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(54) Traction surface for print media feed of a heated printer.

(57) According to the invention, a structure for advancing print media (90) through a print zone of a printer, the structure being subjected to heat during operation of the printer, gives good traction between the structure and the print media (90). The structure provides a high accuracy print media drive for open loop printing. Traction is maintained through a range of temperatures, for a range of print media drag forces and over a long period of use. The structure includes one or more pinch rollers (102), one or more drive rollers (100) against which a corresponding pinch roller (102) exerts a contact force and a means for rotating the one or more drive rollers (100). Each drive roller (100) is coated with a material that provides good traction over a range of operational temperatures without requiring an undesirably large contact force between the pinch roller (102) and drive roller (100) that may result in visible surface markings being formed on the print media (90). Good traction is maintained over a range of print media drag forces throughout the life of the printer. Each drive roller (102) can be coated with a metal thermal spray. The metal thermal spray can be a plasma sprayed tungsten carbide. The spray can include a bonding agent to enhance the bonding between the coating and the drive roller (102). The structure according to the invention can advantageously be used with a thermal inkjet printer and, in particular, with thermal inkjet printers in which the resolution of the printer is greater than 200 dots/inch.

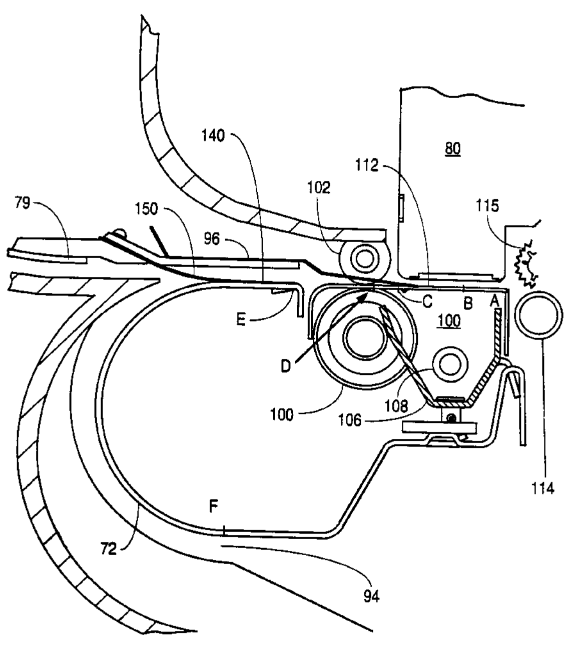

Figure 3

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CROSS-REFERENCE TO RELATED APPLICATIONS

This application is related to and incorporates by reference the U.S. patent application entitled "Airflow System for Inkjet Printer," attorney docket no. 1093135-1, filed by William Schwiebert et al. on the same date as the present application, and assigned to the same assignee as the present application.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to thermal printers and, in particular, to a structure for advancing print media through a print zone of the printer, the structure being subjected to heat during operation of the printer. Most particularly, the invention relates to coating a surface of a printer drive roller to obtain good traction between the drive roller and the print media such that uniform travel of the print media is obtained.

2. Related Art

In an inkjet printer, a print carriage includes one or more print cartridges in which an ink reservoir is formed to hold a particular color of ink. Each print cartridge also includes a printhead having a plurality of nozzles through which ink is ejected. The ink is ejected either through use of a piezoelectric transducer or by heating the ink with a resistor so that a vapor bubble forms and forces ink out through the nozzles onto the portion of the print media that is in the print zone (i.e., area of the print media onto which ink can be ejected at any given time). The print carriage is moved laterally back and forth, and the print media is advanced past the print carriage to enable printing of a desired image or images on the print media.

It is desirable to achieve high throughput (i.e., linear travel of the print media through the printer per unit time) in a printer. However, in previous attempts to achieve high throughput in inkjet printers, distortion of the print media, such as cockling (i.e., print media wrinkling associated with the absorption and drying of the liquid ink on the print media), has been a problem. As a result, it has been necessary to use a heater to heat portions of the print media prior to and during the time that the portions of the print media are in the print zone.

In a high throughput printer, there is only a relatively short period of time to transfer heat to the print media. Thus, a high thermal output heater is required. Integrating a print media drive system (i.e., a structure for advancing the print media through the print zone) with high thermal output heating of the print media has been difficult. In one possible approach, a push drive structure is constructed outside the heat zone to advance the print media through the print zone. In another possible approach, a high temperature drive component that is in full contact with the print media is used to advance the print media through the print zone.

Currently, providing a push drive structure outside the heat zone is preferable to providing a direct contact heated drive component. This is primarily because of the lower cost of the push drive structure located outside the heat zone. Additionally, if a direct contact heated drive component is used, the heated drive component presents a danger during normal servicing. Additional cost must be incurred to provide protection against this danger.

Typically, the push drive structure includes one or more pairs of a drive roller and a pinch roller. In prior vector output plotters, the drive roller has been coated with grains of single crystal aluminum oxide which are adhered to the drive roller with an adhesive to form a "grit wheel" that provided adequate control of print media travel. Additionally, such coatings have been used on plastic drive rollers used with previous non-heated inkjet printers. However, this coated drive roller has several disadvantages when used in a heated printing environment.

The adhesive used for bonding the grit to the roller in the vector output plotters was developed for bonding to a chromated aluminum drive roller. The bond strength of the adhesive is inadequate to resist thermal stresses that arise in a heated environment due to differential coefficients of thermal expansion between the adhesive and drive roller. Further, the glass transition temperature of possible adhesives is near the expected operating temperature of the heated printer, further adversely affecting the bond strength of the adhesive.

Additionally, the use of single crystal aluminum oxide as the grit material resulted in visible tracks being left in the print media when the contact force between the pinch roller and drive roller was elevated to the level needed for proper traction.

Further, the adhesive used to bond the grit material to the drive roller provides inadequate bonding force between the grit and the drive roller to completely prevent shedding of some grit particles during mechanical handling of the drive roller. These contaminants provide a source of contamination to automated assembly equipment used in manufacture of printers using these drive rollers. Further, grit material may also be shed during heated operation of the drive roller, resulting in contamination of the printer and the printing on the print media.

SUMMARY OF THE INVENTION

According to the invention, a structure for advancing a print media through a print zone of a printer, the structure being subjected to heat during operation of the printer, gives good traction between the structure and the print media. The structure provides a high accuracy print media drive for open loop printing. Traction is maintained through a range of temperatures, for a range of print media drag forces and over a long period of use.

In one embodiment of the invention, the structure comprises a pinch roller, a drive roller against which the pinch roller exerts a contact force and a means for rotating the drive roller. Rotation of the drive roller causes the print media to pass between the drive roller and pinch roller. The drive roller is coated with a material such that, for a range of print media drag forces between 0 and 150 grams and a contact force of approximately 1000 grams, the traction loss of the print media is less than 0.05%.

