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(71) Applicant: **COMPUPRINT S.p.A.**
10014 Caluso (Torino) (IT)

(72) Inventor: **Cassiano, Cosimo**
20010 Vittuone (IT)

(74) Representative:
Pezzoli, Ennio et al
Jacobacci & Perani S.p.A.
Via Senato, 8
20121 Milano (IT)

(54) A roller feed device for a print substrate of non-uniform thickness

(57) A roller feed device (154a, 154b) for a print substrate (127) of non-uniform thickness in a transverse direction relative to a feed axis comprises a first feed unit (154a) and a second feed unit (154b) disposed substantially opposite one another, each feed unit (154a; 154b) having a shaft (205; 236) perpendicular to the feed axis for connection to a drive motor for rotating the shaft (205; 236), and at least one friction roller (220a-220e; 238a-238e) mounted on the shaft (205; 236) in order to be rotated by the shaft (205; 236), the friction rollers (220a-220e; 238a-238e) acting on the print substrate (127) in an operative condition in which the print substrate (127) is interposed between the first feed unit (154a) and the second feed unit (154b), in which the shaft (205) of at least one (154b) of the first and second feed units (154a; 154b) is resiliently deformable by flexure in order to bend according to the thickness of the print substrate (127) in the operative condition.

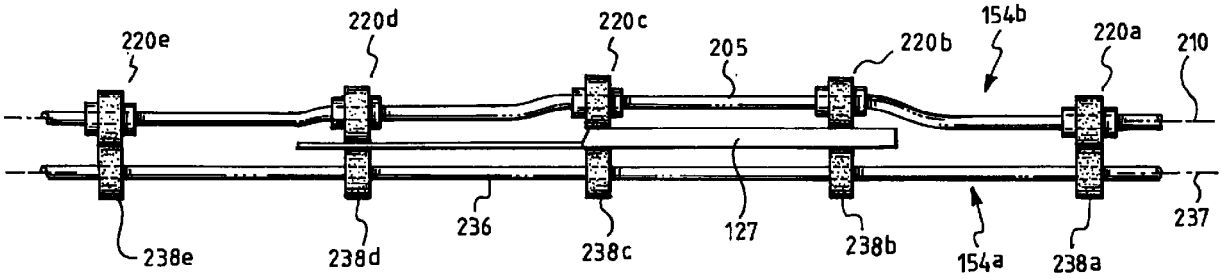

FIG.2b

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Description

[0001] The present invention relates to a roller feed device for a print substrate of non-uniform thickness and, in particular, to a feed device according to the preamble of the first claim.

[0002] Roller feed devices are commonly used in printers of various types such as, for example, dot-matrix printers. A device of this type is formed by two opposed feed units; each feed unit is constituted by a rigid shaft on which friction rollers are mounted for pulling or pushing along a print substrate.

[0003] In the particular case of a very thick print substrate, for example, with a thickness of more than 0.5 mm, it is necessary for both feed units to have driven rollers. The use of a single feed unit with driven rollers with the other feed unit having idle rollers in fact makes it extremely difficult to feed the print substrate between the opposed rollers of the two feed units.

[0004] A disadvantage of the known feed devices described above is that they do not operate correctly in the presence of a print substrate of non-uniform thickness in a transverse direction relative to a feed axis, such as, for example, an open bank book with a spine parallel to the feed axis. In this situation, the rollers are not in fact pressed against a thinner portion of the book with sufficient force; this causes a misalignment of the book, resulting in malfunctioning of the printer.

[0005] One solution could be to incline the shaft of one of the two feed units according to the thickness of the book. However, the inclined arrangement of the shaft, and hence also of the respective rollers, does not enable the rollers to achieve a good grip on the book.

[0006] A different solution could be to use an articulated structure for the shaft of one of the feed units so that the height of each roller could be adapted to the thickness of the book. However, this would require the use of a complex transmission system with joints which would make the feed device extremely expensive.

[0007] The object of the present invention is to prevent the aforementioned problems. To achieve this object, a roller feed device as described in the first claim is proposed.

[0008] In short, the present invention provides a roller feed device for a print substrate of non-uniform thickness in a transverse direction relative to a feed axis, comprising a first feed unit and a second feed unit disposed substantially opposite one another, each feed unit having a shaft perpendicular to the feed axis for connection to a drive motor for rotating the shaft, and at least one friction roller mounted on the shaft in order to be rotated by the shaft, the friction rollers acting on the print substrate in an operative condition in which the print substrate is interposed between the first feed unit and the second feed unit, in which the shaft of at least one of the first and second feed units is resiliently deformable by flexure in order to bend according to the thickness of the print substrate in the operative condition.

