

# United States Patent

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[54] **GAS DEVELOPING APPARATUS**  
6 Claims, 3 Drawing Figs.

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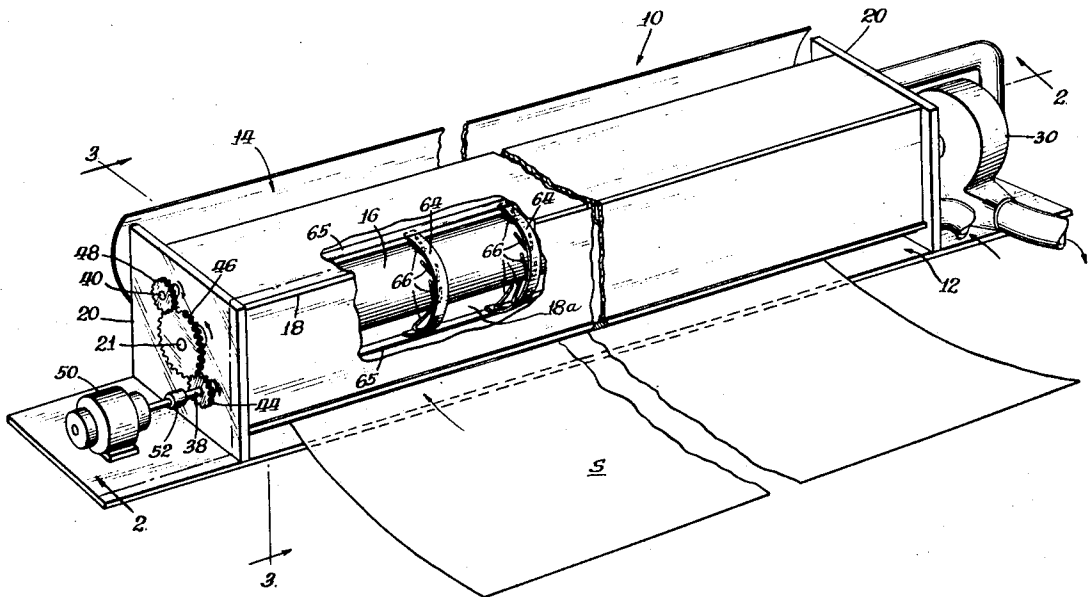
[50] Field of Search.....  
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**ABSTRACT:** A developer unit comprising a developing chamber, gas generator and a blower. The developing chamber is provided with flexible entry and exit sealing members and a transporting unit within the chamber to transport a copy sheet therethrough between the entry and exit members. The gas generator is connected to the chamber by independent inlet and outlet conduits. The blower is used to circulate a predetermined volume of gas from the generator within the chamber and back to the generator.



