

[54] **METHOD FOR DEVELOPING DIAZO PRINTS FROM AN EXTERNAL SUPPLY SOURCE OF AMMONIA AND CARBON DIOXIDE**

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Related U.S. Application Data

[63] Continuation of Ser. No. 273,567, July 20, 1972, abandoned.

[52] U.S. Cl. **96/49; 34/155; 34/219; 354/300**

[51] Int. Cl.² **G03C 5/34**

[58] Field of Search **96/49; 354/300; 34/151, 34/155, 219**

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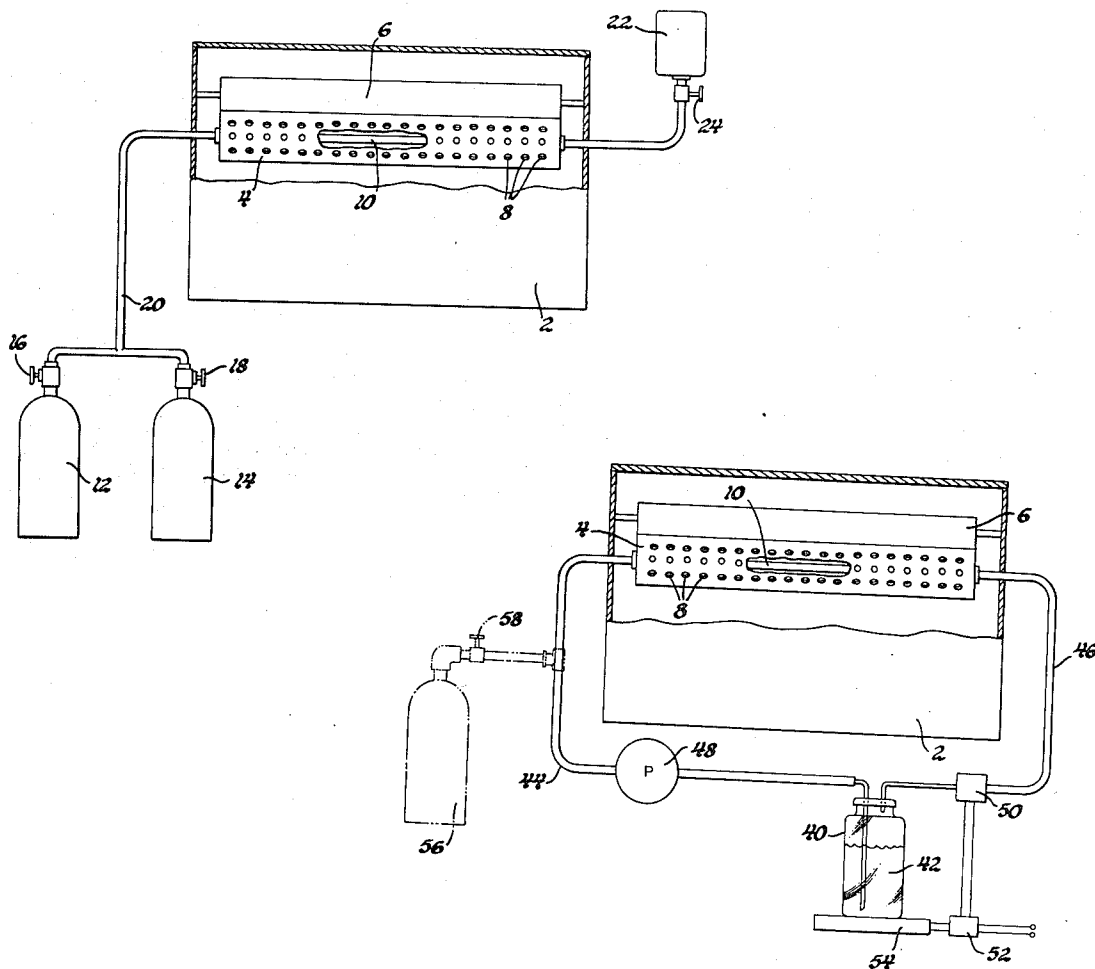
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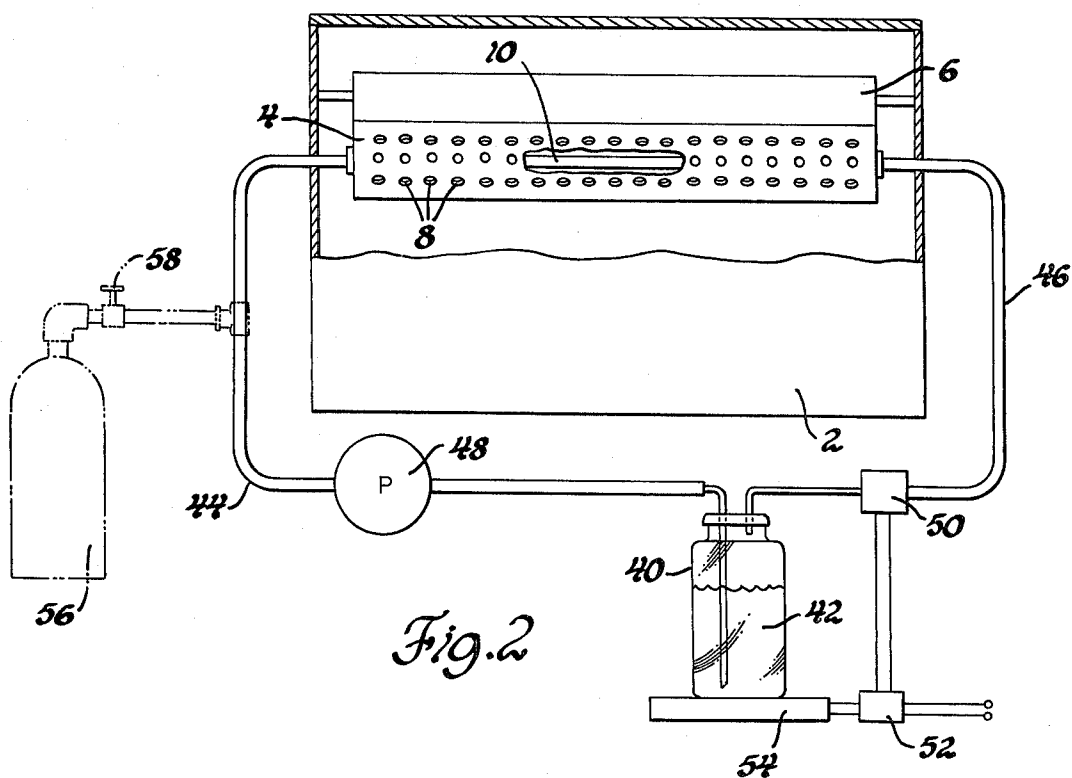
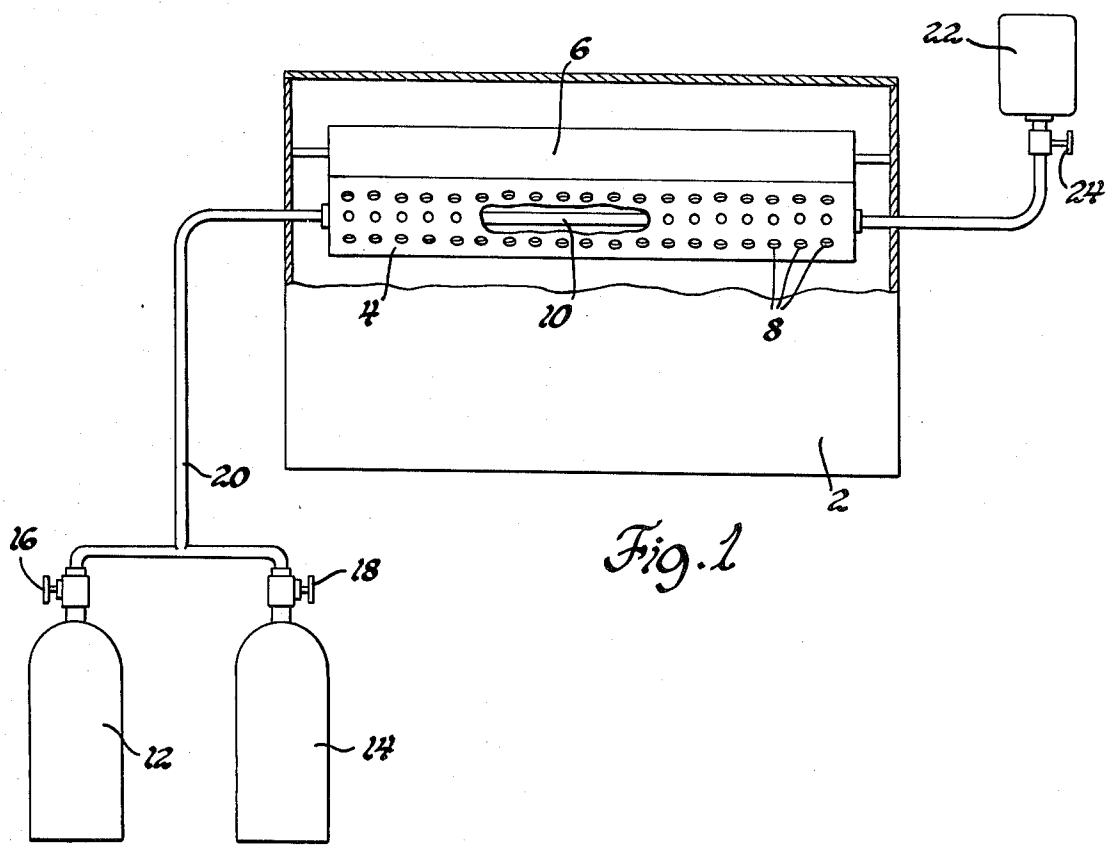
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ABSTRACT

