United States Patent

Niesen et al.

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[54] **APPARATUS FOR APPLYING A CONVERSION LIQUID TO ELECTROSTATIC COPY MATERIAL**

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[52] **U.S. Cl.**.....**118/117,** 118/224

[51] **Int. Cl.** **B05c 1/08,** B05c 11/02

[58] **Field of Search**.....118/116, 227, 117, 228, 224, 118/DIG. 23; 95/89 A

[56] **References Cited**

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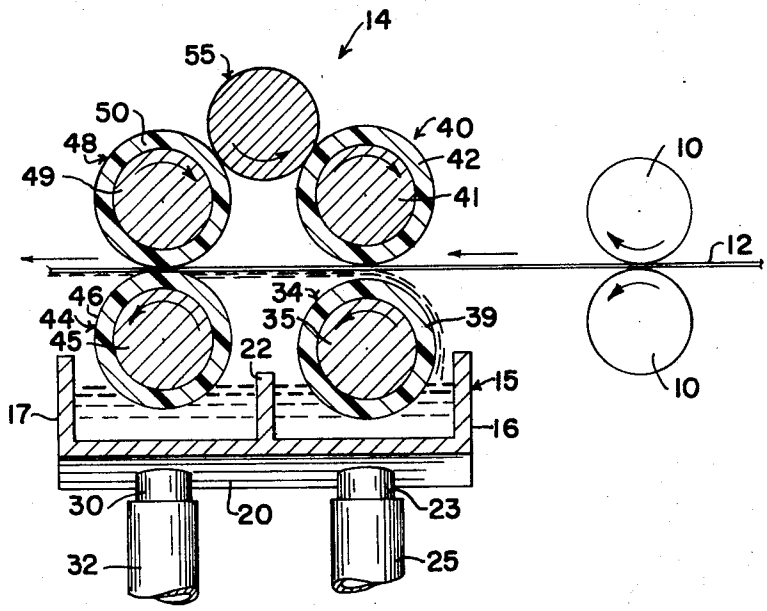
Primary Examiner—John P. McIntosh

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[57] **ABSTRACT**

A length of developed electrostatic copy material is advanced to a conversion zone with the image side facing downwardly and is received in a gap defined by adjacent peripheral surfaces of upper and lower rollers, the lower roller being partially immersed in a conversion liquid contained in a trough. This lower roller is driven such that its linear peripheral speed is approximately three times the speed of the copy material whereupon such roller develops a film of the conversion liquid on its peripheral surface and applies such film as a metered layer to the underside of the copy material as the same passes through said gap. The copy material is then fed to the nip of a pair of upper and lower squeegee rollers, the lower squeegee roller being partially immersed in the conversion liquid. When the apparatus is not in use, the conversion liquid is drained into a closed storage tank.