In further embodiments of the invention, in the above structure, for a range of print media drag forces between 0 and 200 grams, the traction loss of the print media is less than 0.013%, and, after passing up to 210,000 print media through the pinch roller and drive roller, the traction loss is less than 0.06%.

In another embodiment of the invention, the structure includes a pinch roller, drive roller and means for rotation, the drive roller being coated with a material such that, for a range of print media drag forces between 0 and 200 grams and a contact force of approximately 1000 grams, the pitch diameter of the roller is maintained within a range of 0.001 inches less than and 0.001 inches greater than a predetermined nominal pitch diameter. In a further embodiment of the invention, the nominal pitch diameter is 7.001 inches.

In any of the above embodiments, the drive roller can be coated with a metal thermal spray. The metal thermal spray can be a plasma sprayed tungsten carbide.

In yet another embodiment of the invention, the structure includes a pinch roller, drive roller and means for rotation, the drive roller being coated with a material including tungsten carbide. The material can also include a bonding agent that helps to secure the tungsten carbide to the drive roller. As discussed above, the coating material can be applied to the drive roller by plasma spraying. After coating, the nominal diameter of the drive roller is within a tolerance of 25 microns.

The coating on the drive roller of the invention provides good traction between the drive roller and print media without requiring that the contact force of the pinch roller against the drive roller be so great that visible surface markings are formed on the print media after the print media has passed between the print roller and the drive roller.

The structure according to the invention can advantageously be used with a thermal inkjet printer and, in particular, with thermal inkjet printers in which the resolution of the printer is greater than 200 dots/inch. The drive roller coating easily performs acceptably within the typical range of temperatures, e.g., between 10 °C and 130 °C, to which the drive roller will be subjected.

The structure according to the invention can include one or more drive rollers and associated pinch rollers. In additional embodiments of the invention, either of the above embodiments includes a second pinch roller and drive roller, the second pinch roller exerting a contact force on the second drive roller, the second drive roller being coated with the same material as the first drive roller.

Further according to the invention, a printer is provided for producing images on print media, the printer comprising means for ejecting ink onto the print media, means for moving the means for ejecting laterally across the print media, a heater for heating the print media, a pinch roller, a drive roller against which the pinch roller exerts a contact force, and a means for rotating the drive roller so that the print media is advanced through the print zone, the drive roller being coated with a material such that good traction, as discussed above, is maintained between the drive roller and the print media.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a simplified perspective view of a printer according to the invention.

Figure 2 is a cross-sectional view of a portion of the print media feed path through a printer according to the invention.

Figure 3 is a cross-sectional view of a portion of the print media feed path through a printer according to the invention, illustrating the heating zones during printing.

Figure 4 is a perspective view illustrating the arrangement of the print media drive and heating elements of Figure 2.

Figure 5 illustrates a print zone screen for use with the invention.

Figure 6 is a cross-sectional view, taken along section line A-A of Figure 5, of a heating screen for use with the invention.

Figure 7A is a top perspective view of a portion of a printer according to the invention.

Figure 7B is a top perspective view of a portion of the printer of Figure 7A.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

Figure 1 is a simplified perspective view of printer 10 according to the invention. Lid 11 of printer 10 encloses print carriage 12 in which four print cartridges 15a, 15b, 15c, 15d (also known as "pens," printhead cartridges," or "cartridges") are inserted. Print carriage 12 is mounted on slider bar 13 such that a printhead (not shown) on each of print cartridges 15a, 15b, 15c, 15d is adjacent print media 14, e.g., paper, plastic transparency or plastic glossy. An endless belt (not shown) is used to drive print carriage 12 along slider bar 13 in a conventional manner. A conventional linear encoder strip (not shown) is utilized, as is known in the art, to detect the position of print carriage 12 as it moves back and forth adjacent print medium 14, so that carriage 12 can be appropriately positioned during printing. Print carriage 12 is also mounted to a guide rail (not shown) to prevent print carriage 12 from rotating about slider bar 13.

Each of print cartridges 15a, 15b, 15c, 15d is held in place in a corresponding stall of print carriage 12 by a friction fit. A resilient arm (not shown) protrudes from a bottom surface of each of the stalls so that each print cartridge 15a, 15b, 15c, 15d is fitted into the corresponding stall by "snapping" the print cartridge 15a, 15b, 15c or 15d into place such that the corresponding resilient arm prevents the print cartridge 15a, 15b, 15c or 15d from moving in a direction perpendicular to slider bar 13. Springs (not shown) are attached to a side of each stall such that when each print cartridge 15a, 15b, 15c, 15d is snapped into place in the corresponding stall, the spring is compressed and applies a force to the print cartridge 15a, 15b, 15c or 15d to prevent the print cartridge 15a, 15b, 15c or 15d from moving laterally (i.e., parallel to slider bar 13) within the stall.

Print media 14 is fed from print media input stack 17 in input tray 16 through a print media feed mechanism (not shown). Print media 14 is then advanced by rollers (not shown) in a direction perpendicular to slider bar 103 while print carriage 12 is moved back and forth on slider bar 13. As the print cartridges 15a, 15b, 15c, 15d move relative to print media 14, ink is ejected through nozzles formed in each of the printheads. Ink is held in a reservoir within each of print cartridges 15a, 15b, 15c, 15d. Typically, each print cartridge 15a, 15b, 15c, 15d contains a different color of ink, e.g., black, cyan, magenta, yellow. The ink passes through channels formed in each print cartridge 15a, 15b, 15c, 15d to firing chambers formed in each print cartridge 15a, 15b, 15c, 15d in the vicinity of the nozzles. The ink in the firing chamber is heated and vaporized, the vapor bubbles in the ink causing a droplet of ink to be ejected through an associated nozzle onto print media 14. The nozzles in the printhead of each print cartridge 15a, 15b, 15c, 15d are arranged in a pattern, such as a rectangular matrix, and ink selectively ejected onto print media 14 so that desired characters or other images are printed on print media 14.

Though, in the description above, the print carriage 12 contains four print cartridges 15a, 15b, 15c, 15d, each print cartridge 15a, 15b, 15c, 15d containing either black, cyan, magenta or yellow ink, it is to be understood that other numbers of print cartridges can be used, e.g., three print cartridges, and other colors of ink can be used, e.g., red, green and blue. The invention also encompasses, for example, printers including only one print cartridge.

Figure 2 is a cross-sectional view of a portion of the print media feed path through a printer according to the invention. Print media 90 is fed from the input tray (see Figure 1) and driven into the print media feed path in the direction of arrow 92. Print media 90 enters slot 94 defined by the curved surfaces of member 70 and preheater 72. Print media 90 contacts the curved surface of member 70 and is guided around and in contact with the curved surface defined by preheater 72. Guide 96 is secured above the outlet of slot 94, and guides print media 90 so that print media 90 moves in the opposite direction from which print media 90 began moving when picked from the input tray.

