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(54) **DEVELOPMENT BIAS CONNECTOR WITH INTEGRAL BEARING SUPPORT**

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(73) Assignee: **Xerox Corporation**, Norwalk, CT (US)

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Related U.S. Patent Documents

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Filed: **Nov. 14, 1997**

(51) **Int. Cl.**
G03G 21/16 (2006.01)

(52) **U.S. Cl.** **399/111**

(58) **Field of Classification Search** 399/111, 399/119, 222, 240, 265, 270, 285
See application file for complete search history.

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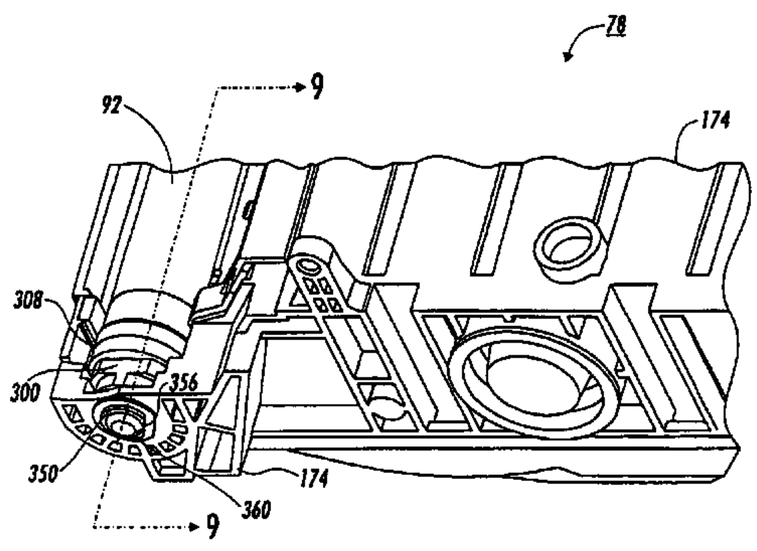
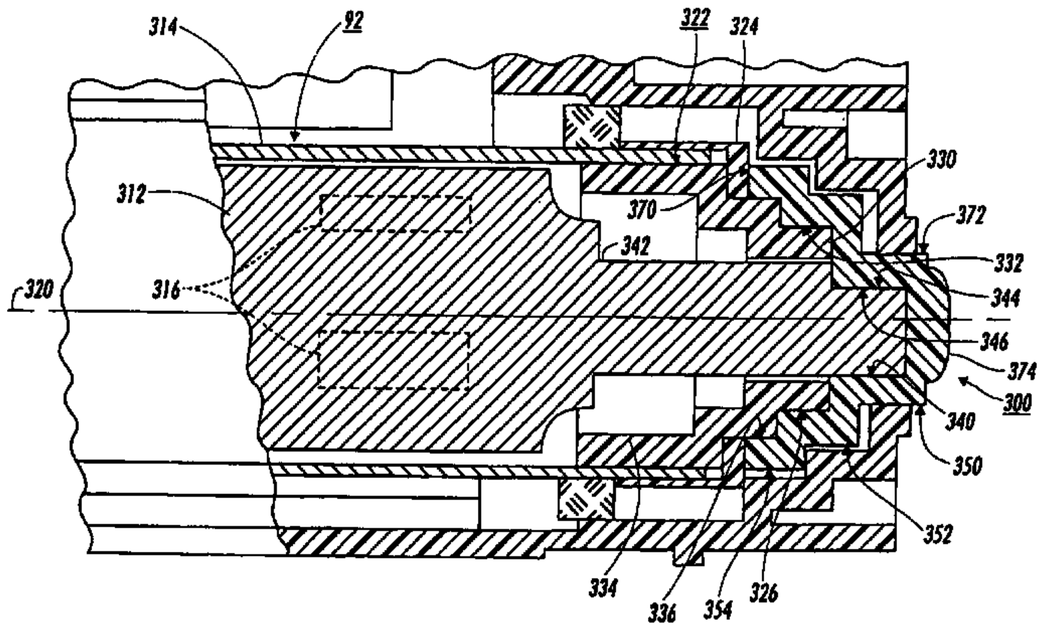
(57) **ABSTRACT**

A bearing support for use in a process cartridge including a roll rotatably mounted to a housing is provided. The roll is used for transporting marking particles to a latent image to form a developed image. The bearing support supports the roll and provides an electrical path between the roll and a voltage source. The bearing support includes a body having a first feature for cooperation with the roll and a second feature for cooperation with the housing. At least one of the first feature and the second feature provides for rotatable motion between the housing and the roll. The bearing support further includes a third feature for providing an electrical path between the roll and the voltage source.

