

(51) International Patent Classification:
B41J 2/165 (2006.01)(21) International Application Number:
PCT/US2018/066871(22) International Filing Date:
20 December 2018 (20.12.2018)

(25) Filing Language: English

(26) Publication Language: English

(71) Applicant: **HEWLETT-PACKARD DEVELOPMENT COMPANY, L.P.** [US/US]; 10300 Energy Drive, Spring, Texas 77389 (US).(72) Inventors: **FORCADA PARDO, Santiago**; Cami de Can Graells, 1-21, 08174 Sant Cugat del Valles (ES). **DEOCON MIR, Javier**; Cami de Can Graells, 1-21, 08174 Sant Cugat del Valles (ES). **MIELGO BARBA, Alejandro**; Cami de Can Graells, 1-21, 08174 Sant Cugat del Valles (ES).(74) Agent: **PERRY, Garry A.** et al.; HP Inc., 3390 E. Harmony Road, Mail Stop 35, Fort Collins, Colorado 80528 (US).(81) Designated States (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.(84) Designated States (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM,

(54) Title: PRINT HEAD MAINTENANCE CARTRIDGE

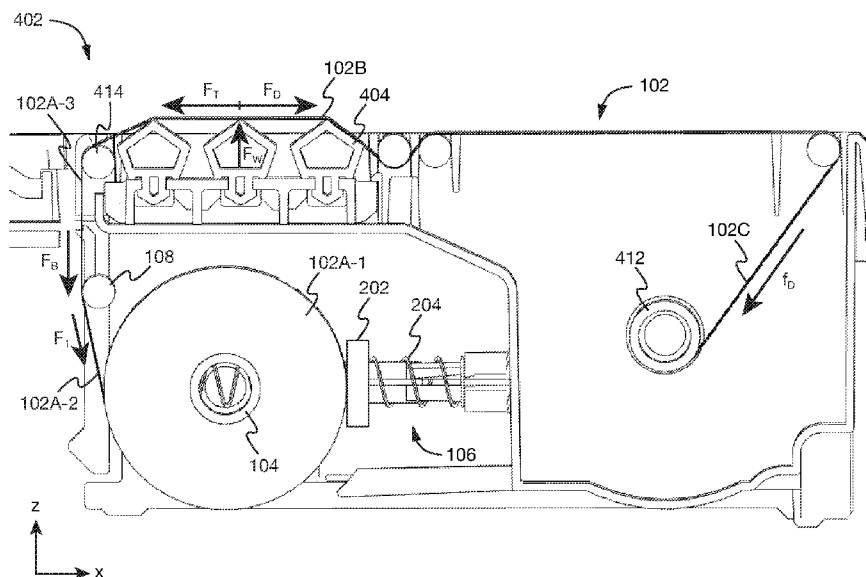


Fig. 5

(57) **Abstract:** Disclosed herein is a print head maintenance cartridge, a printing device and a method of controlling a wiping subsystem of a print head maintenance cartridge. The print head maintenance cartridge comprises a wiping subsystem with a wiping material to wipe a print head; a clean material roll, wherein a clean part of the wiping material is rolled up on the clean material roll at least in part; a brake to generate a first brake force applied to the wiping material; and a friction element to generate a second brake force applied to the wiping material, wherein the friction element compensates at least in part a change in the first brake force to control a total brake force, wherein the total brake force is the sum of the first and second brake forces.



TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW,
KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

- *as to the identity of the inventor (Rule 4.17(i))*
- *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

Published:

- *with international search report (Art. 21(3))*

PRINT HEAD MAINTENANCE CARTRIDGE

BACKGROUND

[0001] Printing devices like ink-jet printers may have to be cleaned regularly to maintain image quality and e.g. prevent partial or complete clogging of print head nozzles. To this end, printing devices can comprise a maintenance subsystem to perform cleaning operations on a print head of the printing device.

BRIEF DESCRIPTION OF DRAWINGS

[0002] In the following, a detailed description of various examples is given with reference to the figures. The figures show schematic illustrations of

[0003] Fig. 1: a wiping subsystem in accordance with an example in side view;

[0004] Fig. 2a: a wiping subsystem with a friction rod and a large amount of wiping material on a clean material roll in accordance with an example in side view;

[0005] Fig. 2b: the wiping subsystem of Fig. 2b with a small amount of wiping material on the clean material roll in side view;

[0006] Fig. 3: forces in a wiping material as a function of an outer radius of the wiping material on a clean material roll in accordance with an example;

[0007] Fig. 4: a maintenance cartridge according to an example in a perspective view;

[0008] Fig. 5: the wiping subsystem of the maintenance cartridge in Fig. 4 in a sectional view;

[0009] Fig. 6: a printing device in accordance with an example in top view; and

[0010] Fig. 7: a flow chart of an example of a method of controlling a wiping subsystem.

DETAILED DESCRIPTION

[0011] To clean a print head, a printing device can comprise a maintenance cartridge with a number of subsystems for performing cleaning operations. The maintenance cartridge can for example comprise a wiping subsystem with a wiping material, which can be brought in contact with the print head to wipe off contaminants from the print head. To ensure an effective cleaning, a tension may be created in the wiping material, e.g. by generating a driving force in the

wiping material and countering the driving force with a brake force. The brake force may vary over time, which can cause problems as the tension in the wiping material may increase or decrease.

[0012] Fig. 1 depicts a wiping subsystem 100 according to an example in side view. The wiping subsystem 100 may for example be part of a maintenance cartridge in a printing device (not shown in Fig. 1). The wiping subsystem 100 comprises a wiping material 102 to wipe a print head. The wiping material 102 may for example be a continuous microfiber textile or web wipe. The wiping material 102 comprises a clean part 102A to be used to clean the print head. At least a portion 102A-1 of the clean part 102A is rolled up on a clean material roll 104, which may e.g. be a rotatably mounted cylinder or tube. By rotating the clean material roll 104, the wiping material 102 may be unrolled from the clean material roll 104. In some examples, the clean material roll 104 may be coupled to an actuator to rotate the clean material roll 104, e.g. an electric motor.

[0013] The wiping subsystem 100 further comprises a brake 106 to generate a first brake force F_1 applied to the wiping material 102. The first brake force F_1 may for example be applied along a longitudinal direction of the wiping material 102, wherein the longitudinal direction is the direction of the wiping material 102 along which the wiping material 102 is rolled-up on the clean material roll 104. The first brake force F_1 may either be a static force like friction that opposes any dynamic force applied to accelerate the wiping material 102 or may be a dynamic force that can accelerate the wiping material 102. In one example, the brake 106 comprises a brake shoe, which is pressed against the wiping material 102 with a force f_1 to generate the first brake force F_1 . The brake shoe may for example be pressed against the portion 102A-1 of the wiping material 102 that is rolled up on the clean material roll 104. In another example, the brake 106 may be part of or coupled to the clean material roll 104. The brake 106 may for example create friction that has to be overcome in order to rotate the clean material roll 104, e.g. by pressing a brake shoe against the clean material roll. Alternatively, the brake 106 may generate a torque on the clean material roll 104, e.g. using the actuator. The torque may for example be generated to resist rotation of the clean material roll 104.

[0014] The wiping subsystem 100 also comprises a friction element 108 to generate a second brake force F_2 along the wiping material 102. The friction element 108 may be similar to the brake 106. The friction element 108 may e.g. be pressed against the wiping material 102 with a force f_2 to generate the second brake force F_2 . In other examples, the friction element 108 may be a static element at a fixed position that is in contact with the wiping material 102 as detailed below with reference to Figs. 2a and 2b, wherein the second brake force F_2 results from friction between the friction element 208 and the wiping material 102.

[0015] The first and second brake forces add up, yielding a total brake force $F_B = F_1 + F_2$ along the wiping material 102. The total brake force F_B is the force that has to be overcome to move the wiping material 102. The total brake force F_B may for example counteract a driving force F_D , which may e.g. be applied to the wiping material 102 to generate a tension in the wiping material 102 or to unroll the wiping material 102 from the clean material roll 104. If the driving force F_D is smaller than the total brake force F_B , the total brake force F_B prevents the wiping material 102 from moving.

