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(72) Inventors:
• **Kumar, Ajay**
Fairport New York 14450 (US)
• **Damji, Dharendra C.**
Webster New York 14580 (US)

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(71) Applicant: **Xerox Corporation**
Rochester, New York 14644 (US)

(74) Representative:
Grünecker, Kinkeldey,
Stockmair & Schwanhäusser
Anwaltssozietät
Maximilianstrasse 58
80538 München (DE)

(54) **Printing cartridge with planar drive train**

(57) A process cartridge for use in a printing machine is provided. The process cartridge includes a housing having a first support surface and a second support surface. The housing further includes a first member rotatably secured to the housing at the first support surface and the second support surface. The housing further includes a second member spaced from the first member and rotatably secured to the housing at

the first support surface and the second support surface. The housing further includes a first gear operably associated with the first member and rotatable therewith. The housing further includes a second gear operably associated with the second member and rotatable therewith. The first gear and the second gear are positioned adjacent the first support surface.

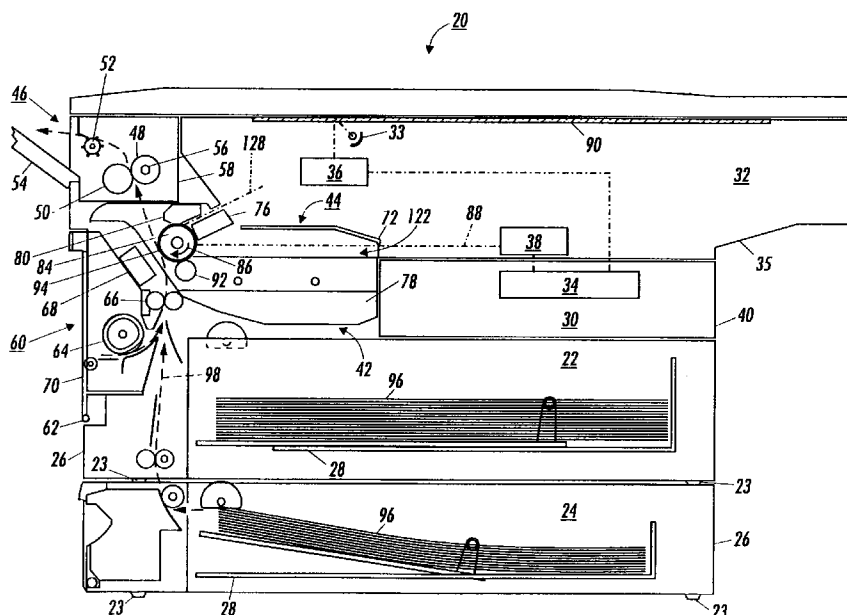


FIG. 1

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Description

BACKGROUND

[0001] This invention relates to electrostatographic reproduction machines, and more particularly to an economical and capacity-extendible all-in-one process cartridge for easy adaptive use in a family of compact electrostatographic reproduction machines having different volume capacities and consumable life cycles. Specifically this invention relates to such a cartridge including a printing cartridge with a planar drive train.

[0002] Generally, the process of electrostatographic reproduction, as practiced in electrostatographic reproduction machines, includes charging a photoconductive member to a substantially uniform potential so as to sensitize the surface thereof. A charged portion of the photoconductive surface is exposed at an exposure station to a light image of an original document to be reproduced. Typically, an original document to be reproduced is placed in registration, either manually or by means of an automatic document handler, on a platen for such exposure.

[0003] Exposing an image of an original document as such at the exposure station, records an electrostatic latent image of the original image onto the photoconductive member. The recorded latent image is subsequently developed using a development apparatus by bringing a charged dry or liquid developer material into contact with the latent image. Two component and single component developer materials are commonly used. A typical two-component dry developer material has magnetic carrier granules with fusible toner particles adhering triboelectrically thereto. A single component dry developer material typically comprising toner particles only can also be used. The toner image formed by such development is subsequently transferred at a transfer station onto a copy sheet fed to such transfer station, and on which the toner particles image is then heated and permanently fused so as to form a "hardcopy" of the original image.

[0004] It is well known to provide a number of the elements and components, of an electrostatographic reproduction machine, in the form of a customer or user replaceable unit (CRU). Typically such units are each formed as a cartridge that can be inserted or removed from the machine frame by a customer or user. Reproduction machines such as copiers and printers ordinarily include consumable materials such as toner, volume limiting components such as a waste toner container, and life cycle limiting components such as a photoreceptor and a cleaning device. Because these elements of the copying machine or printer must be replaced frequently, they are more likely to be incorporated into a replaceable cartridge as above.

[0005] There are therefore various types and sizes of cartridges, varying from single machine element cartridges such as a toner cartridge, to all-in-one elec-

trostatographic toner image forming and transfer process cartridges. The design, particularly of an all-in-one cartridge can be very costly and complicated by a need to optimize the life cycles of different elements, as well as to integrate all the included elements, while not undermining the image quality. This is particularly true for all-in-one process cartridges to be used in a family of compact electrostatographic reproduction machines having different volume capacities and elements having different life cycles.

[0006] There is therefore a need for a quality image producing, economical and capacity-extendible all-in-one process cartridge that is easily adapted for use in various machines in a family of compact electrostatographic reproduction machines having different volume capacities and elements with different life cycles.

[0007] Printing or process cartridges include a number of components which rotate. For example, such components include a photoconductive drum, a developer roll, augers, and agitators which are used to move the marking particles about the toner cartridge. These rotating elements are rotated by motor or motors connected thereto. For simplicity and to reduce cost, at least some of the rotating components are mechanically interconnected by means of a mechanical drive train. The slow rotating speeds of the shafts within a printing cartridge often are accommodated by a transmission consisting of gears.

[0008] The use of gears or a gear train including a number of gears meshing together to rotate the elements of the printing cartridge require that a large expensive rigid housing be used to accommodate the gear forces utilized in the printing machine. The gears are typically positioned at ends of the shafts which the gears are caused to rotate.

[0009] The relative rotational speeds of the paddles, augers, photoreceptors or developer rolls may need to be adjusted to account for varying the speed and improving quality. Often times many gears may need to be changed in order for either the speeding up or slowing down of one particular rotating mechanism.

[0010] To promote recycleability and to keep manufacturing and material costs to a minimum, the gears in a process cartridge typically are made of plastic. These gears wear quickly, have low precision, and as such may be responsible for motion quality problems including deletion and banding errors.

[0011] The gears, particularly if they are helical gears, require axial restraints and, in the case of helical gears, require thrust faces to accommodate the thrust from the gear forces.

[0012] US-A-5,126,800 discloses a process cartridge having an image bearing member having first and second drive transmission portions. A developer carrying member has a third drive transmitting portion which is selectively engagable with the first and second drive transmission portions.

[0013] US-A-5,602,623 discloses a process cartridge

including a first gear and a second gear adjacent to and outside the first gear. The first gear and the second gear are integrally formed. The gears provide a smoothly rotating image bearing member.

[0014] US-A-5,634,178 discloses a gear unit usable with an image forming apparatus. The gear unit includes an image bearing drive gear, a member drive gear, a feed drive gear, and a supporting member for supporting the image bearing drive gear, the member drive gear, and the feed drive gear.

SUMMARY OF THE INVENTION

[0015] In accordance with one aspect of the present invention, there is provided a process cartridge for use in a printing machine. The process cartridge includes a housing having a first support surface and a second support surface. The housing further includes a first member rotatably secured to the housing at the first support surface and the second support surface. The housing further includes a second member spaced from the first member and rotatably secured to the housing at the first support surface and the second support surface. The housing further includes a first gear operably associated with the first member and rotatable therewith. The housing further includes a second gear operably associated with the second member and rotatable therewith. The first gear and the second gear are positioned adjacent the first support surface.

