This invention relates in general to certain new and useful improvements in electrostatic printing, and more particularly, to a mechanism for feeding powdered ink to the charged screen of electrostatic printing systems.

In the presently available electrostatic printing devices, particularly in electrostatic screen process printing apparatus and in electrostatic coating apparatus, the article which is to be printed and coated is supported in spaced relationship to a feed or so-called "discharge" electrode and a receiving electrode. A screen is interposed between the feed electrode and the receiving electrode and is provided with a series of apertures to be formed in the shape of an image to be ultimately printed on an element on the receiving electrode. A substantial potential difference is maintained between these electrodes in order to create an electrostatic field. The presently available electroscopic inks which are suitable for employment in these electrostatic systems are generally formed of a resinsoid based material, such as a natural resin or various synthetic polymers and are designed to carry a suitable coloring material. The particles of ink suitable for use in these electrostatic printing systems are extremely small, in the area of 2 to 20 microns. Moreover, ink particles of this type are capable of triboelectric charging or corona discharge type of charging.

The electroscopic ink feeding mechanism of the prior art generally employs a physical mechanism for carrying the ink to the electrostatic charged screen, such as by the use of a rotating or oscillating brush. After the powder is delivered to the surface of the screen, it is deposited in the electrostatic field, maintained between the screen and the receiving electrode and the powder is thereafter carried through the apertures of the screen to the element on the receiving electrode. However in all of the devices heretofore provided, a mechanical mechanism was used to physically carry the powder from a hopper or suitable ink containing mechanism to the surface of the screen.

However, mechanical devices used to carry the ink create many serious problems in the art of electrostatic printing. Due to the fact that the ink particles are relatively small and extremely light in weight, they are readily compressible and moreover, very difficult to control. These small ink particles have a tendency to cling together in agglomerates and due to the resinous nature thereof, tend to become permanently bonded when subjected to even moderate compression. Moreover, inasmuch as they are capable of being triboelectrically charged, they are always affected by static charges of the material with which they come into contact. Furthermore, the use of a mechanical system for transferring the ink particles creates an undesirable situation in that heat and friction have been generated at the place of contact between the mechanical mechanism such as a rotating brush and the screen or other transfer media. The inks which are used in electrostatic printing systems are thermoplastic in nature and, therefore, are quite sensitive to both heat and pressure with regard to softening and fusing.

It is also known that even distribution and flow of the ink particles materially affect the efficiency of the printing operation and of the line definition thus obtained. The problems of metering a selected quantity of ink, spread-
an electrically charged mandrel or counter-electrode, and an electrically charged screen, the latter having a suitable imprinted pattern for creating a desired printing image. The screen or stencil generally comprises a fine mesh element of conductive material having masked non-printing areas. The ink particles are sized to pass through the interstices of the masked areas and carried by an electrostatic field to the mandrel or counter electrode.

The apparatus of the present invention generally comprises a hopper containing a desired electrosopic ink. Rotatably mounted in the hopper is a continuously moving agitator for keeping the ink particles in a suspended or levitated state. The hopper is formed with an arcuate base and with a discharge slot through which the ink particles can pass. Operatively mounted beneath the hopper and extending upwardly through the discharge slot is a distributor roller having a pile fabric outer surface. Thus, as the distributor roller rotates, it will pick up a charge of ink and deposit the same in the interstices of the pile fabric. Rotation of the distributor roller will cause the ink to become deposited in a transfer area which is formed by an adjustable plug or a counter roller disposed beneath the distributor roller. The transfer area consists of a space between the plug or counter roller and distributor roller where the electroscopic ink is carried by a stream of air. The quantity of ink picked up from the distributor roller is related to the rotational speed of the distributor roller and to the space of the transfer area which is regulated by adjusting the plug. Regulation of the position of the plug will, in turn, adjust the air flow through the transfer area.

The ink particles which are carried in the stream of air pass through a metal triboelectric charging chamber where the particles are turbulently propellated against the walls of the metallic chamber. Constant bombardment with the walls of the chamber will create a triboelectric charge on the ink particles as they pass through the chamber. The ink particles are then delivered to the electrically charged screen.

An exhaust or scavenging system is maintained and consists of a tube concentrically disposed around the ink feeding tube which carries the ink particles in the air stream. After the ink particles are delivered to the screen, the air is removed by the vacuum system, thereby suspending the ink particles in the electrostatic field.

The ink feeding mechanism of the present invention is also provided with a relatively flat but wide chamber having a series of longitudinally spaced electrically charged wires which provide a corona discharge. Thus, it is possible to charge the ink particles by means of a corona discharge in addition to the triboelectric charging. In this way, the particles are less affected by static charges of other objects.