[0009] The present invention also proposes a printer comprising the feed device.

[0010] Further characteristics and the advantages of the feed device according to the present invention will become clear from the following description of a preferred embodiment thereof, given by way of non-limiting example, with reference to the appended drawings, in which:

Figure 1 shows, schematically and in section, an example of a printer in which the feed device of the present invention can be used,

Figure 2a shows, in perspective, the feed device fitted in the printer,

Figure 2b is a front view of the feed device in an operative condition.

[0011] With reference in particular to Figure 1, this shows a serial dot-matrix printer 100 for banking uses. The printer 100 has a mechanical support framework 103; inside the frame 103 there is a print head 106 having a matrix of pins (not shown in the drawing). The head 106 is supported by a carriage 109 which can run on two guide bars 112a, 112b.

[0012] The pins of the head 106 face a platen 115 parallel to the guide bars 112a, 112b. A cartridge of inked ribbon 118 is arranged in a manner such that a portion of the inked ribbon is interposed between the pins of the head 106 and the platen 115. The movement of the head 106 defines a printing line 121 on the platen 115.

[0013] A support platform 124 is articulated to the frame 103 externally. A bank book 127 is placed on the platform 124 in order to be inserted manually through a front slot 130. A slide 133 and a support plate 136 face one another and are arranged between the front slot 130 and the head 106. The support plate 136 houses alignment rollers 139 (bearing against an abutment element 142), thickness-detection levers 143, and a feed unit 148b with idle rollers (opposite a feed unit 148a with driven rollers). A stopper 145 constituted, for example, by a series of teeth projecting upwards from the slide 133, is provided between the support plate 136 and the head 106. A lower slide 151a and an upper slide 151b which face one another are arranged on the opposite side of the head 106. On the slides 151a and 151b there is a feed device (described in detail below) constituted, respectively, by a feed unit 154a with driven rollers and by a feed unit 154b with driven rollers, disposed opposite one another.

[0014] The printer 100 also includes a pair of tractor-feed devices 157 which are used for feeding towards the print line 121 a continuous (fanfold) module not shown in the drawing, which is inserted through a rear slot 160.

[0015] Printing data are supplied by a processing system (not shown in the drawing) by means of a suitable cable connected to an interface connector 163. The operation of the printer 100 is controlled by a microprocessor logic control unit 166 in response to commands supplied by the processing system or input by a user by means of an external panel 169.

[0016] In a waiting (stand-by) condition of the printer 100, the alignment rollers 139 and the idle rollers of the feed unit 148b are raised so as to be spaced from the abutment element 142 and from the driven rollers of the feed unit 148a, respectively; at the same time, the stopper 145 is raised to block access to the printing line 121. When the book 127 is inserted in the front slot 130, the book 127 is interposed between the slide 133 and the support plate 136. A presence sensor (not shown in the drawing), disposed on the support plate 136, detects the insertion of the book 127. The logic control unit 166 consequently lowers the alignment rollers 139; these rollers 139 align the book 127 relative to the printing line 121 (in dependence on signal supplied by a pair of alignment sensors, not shown in the drawings, disposed on the support plate 136) and simultaneously urge the book 127 against the stopper 145.

[0017] Once the book 127 is aligned, the idle rollers of the feed unit 148b and the stopper 145 are lowered. The units 148a, 148b then feed the book 127 towards the printing line 121 along an axis 172 perpendicular thereto. The book 127 is transported to the printing line 121 between the head 106 (and the respective inked ribbon 118) and the platen 115. The distance of the head 106 from the platen 115 is adjusted dynamically in dependence on the thickness of the book 127 detected by the levers 143. The book 127 is advanced with an intermittent motion; each time the book 127 stops, the head 106 passes across the printing line 121 (in the two directions alternately) so as to print several lines (of characters or of a graphics image) on the book 127 in succession. The book is then pulled along by the feed device 154a, 154b disposed downstream of the printing line 121.