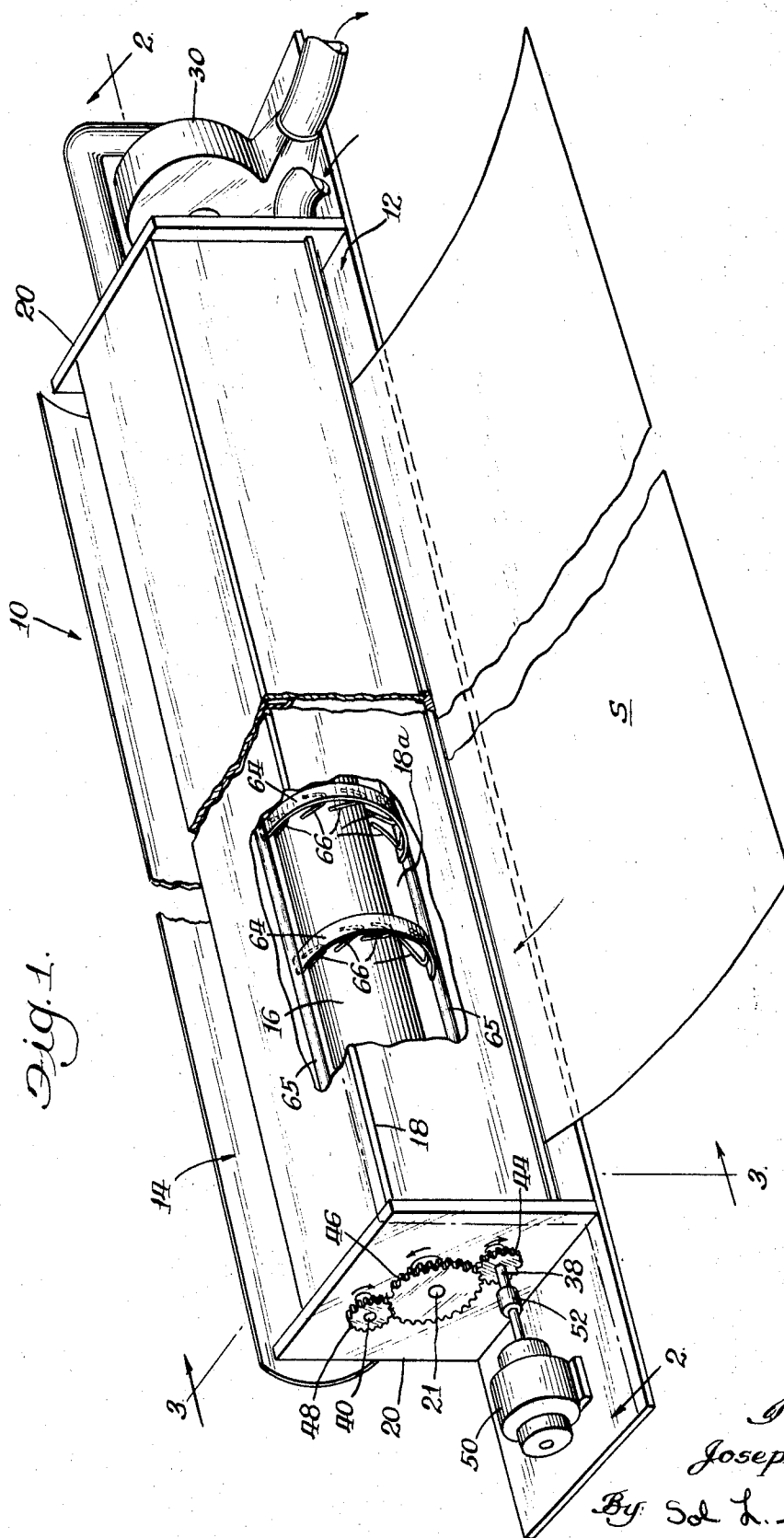
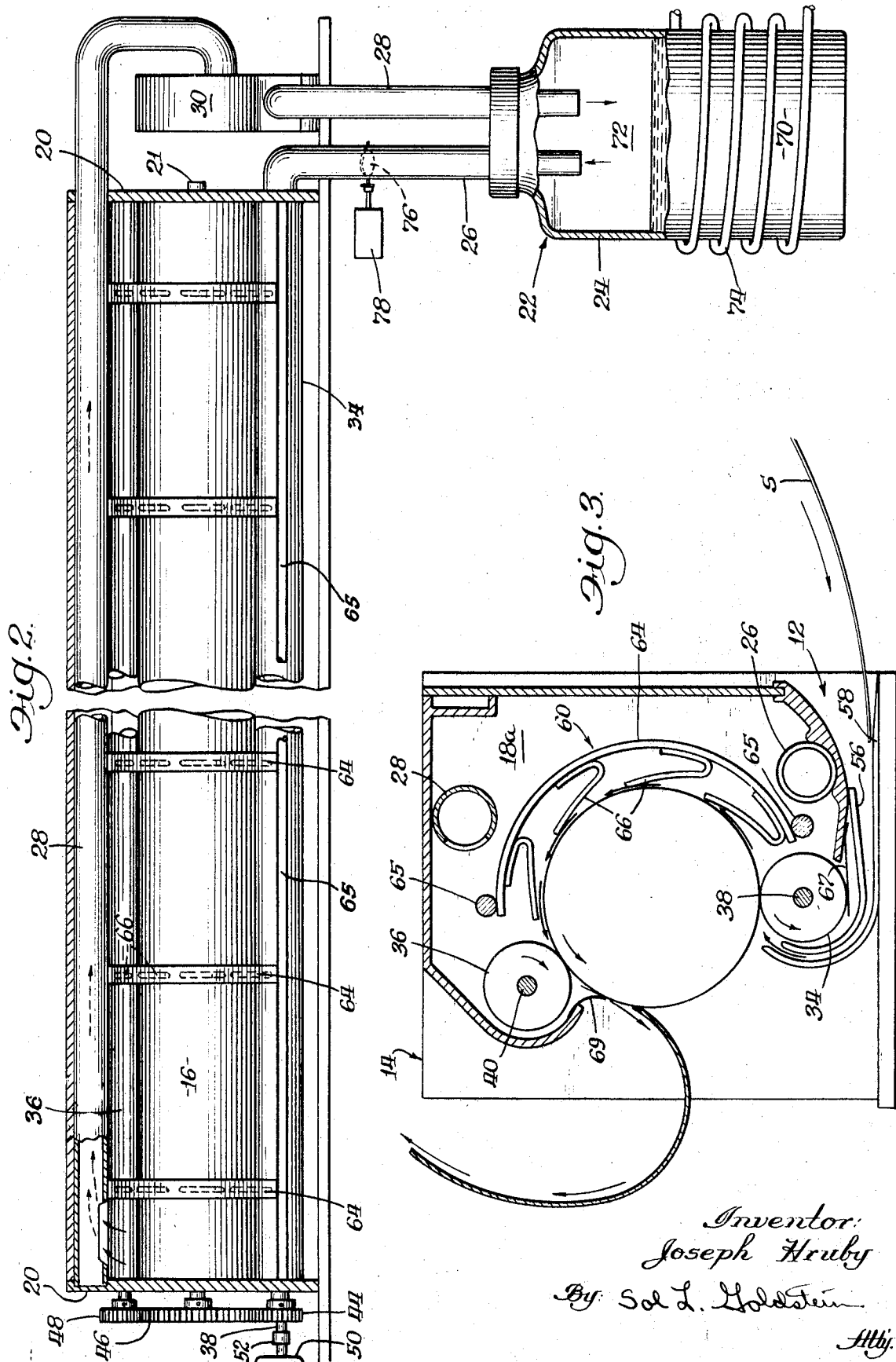


