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(11) **EP 1 074 896 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
07.02.2001 Bulletin 2001/06

(51) Int. Cl.⁷: **G03G 15/20**

(21) Application number: **00306139.7**

(22) Date of filing: **19.07.2000**

(84) Designated Contracting States:
**AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU
MC NL PT SE**
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **03.08.1999 US 147012 P**
06.04.2000 US 544093

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(54) **Nip width converting mechanism for use in a fusing apparatus**

(57) A fusing nip width converting mechanism (100) and a compact long nip width fusing apparatus including such a mechanism are disclosed for use in a reproduction machine. The compact long nip width fusing apparatus (100) includes a rotatable fuser roller (96) and a rotatable pressure roller (98) forming a roller nip (99) against one another. The fusing nip width converting mechanism (100) includes a first belt directing roller (104) for positioning on an exit side of the roller nip (99), a second belt directing roller (102) for positioning on an entrance side of the roller nip (99), and an endless belt member (106) mounted over the first belt directing roller (104), through the roller nip (99), and over the second belt directing roller (102), thus forming a closed loop. The closed loop of the belt member (106) as mounted is pinched and deflected by the rotatable fuser roller (96) and the rotatable pressure roller (98) within the roller nip (99), and the closed loop as pinched forms a long width fusing nip (110) against the rotatable fuser roller (96), thereby increasing fusing dwell time and fusing thermal efficiency, relative to the roller nip.

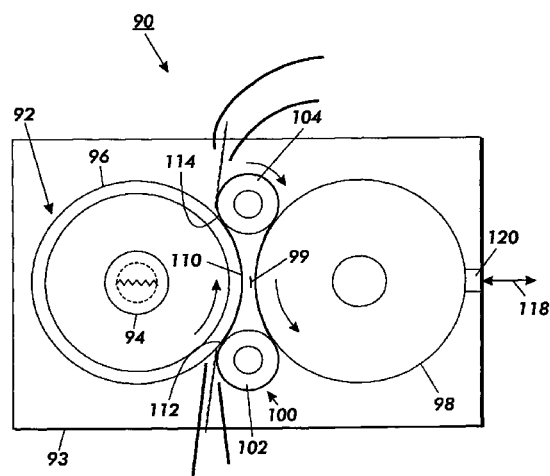


FIG. 3

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Description

[0001] This invention relates generally to electrostatic photographic reproduction machines, and more particularly to a nip width converting mechanism and a compact fusing apparatus including such a mechanism for use in such a machine for increasing fusing dwell time and fusing thermal efficiency.

[0002] In a typical electrophotographic printing process, a photoconductive member is charged to a substantially uniform potential so as to sensitize the surface thereof. The charged portion of the photoconductive member is exposed to selectively dissipate the charges thereon in the irradiated areas. This records an electrostatic latent image on the photoconductive member. After the electrostatic latent image is recorded on the photoconductive member, the latent image is developed by bringing a developer material into contact therewith. Generally, the developer material comprises toner particles adhering triboelectrically to carrier granules. The toner particles are attracted from the carrier granules either to a donor roller or to a latent image on the photoconductive member. The toner attracted to a donor roller is then deposited on a latent electrostatic image on a charge retentive surface which is usually a photoreceptor. The toner powder image is then transferred from the photoconductive member to a copy substrate. The toner particles are heated to permanently affix the powder image to the copy substrate.

[0003] In order to fix or fuse the toner material onto a support member permanently by heat, it is necessary to elevate the temperature of the toner material to a point at which constituents of the toner material coalesce and become tacky. This action causes the toner to flow to some extent onto the fibers or pores of the support members or otherwise upon the surfaces thereof. Thereafter, as the toner material cools, solidification of the toner material occurs causing the toner material to be bonded firmly to the support member.

