

12 **EUROPEAN PATENT APPLICATION**

21 Application number: 90301718.4

51 Int. Cl.⁵: G03G 15/08

22 Date of filing: 16.02.90

30 Priority: 16.02.89 US 311491

43 Date of publication of application:
22.08.90 Bulletin 90/34

84 Designated Contracting States:
DE FR GB

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54 **Air nozzle.**

57 An apparatus is disclosed for removing large particles from a toner powder image developed on a latent image which is recorded on an image receiving member. The apparatus includes a nozzle (100), interposed between the development station (C) and the transfer station (D) at which the toner powder image is transferred to a copy sheet. The nozzle directs a high velocity flow of gas across the toner powder image to remove large particles therefrom without affecting image integrity.

EP 0 383 625 A2

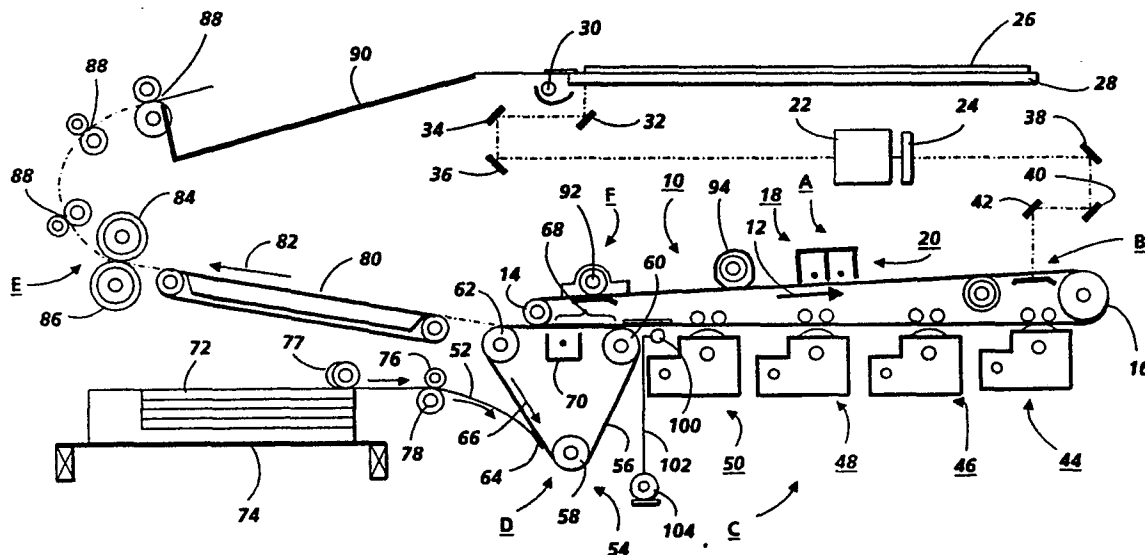


FIG. 1

This invention relates generally to toner powder images on image receiving members, especially photoconductive members in electrophotographic printing machines.

In an electrophotographic printing machine, a photoconductive member is charged to a substantially uniform potential to sensitize the surface thereof. The charged portion of the photoconductive member is exposed to a light image of an original document being reproduced. Exposure of the charged photoconductive member selectively dissipates the charge thereon in the irradiated areas. This records an electrostatic latent image on the photoconductive member corresponding to the informational areas contained within the original document being reproduced. After the electrostatic latent image is recorded on the photoconductive member, the latent image is developed by bringing marking particles into contact therewith. This forms a powder image on the photoconductive member which is subsequently transferred to a copy sheet. The copy sheet is heated to permanently affix the marking particles thereto in image configuration.