[0016] The friction element 108 compensates at least in part a change in the first brake force F_1 to control the total brake force F_B . The friction element 108 may for example compensate at least in part a decrease in the first brake force F_1 by an increase in the second brake force F_2 or an increase in the first brake force F_1 by a decrease in the second brake force F_2 . The friction element 108 can compensate a change in the first brake force F_1 to maintain the total brake force F_B to be constant or about constant. In one example, the friction element 108 keeps the total brake force F_B in a target range, e.g. a range between 80% and 120% of a target value.

[0017] The friction element 108 may e.g. be connected to a controller (not shown in Fig. 1) that determines the first brake force F_1 and adjusts the second brake force F_2 accordingly. Alternatively or additionally, the brake 106 and the friction element 108 may be arranged such that a change in the first brake force F_1 , e.g. due to a change in the force f_1 , leads to or is associated with a change of a path along which the wiping material 102 extends. This change of the path

of the wiping material 102 may lead to a change in the second brake force F_2 , e.g. by changing the force f_2 or by changing a size of a contact area between the friction element 108 and the wiping material 102. One example for this is described in more detail below with reference to Figs. 2a and 2b. In another example, the brake 106 and the friction element 108 may be adjacent to each other and may press against the wiping material from the same side with the forces f_1 and f_2 , respectively, e.g. using two springs. A decrease in f_1 may lead to an increase in f_2 , e.g. due to a compression of a spring in the friction element 108 by the wiping material 102 as a result of the decrease in f_1 .

[0018] Figs. 2a and 2b illustrate another example of a wiping subsystem 200 in side view. The wiping subsystem 200 also comprises a wiping material 102, a clean part 102A of which is partially rolled up on a clean material roll 104. Fig. 2a depicts the wiping subsystem 200 in a state in which a major portion 102A-1 of the wiping material 102 is rolled up on the clean material roll 104, whereas Fig. 2b shows the wiping subsystem 200 in a state in which a smaller portion 102A-1 of the wiping material 102 is rolled up the clean material roll 104.

[0019] The wiping subsystem 200 further comprises a brake 106 to generate a first brake force F_1 along a longitudinal direction of the wiping material 102 in a first portion 102A-2 of the clean part 102A of the wiping material 102. The brake 106 comprises a spring 204 to press a brake shoe 202 with a force f_1 against the clean part 102A of the wiping material 102, e.g. the portion 102A-1 of the clean part 102A that is rolled up on the clean material roll 104. One end of the spring 204 may be attached to a frame of the wiping subsystem 200 or of a maintenance cartridge comprising the wiping subsystem 200. The brake shoe 204 may for example consist of or comprise plastic, rubber or metal.

[0020] The wiping subsystem 200 further comprises a friction element 108 to generate a second brake force F_2 along the wiping material 102. The friction element 108 is to convert the first brake force F_1 in the first portion 102A-2 to a friction force along the longitudinal direction of the wiping material 102 in a second portion 102A-3 of the clean part 102A of the wiping material 102 to generate the second brake force F_2 . In this example, the friction force corresponds to the total brake force F_B . The friction force is to be understood as a force that

arises at least in part from friction between the wiping material 102 and the friction element 108. Converting the first brake force F_1 to the friction force refers to modifying the force acting along the longitudinal direction of wiping material 102 such that the friction force acts in the second portion 102A-3 instead of the first brake force F_1 if the first brake force F_1 is applied in the first portion 102A-2. This may comprise changing a direction and/or magnitude of the first brake force F_1 . The first portion 102A-2 may lie between the friction element 108 and the portion 102A-1 of the clean part 102A that is rolled up on the clean material along 104. The second portion 102A-3 may lie between the friction element 108 and a cleaning part 102B (not shown in Figs. 2a and 2b) of the wiping material 102 that is to be brought in contact with a print head.

[0021] The friction element 108 is in contact with the wiping material 102, e.g. with a portion of the wiping material 102 connecting the first 102A-2 and second portions 102A-3. The friction element may divert the wiping material 102 by a deflection angle, i.e. may change a longitudinal direction into which the wiping material 102 extends in the second portion 102A-3 as compared to the first portion 102A-2. Contact between the friction element 108 and the wiping material 102 can generate the friction force, wherein the second brake force F_2 may correspond to the friction caused by the friction element 108 that adds to the first brake force F_1 . The second brake force F_2 may e.g. depend on the direction and magnitude of the first brake force F_1 , the size of a contact area between the wiping material 102 and the friction element 108, the deflection angle, the wiping material 102 and/or a surface material of the friction element 108.

[0022] In the example shown in Figs. 2a and 2b, the friction element 108 is a cylindrical rod extending in the direction of view. Alternatively, the friction element 108 may have a different shape and may e.g. be a rod with an elliptical, rectangular, hexagonal or irregularly shaped cross section. The portion of the wiping material 102 connecting the first portion 102A-2 and the second portion 102A-3 is wrapped around the rod 108 spanning a contact angle β . The contact angle β is the angle enclosed by the first and last points of contact between the friction element 108 and the wiping material 102 with respect to the center of the rod 108 as illustrated by the dashed lines in Fig. 2a. The contact angle β may be

equal to the deflection angle. For a cylindrical rod, the friction between the rod 108 and the wiping material 102 can be modeled using the Capstan equation, also known as the belt friction equation, which relates the second brake force F_2 to the first brake force F_1 and the contact angle β :

$$F_2 = F_1 (e^{\mu\beta} - 1)$$

wherein μ is a static friction coefficient, which can e.g. depend on the wiping material 102, the surface material of the rod 108 and a structure of the respective surfaces. According to the Capstan equation, the second brake force F_2 increases exponentially with the contact angle β such that a small change in the contact angle β can lead to a drastic change in the second brake force F_2 . If the friction element 108 has a different shape, the relation between the first F_1 and second brake forces F_2 may differ from the Capstan equation. In general, however, the second brake force F_2 will also strongly depend on the contact angle β .

[0023] The second brake force F_2 may be controlled by changing the contact angle β , e.g. to compensate at least in part a change in the first brake force F_1 . This is illustrated in Figs. 2a and 2b. The first brake force F_1 may depend on the amount of wiping material 102A-1 rolled up on the clean material roll 104. For example, the spring 204 may extend increasingly as the wiping material 102 is unrolled from the clean material roll 104, which may lead to a smaller spring force f_1 and hence a smaller first brake force F_1 . This decrease in the first brake force F_1 may be compensated at least in part by changing the contact angle β . A winding direction of the wiping material 102A-1 on the clean material roll 104 and a winding direction of the wiping material 102 on the rod 108 may for example be such the contact angle β increases as the amount of wiping material 102A-1 rolled-up on the clean material roll 104 decreases as shown in Figs. 2a and 2b. The dotted line in Fig. 2b illustrates the path of the wiping material 102 in the configuration of Fig. 2a. In this example, the contact angle β increases as the outer radius R of the wiping material 102A-1 rolled-up on the clean material roll 104 decreases. Accordingly, the second brake force F_2 increases. The position of the friction element 108 relative to the position of the clean material roll 104 may be chosen such that the increase in the second brake force F_2 compensates at least in part a change in the first brake force F_1 arising from a

change in the amount of wiping material 102A-1 rolled up on the clean material roll 104.

[0024] An example for the evolution 300 of the spring force f_1 , the first brake force F_1 and the total brake force $F_B = F_1 + F_2$ as a function of the outer radius R of the wiping material 102A-1 rolled up on the clean material roll 104 is illustrated in Fig. 3. As described above, the spring force f_1 decreases with decreasing radius R as the wiping material 102 is unrolled from the clean material roll 104 and the spring 204 extends. The first brake force F_1 may be proportional or approximately proportional to the spring force F_1 and hence may also decrease with decreasing radius R . By appropriately adjusting the contact angle β , the decrease in the first brake force F_1 may be compensated at least in part through an increase in the second brake force F_2 , e.g. due to an increased friction between the wiping material 102 and the friction element 108, such that the total brake force F_B remains constant or approximately constant independent of the radius R . In one example, the total brake force F_B may change by less than 20%, preferably less than 10% as the wiping material 102 is completely unrolled from the clean material roll 104.

[0025] Fig. 4 depicts a maintenance cartridge 400 according to an example in a perspective view. The maintenance cartridge 400 may for example be employed in a printing device to perform cleaning operations on a print head of the printing device. The maintenance cartridge 400 comprises a wiping subsystem 402 having a number of wipers 404 to press a wiping material 102 against the print head. The wiping subsystem 402 is described in more detail below with reference to Fig. 5. The maintenance cartridge 400 further comprises a capping subsystem 406 having a plurality of caps 408, e.g. to cover a nozzle plate of the print head after the cleaning or when the print head is not in use. For simplicity, only a single cap 408 and a single wiper 404 are provided with reference signs in Fig. 4. The maintenance cartridge 400 also comprises a spittoon subsystem 410 having a reservoir to receive material ejected from the print head. The spittoon subsystem 410 may further comprise a spit roller or transfer unit (not shown) arranged in or adjacent to the reservoir, e.g. to transfer material ejected from the print head into the reservoir.

