Aug. 20, 1968 E. STONE 3,397,980

PROTECTIVE LAMINATE FOR FILM CONTAINING SILVER MICRO-IMAGE

Filed June 1, 1964 2 Sheets-Sheet 1

FIG.1

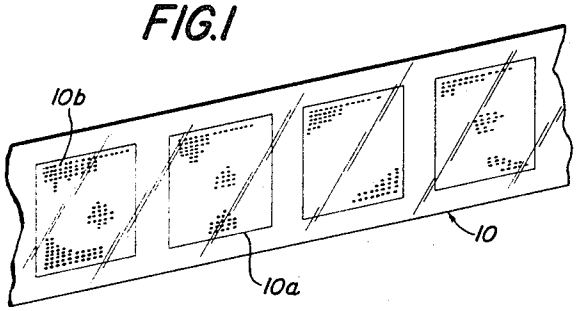


FIG.2

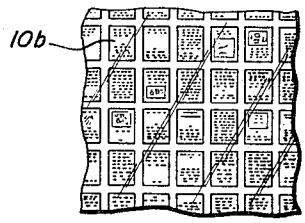


FIG.3

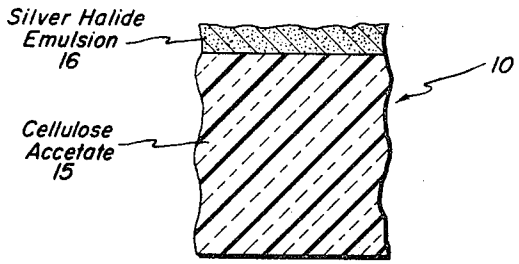
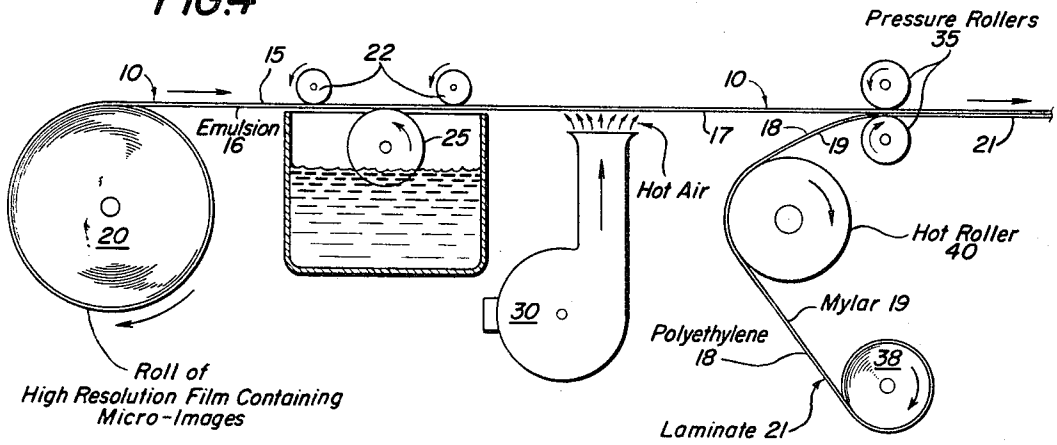