Hereinbefore, different types of development systems have been used. These systems utilize two component developer mixes or single component developer materials. Typical two component developer mixes employed are well known in the art, and generally comprise dyed or colored thermoplastic powders, known in the art as toner particles, which are mixed with coarser granules, such as ferromagnetic granules. The toner particles and carrier granules are selected such that the toner particles acquire the appropriate charge relative to the electrostatic latent image recorded on the photoconductive surface. When the developer mix is brought into contact with the charged photoconductive surface the greater attractive force of the electrostatic latent image recorded thereon causes the toner particles to transfer from the carrier granules and adhere to the electrostatic latent image.

Multi-color electrophotographic printing is substantially identical to the foregoing process of black and white printing. However, rather than forming a single latent image on the photoconductive surface, successive latent images corresponding to different colors are recorded thereon. Each single color electrostatic latent image is developed with toner particles of a color complementary thereto. This process is repeated a plurality of cycles for differently colored images and their respective complementarily colored toner particles. Each single color toner powder image is transferred to the copy sheet in superimposed registration with the prior toner powder image. This creates a multi-layered toner powder image on the copy sheet. Thereafter, the multi-layered toner powder image is permanently affixed to the copy sheet creating a color

copy.

Agglomerates of toner particles, carrier granules, and other large particles on the surface of the photoconductive member prior to transfer of the toner powder image cause image deletions or white spots. In multi-color electrophotographic printing machines, this problem is aggravated by the requirement to transfer a plurality of different color toner powder images from the photoconductive surface to the copy sheet. In addition, when the toner is not spread evenly over the latent image, the mounds or peaks of toner particles cause patches of unevenly fused toner particles on the copy sheet. This results in the solid areas being of non-uniform density, deletion areas having information missing therefrom, and the print having graininess. Thus, it is highly desirable to remove large particles and improve the evenness of the toner powder image prior to transfer from the photoconductive member to the copy sheet.

Various techniques have been devised to improve the toner image transferred to the copy sheet. The following disclosures are of interest:

US-A-3,741,157

Patentee: Krause

Issued: June 26, 1973

US-A-3,741,643

Patentee: Smith et al.

Issued: June 26, 1973

US-A-3,767,300

Patentee: Brown et al.

Issued: October 23, 1973

US-A-4,348,684

Patentee: Binder

Issued: September 7, 1982

The relevant portions of the foregoing patents may be briefly summarized as follows:

US-A-3,741,157 discloses a nozzle for directing a jet of air onto a photoconductive drum after the transfer station. The nozzle has a tube with apertures along a line facing the electrophotographic plate. Air is directed through the line toward the drum to clean the drum surface.

US-A-3,741,643 describes an air knife for removing excessive developer liquid from a photoconductive surface. The air knife is located between the development and transfer stations.

US-A-3,767,300 discloses an air knife for removing excess liquid developer from a photoconductive drum. The air knife is located immediately after the development station.

US-A-4,348,684 describes an air knife located after the development station. The air knife has a slit opposed to a drum having pigmented particles developed thereon. Pressurized air flows from the slit of the air knife into the sensitized and unsensitized zones of the surface of the drum to remove excess pigment particles therefrom.

According to one aspect of the present invention, there is provided an apparatus for removing large particles from a toner powder image developed on a latent image recorded on an image receiving member. The apparatus includes means for supplying a pressurized gas. Means, coupled to the supplying means and positioned adjacent the image receiving member, direct a high velocity flow of gas across the toner powder image to remove large particles therefrom.

In another aspect of the present invention, there is provided an electrophotographic printing machine of the type in which an electrostatic latent image recorded on a photoconductive member is developed, at a development station, with a toner particles to form a toner powder image on the photoconductive member, and the toner powder image is transferred, at a transfer station, from the photoconductive member to a copy sheet. Means supply a pressurized gas. Means, coupled to the supplying means and positioned adjacent the photoconductive member between the development station and the transfer station, direct a high velocity flow of gas across the toner powder image to remove large particles therefrom before the transfer of the toner powder image from the photoconductive member to the copy sheet.

By way of example an embodiment of the invention will be described with reference to the accompanying drawings, in which:

Figure 1 is a schematic elevational view depicting an electrophotographic printing machine; and

Figure 2 is a schematic elevational view showing further details of a component of the Figure 1 printing machine.