Fig. 1.

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## GAS DEVELOPING APPARATUS

This invention relates to gas type developing apparatus for developing light-sensitive sheet material and, more particularly, to an arrangement for supplying a gas enriched atmosphere generated at a location remote from the developing site for use when copy sheets are being developed and stopping the supply during idle periods.

In the photocopying art, a two-component diazotype light-sensitive material, which has first been exposed to a light image, is developed to produce thereon an azo-dye image by bringing the copy sheet into contact with a humidified atmosphere of ammonia vapor. The ammonia vapor is produced by heating an ammonium hydroxide solution or by the use of anhydrous ammonia gas. The construction of known copying equipment for developing copy sheets of this type involves the use of a gas chamber in which the ammonia vapor is generated directly from a tank containing ammonium hydroxide solution or the ammonia vapor is piped in from tanks of anhydrous ammonia which is admixed with water vapor generated within the gas chamber. Generally, the equipment is maintained in a full operating condition during the working day once it has been started up, which means that the ammonia gas producing instrumentalities are in continuous operation while the machine is on.

The gas producing instrumentalities usually call for circulatory pumping equipment which continually supplies fresh ammonium hydroxide and/or anhydrous gas into the chamber maintaining the chamber in a state of readiness to receive the copy sheets.

Photocopying machines relying on the gas developing process as a means for producing copies, are desirable because the process is dry, obviating the need for bringing liquid materials into direct contact with the copy sheet for development; it produces azo-dye images of high density; and is capable of developing copies at a rapid rate. Inherent in the use of such equipment is the requirement to place it under exhaust to the outside atmosphere in order to remove the noxious ammonia vapor from the working environment.