FIG.4



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PROTECTIVE LAMINATE FOR FILM CONTAINING SILVER MICRO-IMAGE

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FIG.5

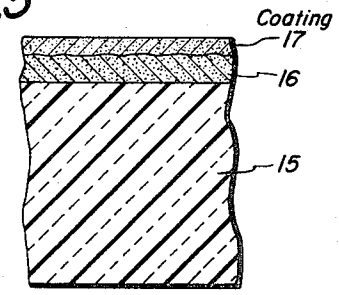


FIG.6

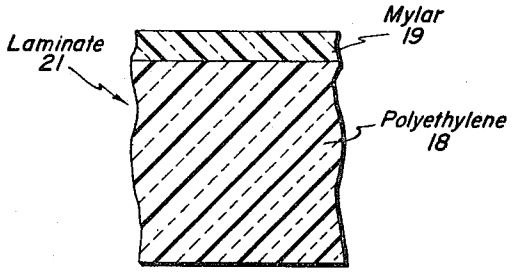


FIG.7

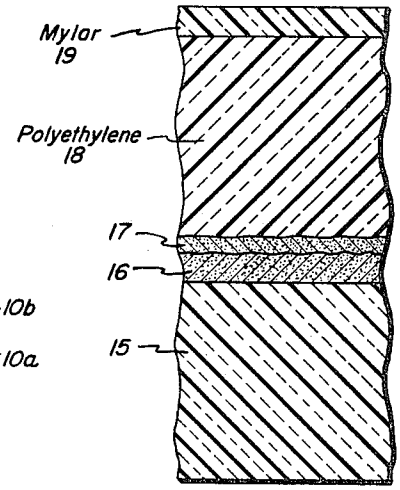


FIG.9

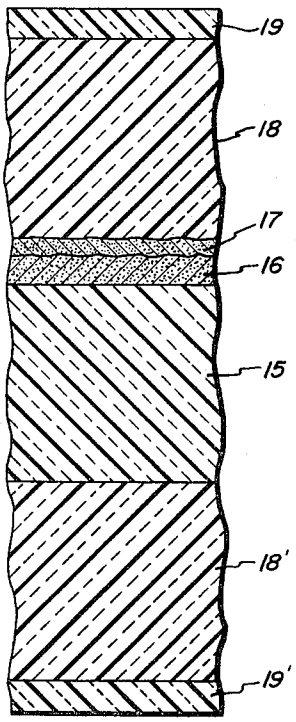


FIG.10

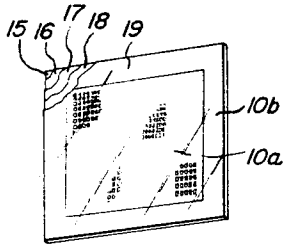
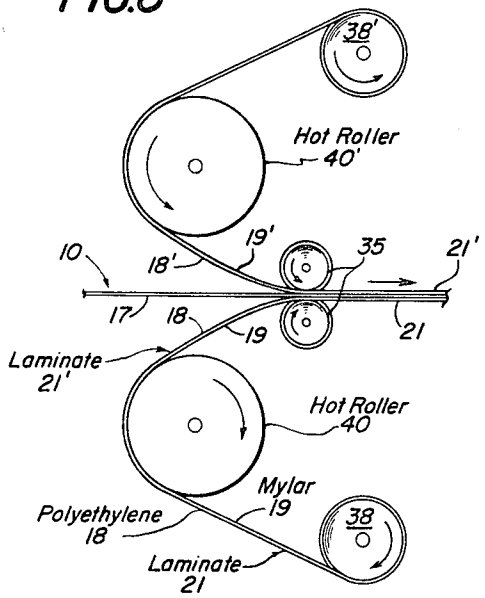


FIG.8



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3,397,980

PROTECTIVE LAMINATE FOR FILM CONTAINING SILVER MICRO-IMAGE

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Filed June 1, 1964, Ser. No. 371,302
14 Claims. (Cl. 96—50)

ABSTRACT OF THE DISCLOSURE

A photographic film having micro-images formed thereon is provided with a protective transparent laminate overlay. The laminate is comprised of a durable outer layer and an inner layer of polyethylene. The laminate is bonded to the emulsion coating of the photographic film with an intermediate layer of a polyvinyl acetate binder that intimately bonds to both the emulsion and the polyethylene. The protective overlay protects film from harmful scratches and the like and also inhibits duplication of the micro-images formed on the emulsion by the process of contact printing. The polyvinyl acetate binder prevents separation of the protective layer from the photographic film without ruining the micro-image.