In the drawings, like reference numerals have been used throughout to designate identical elements. Figure 1 schematically depicts the various components of an illustrative electrophotographic printing machine incorporating apparatus in accordance with the present invention. It will become evident from the following discussion that the apparatus is equally well suited for use in a wide variety of electrostatographic printing machines, and is not necessarily limited in its application to the particular electrophotographic printing machine shown herein.

Inasmuch as the art of electrophotographic printing is well known, the various processing stations employed in the Figure 1 printing machine will be shown hereinafter schematically and their operation described briefly with reference thereto.

As shown in Figure 1, the electrophotographic printing machine employs a photoconductive belt 10. Preferably, the photoconductive belt 10 is made from a photoconductive material coated on a grounding layer, which, in turn, is coated on an

anti-curl backing layer. The photoconductive material is made from a transport layer coated on a generator layer. The transport layer transports positive charges from the generator layer. The interface layer is coated on the grounding layer. The transport layer contains small molecules of di-m-tolyldiphenylbiphenyldiamine dispersed in a polycarbonate. The generation layer is made from trigonal selenium. The grounding layer is made from a titanium coated Mylar. The grounding layer is very thin and allows light to pass therethrough. Other suitable photoconductive materials, grounding layers, and anti-curl backing layers may also be employed. Belt 10 moves in the direction of arrow 12 to advance successive portions of the photoconductive surface sequentially through the various processing stations disposed about the path of movement thereof. Belt 10 is entrained about idler roller 14 and drive roller 16. Idler roller 14 is mounted rotatably so as to rotate with belt 10. Drive roller 16 is rotated by a motor coupled thereto by suitable means such as a belt drive. As roller 16 rotates, it advances belt 10 in the direction of arrow 12.

Initially, a portion of photoconductive belt 10 passes through charging station A. At charging station A, two corona generating devices, indicated generally by the reference numerals 18 and 20 charge photoconductive belt 10 to a relatively high, substantially uniform potential. Corona generating device 18 places all of the required charge on photoconductive belt 10. Corona generating device 20 acts as a leveling device, and fills in any areas missed by corona generating device 18.

Next, the charged photoconductive surface is rotated to exposure station B. Exposure station B includes a moving lens system, generally designated by the reference numeral 22, and a color filter mechanism, shown generally by the reference numeral 24. An original document 26 is supported stationarily upon a transparent viewing platen 28. Successive incremental areas of the original document are illuminated by means of a moving lamp assembly, shown generally by the reference numeral 30. Mirrors 32, 34 and 36 reflect the light rays through lens 22. Lens 22 is adapted to scan successive areas of illumination of platen 28. The light rays from lens 22 are reflected by mirrors 38, 40, and 42 to be focused on the charged portion of photoconductive belt 10. Lamp assembly 30, mirrors 32, 34 and 36, lens 22, and filter 24 are moved in a timed relationship with respect to the movement of photoconductive belt 10 to produce a flowing light image of the original document on photoconductive belt 10 in a non-distorted manner. During exposure, filter mechanism 24 interposes selected color filters into the optical light path of lens 22. The color filters operate on the light rays

passing through the lens to record an electrostatic latent image, i.e. a latent electrostatic charge pattern, on the photoconductive belt corresponding to a specific color of the flowing light image of the original document.