[0026] A sectional view of the wiping subsystem 402 of the maintenance cartridge 400 is shown in Fig. 5. Similar to the wiping subsystems 100 and 200, the wiping subsystem 402 comprises a wiping material 102 that is to be brought in contact with the print head to wipe off contaminants from the print head. The wiping material 102 comprises a clean part 102A, a cleaning part 102B and a used part 102C. The clean part 102A may e.g. be used for cleaning the print head in the future and is rolled up on a clean material roll 104 at least in part. The cleaning part 102B is arranged on top of a plurality of wipers 404. In the example shown in Figs. 4 and 5, the wiping subsystem 400 comprises three wipers 404. In others examples, the wiping subsystem 400 may comprise a different number of wipers, e.g. a single wiper. The wipers 404 are to press the cleaning part 102B against the print head with a wiper force F_w to wipe the print head. The wipers 404 may consist of or comprise a flexible material like rubber such that the wipers 404 may be compressed to generate a spring force pressing the wiping material 102 towards the print head. The used part 102C may e.g. have been used for cleaning the print head previously and may be stored by rolling up the used part 102C on a used material roll 412 at least in part.

[0027] The wiping subsystem 402 comprises a brake 106 to generate a first brake force F_1 along a longitudinal direction of the wiping material 102 in a first portion 102A-2 of the clean part 102A of the wiping material 102. The brake 106 may e.g. have a spring 204 to press a brake shoe 202 against a portion 102A-1 of the wiping material 102 rolled up on the clean material roll 104. The wiping subsystem 402 further comprises a friction element 108 to convert the first brake force F_1 to a friction force along the longitudinal direction of the wiping material 102 in a second portion 102A-3 of the clean part 102A of the wiping material 102 to generate the second brake force F_2 . In this example, the friction force corresponds to a total brake force F_B that is the sum of the first and second brake forces F_1 and F_2 . The friction element 108 may for example be a rod, wherein the wiping material 102 is wrapped around the rod 108 spanning a contact angle β . As discussed above, the total brake force F_B may then be related to the first brake force F_1 through the Capstan equation $F_B = F_1 e^{\mu\beta}$. Accordingly, the friction element 108 amplifies the first brake force F_1 by an amplification fac-

tor $e^{\mu\beta}$. By adjusting the amplification factor, the friction element 108 can compensate at least in part a change in the first brake force F_1 to control or maintain the total brake force F_B . The amplification factor may for example be adjusted by changing the contact angle β , e.g. as described above with reference to Figs. 2a and 2b.

[0028] The total brake force F_B in the second portion 102A-3 generates a tension force F_T in the cleaning part 102B, wherein the tension force F_T also acts along the longitudinal direction of the wiping material 102. The tension force F_T may be equal to the total brake force F_B , e.g. if no additional elements are in contact with the wiping material 102 between the second portion 102A-3 and the cleaning part 102B. In other examples, the tension force F_T may be different from the total brake force F_B , e.g. if the wiping material 102 passes by an additional steering element like a deflection rod 414 between the second portion 102A-3 and the cleaning part 102B as shown in Fig. 5. The steering element may e.g. create friction such that the tension force F_T may be larger than the total brake force F_B .

[0029] The tension force F_T can counteract a driving force F_D in the cleaning part 102B, wherein the driving force F_D may e.g. be applied such that the driving force F_D points from the clean part 102A towards the used part 102C along the longitudinal direction of the wiping material 102. To generate the driving force F_D , the wiping subsystem 402 or the maintenance cartridge 400 may comprise an actuator. The actuator may e.g. be coupled to the used material roll 412 to rotate the used material roll 412, thereby creating a force f_D towards the used material roll 412 in the used part 102C. The force f_D in the used part 102C translates into the driving force F_D in the cleaning part 102B, e.g. as described above with respect to the tension force F_T . In other examples, the actuator may be coupled to a steering element like a deflection rod, e.g. to rotate or move the steering element to generate the driving force F_D . In yet another example, a force may be applied to the steering element, e.g. via a spring, to generate the driving force F_D in the wiping material 102.

[0030] When the driving force F_D is applied, the brake 106 generates the tension force F_T acting along the wiping material 102 in a direction opposite to the

driving force F_D . As long as the driving force F_D is smaller than or equal to the maximum tension force F_T , the tension force F_T prevents the wiping material 102 from moving. The two opposing forces F_T and F_D thus create a tension in the cleaning part 102B. The wiper force F_W can depend on the tension in the cleaning part 102B, e.g. due to a compression of the wipers 404 as a result of the tension, which may change the wiper force F_W as detailed below with reference to Fig. 6. The friction element 108 can compensate at least in part a change in the tension force F_T , e.g. due to a change in the first break force F_1 , to control or maintain the wiper force F_W . In one example, the wiper force F_W changes by less than 20%, preferably less than 10% as the wiping material 102 is completely unrolled from the clean material roll 104. If the driving force F_D is larger than the maximum tension force F_T , the driving force F_D may advance the wiping material 102 from the clean material roll 104 towards the used material roll 412.

[0031] Fig. 6 illustrates a printing device 600 in accordance with an example in top view. The printing device 600 comprises a print head 602, e.g. an ink-jet print head having a reservoir for a printing fluid such as ink and a nozzle plate for depositing the printing fluid on a print medium. The print head 602 can be movable along a print head path 604 in a scanning direction, which is illustrated by the arrow labeled “Y” in Fig. 6. The scanning direction may e.g. be perpendicular to a direction of movement of the print medium, also referred to as media advance direction. In other examples, the printing device 600 may be a 3D printer and the print head 602 may be moveable in multiple directions. The printing device 600 may comprise an actuator for moving the print head 602 along the print head path 604, for example an electric motor coupled to a carriage carrying the print head 602 via a drive belt or a gear drive such as a worm drive.

[0032] The printing device 600 also comprises a maintenance cartridge, e.g. the maintenance cartridge 400 with the wiping subsystem 402 described above. The maintenance cartridge 400 may e.g. be arranged in a maintenance area adjacent to one end of the print head path 604. In some examples, the maintenance cartridge 400 may be movable along a maintenance path 606 as illustrated by the arrow labeled “X”, e.g. to position the maintenance cartridge 400

relative to the print head 602 to perform a cleaning operation with one of the subsystems 402, 406, and 410. The maintenance path 606 may e.g. be aligned with the media advance direction to traverse the print head path 604. To move the maintenance cartridge 400, the printing device 600 may further comprise an actuator, e.g. an electric motor coupled to the maintenance cartridge 400 via a drive belt or a gear drive such as a worm drive.

[0033] To wipe the print head 602, the print head 602 and the maintenance cartridge 400 may be brought into a wiping configuration, in which the print head 602 is adjacent to the maintenance cartridge 400. For this, the print head 602 may for example be moved to a cleaning position in the maintenance area, e.g. such that the print head 602 is located above the maintenance cartridge 400 in the direction of view of Fig. 6, and the maintenance cartridge 400 may be moved along the maintenance path 606 to a wiping position. In the wiping configuration, the cleaning part 102B of the wiping material 102 is in contact with the print head 602, e.g. with a nozzle plate on the bottom of the print head 602. The cleaning part 102B is pressed against the print head 602 by the wipers 404 with the wiper force F_w .

[0034] The wiper force F_w may e.g. depend on the tension in the cleaning part 102B of the wiping material 102 and a distance between the wiping subsystem 402 and the print head 602. When the wiping material 102 is not in contact with the print head 602, the spring force that is generated by the wipers 404 and presses the wiping material 102 upwards may be countered by the tension in the cleaning part 102B, creating a stable equilibrium. When the wiping material 102 comes in contact with the print head 602, the print head 602 may further compress the wipers 404 such that the wipers 404 generate the wiper force F_w in addition to the equilibrium spring force. Accordingly, the wiper force F_w presses the wiping material 102 against the print head 602. If the tension force F_T is too small, the print head 602 may deform or move the wiping material 102 on the wipers 404. This may result in an insufficient cleaning of the print head 602 by the wiping material 102. If the tension force F_T is too large, the tension in the cleaning part 102B may lead to a compression of the wipers 404. This can result in a reduced wiper force F_w or may even prevent contact between the wip-

ing material 102 and the print head 602. This may also affect the quality of the cleaning.