Another problem experienced with these developing devices is the condensation of the water vapor on the humidified developing chamber resulting in the deposition of condensate on the rollers or belts which convey the copy sheet through the chamber so that when the copy sheet comes in contact with the wet surfaces, it mars the image. Accordingly, shutting down the developing chamber at the end of the copy making operation requires controlling the environment therein, such as the use of heaters in order to prevent the condensate from forming.

It will be appreciated from the foregoing discussion that due to the complexity of the heretofore known gas developing equipment, its advantages were not available in small desk-top copiers for office use where the copying demand is, at best, occasional or only intermittent. The requirements for complex feed systems and heating systems related to the developing chamber made such equipment impractical and too expensive for the low-cost machine copying field.

Attempts have been made to produce a machine which has a simplified gas chamber construction in which the ammonium hydroxide is flushed through an open channel in the developing chamber in order to enrich the atmosphere with ammonia and immediately drained out. While this provides a simplified arrangement, the concentration of gas in the chamber will vary greatly leaving it to the judgment of the operator to determine when the chamber is again to be exposed to ammonium hydroxide solution.

Now, in accordance with the present invention, a simplified, inexpensive gaseous developing apparatus designed for the intermittent copy demands occasioned in office-type installations is provided which ostensibly eliminates the need for auxiliary exhaust equipment, is simple to operate, which produces high quality copies consistently.

A primary object of the present invention is to provide a simplified, low-cost, gaseous developing apparatus capable of

intermittent use which employs a humidified-ammonia enriched atmosphere in the developing chamber.

Another object is to provide an improved gas developing apparatus in which the ammonia enriched and humidified developing atmosphere is circulated through the developing chamber having been generated at a location remote from the chamber and which apparatus does not require exhaust to the outside atmosphere.

It is another object to provide a developing apparatus in which the copy sheet passes through an ammonia enriched atmosphere which is force circulated through the chamber.

It is another object of this invention to provide an improved developing method for developing copy material by passing it through an enclosed chamber filled with an ammoniacal vapor enriched atmosphere, said atmosphere being generated and maintained at a predetermined level of enrichment at a station remote from the developing chamber.

In accordance with these and many other objects an embodiment of this invention comprises a gas developing chamber formed by enclosing a copy sheet conveying assembly with an outer shell. The sheet conveying assembly for carrying the exposed diazo copy sheet through the chamber comprises a large drum rotatably mounted within the enclosure. A feed-in station and an exit station are provided by rollers placed in driving engagement with the periphery of the copy drum, one located at each station. The distance around the periphery of the drum between these stations determines the minimum length of copy that can be safely handled by the copy carrying assembly.

The gas developing chamber that is formed in the space around the copy conveying assembly is closed due to the atmosphere in its immediate vicinity by sealing means located at the respective stations. The opening between the shell and the respective rollers is effected by flexible flap means which contacts the feed-in roller along its entire extent and at the exit station, closure is effected by a similar flap urged against the drum so as to have the nipping portion between the exit roller and the drum contained within the enclosure. The flap at the exit portion is sufficiently flexible so that the sheet of paper being advanced by the exit roller and the drum can lift the flap in order to move out of the enclosure. The aforescribed sealing technique is intended to close off the atmosphere inside the chamber so that it is prevented from mixing with the general room atmosphere in which the apparatus is located.

A series of guide members are disposed around the periphery of the drum surface guiding the copy sheet in a path around the periphery of the drum leading to the nip between the exit roller and the drum. In this manner the path of the copy sheet is controlled so as to assure the lead edge entering the nip between the exit roller and the drum while the tail of the copy sheet is still under the influence of the roller at the entryway.