Subsequent to the recording of the electrostatic latent image on photoconductive belt 10, belt 10 advances the electrostatic latent image to development station C. Development station C includes four individual developer units generally indicated by the reference numerals 44, 46, 48 and 50. The developer units are of a type generally referred to in the art as "magnetic brush development units." Typically, a magnetic brush development system employs a magnetizable developer material including magnetic carrier granules having toner particles adhering triboelectrically thereto. The developer material is continually brought through a directional flux field to form a brush of developer material. The developer particles are continually moving so as to provide the brush consistently with fresh developer material. Development is achieved by bringing the brush of developer material into contact with the photoconductive surface. Developer units 44, 46, and 48, respectively, apply toner particles of a specific color which corresponds to the complement of the specific color separated electrostatic latent image recorded on the photoconductive surface. The color of each of the toner particles is adapted to absorb light within a preselected spectral region of the electromagnetic wave spectrum corresponding to the wave length of light transmitted through the filter. For example, an electrostatic latent image formed by passing the light image through a green filter will record the red and blue portions of the spectrums as areas of relatively high charge density on photoconductive belt 10, while the green light rays will pass through the filter and cause the charge density on the photoconductive belt 10 to be reduced to a voltage level ineffective for development. The charged areas are then made visible by having developer unit 44 apply green absorbing (magenta) toner particles onto the electrostatic latent image recorded on photoconductive belt 10. Similarly, a blue separation is developed by developer unit 46 with blue absorbing (yellow) toner particles, while the red separation is developed by developer unit 48 with red absorbing (cyan) toner particles. Developer unit 50 contains black toner particles and may be used to develop the electrostatic latent image formed from a black and white original document. Each of the developer units is moved into and out of the operative position. In the operative position, the magnetic brush is closely adjacent the photoconductive belt, while, in the non-operative position, the magnetic brush is spaced therefrom. During development of each electrostatic latent image only one developer unit is

in the operative position, the remaining developer units are in the non-operative position. This insures that each electrostatic latent image is developed with toner particles of the appropriate color without co-mingling. In Figure 1, developer unit 44 is shown in the operative position with developer units 46, 48 and 50 being in the non-operative position.

After development, the toner powder image developed on photoconductive belt 10 advances beneath a nozzle, indicated by the reference numeral 100. Nozzle 100 is positioned adjacent photoconductive belt 10 and spaced therefrom by about 2 millimeters. A conduit 102 couples nozzle 100 to a blower 104. Blower 104 furnishes a pressurized gas which exits nozzle 100 at a high velocity. Nozzle 102 directs the the flow of the gas across the toner powder image. Preferably, gas exits nozzle 100 at a substantially uniform velocity along the length thereof. By way of example, gas may exit nozzle 100 at a velocity of about 3500 feet per minute. Nozzle 102 is made from a tube having a slit therein. The tube extends across belt 10 with the longitudinal axis thereof substantially normal to the direction of movement of belt 10, as indicated by arrow 12. Preferably, the gas exiting nozzle 100 is air. The high velocity air flowing across the toner powder image developed on the electrostatic latent image recorded on photoconductive belt 10, removes large particles such as agglomerates of toner particles, carrier granules and other large particles, by blowing these particles off the toner powder image. The high velocity air exerts a greater force on the large particles than on the toner particles of the toner powder image because of the greater cross sectional area of the large particles. In addition to removing the large particles, the high velocity air may spread the toner particles of the toner powder image more evenly improving the solid area density of the toner powder image without disturbing the image integrity. Nozzle 100 will be discussed in further detail hereinafter with reference to Figure 2.

Next, the toner image is moved to transfer station D where the toner image is transferred to a sheet of support material 52, i.e. a copy sheet such as plain paper, amongst others. At transfer station D, the sheet transport apparatus, indicated generally by the reference numeral 54, moves sheet 52 into contact with photoconductive belt 10. Sheet transport 54 has a pair of spaced belts 56 entrained about three rolls 58, 60 and 62. A gripper 64 extends between belts 56 and moves in unison therewith. Sheet 52 is advanced from a stack of sheets 72 disposed on tray 74. Feed roll 77 advances the uppermost sheet from stack 72 into the nip defined by forwarding rollers 76 and 78. Forwarding rollers 76 and 78 advance sheet 52 to sheet transport 54. Sheet 52 is advanced by for-

