

Aug. 11, 1964

G. R. LAMBERT

3,144,334

METHOD OF DEVELOPING PHOTOGRAPHIC MATERIALS BY  
MEANS OF GASES OR VAPOURS AND TO APPARATUS  
FOR CARRYING THE METHOD INTO EFFECT  
Filed April 22, 1959

*Fig. 1.*

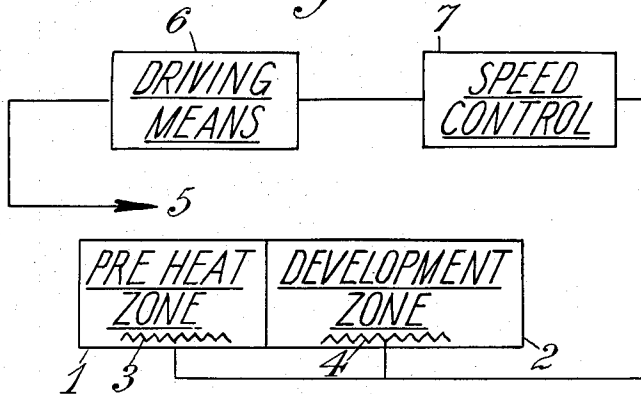
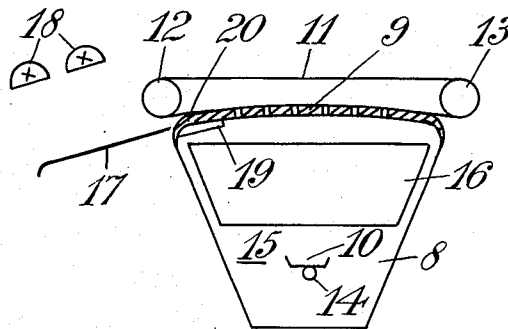


*Fig. 2.*



Inventor:  
George Randolph Lambert  
By: Hooper Leonard Russell,  
attys

1

3,144,334

## METHOD OF DEVELOPING PHOTOGRAPHIC MATERIALS BY MEANS OF GASES OR VAPOURS AND TO APPARATUS FOR CARRYING THE METHOD INTO EFFECT

George Randolph Lambert, Loughton, England, assignor to Ozalid Company Limited, Loughton, England, a British company

Filed Apr. 22, 1959, Ser. No. 808,034

Claims priority, application Great Britain Apr. 24, 1958  
3 Claims. (Cl. 96—49)

This invention relates to an improved method of developing photographic material by means of gases or vapours and to apparatus for carrying such a method into effect and more particularly its relates to an improved method of developing light sensitive diazotype materials by means of heated moist ammonia vapours and to improved apparatus for carrying such method into effect.

The light sensitive layers of diazotype material suitable for development by means of gases or vapours comprise one or more diazonium compounds and one or more coupling components together with a substance or substances which under normal conditions inhibits or inhibit the action of coupling to produce an azo dye.

In the development of such materials the inhibiting action of the coupling inhibiting substance or substances which is or are usually of an acidic nature is suppressed by exposing the said materials to the action of gases or vapours.

These so-called two components light sensitive diazotype materials are usually developed after exposure to actinic light beneath an original by traversing the exposed material over a perforated or open wall of a tank or chamber in which an aqueous ammonia solution is vaporised to produce ammoniacal vapours which vapours come into contact with the diazotype material as it is traversed over the said wall of the development tank or chamber. In such an apparatus in addition to heating means disposed within the development tank or chamber for the purpose of vaporising the aqueous ammonia solution, it is known that additional thermostatically controlled heating elements may be positioned in the said tank so that the vapours emanating from the perforations are heated before they come into contact with the material being traversed over the said perforated wall, the perforated wall itself being heated by convection and/or by radiation by the said heating elements.

While therefore the perforated wall of the developing tank or chamber is heated during the working of the machine, it has been found in practice virtually impossible to maintain the end portions of the chamber or tank at the same temperature as the central zone thereof, this, in the main, being due to the fact that heat losses occur more rapidly at the ends of the tank than at the central zone thereof.