[0004] One approach to thermal fusing of toner material images onto the supporting substrate has been to pass the substrate with the unfused toner images thereon between a pair of opposed roller members at least one of which is internally heated. During operation of a fusing system of this type, the support member to which the toner images are electrostatically adhered is moved through the nip formed between the rollers with the toner image contacting the heated fuser roller to thereby effect heating of the toner images within the nip. In a Nip Forming Fuser Roller (NFFR), the heated fuser roller is provided with a layer or layers that are deformable by a harder pressure roller when the two rollers are pressure engaged. The length of the nip determines the dwell time or time that the toner particles remain in contact with the surface of the heated roll.

[0005] Roller fusers work very well for fusing color images at low speeds since the required process conditions such as temperature, pressure and dwell can eas-

ily be achieved. When process speeds approach 100 pages per minute (ppm) roller fusing performance starts to falter. At such higher speeds, dwell must remain constant which necessitates an increase in nip width. Increasing nip width can be accomplished most readily by either increasing the fuser roller (FR) rubber thickness and/or the outside diameter of the roll. Each of these solutions reach their limit at about 100 ppm. Specifically, the rubber thickness is limited by the maximum temperature the rubber can withstand and the thermal gradient across the elastomer layer. The roller size becomes a critical issue for reasons of space, weight, cost, & stripping.

[0006] US-A-5,250,998 discloses a toner image fixing device wherein there is provided an endless belt looped up around a heating roller and a conveyance roller, a pressure roller for pressing a sheet having a toner image onto the heating roller with the endless belt intervening between the pressure roller and the heating roller.

[0007] US-A-5,465,146 relates to a fixing device to be used in electrophotographic apparatus for providing a clear fixed image with no offset with use of no oil or the least amount of oil, wherein an endless fixing belt provided with a metal body having a release thin film thereon is stretched between a fixing roller having an elastic surface and a heating roller, a pressing roller is arranged to press the surface of the elastic fixing roller upwardly from the lower side thereof through the fixing belt to form a nip portion between the fixing belt and the pressing roller, a guide plate for an unfixed image carrying support member is provided underneath the fixing belt, between the heating roller and the nip portion, to form substantially a linear heating path between the guide plate and the fixing belt, and the metal body of the fixing belt has a heat capacity per cm² within the range of 0.001 to 0.02 cal/°C.

[0008] According to the present invention, there is provided a fusing nip width converting mechanism and a compact long nip width fusing apparatus including such a mechanism are disclosed for use in a reproduction machine. The compact long nip width fusing apparatus includes a rotatable fuser roller and a rotatable pressure roller forming a roller nip against the rotatable fuser roller. Importantly, the fusing nip width converting mechanism includes a first belt directing roller for positioning on an exit side of the roller nip formed by the rotatable fuser roller and the rotatable pressure roller, a second belt directing roller for positioning on an entrance side of the roller nip, and an endless belt member mounted over the first belt directing roller, through the roller nip, and over the second belt directing roller, forming a closed loop thereof. The closed loop of the belt member as mounted is pinched and deflected by the rotatable fuser roller and the rotatable pressure roller within the roller nip, and the closed loop as pinched forms a long width fusing nip against the rotatable fuser roller, thereby increasing fusing dwell time

and fusing thermal efficiency, relative to the roller nip. The compact long nip width fusing apparatus as such is suitable for use in an electrostatographic reproduction machine for producing high quality fused toner images.

[0009] A particular embodiment will now be described with reference to the accompanying drawings; in which:-

FIG. 1 is a schematic illustration of an electrostatographic reproduction machine incorporating the nip width converting mechanism and fusing apparatus of the present invention;

FIG. 2 is a perspective representation of the nip width converting mechanism of the machine of FIG. 1; and

FIG. 3 is a detailed end view schematic of the nip width converting mechanism and fusing apparatus of FIG. 1 in accordance with the present invention.