warding rollers 76 and 78 in synchronism with the movement of gripper 64. In this way, the leading edge of sheet 52 arrives at a preselected position to be received by the open gripper 64. The gripper then closes securing the sheet thereto for movement therewith in a recirculating path. The leading edge of the sheet is secured releasably by gripper 64. As the belts move in the direction of arrow 66, the sheet 52 moves into contact with the photoconductive belt, in synchronism with the toner image developed thereon, at the transfer zone 68. A corona generating device 70 sprays ions onto the backside of the sheet so as to charge the sheet to the proper magnitude and polarity for attracting the toner image from photoconductive belt 10 thereto. Sheet 52 remains secured to gripper 64 so as to move in a recirculating path for three cycles. In this way, three different color toner images are transferred to sheet 52 in superimposed registration with one another. Thus, the previous cycle is repeated for each color to form a multi-color copy of a colored original document.

After the last transfer operation, grippers 64 open and release sheet 52. Conveyor 80 transports sheet 52, in the direction of arrow 82, to fusing station E where the transferred image is permanently fused to sheet 52. Fusing station E includes a heated fuser roll 84 and a pressure roll 86. Sheet 52 passes through the nip defined by fuser roll 84 and pressure roll 86. The toner image contacts fuser roll 84 so as to be affixed to sheet 52. Thereafter, sheet 52 is advanced by forwarding roll pairs 88 to catch tray 90 for subsequent removal therefrom by the machine operator.

The last processing station in the direction of movement of belt 10 as indicated by arrow 12 is cleaning station F. A rotatably mounted fibrous brush 92 is positioned in cleaning station F and maintained in contact with photoconductive belt 10 to remove residual toner particles remaining after the transfer operation. Thereafter, lamp 94 illuminates photoconductive belt 10 to remove any residual charge remaining thereon prior to the start of the next successive cycle.

Referring now to Figure 2, there is shown nozzle 100 in greater detail. As depicted thereat, nozzle 100 includes an elongated tube 106 having end 108 opened and end 110 closed. Open end 108 is connected to conduit 102 (Figure 1). A slot 112 extends in a direction substantially parallel to the longitudinal axis of the tube 106. Tube 106 is positioned so that its longitudinal axis extends in a direction substantially normal to the direction of movement of belt 10, as indicated by arrow 12 (Figure 1). Slot 112 is opposed to belt 10 and spaced by about 2 millimeters therefrom. By way of example, tube 106 is made from aluminum having an outer diameter 0.625 inches (about 16 mm)

and an inner diameter of 0.56 inches (about 14 mm). Tube 106 is about 457 millimeters long. Slot 112 is about 368 millimeters long and about 3 millimeters wide. Slot end 114 is about 26 millimeters from the closed end 110 of tube 106. Slot end 116 is about 63 millimeters from open end 108 of tube 106. A tube holder (not shown) secures tube 106 to the printing machine.

One skilled in the art will appreciate that that there are various modifications and alternatives that may be used. For example, in a modified arrangement, a manifold having air sucked therein may be used to collect the large particles blown off the image by nozzle 100. In an alternative form of the apparatus, air may be drawn away from the toner powder image by the nozzle at such a velocity as to collect only the large particles.

In recapitulation, the apparatus described above with reference to the drawings includes a nozzle positioned between the development and transfer stations of an electrophotographic printing machine. A blower is connected via a duct to the nozzle. The nozzle directs a high velocity flow of gas across the toner powder image to remove large particles therefrom without disturbing image integrity.

Claims

1. An apparatus for removing large particles from a toner powder image developed on a latent image recorded on an image receiving member, including:

means (100) positioned adjacent the image receiving member (10), for causing a high velocity flow of gas across the toner powder image to remove large particles therefrom without substantially affecting the integrity of the toner powder image.

2. An apparatus as claimed in claim 1, wherein the said means is coupled to a supply (104) of pressurized gas and is operable to direct a high velocity flow of gas across the toner powder image.

3. An apparatus according to claim 2, wherein the said means is operable to direct high velocity flow of gas that spreads toner particles more evenly over the latent image to improve toner powder image solid area density.