The gas developing atmosphere that is necessary to create the environment in which an azo-dye image can be formed is produced in a gas generator remote from the gas developing chamber proper. The gas generator can comprise any means for producing an ammonia enriched-humidified atmosphere captured in a closed container. In the instant invention, a large closed container is partially filled with a concentrated ammonium hydroxide solution maintained in a temperature range from room temperature to about 100° F., preferably slightly above room temperature. The atmosphere above the liquid will contain an amount of ammonia and water vapor equal to the vapor pressure of the ammonia and water vapor at the particular temperature. The portion of the gas generator above the liquid level is placed in communication with the gas chamber through suitable air ducts leading into and out of the gas chamber and having an exhaust blower in the exit duct from the chamber to the gas generator. In this manner, an ammonia vapor enriched-humidified atmosphere is applied to the chamber on demand and the supply stops when the blower stops. Except for the residual atmosphere in the chamber, the supply of ammonia to the chamber stops when the demand for

copying stops. The force circulation keeps the concentration of ammonia in the system at a level that is in equilibrium with the ammonia content of the liquid in the gas generator. As ammonia is depleted from the atmosphere it is continually replenished as it is recirculated through the gas generator.

It has been found that in the technique embodied in this invention the concentration of ammonia in the atmosphere produced in the gas generator and the humidity of the atmosphere are sufficiently high to insure proper development of the copy material processed through the developer unit. It has been found that starting with a 26 Baumé ammonium hydroxide solution maintained at 70-75° F. the ammonia that can be produced in a developing chamber of approximately 0.3 cubic feet is sufficiently concentrated to rapidly develop a dense azo-dye image. The concentration of ammonia and relative humidity can be maintained as the Baumé of the solution in the gas generator decreases due to the depletion of ammonia used up in developing the azo copies, by increasing the temperature of the solution. For example, at 24-25 Baumé, the abovedescribed ammonia concentration and relative humidity can be maintained by heating the solution in the gas generator to a temperature of 80-90° F. At a 22-23 Baumé value the effectiveness of the solution can be maintained by increasing its temperature to 90-100° F. This process of heating the charge solution may be kept up until the solution reaches a Baumé value of 20-21 which is deemed a practical limit beyond which the evolution of ammonia requires greater heat input. However, if desired, heating the solution may be continued at lower Baumé levels.

Other materials may be used as the source of ammonia vapor other than ammonium hydroxide such as  $(\text{NH}_4)_2\text{CO}_3$  contained in an inert fluid such as silicone oil or paraffin oil. The ammonia carbonate is placed in the gas generator 24, covered with the inert liquid and when heated to suitable temperature, ammonia gas bubbles through the inert liquid layer. The liquid seals the  $(\text{NH}_4)_2\text{CO}_3$  during periods when no copies are being made.

At the relative humidity levels described above, the problem of condensate accumulating in the developing chamber is obviated.

Many other objects and advantages of the present invention will become apparent from considering the following detailed descriptions in conjunction with the drawings in which:

**FIGURE 1** is a perspective view of the developing apparatus of this invention with portions of the outer shell broken away to show the sheet conveying assembly;

**FIGURE 2** is a sectional view taken along line 2-2 of **FIG. 1** showing the gas generator connected to the gas chamber;

**FIGURE 3** cross sections the developer apparatus taken along line 3-3 of **FIG. 1**.

Referring to **FIGURES 1** and **2**, there is shown an embodiment of the gas developing apparatus of this invention, generally indicated as 10, having an inlet 12 for receiving a copy sheet S and a copy delivery station 14 for receiving the developed copy sheet. Enclosing a rotatably mounted drum 16 there is provided a rectangularly shaped box or shell 18 including side walls 20 which serve to support the drum mounted on a shaft 21 which is received in suitable bearings through the side walls. Enclosure 18 surrounding the drum provides a gas developing chamber 18A which is in communication with a gas generating assembly 22 (**FIG. 2**), comprising a gas generator 24 equipped with a feed and exhaust conduit 26 and 28, respectively, and the motor operated blower 30 to force circulate the active gaseous medium passing through the conduit system.