This invention relates generally to means and methods for controlling and protecting micro-images. More particularly, this invention relates to means and methods for protecting a film containing a plurality of high resolution micro-images, and for preventing its duplication, while at the same time maintaining the optical fidelity of the film for retrieval of the micro-images contained thereon.

In recent years micro-image technology has taken on new importance and more and more attention is being given to the employment of micro-image techniques in a wide variety of fields, particularly those fields where great masses of data must be stored, retrieved and disseminated. While a number of systems have been developed which are capable of providing and utilizing micro-images of 25:1 to 60:1 reduction ratios, it has been found extremely difficult to obtain a practical system for providing and utilizing micro-images at greater than 100:1 reduction ratios. A major breakthrough in providing such extremely high reduction ratio micro-images has recently been achieved, and is disclosed and claimed in the commonly assigned copending patent application Ser. No. 111,759, filed May 22, 1961, now U.S. Patent No. 3,185,026. This breakthrough is also disclosed in the publication "Photochromic Micro-Images: A Key to Practical Microdocument Storage and Dissemination," by A. S. Tauber and W. C. Myers, Advances in Microfilm Technology (Proceedings of the National Microfilm Association Eleventh Annual Meeting, April 1962), Ed. by Vernon Tate, pp. 256–269, Washington, D.C., Sparton Books (October 1962), also reprinted in American Documentation, vol. 13, No. 4, pp. 403–409 (October 1962).

Typically, the above-mentioned breakthrough achieves reduction ratios of the order of 200:1 by employing an intermediate step between the individual documents and the exposure of the final photographic film, whereby the documents to be recorded are first reduced to conventional microfilm, and micro-images of each are then formed, one at a time, and at a greater than 200:1 reduction ratio at selected positions on a high resolution reversible photochromic film which does not require the formation of a latent image. After inspection indicates that all the micro-images are properly formed on the photochromic film (improperly formed images being corrected if necessary), they are then transferred in bulk

by contact printing to conventional photographic film. The above-described technique may be contrasted with the prior art step-and-repeat technique where the micro-images are recorded, one at a time, directly on conventional photographic film. In such a case, no inspection or correction is possible, and any errors discovered after development of the latent images (which errors can occur with fairly high probability when inspection is not possible) necessitate repetition of the whole recording procedure.

Once having achieved the high resolution 200:1 reduction micro-images made possible by the photochromic system disclosed in the aforementioned copending patent application and article, it then becomes important to provide suitable protection for them after transference to photographic film so as to permit the film to be handled and used in a normal manner without degradating the optical fidelity of the micro-images thereon. It will be appreciated that micro-images of greater than 100:1 reduction ratios are in very much greater need of protection than, for example, commercially available microfilm having a reduction ratio of only 25:1, since a scratch or spot which would obliterate just a few letters on microfilm, could obliterate a whole page of a 200:1 reduction ratio micro-image.

Besides the problem of protecting a micro-image film from scratching and/or other damage, it is also highly desirable from the copyright viewpoint, as well as from the viewpoint of the supplier, that this micro-image film is incapable of economical duplication. Again, any such means provided for this purpose must maintain the optical fidelity of the micro-images for retrieval purposes.

Accordingly, it is the broad object of the present invention to provide means and methods for treating a film containing high resolution micro-images of high reduction ratio (such as is producible in accordance with the aforementioned copending patent application Ser. No. 111,759 filed May 22, 1961) so that the resulting article will not only be protected from ordinary use and handling, but also will not permit economic duplication, both being accomplished in a simple and economical manner while maintaining the optical fidelity of the micro-images for retrieval of the information contained therein.