The art of electrostatic printing is still a recent technological innovation, and the terminology peculiar to this technology has not yet achieved a commonly acceptable and understood usage and definition. Accordingly, the term "printing" as used herein, is employed to describe the operation of delivering ink from the ink member to the element being printed, although it is to be understood that the word "printing" as used herein does not connote any mechanical pressure. The word "printing" is used in its much broader sense of the word merely to mean the transfer of a design from one element to another in analogous form. The term "printing" has, however, been particularly appropriated where mechanical pressure is not the cause of transference of the design. The ink feeding mechanism of the present invention is designed for use in electrostatic printing systems of the type where mechanical pressure is not employed to cause a transference of the design. Therefore, in the interpretation of the specification and the following claims, all terminology borrowed from the conventional printing art must, therefore, be given a broad meaning appropriate to this specialized field of electrostatic printing.

Referring now in more detail and by reference characters to the drawings which illustrate a practical embodiment of the present invention, A designates an ink feeding mechanism which is adapted for use with electrostatic printing systems of the type described and illustrated in my copending application Serial No. 465,109 filed June 11, 1965.

The ink feeding mechanism A generally comprises a hopper 1 which may be molded or formed from any suitable synthetic resin or plastic material, or any other material which is inert with respect to the ink. The hopper 1 is also suitably mounted on a conventional support mechanism (not shown). The hopper 1 is provided with an internal chamber 2 which constitutes of fluidized ink reservoir for retaining a desired electrosopic ink. The electrosopic ink is maintained in a fluidized state or so-called "fluid state" and may be fluidized by any conventional process such as passing low pressure air through a porous membrane on which the ink particles are maintained, in combination with a vibratory action. The internal chamber 2 is formed by relatively flat front and back walls 3, 3' and flat side interior walls 4, the latter of which merge at their lower end into an arcuately shaped bottom wall 5. The bottom wall 5 is provided with an elongated discharge slot 6 which extends the transverse length of the chamber 2, that is to say, it extends the distance between the interior front wall 3 and the interior back wall 3'. The hopper opening is open at its upper end and is provided with a removable cover plate c in the manner as shown in FIGURE 1.

The front and back walls 3, 3' are bored to accommodate bearings (not shown) and extending transversely therethrough and journaled in the bearings is an agitator shaft 7. The shaft 7 may be driven through any conventional means, such as through a pulley 8 and electrical motor (not shown). The shaft 7 is axially positioned by means of set collars 8' which engage the interior surfaces of the front and back walls 3, substantially in the manner as shown in FIGURES 1 and 2. Secured to the set collars 8' is an agitator blade 9 formed of a rod-like member and consisting of four radially spaced rectangularly shaped agitator blades 10. The ends of the blades 10 are inserted in small apertures formed in the set collars 8' and are retained by means of set screws substantially as shown in FIGURES 1 and 2. FIGURE 3, it can be seen that the agitator blades 10 are provided with two radially extending leg portions 11 which are disposed in close proximity to the front and back walls 3 and are connected by a bight portion 12 which is sized to closely approach the interior surface of the side walls 4 and the bottom wall 5. Moreover, rod-like member in which the agitator blades 10 are formed is circular in cross section and has a relatively small diametral size in the area of approximately 3/8 inch. The agitator 9 as previously mentioned, is driven through any conventional electrical motor, and preferably a motor provided with a variable speed mechanism. As indicated in FIGURE 3, the pulley 8 may consist of a series of wheels of different diameter for accepting a driving element. Thus, it is possible to rotate the agitator 9 at a desired speed which is just sufficient to maintain the ink particles in a levitated or fluidized state.

The ink hopper 1 is provided with a relatively thick base 13 having a relatively flat base plate 14, which is in turn welded or otherwise rigidly secured to a pair of transversely spaced slide bars 15. The slide bars 15 are shiftable in channels 16 which form part of upstanding support brackets 17. A suitable locking mechanism of conventional construction (not shown) may be secured to the slide bars 15 for rigidly holding the hopper 1 in any desired position. The given base 13 is transversely bored in the provision of an ink distributing chamber 18 having arcuately shaped side walls 19 which merge at their upper
end with the bottom wall 5 at the discharge slot 6. The chamber 8 is integral and includes a distributor roller 20 which is mounted on a roller supporting shaft 21 and retained therein by means of set collars 22 and washers 23, the latter of which bear against the exterior surfaces of the front and back walls of the hopper 1. The roller supporting shaft 21 is preferably connected to an electrically-driven variable speed motor (not shown) so that the speed of the roller 20 may be varied as desired. As illustrated in FIGURE 3, a pulley 24 consisting of a series of wheels of different diameters is secured to one end of the shaft 21 for accepting a flexible drive element. Thus, it is also possible to regulate the speed of the shaft 21 by varying the particular wheel of the pulley 24.