In accordance with the invention diazo-dye coated sheets are developed in the presence of water vapor in the development chamber of apparatus for making diazo dye type reproductions by conducting into the chamber a flow of ammonia in vapor form sufficient to fully develop said diazo-dye coated sheets and a flow of carbon dioxide in vapor form sufficient to substantially reduce the ammonia odor.

4 Claims, 2 Drawing Figures





METHOD FOR DEVELOPING DIAZO PRINTS FROM AN EXTERNAL SUPPLY SOURCE OF AMMONIA AND CARBON DIOXIDE

This is a continuation of application Ser. No. 273,567 filed July 20, 1972, now abandoned.

This invention relates to a method for developing diazo coated paper or other sheet material in the dry process of making diazo type reproduction or prints.

The machine used in the dry process for making diazo dye type reproductions or prints comprises an exposure unit and a developing unit. In the exposure unit the diazo-dye coated paper or other sheet material is subjected to light which decomposes the dye in the areas on the sheet not shielded from, and hence exposed to, the light. The sheet is then transferred to the developing unit which comprises a chamber wherein the sheet is exposed, in the presence of the water vapor, to ammonia in gaseous, i.e., vapor form, the ammonia reacting with the dye to develop the same and produce the desired image on the sheet. There are two known systems for supplying the gaseous ammonia to the chamber for contact with the sheets. In one system the ammonia and water are pumped into the chamber in its gaseous or vapor form. In the other system an aqueous solution of ammonia, i.e., ammonium hydroxide, is introduced into the chamber where it is heated so as to provide the water and ammonia vapors for contact with the sheets.

A problem common to both of these systems is that the ammonia vapor, which is noxious, toxic and irritating, escapes from the chamber and creates not only uncomfortable working conditions, but also a hazard to personnel in the vicinity of the reproducing machine. Also, the reproductions or prints themselves often carry the ammonia odor for a significant period after being removed from the machine. Elaborate systems of venting have been considered and used in an attempt to alleviate this problem; however, this is expensive and even then does not serve to fully solve the problem.