The specific nature of the present invention as well as other objects, advantages, and features thereof will become apparent from the following description and the accompanying drawings in which:

FIG. 1 is a fragmentary view of a high resolution photographic film containing micro-images which is to be operated on in accordance with the invention;

FIG. 2 is a greatly enlarged fragmentary view of a typical group of micro-images formed on the photographic film of FIG. 1;

FIG. 3 is a greatly enlarged cross-sectional view of the photographic film of FIGS. 1 and 2;

FIG. 4 is a schematic diagram illustrating apparatus for operating on the film of FIGS. 1–3 in accordance with the invention;

FIG. 5 is a cross-sectional view showing the film at an initial stage in the operations performed thereon by the apparatus of FIG. 4;

FIG. 6 is a cross-sectional view of a typical laminate which may be employed with the apparatus of FIG. 4;

FIG. 7 is a cross-sectional view of the resulting article produced by the apparatus of FIG. 4;

FIG. 8 illustrates a modification of the apparatus of FIG. 4;

FIG. 9 is a cross-sectional view of the resulting article produced by the apparatus of FIG. 8; and

FIG. 10 is a pictorial view, partially cut away, of a typical completed article using the apparatus of FIG. 4.

Like numerals designate like elements throughout the figures of the drawings.

Referring first to FIG. 1, illustrated therein is a typical portion of a strip of flexible photographic film **10** containing a plurality of blocks of micro-images, a typical block being illustrated at **10***a*. Each block comprises a large plurality of high resolution micro-images, a single micro-image being illustrated at **10***b*. FIG. 2 is a greatly enlarged fragmentary view of a group of micro-images in a typical block. It will be understood that the film **10** containing blocks **10***a* of high resolution micro-images **10***b* may be provided as disclosed in the aforementioned copending patent application Ser. No. 111,759, filed May 22, 1961. Also, a preferred manner in which the film **10** may be contact printed from masters derived from photochromic film is disclosed in copending patent application for Contact Printer, Ser. No. 370,314, filed May 26, 1964, in the names of Carl O. Carlson, Benjamin F. Scherr and Ivan V. Rondas, now U.S. Patent No. 3,316,825.

FIG. 3 illustrates a greatly enlarged cross-section of the high resolution micro-image film **10** of FIGS. 1 and 2. Typically, the high resolution film **10** comprises a flexible cellulose acetate base **15** suitably coated with a silver halide emulsion **16**.

Referring now to FIG. 4, the micro-image film **10** illustrated in FIGS. 1–3 is carefully wound up on a roller **20** under "clean room" conditions. The roller **20** is caused to rotate in the direction indicated so as to permit the film **10** to be unwound therefrom with the emulsion side **16** down at a rate, for example, of 5 feet per minute. The film **10** advances from the roller **20** past two guide rollers **22** which cooperate with a highly polished reverse roll applicator **25** to cause a thin transparent coating **17** of the order of 0.1 mil to be uniformly applied over the emulsion **16**, as illustrated in FIG. 5, so as to form an intimate bond therewith. The highly polished nature of the reverse roll applicator **25** permits the thin coating **17** to be applied to the emulsion **16** in a highly uniform manner so as not to detract from the optical fidelity of the micro-images. Preferably the coating **17** is of the order of 0.1 mil, but in any case should not be greater than 1 mil.

After the coating **17** is applied, it advances past a hot air blower **30** which dries the coating **17** prior to the film **10** being fed to the pressure rollers **35** for the final operation. It is here that a laminate **21** is applied over the thin coating **17**. The laminate **21** is illustrated in FIG. 6 and may typically be a polyethylene-coated Type D Mylar polyester film in which the Mylar **19** has a thickness of the order of 1 mil and the polyethylene **18** has a thickness of the order of 4 mils, the width across the laminate **21** being approximately the same as that of the film **10**.