The roller 20 is provided on its annular surface with a relatively thick brush-like fabric 25, preferably a mohair pile fabric. The fabric 25 can be secured to the annular surface of the roller 20 in any conventional manner, such as by a suitable adhesive. It has been found in connection with the present invention that when the fabric 25 is formed of a foamed elastomer material, very effective results have been obtained. The fabric 25 is preferably limited to that portion of the roller 20 to such extent as the important criterion in selection of the fabric is that the fabric 25 must be capable of sealing the discharge slot 6 and yet have a sufficient number of cavities or interstices into which the ink powder can be deposited and subsequently transferred. By reference to FIGURE 1, it can be seen that the distributor roller 20 is so located that the fabric 25 extends upwardly through the discharge slot 6 into the chamber 2 and thereby forms an effective sealing means for the chamber 2. Through this construction, the bristles of the fabric 25 are able to engage the fine mesh particles of electrostatic ink where the particles of ink will become deposited in the interstices of the fabric 25. It has also been found that the fabric 25 must have a different triboelectric charging potential than the ink which is selected for use in the electrostatic printing system. It can be seen that the chamber 18 is so designed that it just accommodates the diametral size of the roller 20. Thus, the ink which is engaged by the bristles of the fabric 25 is retained in the interstices of the fabric 25 until it is deposited in a transfer area to be hereinafter described. Moreover, it can be seen that the arcuate walls 19 are designed to close around the annular surface of the roller 20 for preventing the scattering of the ink particles.

The base 13 is longitudinally bored to accommodate an ink delivery tube 25 which is connected at one end to a suitable source of air pressure (not shown). The ink delivery tube 25 is cut away in the provision of an ink receiving slot 27 at a point immediately beneath the distributor roller 20. The tube 26 is formed with a pair of arcately shaped internally extending flanges 28 which, in effect, form continuations of the arcuate walls 19 in the manner as shown in FIGURE 1.

The base 13 is vertically drilled and the ink delivery tube 26 is further cut away in the provision of a plug receiving slot 29 for accommodating an adjustable plug 30, thereby forming an air gap 31 between the lower margin of the ink delivery roller 20 and the upper margin of the plug 30, which constitutes an ink transfer zone. The adjustable plug 30 is disposed within a vertical bore formed in the base 13 and being secured to the base plate 14. The shield is provided with an upwardly extending peripheral flange 33 which extends into the tube 26 through the slot 29. Further reference to FIGURE 1, it can be seen that the ink delivery tube 26 may be formed with a pair of inwardly struck flanges (not shown) to prevent the plug 30 from being extruded from the slot 30, if desired, and which can be welded to the peripheral flange 33 for an air-tight seal. The peripheral flange 33 of the shield 32 closely conforms to the outer surface of the plug 30. The plug 30 is provided with a crowned upper surface or top wall 35 and relatively flat side walls 36, the latter of which are engageable by the flange 33 to form an air-tight seal between the plug 30 and the flange 33. Moreover, the relative position of the plug 30 can be adjusted in the shield 32 by means of a bolt 37 which is threadedly retained in the plug 30. The plug 30 is biased against a conventional nut 38 of the bolt 37 by means of a spring 39 disposed therearound and which bears against the base plate 14. Thus, by adjustment of the bolt 37, it is possible to provide a desired height of the plug 30 in the ink transfer zone.

On the downstream side, the ink delivery tube 26 integrally merged into an ink feed nozzle 39 which has relatively small height and relatively wide width. By reference to FIGURE 2, it can be seen that the width of the nozzle 39 is approximately equal to the width of an electrostatic printing screen S which is retained on a screen frame F. The screen frame F and the screen S are of the type described in copending application Serial No. 463,109 filed June 11, 1965, and is, therefore, not described in detail herein. However, it is pointed out that the screen frame F oscillates and shifts a distance which is at least equal to the length of the screen S. It is desired in connection with the present invention that a very effective type of screen which can be employed in electrostatic printing operations of this type is an electroformed nickel screen with 250 wires to the inch. The screen or so-called "stencil" is coated with a photosensitive material or so-called "resist." This coating is applied so that it spans all of the interstices in the screen. The sensitized screen is then exposed to an ultraviolet light through an interposed positive image of the desired copy for a proper length of time to harden the area where the interposed image transmits light. Thereafter, this coated screen is then developed and the development will dissolve away the areas of the material which were protected from light by the opaque areas of the film image, thereby leaving a solid mask in the areas affected by the light.

Various methods of preparing the stencil can be used. It is only necessary that the non-printing area be effectively masked to prevent the movement of pigment therethrough in subsequent electrostatic printing operation. This is accomplished very well by various known methods as well as the use of photosensitive coatings on the open mesh. Techniques familiar in the silk-screen process printing may be utilized in the production of stencils for electrostatic printing operations. It is not necessary to have the regularity of openings of a fine mesh screen or sensitized net. The regular openings in fibrous material and the like can be satisfactory as long as the openings and the particle size of the pigment are compatible for movement therethrough.