7 Claims, 5 Drawing Figures



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SHEET 1 OF 2

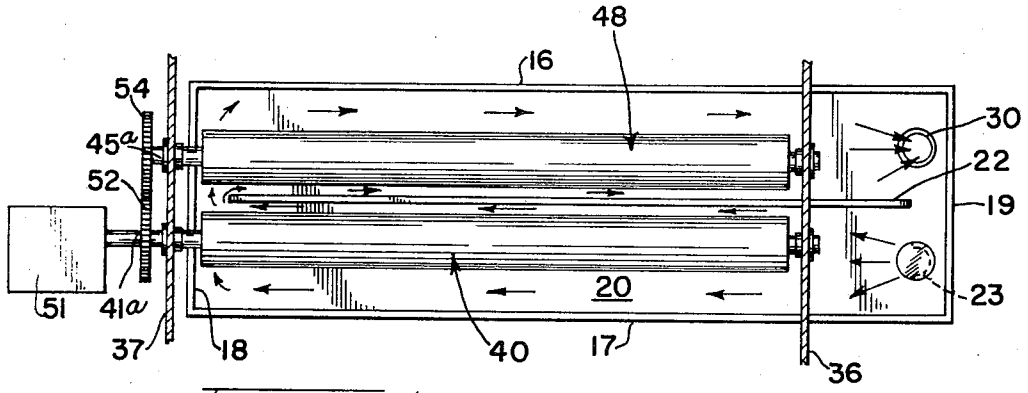


FIG. 2

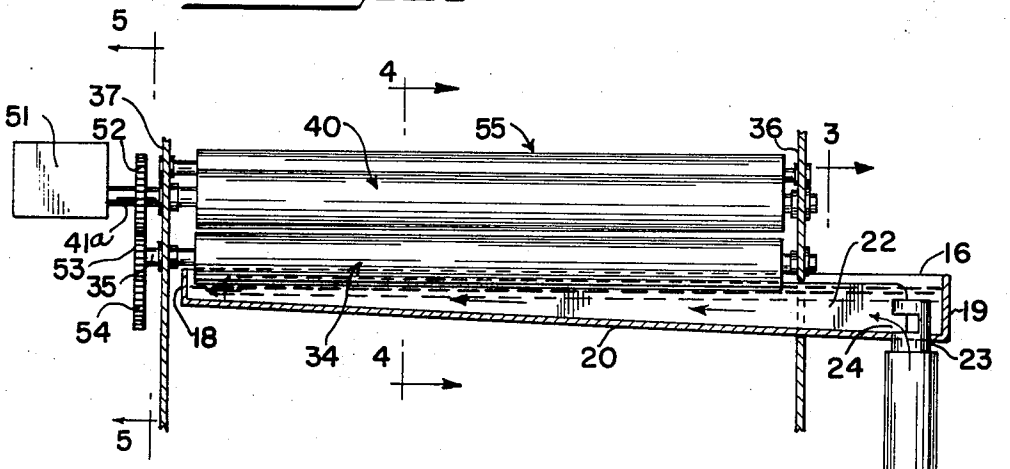


FIG. 1

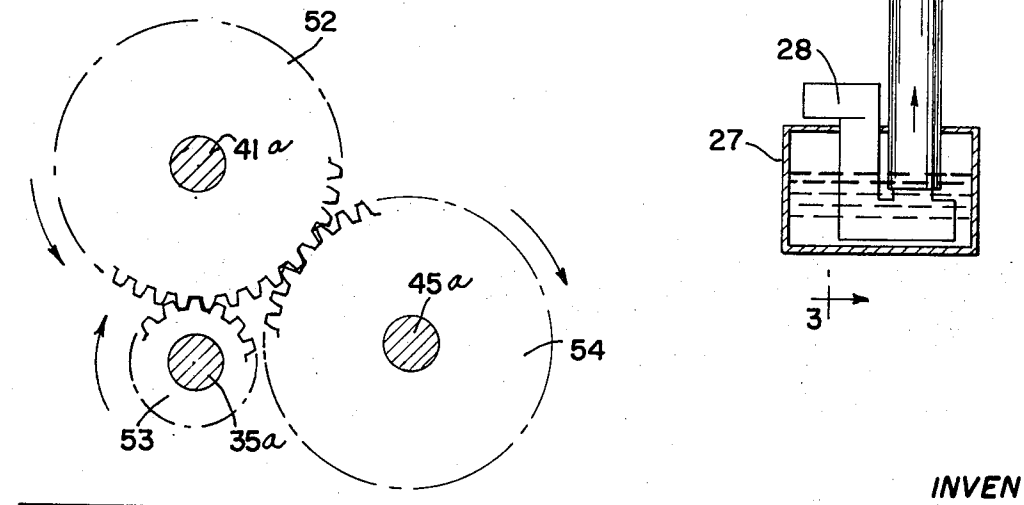


FIG. 5

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FIG. 4

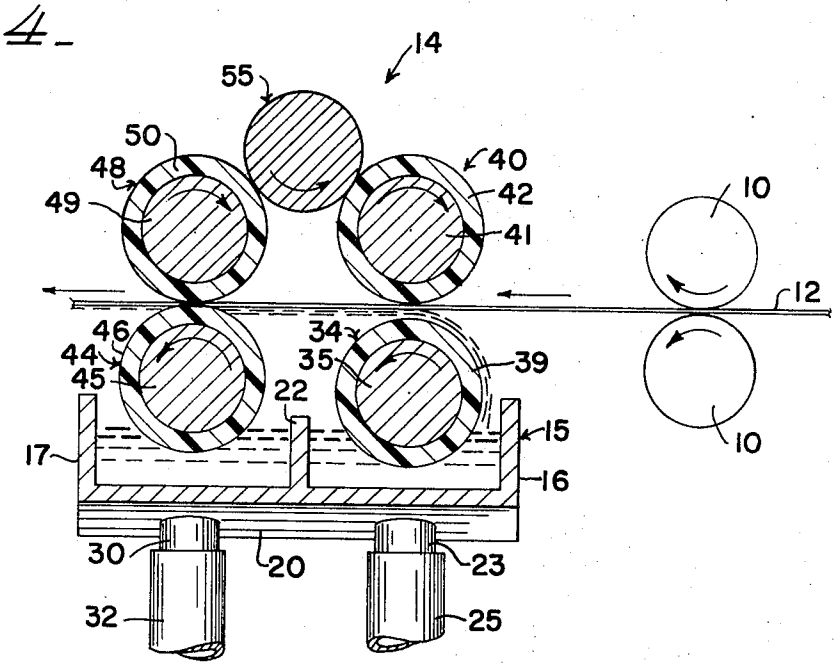
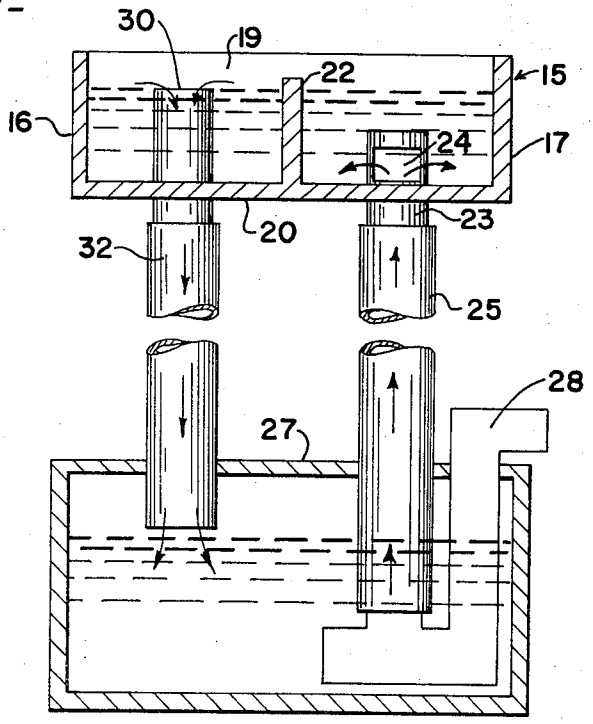


FIG. 3



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APPARATUS FOR APPLYING A CONVERSION LIQUID TO ELECTROSTATIC COPY MATERIAL

BACKGROUND OF THE INVENTION

1. Field of the Invention

The field of the present invention relates to electrostatic copying machines which receive a sheet of copy material having a photoconductive coating thereon. This sheet receives an electrostatic charge and then is exposed to an image of an original to produce a latent electrostatic image of the original, such image being developed by being brought into contact with a developer or toner solution.

More particularly the invention relates to apparatus for applying a conversion liquid to such a developed electrostatic copy. As is known to those skilled in the art, in order to make an electrostatic copy of this type suitable for use as a master in an offset duplicating machine, the surface of the copy material, which has a hydrophobic property, must be converted to exhibit a hydrophilic property. This is achieved by applying a suitable conversion liquid to the image side of the developed electrostatic copy.

2. The Prior Art

In prior art conversion apparatus of which the applicants are aware, the developed electrostatic image is passed through a body of conversion liquid contained in a tank, the copy material being completely immersed in the liquid in what might be characterized as a "bath" application of the conversion liquid. This technique has a major disadvantage in that the backside of the copy material, i.e., the side which does not contain the developed image, becomes wet and often blurs or disfigures the image on an adjacent sheet of master copy material when such material is placed in a stack after application of the conversion liquid, which is usually the case.

Another problem encountered in such prior art system stems from the fact that the copy material, which is passed through the bath of conversion liquid image side facing downwardly, often receives scratches during the course of passing through the trough or tank containing the conversion liquid. Still another problem in this prior art system resides in the build-up of crystals on the squeegee rollers which are mounted above the level of conversion liquid and which receive the copy material after it has passed through the body of conversion liquid. Further, when the prior art apparatus of the type under consideration is started up, the first sheet of copy material that comes into contact with the build-up of crystals on the squeegee rollers is blinded because of the high concentration of conversion salts thereon.