[0018] Upon completion of a printing operation, the idle rollers of the feed unit 148b are raised and the direction of rotation of the driven rollers of the feed units 154a, 154b and 148a is reversed so as to urge the book 127 towards the front slot 130. In particular, when the book 127 has passed over the feed unit 148a but before it leaves the feed device 154a, 154b, the idle rollers of the feed unit 148b are lowered. The book 127 is thus urged outwardly by the rollers 139 which put the book 127 out of alignment in order to indicate the completion of the printing operation visually to an operator. The alignment rollers 139, the idle rollers of the feed unit 148b, and the stopper 145 are raised and the printer 100 returns to the stand-by condition.

[0019] Similar considerations apply if the serial dot-matrix printer has a different structure, for example, with two or more feed units with driven rollers; alternatively, a parallel printer, a daisy-wheel printer, an ink-jet printer, or the like is envisaged.

[0020] With reference now to Figure 2a (the elements already shown in Figure 1 are identified by the same reference numerals), the book 127 is fed in with a spine parallel to the feed axis 172 so that its thickness is not uniform in a transverse direction relative to this axis. Similar remarks apply if another print substrate such as a passport, an airline ticket, or the like is used; it should in any case be noted that the feed device of the present invention may be used with any type of print substrate even with a thin substrate of uniform thickness (such as, for example, a sheet of paper).

[0021] The feed unit 154b is constituted by a shaft 205 which is elongate along a longitudinal axis 210 perpendicular to the feed axis 172 and the ends of which are connected (by means of suitable bearings, not shown in the drawing) to the frame of the printer. The shaft 205 has a generally rectangular cross-section with slightly convex smaller side surfaces.

[0022] Friction rollers 220a-220e (of which there are five in the embodiment shown) are fitted on the shaft 205. The roller 220a (similar remarks apply to the other rollers 220b-220e) is constituted by a central disk-shaped body 225; the disk 225 is typically made of rubber and has a rough lateral surface. In the centre of the disk 225 there is a hub 230 constituted by a hollow cylinder with a radius smaller than that of the disk 225; the hub 230 is longer than the disk 225 and projects to an equal extent from both ends (to the left and to the right) of the disk 225. Inside the hub 230 (half way along its length) there is a partition in which a through-hole 235 complementary to the shaft 205 is formed. The through-hole 235 is slightly larger than the shaft 205 so that the roller 220a is coupled loosely to the shaft 205.

[0023] The feed unit 154a is constituted by a shaft 236 of square cross-section which is elongate along a longitudinal axis 237 (coplanar with and parallel to the axis 210). Friction rollers 238a-238e projecting from the lower slide 151a are coupled with the shaft 236 in a fixed manner and each bears against a corresponding roller 220a-220e of the feed unit 154b.

[0024] The shafts 205 and 236 are connected by a system of gears 239 to a drive motor (not shown in the drawings). When the motor drives the system of gears 239, the shafts 205 and 236 rotate about the respective longitudinal axes 210 and 237, rotating the rollers 220a-220e and 238a-238e, respectively.

[0025] Alternatively, the corresponding rollers of the two feed units are spaced apart slightly, a different number of friction rollers (or even only one roller) is provided, the central body of each roller has a structure with spokes, the rollers are mounted on the shaft in another manner, etc.

[0026] In the feed unit according to the present invention, the shaft 205 is resiliently deformable by flexure so that, in an operative condition in which the book 127 is interposed between the feed units 154a and

154b, the shaft 205 bends according to the thickness of the book 127, as shown in the front view of Figure 2b (the elements already shown in Figure 2a are identified by the same reference numerals). The shaft 236, however, is rigid (that is, with negligible deformation in the application in question) so that it remains straight when the book 127 is interposed between the feed units 154a and 154b. Similar remarks apply if the shaft 236 is resiliently deformable and the shaft 205 is rigid, or if the shafts of both feed units 154a, 154b are resiliently deformable.

[0027] In this structure, when the book 127 is interposed between the feed units 154a and 154b, the rollers 220a-220e are moved upwards by the corresponding thickness of the book 127. The deformation of the shaft 205 generates a resilient force which urges the rollers 220a-220e against the book 127, ensuring an optimal grip thereon at every point.

[0028] The solution of the present invention is also extremely reliable, simple and can be mass-produced at very low cost.