4. An apparatus according to claim 2 or claim 3, wherein said directing means includes a nozzle positioned adjacent and spaced from the image receiving member.

5. An apparatus according to claim 4, wherein the gas exiting from said nozzle is at a substantially uniform velocity across the toner powder image.

6. An apparatus according to claim 4 or claim 5, wherein said nozzle comprises an elongated

tube (106) having an elongated slot (112) therein with said tube being positioned to extend across the image receiving member with the slot therein being opposed to the image receiving member.

7. An apparatus according to any one of claim 2 to 6, wherein said gas supply includes a blower. 5

8. An apparatus according to any one of the preceding claims, wherein the gas is air.

9. An apparatus according to claim 6, wherein gas exiting the slot of said tube has a velocity of about 3500 feet per minute. 10

10. An electrophotographic printing machine of the type in which an electrostatic latent image recorded on a photoconductive member (10) is developed, at a development station (C), with toner particles to form a toner powder image on the photoconductive member, and the toner powder image is transferred, at a transfer station (D), from the photoconductive member to a copy sheet (52), the machine including an apparatus according to any one of the preceding claims, wherein the said means is positioned adjacent the photoconductive member between the development station and the transfer station for directing a high velocity flow of gas across the toner powder image to remove large particles therefrom, before the transfer of the toner powder image from the photoconductive member to the copy sheet, without substantially affecting the integrity of the toner powder image. 15 20 25 30

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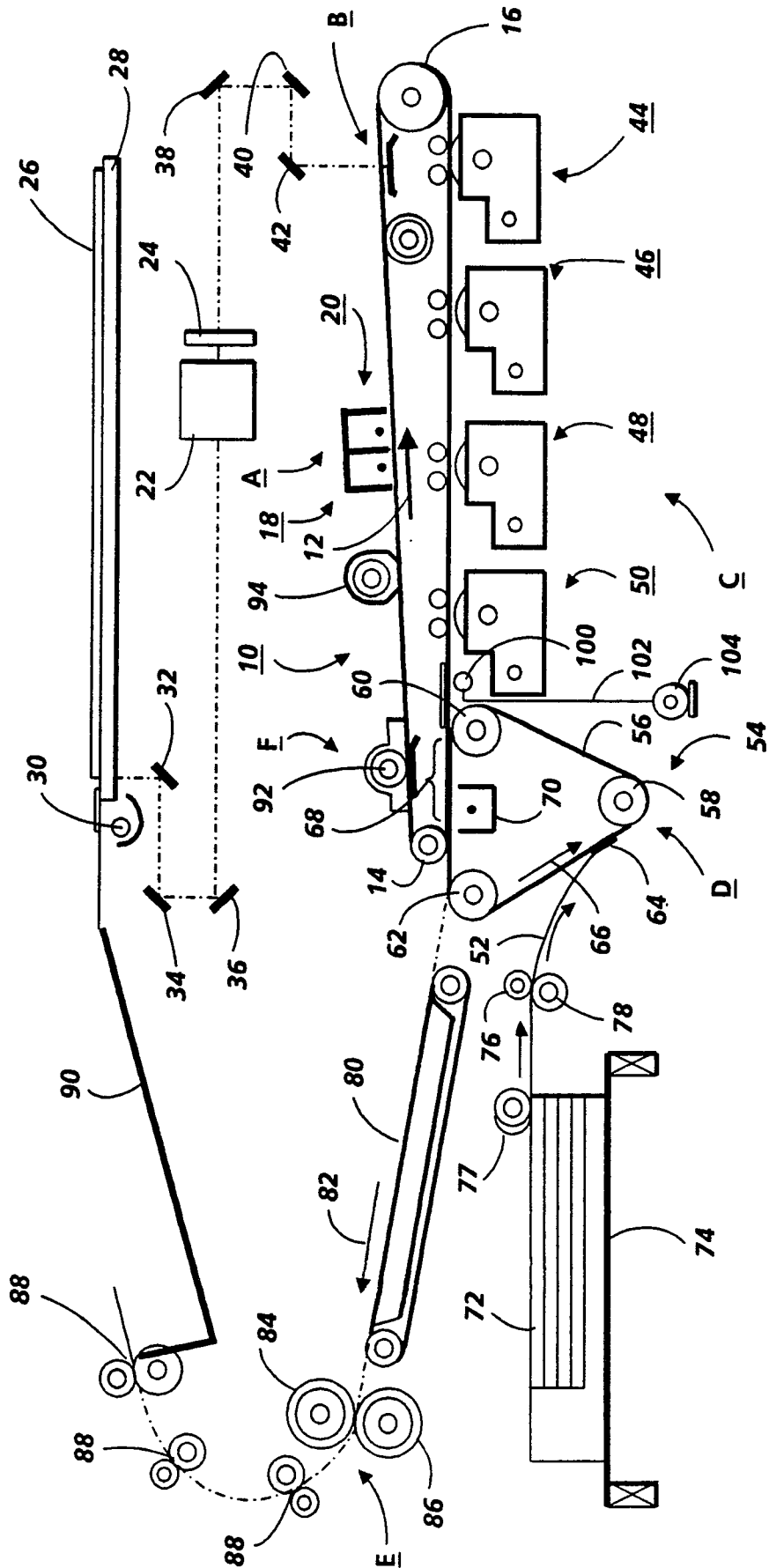