This results in a temperature gradient across the width of the tank, i.e. transverse to the direction of travel of the material being developed. This means that not only is the central portion of the perforated wall of the chamber or tank maintained at a higher temperature than is either end but the vapour emanating from the central zone of the chamber or tank is at a higher temperature than the vapour emanating from the tank adjacent to its ends.

This undesirable temperature gradient may result in defects in development (such as uneven development or colour across the developed product) and these may be due to (a) the difference in temperature between the end portions of the upper surface of the developing chamber over which the material is traversed and the central portion thereof resulting in the material itself being at a

2

higher temperature at its central zone than at either end and/or (b) the vapour coming into contact with the light sensitive diazotype material is not at a constant temperature for the full width of the machine and/or (c) the constitution of the development vapour may vary across the width of the machine, being different at and towards either end of the development chamber or tank from what it is in the central zone thereof.

In diazotype developing machines as heretofore constructed, the exposed material is traversed over the perforated wall of the developing tank or chamber by means of a moving endless belt or band which not only carries the material over the perforated wall but also seals the tank and prevents the ammoniacal vapours escaping into the surrounding atmosphere.

The speed with which the diazotype material is carried over the perforated wall of the developing chamber depends upon the speed of movement of the endless print traversing belt or band and in present day machines the speed of movement of the print traversing belt is variable, for instance by electronic speed control means, so that speeds of between say 1 ft. a minute and 40 ft. a minute may be achieved substantially instantaneously by actuation of the speed control member.

It will be appreciated that with the machine running at a low speed of say 2 ft. a minute the material being developed will be exposed to the action of the development vapours and to the heat emanating the heated perforated surface of the developing chamber for a considerably longer period than when the machine is running to say 40 ft. a minute.

In the development of light sensitive diazotype materials by gases or vapours it has been established that the temperature of the light sensitive layer prior to its exposure to the effect of the development vapours may have a considerable effect on the manner in which azo dye formation occurs in the said layer.

In diazotype materials the light sensitive coating of which comprises one coupler little difficulty may be experienced in producing a developed print having a constant hue or colour at any speed of development. However certain diazotype materials particularly those producing black images may comprise at least two different couplers and possibly more than one diazonium compound. In this case certain difficulties may be experienced in producing prints having a consistent black hue. If the development is carried out at a slow speed there is a tendency for the developed print to have a pronounced overall blue colour while if development take places at fast speed the resulting print tends to have an overall yellow colour.

This colour change effect due to different speeds of development is thought to be due at least in part to the temperature difference of the light sensitive layer as between development at slow speeds and development at high or relatively high speeds.

It is accordingly one of the objects of the present invention to provide an improved method of and apparatus for developing light sensitive diazotype materials by means of gases or vapours in which prints of a constant hue or colour may be produced at any speed of development, for instance between say 1 ft. per minute up to as much as say, 100 ft. per minute or more.

It is a further object of the present invention to provide an improved diazotype developing apparatus in which the beforementioned undesirable temperature gradient across the width of the said apparatus will be eliminated or at least reduced to a minimum.

Broadly stated the method of developing light sensitive diazotype materials by means of ammoniacal developing vapours according to the present invention comprises the

step of heating the said materials prior to their exposure to the effects of the developing vapours.

More specifically the method according to this invention comprises moving the light sensitive diazotype material at a variable speed and in such manner that it is exposed to the effects of the developing vapours, heating the said material prior to its exposure to the effects of the said developing vapours and controlling the heat to which the said material is exposed to consonance with the speed of movement of the said material.

In the method of the present invention it may be desirable in the lower ranges of speed of movement of the material for no additional heat to be applied prior to the development action and the control of the heating means may be such that it is operative only when a certain predetermined speed of movement of the material has been reached.