[0016] In accordance with another aspect of the present invention, there is provided an electrophotographic printing machine of the type including a process cartridge. The process cartridge includes a housing having a first support surface and a second support surface. The housing further includes a first member rotatably secured to the housing at the first support surface and the second support surface. The housing further includes a second member spaced from the first member and rotatably secured to the housing at the first support surface and the second support surface. The housing further includes a first gear operably associated with the first member and rotatable therewith. The housing further includes a second gear operably associated with the second member and rotatable therewith. The first gear and the second gear are positioned adjacent the first support surface.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] In the detailed description of the invention presented below, reference is made to the drawings, in which:

FIG. 1 is a front vertical illustration of an exemplary compact electrostatographic reproduction machine comprising separately framed mutually aligning modules in accordance with the present invention; FIG. 2 is a top perspective view of the module hous-

ing of the CRU or process cartridge module of the machine of FIG. 1;

FIG. 3 is a bottom perspective view of the developer subassembly of the CRU or process cartridge module of the machine of FIG. 1 with the bottom of the developer housing unattached;

FIG. 4 is an open bottom perspective view of the CRU or process cartridge module of the machine of FIG. 1;

FIG. 5 is an exploded view of the various sub-assemblies of the CRU or process cartridge module of the machine of FIG. 1;

FIG. 6 is a vertical section (front-to-back) of the CRU or process cartridge module of the machine of FIG. 1;

FIG. 7 is a plan view of a gear train for use in the CRU or process cartridge module of FIG. 2 utilizing the planar gear train according to the present invention;

FIG. 8 is a cross sectional view of FIG. 7 along the line 8-8 in the direction of the arrows;

FIG. 9 is a cross sectional view of the waste toner auger gear with integral axial constraint of the FIG. 7 gear train; and

FIG. 10 is a perspective view of the machine of FIG. 1.

DETAILED DESCRIPTION OF THE INVENTION

[0018] While the present invention will be described in connection with a preferred embodiment thereof, it will be understood that it is not intended to limit the invention to that embodiment. On the contrary, it is intended to cover all alternatives, modifications, and equivalents as may be included within the spirit and scope of the invention as defined by the appended claims.

[0019] Referring now to FIG. 1 and 9, there is illustrated a frameless exemplary compact electrostatographic reproduction machine 20 comprising separately framed mutually aligning modules according to the present invention. The compact machine 20 is frameless, meaning that it does not have a separate machine frame to which electrostatographic process subsystems are assembled, aligned to the frame, and then aligned relative to one another as is typically the case in conventional machines. Instead, the architecture of the compact machine 20 is comprised of a number of individually framed, and mutually aligning machine modules that variously include pre-aligned electrostatographic active process subsystems.

[0020] As shown, the frameless machine 20 comprises at least a framed copy sheet input module (CIM) 22. Preferably, the machine 20 comprises a pair of copy sheet input modules, a main or primary module the CIM 22, and an auxiliary module the (ACIM) 24, each of which has a set of legs 23 that can support the machine 20 on a surface, therefore suitably enabling each CIM 22, 24 to form a base of the machine 20. As also shown,

each copy sheet input module (CIM, ACIM) includes a module frame 26 and a copy sheet stacking and lifting cassette tray assembly 28 that is slidably movable in and out relative to the module frame 26. When as preferred here, the machine 20 includes two copy sheet input modules, the very base module is considered the auxiliary module (the ACIM), and the top module which mounts and mutually aligns against the base module is considered the primary module (the CIM).

[0021] The machine 20 next comprises a framed electronic control and power supply (ECS/PS) module 30, that as shown mounts onto, and is mutually aligned against the CIM 22 (which preferably is the top or only copy sheet input module). A framed latent image forming imager module 32 then mounts over and is mutually aligned against the ECS/PS module. The ECS/PS module 30 includes all controls and power supplies (not shown) for all the modules and processes of the machine 20. It also includes an image processing pipeline unit (IPP) 34 for managing and processing raw digitized images from a Raster Input Scanner (RIS) 36, and generating processed digitized images for a Raster Output Scanner (ROS) 38. The ECS/PS module 30 also includes harnessless interconnect boards and inter-module connectors (not shown), that provide all power and logic paths to the rest of the machine modules. An interconnect board (PWB) (not shown) connects the ECS controller and power supply boards (not shown) to the inter-module connectors, as well as locates all of the connectors to the other modules in such a manner that their mating connectors would automatically plug into the ECS/PS module during the final assembly of the machine 20. Importantly, the ECS/PS module 30 includes a module frame 40 to which the active components of the module as above are mounted, and which forms a covered portion of the machine 20, as well as locates, mutually aligns, and mounts to adjacent framed modules, such as the CIM 22 and the imager module 32.

[0022] The framed copy sheet input modules 22, 24, the ECS/PS module 30, and the imager module 32, as mounted above, define a cavity 42. The machine 20 importantly includes a customer replaceable, all-in-one CRU or process cartridge module 44 that is insertably and removably mounted within the cavity 42, and in which it is mutually aligned with, and operatively connected to, the framed CIM, ECS/PS and imager modules 22, 30, 32.

[0023] As further shown, the machine 20 includes a framed fuser module 46, that is mounted above the process cartridge module 44, as well as adjacent an end of the imager module 32. The fuser module 46 comprises a pair of fuser rolls 48, 50, and at least an exit roll 52 for moving an image carrying sheet through, and out of, the fuser module 46 into an output or exit tray 54. The fuser module also includes a heater lamp 56, temperature sensing means (not shown), paper path handling baffles(not shown), and a module frame 58 to

which the active components of the module, as above, are mounted, and which forms a covered portion of the machine 20, as well as locates, mutually aligns, and mounts to adjacent framed modules, such as the imager module 32 and the process cartridge module 44.

[0024] The machine then includes an active component framed door module 60 that is mounted pivotably at pivot point 62 to an end of the CIM 22. The door module 60 as mounted, is pivotable from a substantially closed vertical position into an open near-horizontal position in order to provide access to the process cartridge module 44, as well as for jam clearance of jammed sheets being fed from the CIM 22. The Door module 60 comprises active components including a bypass feeder assembly 64, sheet registration rolls 66, toner image transfer and detack devices 68, and the fused image output or exit tray 54. The door module 60 also includes drive coupling components and electrical connectors (not shown), and importantly, a module frame 70 to which the active components of the module as above are mounted, and which forms a covered portion of the machine 20, as well as, locates, mutually aligns, and mounts to adjacent framed modules, such as the CIM 22, the process cartridge module 44, and the fuser module 46.

[0025] More specifically, the machine 20 is a desktop digital copier, and each of the modules 22, 24, 30, 32, 44, 48, 60, is a high level assembly comprising a self-containing frame and active electrostatographic process components specified for sourcing, and enabled as a complete and shippable product. It is believed that some existing digital and light lens reproduction machines may contain selective electrostatographic modules that are partitioned for mounting to a machine frame, and in such a manner that they could be designed and manufactured by a supplier. However, there are no known such machines that have no separate machine frame but are comprised of framed modules that are each designed and supplied as self-standing, specable (i.e. separately specified with interface inputs and outputs), testable, and shippable module units, and that are specifically crafted and partitioned for enabling all of the critical electrostatographic functions upon a simple assembly. A unique advantage of the machine 20 of the present invention as such is that its self-standing, specable, testable, and shippable module units specifically allow for high level sourcing to a small set of module-specific skilled production suppliers. Such high level sourcing greatly optimizes the quality, the total cost, and the time of delivering of the final product, the machine 20.

[0026] Referring now to FIGS. 1-6, the CRU or process cartridge module 44 generally comprises a module housing subassembly 72, a photoreceptor subassembly 74, a charging subassembly 76, a developer subassembly 78 including a source of fresh developer material, a cleaning subassembly 80 for removing residual toner as waste toner from a surface of the photoreceptor, and a

waste toner sump subassembly 82 for storing waste toner. The module housing subassembly 72 of the CRU or process cartridge module 44 importantly provides and includes supporting, locating and aligning structures, as well as driving components for the process cartridge module 44.

[0027] Still referring to FIG. 1, operation of an imaging cycle of the machine 20 using the all-in-one process cartridge module 44 generally, can be briefly described as follows. Initially, a photoreceptor in the form of a photoconductive drum 84 of the customer replaceable unit (CRU) or process cartridge module 44, rotating in the direction of the arrow 86, is charged by the charging subassembly 76. The charged portion of the drum is then transported to an imaging/exposing light 88 from the ROS 38 which forms a latent image on the drum 84, corresponding to an image of a document positioned on a platen 90, via the imager module 32. It will also be understood that the imager module 32 can easily be changed from a digital scanning module to a light lens imaging module.