Print media can also be hand-fed into the print media feed path. Members 70 and 79 define slot 78 through which print media may enter the print media feed path. Print media are pushed by hand through slot 70 until engaged and pulled through the print zone 104, as described below.

Flexible bias guide 150 is positioned above upper guide 140 and preheater 72, so that a surface of flexible bias guide 150 is in contact with the preheater 72, when no print media is present. As print media 90 passes underneath flexible bias guide 150, flexible bias guide 150 forces print media 90 against preheater 72 to ensure adequate preheating of print media 90. The leading edge of the preheated print media 90 is then fed into the "nip" (i.e., area of application of a normal load against print media 90) between drive roller 100 and pinch roller 102. Drive roller 100 and pinch roller 102 rotate to drive print media 90 past print zone 104. In print area 104, radiant heat is directed on the undersurface of print media 90 by reflector 106 and heater element 108 disposed in heater cavity 110 defined by reflector 106. Print zone screen 112 is fitted over cavity 110, and supports print media 90 as print media 90 passes through print zone 104, while at the same time permitting radiant heat transfer from the cavity 110 to the print media 90.

Once print media 90 enters print zone 104, print media 90 can be stopped by stopping the drive roller 100 (tension roller 114, driven synchronously with drive roller 100, also stops). Ink is then ejected from print cartridge 80 while print cartridge 80 is moved laterally across print media 90, as described above with respect to Figure 1, to print a desired area across the upper surface of print media 90. After printing a swath across print media 90, drive roller 100 and tension roller 114 are actuated, and print media 90 advanced a predetermined amount. Once again, drive roller 100 and tension roller 114 are stopped and a new area is printed across the width of print media 90. After print media 90 passes a certain distance past print zone 104, print media 90 contacts tension roller 114 (driven at a slightly greater rate than drive roller 100) which propels print media 90 past star wheel 115 into the output tray (see Figure 1).

Figure 3 is a cross-sectional view of a portion of the print media feed path through a printer according to the invention, illustrating the heating zones during printing. For automatic print media feed, i.e., print media 90 passing through slot 94, print media 90 is preheated in the region between the point designated F in Figure 3 to the point designated E. From point E to point D, heat is not applied to print media 90. Then, when print media 90 passes from point D to point A (including passing through print zone 104), print media 90 is heated again.

Figure 4 is a perspective view illustrating the arrangement of the print media drive and heating elements of Figure 2. For clarity, screen 112 is not shown in this view. Drive rollers 100A and 100B are mounted for rotation on drive shaft 160. Tension roller 114 is mounted on tension shaft 162. Both drive shaft 160 and tension shaft 162 have a relatively small diameter, e.g., 0.25 inches. Both drive shaft 160 and tension shaft 162 are made of 1018 steel. This material, in combination with the relatively small diameter, make drive shaft 160 and tension shaft 162 relatively nonrigid. In order to provide stability and the shaft stiffness required for accurate operation, both of drive shaft 160 and tension shaft 162 are mounted on three bearings. Drive shaft 160 is mounted on bearings 161A, 161B and 161C. Tension shaft 162 is mounted on bearings 163A, 163B and 163C. Connector plates 165A and 165B are integral with bearings 161A, 163A and 161B, 161C, 163B, 163C, respectively, so that the bearings 161A, 163A, 161B, 161C, 163B, 163C self-align the relative position between drive shaft 160 and tension shaft 162.

Drive rollers 100A and 100B are 0.701 inches in diameter, and are fabricated of a heat-resistant material covered with a coating as described in more detail below. With drive rollers 100A and 100B larger than the diameter of the shaft 160, the effective heating area defined by the reflector opening can be maximized, since the rollers 100A and 100B can be made to intrude into the edges of the cavity 110, but without reducing the area of the reflector 106 opening between drive rollers 100A and 100B. Pinch roller 102 (Figures 2 and 3) has a similar configuration to driver roller 100, and star wheel 115 (Figures 2 and 3) has a similar configuration to tension roller 114. As a result, the heating area provided by the heater assembly comprising the reflector 106 need not be sacrificed, while at the same time the handoff distance between the drive rollers 100A, 100B and tension rollers 114 can be kept small. Minimizing the print media handoff distance between the drive rollers 100A, 100B and tension rollers 114 contributes to accuracy in print media advancement, since it minimizes the print media area over which the drive rollers 100A, 100B and tension rollers 114 are simultaneously acting. Moreover, no additional output rollers or mechanisms, other than the tension roller 114, are required to stack the media in the output tray (Figure 1). In previous inkjet printers, it is common to employ two output rollers to stack the media.

In a preferred embodiment, the driver rollers 100A and 100B engage the print media 90 (Figure 2) adjacent opposed edges thereof, and within marginal areas on which no printing occurs. The rollers have a width dimension of 0.375 inches in this example, smaller than the print media margin width.

The print media drive mechanism of the printer further comprises a stepper motor 166 having two pinion gears 168 and 170 of different sizes mounted on the motor shaft 172. The pinion gears 168 and 170 directly drive the respective drive shaft 160 and tension shaft 162 through a drive gear 174 and a tension gear 176. The drive gear 174 is slightly larger than the tension gear 176; the sizes of the pinion gears 168 and 170 are selected with the sizes of the drive gear 174 and tension gear 176 to produce substantially equal drive shaft 160 and tension shaft 162 linear surface speeds. All gears have helical gear teeth to minimize drive train noise. In this embodiment, drive gear 174 and tension gear 176 are fabricated of an engineering plastic.

An anti-backlash device 202 is provided to prevent backlash movement of the gear train, thereby improving the accuracy and control of print media 90 (Figure 2) advancement and positioning. The device 202 includes a first pair of spring fingers 202A and 202B, which lightly grip the tension gear 176 with sufficient grip force to prevent backlash movement, yet permit the tension gear 176 to be driven by the motor 166. The device 202 further includes a second pair of spring fingers 202C and 202D which grip drive gear 174 in the same manner.

The heater element 108 comprises a transparent quartz tube, open to the air at each end thereof, and a heater wire element, driven by a low voltage supply. The wire element generates radiant heat energy when electrical current is conducted by the wire element.

The print zone screen 112 in this embodiment is further illustrated in Figures 5 and 6, and performs several functions. The print zone screen 112 supports the print media at the print zone 104 and above the heater reflector 106. The screen 112 is strong enough to prevent users from touching the heater element 108. The screen 112 transmits radiative and convective heat energy to the print media, while transmitting little if any conductive heat energy, which would cause print anomalies, due to nonuniform heat transfer. The screen 112 is designed such that the print media does not catch a surface of the screen 112 as it is driven through the print zone 104.