By further reference to FIGURES 1 and 2, it can be seen that the nozzle 39 terminates in very close proximity to the screen surface so that the air gap between the surface of the screen presented toward the nozzle and the nozzle itself is only about .005" to .012". For purposes of the present invention, it has been found that the nozzle should have a thickness in the vertical dimension that is a height relative to the direction in which the screen moves, within the range of 3/16" to 3/8". The overall thickness of the nozzle will, however, be dependent on the particular screen. It has been found in connection with these two factors and the relative rate of movement therebetween. Accordingly, the feed nozzle is provided with a feed aperture 40 at its outer end. In this manner, a relatively thin line of ink which is substantially equal in length to the width of the screen S is delivered to the screen S. Accordingly, the screen S receives a continually supplied relatively thin line from the nozzle 39, if desired; but the screen S moves in a relatively vertical direction past the nozzle 39. In the areas of the screen which are provided with image openings, the ink passes through to a counter-
The electrode C established immediately behind the screen and may be deposited upon any article supported on the counter-electrode C. Generally, the counter-electrode C may be in the form of a mandrel for supporting containers or other items to be printed.

An air removal system 41 is provided for removing the fluid which carries the ink particles to the screen S. If the air was forced through the openings of the screen or designed to carry the ink particles through the open portions of the screen, the final print on the article retained by the counter-electrode C would be blurred.

Accordingly, the air removal system 41 is designed to reduce the air velocity to substantially zero at the nozzle feed aperture 40, so that the ink particles which are tribo-electrically charged, in a manner hereinafter described, will be drawn from the nozzle by an electrostatic field created between the nozzle, the screen S and the counter-electrode C.

The air removal system 41 generally comprises an exhaust tube 42 which has the same configuration as the nozzle 39 and is disposed around the nozzle 39, in the manner as shown in FIGURE 1. Thus, it can be seen that the exhaust tube 42 is provided with a relatively wide width, slightly larger than the width of the screen S, and a height which is slightly greater than the height of the discharge nozzle 39. Moreover, the exhaust tube 42 is provided with intake apertures 43 on its end which is terminal to the feed aperture 40. The exhaust tube 42 forms part of an exhaust manifold 44 which is, in turn, connected to any suitable vacuum device (not shown) through a fitting 45 for removing the air which carries the ink particles in the delivery tube 26. The air removal system 41 which generally consists of the tube 42 and the manifold 44 is shiftable along the length of the discharge nozzle or feed nozzle 49 so that the positions of the manifolds 44 can be adjusted with respect to the feed aperture 40. The exhaust manifold 44 is releasably secured to the delivery tube 26 at selected positions through a conventional clamp 46. The manifold 44 and the exhaust tube 42 may be provided with suitable sealing rings which extend around the nozzle 39 so that the air removal system 41 can be shiftable therealong. The method of sealing the air removal system 41 is conventional, and is, therefore, neither illustrated nor described in detail herein. However, it should be pointed out that the air flow through the manifold 44 would terminate in approximately the same vertical plane as the feed aperture 40 and could be extended beyond the terminal end of the feed nozzle 39 to a maximum distance of approximately 1/4. The tube 42 can be extended beyond the feed nozzle 39 for a slight distance inasmuch as it is desirable to reduce the air velocity to zero before the ink particles are introduced into the screen S. As previously mentioned, the screen S is generally of the type carried by the frame F which, in turn, generally oscillates for the full vertical length of the screen S. This type of screen operating mechanism is more fully described in copending application Serial No. 463,109, filed June 11, 1965. After a number of passes across the discharge nozzle 39, the ink will begin to gather on the screen in the areas where there are no openings provided. Continued removal of this excess ink is necessary in order to prevent the ink from accumulating on the surface of the screen S which will eventually interfere with the printing operation. Accordingly, the vacuum maintained on the exhaust tube 42 can be increased for cleansing purposes when it is desired to remove the excess ink particles from the screen S. The vacuum is sufficient so that it is able to remove the excess ink particles gathered and adhered to the surface of the screen S. This ink removal is also aided by reversal of the polarity of the electric field between the nozzle and the screen. A conventional ink recovery zone (not shown) is employed in connection with the air removal system 41, it is desirable to recover the excess ink particles from the screen S. The ink delivery tube 26 is preferably formed of the same material which is used in the construction of the hopper 1. However, the ink delivery tube 26 is provided with a metal shield 47 on its interior surface in the area immediately before the tube 26 merges into the feed nozzle 39. This metal shield 47 on the interior surface of the tube 26 serves as a charging chamber 48. The air pressure is sufficient so that it is capable of picking up the ink contained in the interstices of the bristles or fabric surface 25 and carry the same into the charging chamber 48. The ink particles which are turbulently carried in the air stream will be continually bombarded against the metal shield 47 and hence become triboelectrically charged. It has been found in connection with the present invention that an air pressure on the upstream side of the distributor roller 20 and plug 30 can be as much as three to four p.s.i.g., and still produce very suitable results.