[0029] The shaft 236 is typically made of steel. The shaft 205, on the other hand, is made of a material having a modulus of elasticity substantially lower than that of steel (205,800 N/mm^2), for example 3-6 times lower; the shaft 205 is preferably made of a polyamide resin. With suitable dimensions of the cross-section of the shaft 205, it is possible to achieve an optimal flexibility value thereof (the ratio between the deflection and the force bringing it about, which is substantially linear in the field of application in question), so as to allow the shaft 205 to bend according to the thickness of the book 127 whilst exerting a resilient force on the book 127 such as to keep the rollers 220a-220e pressed well against the book. The flexibility of the shaft 205 at a central point along the axis 210 is preferably between 1 mm/N and 50 mm/N; for example, with a shaft 25 cm long and with a rectangular cross-section with sides of 5 mm and 3 mm, a flexibility of 10 mm/N is achieved (in the direction of the smaller sides). Polyamide resin also ensures good torsional stiffness (for the driving of the rollers 220a-220e). Alternatively, the shaft has a different cross-section, is made of a different material such as an acetal resin, etc.

[0030] With reference again to Figure 2a, in a preferred embodiment of the present invention, a flat spring 240a-240e made, for example, of spring steel, is associated with each of the rollers 220a-220e. The spring 240a (similar remarks apply to the other springs 240b-240e) has a rear end 245 which is bent slightly downwards; two through-holes provided in the rear end 245 are used for riveting the spring 240a to the upper slide 151b. The spring 240a terminates at the front in a fork (formed, for example, by blanking) having a left-hand arm 250a and a right-hand arm 250b. A free end of each arm 250a, 250b is bent to a semicircular shape (open at the bottom) and bears on a respective end of the hub 230 which projects from the disk 225.

[0031] When the book 127 is interposed between the feed units 154a, 154b, each spring 240a, 240e therefore exerts a further resilient force which presses the associated roller 220a-220e towards the feed unit 154a; this ensures an improved grip of the rollers 220a-220e on the book 127, or permits the use of a more flexible shaft which follows the thickness of the book 127 better (for a given pressure exerted by the rollers 220a-220e on the book 127). Similar remarks apply if the flat springs have a different structure or if other equivalent resilient means are used; the feed unit of the present invention may, in any case, also be formed without such springs.

[0032] Each flat spring 240a-240e described above also keeps the associated roller 220a-220e, which is fitted loosely on the shaft 205, in axial position (relative to the upper slide 151b, which is fixed to the frame of the printer). Two shoulders 255a and 255b are preferably provided on the shaft 205, between two adjacent rollers, for example, the rollers 220c and 220d. Each shoulder 255a, 255b abuts the partition inside the hub of the roller 220c and 220d, respectively. This keeps the shaft 205 in axial position relative to the rollers 220c and 220d (which are fixed to the upper slide 151b by means of the springs 240c and 240d, respectively) preventing removal of the shaft 205.

[0033] In the structure described above, when the book 127 is interposed between the feed units 154a and 154b, the resilient deformation of the shaft 205 and of the springs 240a-240e is not generally uniform along the shaft 205 but is greater in its centre (particularly in the case of print substrates which are very narrow with respect to the feed axis 172). In a particularly advantageous embodiment of the present invention, the outer springs 240a and 240e (disposed at the ends of the shaft 205) have an elastic constant (stiffness) greater than that of the inner springs 240b-240d (disposed between the outer springs 240a and 240e); in particular, the outer springs 240a and 240e are made from two superimposed metal plates, whereas the inner springs 240b-240d are made from a single metal plate. The resilient force exerted (by the shaft 205 and by the springs 240a-240e) on each roller 220a-220e is thus substantially uniform along the shaft 205, ensuring optimal operation of the feed device 154a, 154b.

[0034] Similar remarks apply if two or more springs disposed in the vicinity of each end of the shaft have an elastic constant greater than those of the other springs, if the outer springs are made of a thicker metal plate than the inner springs, etc. The feed device of the present invention may, in any case, also be formed with identical springs for all of the rollers (possibly with the shaft having a variable cross-section along the longitudinal axis).

[0035] Naturally, in order to satisfy contingent and specific requirements, an expert in the art may apply to the above-described feed device many modifications and variations all of which, however, are included within

the scope of protection of the invention as defined by the following claims.