For convenience of reference it is proposed hereafter to refer to the heating of the material prior to its exposure to the effects of the developing vapours as "preheat."

As previously mentioned it is thought that the temperature of the light sensitive layer prior to its exposure to the effects of the developing vapours may be an important factor in the achievement of consistent development at different speeds.

In the development of two component light sensitive diazotype material by conventional machines, the temperature of the light sensitive layer (i.e. the layer temperature) depends to a large extent upon the speed at which the material is traversed through the machine and upon the temperature to which the said material is exposed during development (in conventional machines this would be dependent upon the temperature of the perforated plate of the development tank) so that, in the main, the faster the speed at which the material is traversed through the machine, the lower the layer temperature, assuming a given plate temperature.

However, certain factors, some of which may not be directly related to circumstances referred to in the preceding paragraph may influence the optical characteristics of the developed image. These factors may arise from the nature and mass of the base material used, the chemical constitution of the layer or possibly from variation of the actual physical mass as between one type of machine and another.

In general however, in applying the above hypothesis to the design of a machine for carrying out the method of this invention any appropriate form of apparatus may be utilised, preferably however apparatus according to this invention comprises a preheat zone, the temperature of preheat being variable in consonance with inter alia the speed of the machine and a development zone in which the material being developed is exposed to the effects of heated moist ammonia vapour, the temperature of the said ammonia vapour being variable in consonance with the speed of the machine and/or in consonance with the temperature of the preheat zone.

Heating means may also be provided within the development zone so that an even or a substantially even temperature is maintained over the whole width of the said development zone.

Various overriding control means may be provided to take into account the influencing factors referred to previously e.g. there may be a control member operable to take into account the different base materials used and a second control member to take into account the chemical constitution of the layer.

Considering next the modification of a conventional machine for this purpose as previously mentioned, the speed of such machine may be varied substantially instantaneously by the electronic speed control means.

To provide for a constant layer temperature therefore at any speed it becomes necessary to provide means whereby the plate temperature may be varied substantially instantaneously.

In conventional developing machines owing to the relatively large mass of metal comprising the development tank of such machines, difficulty must inevitably follow in an endeavour instantly to vary the plate temperature at all speeds of working of the machine.

In the adaptation of conventional machines means are provided according to the present invention whereby the layer temperature may be varied substantially instantaneously.

Apparatus for developing diazotype materials by gases or vapours according to this aspect of the present invention comprises heating means so disposed that the material to be developed in its passage over the conventional feed board of such machines, passes such heating means to be heated thereby prior to the exposure of the material to the effects of the developing vapours emanating from the perforated wall of the developing tank or chamber.

Further, in accordance with this invention means may be provided disposed within said developing chamber or tank adjacent to its front or leading edge to apply heat to the light sensitive diazotype material before it is exposed to the effects of the development atmosphere and means to heat the said chamber or tank adjacent to the end walls thereof.

The heating means may be disposed at any convenient location on or adjacent to the machine, for instance it may be located on or adjacent to a feed board of the machine, to form a preheat zone adjacent to the feed-in side of the perforated wall of the developing tank or chamber or as mentioned previously it may be disposed within the said tank or chamber along a front unperforated portion of the perforation wall thereof.

It is preferred, additionally to heat the chamber or tank adjacent to its end walls by means of heaters disposed within the said chamber or tank and extending from front to rear thereof in a direction parallel with the direction of travel of the sensitised material as it is being exposed to the development atmosphere.

The electric heaters used heretofore in diazotype developing apparatus have been of the conventional rod type and it has been necessary to mount or support them in the end walls of the tank so that they extend into the tank with their central longitudinal axes parallel or substantially parallel with front surface of the tank, i.e. they extend across the feed width of the machine.

With such an arrangement, it is found that less heat is applied adjacent to the end walls of the tank than at the central zone thereof and this together with the fact that the end walls lose heat more rapidly than the central zone of the tank produces quite a serious temperature gradient across the width of the tank.