As shown in FIG. 4, the laminate **21** is wound up on a roller **38** which is rotated at a speed which causes the laminate **21** to be unwound from the roller **38** at the same speed of advancement as the film **10** from the roller **20**. As also shown in FIG. 4, the laminate **21** is passed over a rotating hot roller **40**, Mylar side down, before being fed to the pressure rollers **35**. The hot roller **40** may be of conventional construction and may typically be at a temperature of 280° Fahrenheit so as to cause the polycthylene **18** to soften to the point where it is tacky and moldable, but not so soft as to run. At the pressure rollers **35**, the softened polyethylene **18** is forced against the coating **17** so as to mold into the surface of the coating **17** and form an intimate bonding contact therewith.

At this point in the description, it is important to note that the thin coating **17** is not provided for protective purposes. It is the laminate **21** which is provided for protection. Rather, the coating **17** serves two other important, although unexpected, purposes in the completed article.

First, because the coating **17** has been caused to be in intimate bonding contact with both the emulsion **16** and the polyethylene layer **18** of the laminate **21**, air spaces or bubbles which could interfere with the optical fidelity of the micro-images are substantially eliminated. Second, the intimate bonding contact which the coating **17** makes with both the emulsion **16** and the polyethylene layer **18** of the laminate **21** serves to prevent economical duplication of the completed article.

Prevention of economical duplication is achieved because, as a practical matter, the only economical way to duplicate the finished article would be by contact printing. However, to obtain usable contact prints of micro-images, it is necessary to obtain extremely close contact between the original and the new film to be exposed. Such extremely close contact cannot be obtained because of the presence of the laminate **21**. If one should attempt to remove the laminate **21** from the completed article, the coating **17** which is in intimate contact with both the emulsion **16** as well as the polyethylene layer **18** of the laminate **21** will not separate cleanly, and will cause portions of the emulsion **16** to be pulled off from the base **15** of the film **10**, thereby ruining the micro-images.

The purpose of the coating **17** should thus now be clearly evident. By providing such a bonding coating **17** which would not otherwise be required if only the laminate **21** was to be applied (since the softened thermoplastic layer **18** of the lamination would adequately stick to the emulsion **16** by itself), the invention achieves not only micro-image protection and the substantial elimination of air bubbles, but also achieves the additional important feature of preventing economical duplication of the resulting article.

A suitable material for the coating **17** is one available from Dow Chemical Company having a polyvinyl acetate base and designated "X–1272–G PHOTO COAT." It is to be understood that other materials may also be used for coating **17**. The important properties are that the coating **17** be able to form an intimate bond with both the emulsion **16** and the adjacent layer **18** of the laminate **21**, and that the coating **17** have suitable optical properties such that it will permit the satisfactory retrieval of the micro-images.

It is to be understood that other materials may be used for the laminate **21** besides the type D Mylar polyester film previously mentioned herein. The laminate chosen should have properties such that the layer to be pressed against the coating **17** be able to make intimate bonding contact therewith while providing suitable optical properties so as not to interfere with the retrieval of micro-images. A clear transparent thermoplastic having a softening point below about 300° Fahrenheit would be suitable for this layer of the laminate. The other layer of the laminate which forms the outer surface should be of a clear transparent durable scratch-resistant material from which dirt and fingerprints can easily be wiped.

From the viewpoint of the retrieval of micro-images (such as may be accomplished using the viewer disclosed in the commonly assigned copending patent application Ser. No. 329,743 filed Dec. 11, 1963), now U.S. Patent No. 3,267,801, it is important that the laminate **21** provides a spacing between the emulsion **16** and the outer surface of the laminate which is greater than the depth of field at the reduction ratio employed. This requirement is important so that, when a micro-image is brought into focus, any scratches or defects on the laminate outer surface will be out of focus and thereby have a much less detrimental effect on the ability to read the micro-image. At a reduction ratio of 200:1, a spacing of not less than 4 mils between the emulsion and the laminate outer surface is preferred, but in any case, the spacing should be not less than 2 mils. At a 100:1 reduction ratio, a spacing of 8 mils is preferred, with 4 mils as a minimum.