The present invention is directed to a new and improved apparatus for applying a conversion liquid to an electrostatic copy, which apparatus does not possess the aforesaid disadvantages.

SUMMARY AND OBJECTS OF THE INVENTION

The invention may be summarized as residing in the provision of an apparatus for applying a conversion liquid to a developed electrostatic copy by means of rollers, including a pair of rollers having their adjacent peripheral surfaces spaced to define a gap for applying a film of the conversion liquid as a metered layer to the underside of the copy material as it passes through such gap.

A primary object of the present invention is the provision of a new and improved conversion apparatus for making an electrostatic master suitable for use in an offset duplicating apparatus.

Another object of the present invention is the provision of an apparatus of the type described which will provide a converted master free from mechanical or chemical damage.

Another object of the present invention is to provide an apparatus of the type described which is self-draining to reduce maintenance by leaving a minimum of residue solution to evaporate and crystalize in the trough which contains the conversion liquid and to reduce the exposure of the stored conversion solution to the ambient air thereby to minimize evaporation of the solution such that the same will remain at a given concentrate level for a longer period of time.

Still another object of the present invention is to provide an apparatus of the type under consideration which will assure proper functioning on start up and after the apparatus has been standing idle.

Another object of the present invention is the provision of an apparatus of the type described wherein the rollers are self-cleaning by becoming wet thereby dissolving the remaining crystals on the rollers before arrival of the copy material.

Still another object of the present invention is the provision of an apparatus of the type described which produces a converted master that may be stacked with other masters without danger of blinding or blurring the images thereon.

These and other objects and advantages of the present invention will become apparent from the following specification disclosing a preferred embodiment shown in the accompanying drawings.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a vertical section taken through the apparatus of the present invention, such section being in a plane perpendicular to the path of movement of the copy material;

FIG. 2 is a top plan view of the apparatus with one of the rollers removed for better illustration of the invention;

FIG. 3 is an enlarged section taken along the line 3—3 of FIG. 1;

FIG. 4 is an enlarged section taken along the line 4—4 of FIG. 1; and

FIG. 5 is an enlarged section taken along the line 5—5 of FIG. 1.

DESCRIPTION OF A PREFERRED EMBODIMENT

The apparatus of the present invention may be an integral part of an electrostatic copying machine such as the machine disclosed in the copending application of George C. Niesen et al. Ser. No. 145,607, filed May 21, 1971, and assigned to the assignee of the present invention. In the machine shown in that application, a sheet of material having a photoconductive coating thereon receives an electrostatic charge and then is exposed to an image of an original to produce a latent electrostatic image of the original on the copy material. The copy material carrying the latent electrostatic image is passed through a developing zone in which it is brought into contact with particles of a liquid toner material which adhere to the copy material over the charged

areas of the latent image. After passing through the developing zone, the copy material is advanced through a drying station where the developed image is fixed.

Alternatively, the apparatus of this invention may be in the form of a separate unit. In either case, it will be understood that such apparatus is adapted to receive a length or sheet of copy material having a developed electrostatic image of the type just described. As will be explained herein, the apparatus of this invention applies a conversion liquid to such copy for the purpose of changing its surface properties from hydrophobic to hydrophilic thereby making the copy useful as a master in an offset duplicating apparatus.

Referring now to the drawings, a pair of rollers **10** advances a length or sheet of copy material **11** along a path to a converting zone constituted by an apparatus, generally designated **14**, which embodies the present invention. It will be understood that the copy material **12** has a developed electrostatic image thereon and that such image is on the underside of the sheet **12**.

The apparatus **14** includes a trough, generally designated **15**, which extends transversely of the path of the copy material and is defined by side walls **16, 17**, end walls **18, 19** and a bottom **20**. As noted in FIG. **1**, the bottom is inclined transversely of the path of the copy material such that the trough has one of its ends lower than its other end. The trough **15** includes an upstanding divider bar **22** which extends longitudinally thereof in parallel and equally spaced relation from the side walls **16** and **17**. It is noted that the ends of the divider bar are in spaced relation from the adjacent end walls **18** and **19**.

The bottom **20** of the trough includes an opening receiving a pipe **23** having an inlet/drain opening **24**, the lower edge of which is substantially flush with the adjacent portion of the trough bottom. The pipe **23** is connected in one end of a conduit **25**, the other end of which conduit extends into a closed storage tank **27** and is connected with a sump pump **28** of any suitable construction. It will be understood that such pump is capable of forcing developer liquid from the tank **27** into the trough **15** through the conduit **25** and pipe **23**. When such pump is deactivated, it will allow the liquid in the trough to drain into the storage tank through the inlet/drain opening **24** and through the conduit **25**.

The trough includes another opening in its bottom and at its lower end which receives an overflow pipe **30**, such pipe being open at its upper end to establish the level of liquid developer in the trough. As noted in FIG. **3**, the upper horizontal edge of the divider bar **22** is at an elevation slightly above the open upper end of the overflow pipe **30**. The pipe **30** is received in one end of a conduit **32**, the other end of such conduit extending into the closed storage tank **27**.

A first roller, generally designated **34**, includes a shaft portion **35** having reduced-in-diameter opposite ends rotatably received in suitable journals in a pair of support plates **36, 37** thereby mounting such roller for rotation about a horizontal axis extending transversely of the path of movement of the copy material. The roller **34** has its peripheral surface defined by a cylindrical element **39**, preferably formed of Neoprene. It is noted that the roller **34** is mounted at an elevation above the bottom of the trough **15** such that a portion of this roller will be immersed in the conversion liquid in the trough when the latter is at a level established by the overflow pipe **30**.

Another roller, generally designated **40**, includes a shaft portion **41** having reduced-in-diameter opposite ends received in journals in the plates **36, 37** thereby mounting this roller for rotation about an axis parallel with the axis of rotation of the roller **34**. The roller **40** is further defined by a cylindrical element **42** of Neoprene material. This roller is mounted over the roller **34**; the adjacent peripheral surfaces of these two rollers are closely spaced to define a metering gap in the order of 0.031 inches. It will be understood that the primary function of the roller **40** is to maintain the copy material **12** in predetermined spaced relation with the periphery of the roller **34**.

A squeegee roller, generally designated **44**, has a shaft portion **45** with reduced-in-diameter opposite ends received in journals in the plates **36, 37** thereby mounting this roller for rotation about a horizontal axis transverse to the path of movement of the copy material and parallel with the axes of rotation of the rollers **34, 40**. The roller **44** includes a cylindrical Neoprene element **46**. It is noted that this roller is mounted at an elevation such that a portion thereof will be immersed in the conversion liquid contained in the trough **15** when such liquid is at a level established by the overflow opening **30**.

Another squeegee roller, generally designated **48**, includes a shaft portion **49** having reduced-in-diameter opposite ends received in journals in the plates **36, 37** thereby mounting such roller for rotation about an axis parallel with the axis of rotation of the roller **44**. The roller **48** includes a cylindrical Neoprene element **50**. The squeegee rollers **44, 48** are mounted such that their peripheral surfaces engage each other thereby to define a nip for receiving the copy material after the same has passed through the gap defined by the rollers **34, 40**.

The drive for the rollers described above may be understood by reference primarily to FIG. **5**. One reduced-in-diameter end **41*a*** of the shaft portion **41** of the roller **40** is driven by an electric motor **51**, which motor is shown only in block form in FIGS. **1** and **2** and may be of any suitable type. The shaft end **41*a*** mounts a gear **52**; this gear is in meshing engagement with a gear **53** mounted on the reduced-in-diameter end **35*a*** of the shaft portion **35** of the roller **34**. The relative radii of the gears **52, 53** are such as to provide that the linear peripheral speed of the roller **34** is approximately three times the speed of the copy material and the linear peripheral speed of the roller **40** is substantially the same as the speed of the copy material **12**. The gear **52** is in meshing engagement with a gear **54** mounted on the reduced-in-diameter end **45*a*** of the shaft portion **45** of the roller **44**. The gears **52, 54** have equal radii; hence, these two gears and the associated rollers rotate at a 1:1 ratio.

The motor **52** is energized to rotate the gears and rollers in the directions of rotation indicated in FIGS. **4** and **5**. The linear peripheral speeds of the rollers **40, 44** are substantially the same as the speed of the copy material, whereas the linear peripheral speed of the roller **34** is three times the speed of the copy material. The roller **48** is rotated by the roller **44** due to the fric-

tional engagement of their peripheral surfaces prior to receiving the copy material; the roller **48** is rotated by frictional engagement with the copy material after the latter is received in the nip defined by the squeegee rollers **44, 48**.

A transfer roller, generally designated **55**, is preferably formed of chrome-plated steel and rests or lays between the rollers **40, 48**. This roller need not be mounted in journals in the manner of the other rollers described above. The transfer roller **55** carries solution from the roller **48** to the roller **40** to clean the latter and to dissolve any dried conversion solution thereon.

Although any suitable conversion liquid may be used, the closed storage tank **27** is preferably provided with a supply of conversion solution of a type disclosed and claimed in the application of George M. Ort, filed Oct. 23, 1970, Ser. No. 83,629, and assigned to the assignee of this application. For purposes of illustration, such solution may contain 2 percent by weight potassium ferrocyanide and 4 percent by weight amonium diacid phosphate. This solution contains water, with or without glycerin. A hydrogen phosphate is added to adjust the pH. A chelating agent is added to pick up iron.

The operation of the apparatus of the present invention is as follows:

Assume that the pump **28** is deactivated and that the electric motor **51** is de-energized. The trough **15** will be empty as the conversion solution will have been allowed to drain into the closed storage tank **27**.

Now assume that the pump **28** and the motor **51** are energized; these events occur prior to the arrival of the copy material to the apparatus **14**. The pump **28** will force the conversion liquid into the trough **15** through the inlet/drain opening **24**. The solution is pumped in at a rate such that its flow pattern through the trough **15** is as indicated by the arrows in FIG. **2** thereby to cause proper circulation of the liquid and to prevent development of stagnant areas. In other words, most of the incoming fluid flows between the divider bar **22** and the side wall **17**, around the end of the divider bar and then between the latter and the other side wall **16**. The pump will continuously circulate the conversion solution such that a quantity thereof will be maintained in the trough **15** as determined by the overflow opening **30**.

The rapidly rotating roller **34** generates a film of the conversion solution on its peripheral surface and applies this film as a metered layer to the underside of the copy material as the same passes through the gap defined by the rollers **34, 40**. The thickness of this film generated on the periphery of the roller **34** is approximately the same as the dimension of the gap between this roller and the roller **40**, i.e., 0.031 inches. The rollers **44, 48** receive the copy material and perform a squeegee action to the same with the layer or film of conversion liquid thereon. After the last sheet or length of copy material passes through the apparatus **14**, the motor **51** is de-energized and the pump **28** is deactivated, whereupon substantially all of the solution in the trough **15** will drain into the closed storage tank **27** through the inlet/drain opening **24**.

It will be apparent that the foregoing invention provides a new and improved apparatus for applying a conversion liquid to developed electrostatic copy material. The image side of the copy material is contacted only by the roller **44** thereby insuring that the image does not receive scratches, guide marks or abrasions as in prior art conversion devices. Since the conversion solution in the trough **15** is allowed to drain into the closed storage tank when the apparatus is shut down, a minimum of residue solution is left in the trough to evaporate and crystalize. Since all of the conversion solution is drained into the closed storage tank, there is very little exposure of the storage solution to the ambient air, and accordingly, evaporation is maintained at a minimum resulting in the solution remaining at a given concentrate level for a longer period of time.

According to the present invention, the several rollers thereof are essentially self-cleaning as they become wetted with the conversion liquid prior to the arrival of the copy material. This results in dissolution of crystals which remain on the rollers after shut down, and therefore, the first sheet or length of copy material will not be contacted with an over concentrated solution on the rollers. In this regard, the transfer roller **55**, which is desirable but not essential, insures that the roller **40** becomes dampened prior to the arrival of the copy material. The roller **54** provides a kneading action to break as quickly as possible, any dry salts on the peripheries of rollers **40, 48**. According to the present invention, the rollers **40, 48** do not wet the back of the copy material **12** to any substantial degree and accordingly the master copy material leaving the apparatus **14** may be immediately stacked with other masters without the danger of blinding or blurring the images on such masters.