One proposed solution to the problem is set forth in Canadian Pat. No. 583,923, one of the co-inventors of this patent application being a co-inventor of the solution disclosed and claimed therein. In accordance with the Canadian patent, a carbonated solution of ammonium hydroxide, i.e., an aqueous solution of ammonia and carbon dioxide, is pumped into the developing chamber where it is then heated so as to evolve both ammonia and carbon dioxide. Although there is as yet no full explanation, the presence of carbon dioxide serves to reduce the ammonia escape and odor problem. One theory is that there is formation of ammonium carbonate on the sheet material being developed and presumably elsewhere in the chamber, the escape of ammonia being prevented by reason of it combining with carbon dioxide, in the presence of water, to form ammonium carbonate. However, the difficulty with the system of the Canadian patent is that solid material rather quickly develops in the chamber and this solid material clogs the various inlets, outlets, orifices and vents and coats the heating elements and other components in the chamber and even causes a corrosion problem in the machine, thereby resulting in very expensive maintenance problems. So much did this prove to be a problem that the system fell out of use despite the fact that it did alleviate the ammonia escape and odor problem.

The object of the present invention is to provide a method for developing diazo-dye coated sheet material, by contact thereof with ammonia vapor, which eliminates or at least greatly reduces the ammonia escape and odor problem and yet which does not create or result in the problem of solid materials being generated within the development chamber such as would clog the orifices, vents and other necessary openings and components in the chamber.

Briefly, our invention is predicated on our discovery that if, instead of introducing an aqueous solution of ammonia and carbon dioxide into the developing chamber, there is introduced into the chamber ammonia and carbon dioxide in gaseous form, then not only is the ammonia escape and odor problem eliminated or greatly reduced, but also there is no resulting problem by way of solids forming in the chamber. This was unexpected since theory and practice in the utilization of the system set forth in the Canadian patent as discussed above indicated that the solid formed was largely, if not entirely, ammonium carbonate. It had been expected, therefore, that with the introduction of ammonia and carbon dioxide in gaseous form into the chamber, and with water vapor also being present, there would be a resultant formation in the chamber of solid ammonium carbonate which would cause vent and orifice clogging as well as corrosion problems. Yet, as stated above, with the method of the present invention, wherein the ammonia and carbon dioxide are introduced into the chamber in gaseous form, the ammonia escape and odor problem is substantially reduced or eliminated without the formation of solids within the chamber and, therefore, without the clogging and corrosion problems discussed above.

Other objects, features and advantages of the invention will appear more clearly from the following detailed description thereof made in part with reference to the accompanying drawings, wherein:

FIG. 1 is a cross-sectional view of a first embodiment of apparatus suitable for practice of a preferred embodiment of the method of this invention wherein ammonia and carbon dioxide are stored in gaseous form and admitted to the development chamber from the storage means; and

FIG. 2 is a cross-sectional view of apparatus suitable for practice of a second embodiment of the method of this invention wherein the ammonia and carbon dioxide are provided to the apparatus in vapor form derived by bubbling exhaust from the development chamber through an aqueous solution containing ammonia and carbon dioxide.

Referring now to FIG. 1, there is shown apparatus comprising a development chamber 2 containing suitable means for supporting and transporting there-through diazo-dye coated paper for development by contact with ammonia vapor in the presence of water vapor. In the particular apparatus shown the means for supporting and transporting the diazo dye treated paper in the chamber comprises a rotatable hollow perforated metal roll 4 which is coaxial and in contact with a second rotatable roll 6 made of rubber. An electric motor or the like (not shown) causes roll 6 to rotate which in turn causes rotation of perforated roll 4. The diazo dye treated paper is fed, by any suitable mechanism (not shown) between the rolls and as it does so it is developed by ammonia vapor which passes from the interior of the roll through the perforations 8 and into

contact with the paper. Of course, the diazo-dye coated paper has, prior to entry into chamber 2, already been through the exposure unit (not shown) and is ready for development, by contact with the ammonia vapor, of the diazo dye which has not been decomposed by exposure to light in the exposure unit and which will provide the desired reproduction or print.

A resistance heating element 10 is disposed within the interior of the perforated roll 4 and acts to maintain the vapor in the roll at a suitable temperature, as is well known in the art, for reaction with a diazo-dye coated paper admitted to the chamber.

Ammonia gas and carbon dioxide gas are provided to the system from a pair of gas storage tanks 12 and 14 which must be replenished periodically. A pair of manually adjustable flow and pressure reduction valves 16 and 18, disposed adjacent to the outputs of the containers 12 and 14 for the ammonia gas and carbon dioxide gas respectively, admit the gases to a conduit 20 which directs the gas flow to the interior of the perforated chamber 8.