[0028] The portion of the drum 84 bearing a latent image is then rotated to the developer subassembly 78 where the latent image is developed with developer material such as with charged single component magnetic toner using a magnetic developer roller 92 of the process cartridge module 44. The developed image on the drum 84 is then rotated to a near vertical transfer point 94 where the toner image is transferred to a copy sheet substrate 96 fed from the CIM 22 or ACIM 22 along a copy sheet or substrate path 98. In this case, the detach device 68 of the door module 60 is provided for charging the back of the copy sheet substrate (not shown) at the transfer point 94, in order to attract the charged toner image from the photoconductive drum 84 onto the copy sheet substrate.

[0029] The copy sheet substrate with the transferred toner image thereon, is then directed to the fuser module 46, where the heated fuser roll 48 and pressure roll 50 rotatably cooperate to heat, fuse and fix the toner image onto the copy sheet substrate. The copy sheet substrate then, as is well known, may be selectively transported to the output tray 54 or to another post-fusing operation.

[0030] The portion of the drum 84 from which the developed toner image was transferred is then advanced to the cleaning subassembly 80 where residual toner and residual charge on the drum 84 are removed therefrom. The imaging cycle of the machine 20 using the drum 84 can then be repeated for forming and transferring another toner image as the cleaned portion again comes under the charging subassembly 76.

[0031] The detailed and specific advantageous aspects of the structure and operation of the all-in-one CRU or process cartridge module 44, will now be described with particular reference to FIGS. 1 to 6. As shown, the all-in-one CRU or process cartridge module

44, generally includes six subassemblies comprising the module housing subassembly 72 (FIG. 2); the cleaning subassembly 80; the photoreceptor subassembly 74; the charging subassembly 76; the developer subassembly 78 (FIG. 3); and the waste toner sump subassembly 82. Generally, the function of the all-in-one CRU or process cartridge module 44 in the machine 20 is to electrostatically form a latent image, develop such latent image into a toner image through toner development, and transfer the toner image unfused onto a printing medium, such as a sheet of paper. The CRU or process cartridge module is left-side accessible to an operator facing the CIM 22 by opening the door module 60 (FIG. 1). Once the door module is opened, an operator or customer can remove or insert the CRU or process cartridge module 44 with one hand.

[0032] Referring now to FIGS. 1-6, the module housing subassembly 72 is illustrated (FIG. 2). As shown, it comprises a generally rectangular and inverted trough shaped module housing 100 having a first side wall 102, a second and opposite side wall 104, a top wall 106 including a substantially horizontal portion 108 and a nearly vertical portion 110 defining a raised rear end 112 (rear as considered relative to the process cartridge 44 being inserted into the cavity 42). There is no rear wall, thus resulting in an open rear end 114 for mounting the photoreceptor subassembly 74. The trough shaped module housing also includes a front end wall 116 that connects at an angle to the top wall 106. The trough shaped module housing 100 of course, has no bottom wall, and hence as inverted, it defines a trough region 118 that is wide open for assembling the developer subassembly 78 (FIG. 3). The top wall 106 and the front end wall 116 each include a first cutout 120 formed through their adjoining corner for partially defining a first light path 122 (FIG. 1) for the exposure light 88 from the ROS 38 of the imager module 32. The top wall 106 also includes a second cutout 124 formed thereinto at the adjoining angle between the horizontal 108 and near vertical 110 portions thereof for mounting the charging subassembly 76 (FIG. 5), and for partially defining a second light path 126 (FIGS. 1 and 6) for an erase light 128 being focused into the photoreceptor area at the raised rear end 112 of the module housing 100.

[0033] Importantly, the module housing 100 includes two top wall cross-sectional surfaces 130, 132 defining the second cutout 124, and one 130, of these cross-sectional wall surfaces, has a desired angle 134 (relative to the photoreceptor surface) for mounting and setting a cleaning blade 138 (FIG. 6) of the cleaning subassembly 80. Attachment members 140, 142 are provided at the raised rear end 112 and extending from the first and second side walls 102, 104 respectively, for attaching a module handle 144 to the module housing 100.

[0034] As pointed out above, the module housing 100 is the main structure of the all-in-one CRU or process cartridge module 44, and importantly supports all other

subassemblies (cleaning subassembly 80, charging subassembly 76, developer subassembly 78, and sump subassembly 82) of the all-in-one process cartridge module 44. As such, it is designed for withstanding stresses due to various dynamic forces of the subassemblies, for example, for providing a required reaction force to the developer subassembly 78. Because it is located just about 3 mm below the fuser module 46, it is therefore made of a plastic material suitable for withstanding relatively high heat generated from the fuser module. Mounts (not shown) to the developer subassembly within the trough portion of the module housing subassembly are located such that the top wall 106 of the module housing defines a desired spacing comprising the first light path 122 between it and the top 146 of the developer subassembly. Similarly, the raised rear end 112 of the top wall 106 of the module housing is also such as to define a desired spacing between the charging subassembly 76 and the photoreceptor or drum 84, when both are mounted to the raised rear end 112 of the module housing 100. Additionally, the module housing 100 provides rigidity and support to the entire process cartridge module 44, and upon assembly mutually self-aligns the CRU or process cartridge module 44 relative to abutting modules such as the CIM 22, and ECS/PS module 30.

[0035] Referring in particular to FIG. 2, the first side wall 102 includes electrical connectors 148, 150 for supplying power from the ECS/PS module 30 (FIG. 1) via the sump subassembly 82 to the charging subassembly 76. It also includes an electrical connector 152 for supplying an electrical bias to the developer subassembly 78, as well as an alignment member 154 for aligning the detach device 68 (FIG. 1) to the photoreceptor. As also shown, the first side wall 102 further includes an apertured retainer device 156 for receiving an electrical grounding pin 160 for the photoreceptor 84. Importantly, the first side wall 102 further includes mounting members 162, 164, 166 for mounting the sump subassembly 82 to the module housing 100, and an opening for mounting an auger 170 of the cleaning subassembly 80 (FIGS. 1 and 5). The opening 168 also passes waste toner received from the photoreceptor 84 in the raised rear end 112, into the sump assembly 82, when mounted as above.

[0036] Referring now to FIG. 3, the developer subassembly 78 of the process cartridge module 44 is illustrated with an expandable bottom member 172 unattached in order to reveal the inside of the developer subassembly. As shown, the developer subassembly 78 comprises a generally rectangular developer housing 174 having the bottom member 172, the top 146, a first side 176, a second and opposite side 178, a front end 180 (relative to cartridge insertion), and a rear end 182. The developer housing 174 is for containing developer material, such as, single component magnetic toner (not shown), and it additionally houses the magnetic developer roll 92 (FIG. 1), a development bias applica-

tion device 184, and a pair of developer material or toner agitators 186, 188.

[0037] As shown in FIG. 4, the developer subassembly 78 is mounted to the module housing 100, and inside the trough region 118. With the bottom member 172 of the developer housing removed (for illustration purposes only), the agitators 186, 188 can clearly be seen. Also shown in FIG. 4 are the photoreceptor or drum 84 mounted within the raised rear end 112 of the module housing 100, as well as, the module handle 144 attached to the side walls 102, 104 at the raised rear end 112. The whole sump subassembly 82 is further shown with an outside surface 190 of its inside wall 192, mounted to the first side wall 102 of the module housing 100. The outside surface 194 of the outside wall 196 of the sump assembly is also clearly visible. The inside wall 192 and outside wall 196 partially define the sump cavity (not shown) for containing received waste toner, as above.

