Feb. 22, 1966 W. LIMBERGER 3,236,650

METHOD FOR DEVELOPING FILMS

Filed April 14, 1965 3 Sheets-Sheet 1

FIG. 1

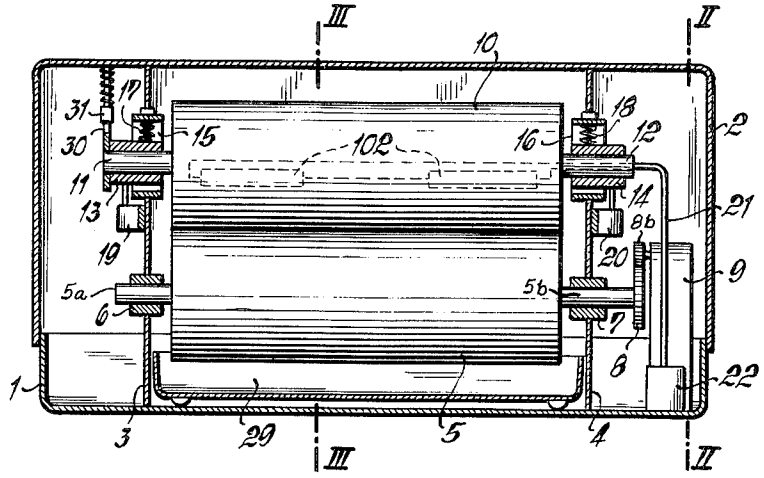


FIG. 2

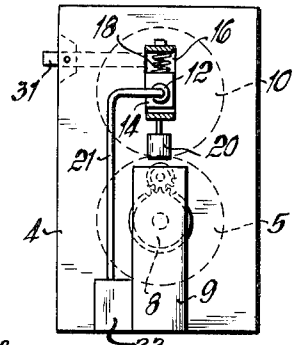
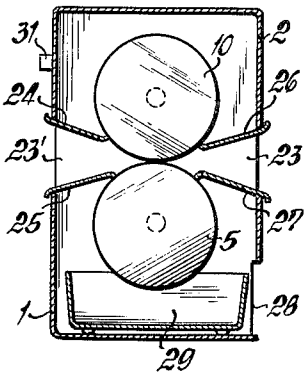


FIG. 3



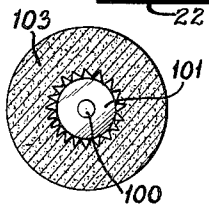


FIG. 4

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METHOD FOR DEVELOPING FILMS

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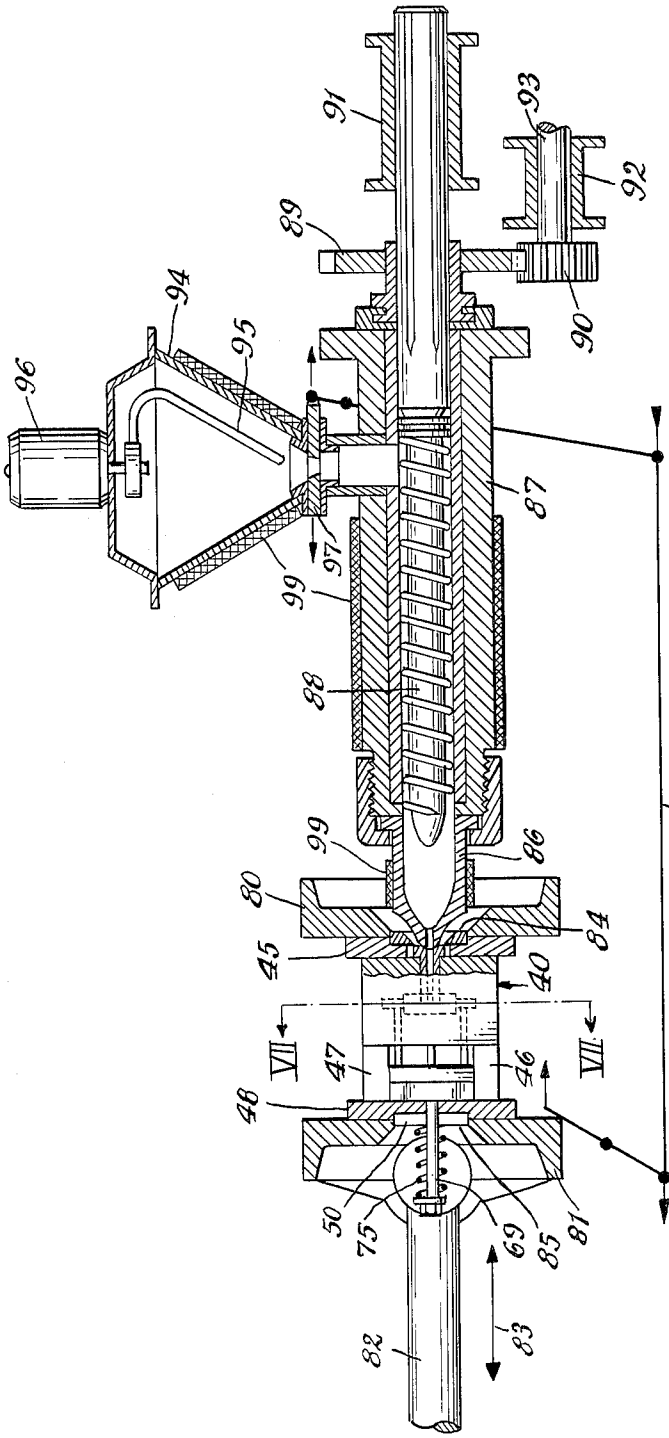


