Aug. 24, 1965 R. G. OSTENSEN 3,202,526

METHOD AND APPARATUS FOR LIQUID DEVELOPMENT OF LATENT IMAGES

Filed Oct. 5, 1961

2 Sheets-Sheet 1

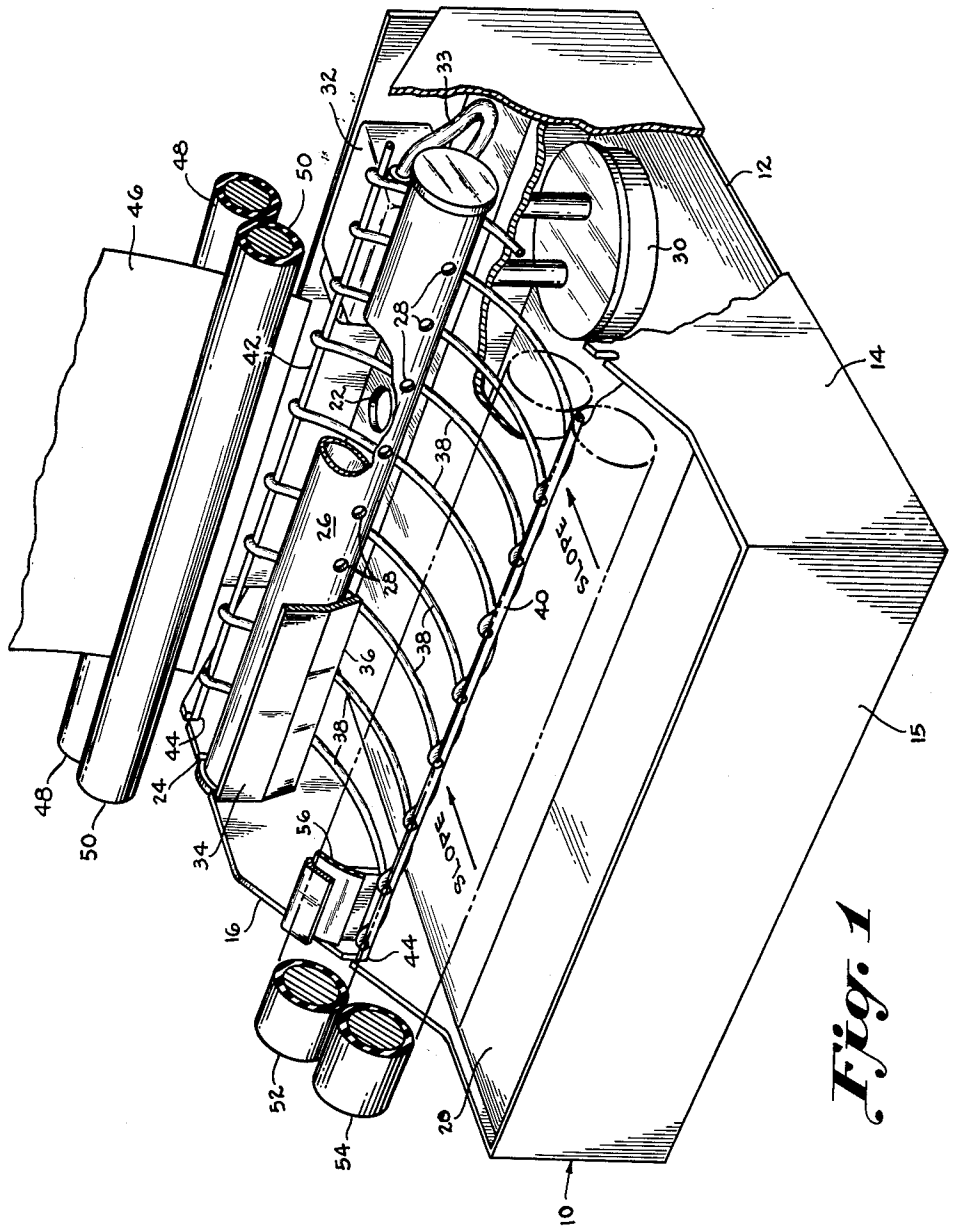


Fig. 1

INVENTOR.
RALPH G. OSTENSEN

BY

Strauch, Nolan & Neale
ATTORNEYS

Aug. 24, 1965 R. G. OSTENSEN 3,202,526

METHOD AND APPARATUS FOR LIQUID DEVELOPMENT OF LATENT IMAGES

Filed Oct. 5, 1961 2 Sheets-Sheet 2

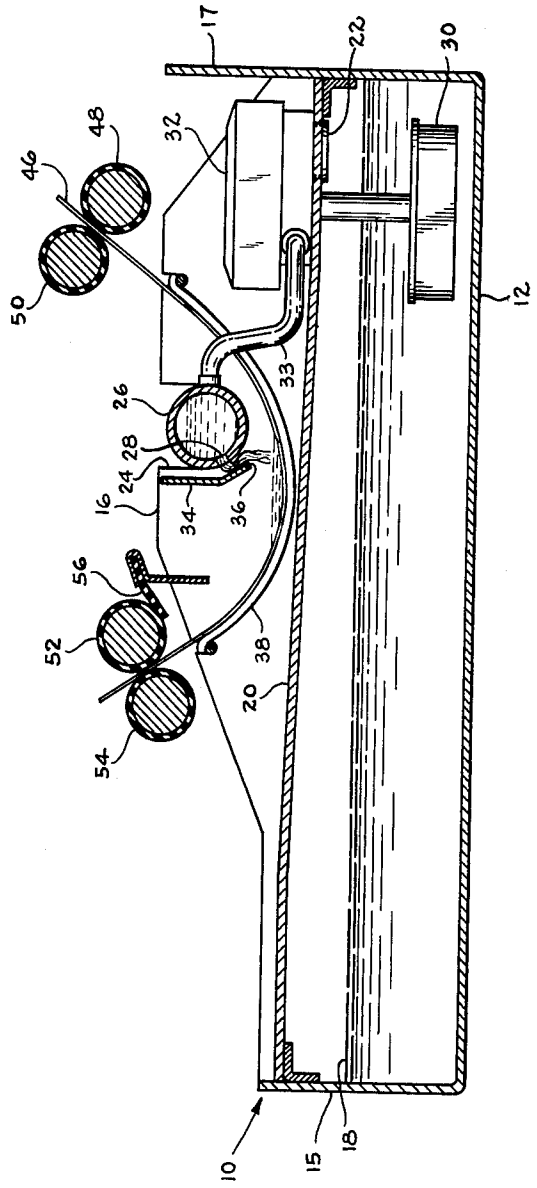


Fig. 2

INVENTOR.
RALPH G. OSTENSEN

BY

Staudt, Nolan & Neale
ATTORNEYS

United States Patent Office 3,202,526 Patented Aug. 24, 1965

3,202,526

METHOD AND APPARATUS FOR LIQUID DEVELOPMENT OF LATENT IMAGES

Ralph G. Ostensen, Morton Grove, Ill., assignor to SCM Corporation, a corporation of New York

Filed Oct. 5, 1961, Ser. No. 143,086
14 Claims. (Cl. 117—37)

This invention relates to the field of photographic developing and more specifically to a tank device for liquid developing latent images which have been placed on photographically coated carriers and particularly carriers of the direct positive paper type.

While the present invention is of general applicability to photographic printing it will be described in connection with the development on a carrier or sheet of a latent electrostatic image which may be formed in accordance with well-known electrophotography techniques. A carrier, which may be a sheet of paper coated with a photoconductive insulating material such as zinc oxide, may be charged by charging electrodes, such for example as shown in Patent No. 2,922,883 to thereby have a homogeneous electric field. The electric field is subsequently selectively discharged or released by light from an image to be recorded. At locations on the carrier where little or no light impinges, the electric field is of a strength sufficient to attract electrostatically charged pigment and thus produce a graphic copy.

In the prior art, it has been common to use dry electroscopic powder for conversion of a latent electrostatic image into a visible image. One novel feature of the present invention resides in the method of applying the electrostatically charged pigment to the carrier wherein the pigment is carried as a suspension in a liquid to thus provide a liquid developer. While the liquid developer offers advantage in contrast and degree of resolution of the image on the copy carrier, complete saturation of the carrier results and much time loss and inconvenience occurs due to the drying period required after developing.

A primary object of this invention is to provide a novel method and apparatus for performing the method, whereby only a very small portion of the carrier is dampened at a time, and only the coated surface is ever dampened thereby avoiding saturation of the carrier and providing a substantially dry copy which is ready for immediate use.