[0038] Referring now to FIG. 5, there is presented an exploded perspective view of the various subassemblies, as above, of the CRU or process cartridge module 44. As shown, the module handle 144 is attachable to mounting members 140, 142 at the raised rear end 112 of the module housing 100, and the sump subassembly 82 is mountable to the first side wall 102 of the cartridge housing. The developer subassembly 78 is mounted within the trough region 118 of the module housing 100, and is partially visible through the first cutout 120. Advantageously, the developer subassembly fits into the trough region 118 such that the top 146 (FIG. 3) of the developer subassembly and the inside of the top wall 106 of the module housing define the first light path 122 for the exposure light 88 from the ROS 38 (FIG. 1). As also shown, the charging subassembly 76 is mountable, at the second cutout 124, to the module housing 100, and includes a slit 198, through the charging subassembly, that defines part of the second light path 126 for the erase light 128 to pass to the photoreceptor 84.

[0039] Referring next to FIG. 6, a vertical (rear-to-back) section of the CRU or process cartridge module 44 as viewed along the plane 6-6 of FIG. 5 is illustrated. As shown, the developer subassembly 78 is mounted within the trough region 118 of the module housing subassembly 72 as defined in part by the front end wall 116, the second side wall 104, and the top wall 106 of the module housing subassembly. The module handle 144 as attached to mounting members 140, 142, (only one of which is visible), forms a portion of the sheet or paper path 98 of the machine 20 (FIG. 1) by being spaced a distance 200 from photoreceptor 84 in the raised rear end 112 of the module housing 100. The photoreceptor or drum 84 is mounted to the side walls 102, 104, (only one of which is visible), and as shown is located within the raised rear end 112 and is rotatable in the direction of the arrow 86. The charging subassembly 76 is mounted within the second cutout 124 in the top wall 106 and includes the slit 198 defining part of the second

light path 126 for erase light 128 to pass to the photoreceptor 84. Upstream of the charging subassembly 76, the cleaning subassembly 80, including the cleaning blade 138 and the waste toner removing auger 170, is mounted within the raised rear end 112, and into cleaning contact with the photoreceptor 84. As further shown, the top wall 106 of the module housing 100 is spaced from the top 146 of the developer subassembly 78, thus defining the part of first light path 122 for the exposure light 88 from the ROS 38 (FIG. 1). The first light path 122 is located so as to be incident onto the photoreceptor at a point downstream of the charging subassembly 76.

[0040] The front 180, top 146, and bottom member 172 of the developer subassembly define a chamber 202, having an opening 204, for containing developer material (not shown). The first and second agitators 186, 188 are shown within the chamber 202 for mixing and moving developer material towards the opening 204. The developer material basing device 184 and a charge trim and metering blade 206 are mounted at the opening 204. As also shown, the magnetic developer roll 92 is mounted at the opening 204 for receiving charged and metered developer material from such opening, and for transporting such developer material into a development relationship with the photoreceptor 84.

[0041] According to the present invention and referring now to FIG. 4, the process cartridge 72, including planar drive train 302 is shown. The process cartridge 72 includes a process cartridge housing 304 about which development cartridge 78 rotates. The process cartridge 72 and the development cartridge 78 support rotating elements that have an axis of rotation which extends in the direction of arrows 308 and 310.

[0042] As shown in FIG. 4, and as claimed in the invention, the planar drive train 302 is positioned in a plane between process cartridge end wall 312 and developer cartridge end wall 314. The gears which rotate the members shown in the process cartridge 72 thus form a planar drive train 302 between the end walls 312 and 314.

[0043] As shown in FIG. 4, the first member 188 in the form of a first agitator or paddle is rotatably secured to the developer cartridge 78. A first paddle gear 320 is connected to the first paddle 188 and is positioned outside end wall 314 of the developer cartridge 78. Similarly, a second member in the form of second paddle 186 is likewise rotatably mounted to the developer cartridge 78 and is operably connected to a second paddle gear 324 located external to the end wall 314 of the developer cartridge 78. The first idler gear 326 is positioned between the first paddle gear 320 and the second paddle gear 324 and is likewise positioned outside end wall 314 of the developer cartridge 78.

[0044] Developer roll 92 is likewise mounted to the developer cartridge 78.

[0045] On the other hand, photoconductive drum 84

and waste toner auger 334 are rotatably mounted to the process cartridge 72.

[0046] The development roll 92 is rotated by development roll gear 336 mounted on developer roll 92 and extending outwardly from end wall 314 of the developer cartridge 78. Second idler gear 340 is connected to the second paddle gear 324. Third idler gear 342 is connected to the second idler gear 340. Developer roll gear 336 is connected to the third idler gear 342. The second idler gear 340 and the third idler gear 342 are mounted to gear housing 308 which is mounted to end wall 314 of the developer cartridge 78.

[0047] Photoconductive drum gear 344 is mounted to end wall 312 of the process cartridge 72 and mates with developer roll gear 336. Waste toner auger gear 346 is likewise mounted to end wall 312 of process cartridge 72. Waste tone auger gear 346 mates with photoconductive drum gear 344.

[0048] Referring now to FIG. 7, the gears which comprise the planar drive train 302 are shown in greater detail. The first agitator gear 320, the first idler gear 326, and the second agitator gear 324 are mounted to the developer cartridge 78. The gears 320, 324, and 326 are as shown in FIG. 7 spur gears. The first and second agitator gears 320 and 324 have approximately the same size and rotate with approximately the same angular velocity. The idler gear 326 serves to permit the first and second agitator gears 320 and 324 to rotate in the same direction to advance the marking particles towards the developer roll 330 (see FIG. 4).

[0049] The second idler gear 340 and the third idler gear 342 are mounted to gear housing 308 which is mounted to the developer cartridge 78. The second idler gear 340 includes a first small set of teeth 350 and a second large set of teeth 352. As shown in FIG. 7, the first set of teeth 350 and second set of teeth 352 on the second idler gear 340 are spur gears.

[0050] The third idler gear 342 includes a first small set of teeth, which as shown in FIG. 7 are spur teeth. The third idler gear 342 also includes a second large set of teeth 356 which as shown in FIG. 7 include helical teeth. The second set of teeth 356 of the third idler 342 mesh with developer roll gear 336. Developer roll 336 is thus likewise a helical gear. Developer roll gear 336 is mounted to process cartridge 72.

[0051] The photoconductive drum gear 344 is mounted to the process cartridge 72 and meshes with developer roll gear 336. The waste toner auger gear 346 is mounted to process cartridge 72 and meshes with photoreceptor drum gear 344.

[0052] To reduce wear on gear teeth, applicants have found that providing gears with mating teeth made of different materials reduces the wear on the gear teeth and prolongs the life of the gears. For example, as shown in FIG. 7, the first agitator gear 320, the second agitator gear 324, the third idler gear 342, and the photoreceptor drum gear 344 may all be made of a first material, for example acetyl.

[0053] Conversely, the first idler gear 326, the second idler gear 340, the developer roll gear 336, and the waste toner auger gear 346 may be made of a second different material from what previously mentioned, for example, of a material different than acetyl, for example, polycarbonate. Other suitable materials include compounds of Delrin™ a trademark of DuPont (UK) Ltd, for example Delrin™ 8903.

[0054] Referring now to FIG. 8, the first agitator gear 320, the first idler gear of 326, and the second agitator gear 324 are shown in greater detail. As shown in FIG. 8, the first idler gear preferably includes a outer collar or lip 360 which extends past the first agitator gear 320 and past the second agitator gear 324. The lip 360 provides an axial restraint for the gears 320 and 324. Thus, the agitator gears 320 and 324 do not require a snap ring or other device to maintain their axial position. The first idler gear, however, includes a snap ring 362 which is positioned between the first idler gear 326 and the first idler gear shaft 364. The use of the shoulder 360 may eliminate the need for retaining rings on the mating gears 320 and 324.

[0055] Referring now to FIG. 9, waste toner auger gear 346 is shown in greater detail. The waste toner auger gear 346 is preferably made from an integral piece of plastic, for example, acetyl or polycarbonate. Other suitable materials include compounds of Delrin™ a trademark of Dupont (UK) Ltd, for example Delrin™ 8903. The waste toner auger gear 346 includes a flexible inner arm 366 which extends axially adjacent the bore 368 of the gear 346. The arm 366 includes a protrusion 370 which extends inwardly from the bore 368 of the gear 346. The protrusion 370 of the gear 346 matingly fits with notch 372 formed on shaft 374 of auger 334. The protrusion 370 mates with the notch 372 to provide axial restraint for the gear 346. The use of the notch 372 and the protrusion 370 eliminates the need for a retaining ring or snap ring to maintain the position of the gear.