[0035] As described above, the tension force F_T results from the first break force F_1 generated by the brake 106, which is amplified by the friction element 108 yielding the total break force F_B . The friction element 108 is to adjust the amplification factor to compensate at least in part a change in the tension force F_T to control the wiper force F_W . A change in the tension force F_T may for example arise from a change in the first break force F_1 , e.g. due to a change of the amount of wiping material 102A-1 rolled up on the clean material roll 104. To compensate this change at least in part, the friction element 108 and the clean material roll 104 may be positioned such that the contact angle β increases as the amount of wiping material 102A-1 rolled up on the clean material roll 104 decreases. An increase in the contact angle β can enhance the amplification factor, which may compensate the decrease in the first break force F_1 at least in part, e.g. to maintain a constant or approximately constant wiper force F_W . In one example, the wiper force F_W changes by less than 20%, preferably less than 10% as the wiping material 102 is completely unrolled from the clean material roll 104.

[0036] Fig. 7 shows a flow chart for an example of a method 700 of controlling a wiping subsystem of a print head maintenance cartridge. The method 700 may e.g. be used to control any one of the wiping subsystems 100, 200, and 402 and is described in the following with reference to Figs. 2a, 2b, and 5. This is, however, not intended to be limiting in any way. The method 700 may be executed with any wiping subsystem comprising a wiping material at least partially rolled-up on a material roll.

[0037] The method 700 comprises, in 702, applying a driving force F_D along a longitudinal direction of the wiping material 102 in a cleaning part 102B of the wiping material 102. As detailed above, the driving force F_D may for example be generated by an actuator, e.g. an electric motor. The actuator may e.g. be part of or coupled to the used material roll 412 to rotate the used material roll 412 and thereby generate a force along the wiping material 102. In other examples, the actuator may be coupled to a steering element like a deflection rod, e.g. to

rotate or move the steering element to generate the driving force F_D . In yet another example, a force may be applied to the steering element, e.g. via a spring, to generate the driving force F_D in the wiping material 102.

[0038] The method 700 further comprises, in 704, applying a brake force F_1 along the longitudinal direction of the wiping material 102 in a brake portion 102A-2 of the wiping material 102 to counteract the driving force F_D . The brake force F_1 may for example be generated by the brake 106, e.g. by pressing the brake shoe 202 with a force f_1 against a portion of the clean part 102A of the wiping material 102. The brake shoe 202 may e.g. be pressed against the portion 102A-1 of the wiping material 102 rolled up on the material roll 104 or against a portion of the clean part 102A that is unrolled from the material roll 104, e.g. a portion of the brake portion 102A-2. In other examples, the brake force F_1 may be generated via the material roll 104, e.g. due to friction impeding a rotation of the material roll 104 or by applying a torque to the material roll 104.

[0039] In 706, the brake force F_1 is converted to a tension force F_T in the cleaning part 102B that counters the driving force F_D , i.e. the tension force F_T is equal and opposite to the driving force F_D . For example, if the driving force F_D acts away from the material roll 104, the tension force F_T points towards the material roll 104. The counteracting forces create a tension in the cleaning part 102B. Converting the brake force F_1 to the tension force F_T refers to modifying the force acting along the longitudinal direction of wiping material 102 such that, if the brake force F_1 is applied in the brake portion 102A-2, the tension force F_T acts in the cleaning part 102B instead of the brake force F_1 . This may comprise changing a direction and/or magnitude of the first brake force F_1 . Converting the brake force F_1 to the tension force F_T may for example comprise generating a second brake force F_2 along the wiping material 102 e.g. via the friction element 108 as described below in more detail. Additionally, converting the brake force F_1 to the tension force F_T may comprise converting the total brake force F_B corresponding to the sum of the first F_1 and second brake forces F_2 to the tension force F_T , e.g. via additional steering elements like the deflection rod 414.

[0040] The method 700 further comprises, in 708, unrolling a part of the wiping material 102A-1 from the material roll 104. This may for example comprise in-

creasing the driving force F_D pointing away from the material roll 104 along the longitudinal direction of the wiping material 102 such that the driving force F_D exceeds the maximum tension force F_T . The driving force F_D may be generated as described above. When unrolling a part of the wiping material 102A-1 from the material roll 104, the outer radius R of the wiping material 102A-1 rolled up on the material roll 104 may decrease. As a result of this, the brake force F_1 may change, e.g. due to a change of the force f_1 pressing the brake shoe 202 against the wiping material 102A-1 on the material roll 104. The force f_1 may for example be given by the product of a spring constant of the spring 204 and a length by which the spring 204 is compressed compared to its equilibrium length. As the spring 204 relaxes, the force f_1 may decrease as the spring 204 approaches its equilibrium length.

[0041] The method 700 further comprises, in 710, compensating at least in part a change in the brake force F_1 to maintain the tension force F_T in the cleaning part 102B to be constant or about constant. In one example, the tension force F_T in the cleaning part 102B may change by less than 20%, preferably less than 10% as the wiping material 102 is completely unrolled from the material roll 104. Compensating at least in part the change in the brake force F_1 may comprise adjusting

[0042] The method 700 may comprise wrapping a portion of the wiping material 102 between the brake portion 102A-2 and the cleaning part 102B around the friction element 108 along a contact angle β . The contact angle β is the angle enclosed by the first and last points of contact between the friction element 108 and the wiping the conversion of the brake force F_1 to the tension force F_T such that the tension force F_T remains constant or approximately constant, e.g. by adjusting the second brake force F_2 .

[0043] The flow diagram shown in Fig. 7 does not imply a certain order of execution of the method 700. As far as technically feasible, the method 700 may be performed in any order and different parts may be performed simultaneously at least in part. For example, the brake force F_1 in 704 may be generated simultaneously with the application of the driving force F_D in 702. Furthermore, the brake force F_1 may e.g. be converted to the tension force F_T immediately, e.g.

such that any driving force F_D applied to the wiping material 102 is immediately countered by the tension force F_T . A change in the break force F_1 may continuously be compensated for in 710 while unrolling the wiping material 102 in 708 to maintain the tension force F_T . The brake force F_1 and/or the tension force F_T may be adjusted continuously whenever the driving force F_D is changed.

[0044] In one example, the method 700 can further comprise providing a friction element 108. The friction element 108 may for example be used to generate the second break force F_2 to convert the break force F_1 to the tension force F_T , e.g. by pressing an element against the wiping material 102 as in the wiping subsystem 100 or using a deflecting element like a rod in contact with the wiping material 102 as described above with reference to Figs. 2a and 2b.

[0045] material 102 with respect to the center of the friction element 108. In one example, the friction element 108 may be a cylindrical rod as in Figs. 2a and 2b. Alternatively, the friction element 108 may have a different shape, e.g. a rod with an elliptical, rectangular, hexagonal or irregularly shaped cross section.

[0046] Compensating at least in part the change in the brake force F_1 may comprise changing the contact angle β . As described above with reference to Figs. 2a and 2b, increasing the contact angle β may increase the friction between the friction element 108 and the wiping material 102 and may thus generate a larger second break force F_2 . Accordingly, decreasing the contact angle β may decrease the friction between the friction element 108 and the wiping material 102 and may thus generate a smaller second break force F_2 . Thereby, the second break force F_2 may be adjusted to compensate at least in part the change the brake force F_1 to maintain at least approximately the total break force F_B and thus the tension force F_T .

[0047] The friction element 108 may be provided at a fixed position and changing the contact angle β may comprise changing at the friction element 108 an input angle of the wiping material 102 coming from the material roll 104. The input angle may be defined as the angle between the orientation of the wiping material 102 upstream of the friction element 108, i.e. on the side of the material roll 104, and a fixed direction within the wiping subsystem 402, e.g. the orientation of the wiping material 102 downstream of the friction element 108, i.e. on

the side opposite to the material roll 104. In the example shown in Figs. 2a and 2b, the path of the wiping material 102 between the material roll 104 and the friction element 108, i.e. in the first portion 102A-2, depends on the outer radius R of the wiping material 102A-1 rolled up on the material roll 104, i.e. on the amount of wiping material 102A-1 on the material roll 104. Accordingly, as illustrated by the dotted line in Fig. 2b, the input angle and thus the contact angle β change as the wiping material 102 is unrolled from the material roll 104. The position at which the friction element 108 is provided relative to the material roll 104 may be chosen such that the change in the contact angle β is sufficient to compensate, at least in part, the change in the break force F_1 that arises from unrolling the wiping material 102 from the material roll 104. In other examples, the friction element 108 or the material roll 104 may be movable and changing the contact angle β may comprise moving the friction element 108 and/or the material roll 104 to compensate the change in the break force F_1 at least in part.