Fig. 5

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METHOD FOR DEVELOPING FILMS

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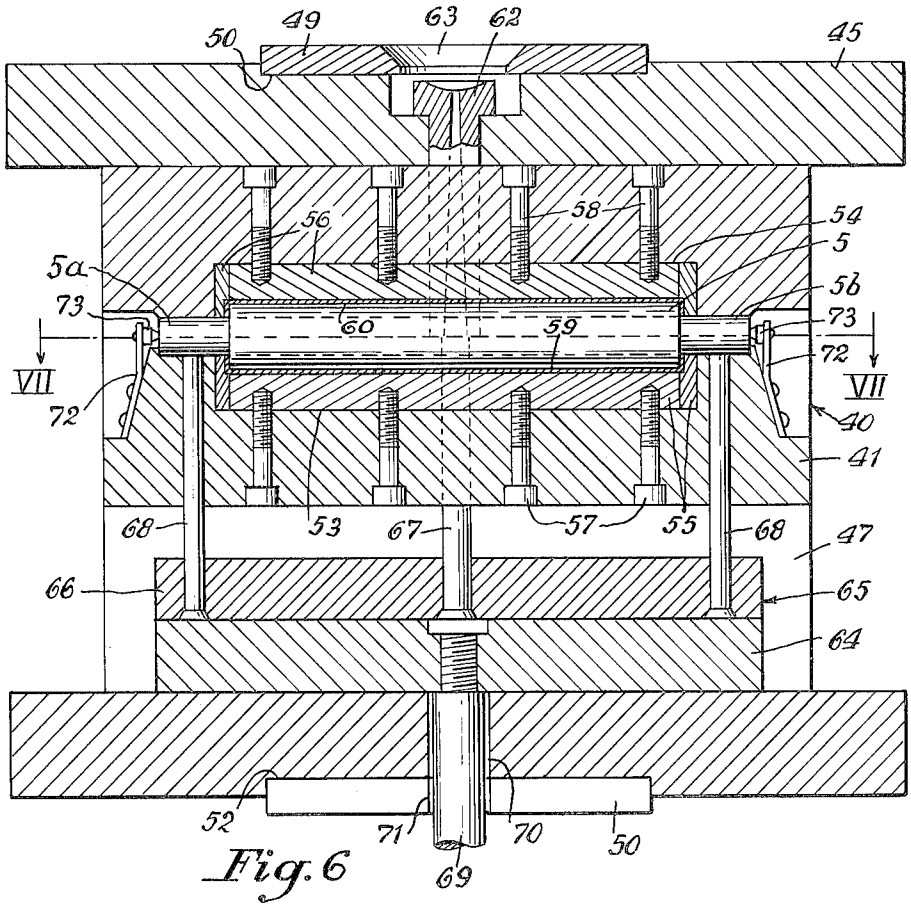