25 Claims, 11 Drawing Sheets





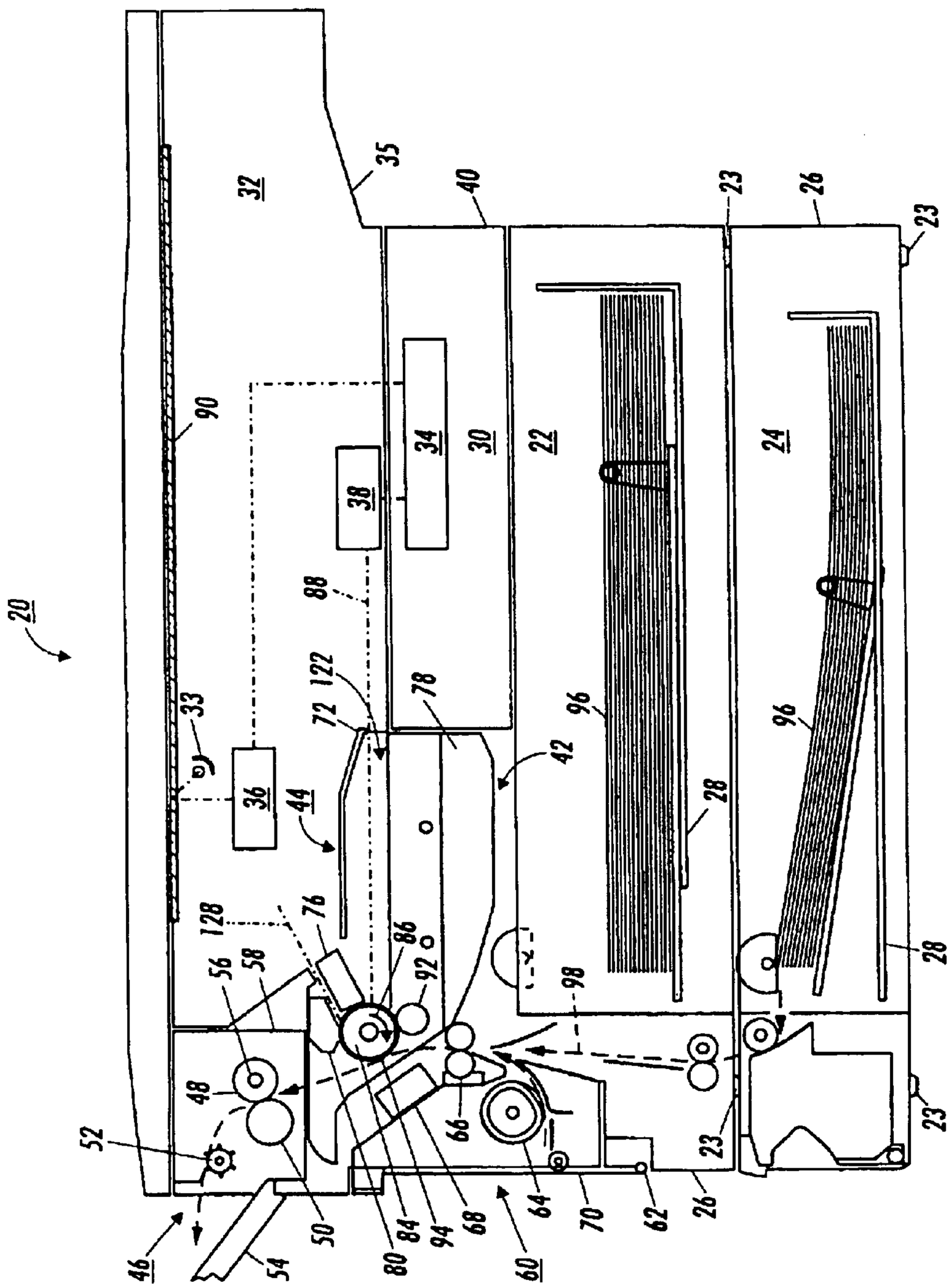

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FIG. 1

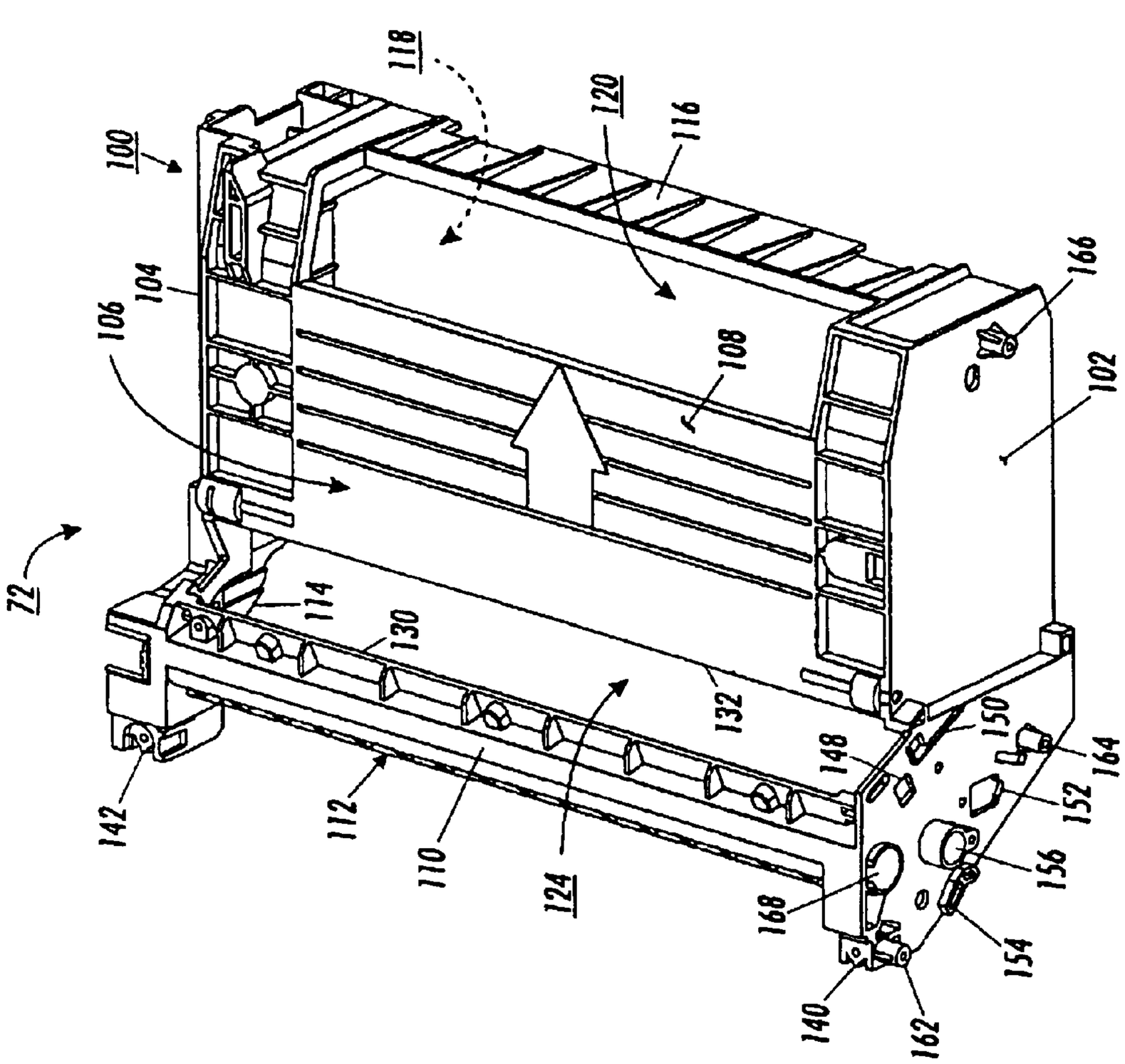
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FIG. 2