[0010] Referring now to the drawing FIG. 1, will be described only briefly. An electrostatographic reproduction machine 8, in which the present invention finds advantageous use, utilizes a charge retentive image bearing member in the form of a photoconductive belt 10 consisting of a photoconductive surface 11 and an electrically conductive, light transmissive substrate. The belt 10 is mounted for movement past a series of electrostatographic process stations including a charging station AA, an exposure station BB, developer stations CC, transfer station DD, fusing station EE and cleaning station FF. Belt 10 moves in the direction of arrow 16 to advance successive portions thereof sequentially through the various processing stations disposed about the path of movement thereof. Belt 10 is entrained about a plurality of rollers 18, 20 and 22, the former of which can be used to provide suitable tensioning of the photoreceptor belt 10. Roller 20 is coupled to motor 23 by suitable means such as a belt drive. Motor 23 rotates roller 20 to advance belt 10 in the direction of arrow 16.

[0011] As can be seen by further reference to FIG. 1, initially successive portions of belt 10 pass through charging station AA. At charging station AA, a corona discharge device such as a scorotron, corotron or dicorotron indicated generally by the reference numeral 24, charges the belt 10 to a selectively high uniform positive or negative potential. Any suitable control, well known in the art, may be employed for controlling the corona discharge device 24.

[0012] Next, the charged portions of the photoreceptor surface are advanced through exposure station BB. At exposure station BB, the uniformly charged photoreceptor or charge retentive surface 10 is exposed to a laser based input and/or output scanning device 25 which, as controlled by controller or ESS 26, causes the charge retentive surface to be discharged in accordance with the output from the scanning device. The ESS 26, for example, is the main multi-tasking processor for operating and controlling all of the other machine sub-

systems and printing operations, including aspects of the present invention. The scanning device is a three level laser Raster Output Scanner (ROS). The resulting photoreceptor contains both charged-area images and discharged-area images.

[0013] At development station CC, a development system, indicated generally by the reference numeral 30 advances developer materials into contact with the electrostatic latent images, and develops the image. The development system 30, as shown, comprises first and second developer apparatuses 32 and 34. The developer apparatus 32 comprises a housing containing a pair of magnetic brush rollers 35 and 36. The rollers advance developer material 40 into contact with the photoreceptor for developing the discharged-area images. The developer material 40, by way of example, contains negatively charged color toner. Electrical biasing is accomplished via power supply 41 electrically connected to developer apparatus 32. A DC bias is applied to the rollers 35 and 36 via the power supply 41.

[0014] The developer apparatus 34 comprises a housing containing a pair of magnetic brush rolls 37 and 38. The rollers advance developer material 42 into contact with the photoreceptor for developing the charged-area images. The developer material 42 by way of example contains positively charged black toner for developing the charged-area images. Appropriate electrical biasing is accomplished via power supply 43 electrically connected to developer apparatus 34. A DC bias is applied to the rollers 37 and 38 via the bias power supply 43.

[0015] Because the composite image developed on the photoreceptor consists of both positive and negative toner, a pre-transfer corona discharge member 56 is provided to condition the toner for effective transfer to a substrate using corona discharge of a desired polarity, either negative or positive.

[0016] Sheets of substrate or support material 58 are advanced to transfer station DD from a supply tray, not shown. Sheets are fed from the tray by a sheet feeder, also not shown, and advanced to transfer station DD through a corona charging device 60. After transfer, the sheet continues to move in the direction of arrow 62 towards fusing station EE.

[0017] As illustrated, fusing station EE has a compact belt fusing apparatus 90 in accordance with the present invention that includes the nip width converting mechanism 100 in accordance with the present invention. As illustrated, the fusing apparatus 90 includes a rotatable fuser roller 92. Fuser roller 92 is heated for example by a heating device 94 (shown as an internal lamp but as well could be an external heater) for elevating temperatures of the surface 96 of the fuser roller to a suitable toner fusing temperature. The fusing apparatus 90 also includes a rotatable pressure roller 98 that forms a roller nip 99 against the rotatable fuser roller 92.