Fig. 6

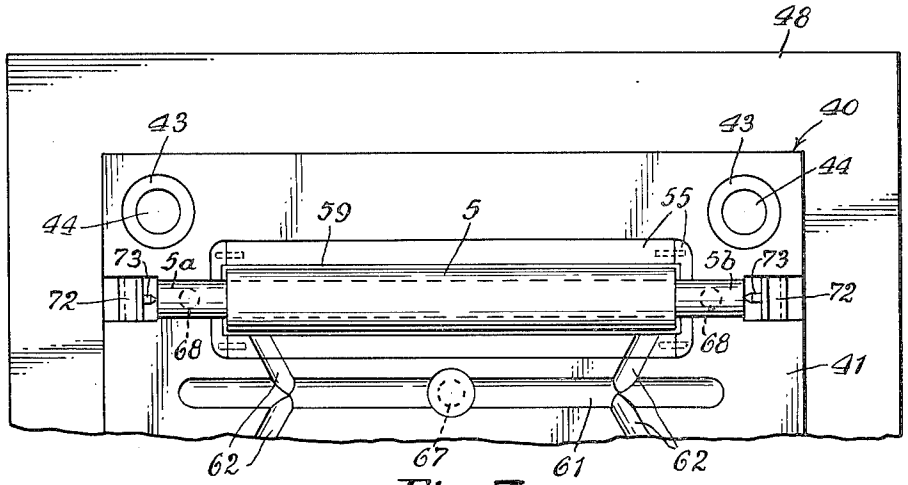


Fig. 7

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3,236,650

METHOD FOR DEVELOPING FILMS

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12 Claims. (Cl. 96—50)

This application is a continuation-in-part of my patent application Serial No. 221,809, filed September 6, 1962, now abandoned.

The invention relates to a method of treating exposed photographic emulsions on a layer carrier. In particular, the invention relates to the developing of photographic silver halide emulsions.

Known surface developing methods operate with developer liquid which must be specially prepared and renewed from time to time. In time, the quality of the liquid deteriorates, e.g. by oxidation, so that besides the disadvantages which arise from the use of a developer liquid varying development results are obtained with increasing age of the developer.

It is further known to arrange the halogen silver emulsion layer, together with the layer with the developer material, on a paper backing. One disadvantage of this arrangement lies in the limitation of the storage period of the paper, which furthermore must be stored under comparatively constant conditions in order to avoid a premature starting of the effect. For long storage periods, however, reactions can occur under normal conditions which impair the usefulness of the film.

The main object of the invention is to provide a method of the kind indicated which comprises the steps of forming a solid member from a fusion material combined with a treatment medium selected from the group consisting of developers, developer forming materials, and fixing materials, causing a surface layer of said member to dissolve, and moving said member and layer carrier relative to each other with said dissolved surface layer of the member in contact with said photographic emulsion.

Another object of the invention is to carry out said step of causing a surface layer of the member to dissolve by applying heat to said member.

A further object of the invention is carry out said step of causing a surface layer of the member to dissolve by applying a solvent to said member.

Other objects and advantages of the invention will become evident from the following description thereof with reference to the accompanying drawings, in which:

FIG. 1 is a vertical section of an embodiment of an apparatus suitable for practicing the invention,

FIG. 2 is a section on line II—II of FIG. 1,

FIG. 3 is a section on line III—III of FIG. 1,

FIG. 4 is a cross-section of the abovementioned solid member, in this case in the form of a roller,

FIG. 5 is a vertical section of a machine suitable for molding the solid member in the form of a roller,

FIG. 6 is a section of a mold used in the machine of FIG. 5, and

FIG. 7 shows a portion of said mold viewed as indicated by the arrows VII—VII in FIG. 6.

The apparatus shown in FIGS. 1–3 comprises a housing having a lower part 1 and a removable cover 2. The parts within the housing are supported on intermediate walls 3, 4, which if necessary can be arranged in the lower part 1 so as to be removable after removal of the cover 2 and release of the drive connection with the parts supported thereon.

Between the walls 3 and 4 a chemical roller 5, described in detail below, is rotatably supported in the lower part of the housing.

The chemical roller 5 is carried on a shaft the ends 5*a*, 5*b* of which are rotatably supported in bearings 6, 7. The

shaft end 5*b* extends through the wall 4 and carries a drive wheel 8. With this drive wheel there engages a pinion 8*a* on the drive shaft of a motor drive unit 9 which is arranged on the side of the wall 4 facing away from the wall 3 within the housing 1, 2.

In the walls 3, 4 a drum 10 is supported so as to be adjustable in height and, as can be seen from FIGURES 1 and 2, has shaft ends 11, 12 rotatably mounted in bearing sleeves 13, 14 having two vertical and parallel sides engaging in longitudinal slots 15, 16 in the walls 3, 4. Between the upper limiting edge of the slots 15, 16 and the bearing sleeves 13, 14 there are respectively arranged compression springs 17, 18 which are stressed to press the drum 10 downwards onto the roller 5. The lower ends of these springs are supported on shoulders on the sleeves 13, 14, adjustable countersupports being provided for the upper ends of these springs. In view of the driven operation of the roller 5 the slots 15, 16 must extend downwards sufficiently to enable the drum 10 to be rotated by engagement with the roller 5.