[0048] In one example, the contact angle β is increased as the amount of wiping material 102A-1 rolled up on the material roll 104 decreases, e.g. to compensate a decreasing brake force F_B at least in part by a larger friction between the friction element 108 and the wiping material 102. In Figs. 2a and 2b for example, the input angle and the contact angle β are smaller at a larger radius $R = R_a$ of the wiping material 102A-1 rolled up on the material roll 104 as in Fig. 2a than at a smaller radius $R = R_b$ as in Fig. 2b. The winding direction of the wiping material 102 on the material roll 104 and on the friction element 108 and their relative positions may be chosen such that the contact angle β increases as the wiping material 102 is unrolled from the material roll 104.

[0049] This description is not intended to be exhaustive or limiting to any of the examples described above. The print head maintenance cartridge, printing device and method disclosed herein can be implemented in various ways and with many modifications without altering the underlying basic properties.

CLAIMS

1. A print head maintenance cartridge with a wiping subsystem, the wiping subsystem comprising:
 - a wiping material to wipe a print head;
 - a clean material roll, wherein a clean part of the wiping material is rolled up on the clean material roll at least in part;
 - a brake to generate a first brake force applied to the wiping material; and
 - a friction element to generate a second brake force applied to the wiping material,wherein the friction element compensates at least in part a change in the first brake force to control a total brake force, wherein the total brake force is the sum of the first and second brake forces.
2. The print head maintenance cartridge of claim 1 wherein:
 - the brake is to generate the first brake force along a longitudinal direction of the wiping material in a first portion of the clean part of the wiping material; and
 - the friction element is to convert the first brake force to a friction force along the longitudinal direction of the wiping material in a second portion of the clean part of the wiping material to generate the second brake force.
3. The print head maintenance cartridge of claim 2, wherein the friction element is a rod and a portion of the wiping material connecting the first and second portions is wrapped around the rod spanning a contact angle.
4. The print head maintenance cartridge of claim 3, wherein the friction element is to compensate at least in part a change in the first brake force by a changing contact angle.

5. The print head maintenance cartridge of claim 4, wherein a winding direction of the wiping material on the clean material roll and a winding direction of the wiping material on the rod are such the contact angle increases as the amount of wiping material rolled up on the clean material roll decreases.
6. The print head maintenance cartridge of claim 1, wherein
the brake comprises a spring to press a brake shoe against the clean part of the wiping material rolled up on the clean material roll to generate the first brake force; and
the friction element is to compensate at least in part a change in the first brake force arising from a change in the amount of wiping material rolled up on the clean material roll.
7. The print head maintenance cartridge of claim 1, wherein the friction element is to compensate at least in part a change in the first brake force to maintain the total brake force to be constant or about constant.
8. The print head maintenance cartridge of claim 1, further comprising an actuator to generate a driving force along the longitudinal direction of the wiping material, wherein the driving force acts in a direction away from the clean roll and the total brake force acts along the wiping material in a direction opposite to the driving force.
9. A printing device comprising:
a print head, wherein the print head is movable along a print head path in a scanning direction; and
a print head maintenance cartridge with a wiping subsystem, the wiping subsystem comprising a wiping material; a clean material roll, on which a clean part of the wiping material is rolled up at least in part; a brake; a friction element; and a wiper,

the wiper to press a cleaning part of the wiping material with a wiper force against the print head in a wiping configuration, in which the print head is adjacent to the print head maintenance cartridge;

the brake to generate a tension force in the cleaning part, when a driving force is applied along a longitudinal direction of the wiping material in the cleaning part, wherein the tension force acts along the wiping material in a direction opposite to the driving force;

the friction element to amplify the tension force by an amplification factor;

and

the friction element further to adjust the amplification factor to compensate at least in part a change in the tension force to control the wiper force.

10. The printing device of claim 9, wherein the wiper force changes by less than 20%, preferably less than 10% as the wiping material is completely unrolled from the clean material roll.

11. A method of controlling a wiping subsystem of a print head maintenance cartridge, wherein the wiping subsystem comprises:

a wiping material at least partially rolled-up on a material roll;

the method comprising:

applying a driving force along a longitudinal direction of the wiping material in a cleaning part of the wiping material,

countering the driving force by a tension force to create a tension in the cleaning part, wherein the tension force is generated by a brake force applied along the longitudinal direction of the wiping material in a brake portion of the wiping material and converting the brake force to the tension force;

unrolling a part of the wiping material from the material roll; and

compensating at least in part a change in the brake force to maintain the tension force in the cleaning part to be constant or about constant.

12. The method of claim 11, further including
providing a friction element;
wrapping a portion of the wiping material between the brake portion and
the cleaning part around the friction element along a contact angle; and
compensating at least in part the change in the brake force comprises
changing the contact angle.
13. The method of claim 12, wherein the friction element is provided at a
fixed position and changing the contact angle comprises changing at the friction
element an input angle of the wiping material coming from the material roll.
14. The method of claim 12, wherein the contact angle is increased as the
amount of wiping material rolled up on the material roll decreases.
15. The method of claim 11, wherein the brake force is generated by pressing
a brake against a part of the wiping material rolled up on the material roll.