Distilled water is introduced into the chamber at the opposite end of the perforated roll 4 from a refillable container 22 by gravity feed through a flow regulating valve 24.

In operation the heating element 10 is first energized. The valve 24 is then adjusted so as to admit a slow trickle of water from the container 22 into the perforated roll. This trickle is so limited that the entire flow immediately becomes vaporized by the heat generated by the element 10 upon entering the chamber.

The valve 16 is then adjusted to allow a flow of ammonia gas or vapor sufficient for full development of diazo-coated paper passed between the rolls 6 and 4. This vapor will be heated by the resistance heating element 10 to between 120° and 250°F.

The valve 18 is adjusted to allow a flow of carbon dioxide sufficient to substantially reduce or eliminate the odor due to the escape of ammonia into the atmosphere as well as the presence of residual ammonia on paper between the rolls 4 and 6.

An alternate and preferred embodiment of the invention is illustrated in FIG. 2. This embodiment again employs a development chamber 2 containing a perforated development roll 4 in abutment with a rubber drive roll 6. A heating element 10 is contained within the roll 4. Below the development chamber is a container 40 which contains an aqueous solution 42 of ammonia and carbon dioxide. A conduit 44 extends from the upper end of the container to the interior of the hollow roll 4. A second conduit 46 extends from the other end of the roll 4 to the bottom of the container 40.

Conduit 44 has therein a vapor or gas pump 48 and conduit 46 has fixed thereto a thermostat 50 which is connected by the wires as shown, to a switch 52 in the electrical inlet of an electrical heating element 54 beneath the container 40.

In operation the pump 48 draws vapor from the interior of the roll 4 and causes it to flow through the conduit 44 from which it exits at the bottom of the container 40 and bubbles upwardly through the aqueous solution of ammonia and carbon dioxide, the vapor evolving from the solution then flowing through conduit 46 into the hollow roll 4. The heating element 54, controlled by the thermostat 52, heats the solution in the container to within a predetermined temperature range as will hereinafter be described.

It will be noted that the systems shown and described for both embodiments of the invention are not truly closed systems in that a portion of the vapor circulated into the perforated roll 4 flows through the perforations 8 to develop the diazo-dye treated paper, and vapor can escape from the chamber 2 through vent openings or otherwise since the chamber is not sealed. Further, in the embodiment of FIG. 2, the composition of the vapor pumped from the roll 4 for circulation upwardly through the solution 42 is not the same as the composition of the vapor which evolves from the solution 42 and is circulated through conduit 46 into perforated roll 4 — this because, for one reason, at least some portion of the ammonia vapor content of the vapor circulated into the roll 4 is used up in the development of the diazo dye. The key aspect as regards the present invention, is the combination of vapors circulated into the chamber 2, via the conduits 20 or 46 and the perforated roll 4 in the apparatus shown. That is, in accordance with the invention there is circulated into the chamber 2 ammonia and carbon dioxide, both of which are in vapor, i.e., gaseous form. In both embodiments the carbon dioxide and ammonia admitted into the chamber are in a mixture with each other, and in the embodiment of FIG. 2 such mixture also includes water vapor. The composition of the mixture and the carbon dioxide to-ammonia ratio therein is dependent upon the settings of the valves 16 and 18 or the composition of the aqueous solution of carbon dioxide and ammonia from which the mixture evolves. In all cases it is desirable that the amounts of ammonia and carbon dioxide vapors conducted into the chamber be such that at least about one part by volume carbon dioxide vapor is conducted into the chamber for every 10 parts by volume ammonia vapor conducted into the chamber. As for the water vapor, it is only necessary that it be present in sufficient amounts to allow the development reaction between the ammonia and the diazo dye to take place as is well known in the art. Excess water vapor does no harm except insofar as it leads to deleterious water condensation within the chamber.

For optimum practice of the invention in connection with the preferred embodiment of FIG. 2 it is appropriate to discuss in detail the preferred composition for the aqueous solution 12.

First, the following general factors are applicable to the composition or concentration of ingredients in the aqueous solution for the practice of the invention.