It will be appreciated that an additional laminate may be applied, if desired, on the side of the micro-image film **10** opposite from the emulsion **16**, that is, on the cellulose acetate side **15** of the film **10**. This may be accomplished, as illustrated in FIG. 8, by providing an

additional roller 38' (similar to roller 38 in FIG. 4) on which is wound a laminate 21' having a polyethylene layer 18' and a Mylar layer 19' (similar to layers 18 and 19 of laminate 21). This additional laminate 21' is fed to pressure rollers 35 via a hot roller 40' (similar to hot roller 40 in FIG. 4), whereby laminate will be provided on both sides of the film 10 as illustrated in FIG. 9.

It is also to be understood that, as another variation, the width across each of the laminates 21 and 21' in FIG. 9 may be chosen larger than the width across the film 10, so that, after traversing the pressure rollers 35, the film 10 will have laminates on both sides and the overlapping portions of the laminates 21 and 21' will adhere to one another so as to completely enclose the film 10 therebetween. Also, whether the resultant film has laminate on one or both sides, it may be cut to form convenient size individual films, such as illustrated in FIG. 10, each of which may contain, for example, one of the blocks 10*a* in FIG. 1.

While the foregoing disclosure has primarily been concerned with particular exemplary embodiments, it will be understood that various modifications and variations are possible within the scope of the invention as defined in the appended claims.

What is claimed is:

1. An article of manufacture comprising: a film having a polymeric base and a gelatin emulsion on which is formed at least one high resolution silver micro-image, a transparent polyethylene layer coated on a durable transparent film disposed adjacent said emulsion, and a transparent coating having a polyvinyl acetate base disposed between said layer and said emulsion so as to make intimate bonding contact with both, said coating cooperating with said emulsion and said layer so that separation thereof will cause portions of said emulsion to be pulled off from the base of said film, ruining said image.

2. An article of manufacture comprising: a high resolution film having a polymeric base and a gelatin emulsion coating on which silver micro-images are formed, a transparent polyethylene layer film is comprised of polyethylene-terephthalate and said layer is disposed adjacent said emulsion to prevent satisfactory contact printing of said micro-images through said layer, and a thin transparent uniform coating having a polyvinyl acetate base disposed between said emulsion and said layer and making intimate bonding contact with both, said coating cooperating with said emulsion and said layer so that separation of the two will cause significant portions of said emulsion to be pulled off.

3. The invention in accordance with claim 2 wherein said film is comprised of polyethylene-terephthalate and said layer is comprised of a clear transparent polyethylene which softens at a temperature below 300° Fahrenheit.

4. An article of manufacture comprising: a high resolution film having a polymeric base and a gelatin emulsion on which silver micro-images are formed, a thin uniform transparent coating having a polyvinyl acetate base disposed over said emulsion so as to make intimate bonding contact therewith, and a transparent protective laminate of polyethylene coated on a durable transparent film disposed over said coating and also making intimate contact therewith to prevent satisfactory contact printing of said micro-images therethrough, said coating cooperating with said emulsion and said laminate so that when said laminate and said film are separated portions of said emulsion are pulled off, ruining at least one of said micro-images.

5. An article of manfacture comprising: a high resolution film having a polymeric base and a gelatin emulsion on which are formed a large plurality of silver micro-images, a transparent polyethylene layer coated on a durable transparent film disposed adjacent said emulsion to prevent satisfactory contact printing of said micro-images therethrough, and a thin transparent uniform coating having a polyvinyl acetate base not greater than 1 mil disposed between said emulsion and said layer so as to make intimate bonding contact with both, said coating cooperating with said emulsion and said layer so that when said layer and said film are separated significant portions of said emulsion are pulled off, ruining a plurality of said micro-images.