The transport of the copy sheets, as is best shown in **FIG. 3**, fed in from the inlet 12 to the copy delivery station 14, is accomplished by the rollers 34 and 36 mounted on shafts 38 and 40, respectively, and being rotatably mounted within the chamber 18A between the side walls 20 and in rolling contact with the drum 16. The rollers 34 and 36 are spaced from each other around the periphery of the drum a predetermined distance; it is this distance which determines the shortest

length of paper which the developer unit will be capable of handling. The drum 16 and roller 36 are driven through a gear train comprising gears 44, 46 and 48 axially mounted on the extensions of the shafts 38, 21, 40, respectively. The shaft 38 is driven by a motor 50 through a coupling connection 52 thereby driving the copy transport assembly.

The inlet 12 is formed of a pair of converging, curved guideplates 56 and 58 so as to form a guideway that changes direction of the copy sheet approximately 180° after it enters the inlet 12, directing it to the nip between the drum 16 and the feed roller 38. Superimposed around the drum is a paper guide structure 60 comprising a series of arcuately shaped supports 64 at spaced intervals along the length of the drum mounted on the tie rods 65 disposed between the walls 20 and extending circumferentially around the drum covering the distance between the rollers 34 and 36. The copy sheet S may be more positively urged to conform to the surface of the drum by the use of projecting fingers 66 which are made of a resilient plastic or light metal construction. With the aid of the paper guide structure 60 the copy sheet is positively directed through the chamber along a predetermined path to the nip formed between the roller 36 and the drum 16 where it is gripped and driven to the copy delivery station 14.

In order to complete the closure of the gas chamber 18A from the atmosphere at the point where the shell 18 meets the rollers 34 and 36, flexible flap extensions 67 and 69 are provided which form seals between the roller 36 and the shell 18 and between the shell 18 and the drum in the case of flap 69. The flaps may be formed of a thin flexible sheet metal or plastic material. Sealing flaps made of a fluorocarbon polyester material sold under the trade name "Teflon" have been very successful since they are sufficiently resilient to engage the particular rotating surface, and have a low coefficient of friction which permits the copy paper to escape this resilient force of the flap.

Referring to **FIG. 2** the gas generator 24 may comprise any closed vessel such as, for example, a large polyethylene bottle ranging in capacity from 3 to 10 liters into which is charged the source of the ammonia vapor 70. In the preferred embodiment a 26 Baumé solution of ammonium hydroxide is used. The vessel 24 is filled to about one-half to two-thirds its capacity leaving an air space 72 above the liquid level into which is accumulated the ammonia and water vapors.

The gas generator is charged with a 26 Baumé ammonium hydroxide solution (29.4% molal concentration of ammonia) and permitted to come to room temperature. Upon the start-up of the developer apparatus, the blower 30 is energized which begins to circulate the air from the gas chamber 18A through the air space 72 where it becomes enriched with a sufficient concentration of ammonia vapor and water vapor to develop a diazo copy passing through the chamber at the rate of 6 to 8 feet per minute.

In the instant invention the gas chamber may range from 0.25 cubic feet to 0.5 cubic feet, preferably about 0.3 cubic feet, is maintained with a sufficient concentration of ammonia-water vapor from a 3 to 5 liter supply of 26 Baumé ammonium hydroxide maintained at 55° to 75° F. After several hours of operation, the Baumé value of the ammonium hydroxide drops due to the depletion of ammonia from the system and, hence, the vapor pressure correspondingly decreases. Obviously, the depletion of ammonia occurs due to the usage of ammonia in carrying out the development of copy sheets and also from the small amounts of leakage from the system.

To correct for the decrease in ammonia concentration resulting from the lower vapor pressure, the solution in the gas generator is heated by means of a heating coil 74 or other suitable means to a temperature of 80° to 90° F. thereby increasing the vapor pressure. The use of heat in this manner may be continued until the Baumé value drops to about 20 which is the practical level at which the liquid in the generator emits ammonia. It can be heated until still lower Baumé levels, but the efficiency drops off. It has been found that from an ini-

tial charge of 3.8 liters of 26 Baumé the apparatus will process between 32,000 square feet to 36,000 square feet of diazo copy processed through a gas chamber having a volume of 0.3 cubic feet and passing through at the rate of 7 feet per minute.