In order to provide additional charging of the ink particles, a series of longitudinally spaced transversely extending corona discharge wires 49 extend across the feed nozzle 39 in the manner as shown in FIGURE 2. The corona discharge wires 49 are suitably connected to a suitable source of electrical power which is sufficient to electrically charge the ink particles as they pass through the feed nozzle. A corona discharge type of charging of the ink particles has been found to be very effective, inasmuch as the ink particles are not readily susceptible to losing the charge if they should contact another metal surface having a lower charging potential than the ink particle. In effect, through the use of the corona discharge, the air around each of the ink particles becomes ionized and hence, the particle is more readily able to maintain its electrical charge as it enters the electrostatic field.

The electrostatic printing system of the present invention is designed for use with any conventional type of electrostatic screen process printing apparatus, such as the apparatus described in copending application Serial No. 463,109, filed June 11, 1965. The electroscopic ink maintained within the hopper 1 is always maintained within a suspended or levitated fluidized state through the air current agitation wires 49 and agitator 9. The agitation speed can be regulated for various types and sizes of ink particles.

The rotation of the distributor roller 20 will cause the fabric surface 25 which extends through the discharge slot 6 to pick up a quantity of ink as it continually rotates past the discharge slot 6. As this occurs, the ink will be caught by the extended bristles and held in the interstices of the fabric 25. Thereafter as the ink particles pass through the transfer zone, the air in the ink delivery tube 26 will force the ink particles out of the interstices of the fabric surface 25 and carry the ink particles through the ink delivery tube 26. The distance between the delivery roller 20 and the plug 30 can be adjusted for various types of ink and sizes of ink particles so that a desired downstream air pressure is maintained. The ink particles which are carried in the downstream side are usually carried in a turbulent flow so that they strike the metal shield 47. Charging of the shield 47 will create a triboelectric charging of the ink particles. Thereafter, the ink particles are carried by the stream of air into the feed nozzle 39. As they are carried past the corona discharge wires 49, the air surrounding the ink particles becomes ionized thereby creating a charge on those particles which did not receive a sufficient triboelectric charge in the charging chamber 48.

Thereafter, the ink is propelled through the feed aperture 40 toward the screen S. However, the air velocity at the feed aperture 40 is essentially reduced to zero due...
to the air removal system 41. The exhaust maintained on the exhaust tube 42 is sufficient just to remove the air which carried the ink particles. Due to the differences in molecular weights and densities of the ink particles and the air particles, the air will be removed while the momentum of the ink particles is sufficient to carry the ink particles toward the screen S where they are then caught in the electrostatic field between the nozzle and the screen S and are accelerated toward and through the screen and to the counterelectrode C.

The feeding mechanism A, the screen S and the mandrel C are all electrically charged at a different electrical potential so that charged ink particles are located in an electrical potential gradient between the feeding mechanism screen and mandrel. The downward potential gradient provides the necessary electrostatic field to carry the ink particles. The circuitry for creating the electrostatic field is conventional and, therefore, is neither illustrated nor described in detail herein.

The ink will then pass through the open areas of the screen S and form the desired image on an article retained on the counterelectrode C. The electroscopic ink employed in the present invention may be any type of a conventionally available ink in the art of electrostatic printing. It is only necessary that the pigments (not shown) in the form of ink particles have a particle size which is small enough to pass through the interstices of the open areas of the screen S. The image is thereafter fixed by any of the known methods of fixing electroscopic ink, such as by heat, a solvent, or a vapor, or by any other suitable means, depending upon the type of pigment powder which has been employed and the nature of the material being printed.

After a number of cycles of operation, the screen S can be oscillated and the exhaust pressure maintained on the exhaust tube 42 increased so that the extra ink particles which have accumulated on the screen S can be removed, aided by reversal of polarity between the nozzle and the screen.

The ink delivery system of the present invention is particularly adaptable for use in the printing method for printing on curved surfaces and described in copending application Serial No. 473,829 filed July 19, 1965 and which relates to electrostatic screen process printing. The printing on curvilinear surfaces such as conically shaped cups, the cup is positioned in an axis of rotation so that the exterior wall tangentially approaches and departs from the screen. Thus, the printing will occur along an elemental line of closest approach between the cup and screen. Afterwards, the delivery, or container, is rotated at approximately the same rate of speed of the movement or rotation of the screen so that a continuous line of tangency occurs between the surface of the container and the surface of the screen. Simultaneously with the rotation of the screen and the container, the electroscopic ink particles are moved toward and through the screen to the substrate by the electrostatic field. The ink particles are passed through the screen along this line or band of tangency. In this manner, it is possible to provide electrostatically printed images on the surface of a curvilinearly shaped article, such as a conically shaped container.