The screen 112 performs these functions by the placement of a network of thin primary and secondary webs which outline relatively large screen openings. Exemplary ones of the primary and secondary webs are indicated as respective elements 190 and 192; exemplary screen openings are indicated as 194. The secondary webs 192 provide additional strength to the web network. The screen 112 is preferably made from a high strength material such as stainless steel. The openings 194 can be formed by a die cutting or etching processes. The screen 112 is processed to remove any burrs which might snag the print media.

Figure 6 shows a cross-sectional view, taken along section line A-A of Figure 5, of the one-piece member defining the screen 112, bent at one edge to define flange 112A, and bent at the other edge to define flange 112B. The web network is wrapped around the edge 112C such that it is defined not only on the horizontal surface 112D of the screen 112 but also in the flange 112A, down to line 112E. This permits radiant heat to escape through the flange openings as well as the openings defined in the horizontal surface 112D, thereby expanding the post-printing heating area.

Figure 7A is a top perspective view of a portion of printer 700 according to the invention. The print carriage is not shown for clarity. Pinch rollers 702a, 702b contact drive rollers 701a, 701b. A print media (for clarity, not shown) is fed between pinch rollers 702a, 702b and drive rollers 701a, 701b, as described above. Pinch rollers 702a, 702b press the print media against drive rollers 701a, 701b which grip the print media and pull the print media into the print zone, as described above.

Figure 7B is a top perspective view of a portion of printer 700 of Figure 7A. In Figure 7B, the area of application of a normal load by pinch roller 702a through the print media against drive roller 701a (i.e., the "nip") is designated by numeral 703.

Each of pinch rollers 702a, 702b have a nominal diameter of 0.350 inches. The inner axle (not shown) on which pinch rollers 702a, 702b are mounted is formed of stainless steel and is mounted on a swing arm that is used to apply the contact force of pinch rollers 702a, 702b against drive rollers 701a, 701b. Each of pinch rollers 702a, 702b include inner and outer roller portions. The inner roller portion is mounted on the inner axle and is made of urethane thermoset with a hardness of 60 durometer Shore D. The outer roller portion is also made of urethane thermoset; however the outer roller has a hardness of 80 durometer Shore A.

Drive rollers 701a, 701b have a nominal diameter of 0.701 inches and a width of 0.375 inches. Drive rollers 701a, 701b are mounted on a shaft (not shown) made of, for instance, 1018 steel. Since drive rollers 701a, 701b are relatively thin, drive rollers 701a, 701b do not shield the print media from the heat source by an appreciable amount. Too, the relatively small diameter of drive rollers 701a, 701b minimize shielding of the print media from the heat source by drive rollers 701a, 701b. For instance, in some prior heated inkjet printers, drive rollers having a diameter in excess of 2.0 inches have been used. Thus, drive rollers 701a, 701b can be located close to the heated print zone so that the distance between the drive rollers 701a, 701b and the tension roller is minimized, thus enabling better control of the print media, and therefore providing better print quality, than would otherwise be achieved.

As explained above, drive rollers 701a, 701b are exposed to heat during operation of printer 700. The temperature of drive rollers 700a, 700b during operation of printer 700 is typically between 10 °C and 130 °C. Previously known drive roller coatings such as adhesively bonded aluminum oxide operate unacceptably in such a heated environment, e.g., the coating material sheds during printing.

In printer 700, a coating for drive rollers 701a, 701b must meet several operational criteria. The coating must be tolerant (e.g., must not shed) to both the temperature extremes and thermal cycling to which drive rollers 701a, 701b are exposed during operation of printer 700. The coating should also remain relatively dimensionally stable during the temperature excursions to which drive rollers 701a, 701b are subject during operation of printer 700, i.e., the coefficient of thermal expansion (CTE) of the coating should be relatively close to the CTE of the drive rollers 701a, 701b.

In addition to the thermal requirements, the coating must provide adequate print media traction. For a given nip configuration, the coating must provide sufficient traction to move the print media through the print media travel path accurately (i.e., within a specified tolerance) for a range of print media drag loads. Further, this traction must be maintainable throughout the printer's life. Additionally, sufficient traction must be obtained to enable the contact force between drive rollers 701a, 701b and corresponding pinch rollers 702a, 702b to be made small enough so that tracks or indentations are not left on the print media after passing through the nip area.

The coating must also be suitable for use in automated, high volume, low cost manufacturing processes that are preferably used to manufacture printer 700. The coating must be resistant to mechanical handling damage that may occur during the manufacturing processes. The coating must be able to be applied so that tight coating thickness, roughness and uniformity (of thickness and roughness among coated rollers) specifications can be met.

According to the invention, drive rollers 701a and 701b are coated with a metal thermal spray. In one embodiment, the coating includes tungsten carbide. The coating is applied by, for instance, plasma spraying. In an additional embodiment, in addition to tungsten carbide, the coating includes a bonding agent that helps to secure the tungsten carbide to drive rollers 701a, 701b. The bonding agent can be, for instance, a metallic bonding agent. The coating is applied by carefully controlling the coating composition, the coating particle size, the coating flow rates, the plasma energy and the orientation of the drive roller to the coating equipment.

A drive roller with a coating according to the invention can be used in a heated printer to maintain good traction of the print media with the drive roller. Using James River plain copy paper as print media, a pinch roller having a nominal outside diameter of 9.0 mm, nominal width of 5.0 mm and hardness of 80 durometer shore A, a drive roller having a nominal outside diameter of 17.8 mm, and applying a nominal contact force of 1000 grams against the drive roller with the pinch roller, traction loss (i.e., slippage of the print media from the no slip position) is held below 0.05% for a range of paper drag force between 0 and 150 grams. Further, the traction loss does not exceed 0.13% for a range of paper drag force between 0 and 200 grams. (Note that, typically, in a printer according to the invention, the print media drag force is between 20 and 180 grams.) Additionally, no visible surface markings are formed on the paper.

Further, a drive roller with a coating according to the invention maintains good control of drive roller pitch diameter in a heated printer environment. (Pitch diameter is the effective drive diameter of a roller that advances print media by frictional force, i.e., the amount of linear motion produced by one rotation of the roller. Pitch diameter is affected by the characteristics of the printer nip, traction of the roller and surface roughness of the roller.) According to the invention, for a coated drive roller with a nominal pitch diameter of 7.001 inches, the actual pitch diameter is held within a tolerance of 0.001 inches for a paper tension between 0 and 200 grams. Further, the eccentricity of the coating is held below 0.007 mm.

The drive roller coating according to the invention also resists wear well. After feeding 210,000 sheets of paper through the drive rollers and pinch rollers, the traction loss was still only 0.06% for paper drag forces between 0 and 150 grams.

The drive roller coating also has good thermal properties. Typically, the drive rollers in a printer according to the invention are subjected to temperatures between 10 °C and 130 °C. The coating according to the invention is capable of withstanding temperatures 4 to 5 times greater than the typical upper temperature of 130 °C. The CTE of the coating is less than the CTE of the drive rollers; however, despite this difference in CTE's, the bonding strength of the coating to the drive rollers is sufficiently great (in excess of 20 kpsi) to resist stresses arising from differential rates of expansion and contraction of the coating and drive rollers during thermal excursions. Because of the high bond strength, the material used for the drive rollers is not constrained by considerations of thermal stresses.