The bearing sleeves 13, 14 extend to the outsides of the walls 3, 4, respectively, from the slots 15, 16 and are formed beneath their ends with supporting surfaces for actuating rods of solenoids 19, 20. The solenoids are arranged on the walls 3, 4 and serve to lift the drum 10 from the roller 5 after stopping of the apparatus. It is possible to arrange the solenoids 19, 20 so that upon stopping of the apparatus they are automatically actuated. Furthermore, it is possible to latch the lifting rods in the raised position by means of special latching mechanisms (not shown) so that the solenoids can be de-energized after raising of the drum 10, the latching parts being releasable by special electromagnets (not shown) when the apparatus is again operated.

The drum 10 is a heating drum having a peripheral surface of good heat conducting material, if required with a covering of plastics material, which is preferred to other substances. Heater elements 102 are supported within the drum, for example on its end walls. The electrical connection to the heater elements is effected through the hollow ends 12 by flexible conductors 21 which lead to a power supply unit 22.

It is to be noted that an arrangement of the chemical rollers above the heating drum also lies within the scope of the invention, whereby the heat rising within the apparatus is used particularly advantageously. From FIG. 3 it can be seen that at the level of the nip between the drum 10 and the roller 5 slots 23, 23′ are arranged in the side walls of the apparatus for the introduction and discharge of films. Between these slots and the drum guide elements 24, 25 and 26, 27 are provided for guiding films to the nip between the roller and the drum.

There is suitably arranged beneath the chemical roller 5 a collecting container 29, removable through an opening 28 in the housing, which receives any downwardly falling dust.

It is possible to arrange special strips at the inner ends of the guide elements 24 to 27 extending the length of the drum or the roller in order to ensure a safe guiding of the films. In particular, the drum 10 can be constructed with peripheral grooves in which fingers of the guide elements 24 engage at the outlet side.

In the illustrated embodiment only the roller 5 is driven, while the drum 10 is rotated by engagement with the roller 5. In this way, there is obtained a relative speed which causes a friction effect between the roller 5 and any film passing through. This friction provides transfer of the substances contained in the chemical roller to the emulsion layer on the film. Suitably, there is provided an adjustable braking of the drum 10 by means of an elastic braking element which can be pressed

against the drum **10** and which is indicated in FIGURE 1 by reference numeral **30**. By means of this braking element the relative speed or the friction effect can be adjusted. An actuating lever **31** for this braking element extends sideways through a slit in the housing, as shown in FIGURES 2 and 3 and can be locked in various positions by known means (not shown).

Other embodiments of the apparatus are shown in the abovementioned parent application.

The roller **5** may be produced in any suitable way. In the machine of FIGS. 5–7 a mold **40** is used for the purpose. As indicated in FIG. 7, this mold is designed for producing two identical rollers **5** simultaneously, only part of the mold being shown in said FIG. 7.

As viewed in FIGS. 6 and 7, the mold **40** is split on a horizontal plane including the broken line connecting the arrows VII—VII. The lower mold portion **41** and the upper mold portion **42** are provided with accurately aligned vertical bushings **43** in which guide rods **44** are received with a snug fit to ensure accurate alignment of the two mold portions **41, 42**. To the top of the upper mold portion **42** a horizontal press plate **45** is removably secured by any suitable means (not shown). The lower mold portion **41** is provided with depending legs **46, 47** (see also FIG. 5) at two opposite sides thereof, and another horizontal press plate **48** is secured to the bottom ends of said legs **46, 47**. Centering discs **49, 50** are disposed in central recesses **51** and **52**, respectively, in the outer sides of the press plates **45, 48** and project from said recesses for a purpose explained below.

In the surfaces facing each other the mold portions **41, 42** are each provided with a recess **53** and **54**, respectively, adapted to receive lower and upper mold inserts **55** and **56**, respectively, which are removably secured in place by means of bolts **57, 58** which are accessible from the outside of the mold portions **41, 42** after removal of the press plates **48, 45**. The inserts **55, 56** are provided with a lining **59, 60** of Teflon or a similar material on their inner surfaces which together define a cylindrical cavity corresponding to the chemical roller **5** to be produced.