This method and apparatus basically involves guiding an exposed photographic carrier with continuous movement beneath a header pipe as by means of a curved rack and causing a gentle flow of liquid developer to cascade or trickle down onto a short length but across the full width of the declivity of the curved portion of the coated surface of the carrier. Thus, only a small length of the coated surface is dampened at a time and on one side only of the carrier. The excess liquid drains off laterally from both sides of the carrier and returns to the tank. Due to the fact that the carrier is not saturated, the carrier is sufficiently dry when it emerges from the tank of an office type copying machine to be ready for immediate use in an office.

Another object of this invention is the provision of a novel circulating system for the liquid developer affording minimum exposure of the liquid developer to light and air, resulting in longer developer life, and including a novel developing unit equipped with a header type developer dispenser for more even distribution of developer over the coated surface of the exposed carrier.

A further object of this invention is the provision of a capable developing unit sufficiently compact to be installed inside a office type photographic printer as an integral part thereof whereby a latent image on a carrier

may be developed immediately after the image is produced in the carrier before the carrier emerges from the machine.

Still another object of this invention is the provision of a pump capable of maintaining a pumping capacity in a balanced ratio with the header pipe, and keeping the header pressure constant at all times regardless of the developer level in the tank reservoir. The header pipe is provided with numerous apertures of a predetermined diameter along its length, and has a volumetric capacity precisely balanced with the volumetric output of the pump. Excessive pressure build-ups in the header are thus prevented and a substantially gravity flow is provided which, when applied to a baffle plate, permits the developer to cascade and being evenly distributed across the entire width of the carrier surface as a thin film with small impact force and thus causes a minimum amount of wetting of the carrier, and uniform development.

These and other objects will become more fully apparent from the claims, and from the following detailed description taken in conjunction with the accompanying drawings showing a preferred embodiment in which:

FIGURE 1 is a partially cut-away perspective of the tank, showing the relative positions of the plate guide rack, header pipe, pump and carrier feeding mechanisms;

FIGURE 2 is a schematic sectional view in elevation of the developing unit showing the carrier on the guide rack and also showing the relatively small length of the carrier covered by the liquid developer.

Referring now to the drawings, the developing apparatus of the present invention consists of a tank or container 10, which may be of rectangular configuration having bottom wall 12 and side walls 14, 15, 16 and 17 into which the liquid developer may be poured. The upper surface of the liquid developer 18 is substantially below a top wall 20 of tank 10. Top wall 20 slopes downwardly from a relatively high position at the left as viewed in FIGURE 2 to a relatively lower position at the right and contains a central aperture 22 at a depression through which liquid on the upper surface 20 may pass into the interior of tank 10.

Side walls 14 and 16 extend above upper wall 20 and may be notched at 24 to receive hollow header tube 26. Header tube 26 is provided with plurality of apertures 28 which extend substantially across the width of the developer unit. The liquid developer is applied to header 26 by a pump 30 which is immersed in the liquid developer and driven by motor 32. The outlet of pump 30 is connected by hose 33 to header 26. The volume of the header 26 and the number and diameter of apertures 28 are so chosen relative to the capacity of pump 30 that the liquid does not spray under appreciable pressure from apertures 28, but instead passes through the apertures in streams having a relatively low pressure.

Facing apertures 28 is a baffle plate 34 which is suitably mounted in opposite side walls 14 and 16 of tank 10. As best shown in FIGURE 2, baffle plate 34 is curved so that its lower edge 36 extends beneath a vertical line passing through apertures 28 whereby the liquid developer passing through apertures 28 cascades or trickles onto the baffle plate 34 and downwardly onto a carrier when one is present. If no carrier is under header 26, the liquid drops onto upper surface 20 of tank 10 and runs back into tank 10 through aperture 22.

A carrier guide rack composed of a plurality of wires 38 is best shown in FIGURE 1 and is located beneath header 26 and above the tank upper surface 20, and may have a pair of laterally extending wires 40 and 42 that engage slots 44 in the side walls of tank 10. The parallel extending wires 38 are secured as by being bent over and

soldered to lateral wires 40 and 42. The guide rack is sub-assembly which is easily removable and thus of inexpensive construction. Wires 38 are spaced apart and do not interfere with the free flow of developer fluid from apertures 28 in header 26 back onto surface 20 of the tank unit when no carrier is in position to be developed. Wires 38 do not retain or impede the flow of liquid developer to any appreciable extent and when the carrier material passes over wires 38, very little if any liquid is on wires 38 which gets on the rear or bottom surface of the carrier sheet.