The feeding mechanism of the present invention has found unique application in this type of printing since it is capable of providing a continual supply of ink along a flat thin line. This ink feeding mechanism is so located that ink can be supplied to the screen along this continuous line of tangency.

It should be understood that changes and modifications in the form, construction, arrangement and combination of parts presently described and pointed out may be made and utilised for those herein foreseen without departing from the nature and principle of my invention.

Having thus described my invention, what I desire to claim and secure by Letters Patent is:

1. A feeding mechanism for electrostatic printing systems and the like which include a counter-electrode and an electrically charged screen with an electrostatic field established therebetween; said feeding mechanism comprising a container of electroscopic ink, metering means associated with said container for delivering a charge of said ink particles to a transfer area, delivery means associated with said transfer area to carry said ink particles in a fluid media at a first velocity to said screen, means for separating the fluid media from the ink particles before the ink particles reach the screen, said last named means reducing the ink particles to a second velocity which is less than said first velocity and means associated with said delivery means to deliver the ink in a band relatively narrow in one dimension and a width which is at least substantially equal to the width of the screen where the ink particles are then carried by the electrostatic field established between said screen and counter-electrode.

2. A feeding mechanism for electrostatic printing systems and the like which include a counter-electrode and an electrically charged screen with an electrostatic field established therebetween; said feeding mechanism comprising a container of electroscopic ink, metering means associated with said container for delivering a charge of electroscopic ink to a transfer area, delivery means associated with said transfer area to carry said ink particles in a fluid media at a first velocity to said screen, means for separating the fluid media from the ink particles before the ink particles reach the screen, said last named means reducing the ink particles to a second velocity which is less than said first velocity and means associated with said delivery means to deliver the ink in a band relatively narrow in one dimension and a width which is at least substantially equal to the width of the screen where the ink particles are then carried by the electrostatic field established between said screen and counter-electrode.

3. A feeding mechanism for electrostatic printing systems and the like which include a counter-electrode and an electrically charged screen with an electrostatic field established therebetween; said feeding mechanism comprising a container of electroscopic ink, metering means associated with said container for delivering a quantity of electroscopic ink to a transfer area, delivery means associated with said transfer area to carry said ink particles in a fluid media at a first velocity to said screen, means for separating the fluid media from the ink particles before the ink particles reach the screen, said last named means reducing the ink particles to a second velocity which is less than said first velocity, an ink charging zone established between said transfer area and said screen where said ink particles are nonuniformly charged, means for electrically charging said charging zone including a tapered metal shield located for contact with the ink particles and where contact of the ink with the metal shield will create a triboelectric charge on the ink particles, and means associated with said delivery means to deliver the ink in a relatively narrow band in one dimension and a width which is at least substantially equal to the width of the screen, where the ink particles are then carried by the electrostatic field established between said screen and counter-electrode.

4. A feeding mechanism for electrostatic printing systems and the like which include a counter-electrode and an electrically charged screen with an electrostatic field established therebetween; said feeding mechanism comprising a container of electroscopic ink, metering means associated with said container for delivering a charge of electroscopic ink to a transfer area, delivery means associated with said transfer area to carry said ink particles in a fluid media at a first velocity to said screen, means associated with said delivery means to deliver the ink in a band relatively narrow in one dimension and a width which is at least substantially equal to the width of the screen, and exhaust means operatively associated with and terminating on the same side of said screen as said delivery means for removing the fluid at the point of ink delivery at the screen, thereby reducing the ink particles...
to a second velocity where the ink particles are no longer transported by the fluid media and are then carried by the least static field established between said delivery means, screen and counter-electrode.

5. A feeding mechanism for electrostatic printing systems and the like which include a counter-electrode and an electrically charged screen with an electrostatic field established therebetween; said feeding mechanism comprising a container of electroscopic ink, metering means associated with said container for delivering a charge of electroscopic ink to a transfer area, delivery means associated with said transfer area to carry said ink particles in a fluid medium at a first velocity to said screen, a triboelectric ink charging zone established between said transfer area and said screen where said ink particles are turbulently propelled therethrough and receive a triboelectric charge, corona discharge means operatingly interposed in the path of the moving ink particles for providing a discharge and thereby charging said ink particles, means for separating the fluid media from the ink particles before the ink particles reach the screen, said last named means reducing the ink particles to a second velocity which is less than said first velocity, and means associated with said delivery means to deliver the ink in a band of relatively narrow height and a width which is at least substantially equal to the width of the screen, where the ink particles are then carried by the electrostatic field established between said delivery means, screen and counter-electrode.