[0018] Importantly, the compact fusing apparatus 90 includes the fusing nip width converting mechanism

100 for increasing fusing dwell time and fusing thermal efficiency relative to roller nip dwell time and fusing thermal efficiency. Referring now to FIGS. 1-3, and particularly FIG. 2, the nip width converting mechanism 100 includes a first belt directing roller 102 for positioning on an exit side of the roller nip 99, and a second belt directing roller 104 for positioning on an entrance side of the roller nip 99. Each of the belt directing rollers 102, 104 can comprise an extruded aluminum member. As further shown, the nip width converting mechanism 100 also includes an endless belt member 106 that is mounted over the first belt directing roller 102, and over the second belt directing roller 104, thus forming a deflectable or pinchable closed loop 108 thereof about the rollers 102, and 104 (FIG. 2).

[0019] When the nip width converting mechanism 100 is assembled to form a converted fusing nip in accordance with present invention (FIG. 3), the endless belt member 106 is mounted over the first belt directing roller 102, through the roller nip 99, and over the second belt directing roller 104, wherein the deflectable or pinchable closed loop 108 is pinched and deflected by the rotatable fuser roller 92 and the rotatable pressure roller 98 within the roller nip 99 as shown. Advantageously, the closed loop 108 when pinched as such forms a long width fusing nip 110 against the rotatable fuser roller 92 by converting the comparatively short width roller nip 99 into such a long width nip 110. The conversion thereby increases fusing dwell time and fusing thermal efficiency, relative to the same from the roller nip 99.

[0020] According to other aspects of the present invention, the long width fusing nip 110 includes two comparatively high nip pressure areas, comprising an entrance area 112 into the long width fusing nip, and an exit area 114 thereof. As shown, the first high nip pressure area 112 at the entrance into the long width fusing nip is created by the fuser roller 92 pinching a portion of one leg of the closed loop 108 against the second belt directing roller 104. Similarly, the second high nip pressure area 114 at the exit thereof is created by the fuser roller 92 pinching a portion of one leg of the closed loop 108 against the first belt directing roller 102.

[0021] Although both belt directing rollers 102 and 104 preferably are floating idler rollers held in place solely by the closed loop 108 of the belt member 106, the fusing apparatus 90 and nip width converting mechanism 100 work equally well with only one of the belt directing rollers being an idler roller. In the preferred embodiment with both belt directing rollers being idler rollers, either the rotatable fuser roller 92 or rotatable pressure roller 98 is a drive roller.

[0022] To recapitulate, the fusing apparatus 90 utilizes a unique floating idler roller and belt mechanism 100 in which a pair of idler rollers 102, 104 are held in position solely by a closed loop 108 of a belt member 106. The idler rollers 102, 104, as such do not have any conventional radial bearings or positioning

mechanisms. This allows for a simple design that is compact, thermally efficient, and low cost when compared to other belt fusers having a similar long width fusing nip. As pointed out above, the pressure profile of the long width fusing nip 110 of the present invention is also unique in that the highest pressure areas (two of them) can be at the nip entrance area 112, and at nip exit area 114.

[0023] Still referring to FIGS. 1-3, the fuser roller 92 preferably is the drive roller and is mounted in a fixed position in a suitable frame 93 through a pair of end bushings 122 (not shown). On the other hand, the pressure roller 98 is also mounted in the frame 93, but is movable into and away from the fuser roller 92 (arrow 118), and is loadable with a force F as by a spring 120 towards the fuser roller 92. Nip load and belt tension are thus determined by the load or force F applied to the pressure roller 98. The floating idler rollers 102, 104 are held in their respective belt directing positions solely by the closed loop 108 of the belt member 106. As noted above, these idler rollers as assembled in the mechanism 100, and fusing apparatus 90 have no conventional radial bearings or positioning mechanisms. They only need some form of thrust bushing 124 at each end thereof (FIG. 2) for locating them laterally against the end bushings of the fuser roller 92. The mechanism 100 (idler roller/belt loop combination) is held in its nip converting position within the roller nip 99 only by the fuser and pressure rollers 92, 98 respectively.