Carrier 46 may be continuous web or separate pieces of paper cut into lengths of predetermined size, at least as great as the distance between successive drive rollers. A latent image in carrier 46 may be provided as by exposure to a releasing radiation at a position in the machine which lies in the carrier path at a location immediately ahead of the developer tank just described. Carrier 46 is guided downwardly as by two lead-in rollers 48 and 50 along a path into the space beneath header 26 and above the upper surface 20 of tank 10. The carrier guide rack composed of wires 38 directs carrier 46 in its path through the flowing developer fluid at a location near the lowest position in the path of the carrier and upwardly away from tank 10 into two additional squeezing rollers 52 and 54.

The liquid developer in tank 10 is circulated by pump 30 through tube 33 into header pipe 26 and forced out gently (not sprayed) by the slight pressure built up inside header pipe 26. The liquid is pumped at an even rate regardless of the liquid level in the tank 10 so long as the pump inlet is covered, and the relative capacities of pump 30 and header pipe 26 are such that pressure never builds up to a point where liquid is sprayed from apertures 28 in header pipe 26. The liquid flows out of apertures 28 of header pipe 26 against baffle plate 34 where it cascades or trickles down onto the coated surface of the carrier 46 to provide a more evenly distributed stream than if the liquid sprayed directly onto the coated surface of carrier 46. The absence of a pressure spray of the developer liquid onto carrier 46 also minimizes the amount of liquid absorbed by the carrier.

Carrier 46 continues following the guide rack wires 38. Due to the curvature of guide rack wires 38, the liquid 18 (see FIG. 2) covers only a very short length at the curved portion of carrier 46 and runs laterally off the edges of carrier onto upper surface 20 of tank 10 and back into the reservoir inside tank 10 through aperture 22. Carrier 46 is at no time completely saturated as the rear surface is normally never in contact with the liquid developer.

As carrier 46 continues on through the developing unit, its leading edge is picked up by two squeezing rollers 52 and 54 which move carrier 46 upwardly out of the developer station beneath header 26 and remove excess moisture from the upper moistened surface of carrier 46. At least one of rollers 52 and 54 is preferably a resilient material, such as rubber, so that the carrier 46 is subjected to sufficient pressure to cause any liquid remaining on the surface to be rolled from the surface of carrier 46 or onto wiper blade 56 and back onto top surface 20 of tank 10 at an angle substantially equal to the tangential angle of the carrier at the terminal face.

From the foregoing it is apparent that there is no complete saturation of carrier 46 at any time and the squeezing operation between rollers 52 and 54 results in a substantially dry copy ready for immediate use. It is further apparent that the useful life of the developing fluid is greatly extended because only a small portion of the effective material in the developing fluid is absorbed into the carrier due to the small area of the carrier contacted by the developing fluid and due to the short period of time during which the fluid is exposed to the air and to light. Air and light have a very deleterious effect on liquid developers and keeping the exposure time to a minimum affords greatly increased utilization of a given

amount of developing fluid. Furthermore, minimizing the exposure to light and air and carrier contact permits the use of a constant development time for the life of the developer fluid so that no controls are necessary to adjust or change the speed at which the carrier passes through the developing unit.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiment is therefore to be considered in all respects as illustrative and restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed and desired to be secured by United States Letters Patent is:

1. In the method of developing a latent electrostatic image placed on a sheet by application of a liquid developer on the sheet, the improvement comprising the steps of guiding the sheet containing a latent electrostatic image downwardly toward a developer station; deflecting the leading edge of the sheet upwardly by guide means solely contacting the lower surface of the sheet to thereby provide a curved sheet portion at the developer station having a declivity; evenly distributing the liquid developer as a thin film uniformly across the sheet in a direction perpendicular to its direction of travel only on the upper surface of the declivity of the curved sheet at the developer station by depositing the liquid developer on the sheet surface through gravity fall from a supply means that is spaced from the upper surface of the latent image on the sheet to provide total sheet coverage with a minimum penetration of the liquid into the upper sheet surface and substantially no contact by the lower sheet surface with said liquid developer; and removing excess liquid from the sheet while the sheet is adjacent the developer station to produce an image on a substantially dry sheet.