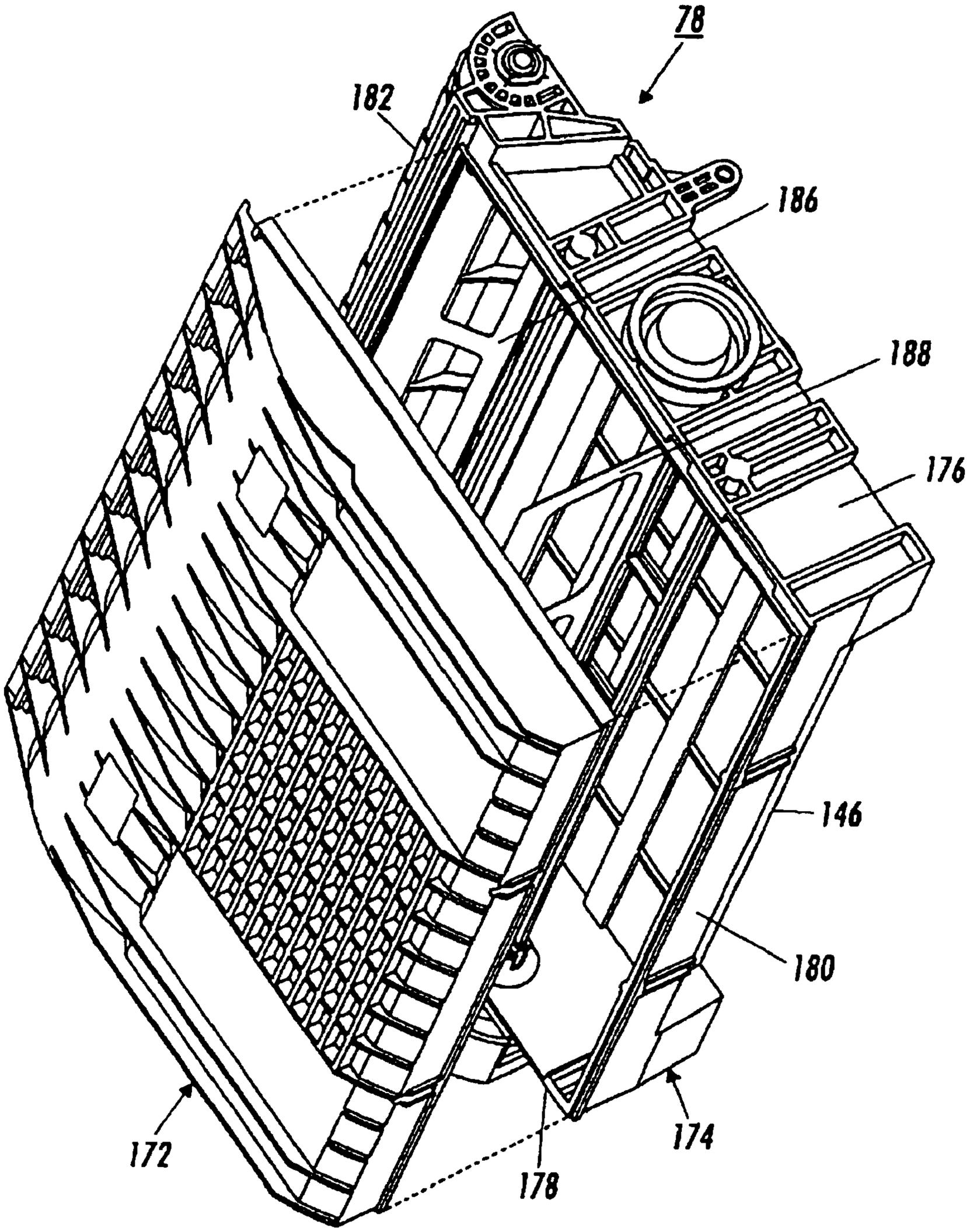

FIG. 3

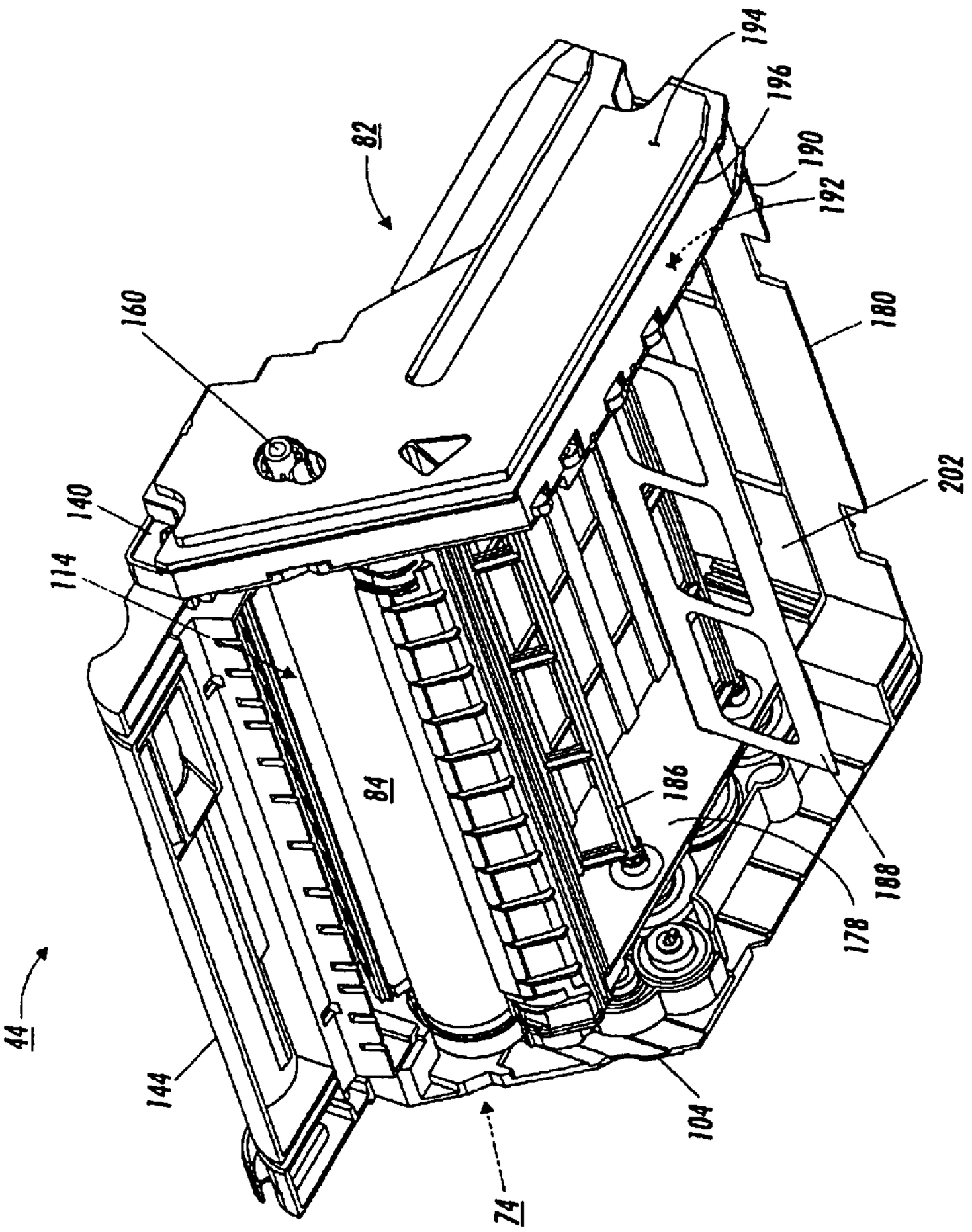
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FIG. 4

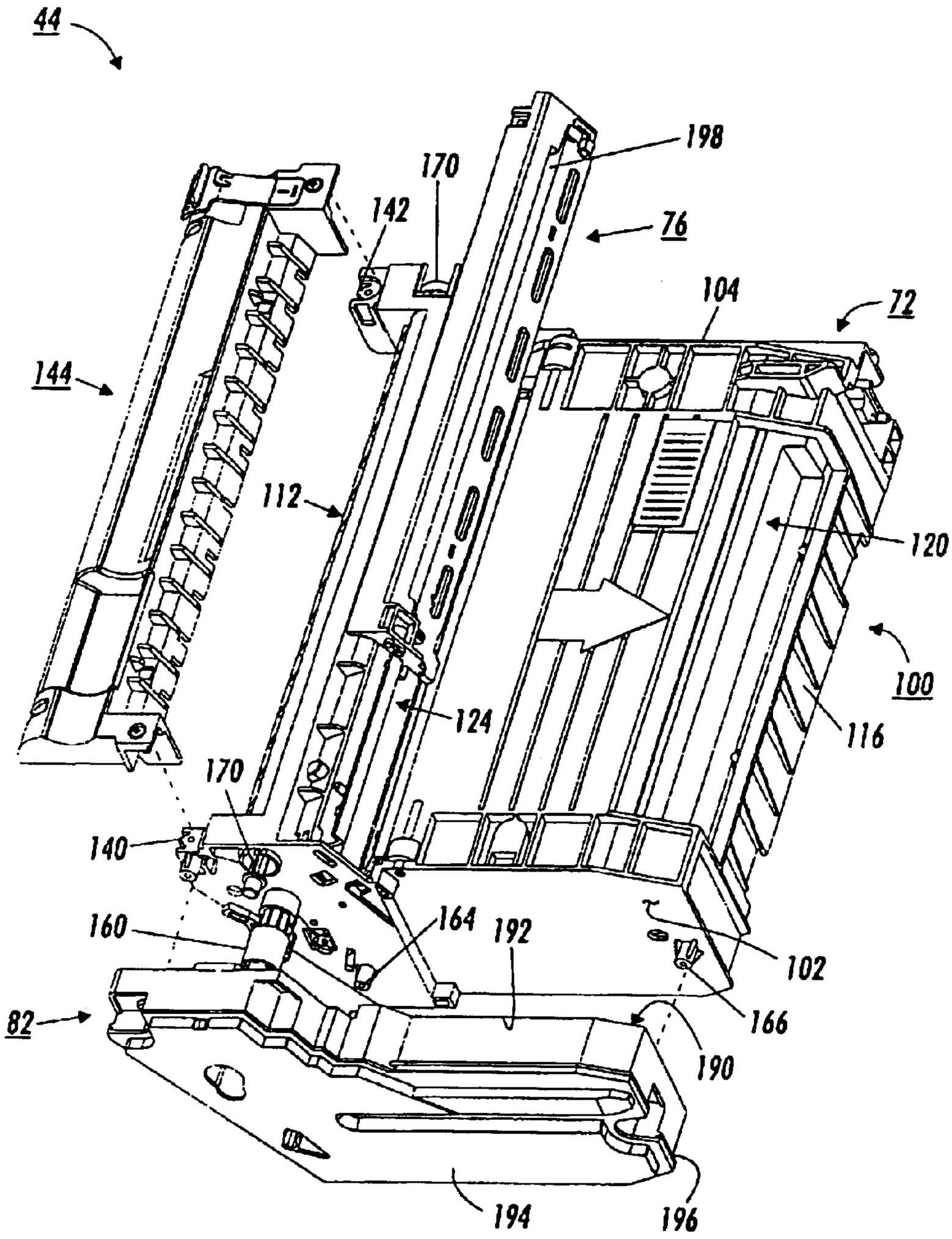
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FIG. 5