6. An article of manufacture comprising: a high resolution photographic film having a polymeric base and a silver halide emulsion on which are formed a large plurality of micro-images, a transparent protective laminate disposed adjacent said emulsion to prevent satisfactory contact printing of said micro-images therethrough, said laminate comprising an outer layer of polyethylene terephthalate and an inner layer of polyethylene, and a thin transparent uniform coating having a polyvinyl acetate base and a thickness not greater than 1 mil disposed between said emulsion and said inner layer of polyethylene so as to make intimate bonding contact with both, said coating cooperating with said emulsion and said protective inner layer so that when said laminate and said film are separated significant portions of said emulsion are pulled off, ruining a plurality of said micro-images.

7. The invention in accordance with claim 6, wherein said micro-images are of the order of 200:1 reduction ratio, and wherein said laminate has a thickness of at least 2 mils.

8. The invention in accordance with claim 6, wherein said micro-images are of the order of 100:1 reduction ratio, and wherein said laminate has a thickness of at least 4 mils.

9. An article of manufacture comprising: a photographic film having a polymeric base and a gelatin emulsion on which silver micro-images are formed, a first transparent polyethylene layer coated on a durable transparent film disposed adjacent said emulsion and a second transparent polyethylene layer coated on a durable transparent film disposed adjacent said base, said transparent layers preventing satisfactory contact printing of said micro-images therethrough, and a thin transparent coating having a polyvinyl acetate base disposed between said emulsion and said first transparent layer so as to make intimate bonding contact with both, said coating cooperating with said emulsion and said first layer so that separation of the two will cause significant portions of said emulsion to be pulled off.

10. The invention in accordance with claim 9, wherein said layers are wider than said film and have their overlapping portions adhered to one another.

11. A method of protecting and preventing contact printing of a film having a polymeric base and a gelatin emulsion on which at least one high resolution silver micro-image is formed, said method comprising: coating said emulsion with a uniform thin transparent coating of a polyvinyl acetate base material which makes intimate bonding contact with said emulsion, and then applying under pressure over said coating a protective transparent laminate having a durable film outer layer and a softened polyethylene inner layer so as to also make intimate bonding contact therewith, said coating being chosen so that significant portions of said emulsion will be pulled off from the base of said film when said film and said laminate are separated.

12. A method of protecting and preventing contact printing of a film having a polymeric base and a gelatin emulsion on which is formed a large plurality of high resolution silver micro-images, said method comprising: coating said emulsion with a uniform thin transparent coating of a polyvinyl acetate base material which makes intimate contact therewith, said coating having a thickness not greater than 1 mil, and then applying under pressure over said coating a protective transparent laminate having a durable film outer layer and a softened polyethylene inner layer so as to also make intimate bond-

ing contact therewith, said coating being chosen so that significant portions of said emulsion will be pulled off from the base of said film when said film and said laminate are separated, said laminate preventing satisfactory contact printing of said micro-images therethrough.

13. A method of protecting and preventing contact printing of a film having a polymeric base and a gelatin emulsion on which a large plurality of silver micro-images are formed, said method comprising: coating the emulsion of said film with a uniform thin transparent coating of a polyvinyl acetate base material which makes intimate bonding contact with the emulsion, drying said coating, and then applying over said coating under rolling pressure a transparent protective laminate having a durable outer layer of polyethylene terephthalate and a heat-softened polyethylene inner layer so as to cause said heat-softened polyethylene inner layer to make intimate bonding contact with the previously applied dried coating, said laminate preventing satisfactory contact printing of said micro-images therethrough.

14. The invention in accordance with claim 13, wherein said coating of a polyvinyl acetate base material has a thickness not greater than 1 mil.

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C. E. DAVIS, *Assistant Examiner.*

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,397,980 August 20, 1968

Eliot Stone

It is certified that error appears in the above identified patent and that said Letters Patent are hereby corrected as shown below:

Column 5, line 40, after "layer" insert -- coated on a durable transparent --; same line 40, cancel "is comprised of"; line 41, cancel "polyethylene-terephthalate and said layer is".

Signed and sealed this 3rd day of February 1970.

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents