United States Patent

Stanley

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[54] **CROSS-MIXING BAFFLE**

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[52] **U.S. Cl.** **259/4,** 118/637

[51] **Int. Cl.** **B01f 15/04**

[58] **Field of Search** 259/4, 18, 36; 101/335, 364; 118/637

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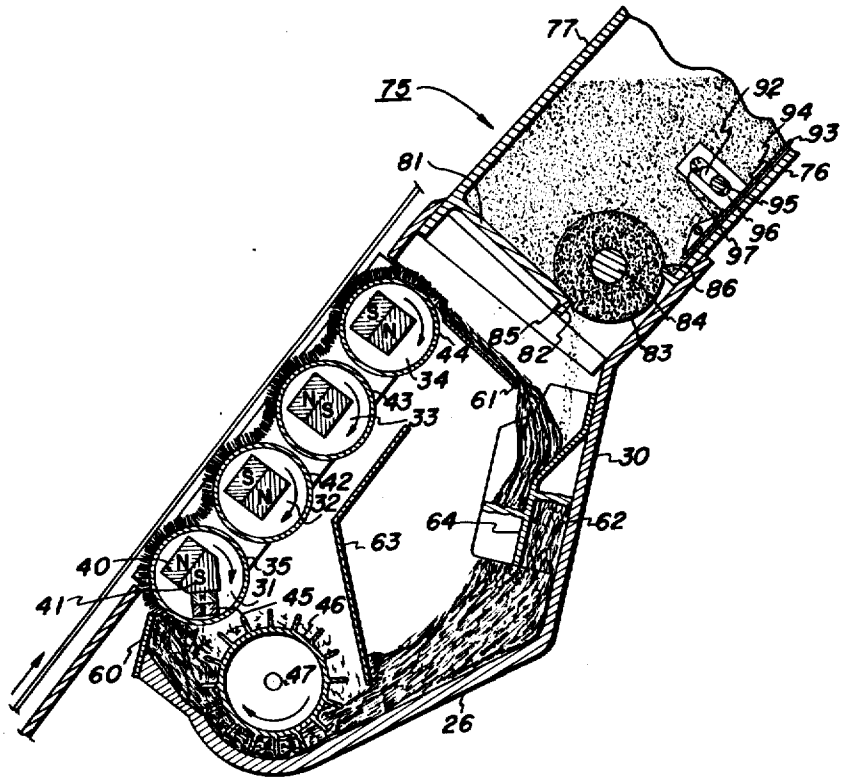
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[57] **ABSTRACT**

A cross-mixing device which is arranged in the flow stream of electrostatic developing material for mixing the material as it flows therethrough. The device is formed with a plurality of deflection elements which effect small incremental movements of some of the material from some zones of the flow stream transversely to other zones thereof utilizing gravitational forces exclusively.

4 Claims, 6 Drawing Figures



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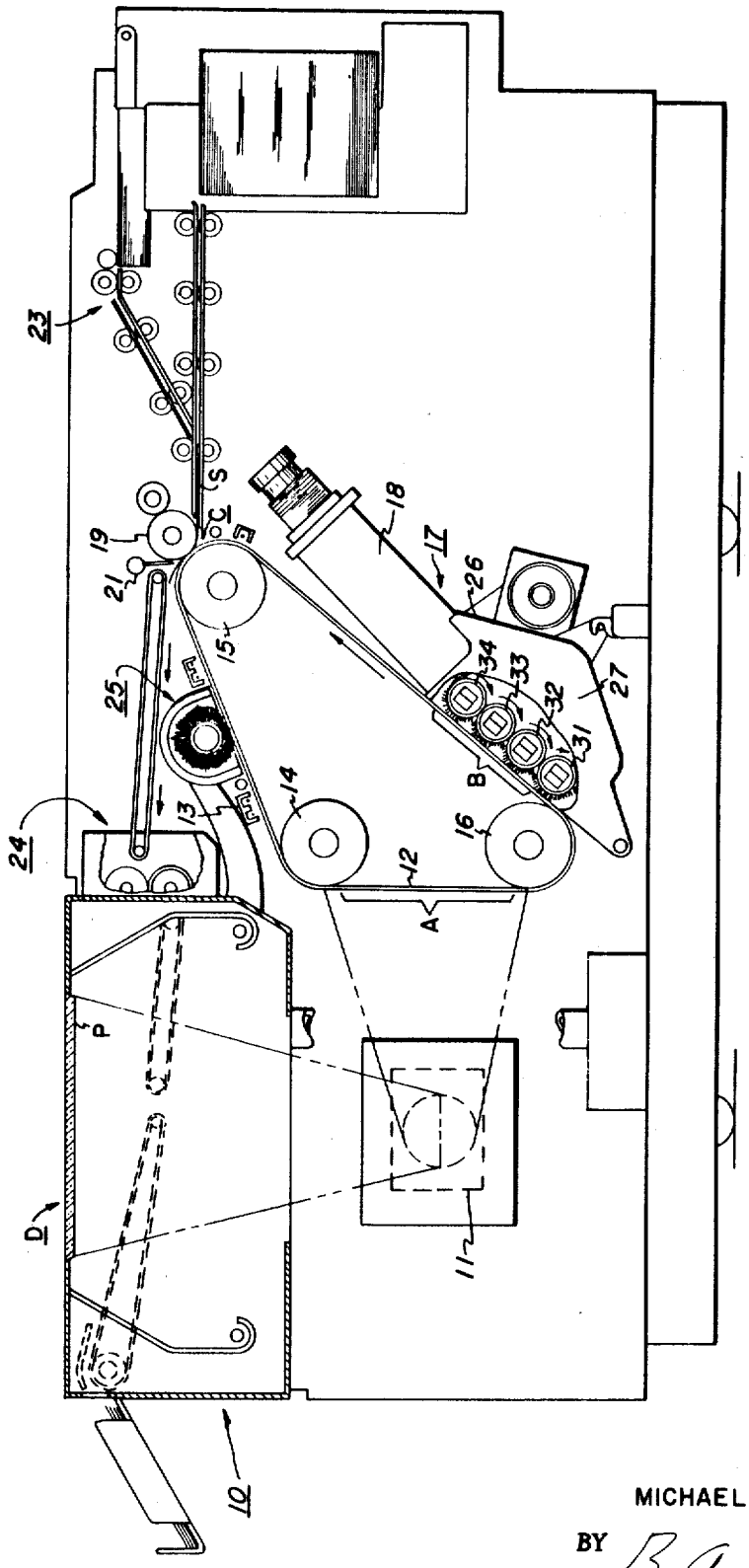


FIG. 1

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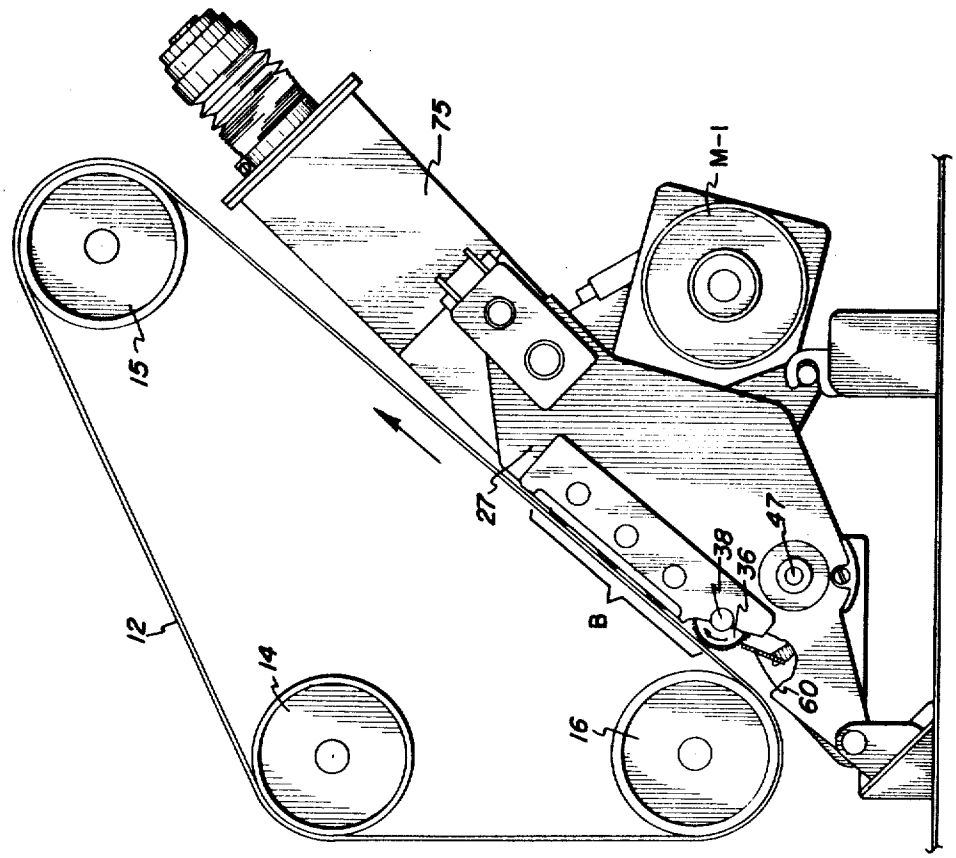


FIG. 2

FIG. 3

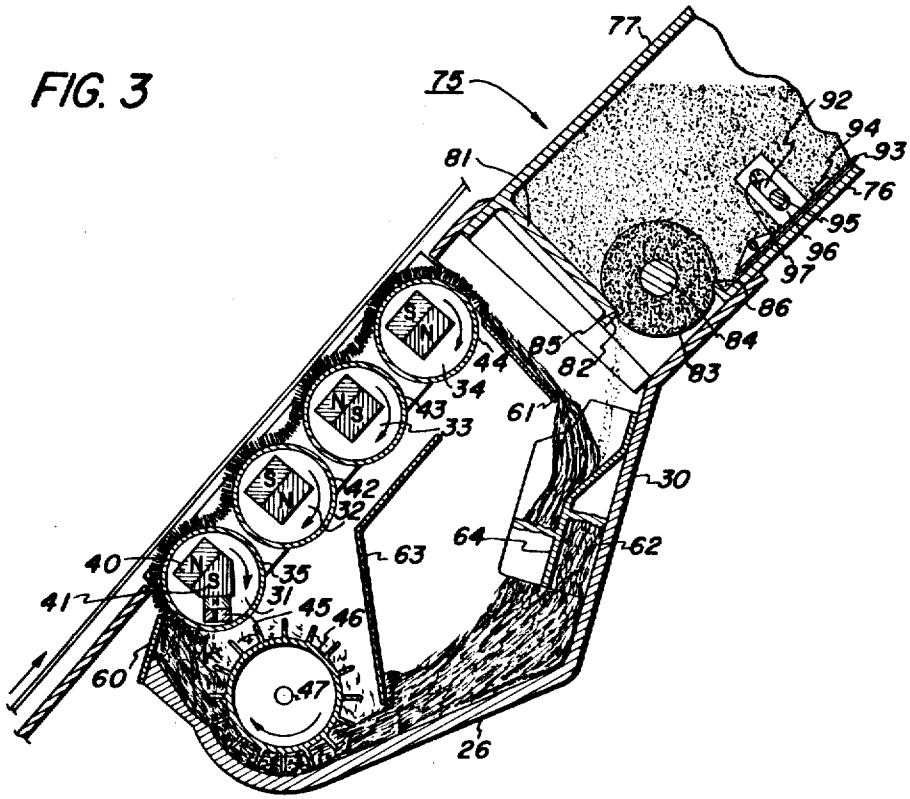

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FIG. 4

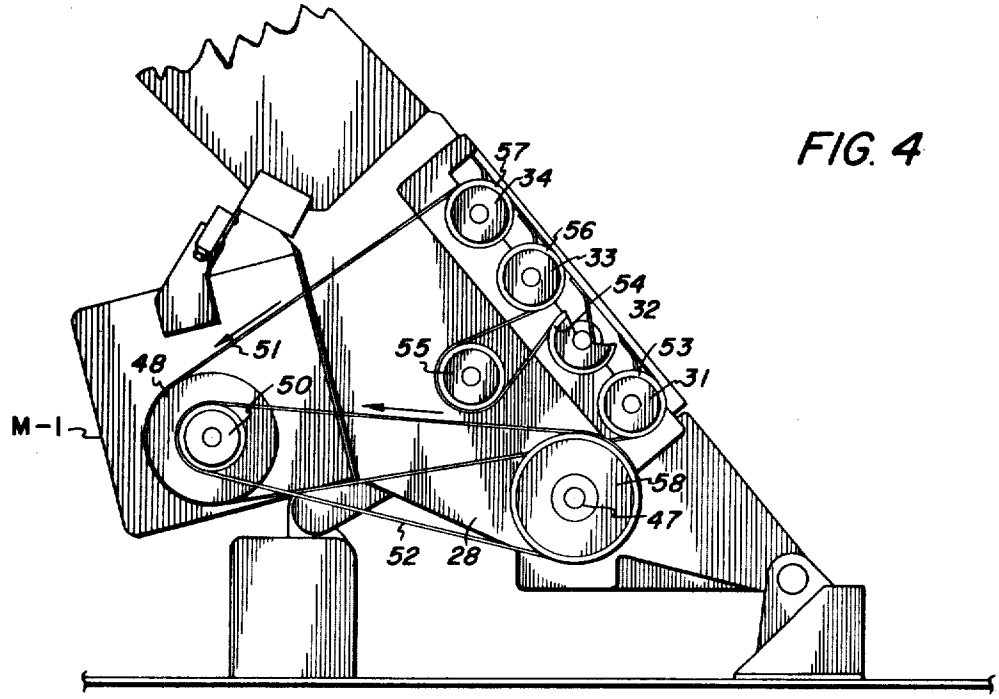

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FIG. 5

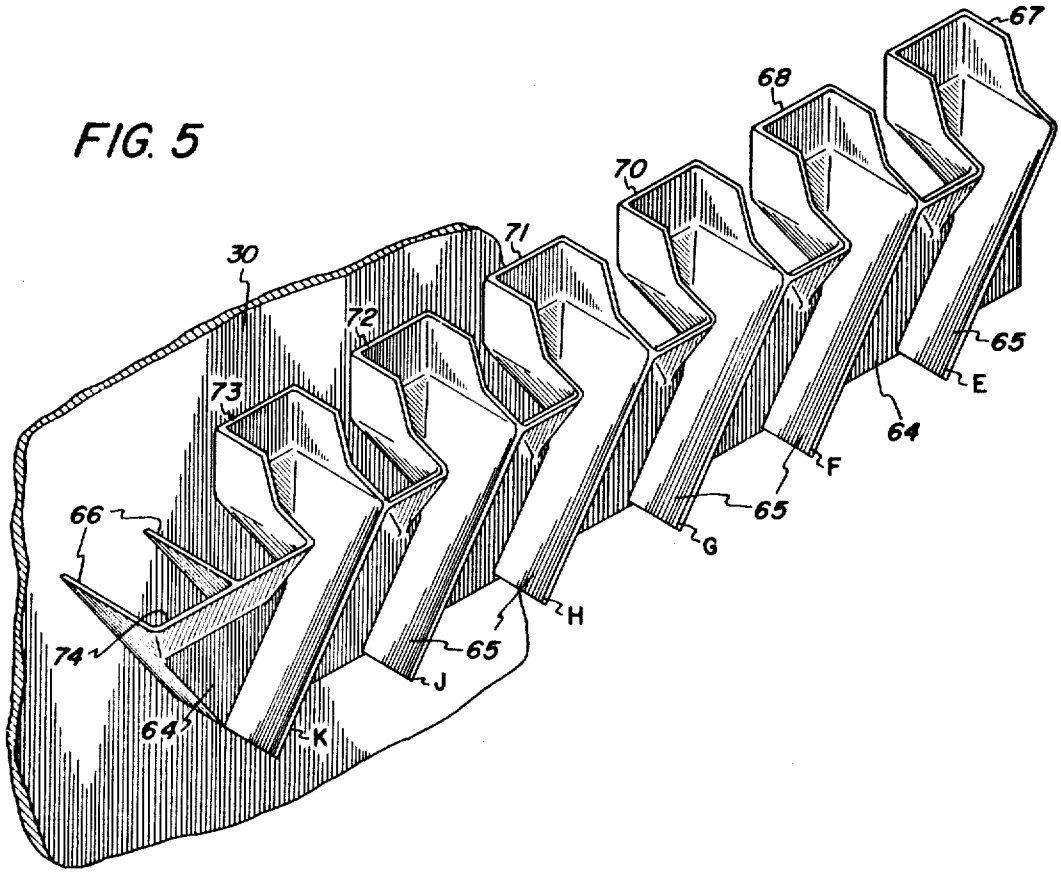
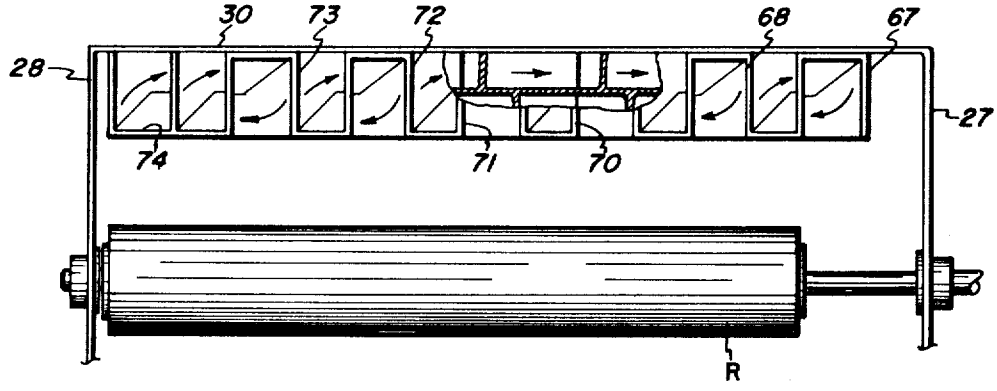

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FIG. 6


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CROSS-MIXING BAFFLE

This invention relates to a flow mixing device for use in electrostatic printing machines, and in particular, to a cross-mixing device which will insure the homogenity of a particulate mixture such as electrostatic developing material during continuous use of developing material in an electrostatic printing machine.

Generally, electrostatic printing machines wherein a dry particulate mixture is utilized as developing material for developing electrostatic latent images and which also utilize magnetic brushes for placing this development material into contact with the latent image formed on a photoreceptor surface, the material is moved in a flow path that is continually recirculating. As a part of this flow path a housing for the magnetic brushes supports one or more conveying augers or the like which may run in opposed directions in order to move development material from one side of the housing to the other thereby assuring homogenity of mixture and preventing toner particle starvation in any zone of the developing apparatus. The use of augers or the like requires a drive mechanism, pulleys, belts, bearings and a housing configuration which will allow a relatively large accumulation of development material to which the augers can be applied in order to present the opportunity for their use. These augers or the like and other devices enumerated above needed for their use are relatively expensive and seriously limit developer housing configuration. Their use also involves the problem of compaction of development material which, among other things, prevents complete and adequate mixing of all the particles which go into a developing mixture. Therefore, it is the principal object of the present invention to improve magnetic brush developing apparatus by insuring adequate cross-mixing of a developing mixture.

Another object of the invention is to improve homogenity in a developing mixture economically and efficiently without the need of moving parts.

The present invention is directed to an entirely different arrangement for performing the general functions of the conventional mixing devices such as augers or the like and may be made relatively simple comprising a single part which does not require any specific housing design and obviates the other disadvantages that mixing devices can present.

A preferred form of the invention is shown in the accompanying drawings in which:

FIG. 1 is a schematic sectional view of an electrostatic reproduction machine embodying the principles of the invention;

FIG. 2 is an enlarged elevational view of a magnetic brush developing apparatus utilized in the machine shown in FIG. 1, with parts broken away;

FIG. 3 is a partial sectional view of the magnetic brush developing system showing the recirculation flow path of developing material;

FIG. 4 is an elevational view of another side of the housing shown in FIG. 3 and showing the drive mechanism for the magnetic brushes;

FIG. 5 is an isometric view of a cross-mixing baffle device utilized in the flow path of the developing material; and

FIG. 6 is a top view of the cross-mixing baffle in relation to one of the magnetic brushes.

For a general understanding of an electrostatic processing system in which the invention may be incorporated, reference is had to FIG. 1 in which various components of a system are schematically illustrated. As in all electrostatic systems such as a xerographic machine of the type illustrated, a light image of an original to be reproduced is projected onto the sensitized surface of a xerographic plate to form an electrostatic latent image thereon. Thereafter, the latent image is developed with an oppositely charged developing material comprising carrier beads and smaller toner particles triboelectrically adhering thereto to form a xerographic powder image, corresponding to the latent image on the plate surface. The powder image is then electrostatically transferred to a support surface to which it may be fixed by a fusing device whereby the powder image is caused permanently to adhere to the support surface.

The electrostatically attractable developing material commonly used in magnetic brush developing apparatus comprises a pigmented resinous powder referred to here as "toner" and a "carrier" of larger granular beads formed with steel cores coated with a material removed in the triboelectric series from the toner so that a triboelectric charge is generated between the toner powder and the granular carrier. The magnetizable carrier also provides mechanical control for the formation of brush bristles by virtue of magnetic fields so that the toner can be readily handled and brought into contact with the exposed xerographic surface. The toner is then attracted to the electrostatic latent image from the carrier bristles to produce a visible powder image on an insulating surface.

In the illustrated machine, an original D to be copied is placed upon a transparent support platen P fixedly arranged in an illumination assembly generally indicated by the reference numeral 10. While upon the platen, an illumination system flashes light rays upon the original thereby producing image rays corresponding to the informational areas on the original. The image rays are projected by means of an optical system 11 to an exposure station A for exposing the photosensitive surface of a moving xerographic plate in the form of a flexible photoconductive belt 12. In moving in the direction indicated by the arrow, prior to reaching the exposure station A, that portion of the belt being exposed would have been uniformly charged by a corona device 13 located at a belt run extending between belt supporting rollers 14 and 15. The exposure station extends between the roller 14 and a third support roller 16, and the belt run between these rollers is encompassed entirely by the exposure station for minimizing the space needed for the belt and its supporting rollers.

The exposure of the belt surface to the light image discharges the photoconductive layer in the areas struck by light, whereby there remains on the belt a latent electrostatic image in image configuration corresponding to the light image projected from the original on the supporting platen. As the belt surface continues its movement, the electrostatic image passes around the roller 16 and through a developing station B located at a third run of the belt and in which there is positioned a developing apparatus generally indicated by the reference numeral 17. Suitable means (not shown) such as, vacuum panels or tensioning means

may be utilized for maintaining the belt flat in all three belt runs, and additionally, the belt run related to the development zone B is maintained at an inclined plane. The developing apparatus 17 comprises a plurality of magnetic brushes which carry developing material to the adjacent surface of the upwardly moving inclined photoconductive belt 12 in order to provide development of the electrostatic image.

As the developing material is applied to the xerographic belt, toner particles in the development material are attracted electrostatically to the belt surface to form powder images. As toner powder images are formed additional toner particles are supplied to the developing material in proportion to the amount of toner deposited on the belt during xerographic processing. For this purpose, a toner dispenser generally indicated by reference numeral 18 is used to accurately meter toner, upon demand, to the developer material in the developing apparatus 17.

The developed electrostatic image is transported by the belt 12 to a transfer station C located at a point of tangency on the belt as it moves around the roller 15 whereat a sheet of copy paper is moved at a speed in synchronism with the moving belt in order to accomplish transfer of the developer image. There is provided at this station a transfer roller 19 which is arranged on the frame of the machine for contacting the non-transfer side of each sheet of copy paper as the same is brought into transfer engagement with the belt 12. The roller 19 is electrically biased with sufficient voltage so that a developed image on the belt 12 may be electrostatically transferred to the adjacent side of a sheet of paper S as the same is brought into contact therewith, and also for tacking the same on the roller 19. A stripping finger or air puffing device 21 utilized for stripping the sheet from the roller is provided to permit pick-up and continued movement of the sheet by a vacuum conveying system 22. In tacking on the roller 19, each sheet of paper travels only a short distance before being stripped therefrom by the stripper 21. Devices such as gripper bars and release elements mounted on the roller 19 may be utilized instead of the stripper 21 for gripping the leading edge of each sheet of copy paper to ensure proper positioning thereon and to effect the release of a copy sheet at a precise time so as to strip the same for pick-up by a conveying system. The timing of the release of each edge relative to the sheet separation from the supply stack of sheets may be for the same period of time.

There is also provided a suitable sheet transport mechanism adapted to transport sheets of paper seriatim from a paper handling mechanism generally indicated by the reference numeral 23 to the developed image on the belt as the same is carried around the roller 15. A programming device operatively connected to the mechanism 23, the stripper device 21 and the illumination device for producing an electrostatic latent image on the belt 12 is effective to present a developed image at the transfer station C in timed sequences with the arrival of a sheet of paper and being coordinated with the activation of the stripper 21 at the precise time that these elements are to function for their intended purpose.

After the sheet is stripped from the belt 12, it is conveyed by the conveying system 22 into a fuser assembly generally indicated by the reference numeral 24 wherein the developed and transferred xerographic powder image on the sheet material is permanently affixed thereto. After fusing, the finished copy is discharged from the apparatus at a suitable point for collection externally of the apparatus. The remaining toner particles remaining as residue on the developed images, background particles and those particles otherwise not transferred are carried by the belt 12 to a cleaning apparatus 25 positioned on the run of the belt between the rollers 14, 15 adjacent the charging device 13. The cleaning device comprises a rotating brush, a corotron for neutralizing charges remaining on the particles and discharge lamp for discharging any remaining electrostatic charges on the belt. It will be appreciated that the run of the belt adjacent the cleaning device is at an incline angle relative to the horizontal as this run leaves the uppermost roller 15 where a developed image is transferred. Such an arrangement maintains the relatively straight line of copy sheet movement which operatively cooperates with the printing belt 12 at its highest point.

From the foregoing, it will be apparent that the configuration and positioning of the processing devices for electrostatic reproductions and the inclined angles of two of the runs are such as to utilize fully all three runs of the photoconductive belt 12 so as tó minimize its size as well as to optimize efficiency and the utilization of machine space. The arrangement also results in a machine which has a height that is ideal for operator that is, waist high, especially in the provision of a paper path of movement above the image processing apparatus. In this manner paper jams can be attended to easily, without dismantling or involvement with other apparatus in the machine, and without having to resort to activities in the vicinity of the floor supporting the machine or the lower regions thereof.

As shown in FIGS. 2 and 3, the developing apparatus comprises a housing 26 having a generally rectangular cross section and a length extending beyond the width of the belt 12. The housing 26 is substantially closed except for an opening adjacent the photoconductive belt 12 whereat development of the latent image is effected. This housing serves as a container, closed at its ends, by end walls 27 and 28 and supporting an inclined bottom wall 30 for containing developing material comprising carrier beads from magnetizable material and colored electrostatic toner particles which adhere electrostatically in great numbers to the carrier beads.

Mounted for rotation within the developer housing are four magnetic brushes 31, 32, 33, and 34 positioned with their axes in parallel and below the selenium belt 12. The magnetic brush 31, comprising outer cylinder 35, made of non-magnetizable material and extending almost the length of the housing 26, is mounted for rotation by and between the end walls 27, 28.

One end of the cylinder 35 is closed by a cap 36 which supports a drive shaft 38 in axial alignment with the cylinder and is mounted in suitable bearings on the end plate wall 27. The other end of the cylinder is similarly supported by the wall 28. Within the cylinder 35 there is positioned elongated bar magnets 40, 41 extending nearly the full length of the cylinder and being mounted therein by means of suitable shafts (not shown) rotatably supported in the end caps for the

cylinder. These shafts on the magnets **40, 41** may be adapted to be rotated by an external control device as will be described hereinafter for rotating the bar magnets. In operation during a development cycle, the brush cylinder **35** is rotated by way of the drive shaft **38** and the magnets **40, 41** remain stationary.

The second, third and fourth magnetic brushes **32, 33** and **34** each comprise a cylinder **42, 43, 44** respectively, end caps for the respective cylinders, complement bar magnets and rotatably supporting shafts therefor. Since each of the brushes **32, 33, 34** is similar to the structure of the brush **31**, further details are not necessary to describe these brushes. Their only distinction lies in the relative orientation of magnet polarities (see FIG. **3** for preferred arrangement) and the inclusion of a pick-up magnetic device **45** for the first brush **31**. The pick-up device **45** includes bar magnets supported by the magnets **40, 41** for the magnetic brush **31** for transporting developing material from the lower sump portion of the housing **26** and to the adjacent periphery of the cylinder **35**.

As shown in FIG. **3**, the peripheral walls of the brush cylinder **35** and those for the other brushes are relatively close to each other. During a development cycle when all cylinders are rotating in unison in the same direction and with their respective magnetic bars held stationary, the brush bristles produced by the influence of the magnetic field emanating from the bar magnets acting upon the magnetizable carrier beads in the developing material will form on the upper region of the cylinder **35** between this cylinder and the undersurface of the selenium belt **12**. Bristles remain formed during the developing cycle, being initiated by the influence of the pick-up device **45** and maintained, during rotation of the cylinder **35** produced by the magnetic field of the magnets **40, 41**. When bristles are moved out of the influence of the magnets **40, 41** beyond the closest distance between the belt **12** and the cylinder **35**, they maintain formation by the influence of the magnetic field for the magnets associated with the brush **32**, which influence is stronger at this point than the diminished strength of the magnetic field attributed to the magnets for the brush **31**. The developing material is carried during rotation of the cylinder **42** until they in turn reach the stronger influence of the magnetic brush **33**, which effects the continued formation of bristles and movement of the bristles until the influence of the last brush **34** is stronger than the diminishing influence of the brush **33**. After passing the last brush **34**, the cylinder **44** thereof transports the remaining developing material around the same from which they will be directed eventually to the sump of the housing **36** by gravity.

During movement of the carrier beads and toner through the development zone B, the magnetic bristles and, therefore, the development material, is in the form of a "magnetic blanket" extending continuously over all of the brushes **31–34** for the entire width of the development zone B wherein the material is disposed or available to some degree for developing purposes. Control means, not shown, may be operatively connected to the shafts associated with each of the bar magnet pairs **40, 41** for each of the magnetic brushes for rotating the pairs in unison in order to terminate the formation of bristles on each of the brushes. In this manner, the "magnetic blanket" over all of the brushes may be quickly eliminated during the operating program for the reproduction machine. Upon a restart of the machine, the control means may be set to be activated as the machine is placed in standby condition wherein all magnet pairs are oriented to operative positions. It will be apparent that the width of the development zone B is larger than the sum of the individual development zones for each of the magnetic brushes. Further details regarding the formation and effect of the "magnetic blanket" are described in the copending application Ser. No. 830,285 assigned to the same assignee as the present application.

Also mounted within the development housing **26** and below the magnetic brush **31** is a paddle wheel impeller **46** having a plurality of blades radially extending therefrom and having its ends rotatably mounted in the end walls **27, 28** by means of a drive shaft **47**. During a development cycle, the impeller **46** is rotated in the direction shown by the arrow in FIG. **3** and serves to transport development material toward the pick-up device adjacent the lower surface of the magnetic brush **31** independent of the state of levelness and the amount of carrier beads in the system. The development material in this vicinity is picked up by the pick-up magnet which commences the formation of bristles on the cylinder **35**. As this cylinder rotates, the newly formed bristles come under the influence of the magnets **40, 41** and the "magnetic blanket" for the assembly **17** will be initiated.

The rotational motion for all of the rotary components of the developing apparatus **17**, as illustrated in FIG. **4**, is derived by a motor M-1 and a drive system comprising a pulley **48** secured to the shaft of the motor, a smaller pulley **50** also secured to the shaft, and timing belts **51, 52** for connecting the pulleys **48, 50** respectively, to the rotary components. Specifically, the belt **51** is drivingly engageable with suitable pulleys **53, 54** mounted on the drive shafts for each of the magnetic brush cylinders **31, 32** respectively, an idler pulley **55** and pulleys **56, 57** secured to the drive shafts for the magnetic brush cylinders **33, 32** respectively. With this arrangement, the four magnetic brush cylinders rotate with the same peripheral speeds, in the same direction and in a direction which moves the "magnetic blanket" comprising magnetic brush bristles upwardly in an inclined plane arranged at the same angle as the angle of the plane which the belt **12** assumes in the development run. The timing belt **52** connects the drive pulley **50** with a driven pulley **58** secured to the shaft **47** for the impeller **46** thereby assuring that the impeller and the magnetic brush cylinders move in unison. The relative speed of the impeller **46** is slightly less than the peripheral speeds of the magnetic brush cylinders but incorporates a surface capacity which provides an excess of development material being transported by the impeller which cannot be picked up by the pick-up device **45** will be carried around the impeller and back into the sump of housing **26**.

In order to optimize the length of the bristles during the formation of the "magnetic blanket" upon the four cylinders, the cylinder **35** has associated therewith a trimming blade **60** secured to the end walls **27, 28** of the housing **26**. This blade extends radially toward the cylinder **35** and being spaced from the periphery

thereof a short distance equal to the desired length of the bristles to be formed on each of the magnetic brush 31. The blade also smoothes the developing material and contains the powder cloud in the housing 26.

The depleted developing material which is carried beyond the magnetic brush 34 or the last brush in the chain of magnetic brushes that comprise the developing device, is conveyed back into the housing 26 in order to be reused for development purposes. As this material is moved by the cylinder 44, away from the development zone B before being directed back into the sump of the housing 26, it is directed by a longitudinal planar baffle plate 61 secured at its ends on the end walls 27, 28 for the developer housing 26 to the upper end of a cross-mixing baffle generally indicated by the numeral 62. Another baffle plate 63 mounted within the housing 26 controls the movement of the development material leaving the cross-mixing baffle 62 into working engagement with the paddle wheel 46 for presenting the development material to the pick-up magnet 45.

The cross-mixing baffle 62 is illustrated in FIGS. 5 and 6 and is preferably formed from a single piece of metallic or plastic material as by a single molding process. The baffle is formed with a centrally disposed, longitudinal wall element 64 secured to and spaced from the rear wall 30 of the developer housing 26 at an angle slightly inclined to the vertical. The front side of the central wall 64, or that side facing the magnetic brushes, is formed with a plurality of deflector plates 65 which project perpendicularly from the wall and are angled downwardly and laterally relative to the vertical. In the illustrated baffle, six of these deflector plates are provided and, in effect, form six open-sided chutes for the flow of development material through this side of the cross-mixing baffle. Similarly, the rear side of the wall 64 is also formed with deflector plates, labeled 66, which extend downwardly and laterally at an angle to the vertical that is equal and opposite to that of the plates 65. Preferably, there are enough deflectors 65 formed so as to provide seven conduits on the rear of the wall 64 defined by the deflectors, the wall 64 and the housing wall 30 so as to equalize cross flow in both directions.

At the upper input end of the baffle 62 there is also formed as integral structure a plurality of U-shaped guide elements which serve as means for deflecting some developing material into the front side of the baffle 62. Specifically, one of these guide elements 67 receives some of the development material flowing downwardly along the baffle 61 and directs this material along the chute E defined by the two adjacent plates 65 near the end wall 27. Similarly, another guide element 68 is arranged on the upper end of the baffle 62 for directing development material down a chute identified by the letter F. Extending along from the wall 27 toward the wall 28, the cross-mixing baffle is also formed with additional U-shaped guide elements 70, 71, 72, 73 which serve to collect and direct development material into and downwardly into corresponding chutes G, H, J and K. Within the confines of the guide element 73, the end wall 28 and the housing wall 30 is an opening 74 provided which serves to direct some development material into the chute defined by the two adjacent plates 66 and the wall 30. This flow of development material will be from left to right as viewed in FIGS. 5 and 6, as distinguished from the movement from right to left produced by the chutes at the front side of the cross-mixing baffle. Similarly, between the guides 72–73, 71–72, 70–71, 68–70 and 67–68, there are openings functionally similar to opening 74 for allowing the passage of development material therethrough for directing this material into the chutes formed by two opposed plates 66.

From the foregoing, it will be apparent that the development material cascading down the baffle 61 will fall along the upper longitudinal edge of the cross-mixing baffle 62 and that this material will fall at random in fairly equal amounts through the guides 67, 68, 70, 71, 72, 73 and through the openings therebetween so that quantities of development material will be cascaded through the baffle 62 on either side of the wall 64. That material which falls through the baffle by virtue of the deflectors 65 on the front side of the wall 64 will be moved or carried in successive steps of movement from the right to the left, under action of gravity. On the other hand, that development material which falls between the wall 64 and the end wall 30 along the chutes defined by the deflectors 66 will be carried along from the left to the right in successive increments of movement.

From the illustrated cross-mixing baffle in FIGS. 5 and 6 with six chutes on the front side of the wall 64 and seven chutes on the back side of this wall so that exits of chutes are lined up with the entrances of the next desired chutes, it will be appreciated that during continuous recirculating movement of development material throughout its flow path in the housing 26 comprising movement around the paddle wheel 46, over the magnetic brushes 31, 32, 33, 34, across the baffle plate 61, and through the baffle 62, 13 such cycles of such movement of the material will result in any quantity of the material being moved as viewed in FIG. 6, from the housing wall 27 to the left to the wall 28 and back to the end wall 27 again. In FIG. 6, one of the magnetic brushes, labeled R, is schematically illustrated in position relative to the baffle 62. In this manner all of the development material utilized in the housing 26 may be carried from one side of the housing to the other continuously thereby insuring at all times a homogenous mixture of toner particles and carrier, and also to assure the presence of fairly equal amounts of toner particles for each carrier particle. Toner starvation, therefore, for any particular zone in a transverse direction of the flow path in the developer housing will be minimized. Such continuous cross-mixing of the developer mixture will also enhance the triboelectric relationship between the particles and carrier beads. It will also be appreciated that the entire process of cross-mixing is accomplished by the action of gravity upon the cross-mixing baffle 62 and without the need for moving structural parts. By utilizing magnetic brushes having their axes of rotation on an inclined plane and in parallel with the inclined plane of a run of an endless photoreceptor belt, recirculation of developing material in its continuous flow path is accomplished by utilizing gravity instead of conveying devices, mixing augers, throwing impellers, etc.

While the invention has been described with reference to the structure disclosed, it is not confined

to the details set forth; but is intended to cover such modifications, or changes as may come within the scope of the following claims.

What is claimed is:

1. A cross-mixing device for use in the flow of moving electrostatic developing materials, said flow having pre-determined dimensions, comprising:

a. Means for separating some of the material within the flow thereof into at least a first flow zone having associated therewith a first material portion and a second flow zone having associated therewith a second material portion;

b. First means interposed in said first zone for diverting said first portion into substantial spatial alignment with said second zone; and

c. second means interposed in said second zone for diverting said second portion into substantial spatial alignment with said first zone; whereby said first and second portions are separately diverted and whereby said first and second zones together are substantially within said pre-determined dimensions.

2. A cross-mixing device for an apparatus utilizing a recirculating flow of electrostatic developing material for co-operating therewith, said flow having pre-determined dimensions, comprising:

a. Means for separating some of the material within the flow thereof into a plurality of flow zones, each having associated therewith a portion of material;

b. First means interposed in some of said zones for diverting said portion of material associated therewith into substantial spatial alignment with other of said zones; and

c. second means interposed in said other zones for diverting said portions of material associated therewith into substantial spatial alignment with said some of said zones, whereby said portions are separately diverted and whereby said plurality of zones together are substantially within said pre-determined dimensions.

3. A cross-mixing device for an apparatus utilizing a recirculating flow of electrostatic developing material wherein the transverse dimension of the flow path is greater than the height dimension thereof, comprising:

a. Means for separating some of the material within the flow thereof into a plurality of flow zones of generally planar configuration, each having associated therewith a portion of material;

b. First means interposed in some of said zones for moving the material portion therein laterally in one direction and into substantial spatial alignment with other of said zones at positions along said transverse dimension of said recirculating flow and in accordance with the extent of the movement produced by said first means;

b. Second means interposed in said other zones for moving the respective material portions therein laterally in a direction opposite the direction imposed by said first means upon the material portions in said some zones and into substantial spatial alignment with said some zones at positions along the transverse dimension of said recirculating flow and in accordance with the extent of the movement produced by said second means, whereby said portions are separately and substantially simultaneously diverted and whereby said plurality of zones together are substantially within said transverse and height dimensions.

4. A cross-mixing device for an apparatus utilizing multiple cycles of recirculation of the flow of electrostatic developing material wherein the cross-section of the flow path has a dimension in one direction greater than the dimension in another direction, said device having means for separating said cross-section into at least first and second cross-sectional areas, comprising:

a. Means interposed in the flow path for diverting material from said first cross-sectional area within the flow path and moving the same in said one direction of the greater dimension into another cross-sectional area within the flow path, in successive steps, one for each cycle of circulation of the material; and

b. Means for diverting material from said second cross-sectional area within the flow path and moving same in a direction opposite that of said one direction, in successive steps, one for each cycle of circulation, whereby movement is effected substantially within said flow path cross section.

* * * * *