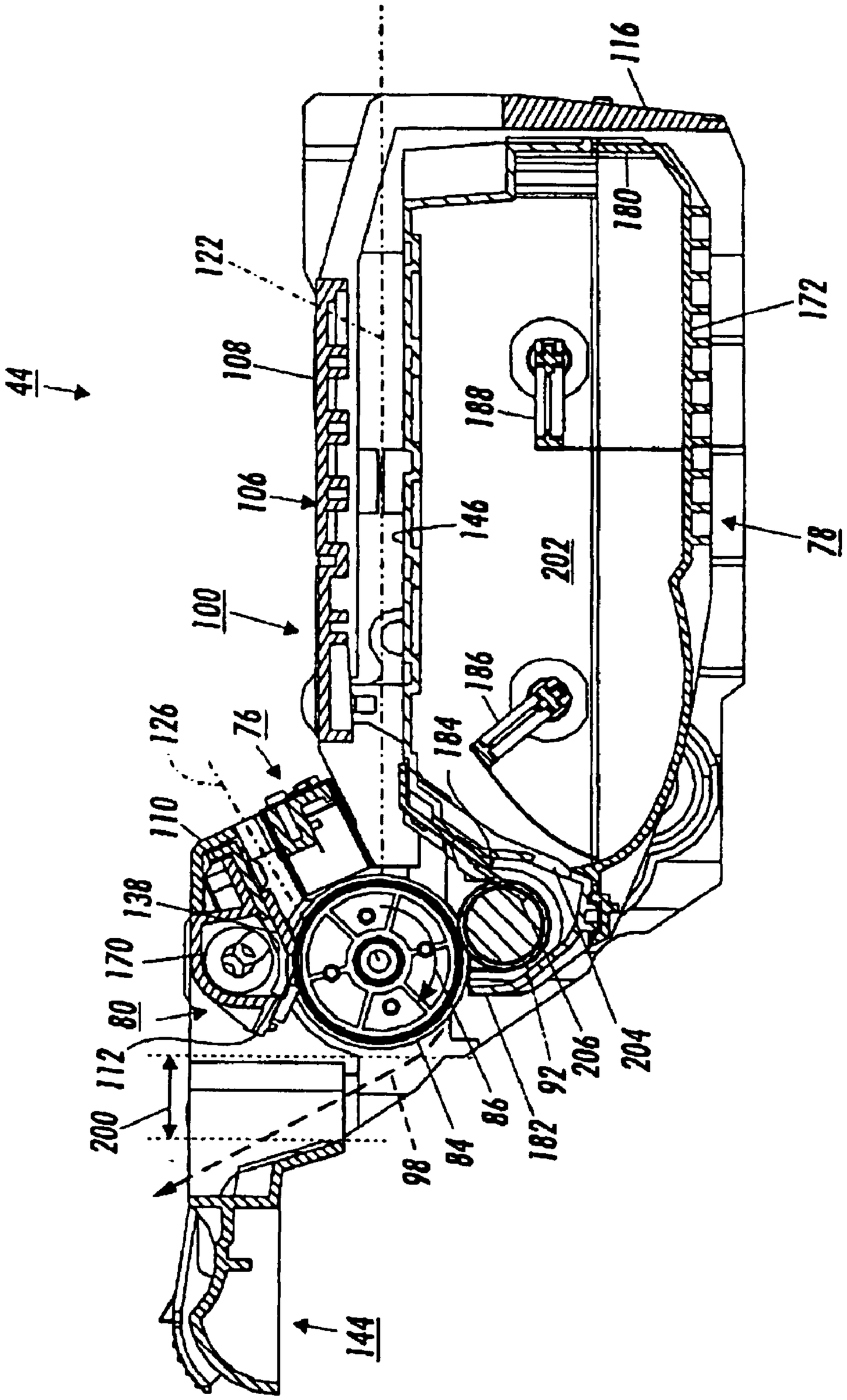
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FIG. 6