The coating according to the invention can also withstand contact with relatively hard surfaces, the coating being unaffected by contact with surfaces having a hardness less than 40 Rc. The coating does not shed during use.

The coating can also be manufactured repeatably. The outside diameter of coated drive rollers 701a, 701b can be held within a tolerance of 0.011 mm. The nominal diameter of coated drive rollers 701a, 701b can be established within a tolerance of 0.005 mm.

Though the structure according to the invention has been described for use with printers in which the print media is heated before and/or during printing; the structure according to the invention can also be used with non-heated printers, i.e., printers in which the print media is not heated (intentionally, as described above) during printing.

Various embodiments of the invention have been described. The descriptions are intended to be illustrative, not limitative. Thus, it will be apparent to one skilled in the art that certain modifications may be made to the invention as described without departing from the scope of the claims set out below.

Claims

1. Structure for advancing print media (90) through a print zone (104) of a printer, the structure being subjected to heat during operation of the printer, the structure comprising:

   a pinch roller (102);

   a drive roller (100) against which the pinch roller (102) exerts a contact force, the print media (90) passing between the drive roller (100) and pinch roller (102), the drive roller (100) being coated with a material such that, for a range of print media drag forces between 0 and 150 grams and a contact force of approximately 1000 grams, the traction loss of the print media (90) is less than 0.05%; and

   drive roller rotation means (160, 166, 168, 172, 174).

2. Structure as in Claim 1, wherein the printer is a thermal inkjet printer.

3. Structure as in Claim 2, wherein the resolution of the printer is greater than 200 dots/inch.

4. Structure as in Claims 1, 2 or 3, wherein the diameter of the drive roller (100) is approximately 0.75 inches.

5. Structure as in Claims 1, 2, 3 or 4, wherein the width of the drive roller (100) is approximately 0.375 inches.

6. Structure as in Claims 1, 2, 3, 4 or 5, further comprising:

a second pinch roller (102), spaced apart from the first pinch roller (102); and

a second drive roller (100), spaced apart from the first drive roller (100), against which the second pinch roller (102) exerts a contact force, the print media (90) passing between the first and second drive rollers (100) and the first and second pinch rollers (102), the second drive roller (100) being coated with the same material and having the same dimensions as the first drive roller (100).

7. Structure as in Claims 1, 2, 3, 4, 5 or 6, wherein the drive roller or rollers (100) and drive roller coating or coatings are heated to temperatures between 10 °C and 130 °C.

8. Structure as in Claims 1, 2, 3, 4, 5, 6 or 7, wherein the coating material includes tungsten carbide.

9. Structure as in Claim 8, wherein the coating material is formed on the drive roller or rollers (100) by plasma spraying.

10. Structure as in Claim 9, wherein the nominal diameter of the drive roller or rollers (100) after being coated is within a range 0.005 millimeters less than and 0.005 millimeters greater than a predetermined nominal diameter.