The apparatus is placed in operation at the time it is required to reproduce one or more diazo copies by starting the drive motor 50 which simultaneously energizes the blower 30 which pulls the atmosphere from the chamber 18A and exhausts it into the air space 72 of the gas generator through the conduit 28. The force flow of air into the space 72 causes it to absorb the ammonia-water vapors and return in an ammonia enriched condition through the return conduit 26.

As soon as the blower 30 is turned on the operator may begin feeding the copy sheets into the inlet 12 to be developed. At the conclusion of the developing cycle the operator turns off the machine by turning off the drive motor 50, as soon as all copies clear the apparatus, which turns off the blower and stops the flow of ammonia to the chamber 18A. In its inoperative condition only the residual ammoniacal atmosphere remains in the chamber 18A which is contained by the sealing flaps 67 and 69.

The return conduit 26 may optionally be equipped with a conventional shutoff damper 76 that can be manually operated or electrically controlled such as by a solenoid 78 concurrent with the energization or deenergization of drive motor 50 in the same manner as the blower. The damper 76 closes the chamber 18A from receiving any wafts of ammonia through the conduit 26 during periods of inoperation. The blower in the conduit 28 closes off the access from the gas generator to the chamber.

I claim:

1. A gas developer unit adapted for the intermittent processing of two-component diazotype copy sheets, the combination comprising:

a gas developing chamber closed from the general atmosphere providing a predetermined gas processing volume,

separate entryway means and exit means for processing said copy sheet through the chamber,

sealing means provided at both said entryway means and said exit means for permitting ingress and egress of a copy sheet to said chamber while maintaining said chamber substantially sealed from the general atmosphere,

copy transport means within said chamber for transporting said copy sheet through said chamber between said entryway means and said exit means along a predetermined path therebetween, for exposing said copy sheet to said gaseous atmosphere therein,

independent gas generating means located outside said chamber for generating a supply of ammonia vapor,

conduit means placing said gas generating means in two-way communication with said gas chamber, and

control means including damper means in said conduit means for controlling the flow between said generating means and said chamber and blower means coupled to said conduit means, said damper and blower means

being operable between a copying and off condition for controlling the movement of ammonia vapor from said generating means into said chamber and from said chamber back to said generating means, said damper and blower means both being operated in said copying condition whereby said predetermined volume is circulated through said generating means during the copying condition and during the off condition forced circulation ceases.

2. The developer unit as defined in Claim 1 wherein said generator includes a reservoir containing an aqueous ammonia liquid for generating said gaseous agent.

3. The developing unit as defined in Claim 1 wherein said gas generating means is charged with an ammonia gas producing material to a level less than its capacity to provide an air space thereabove whereby said ammonia gas is permitted to accumulate in said air space.

4. The developing unit as defined in Claim 3 wherein said gas producing material is a concentrated aqueous ammonium hydroxide solution ranging from 20 Baumé to 26 Baumé.

5. The developing unit as defined in Claim 1 wherein said gas generating means includes heater means for heating the ammonia producing agent.

6. A developer unit for developing a diazotype copy sheet comprising:

A developing chamber sealed from the general atmosphere,

separate entryway and exit means provided in said chamber for processing a copy sheet through said chamber,

sealing means provided at both said entryway means and said exit means for permitting ingress and egress of a copy sheet to said chamber while maintaining said chamber substantially sealed from the general atmosphere,

copy transport means within said chamber for moving said copy sheet through said chamber between said entryway means and said exit means, for exposing said copy sheet to said atmosphere therein, said copy transport means including a rotatable drum and paper guide means comprising a resilient conforming guide member disposed adjacent the surface of said rotatable drum for urging a copy sheet to conform to the surface of the drum as the copy sheet is moved thereby through said chamber,

gas generating means located outside of said gas developing chamber for generating a diazo-developing gaseous agent, and

means connecting said gas generating means and said gas chamber, comprising a gas supply conduit and gas return conduit for respectively conducting developing gas from said generating means to said chamber and from said chamber to said generating means, and circulating means associated with said conduit means for positively circulating a predetermined volume of developing gas from said generating means through said conduit means and said developing chamber.