[0024] In operation, the copy medium 58 with an unfused toner image 89 on the top side as shown, enters the long width fusing nip 110 through the entrance area 112, and exits the nip 110 through the exit area 114. The high pressure area nip entrance will advantageously minimize cockle and other deformities on the incoming medium or sheet, and the high pressure area nip exit will act to improve fused image fixing onto the medium or sheet 58. As can be clearly seen, the toner image is in contact with the heated surface 96 of the fuser roller 92, and travels a much greater distance in such contact through the nip 110, as compared for example to travel through the roller nip 99. As such, fusing dwell time, at a given travel speed, will be significantly greater through the long width nip 110 as compared to a roller nip, e.g. the nip 99.

[0025] Advantageously, the nip converting mechanism 100 and fusing apparatus 90 result in a compact belt fusing apparatus having a relatively small total belt surface area as compared to other belt fusing systems. The compact structure and small surface area minimize heat loss and require less energy for its operation. Fusing tests on a compact fusing apparatus in accordance with the present invention were found to result an 84°F (29°C) reduction in a required fusing temperature as compared to a baseline or conventional heated and pressure roller fusing apparatus. Additionally, the belt member 106 is relative short and hence cost relatively less too, and the belt directing rollers can be low cost

too.

[0026] As can be seen, there has been provided a fusing nip width converting mechanism and a compact long nip width fusing apparatus including such a mechanism are disclosed for use in a reproduction machine. The compact long nip width fusing apparatus includes a rotatable fuser roller and a rotatable pressure roller forming a roller nip against the rotatable fuser roller. Importantly, the fusing nip width converting mechanism includes a first belt directing roller for positioning on an exit side of the roller nip formed by the rotatable fuser roller and the rotatable pressure roller, a second belt directing roller for positioning on an entrance side of the roller nip, and an endless belt member mounted over the first belt directing roller, through the roller nip, and over the second belt directing roller, forming a closed loop thereof. The closed loop of the belt member as mounted is pinched and deflected by the rotatable fuser roller and the rotatable pressure roller within the roller nip, and the closed loop as pinched forms a long width fusing nip against the rotatable fuser roller, thereby increasing fusing dwell time and fusing thermal efficiency, relative to the roller nip.

Claims

1. A fusing nip width converting mechanism (100) for converting a short width roller fusing nip (99) formed between a heated fuser roll (96) and a rotatable pressure roll (98) into a long width belt fusing nip, so as to increase fusing dwell time and thermal efficiency, the fusing nip width converting mechanism (100) comprising:

- (a) a first belt directing roller (104) for positioning on the exit side of the roller fusing nip (99);
- (b) a second belt directing roller (102) for positioning on the entrance side of the roller fusing nip (99); and,
- (c) an endless belt member (106) mounted over said first belt directing roller (104) and over said second belt directing roller (102), said belt member (106) as mounted forming a closed loop thereof, in use, said closed loop of said belt member (106) being locatable between the rotatable heated fuser roller (96) and pressure roller (98) within the roller fusing nip (99), and when so located, forming a long width belt fusing nip (110) that, relative to the roller fusing nip (99), results in increased fusing dwell time and in increased fusing thermal efficiency.

2. A compact long nip width fusing apparatus comprising:

- (a) a rotatable fuser roller (96);
- (b) a rotatable pressure roller (98) forming a

roller nip (99) against said rotatable fuser roller (96); and,

- (c) a fusing nip width converting mechanism according to claim 1;

said closed loop of said belt member (106) being pinched and deflected by said rotatable fuser roller (96) and said rotatable pressure roller (98) within said roller nip (99), and said closed loop (106) as pinched forming a long width fusing nip (110) against said rotatable fuser roller, thereby increasing fusing dwell time and fusing thermal efficiency, relative to said roller nip.