FIG. 1

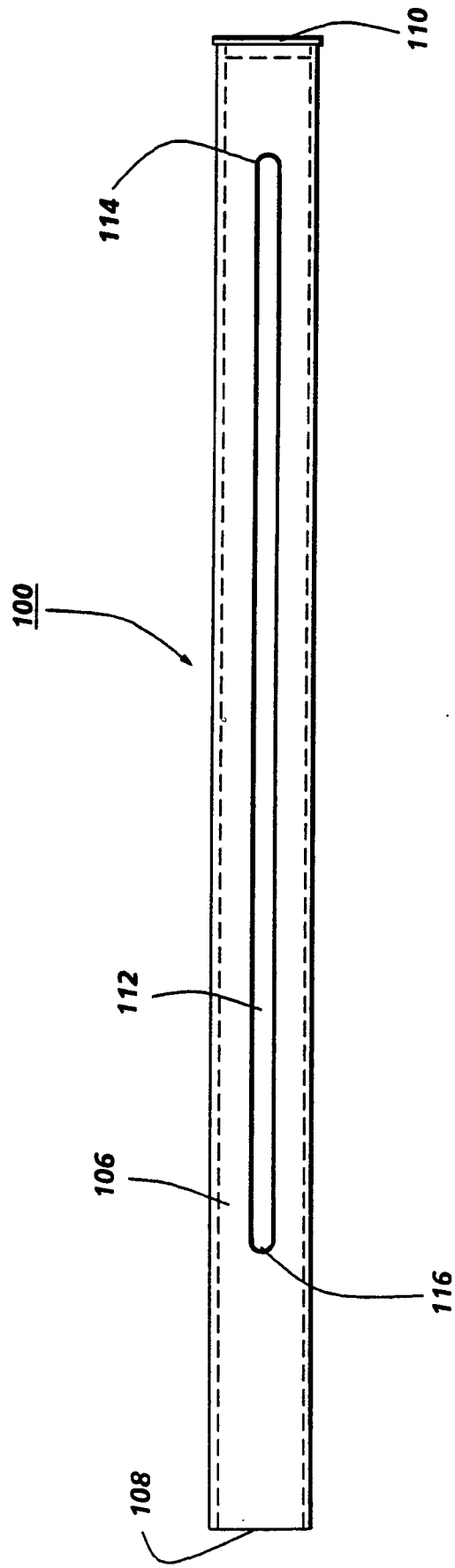


FIG. 2