6. A feeding mechanism for electrostatic printing systems and the like which include a counter-electrode and an electrically charged screen with an electrostatic field established therebetween; said feeding mechanism comprising a container of electroscopic ink, said container having a discharge slot, a metering roller having a pile fabric surface operatively mounted externally of said container and having a portion of the pile fabric extending through said slot into said container to collect a charge of ink and for delivering a charge of electroscopic ink to a transfer area, said metering roller being positioned so that it extends into said transfer area, delivery means associated with said transfer area to carry said ink particles in a fluid medium at a first velocity to said screen, means for separating the fluid media from the ink particles before the ink particles reach the screen, said last named means reducing the ink particles to a second velocity which is less than said first velocity, and means associated with said delivery means to deliver the ink in a relatively narrow band in one dimension and a width which is at least substantially equal to the width of the screen, where the ink particles are then carried by the electrostatic field established between said delivery means, screen and counter-electrode.

7. A feeding mechanism for electrostatic printing systems and the like which include a counter-electrode and an electrically charged screen with an electrostatic field established therebetween; said feeding mechanism comprising a container of electroscopic ink, said container having a discharge slot, a metering roller having a pile fabric surface operatively mounted externally of said container and having a portion of the pile fabric extending through said slot into said container to collect a charge of ink and for delivering a charge of electroscopic ink to a transfer area, said metering roller being positioned so that it extends into said transfer area, rotatable agitator means in said container and approaching tangential contact with said metering roller for maintaining the ink particles in a suspended state, delivery means associated with said transfer area to carry said ink particles in a fluid media at a first velocity to said screen, a plug associated with said delivery means and extending into said transfer area, rotatable agitator means in said container and approaching tangential contact with said metering roller for maintaining the ink particles in a suspended state, delivery means associated with said transfer area to carry said ink particles in a fluid media at a first velocity to said screen, a plug associated with said delivery means and extending into said transfer area, rotatable agitator means in said container and approaching tangential contact with said metering roller for maintaining the ink particles in a suspended state, delivery means associated with said transfer area to carry said ink particles in a fluid media at a first velocity to said screen, a plug associated with said delivery means and extending into said transfer area, rotatable agitator means in said container and approaching tangential contact with said metering roller for maintaining the ink particles in a suspended state, delivery means associated with said transfer area to carry said ink particles in a fluid media at a first velocity to said screen, a plug associated with said delivery means and extending into said transfer area, rotatable agitator means in said container and approaching tangential contact with said metering roller for maintaining the ink particles in a suspended state, delivery means associated with said transfer area to carry said ink particles in a fluid media at a first velocity to said screen, a plug associated with said delivery means and extending into said transfer area, rotatable agitator means in said container and approaching tangential contact with said metering roller for maintaining the ink particles in a suspended state, delivery means associated with said transfer area to carry said ink particles in a fluid media at a first velocity to said screen, a plug associated with said delivery means and extending into said transfer area, rotatable agitator means in said container and approaching tangential contact with said metering roller for maintaining the ink particles in a suspended state, delivery means associated with said transfer area to carry said ink particles in a fluid media at a first velocity to said screen, a plug associated with said delivery means and extending into said transfer area, rotatable agitator means in said container and approaching tangential contact with said metering roller for maintaining the ink particles in a suspended state, delivery means associated with said transfer area to carry said ink particles in a fluid media at a first velocity to said screen, a plug associated with said delivery means and extending into said transfer area, rotatable agitator means in said container and approaching tangential contact with said metering roller for maintaining the ink particles in a suspended state, delivery means associated with said transfer area to carry said ink particles in a fluid media at a first velocity to said screen, a plug associated with said delivery means and extending into said transfer area, rotatable agitator means in said container and approaching tangential contact with said metering roller for maintaining the ink particles in a suspended state, delivery means associated with said transfer area to carry said ink particles in a fluid media at a first velocity to said screen, a plug associated with said delivery means and extending into said transfer area, rotatable agitator means in said container and approaching tangential contact with said metering roller for maintaining the ink particles in a suspended state, delivery means associated with said transfer area to carry said ink particles in a fluid media at a first velocity to said screen, a plug associated with said delivery means and extending into said transfer area, rotatable agitator means in said container and approaching tangential contact with said metering roller for maintaining the ink particles in a suspended state, delivery means associated with said transfer area to carry said ink particles in a fluid media at a first velocity to said screen, a plug associated with said delivery means and extending into said transfer area, rotatable agitator means in said container and approaching tangential contact with said metering roller for maintaining the ink particles in a suspended state, delivery means associated with said transfer area to carry said ink particles in a fluid media at a first velocity to said screen, a plug associated with said delivery means and extending into said transfer area, rotatable agitator means in said container and approaching tangential contact with said metering roller for maintaining the ink particles in a suspended state, delivery means associated with said transfer area to carry said ink particles in a fluid media at a first velocity to said screen, a plug associated with said delivery means and extending into said transfer area, rotatable agitator means in said container and approaching tangential contact with said metering roller for maintaining the ink particles in a suspended state, delivery means associated with said transfer area to carry said ink particles in a fluid media at a first velocity to said screen, a plug associated with said delivery means and extending into said transfer area, rotatable agitator means in said container and approaches the screen of the electrostatic printing system at a first velocity in a fluid media, passing the ink through a thin flat tube so the ink is positioned in a flat line, reducing the velocity of the ink to a second velocity which second velocity is substantially a zero velocity, introducing the ink into an electrostatic field, and causing the ink to deposit on the screen at the second velocity in a band substantially equal to the width of the print area of said screen and which is sufficiently small in another dimension to constitute a thin line of ink.