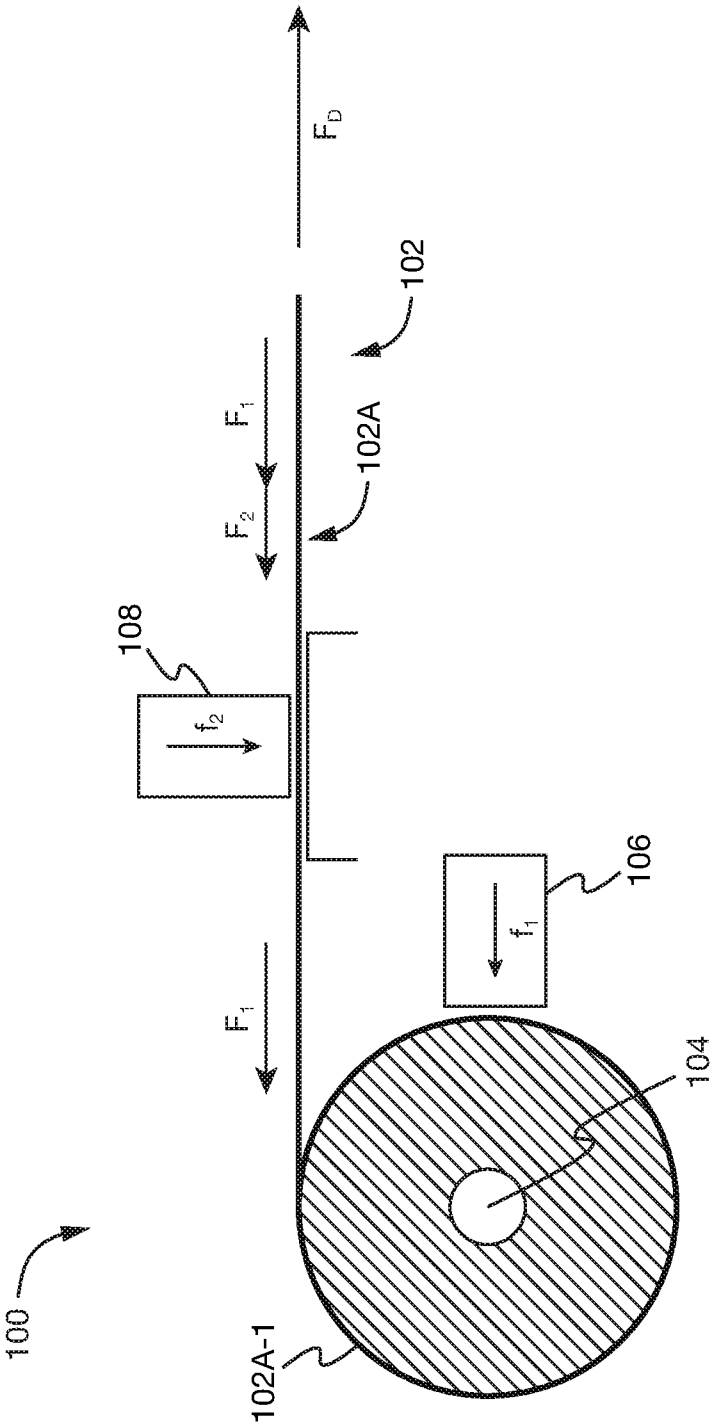


Fig. 1

2/7

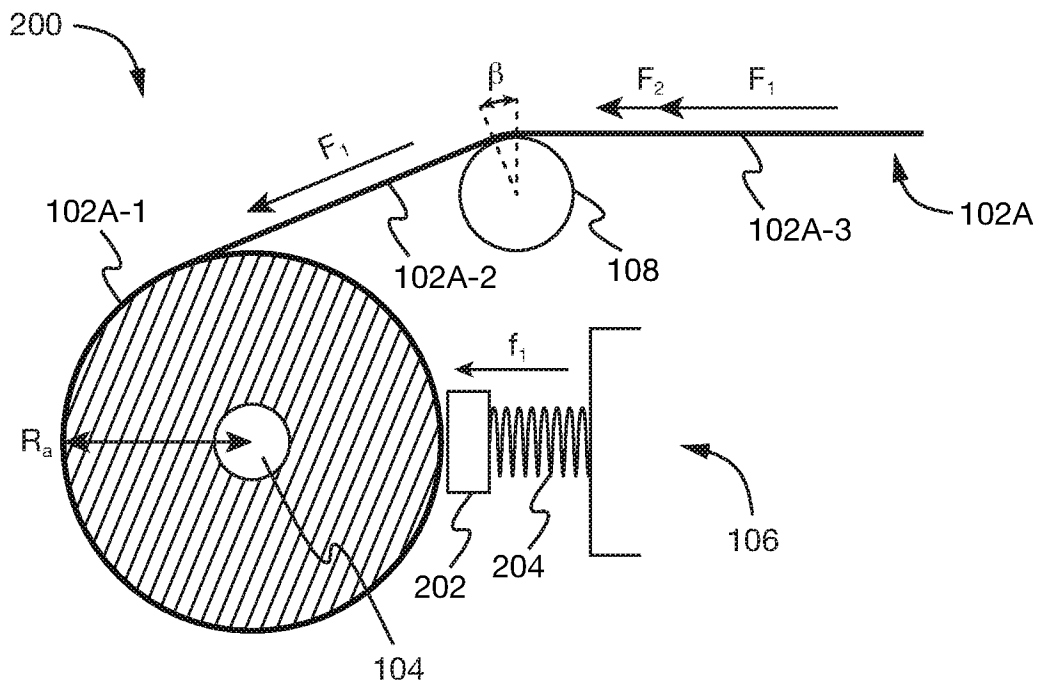


Fig. 2a

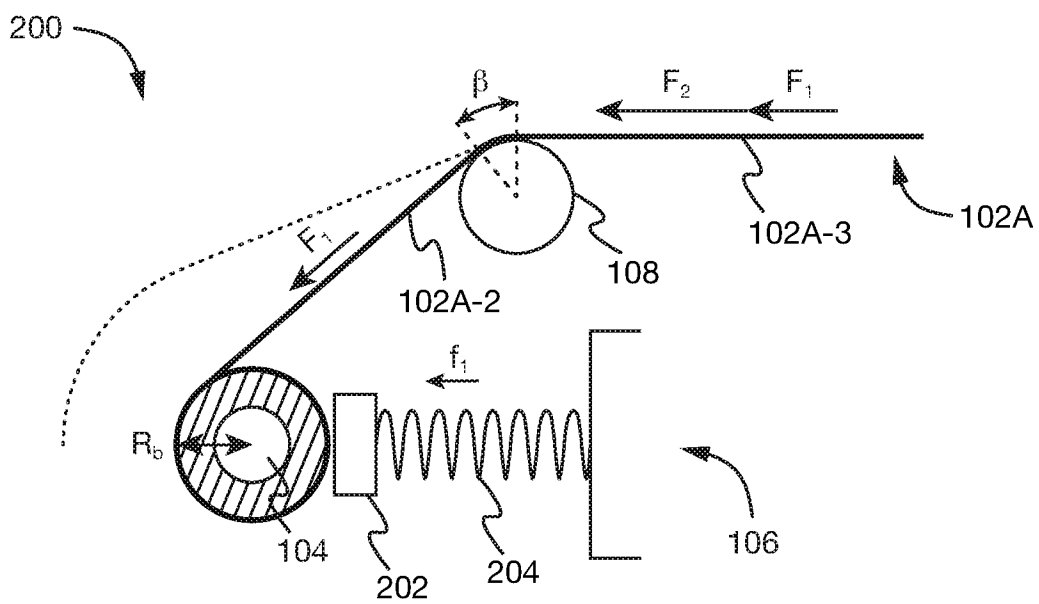


Fig. 2b

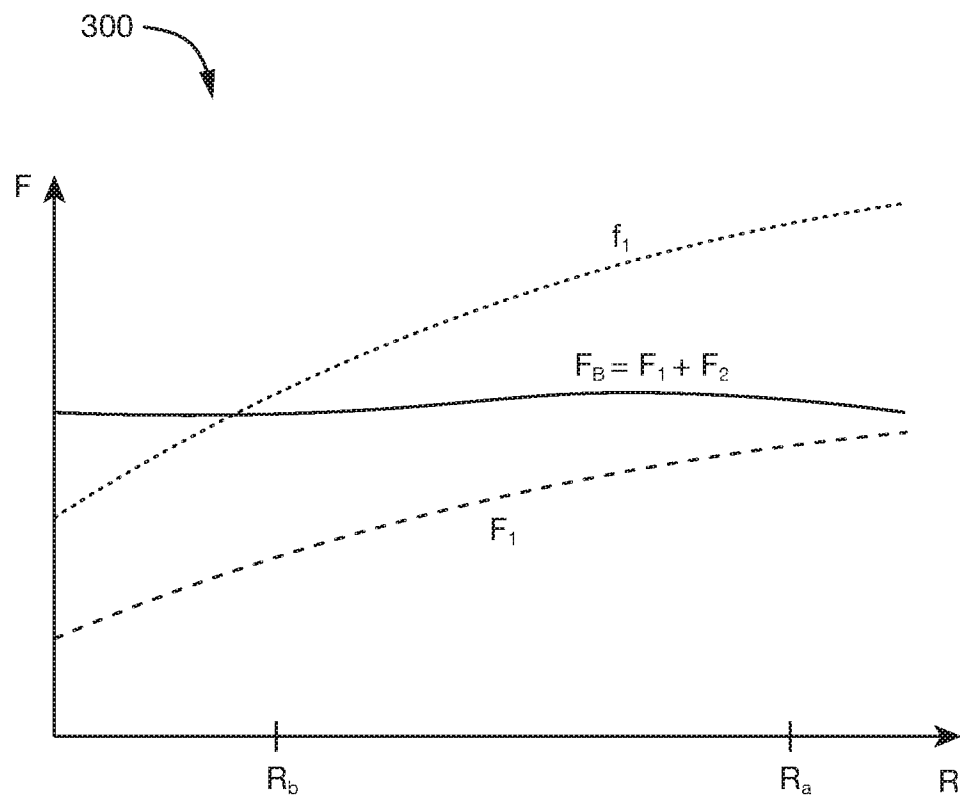


Fig. 3

4/7

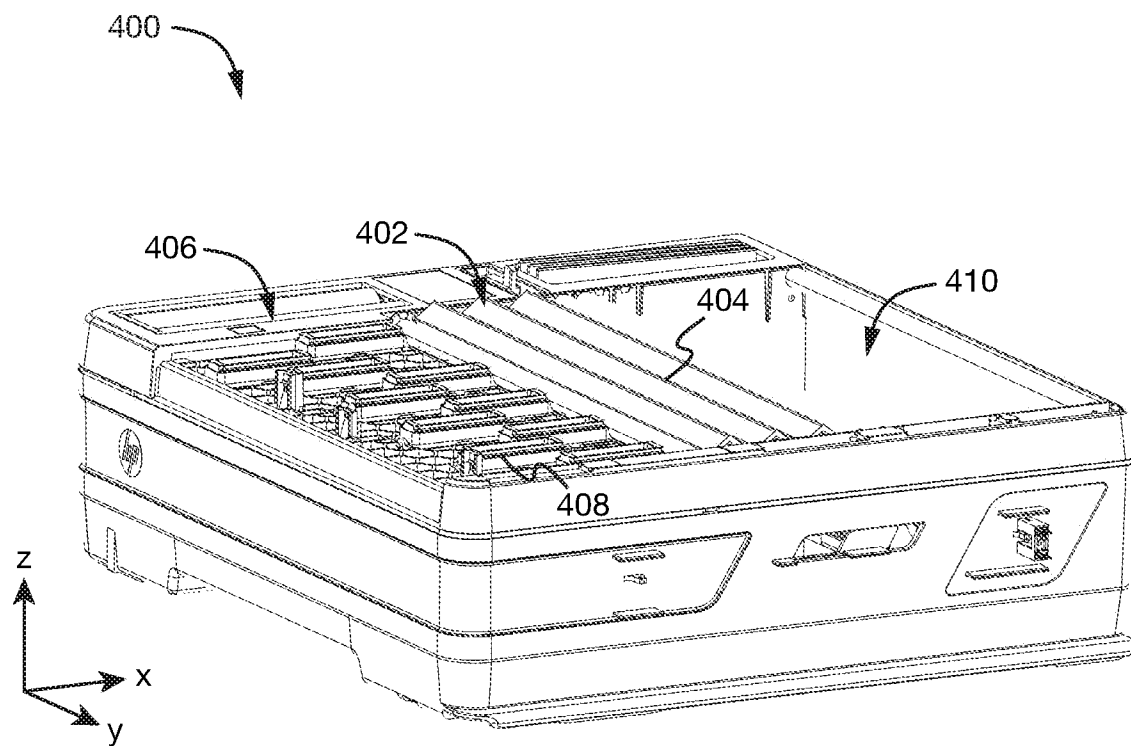
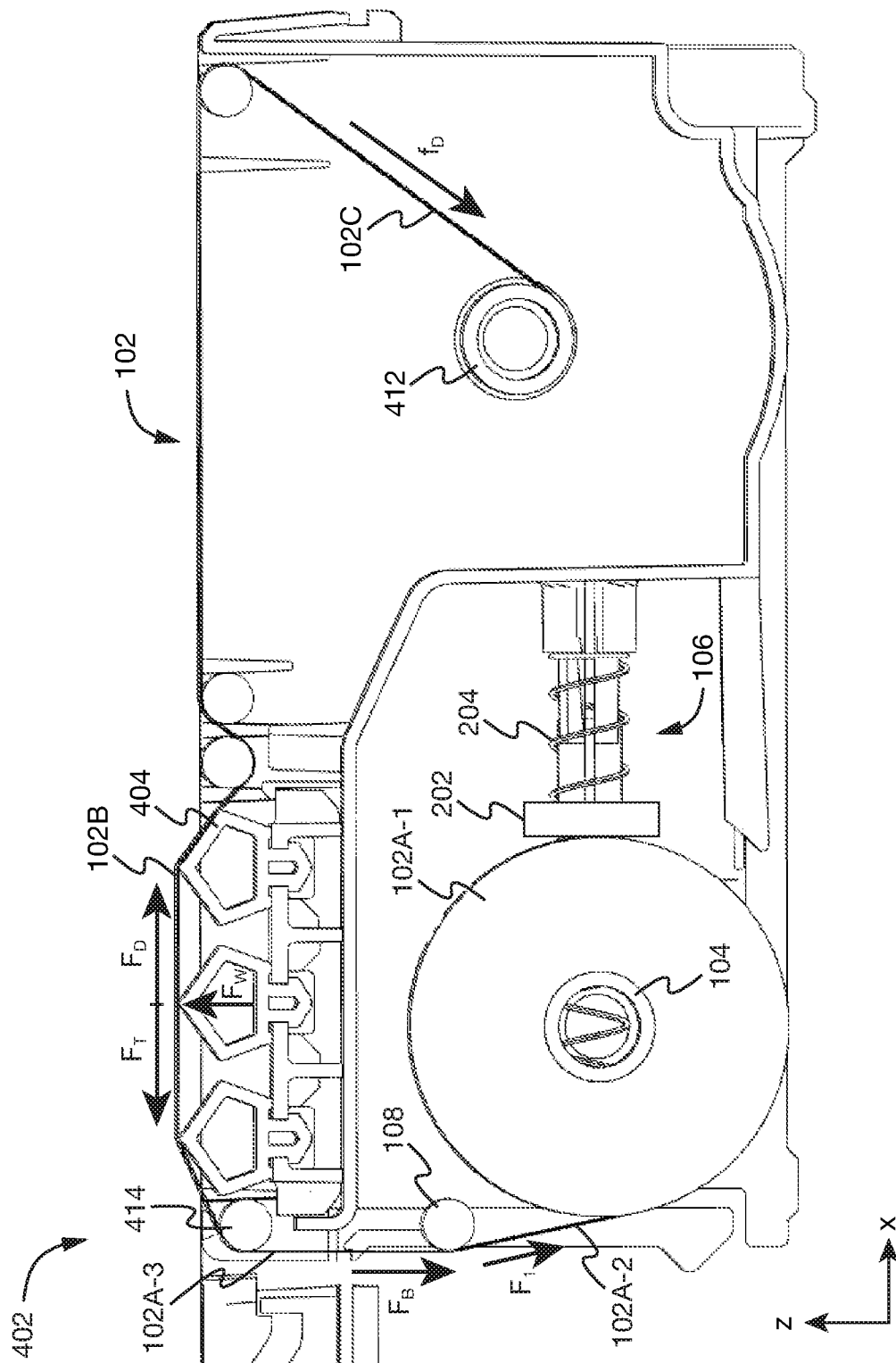


Fig. 4



5
 6
 7
 8
 9
 10
 11
 12
 13
 14
 15
 16
 17
 18
 19
 20
 21
 22
 23
 24
 25
 26
 27
 28
 29
 30
 31
 32
 33
 34
 35
 36
 37
 38
 39
 40
 41
 42
 43
 44
 45
 46
 47
 48
 49
 50
 51
 52
 53
 54
 55
 56
 57
 58
 59
 60
 61
 62
 63
 64
 65
 66
 67
 68
 69
 70
 71
 72
 73
 74
 75
 76
 77
 78
 79
 80
 81
 82
 83
 84
 85
 86
 87
 88
 89
 90
 91
 92
 93
 94
 95
 96
 97
 98
 99
 100
 101
 102
 103
 104
 105
 106
 107
 108
 109
 110
 111
 112
 113
 114
 115
 116
 117
 118
 119
 120
 121
 122
 123
 124
 125
 126
 127
 128
 129
 130
 131
 132
 133
 134
 135
 136
 137
 138
 139
 140
 141
 142
 143
 144
 145
 146
 147
 148
 149
 150
 151
 152
 153
 154
 155
 156
 157
 158
 159
 160
 161
 162
 163
 164
 165
 166
 167
 168
 169
 170
 171
 172
 173
 174
 175
 176
 177
 178
 179
 180
 181
 182
 183
 184
 185
 186
 187
 188
 189
 190
 191
 192
 193
 194
 195
 196
 197
 198
 199
 200
 201
 202
 203
 204
 205
 206
 207
 208
 209
 210
 211
 212
 213
 214
 215
 216
 217
 218
 219
 220
 221
 222
 223
 224
 225
 226
 227
 228
 229
 230
 231
 232
 233
 234
 235
 236
 237
 238
 239
 240
 241
 242
 243
 244
 245