2. A method of developing a latent electrostatic image placed on a sheet by application of a liquid developer comprising the steps of: guiding an end edge of said sheet containing the latent electrostatic image for continuous movement downwardly to a developer station and upwardly away from the developer station to thereby provide a curved sheet portion at the developer station having a declivity; providing a gentle flow of liquid developer onto the upper surface of the declivity of the sheet at the developer station with the liquid flowing laterally across the sheet and off a sheet side edge; and removing the excess liquid from the sheet as the sheet is moved upwardly away from the developer station to provide a substantially dry sheet.

3. The method as defined in claim 2 wherein the gentle flow of liquid developer is provided by cascading of the developer liquid from a header onto a baffle plate which is spaced to be out of contact with the upper surface of the sheet and thence onto said sheet.

4. Apparatus comprising a container for a liquid developer; guide means comprising an open rack for directing a sheet with a latent image on its upper surface downwardly to a position above the developer liquid surface in the container without immersion of the sheet in the liquid and without contacting the upper surface of said sheet and for directing the sheet upwardly to cause the sheet to be curved downwardly to form a declivity at a location nearest the developer liquid surface thus causing the sheet to be in contiguous engagement with the guide means along the entirety of the length of the guide means; means for applying the liquid developer to only one surface of said sheet so that the liquid developer runs down into the declivity and off the side of the sheet into said container to thereby completely moisten the one surface at the declivity; and

means at the end of said guide means for removing said sheet from said rack.

5. Apparatus comprising a container for a liquid developer; guide means comprising an open rack for directing a sheet downwardly to a position above the developer liquid surface in the container without immersion of the sheet in the liquid and without contacting the upper surface of said sheet for directing the sheet upwardly to cause the sheet to be curved downwardly to form a declivity at a portion nearest the developer liquid surface; means including a baffle plate above and out of contact with said sheet for causing the liquid developer to cascade onto only one surface of said sheet at the declivity of said sheet so that the liquid developer runs down into the declivity as a thin film and off the side of the sheet into said container to thereby completely moisten the entire width of the one sheet surface at the declivity; and squeeze rollers immediately above, horizontally adjacent and spaced from the terminal end of said guide means, the squeeze rollers abutting each other so as to receive the sheet at an angle substantially equal to the tangential angle of the sheet at the terminal face of the guide means for removing said sheet from said rack and for removing excess liquid developer from said sheet.

6. Apparatus comprising a container for a liquid developer; guide means comprising an open rack for directing a sheet downwardly to a position above the developer liquid surface in the container but without immersion of the sheet into the liquid developer and without contacting the upper surface of said sheet for directing the sheet upwardly to cause the sheet to be curved at a portion nearest the developer liquid surface; a header having apertures spaced across the width of the sheet and located above the curved portion of said sheet to release said liquid under substantially gravity flow; pump means for supplying the liquid developer to said header thus allowing the liquid developer to run out of said apertures by means of a gravity drop onto the curved portion of said sheet and off the sheet sides into said container; and squeezing roller means for removing excess liquid developer from said sheet.

7. Apparatus as defined in claim 6 wherein said header apertures face away from the curved portion of said sheet and further comprising a baffle plate, above and out of contact with said sheet, facing said header apertures and against which the liquid developer falls from said header apertures, said baffle plate being slightly removed from said header to thereby allow the developer to trickle from the baffle plate as a thin film and to be gravity dropped onto said sheet member and thus cover the entire width of the sheet normal to its direction of travel through said apparatus.

8. Apparatus as defined in claim 7 wherein the baffle plate comprises a curved continuous member having a lower surface extending vertically beneath the header apertures to thereby provide an edge surface over which the liquid developer gravity drops to provide a substantially continuous thin sheet of flowing liquid developer to thereby moisten but avoid saturation of the entire width of the sheet member.

9. Apparatus comprising a container having bottom and side walls and a top wall having an apertured depression through which liquid on the upper side of said top wall returns into said container; an apertured header mounted above the top wall; pump means for circulating developer liquid from said container into said header and from the header apertures onto said top wall and back into said container; paper guiding means comprising a pair of cross members supported by said container side walls and a plurality of spaced paper guiding members secured at opposite ends to said cross members, the header means and the guiding members cooperating to receive the paper therebetween so as to cause the paper to be spaced from the header means and at the same time causing the paper to be in contiguous engagement with the guiding members, said paper guiding members extending beneath the header and above said top wall; and means at opposite ends of said paper guiding means for driving the paper through said apparatus.