11. The method of delivering electroscopic ink to the print receiving element of an electrostatic printing system, said method comprising metering a preseleced portion of the ink from a container holding the ink, engaging the ink on a continuously rotating member and depositing the ink in a transfer area, propelling the ink toward the screen of the electrostatic printing system at a first velocity in a fluid media, passing the ink through a thin flat tube so the ink is positioned in a flat line, reducing the velocity of the ink to a second velocity which second velocity is substantially a zero velocity, introducing the ink into an electrostatic field, and causing the ink to deposit on the screen at the second velocity in a band substantially equal to the width of the print area of said screen and which is sufficiently small in another dimension to constitute a thin line of ink.
in a transfer area, propelling the ink toward the screen of the electrostatic printing system at a first velocity in a fluid media, creating an electric charge on the ink particles before they reach the screen, passing the ink through a thin flat tube so the ink is positioned in a flat line, reducing the velocity of the ink to a second velocity which is substantially a zero velocity, introducing the ink into an electrostatic field, and causing the ink to move toward the screen at the second velocity in a band substantially equal to the width of said screen and which is sufficiently small in another dimension to constitute a thin line of ink.

13. The method of delivering electroscopic ink to the print receiving element of an electrostatic printing system, said method comprising metering a preselected portion of the ink from a container holding the ink, engaging the ink on a continuously rotating member and depositing the ink in a transfer area, propelling the ink toward the screen of the electrostatic printing system at a first velocity in a fluid media, creating a triboelectric charge on the ink particles, creating a corona discharge in the passageway of the moving ink particles for ionizing the air around the ink particles and thereby electrically charging the ink particles, passing the ink through a thin flat tube so the ink is positioned in a flat line, reducing the velocity of the ink to a second velocity which is substantially a zero velocity, introducing the ink into an electrostatic field, and causing the ink to move toward the screen at the second velocity in a band substantially equal to the width of said screen and which is sufficiently small in another dimension to constitute a thin line of ink.

14. A feeding mechanism for electrostatic printing systems and the like which include a counter-electrode and an electrically charged screen with an electrostatic field established therebetween, said feeding mechanism comprising a container of electroscopic ink, said container having a discharge slot, a metering roller having a pile fabric surface operatively mounted externally of said container and having a portion of the pile fabric extending through said slot into said container for collecting a charge of ink and for delivering a charge of electroscopic ink to a transfer area, said metering roller being positioned so that it extends into said transfer area, rotatable agitator means in said container and approaching tangential contact with said metering roller, delivery means associated with said transfer area to carry said ink particles in a fluid media at a first velocity to said screen, a relatively flat tube associated with said delivery means to deliver the ink in a relatively narrow band in one dimension and a width which is at least substantially equal to the width of the screen, a triboelectric ink charging zone established between said transfer and said screen where said ink particles are turbulent propelled therethrough and receive a triboelectric charge, corona discharge means operatively interposed in the path of the moving ink particles for providing a discharge and thereby charging said ink particles, a plug associated with said delivery means and extending into said transfer area opposed from said metering roller thereby providing a gap between said metering roller and plug, means for regulating the size of said gap, an exhaust tube surrounding said relatively flat tube and terminating in approximately the same vertical plane as the end of said flat tube, said exhaust tube being maintained under a reduced pressure for removing the fluid at the point of ink delivery at the screen, thereby reducing the velocity of the ink particles to a second velocity which is substantially less than the first velocity, and means for adjustably positioning said exhaust tube so that the terminal end of the exhaust tube may be extended beyond the terminal end of the flat tube, where the ink particles are then carried by the electrostatic field established between said delivery means, screen and counterelectrode.

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