3. A fusing apparatus according to claim 2, wherein said long width fusing nip (110) includes three comparatively high nip pressure areas, comprising an entrance area (112) into said long width fusing nip (110), an exit area thereof (114), and an area coincident with said roller nip (99).

4. A fusing apparatus according to claims 2 or 3, wherein said each of said first belt directing roller (104) and said second belt directing roller (102) is a floating roller held in place by said closed loop of said belt member (106) and said fuser and pressure rollers (96,98).

5. A converting or fusing mechanism according to any one of the preceding claims, wherein said first belt directing roller (104) or said second belt directing roller (102) is an idler roller.

6. A converting or fusing mechanism according to any one of the preceding claims, wherein both of said first belt directing roller (104) and said second belt directing roller (102) are idler rollers.

7. A converting or fusing mechanism according to any one of the preceding claims, wherein each of said first belt directing roller (104) and said second belt directing roller (102) comprises an extruded aluminum member.

8. An electrostatographic reproduction machine comprising:

- (a) a movable image bearing member having a toner image carrying surface defining a path of movement therefor;

- (b) electrostatographic devices mounted along said path of movement for forming a toner image on said toner image carrying surface;

- (c) means for transferring said toner image from said toner image carrying surface onto a substrate; and

- (d) a compact long nip width fusing apparatus according to any one of claims 2 to 7 for heat-

ing and fusing said toner image onto said substrate.

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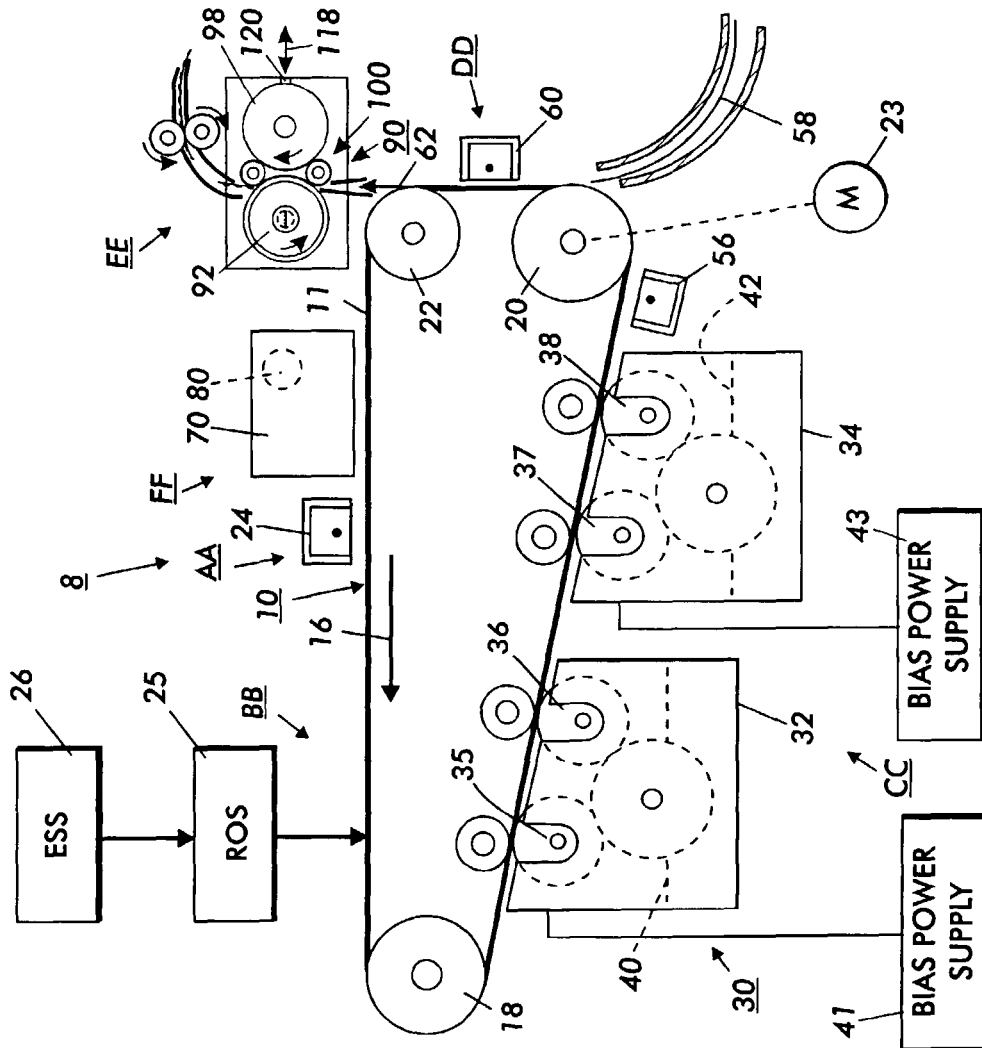