[0056] Referring now to FIG. 10, a printing machine 20 which may utilize the planar drive train 302 of the present invention as shown.

[0057] By providing the planar drive train, only one end of print cartridge or developer cartridge housing requires reinforcement and strength to accommodate gear forces. Thus, cheaper, less expensive and lighter weight housings may be used for the process cartridge and for the developer cartridge.

[0058] By providing a process cartridge and developer cartridge with a planar drive train, a minimum of 2 gears may be required to alter the speed of the gear train. In other words, by having all gears on a common plane, the number of gears required to alter speed is minimized.

[0059] By providing a process cartridge or developer cartridge with a drive train with mating gear teeth made from different material, wear of the gear teeth is reduced and life of the gears are lengthened, improving the qual-

ity of prints from the printing machine.

[0060] By providing a process cartridge and a developer cartridge with molded axial retaining snaps, the need for snap rings and other axial retainers may be eliminated.

[0061] By providing a process cartridge or developer cartridge with gears having flanges which extend past mating gear teeth, gears may be provided which do not require retaining rings or other features to maintain their axial position.

Claims

1. A process cartridge for use in a printing machine comprising, said process cartridge comprising:

a housing having a first support surface and a second support surface;
a first member rotatably secured to said housing at said first support surface and said second support surface;
a second member spaced from said first member and rotatably secured to said housing at said first support surface and said second support surface;
a first gear operably associated with said first member and rotatable therewith; and
a second gear operably associated with said second member and rotatable therewith, said first gear and said second gear positioned adjacent said first support surface.

2. A process cartridge according to claim 1 wherein said first gear comprises a first material and wherein said second gear comprises a second material, said first material being different from said second material.

3. A process cartridge according to claim 1: wherein said first material comprises acetyl; and wherein said second material comprises nylon.

4. A process cartridge according to claim 1, wherein said second gear comprises:

a tooth portion for meshing with at least one of said first gear and said second gear; and
a shoulder portion extending outwardly from the tooth portion, said shoulder portion cooperating with at least one of said first gear and said second gear for restraining the axial motion of at least one of said first gear and said second gear.

5. A process cartridge according to claim 1, wherein said housing comprises a plastic.

6. A process cartridge according to claim 1, wherein

at least one of said first gear, said second gear and said housing comprises a pliable member for restraining the axial motion of at least one of said first gear and said second gear.

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7. A process cartridge according to claim 1, wherein at least one of said first member and said second member comprises a roll for advancing marking particles toward a latent image to form a developed image.

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8. A process cartridge according to claim 1, wherein at least one of said first member and said second member comprises a photoconductive member for forming a latent image thereon.

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9. A process cartridge according to claim 1, wherein at least one of said first member and said second member comprises an agitator for mixing the marking particles stored within the process cartridge.

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10. An electrophotographic printing machine comprising a process cartridge according to any of claims 1 to 8.

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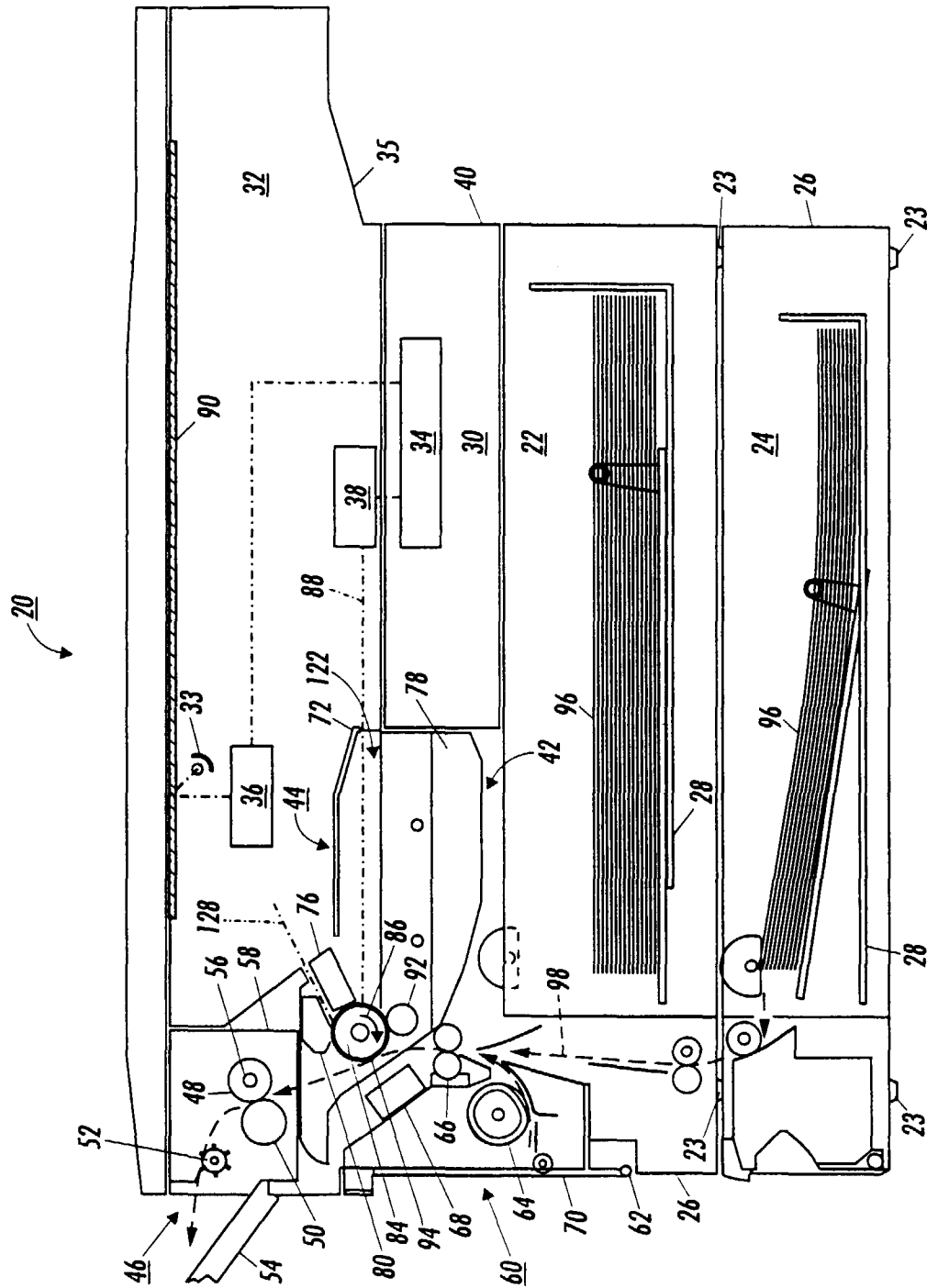