Within recent years however, so-called surface heaters of the kind which may be cut or moulded to shape have become commercially available such heaters comprising a layer or layers of an electrically conductive substance sandwiched between layers of non-conductive substance and it is a feature of the present invention that these surface heaters are used in the apparatus constructed in accordance therewith.

Accordingly, a surface heater of the kind referred to above may be shaped to fit along the inside of the developing chamber or tank adjacent to its front leading edge so that light sensitive diazotype material travelling in contact with the said chamber or tank prior to its exposure to the effects of the development vapours emanating from said chamber or tank will be heated thereby and along the end walls thereof in a direction parallel with the direction of feed of the said material.

Alternatively, if desired, a mat or surface type heater may be arranged on the outer surface of the developing tank or chamber and in such cases the tank surface and the heaters may be covered, for instance, by a sheet or sheets of a plastic material having a low coefficient of friction, such as polytetrafluorethylene.

5

The configuration of the surface heater may be so selected as to eliminate or at least reduce to a minimum the temperature gradient which may exist in conventional machines. For instance the width of the heaters disposed at the ends of the development chamber or tank may be tapered from front to rear.

Apparatus according to this invention preferably also comprises control means whereby the temperature of the preheat zone may be varied, suitably automatically, depending upon the speed of the machine.

The control means may comprise a micro switch, which may be adapted to switch the heating means on when material to be developed is passing to the developing chamber and off when no material is passing and means depending upon an input signal from the conventional electronic speed control apparatus for controlling the heat output of the heating means for the preheat zone.

The heating means according to this invention may comprise infra-red heating tubes or dielectric heating means the heat output of which may be varied substantially simultaneously by means of the control device referred to above.

The control means may be so arranged that unless an input signal of a certain predetermined value (representing a certain predetermined minimum speed) is received from the electronic speed control apparatus, the heating means for the preheat zone remains inoperative.

If desired the control means receiving an input signal from the electronic speed control apparatus and governing the heat output of the heating means may also comprise a further control device which may modify the input signal from the electronic speed control apparatus to take into account different types of diazotype material, e.g. a diazotype material having a paper base or one having a plastic or metal base. Such a control device would in effect take into account some of the factors which affect development.

Alternatively, if desired, the amount of heat applied to the preheat zone may be made dependent upon and controlled by the actual temperature of the sensitised material and/or by the actual temperature of the preheat zone itself.

For instance, thermistors recording the temperature of the sensitised material and of the preheat zone may be connected to a quantitative control device which will maintain the temperature of the sensitised material at a fixed level or which will vary the temperature of the preheat zone in accordance with the speed of travel of the sensitised.

According to another aspect of the present invention the substantially instantaneous variation of temperature required in the carrying out of the method of this invention into effect may be achieved by reducing to a minimum the mass of the developing machine components in contact with the material being developed so as to avoid temperature variation at least due to the heating up and cooling down of the relatively large metallic masses which form part of the developing apparatus of conventional machines.

In the application of this invention to diazotype apparatus of the kind comprising a developing chamber or tank having a perforated upper surface over which the material to be developed is transversed by means of an endless sealing belt or blanket, aqueous ammonia solution being fed to a vaporising tray disposed in said chamber to be heated by a heater associated with said tray to produce a development atmosphere comprising ammonia gas and water vapour; the vaporiser may be heated by a conventional rod type heater.

To provide for preheating the diazotype material a surface heater of the kind comprising a layer of electrically non-conductive material having electrically conductive strips or elements disposed therein may be secured, as by adhesive, to the inner or outer surface of the unperforated top of the chamber or tank.

6

To provide for the maintenance of a constant temperature across the whole width of the development chamber heaters may be applied directly to or adjacent to the undersurface of the unperforated end portions of the perforated top wall of the said chamber the said heaters extending from the front wall towards the rear of the chamber in the direction of travel of the material being developed.