Claims

1. A roller feed device (154a, 154b) for a print substrate (127) of non-uniform thickness in a transverse direction relative to a feed axis (172), comprising a first feed unit (154a) and a second feed unit (154b) disposed substantially opposite one another, each feed unit (154a; 154b) having a shaft (205; 236) perpendicular to the feed axis (172) for connection to a drive motor for rotating the shaft (205; 236), and at least one friction roller (220a-220e; 238a-238e) mounted on the shaft (205; 236) in order to be rotated by the shaft (205; 236), the friction rollers (220a-220e; 238a-238e) acting on the print substrate (127) in an operative condition in which the print substrate (127) is interposed between the first feed unit (154a) and the second feed unit (154b),
characterized in that

   the shaft (205) of at least one (154b) of the first and second feed units (154a, 154b) is resiliently deformable by flexure in order to bend according to the thickness of the print substrate (127) in the operative condition.

2. A feed device (154a, 154b) according to Claim 1, in which the shaft (205) of the at least one feed unit (154b) has a flexibility of between 1 mm/N and 50 mm/N at a central point along a longitudinal axis (210).

3. A feed device (154a, 154b) according to Claim 2, in which the shaft (205) is made of a polyamide resin.

4. A feed device (154a, 154b) according to any one of Claims 1 to 3, in which the at least one feed unit (154b) further comprises resilient means (240a-240e) for urging the at least one roller (220a-220e) towards the other feed unit (154a).

5. A feed device (154a, 154b) according to Claim 4, in which the at least one roller is constituted by a plurality of rollers (220a-220e) each (220a) comprising a disc (225) with a central hub (230) having a first end and a second end projecting from a first end and from a second end of the disk (225), respectively, and in which the resilient means comprise a plurality of flat springs (240a-240e) each associated with a corresponding roller (220a-220e) and terminating in a fork (250a, 250b) having a first arm (250a) and a second arm (250b) bearing on the first end and on the second end of the hub (230), respectively.

6. A feed device (154a, 154b) according to Claim 5, in which the shaft (205) has a non-circular cross-section and in which each roller (220a) has a central through-hole (235) complementary to the shaft (205) in order to couple the roller (220a) loosely to the shaft (205), the roller (220a) being kept in axial position relative to a frame (103) of the printer (100) by the corresponding spring (240a).

7. A feed device (154a, 154b) according to Claim 6, in which the shaft (205) has a first shoulder (255a) and a second shoulder (255b) disposed between two adjacent rollers (220c, 220d) for keeping the shaft (205) in axial position relative to the rollers (220a-220e).

8. A feed device (154a, 154b) according to any one of Claims 5 to 7, in which the outer springs (240a, 240e) disposed in the vicinity of the ends of the shaft (205) have an elastic constant greater than that of the inner springs (240b-240d) disposed between the outer springs (240a, 240e).

9. A feed device (154a, 154b) according to Claim 8, in which the inner springs (240b-240d) include a single metal plate and the outer springs (240a, 240e) include two superimposed metal plates.