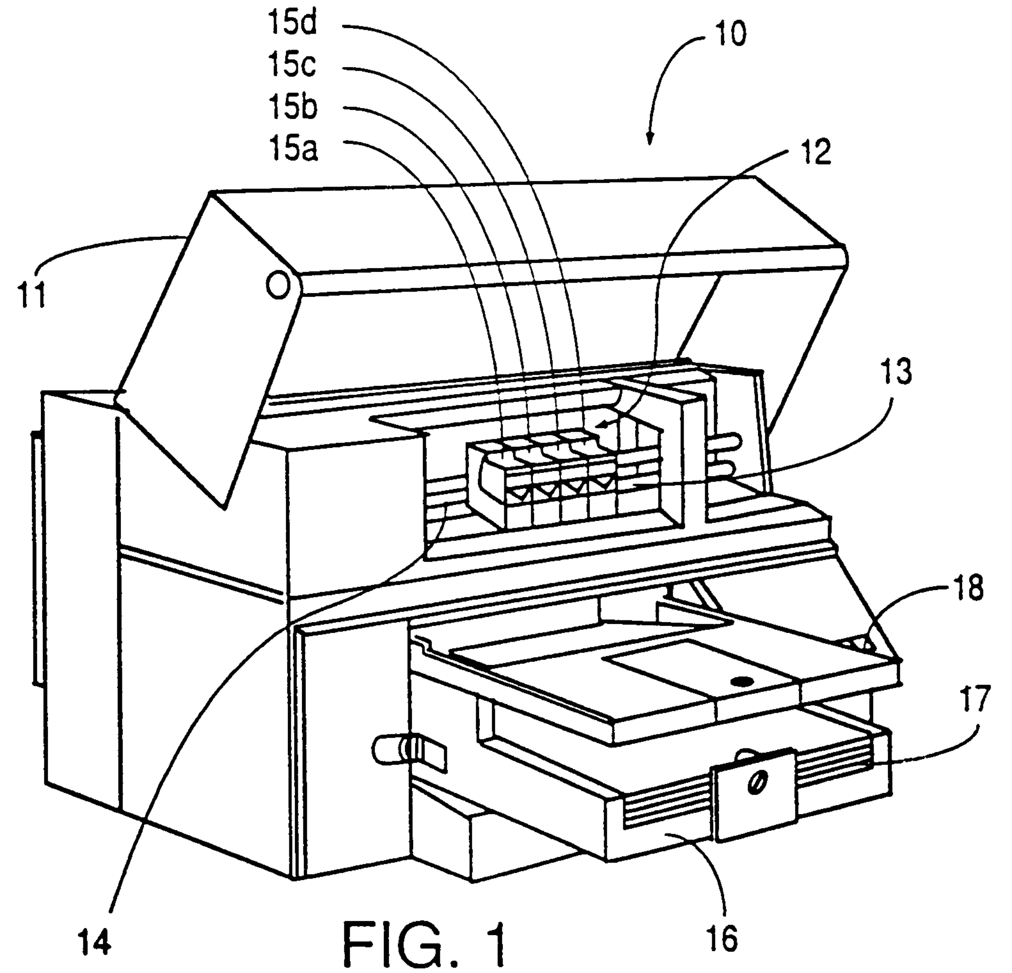

FIG. 1

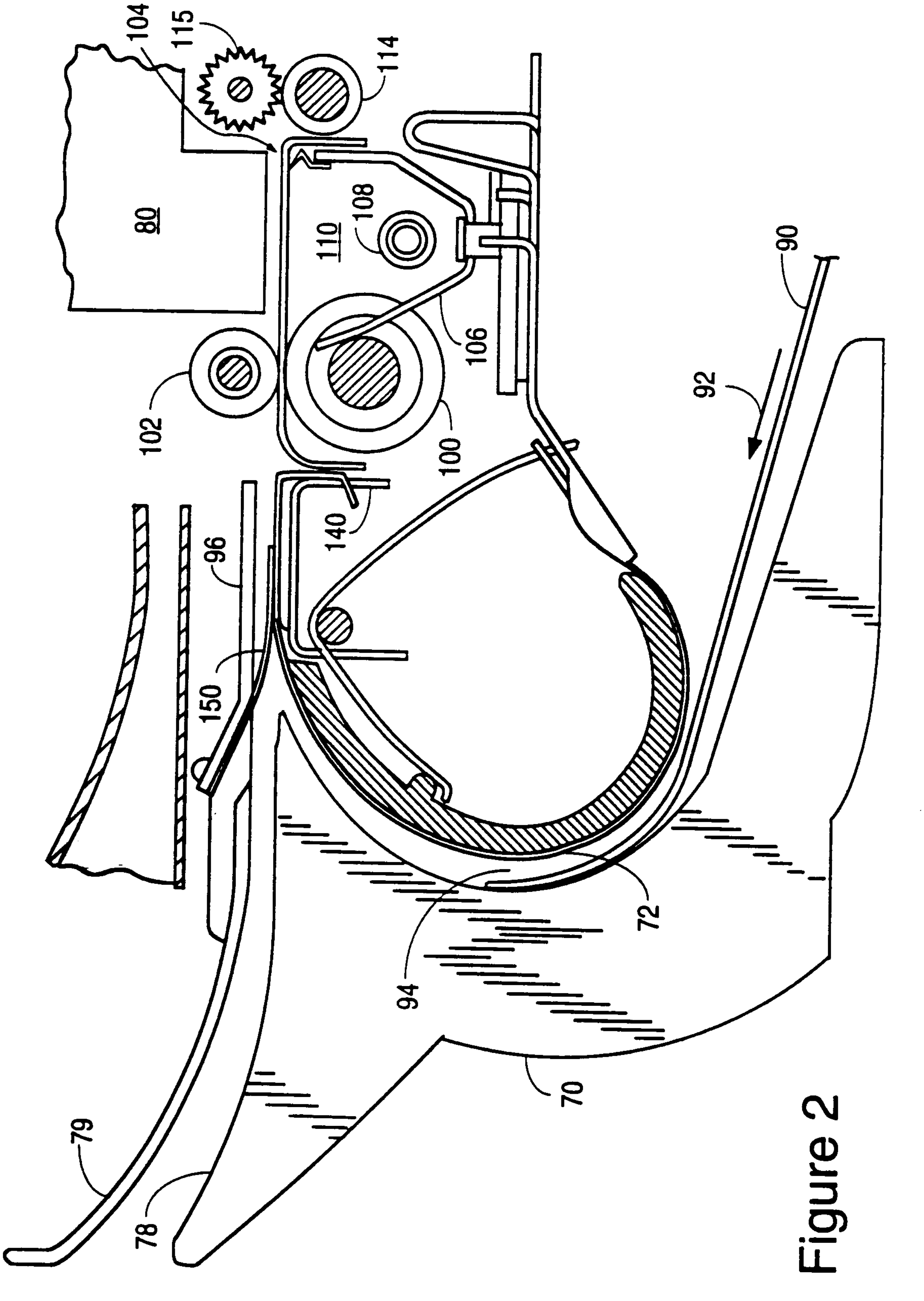

Figure 2

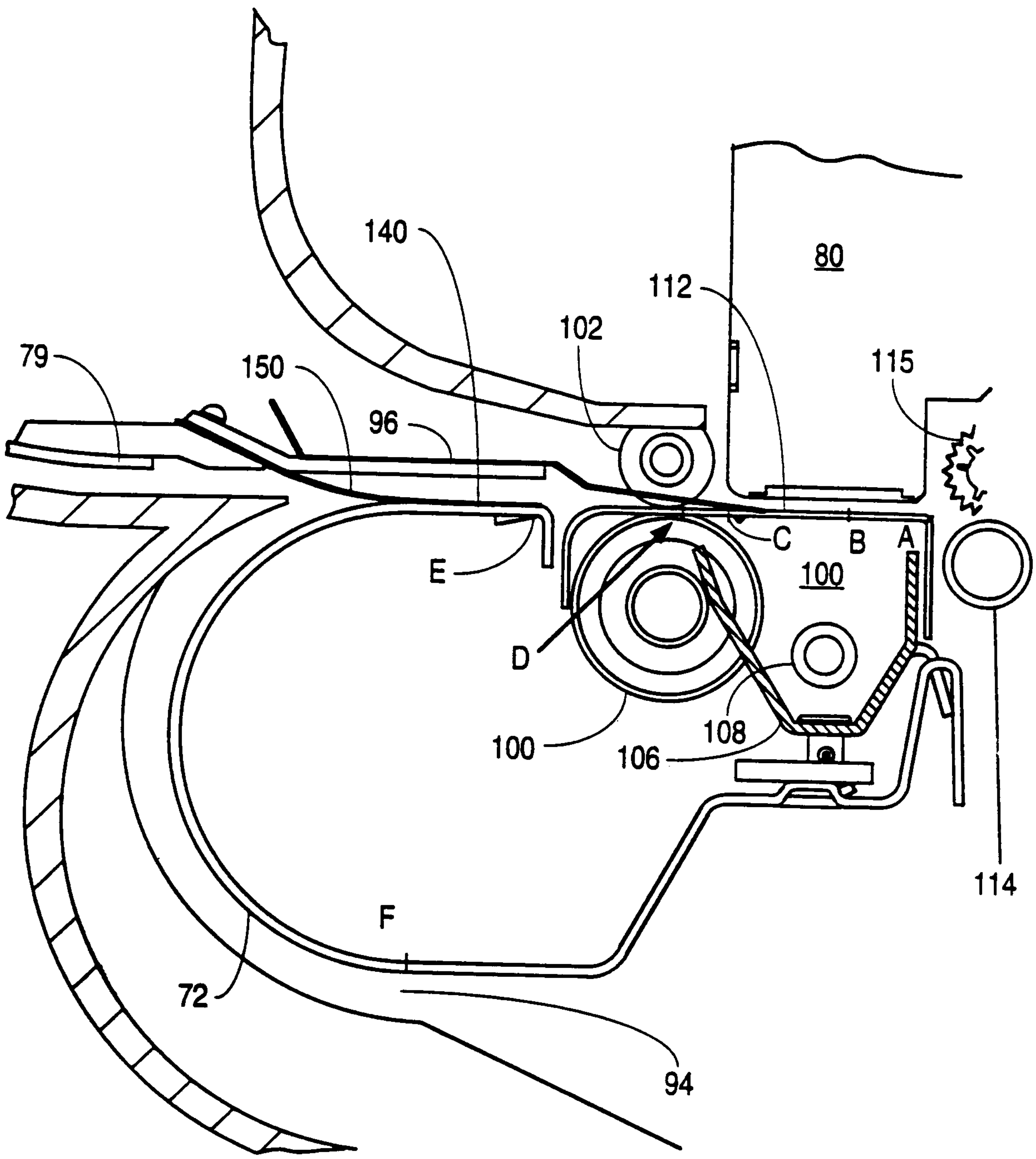

Figure 3