10. Apparatus as defined in claim 9 further having a baffle plate above and out of contact with said paper guiding member, facing said header apertures and positioned to cause developer liquid emitted from the header apertures to strike the baffle plate and then fall through the spaces between the paper guiding members and onto said top wall of the container.

11. In a desk top office size photocopy apparatus for automatically receiving and feeding a single sheet, non-continuous carrier and for developing a photographic image on the carrier, a tank containing a liquid developer; an apertured header having a developer liquid supplied thereto from said tank; means for moving said carrier through said apparatus guiding means comprising a curved open rack extending beneath said header and above said tank and curved to guide the leading edge of said carrier beneath said header and above the upper surface of the liquid developer to produce an image on the carrier without immersion of the carrier in the developer liquid.

12. Apparatus as defined in claim 11 wherein said curved rack comprises: a plurality of wires mounted side by side in a direction parallel to the longitudinal direction of carrier movement on said rack; and a pair of cross members disposed transversely of the plurality of wires with the ends of the plurality of wires bent over to engage and be supported by said pair of cross members and wherein said single sheet, non-continuous carrier is substantially the size of standard office paper.

13. An electrostatic latent image developer station apparatus for use with a liquid developer comprising the combination of:

(a) guide means for directing an electrostatically charged carrier through said developer station comprising:
  (1) an open rack having a pair of cross members, and
  (2) a plurality of wires mounted side by side in a direction parallel to the direction of carrier movement on said rack,
    (a) said wires having bent-over ends to engage and be supported by said cross members,
  (3) said cross members and said wires having rounded upper surfaces to prevent retention of liquid developer thereon;

(b) distribution means for applying liquid developer to only one side of said carrier comprising:
  (1) a large capacity container for said developer,
    (a) said container being spaced from and immediately beneath said guide means,
    (b) having bottom and side walls, and
    (c) a top wall with an apertured depression through which liquid on the upper side thereof returns to the container;
  (2) a distribution pump means to supply said developer from said container for distribution across the upper surface of said carrier;
  (3) an apertured header located above said guide means to receive and distribute said developer from said pump means; and
  (4) a baffle plate to receive said developer from said header and distribute said developer uniformly across the entire width of the upper surface of said carrier;

(c) first and second roller means adjacent the opposite ends of said guide means to guide said carrier onto and away from said guide means,
  (1) said second roller means being adjacent the terminal end of said guide means to compressively remove excess developer from the carrier,

(2) said first roller means being located immediately above, horizontally adjacent, and spaced from the initial end of said guide means to introduce said carrier downwardly into said developer station;

(d) said guide means receiving said downwardly directed carrier from said first roller means, and

(1) thereafter deflecting the leading edge of said carrier upwardly so as to form a declivity in said carrier, and

(2) producing contiguous engagement between said carrier and said guide means along the entire length of said guide means solely on the lower side of said carrier;

(e) said header being located immediately above said apex portion of said carrier,

(1) having spaced apart apertures across the entire width of said carrier and

(2) said apertures being directed away from said apex portion to face said baffle plate and deposit thereon said liquid developer under substantially gravity flow;

(f) said baffle plate being closely spaced from said header to permit said liquid developer to cascade as a thin film onto said apex portion to uniformly and completely moisten but not immerse said carrier; and

(g) said baffle plate and said header being slightly spaced above said carrier to avoid rubbing contact therewith.

14. The apparatus of claim 13 wherein said second roller means are located immediately above, horizontally adjacent, and spaced from the terminal end of said guide means and comprises squeeze rollers resiliently compressed together to receive said carrier at an angle substantially equal to the tangential angle of the carrier at the terminal face of said guide means to withdraw said carrier from said developing station, and simultaneously remove excess developer from said carrier.

References Cited by the Examiner

UNITED STATES PATENTS

593,896	11/97	Johnson	118—325 X
828,773	8/06	Pease	95—89
1,085,820	2/14	Pease et al.	95—94
2,649,758	8/53	Cowgill	118—602
2,742,838	12/56	Paulas	95—94
2,751,814	6/56	Limberger	95—94 X
2,786,401	3/57	Briggs et al.	95—89
2,972,331	2/61	Limberger	118—637
2,991,754	7/61	Johnson	118—637
3,038,073	6/62	Johnson.	
3,099,948	8/63	Van Leeuwen	95—94

FOREIGN PATENTS

762,807	12/56	Great Britain.

WILLIAM D. MARTIN, *Primary Examiner.*