10. A printer (100) comprising at least one roller feed device (154a, 154b) according to any one of Claims 1 to 9.

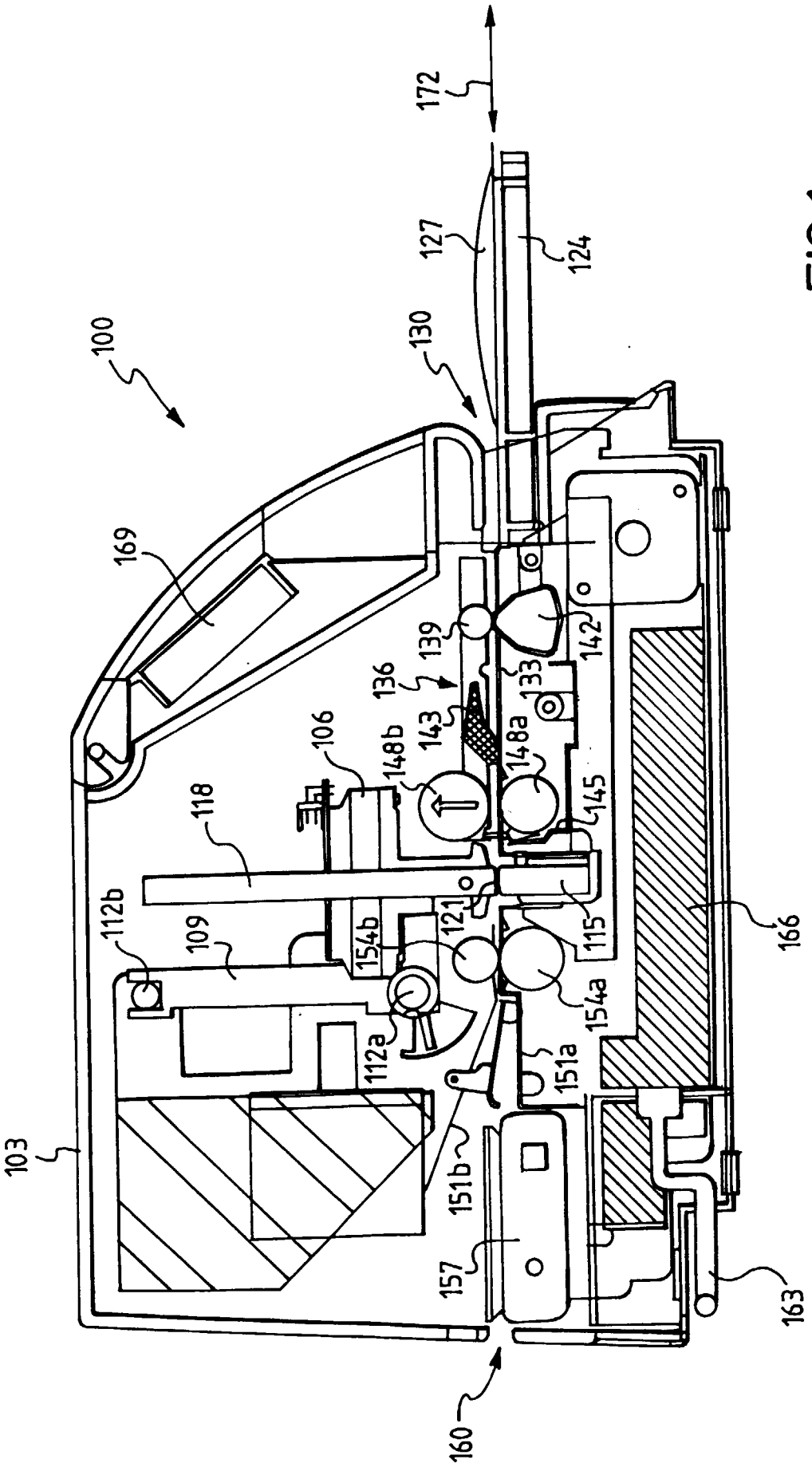
172
127
124
130
100
169
139
142
133
136
143
148a
148b
106
145
118
112b
109
121
154b
115
166
154a
112a
151a
103
151b
157
163
160