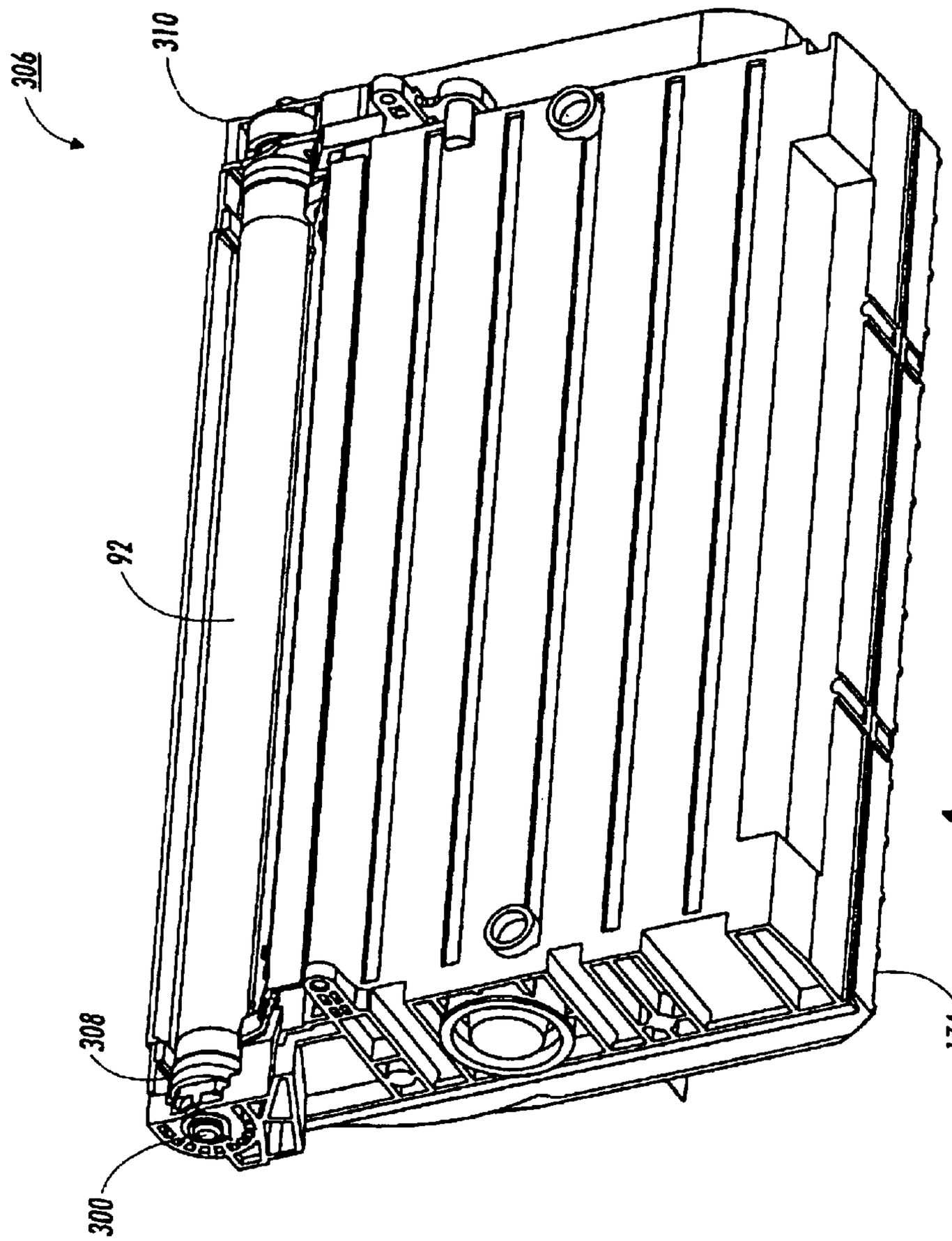

FIG. 7

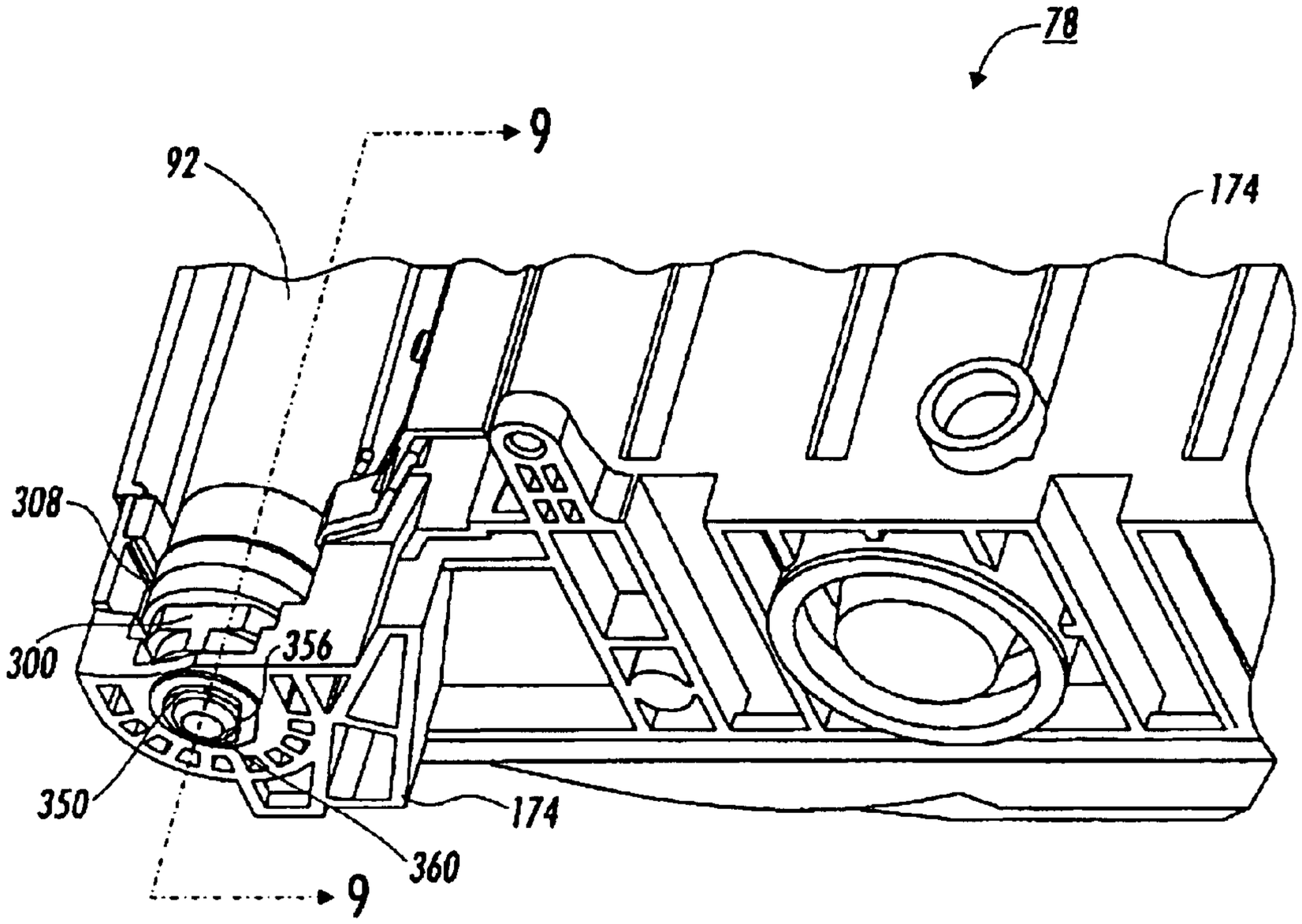

FIG. 8

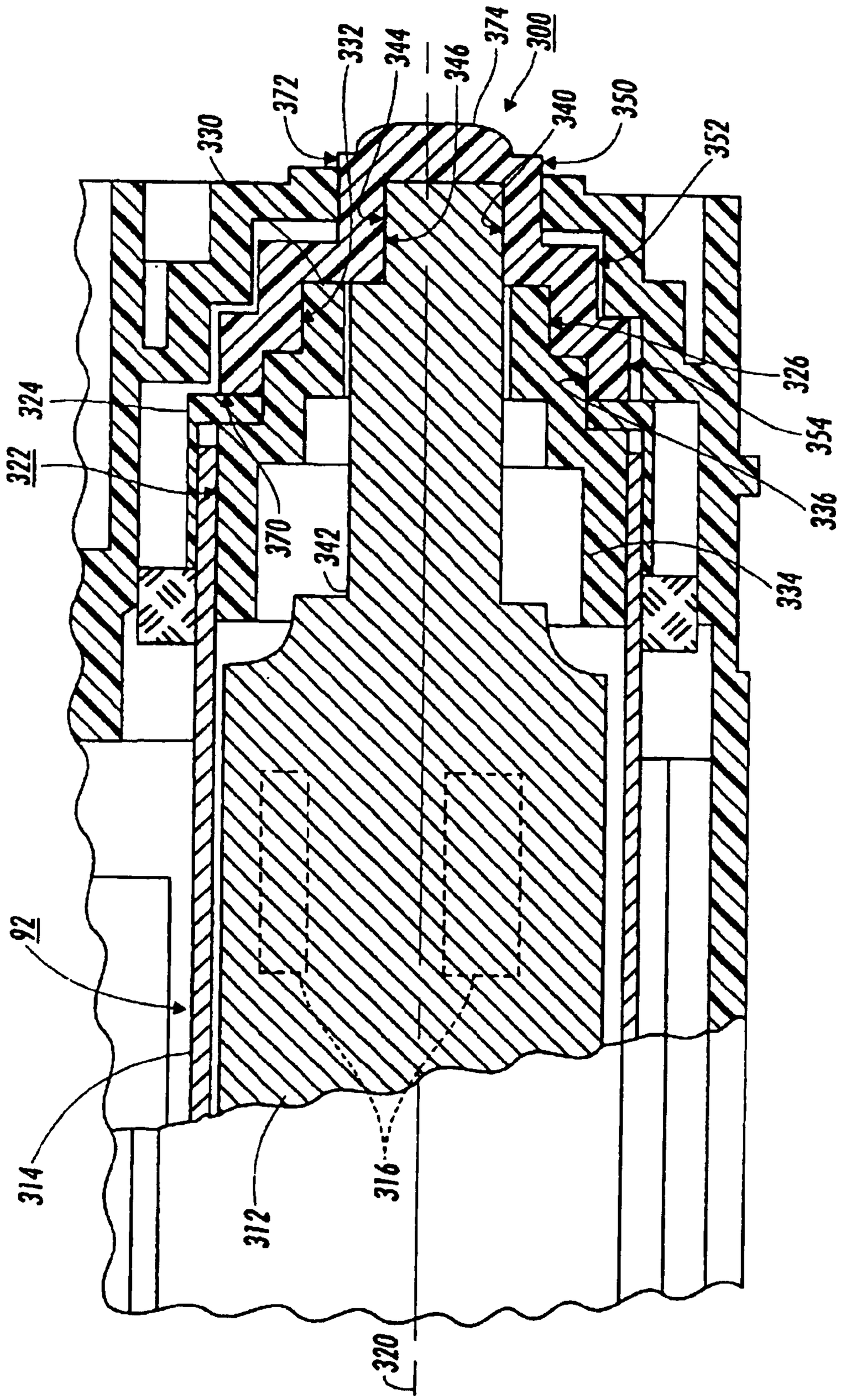
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FIG. 9