In one apparatus constructed in accordance with the present invention, rollers **34, 48** each had a diameter of 1.024 inches. Rollers **40** and **44** each had a diameter of 0.976 inches; the transfer roller **55** had a diameter of 0.750 inches. Rollers **34** and **40** were spaced to provide a gap of 0.031 inches adjacent their peripheral surfaces. All rollers were approximately 12.5 inches in length. The speed of the copy material passing through the apparatus was 6 inches per second. Roller **34** was rotated such that its linear peripheral speed was 18 inches per second; this rotational speed developed a liquid film on roller **34** in the order of 0.031 inches. In the course of experimentation, it was found that when roller **34** was rotated with a linear peripheral speed of 11 inches per second, an insufficient quantity of solution was applied to the copy material. When roller **34** was rotated at a linear peripheral speed of 24 inches per second, too much liquid was applied and an undesirable splash of the liquid resulted.

We claim:

1. Apparatus for subjecting a length of copy material to the action of a conversion liquid in a conversion zone through which said length passes along a path with its image side facing downwardly, said apparatus comprising:

   a. trough means extending transversely of said path and adapted to contain a supply of conversion liquid to a predetermined level therein;

   b. a first roller mounted over said trough means for rotation about a horizontal axis extending transversely of said path and at an elevation such that a portion of said roller will be immersed in the conversion liquid in said trough means;

c. a second roller mounted above said first roller for rotation about an axis parallel with said first mentioned axis, the adjacent peripheral surfaces of said first and second rollers being in predetermined, close, spaced relationship to define a metering gap for receiving the length of copy material therethrough;

d. means for advancing the length of copy material through said gap at a predetermined speed;

e. upper and lower squeegee rollers mounted for rotation about respective axes parallel with the aforementioned axes and having their peripheral surfaces in rolling engagement with each other to define a nip for receiving the copy material after it has passed through said gap, said lower squeegee roller being at an elevation over said trough means such that a portion thereof will be immersed in the conversion liquid in said trough means;

f. drive means connected with at least one of said squeegee rollers for rotating the latter such that their linear peripheral speed is substantially the same as said predetermined speed whereupon such rollers apply a squeegee action to the copy material and advance the same through said conversion zone; and

g. other drive means connected with said first roller for rotating the same in the same direction as said lower squeegee roller and such that the linear peripheral speed of said first roller is a multiple of said predetermined speed by a factor of at least two but less than four whereupon said first roller develops a film of conversion liquid on a portion of its peripheral surface and applies such film as a metered layer to the underside of the copy material as the same passes through said gap.

2. The apparatus according to claim 1 further defined by:

a. said trough means including an inlet/drain opening and an overflow opening;

b. a closed storage tank for the conversion liquid;

c. first and second conduit means connecting said storage tank with said inlet/drain opening and said overflow opening, respectively; and

d. pump means for forcing the conversion liquid in said storage tank through said first conduit and into said trough means at a rate such that said predetermined level is established and maintained by said overflow opening, the overflowing liquid returning to said storage tank through said second conduit, said pump means, when deactivated, permitting said trough means to be drained by the conversion liquid entering said inlet/drain opening and returning to the storage tank through said first conduit.

3. The apparatus according to claim 2 wherein said trough means includes a trough with side walls, end walls and a bottom which is inclined in a direction transversely of said path thereby defining upper and lower ends of said trough, a divider bar supported on the bottom of said trough in upstanding relationship between said first roller and lower squeegee roller and having an upper horizontal edge surface at an elevation higher than said overflow opening, said divider bar extending longitudinally of said trough for substantially the entire length thereof and being in spaced relation with the end wall of said trough which is adjacent said upper end thereof, said inlet/drain opening and said overflow opening being in the lower end of said trough, one on each side of said divider bar.

4. The apparatus according to claim 1 wherein said factor is three.

5. The apparatus according to claim 1 wherein said gap is in the order of 0.031 inches.

6. The apparatus according to claim 1 wherein said predetermined speed is approximately six inches per second.

7. The apparatus according to claim 1 further defined by, a transfer roller mounted for rotation about an axis parallel with said axes and with its peripheral surface engaging the peripheral surfaces of said second roller and said upper squeegee roller for transferring conversion liquid from the latter to the former.

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