is sensitive but which is only slightly absorbed therein, developing said emulsion, thereby providing a primary silver record including substantially all larger grains of said emulsion throughout its entire thickness, maintaining the emulsion sensitive substantially throughout its entire thickness, exposing the emulsion through its support under photographic exposure control by said primary record, with light colored to be easily absorbed by said emulsion, thereby providing a secondary record concentrated near said support whereby the rate of contrast of the primary and secondary records is controlled by means of the primary exposure and of the adjustment of the light absorption during the secondary exposure, hardening the gelatine co-extensive with said secondary record and substantially removing the unhardened gelatine, thereby providing a comparatively smooth gelatine relief.

2. The method of photographically producing gelatine reliefs which comprises the exposure of a silver haloid emulsion with light to which said emulsion is sensitive but which is only slightly absorbed therein, developing said emulsion thereby providing a primary silver record including substantially all larger grains of said emulsion throughout its entire thickness, maintaining the emulsion sensitive substantially throughout its entire thickness, rendering the emulsion absorptive of a light range to which it is sensitive, exposing the emulsion through the emulsion support under photographic exposure control by said primary record, with light of said range, thereby providing a secondary record concentrated near said support whereby the rate of contrast of the primary and secondary records is controlled by means of the primary exposure and of the adjustment of the light absorption during the secondary exposure, hardening the gelatine co-extensive with said secondary record and substantially removing the unhardened gelatine,

thereby providing a comparatively smooth gelatine relief.

3. The method of photographically producing gelatine reliefs which comprises the exposure of
5 a silver haloid emulsion with light to which said emulsion is sensitive but which is only slightly absorbed therein, developing said emulsion in a nonhardening developer to a comparatively
10 high rate of contrast thereby providing a silver record including substantially all larger grains of said emulsion throughout its entire thickness, bleaching the developed emulsion and dyeing it with dye which absorbs light to which the emul-
15 sion is sensitive, exposing the said emulsion through its support to light strongly absorbed by said dye, developing said emulsion in a hardening developer, bleaching said emulsion, and removing the unhardened gelatine.
4. The method of photographically producing
20 gelatine reliefs which comprises the exposure of a silver haloid emulsion with light which is only slightly absorbed by said emulsion, developing

said emulsion thereby providing a primary silver record including substantially all larger grains of said emulsion throughout its entire thickness, sensitizing the emulsion with bichromate, exposing the emulsion substance through its support
5 under photographic exposure control by said primary record, with light colored to be easily absorbed by said emulsion, thereby providing a secondary record concentrated near said support
10 whereby the rate of contrast of the primary and secondary records is controlled by means of the primary exposure and of the adjustment of the light absorption during the secondary exposure, and substantially removing the gelatine not
15 hardened by the exposure of the bichromate sensitized gelatine, thereby providing a comparatively smooth gelatine relief.

CAMBRIDGE TRUST COMPANY,
Executor of the Last Will and Testament of
Leonard T. Troland, Deceased,
By S. MEAD WHEELER,
Its Asst. Secy. 20