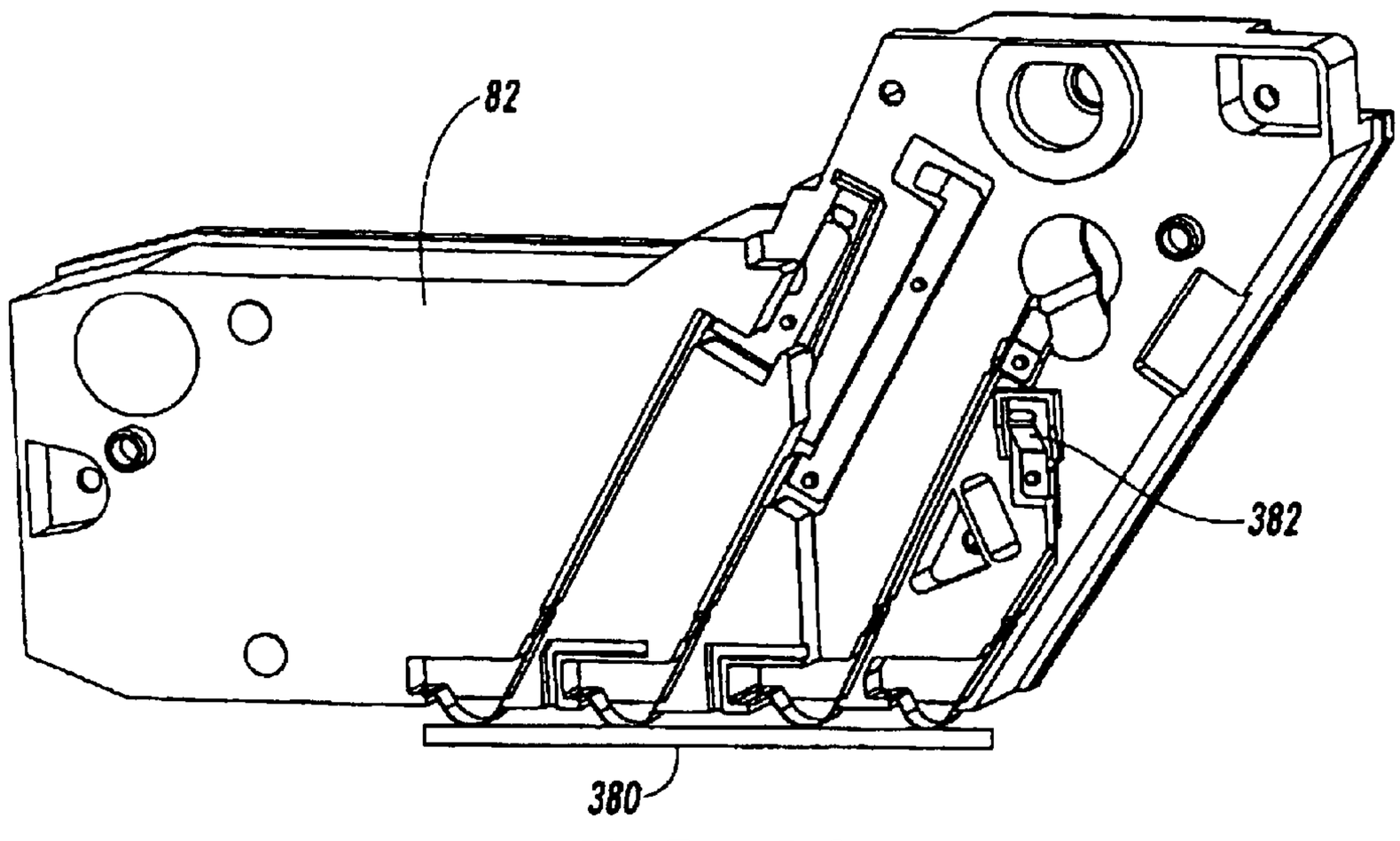

FIG. 10

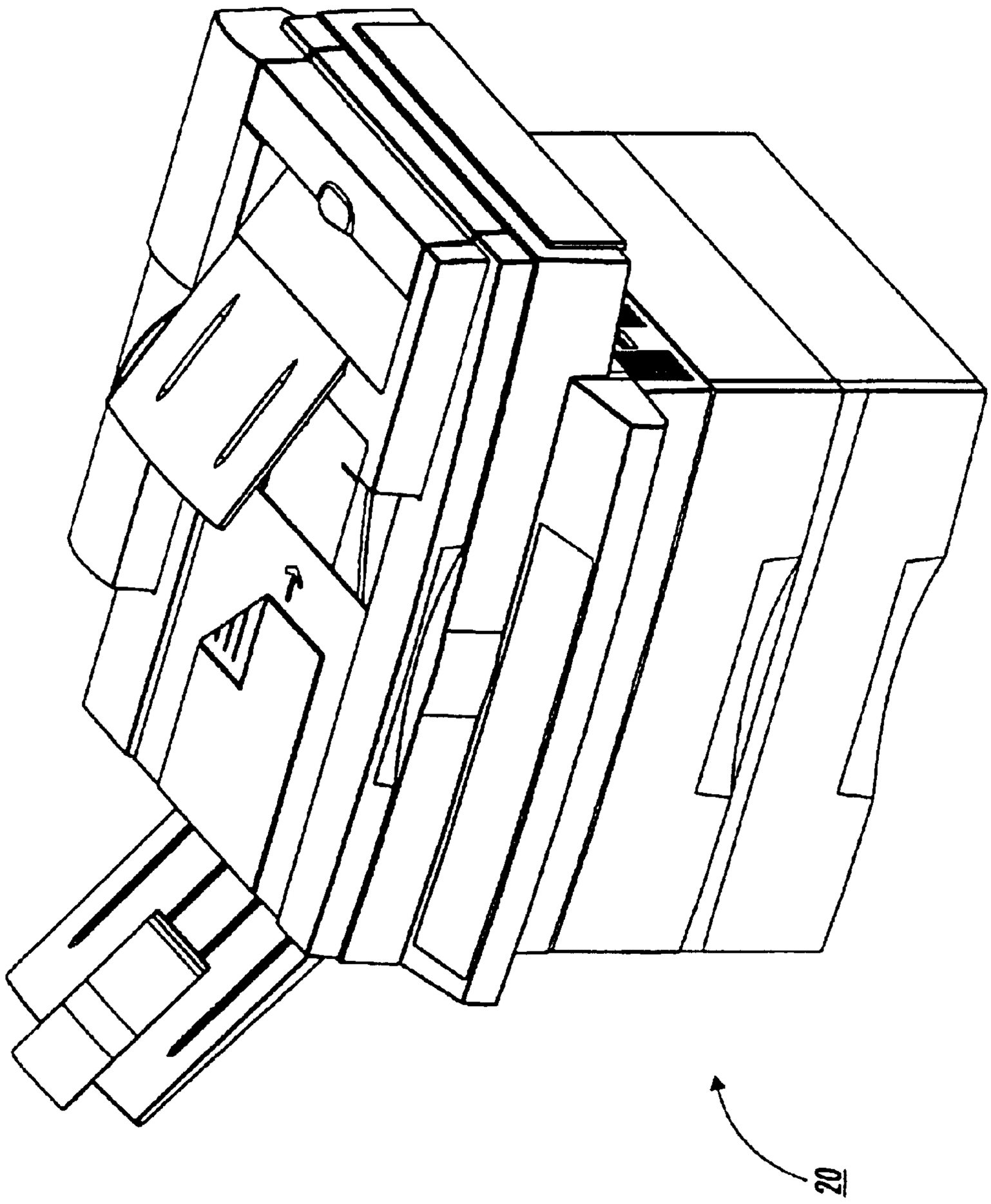

FIG. 11

DEVELOPMENT BIAS CONNECTOR WITH INTEGRAL BEARING SUPPORT

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

RELATED CASES

Cross reference is made to the following applications filed concurrently herewith: U.S. patent application Ser. No. 08/971,073 entitled "Pin Charge Corotron With Optimum Dimensions For Minimum Ozone Production" by Dhirendra C. Damji et al., U.S. patent application Ser. No. 08/971,842 entitled "Charging Device Module For Use With Print Cartridge" by Ajay Kumar et al., U.S. patent application Ser. No. 08/971,098 entitled "Charging Device Having An Electrode With Integral Electrical Connector" by Ajay Kumar et al., Attorney Docket Number U.S. patent application Ser. No. 08/971,015 entitled "Charging Device Having A Shield With Integral Electrical Connector" by Ajay Kumar et al., U.S. patent application Ser. No. 08/970,322 entitled "Process Cartridge Including Process Components Having Critical Image Quality And Life-Extending Process Path Acting Regions" by Dhirendra C. Damji et al., U.S. patent application Ser. No. 08/971,690 entitled "Variable Size, Replaceable Toner Sump Pans For Print Cartridges" by Dhirendra C. Damji et al., U.S. patent application Ser. No. 08/970,313 entitled "Molded Quick Change Photoreceptor Support" by Ajay Kumar et al., U.S. patent application Ser. No. 08/971,010 entitled "Printing Cartridge With Planar Drive Train" by Ajay Kumar et al., U.S. patent application Ser. No. 08/970,839 entitled "Process Cartridge Including A Handle Defining Part Of A Machine Paper Path" by Dhirendra C. Damji et al., U.S. patent application Ser. No. 08/970,321 entitled "Electrostatographic Process Cartridge Having A Non-Metallic Photoreceptor Grounding Pin" by Daniel A. Chiesa et al., U.S. patent application Ser. No. 08/970,318 entitled "Limited Life Electrostatographic Process Cartridge Having A Waste Toner Electro-Sump Subassembly" by Daniel A. Chiesa et al., U.S. patent application Ser. No. 08/970,354 entitled "Process Cartridge Having A Drive Assembly Resultant Force Counter-Acting Member" by Dhirendra C. Damji el al., U.S. patent application Ser. No. 08/970,320 entitled "Process Cartridge Including A Banding Defect Preventing Waste Toner Moving Auger" by Dhirendra C. Damji et al., U.S. patent application Ser. No. 08/971,323 entitled "Process Cartridge Including A Developer Housing Defining Part Of A Machine Paper Path" by Dhirendra C. Damji et al., U.S. patent application Ser. No. 08/970,847 entitled "All-in-One Process Cartridge Including A Photoreceptor And Process Components Having Relative Critical, Image Quality Acting Regions" by Dhirendra C. Damji et al., U.S. patent application Ser. No. 08/971,691 entitled "Printing Cartridge With Molded Cantilever Developer Roller Spacing Spring" by Ajay Kumar et al., and U.S. patent application Ser. No. 08/970,319 entitled "User Interface For An Electrostatographic Reproduction Machine" by Mark L. Leveto.

BACKGROUND

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 development bias connector with integral bearing support.

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.

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 triobelectrically 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.

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.

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

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.

For proper development of a charged surface with marking particles, preferably, an electrical bias is applied at various positions along the developing process. One of the places in which an electrical charge is applied is the development control. An electrical bias is applies at the outer periphery of the developing roll. Since the outer periphery of the developer roll rotates, the electrical charge on the rotating

outer periphery must be commutated in order that it be received from a power source.