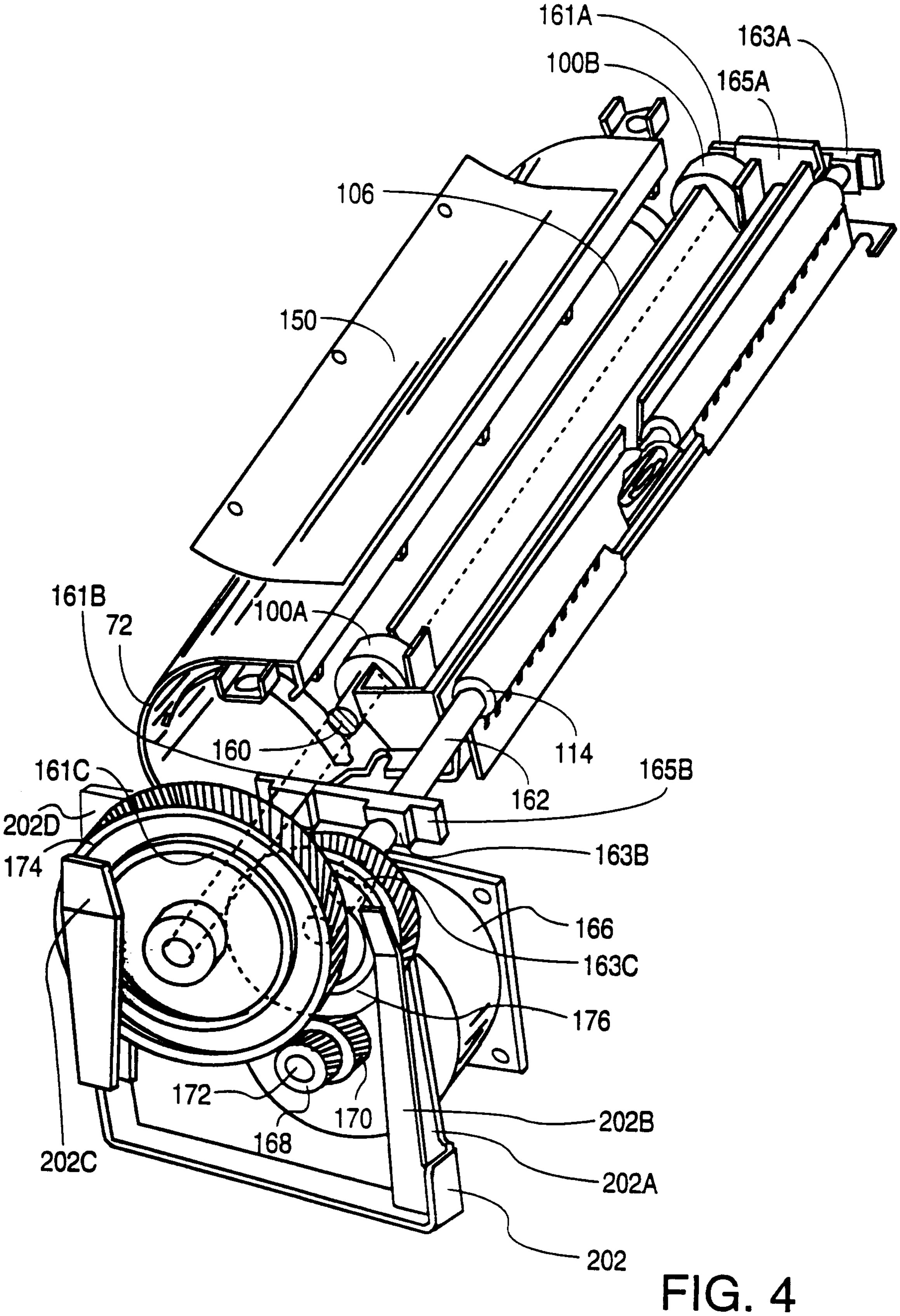
161A
163A
100B
165A
106
150
161B
72
100A
160
114
161C
162
165B
202D
174
163B
166
163C
176
172
170
168
202B
202C
202A
202