FIG.1

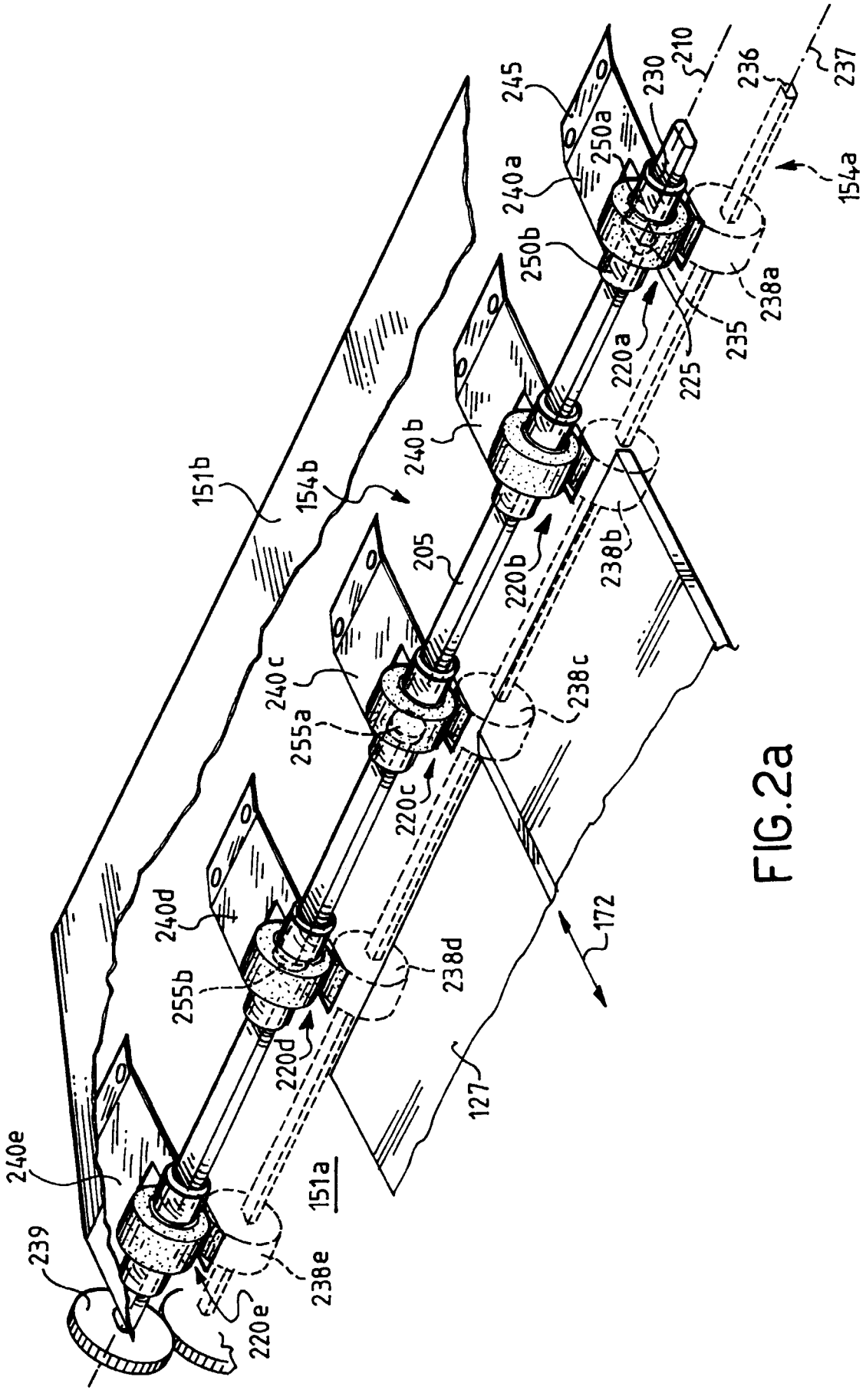
151b
154b
240b
205
240c
255a
220c
238c
220b
238b
240d
255b
238d
220d
172
127
240e
239
238e
151a
220e
240a
250b
250a
245
230
210
236
237
154a
238a
235
225
220a

FIG.2a

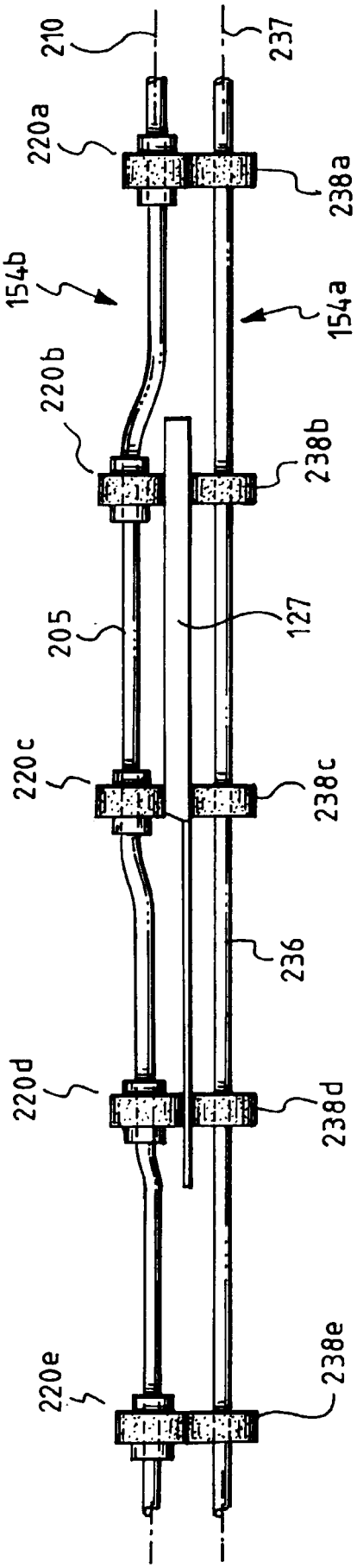
210
237
220a
238a
154b
154a
220b
238b
205
127
220c
238c
236
220d
238d
220e
238e

FIG.2b

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EUROPEAN SEARCH REPORT

Application Number
EP 98 83 0705

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TECHNICAL FIELDS SEARCHED (Int.Cl.6)

B41J
B65H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	27 April 1999	Wehr, W

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