FIG. 1

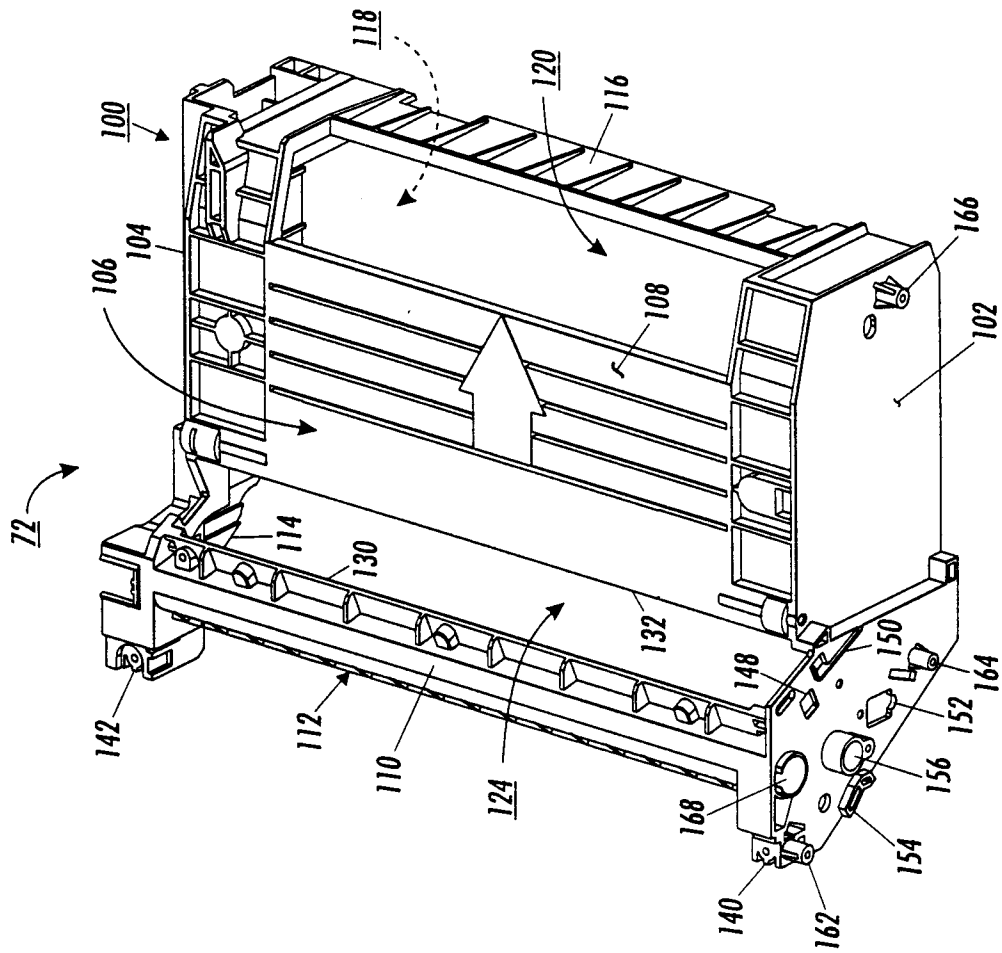


FIG. 2

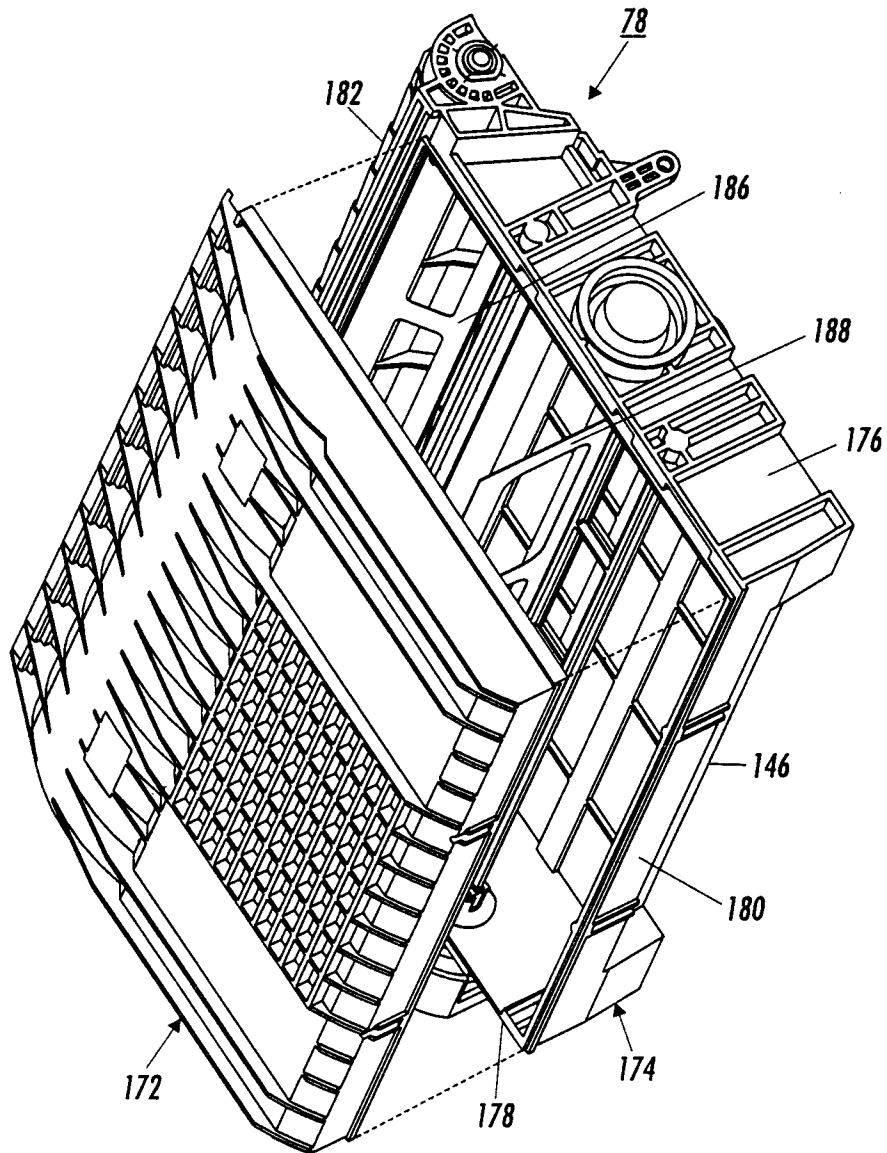
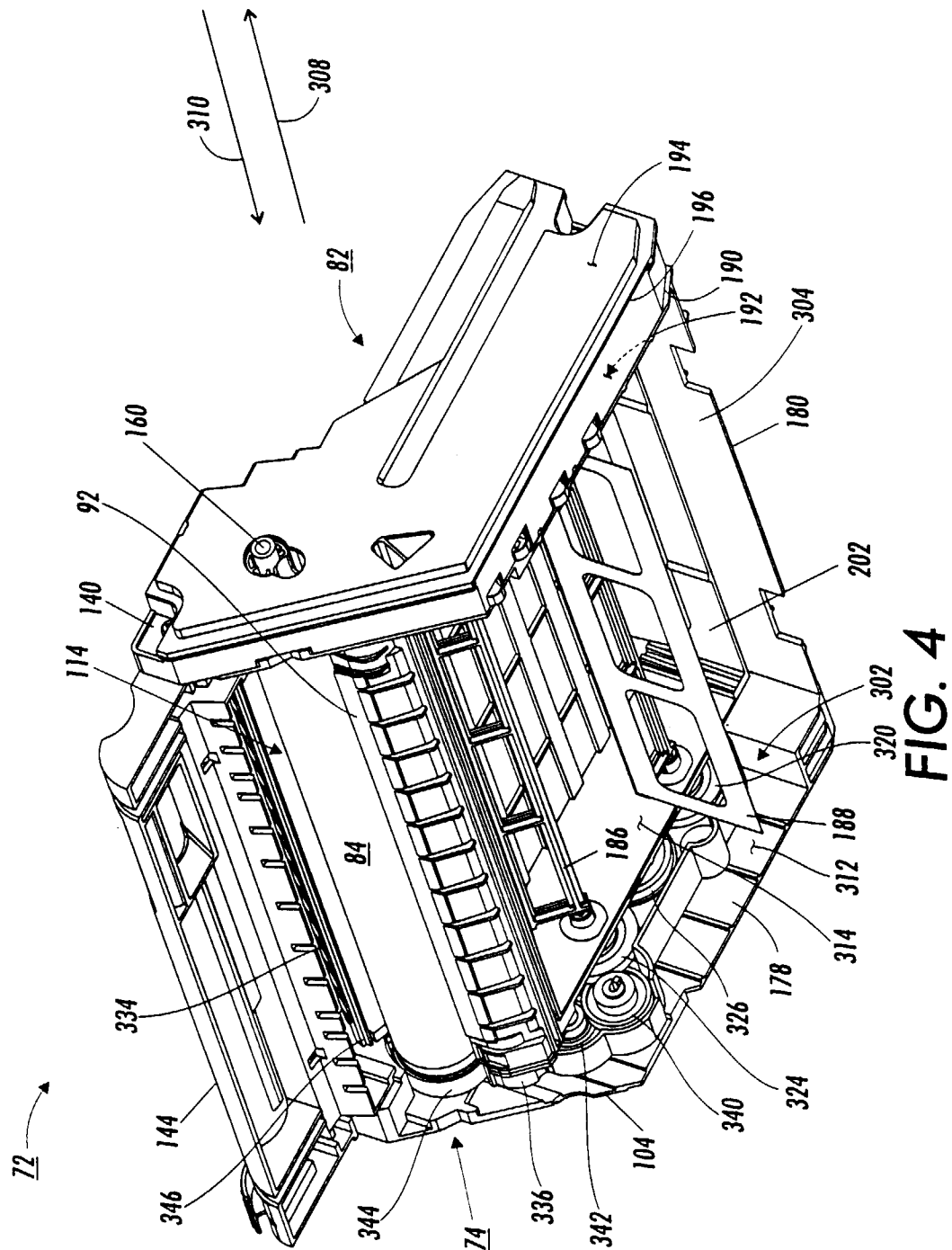