FIG. 4

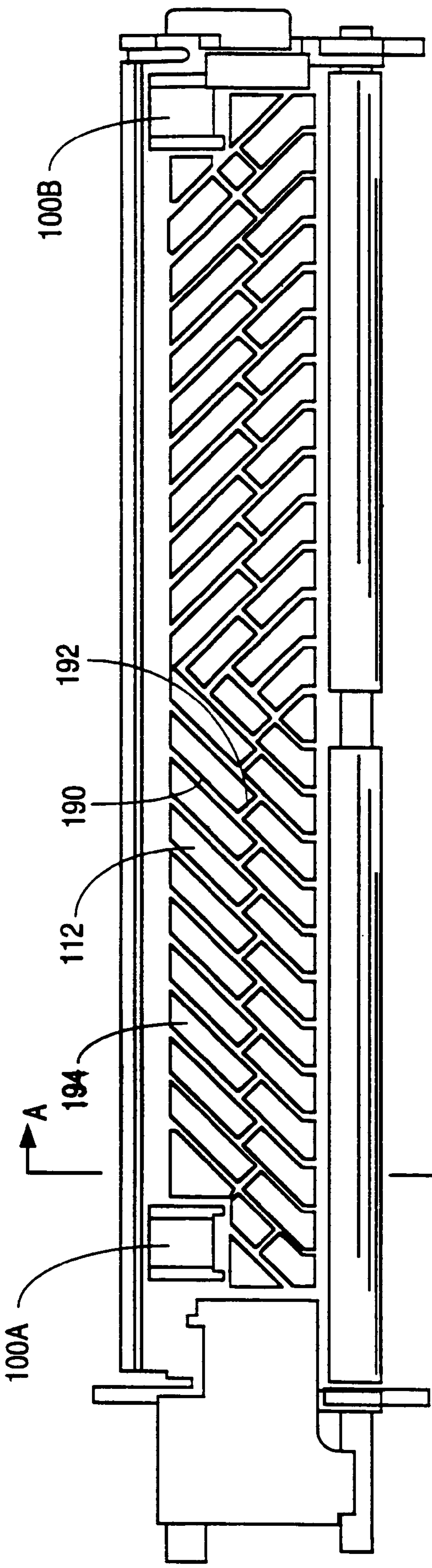

Figure 5

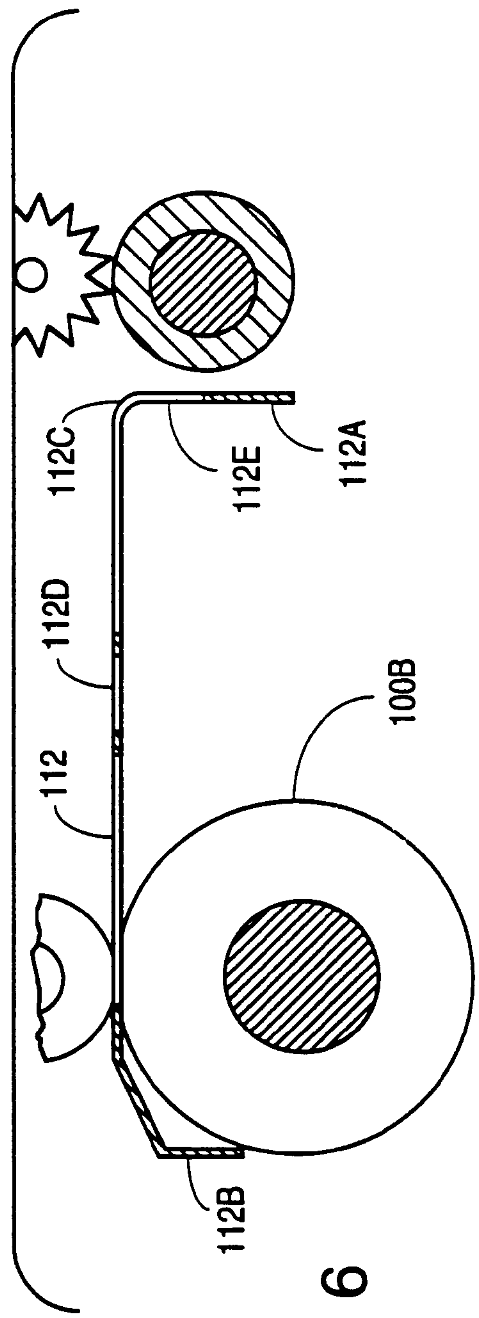

Figure 6

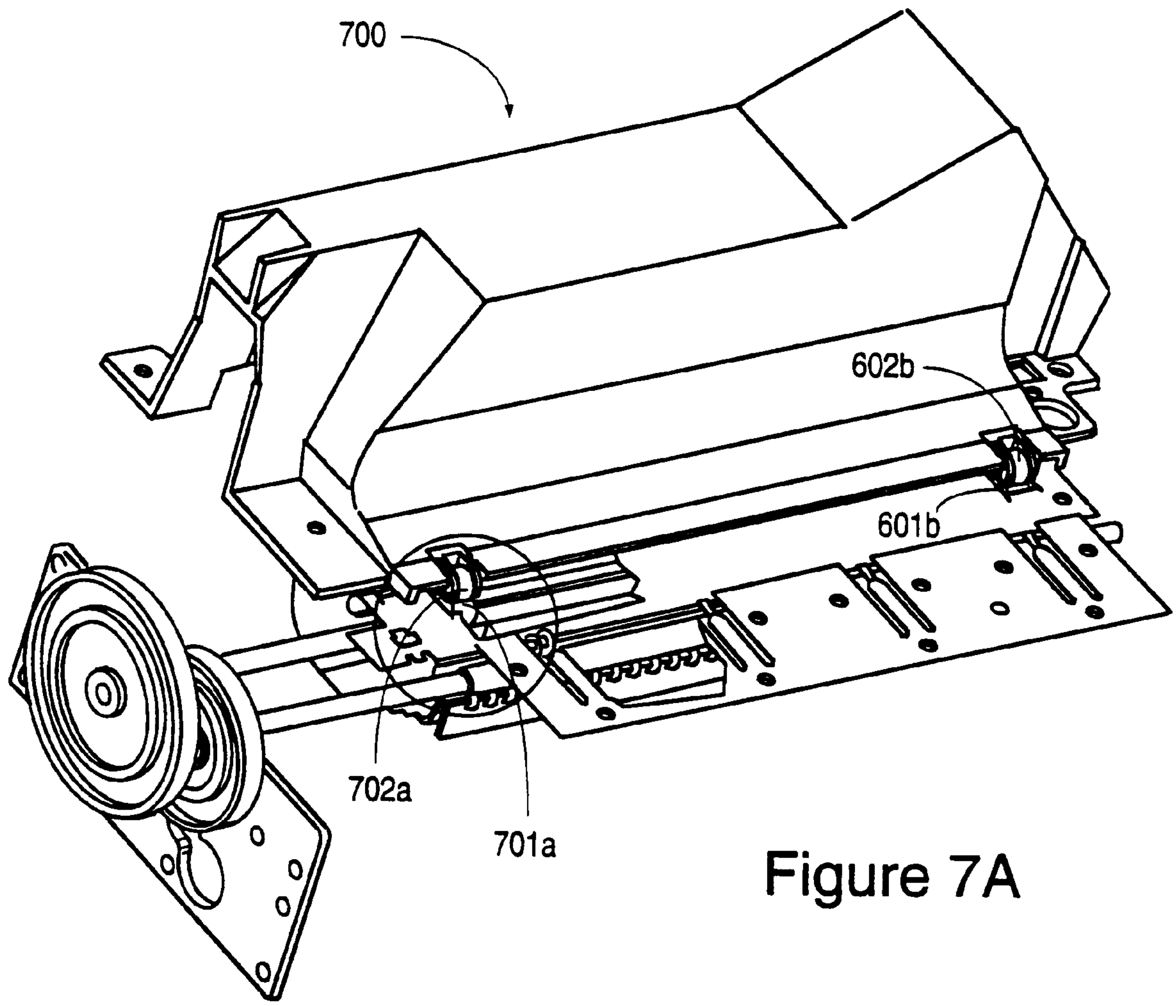

Figure 7A

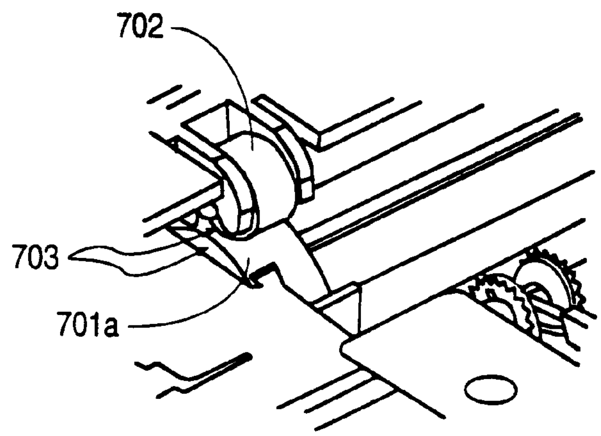

Figure 7B