 246
 247
 248
 249
 250
 251
 252
 253
 254
 255
 256
 257
 258
 259
 260
 261
 262
 263
 264
 265
 266
 267
 268
 269
 270
 271
 272
 273
 274
 275
 276
 277
 278
 279
 280
 281
 282
 283
 284
 285
 286
 287
 288
 289
 290
 291
 292
 293
 294
 295
 296
 297
 298
 299
 300
 301
 302
 303
 304
 305
 306
 307
 308
 309
 310
 311
 312
 313
 314
 315
 316
 317
 318
 319
 320
 321
 322
 323
 324
 325
 326
 327
 328
 329
 330
 331
 332
 333
 334
 335
 336
 337
 338
 339
 340
 341
 342
 343
 344
 345
 346
 347
 348
 349
 350
 351
 352
 353
 354
 355
 356
 357
 358
 359
 360
 361
 362
 363
 364
 365
 366
 367
 368
 369
 370
 371
 372
 373
 374
 375
 376
 377
 378
 379
 380
 381
 382
 383
 384
 385
 386
 387
 388
 389
 390
 391
 392
 393
 394
 395
 396
 397
 398
 399
 400
 401
 402
 403
 404
 405
 406
 407
 408
 409
 410
 411
 412
 413
 414
 415
 416
 417
 418
 419
 420
 421
 422
 423
 424
 425
 426
 427
 428
 429
 430
 431
 432
 433
 434
 435
 436
 437
 438
 439
 440
 441
 442
 443
 444
 445
 446
 447
 448
 449
 450
 451
 452
 453
 454
 455
 456
 457
 458
 459
 460
 461
 462
 463
 464
 465
 466
 467
 468
 469
 470
 471
 472
 473
 474
 475
 476
 477
 478
 479
 480
 481
 482
 483
 484
 485
 486
 487
 488
 489
 490
 491
 492
 493
 494
 495
 496
 497
 498
 499
 500
 501
 502
 503
 504
 505
 506
 507
 508
 509
 510
 511
 512
 513
 514
 515
 516
 517
 518
 519
 520
 521
 522
 523
 524
 525
 526
 527
 528