1. There is no upper limit for the concentrations of the ammonia and the carbon dioxide in the solution other than the limitation imposed by their solubility in water. In this respect it should be mentioned that the presence of precipitate, which might be ammonium carbonate or ammonium carbamate, does no harm to the solution for the practice of the invention and, as will be discussed hereinafter, one manner of accomplishing concentrations of ammonia and carbon dioxide in the solution, whether for the preparation or for the maintenance thereof, is by the addition of ammonium carbonate or ammonium carbamate.

2. The lower limit for the ammonia concentration in the solution is that concentration below which the solution even when heated does not evolve ammonia vapor at a sufficient rate to perform the function of developing the diazo-dye treated paper at the rate at which treated paper is fed through the development chamber. This means that, as a practical matter, the lower limit

for the ammonia concentration in the solution is about 10% by weight. That is, for the efficient practice of the invention the solution should contain at least 10% by weight ammonia. To put this in other terms, the solution should contain approximately 1 pound per gallon ammonia.

3. The concentration of the carbon dioxide in the solution should be at least about .5% by weight or, in other words, about .05 pound per gallon of solution in order to obtain a noticeable reduction in the odor. For optimum results the amount of carbon dioxide in the solution should be about two parts by weight carbon dioxide for every three parts by weight ammonia. Further, as a practical matter, there is no advantage in having in the solution any amount of carbon dioxide which exceeds, in parts by weight, the amount of ammonia in the solution. Hence, the carbon dioxide-to-ammonia ratio, in terms of parts by weight thereof in the solution, should preferably be from about 1:1 to 1:20. When the solution contains a lesser amount of carbon dioxide there is not significant reduction in odor problem relative to those which occur when a plain ammonium hydroxide solution is used. Higher concentrations of carbon dioxide are difficult to achieve and serve to no advantage.

The following table showing three examples of solutions satisfactory for the practice of the preferred embodiments of the invention will serve to further illustrate.

	Solution A	Solution B	Solution C
Weight, pds. per gallon	8.1	8.8	9.6
CO ₂ content, percent by weight	8.4	13.9	20.9
NH ₃ content, percent by weight	22.8	20.2	18.2
H ₂ O content, percent by weight	68.8	65.9	60.9
CO ₂ : NH ₃ ratio, approximate	1:3	2:3	1:1
pH	11.1	10.7	10.0

Of these three solutions, solution B gave the best results in the machines in which it was used. Different solutions might provide optimum results in other machines.

4. In all cases, independently of the concentrations of the ammonia and carbon dioxide in the solution, the vapor mixture evolving therefrom contains ample water vapor to enable the ammonia to perform its function of developing the diazo dye.

The rate at which the aqueous solution evolves the vapor mixture is a function not just of the concentrations of the ammonia and carbon dioxide in the solution, but is also a function of the temperature of the solution. In this regard, we have found that whereas good results can be obtained where the solution is at room temperature or even a bit lower, it is preferable that the solution be maintained at a temperature of at least 80°F — this particularly, when the concentration of the ammonia in the solution is less than about 15% by weight. It is for the purpose of maintaining the solution at this temperature that there is provided, in the apparatus shown, the heating element 54, the heat output of which is controlled by the thermostat 50. Since this thermostat 50 is located on the conduit 46 and in relatively close proximity to the container 40, the temperature of the vapors flowing through the portion of the conduit to which the thermostat is attached is a suffi-