FIG. 1

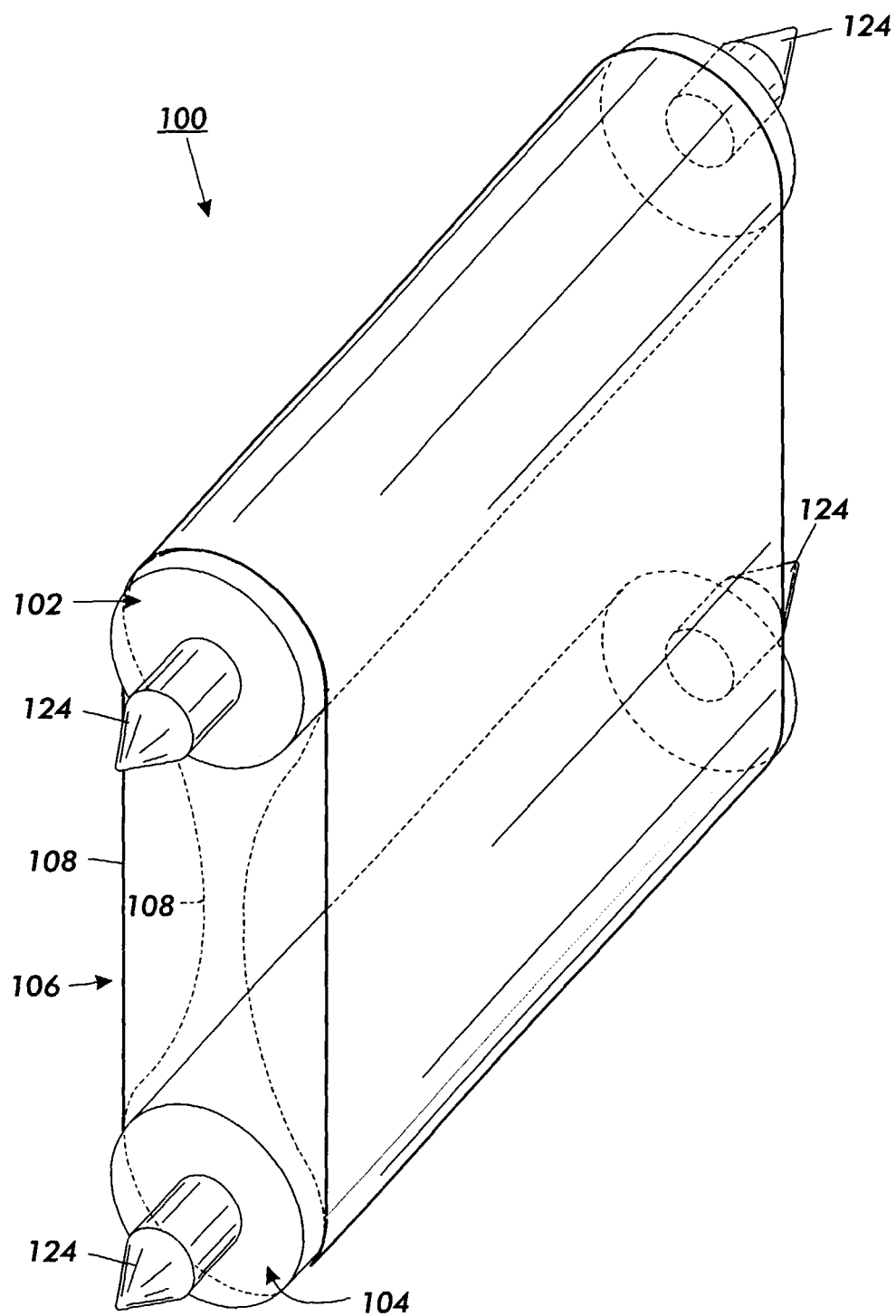


FIG. 2

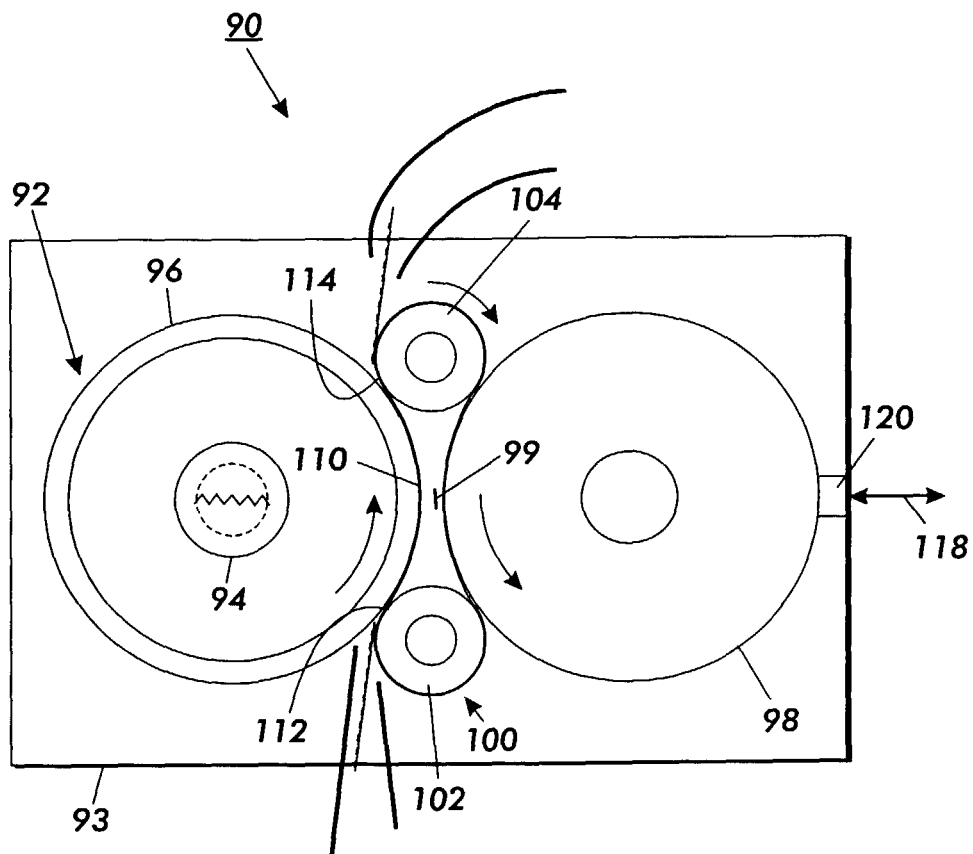


FIG. 3



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EUROPEAN SEARCH REPORT

Application Number
EP 00 30 6139

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			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
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The present search report has been drawn up for all claims			
Place of search MUNICH		Date of completion of the search 20 November 2000	Examiner Kys, W
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EPO FORM 1503 03 82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 00 30 6139

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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