Attempts have been made at commutating a developer roll. For example, a metallic brush may be used between a stationary and rotating element to commutate the roll. Further, a metal rolling element bearing may be used. For a rolling element bearing a conductor grease may be required to adequately commutate the roll. The use of a brush or rubbing element to commutate a roll adds cost and provides a wear item which requires replacement. The use of a conductive bearing is expensive and also is only moderately successful at commutating due to the problems with conductive grease.

The following disclosures may be relevant to various aspects of the present invention:

U.S. Pat. No. 4,839,690

Patentee: Onoda et al.

Issue Date: Jun. 13, 1989

U.S. Pat. No. 5,296,901

Patentee: Davies

Issue Date: Mar. 22, 1994

U.S. Pat. No. 5,581,325

Patentee: Tsuda et al.

Issue Date: Dec. 3, 1996

U.S. Pat. No. 5,634,175

Patentee: Michlin et al.

Issue Date: May 27, 1997

U.S. Pat. No. 4,839,690 discloses an image bearing member including a conductive drum including an insulating flange. A conductive member is electrically connected to an inner surface of the conductive drum. The conductive member is electrically connected with a conductive member of a main assembly when the conductive drum is mounted in the main assembly.

U.S. Pat. No. 5,296,901 discloses a method of applying an electrical bias to a magnetic feed roller. A simple contact is attached to a doctor blade having a finger extending therefrom to ride onto the surface of the magnetic roller. The contact connects the doctor blade to the feed roller.

U.S. Pat. No. 5,581,325 discloses a process cartridge including an electroconductive grounding member which is in electric connection with the image bearing member. The grounding member grounds the image bearing member to a main assembly. A removing member is in contact with a region of the image bearing member contactable to the grounding member.

U.S. Pat. No. 5,634,175 discloses a developer roller including an improved contact device that has a conductive cylindrical member with a rim on one end. The member contacts the inner wall of the roller.

SUMMARY OF THE INVENTION

In accordance with one aspect of the present invention, there is provided a bearing support for use in a process cartridge including a roll rotatably mounted to a housing. The roll is used for transporting marking particles to a latent image to form a developed image. The bearing support supports the roll and provides an electrical path between the roll and a voltage source. The bearing support includes a body having a first feature for cooperation with the roll and a second feature for cooperation with the housing. At least one of the first feature and the second feature provides for rotatable motion between the housing and the roll. The bearing support further includes a third feature for providing an electrical path between the roll and the voltage source.

In accordance with another aspect of the present invention, there is provided a process cartridge for use in a printing machine. The process cartridge is used for applying marking particles to a latent image to form a developed image. The process cartridge includes a housing and a bearing support mounted to the housing. The process cartridge further includes a roll rotatably mounted to said bearing. The roll is used for transporting marking particles to the latent image to form the developed image and for receiving an electrical charge from a voltage source. The bearing support supports the roll and provides an electrical path between the roll and the voltage source. The bearing support includes a body having a first feature for cooperation with the roll and a second feature for cooperation with the housing. At least one of the first feature and the second feature provides for rotatable motion between the housing and the roll. The bearing support further includes a third feature for providing an electrical path between the roll and the voltage source.