The heaters may, if desired, extend under the apertured surface of the developing chamber or tank, providing of course that free access of vapour is not impeded thereby. The arrangement may be such that the heaters are continuous or discontinuous across the area of the apertured surface.

If desired the front and end heaters may be formed as one unit cut or molded to shape or alternatively separate heaters may be used, one along the leading edge of the chamber and one at each end.

It will of course be appreciated that the heater or that portion of the heater extending along the leading edge of the developing chamber will heat the material prior to its coming into contact with the development vapours while the end heaters or the portions of the heater extending in the direction of travel of the material being developed will maintain a substantially even temperature over the entire width of the developing chamber.

If desired the front heaters may extend for a distance down the front wall of the chamber and the end heaters may extend for a distance down the end walls of the chamber.

The invention will now be described with reference to the accompanying drawings which show more or less diagrammatically two embodiments of apparatus for carrying out the method of this invention.

In the drawings FIG. 1 is a diagrammatic illustration of an unconventional type of apparatus, which may be specially designed to have as low a metallic mass in contact with the sensitised material as possible while FIG. 2 illustrates, more or less diagrammatically, a conventional perforated tank type of apparatus adapted for use with the method of this invention.

Referring now to the drawings, but first more particularly to FIG. 1 thereof 1 represents a zone of the machine or apparatus in which the material being developed is preheated prior to its exposure to the effects of the development vapours in development zone 2.

The preheat zone 1 is heated by means of an electric heater indicated at 3 while the development zone is also heated by means of an electric heater indicated at 4. The heaters 3 and 4 may be of any appropriate type and may be either conventional rod heaters or they may be so-called mat or surface heaters.

The material to be developed is traversed over the preheat and development zones 1 and 2 respectively as indicated by the arrow marked 5. Any appropriate means may be provided to move the said material, for instance a conventional conveyor unit comprising an endless moving belt or blanket taking around appropriately disposed supporting rollers may be provided.

The driving means for the conveyor unit is indicated at 6 and this may be controlled by electronic speed control means indicated at 7.

As mentioned previously, electronic speed control means associated with conventional diazotype apparatus is adapted to permit the variation of the speed of the material conveyor unit substantially instantaneously and in the apparatus according to this embodiment of the present invention the heating means 3 and/or 4 associated with the preheat zone 1 and development 2 respectively may be controlled by means of an input signal derived from the said speed control means 7.

Such signals may be such that the faster the speed at which the conveyor unit is driven the higher the heat output of the heaters 3 and/or 4 becomes. If desired the arrangement may be such that until the speed of

the conveyor reaches a certain predetermined minimum, the input signal from the speed control means 7 to the heater 3 of the preheat zone 1 is insufficient to influence the heater 3 which may then remain inoperative.

In combined printing and developing machines for diazotype material it is usual for the printing sections of such machines to be driven synchronously with the developing sections thereof but in apparatus in accordance with this invention means may be provided whereby if desired, and preferably in dependence upon a signal or signals derived from the preheat zone 1 and/or the development zone 2 and from the speed control means 7, the developer section may be driven at a speed different from that of the printing section.

Referring now to FIG. 2 of the accompanying drawings 8 represents a conventional developing chamber or tank having a perforated upper surface 9 through which developing vapours generated by a vaporiser unit indicated at 10 permeate.

The upper perforated surface 9 of the chamber 8 is closed by means of an endless moving sealing belt or blanket 11 taking around appropriately disposed guide rollers 12 and 13 one of which rollers is a driven roller, the speed of which is controlled by conventional electronic control means (not shown).

The vaporiser unit 10 is as shown heated by means of an electric heater indicated at 14 and the end walls of the chamber, one of which is indicated by the reference numeral 15, are each provided with a mat or surface heater 16.

The feedboard of the machine is indicated at 17 the material to be developed being fed over the said feedboard 17 to be traversed over the perforated surface 9 of the developing chamber 8 by means of the conveyor blanket 11.