FIG. 3



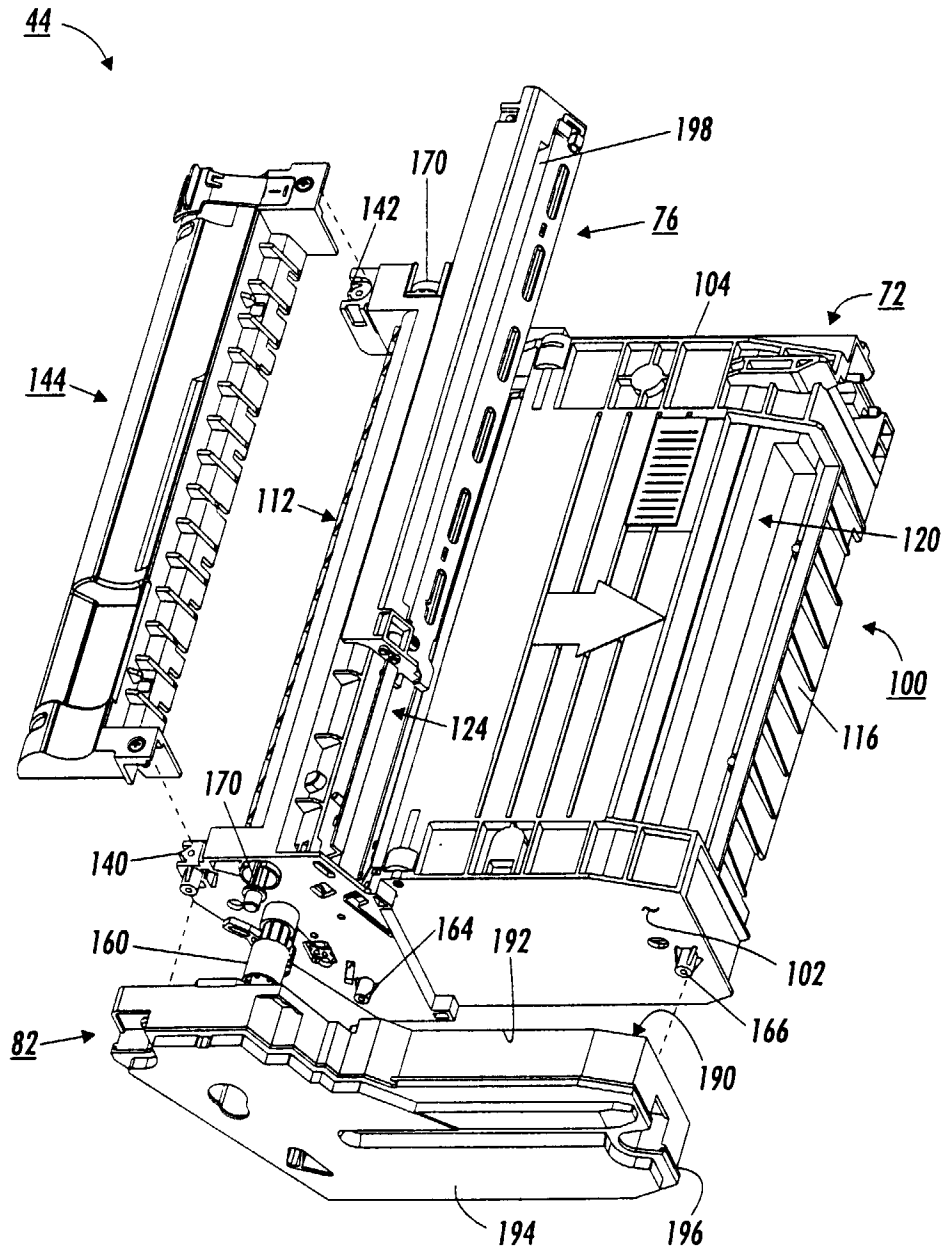


FIG. 5

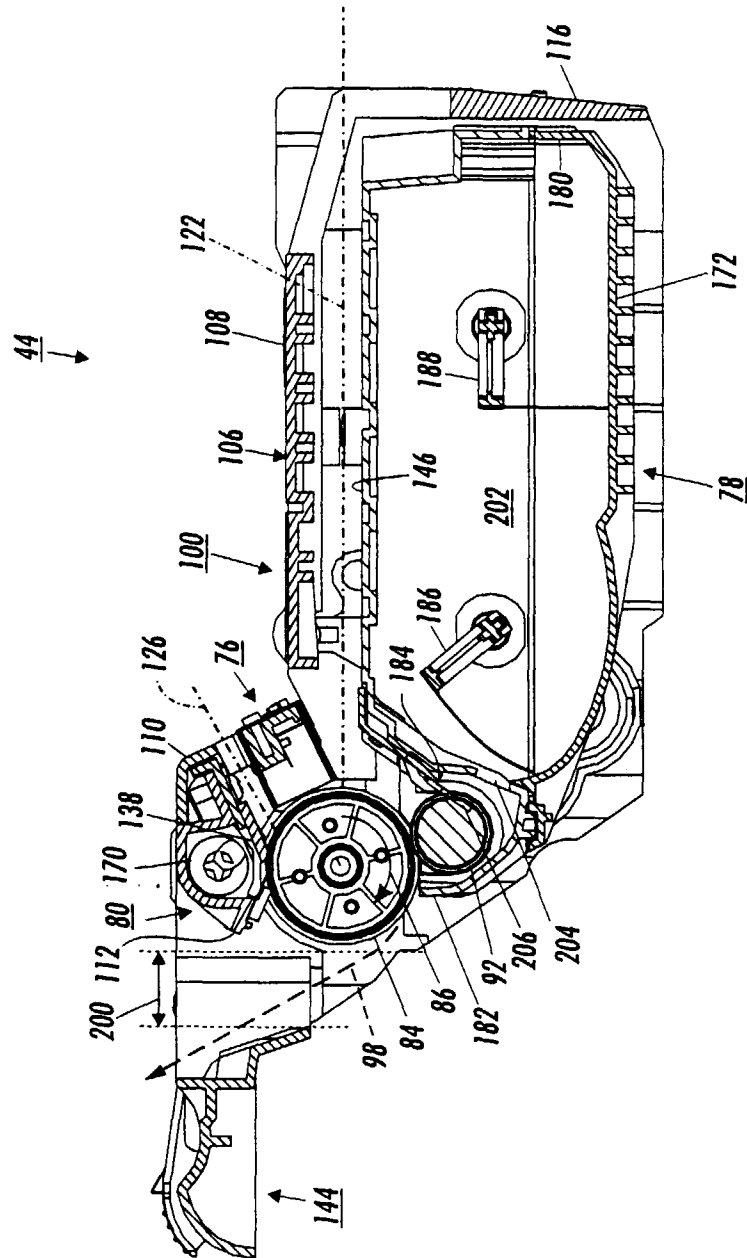


FIG. 6

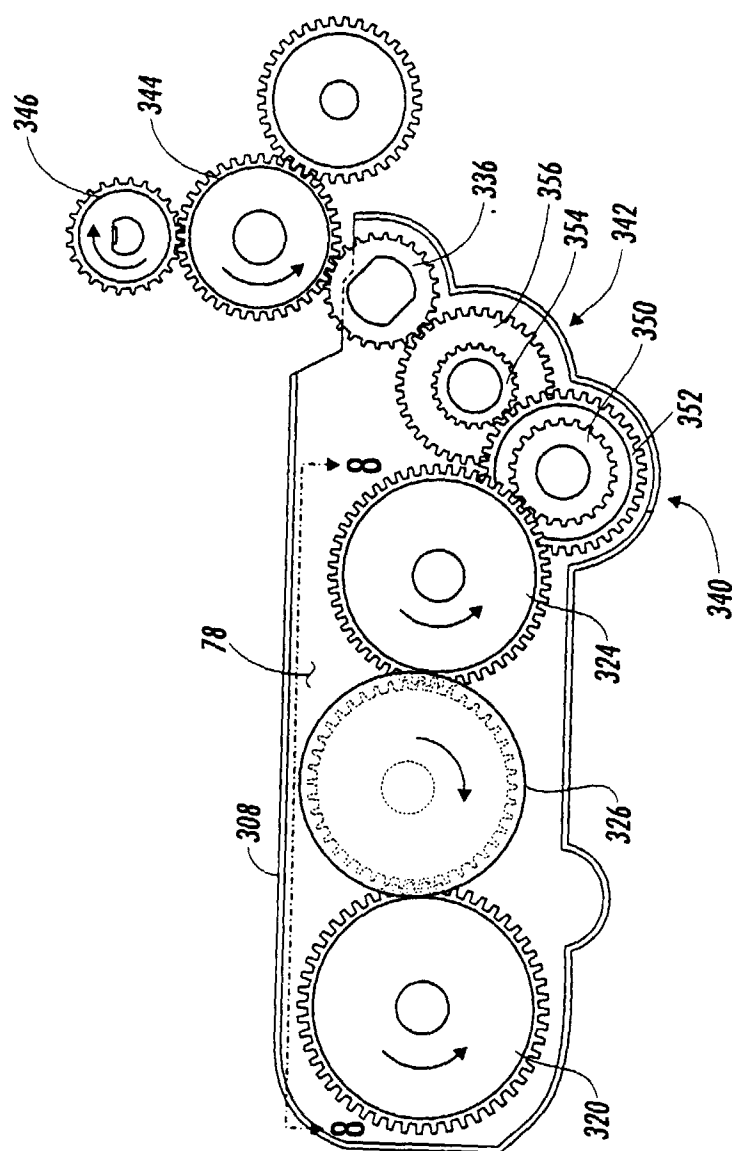