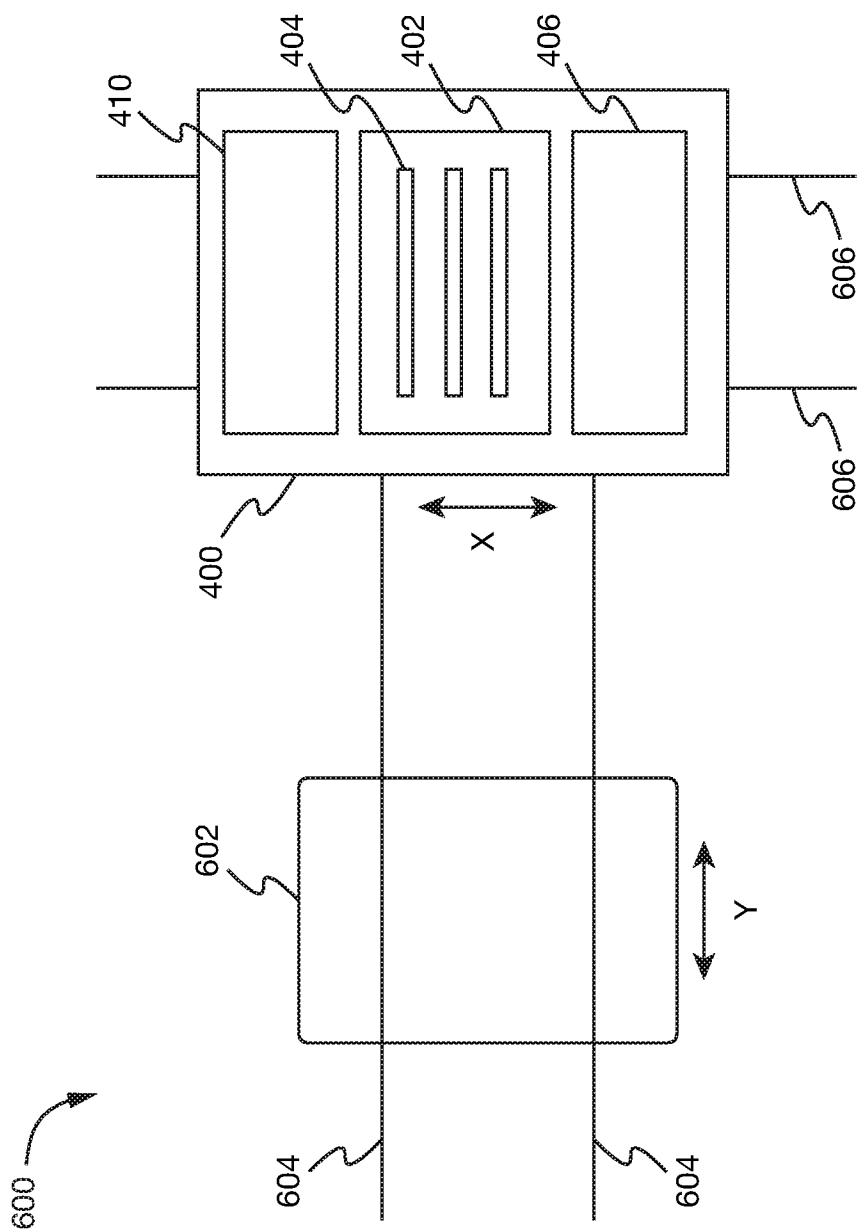


Fig. 6

7/7

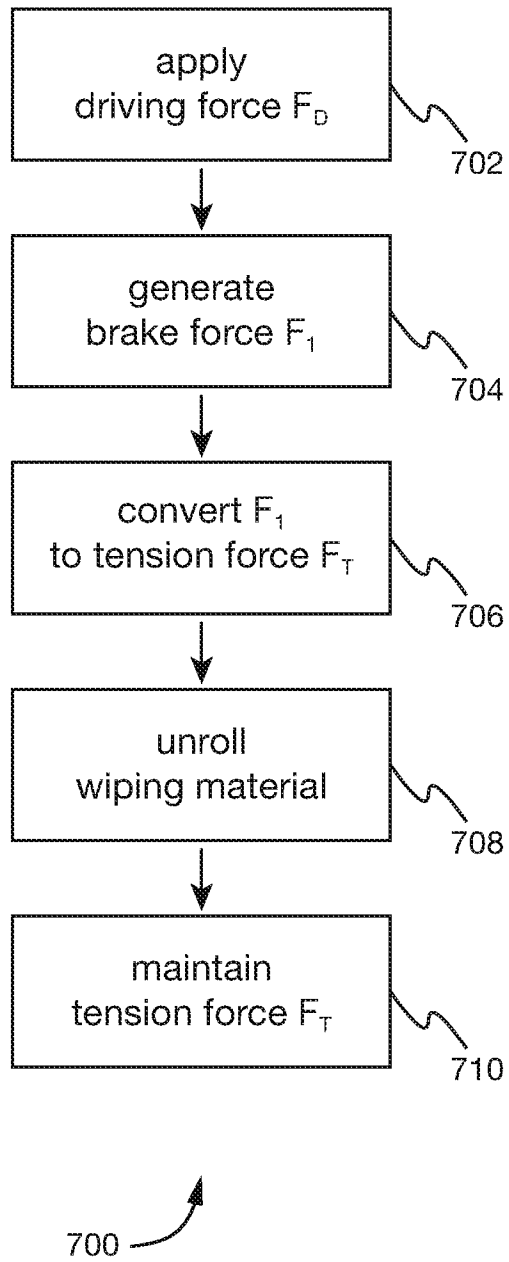


Fig. 7

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 2018/066871

A. CLASSIFICATION OF SUBJECT MATTER		
B41J 2/165 (2006.01)		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols)		
B41J		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
PatSearch (RUPTO internal), Espacenet, DWPI, PAJ, USPTO		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 3254855 A1 (FUJIFILM CORPORATION) 13.12.2017, fig.15, [0219]-[0221]	1-4,7-13,15
A		5,6,14
Y	US 2016/0090243 A1 (WRH WALTER REIST HOLDING AG) 31.03.2016, fig.8, [0025]-[0035],[0103]-[0111],[0159]-[0163]	1-4,7-13,15
Y	US 2164363 A1 (G. C. WATERS) 04.07.1939, fig. 1, p. 3 col. 1, p.46, p. 52 col. 2	15
A	US 2018/0001645 A1 (SEIKO EPSON CORPORATION) 04.01.2018	1-15
☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search		Date of mailing of the international search report
30 July 2019 (30.07.2019)		12 September 2019 (12.09.2019)
Name and mailing address of the ISA/RU: Federal Institute of Industrial Property, Berezhkovskaya nab., 30-1, Moscow, G-59, GSP-3, Russia, 125993 Facsimile No: (8-495) 531-63-18, (8-499) 243-33-37		Authorized officer P. Bystrov Telephone No. (499) 240-25-91