Heating means, indicated at 18, are disposed adjacent to the feedboard 17 so that material fed over the said feedboard is heated thereby.

Any appropriate kind of heating means 18 may be provided for instance the said heating means may comprise one or more infra red lamps.

As an alternative or as an addition to the heating means 18 a mat or surface heater 19 may be provided internally of the chamber 8 and disposed along the front unperforated portion 20 of the perforated upper wall 9 of the said chamber.

It will be appreciated that this arrangement provides, as in the embodiment of the invention referred to in FIG. 1 a preheat zone, consisting of the feedboard 17 and heaters 18 and/or the front unperforated portion 20 of the wall 9 and the mat or surface heater 19, and a development zone consisting of the perforated surface 9 of the tank or chamber 8, and similar control means to these referred to with reference to FIG. 1 for controlling the heat output of the heaters in consonance with the speed are provided.

By the present invention there is provided a simple and efficient method of and apparatus for developing light sensitive diazotype materials by means of gases or vapours in which prints of consistent hue or colour may be provided at widely different speeds of operation of the machine or apparatus.

I claim:

1. A method of developing, by exposure to ammoniacal developing vapours, two-component light-sensitive diazo-

type materials which have been differentially subjected to actinic radiation, which method comprises the steps of subjecting the materials while moving to a temperature in a separate preheat zone sufficient to heat the materials to a preselected temperature during their dwell in said preheat zone, said preselected temperature being so related to the moving speed of the material that upon reaching a developing zone having an entry end and spaced apart exit end the materials reach development temperature immediately adjacent the said entry end, passing the materials at said preselected temperature to a developing zone and subjecting said materials in said zone at said preselected temperature to developing vapours.

2. A method of developing, by exposure to ammoniacal developing vapours, two-component light-sensitive diazotype materials which have been differentially subjected to actinic radiation, which method comprises the steps of subjecting the materials while moving to a temperature in a separate preheat zone varying the temperature in said preheat zone in proportion to the speed of movement of said materials so that said temperature is sufficient to heat the materials to a preselected temperature during their dwell in said preheat zone, said preselected temperature being so related to the moving speed of the material that upon reaching a developing zone having an entry end and spaced apart exit end the materials reach development temperature immediately adjacent the said entry end, passing the materials at said preselected temperature to an adjacent developing zone and subjecting said materials in said developing zone at preselected temperature to developing vapours.

3. A method of developing, by exposure to ammoniacal developing vapours, two-component light-sensitive diazotype materials which have been differentially subjected to actinic radiation, which method comprises the steps of subjecting the materials while moving to a temperature in a separate preheat zone, varying the temperature in said preheat zone in proportion to the speed of movement of said materials so that said temperature is sufficient to heat the materials to a preselected temperature during their dwell in said preheat zone, said preselected temperature being so related to the moving speed of the material that upon reaching a developing zone having an entry end and spaced apart exit end the materials reach development temperature immediately adjacent the said entry end, passing the materials at said preselected temperature to an adjacent developing zone, subjecting said materials in said developing zone at preselected temperature to developing vapours and imparting heat to said vapours and materials along the periphery of the developing zone to maintain a uniform temperature in said materials during their dwell in the developing zone.

#### References Cited in the file of this patent

##### UNITED STATES PATENTS

|           |                  |               |
|-----------|------------------|---------------|
| 2,616,803 | Ravich           | Nov. 4, 1952  |
| 2,923,625 | Herrick          | Feb. 2, 1960  |
| 2,979,404 | Ellsworth et al. | Apr. 11, 1961 |

##### FOREIGN PATENTS

|         |               |               |
|---------|---------------|---------------|
| 570,027 | Great Britain | June 19, 1945 |
| 632,932 | Great Britain | Dec. 5, 1949  |
| 647,617 | Great Britain | Dec. 20, 1950 |
| 562,828 | Great Britain | July 18, 1944 |
| 560,034 | Canada        | July 8, 1958  |