ciently accurate measure of the temperature of the solution in the container. Thermostat 50 in combination with the switch 52 is set such that when the temperature of the vapor flowing through the conduit 46 drops below a predetermined level, for example 90°F, the electrical heating element 54 is actuated so as to heat the solution until the temperature of the vapors in conduit 46 reaches a predetermined level, for example about 105°F, whereupon the heating element is deactivated. It will be understood that the heating element, the switch and the thermostat as well as the vapor pump 48 can all be of conventional construction for the performance of the intended functions as aforesaid. Further, there is nothing particularly critical about the shown arrangement of these elements. As an alternative for the heating element 54 which is in contact with and heats the container 40, the heating element can take the form of a heating coil around the portion of the conduit 44 between the pump 48 and the container whereby desired heat is supplied to the solution by way of the vapor which is caused to pass through the solution. As another alternative the heat can be supplied to the solution by way of a heating element which is immersed in the solution. As just another example of a satisfactory variation from the particular arrangement shown, the thermostat for control of the heat can be located in the solution itself rather than against the conduit 46. As regards the pump 48, the only requirement is that it have sufficient capacity to pump the vapor through the solution 42 to supply the vapor to the chamber at a sufficient rate to accomplish development of the diazo dye. Since the system used is a recirculating system whereby any unused vapor is pumped back through the solution 42, there is no significant disadvantage in having the pump operate at a capacity somewhat greater than that required to accomplish development of the diazo dye treated paper as aforesaid.

Where the solution 42 is heated, as is preferred, less heat is generally required of the heating element within the roll 4 since the vapors are heated to some extent as they reach the roll.

The preferred embodiment of the invention as described can be practiced either on a solution batch basis or on a continuous basis. By batch basis is meant that a container of the aqueous ammonia, carbon dioxide solution, with a relatively high concentration especially of ammonia, can be inserted into the system which is then operated until the ammonia in the solution dissipates to a level at which the solution can no longer supply ammonia vapor at a sufficient rate to perform the developing function. When the ammonia concentration reaches this low level the container of the solution is removed from the system and replaced with a container of fresh solution. This batch basis operation for the practice of the invention has the great virtue of simplicity. However, if desired, the system can be operated on a continuous basis — or at least for a more prolonged period than in the case of the batch basis — by provision of means for continuously or periodically replenishing the solution ingredients particularly the ammonia. To illustrate, there is shown in the drawing a tank 56 of ammonia gas which is connected to the conduit 44, a valve 58 being provided to meter ammonia from the tank into the conduit 44 and hence into the solution 12, either on a continuous or on a periodic basis, is required to maintain the concentration of ammonia in the solution 12 at the desired level. Of course,

carbon dioxide gas can be fed into the system in like manner.

For the preparation of the original solution we prefer to dissolve carbon dioxide and ammonia in water up to the desired concentrations or, alternatively, by dissolving carbon dioxide up to the desired concentration level in commercially purchased aqueous ammonium hydroxide containing the desired ammonia concentration. However, ammonia and carbon dioxide can, if desired, be added to the solution, either for the original preparation of the solution or for the maintenance of the concentration levels, by adding ammonium carbonate or ammonium carbamate.

It will be understood that while the invention has been described in detail specifically with reference to particular embodiments thereof, various changes and modifications may be made all within the full and intended scope of the claims which follow.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. In a method for developing two-component type diazo-dye coated sheets positioned in a development chamber by contacting the sheets with ammonia vapor in the presence of water vapor, the improvement which

comprises conducting into said chamber, through a conduit, a flow of a mixture of ammonia vapor, carbon dioxide vapor and water vapor, said mixture of vapors being withdrawn from an aqueous solution of ammonia and carbon dioxide in a container located exteriorly of said chamber and connected to said chamber by said conduit by passing gases exhausted from the chamber through the solution, the concentration of the carbon dioxide and the ammonia in said solution being such that the carbon dioxide-to-ammonia ratio, in terms of parts by weight thereof in said solution, is from about 1:1 to 1:20 and the concentration of the ammonia is at least about 1 pound per gallon of solution.

2. A method as set forth in claim 1, wherein said solution is maintained at a temperature of at least 80°F.

3. A method as set forth in claim 1, wherein at least about one part by volume carbon dioxide vapor is conducted into the chamber for every 10 parts by volume ammonia vapor conducted into the chamber.

4. A method as set forth in claim 1, wherein said solution is prepared by passing ammonia vapor and carbon dioxide vapor into water, either sequentially or simultaneously, to cause said ammonia and carbon dioxide to dissolve in the water.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,915,708 Dated October 28, 1975

Inventor(s) Norman A. Zausmer and Arnold S. Michlin

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

Column 3, line 41 insert --passed-- after "paper".

Signed and Sealed this

twenty-fourth Day of February 1976

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks

UNITED STATES PATENT OFFICE
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