In the embodiment shown the mold **40** is designed for simultaneous molding of two rollers **5** (only one shown) and in the space between the two corresponding recesses the mold portions **41, 42** are provided with registering ingot grooves, the groove **61** in the top surface of the lower mold **41** being shown in FIG. 7. Connecting grooves **62** provide communication between said ingot grooves **61** and the cavities for the rollers **5** in the mold. From the ingot grooves a nozzle **62** extends upwardly through the mold portion **42** and upper press plate **45** to provide communication with an opening **63** in the center of the upper centering disc **49**.

A holding plate **64** for an ejector assembly, generally marked **65**, is disposed on top of the lower press plate **48**. The ejector assembly **65** comprises an ejector plate **66** provided with upwardly extending ejector pins **67** and **68**. The ejector pin **67** extends through the lower mold portion **41** into abutment with the lower surface of the upper mold portion **42** in the center thereof, while the ejector pins **68** extend through the lower mold portion **41** to the periphery of recesses in the mold portions adapted to receive the projecting shaft ends **5*a***, **5*b*** of the roller **5**, as will be further described below. An ejector rod **69** extends through aligned central openings **70, 71** in the lower press plate **48** and the lower centering disc **50**, respectively, into engagement with the bottom end of the ejector pin **67**. A compression spring **75** (FIG. 5) surrounds the ejector bar **69** and is so arranged as to urge the ejector assembly **65** and holding plate **64** against the lower press plate **48**. Holding springs **72** are secured to the lower mold portion **41** in position to urge centering pins **73** secured thereto into engagement with the shaft ends **5*a***, **5*b***.

It is to be understood that in the above description of the mold terms such as "horizontal," "vertical," "upper," "lower," "top," "bottom," etc., have been used only for convenience in describing the arrangement, and that in actual use the mold may be placed in positions where said terms no longer apply. Thus, in the machine shown in FIG. 5, the mold occupies a position in which, e.g., the press plates **45, 48** are vertical rather than horizontal, etc. The molding machine shown in FIG. 5 is of conventional type and will be only briefly described.

The molding machine comprises a holding disc **80** and a holding disc **81** provided with a horizontal shaft **82** which by conventional means (not shown) is reciprocable on a horizontal axis towards and from the holding disc **80**, as indicated by the arrows **83**. The mold **40** is held between said discs **80, 81** with the projecting portions of the centering discs **49, 50** received in corresponding recesses **84, 85** in the holding discs **80** and **81**, respectively. The holding discs **80, 81** are provided with central openings registering with the openings **63, 71** in the centering discs **49, 50**, as shown. A horizontal nozzle **86** extends into engagement with the nozzle **62** in the mold and is secured to a cylinder **87** in which a feed screw **88** is rotatably mounted and connected with gear means **89, 90** connected with a drive means (not shown). Bearings **91, 92** are provided for the feed screw **88** and an axle **93** carrying the gear **90**, respectively. The outlet end of a feed funnel **94** is in communication with the interior of the cylinder **87** at a point remote from the holding disc **80** and has a stirring device **95** connected with a drive motor **96**. A slide valve **97** is mounted at the outlet end of the funnel **94** and operably connected with the movable holding disc **81** through a linkage system shown diagrammatically at **98**. Heating bands **99** are provided on the outsides of the funnel **94**, the cylinder **87** and the nozzle **86**, as shown.

A preferred embodiment of a roller according to the invention is shown in cross-section in FIG. 4. It comprises a shaft **100** having the end portions **5*a***, **5*b***. To the shaft is secured a longitudinally corrugated metal cylinder **101** to the circumferance of which the chemical material **103** described below is applied. In another preferred embodiment the end portions **5*a***, **5*b*** of the shaft are integral with said shaft and of the same diameter as indicated in broken lines in FIGS. 6 and 7. The cylinder **101** may then be omitted and the chemical material is applied directly to the shaft.

A suitable material for a developer roller is obtained, e.g., by mixing one part by weight of sodium carbonate (Na_2CO_3) with two parts by weight of crystallized sodium tetraborate ($Na_2B_4O_7+10H_2O$) during continuous stirring and heating to about 195° F. For special purposes small amounts of other ingredients, such as alum or methylumbelliferone, may be added, with effects which are known in the art. The mixing and heating may take place in the funnel **94** or before introduction thereinto.

Another example of a suitable material for the roller is a mixture of sodium carbonate and crystallized sodium tetraborate in the proportions set forth and with the addition of one-half part by weight of crystallized sodium acetate ($CH_3COONa\cdot 3H_2O$). This addition improves the contrast characteristics of the images and also renders the roller less sensitive to temperature fluctuations.