FIG. 7

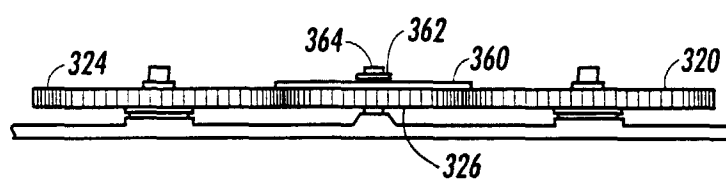


FIG. 8

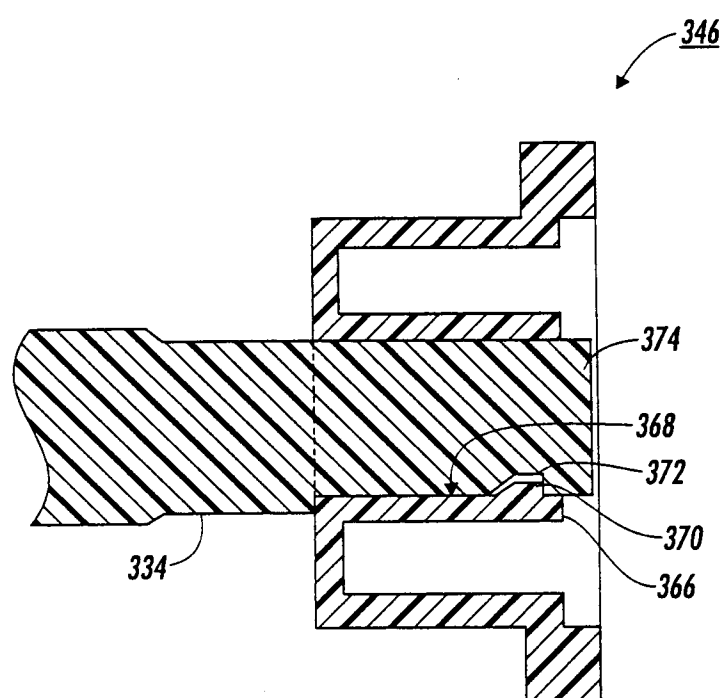


FIG. 9

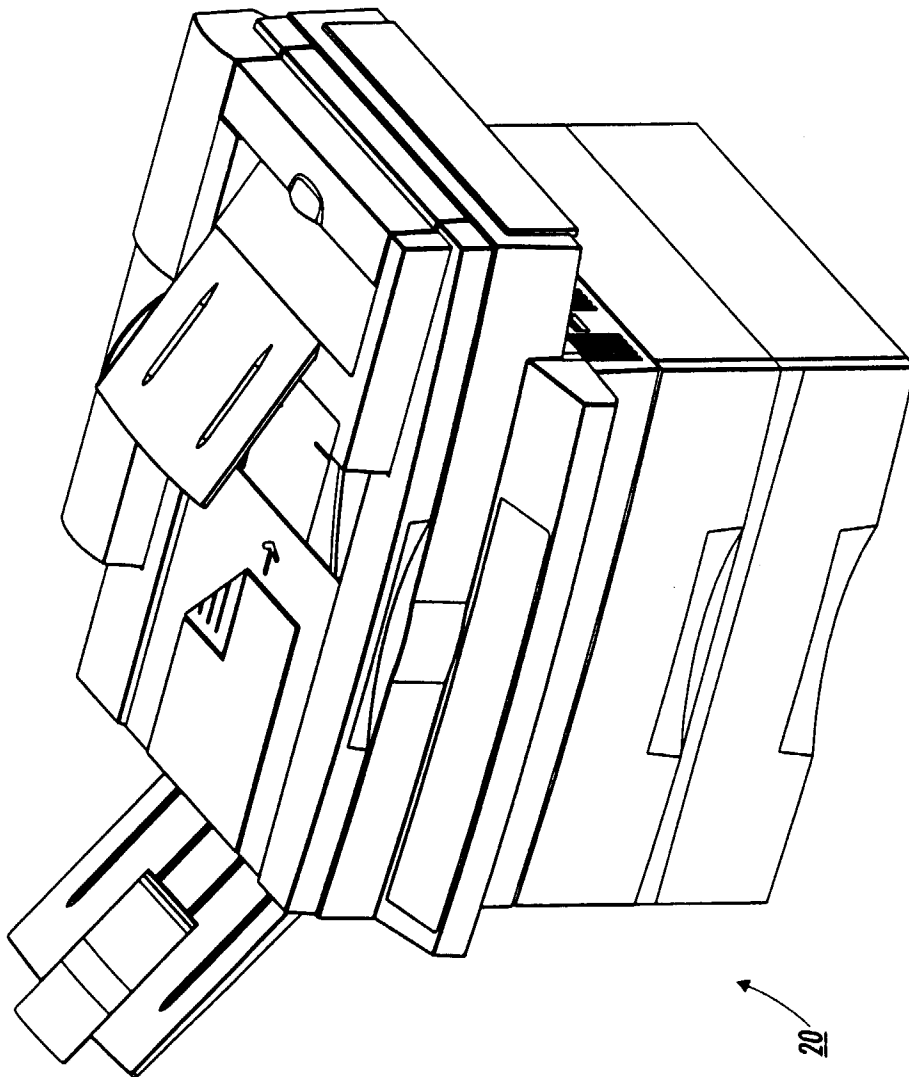


FIG. 10