When a pair of rollers **5** are to be molded in the machine, the mold portions **41, 42** are separaed without relative movement between the mold portion **41** and the ejector assembly **65**. The roller shafts, which are preferably made of a corrosion resistant metal, are then placed in the mold with the shaft ends **5*a***, **5*b*** in proper positions between the springs **72** and the mold is closed whereby the valve **97** is opened through the intermediary of the linkage **98** and the drive means for the feed screw **88** is started. Thereby mixture from the funnel **94** is pressed by the feed screw **88** through the nozzles **86** and **62** into

the grooves 61, 62 and the cavities in the insert aggregate 55, 56 until said spaces are filled and a pressure on the order of 500 atm. has been reached. The feeding in interrupted and the material in the mold 40 is left to cool. The mold portions are then again separated and the ejector assembly is actuated against the action of the spring 75 to free the shaft ends 5*a*, 5*b* from the springs 72 and thus permit removal of the rollers 5. The ejector pins are retracted, a pair of new shafts are inserted, the mold is closed and the procedure is repeated.

The relative velocity of the roller 5 and the layer carrier to be developed in the machine of FIG. 1 is dependent to a certain extent upon whether the heat supply to the press roller 10 is intermittent or constant, and if liquid is used to dissolve the surface of the roller 5, the amount of liquid supplied also has a bearing upon said relative velocity. Generally speaking, it is of the order of about 1:3. In case of heat supply, the temperature should be above about 140° F. It should be noted that the supply of heat instead of through the interior heating means 102 may be effected by heat radiation from the outside.

The pressure of the roller 10 against the roller 5 need only be sufficient to achieve the desired movement of the layer carrier. Its actual value is dependent upon the degree of softness of the surface layer of the roller 5 caused by the heat or liquid used, and it is readily controllable on the basis of visual observation during the first moments of operation.

It is, of course not necessary that the chemical member be in the shape of a roller. It may have the shape of a block or a plate, the essential condition being the relative movement between the chemical member and the layer carrier. In the last mentioned case the manufacturing procedure will be similar to that described above, although the interior shape of the mold inserts will be different.

What I claim is:

1. A method of treating exposed photographic emulsions on a layer carrier, comprising the steps of forming a solid member from a fusion material combined with a treatment medium selected from the group consisting of developers, developer forming materials, and fixing materials, causing a surface layer of said member to dissolve, and moving said member and layer carrier relative to each other with said dissolved surface layer of the member in contact with said photographic emulsion.

2. A method of treating exposed photographic emulsions on a layer carrier, comprising the steps of forming a solid member from a fusion material combined with a treatment medium selected from the group consisting of developers, developer forming materials, and fixing materials, applying heat to said member so as to cause a surface layer thereof to dissolve, and moving said member and layer carrier relative to each other with said dissolved surface layer of the member in contact with said photographic emulsion.

3. A method of treating exposed photographic emulsions on a layer carrier, comprising the steps of forming a solid member from a fusion material combined with a treatment medium selected from the group consisting of developers, developer forming materials, and fixing materials, applying solvent to said member so as to cause a surface layer thereof to dissolve, and moving said member and layer carrier relative to each other with said dissolved surface layer of the member in contact with said photographic emulsion.

4. The method as set forth in claim 1, in which said relative movement between the member and the layer carrier is effected so as to cause pressure and a rubbing action between said surface layer of the member and said photographic emulsion.

5. The method as set forth in claim 1, including incorporating in said fusion material a substance which upon solidification forms a protective coating upon said photographic emulsion.

6. The method as set forth in claim 1, including the use of a fusion material containing water or crystallization.

7. The method as set forth in claim 1, including the use of a fusion material containing borax and soda.

8. The method as set forth in claim 1, including the use of a fusion material containing alkali.

9. The method as set forth in claim 1, including the use of a fusion material containing thiosulfate.

10. The method as set forth in claim 5, including the use of a fusion material containing alum.

11. The method as set forth in claim 5, including the use of a fusion material containing methylumbelliferone.

12. A method of treating exposed photographic emulsions provided on layer carriers, comprising moving a first member formed from a treatment medium containing a developer bound in a dissoluble material over said emulsion in contact therewith while causing said dissoluble material to be dissolved so that said developer is transferred to said emulsion, and moving a second member formed from a treatment medium containing fixer substances bound in a dissoluble material over said emulsion in contact therewith while causing said dissoluble material to be dissolved so that said fixer substances are applied to said emulsion.

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