In accordance with yet another aspect of the present invention, there is provided an electrophotographic printing machine of the type including a process cartridge for applying marking particles to a latent image to form a developed image. The process cartridge includes a housing and a bearing support mounted to the housing. The process cartridge further includes a roll rotatably mounted to the bearing. The roll is used for transporting marking particles to the latent image to form the developed image and for receiving an electrical charge from a voltage source. The bearing support supports the roll and provides an electrical path between the roll and the voltage source. The bearing support includes a body having a first feature for cooperation with the roll and a second feature for cooperation with the housing. At least one of the first feature and the second feature provides for rotatable motion between the housing and the roll. The bearing support further includes a third feature for providing an electrical path between the roll and the voltage source.

BRIEF DESCRIPTION OF THE DRAWINGS

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 housing 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 subassemblies 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 perspective view of the developer subassembly of the CRU or process cartridge module of the machine of FIG. **1** showing the development bias connector with integral bearing support of the present invention;

FIG. **8** is a partial perspective view of the developer subassembly of FIG. **7**;

FIG. **9** is a cross sectional view of FIG. **8** along the line **9**—**9** in the direction of the arrows;

FIG. **10** is a perspective view of a waste toner sump for the process cartridge of FIG. **2** showing the electrical lead for cooperating with the integral bearing support; and

FIG. **11** is a perspective view of the machine of FIG. **1**.

DETAILED DESCRIPTION OF THE INVENTION

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.

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.

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).

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**.

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**.

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**.

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**.

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. sepa-

rately 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**.

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**.

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.

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 detack 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.

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.

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**.

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.

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**.

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**.

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 re-action 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**.

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 detack 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.

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

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.

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**.

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**.

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 biasing 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**.

According to the present invention and referring now to FIG. **7**, conductive bearing support **300** is shown. As shown in FIG. **7**, conductive bearing support **300** is utilized to support roll **92** and to rotatively mount roll **92** within housing **174** of the developer module **78**. While the bearing support **300**, as shown in FIG. **7**, is used to support the roll **92** at first end **308** of the roll **92**, it should be appreciated that the conductive bearing support **300** may likewise be utilized at, for example, second end **310** of roll **92** or to support a paddle, auger or photoreceptor drum or any other component within the process cartridge **72** (see FIG. **6**).

Referring now to FIG. **8**, the bearing support **300** is shown in greater detail. The bearing support **300** is fixedly secured to housing **174** of the developer unit **78**. The bearing support **300** is thus positioned between the housing **174** and first end **308** of the roll **92**.

Referring now to FIG. **9**, the bearing **300** is shown in further detail.

The development roll **92**, as shown in FIG. **9**, includes a fixedly mounted core **312** and a sleeve **314** which is rotatably mounted around core **312**. The core **312** may be made of any suitable durable material which is magnetically conductive, for example, a metal or a magnetically conductive plastic. As shown in FIG. **9**, the core **312** is made of ferrous steel. The core **312** includes magnetic poles **316** which are angularly positioned with respect to roll centerline **320**. The poles **316** are so angularly positioned to provide an optimum magnetic field for the proper development of the marking particles.

The sleeve **314** is spaced from and rotatably mounted with respect to core **312**. The sleeve **314** is made of preferably a magnetically non-conductive and an electrically conductive material. For example, the sleeve **314** may be made of aluminum. The development roll **92** also preferably includes an end cap **322** which is fixedly secured to sleeve **314** and rotates therewith. The sleeve end cap **322** may be made of any suitable durable electrically conductive material. For example, the end cap **322** may be made of a conductive plastic.

To provide proper spacing between the developer roll **92** and the photoconductive surface of the photoreceptor (not shown), the developer roll **92** preferably further includes a development roll sleeve or (DSR) sleeve **324**. The DSR sleeve **324** has a thickness T which sets the gap between the developer roll **92** and the photoconductive surface. The DSR sleeve **324** is fixedly secured to the sleeve **314** and rotates therewith. Thus, the DSR sleeve **324** is in rolling contact with the photoconductor surface of the photoconductive drum.

The conductive bearing support **300** includes a first feature **326** which cooperates with the development roll **92**. According to the present invention, the first feature **326** may be in any form capable of providing support to the development roll **92**. For example, the first feature **326** may be in the form of a journal or a bore cooperating with a mating feature on the development roll **92**.

While the development roll may be in the form of a single rotating component, preferably, as shown in FIG. **9** the development roll **174** includes the stationary core **312** as well as the rotating sleeve **314**. The first feature **326** provides for the rotation of the sleeve end cap **322** which is a part of the development roll **92**. The sleeve end cap **322** rotates relative to the conductive bearing support **300**.

As shown in FIG. **9**, the sleeve end cap **322** includes an inner hub **330** which mates with middle bore **332** of conductive bearing support **300**. Further, as shown in FIG. **9**, the sleeve end cap **322** may include a larger hub **334** which matingly fits with large bore **336** of conductive bearing support **300**.

The core **312** is positioned fixedly to housing **174** by small bore **340** of the support **300** which matingly fits with journal diameter **342** of the core **312**. Preferably, to angularly orient the poles **316** in the core **312** of the development roll **92**, the journal **342** of the development roll **92** includes a flat **344** which mates with flat **346** within bore **340** of the housing support **300**.

The conductive bearing support **300** is fixedly secured to the development housing **174** by any suitable manner. For example, as shown in FIG. **9**, the bearing support **300** includes small OD **350**, medium OD **352**, and large OD **354** which mate with corresponding bores in the housing **174**. It should be appreciated that any or all of the small OD, middle OD **352**, and large OD **354** may be either in clearance or matingly fitted to the respective bore of the housing.

Referring again to FIG. **8**, to angularly orient the conductive bearings support **300** with respect to the housing **174**, preferably, the bearing support **300** includes a locating feature in the form of a flat **356** formed from small OD **350**. Correspondingly, the housing **174** includes a flat **360** which mates with flat **356** of the conductive bearing support **300**. The flat **350** on the housing **174**, the flat **346** on the exterior of the support **300**, the flat **344** on the interior of the support **300**, and the flat **332** on core **312** cooperate to angularly orient the poles of the core **312**.

Referring again to FIG. **9**, preferably, the bearing support **300** further includes an outer end face **370** which contacts and restrains the development roll spacing sleeve **324** between the sleeve **314** of the development roll **92** and the housing **300**.

The conductive bearing support **300** further serves an important function by providing an electrical path from the power supply to the electrically conductive sleeve **314** of the roll **92**. As shown in FIG. **9**, the conductive bearing support **300** is in contact at large bore **336** and middle bore **332** with sleeve endcap **322**. The sleeve endcap **322** is in electrical contact with the sleeve **314**. The sleeve endcap **322** thus provides an electrical connection between the conductive bearing support **300** and the sleeve **314**.

The conductive support **300** is made of any suitable durable material which is electrically conductive. The support thus can be made of a durable metal or, as shown in FIG. **9**, be made of a electrically conductive plastic. For example, the support **300** may be made of a polycarbonate with carbon fibers.

The support **300** includes a feature **372** which extends outwardly from the development housing **174** and serves to provide an electrical path from the power source (not shown) to the development roll **92**. For example, as shown in FIG. **9**, the conductive bearing support **300** includes the central hub **372**. The central hub **372** includes an outer face **374** which provides for the electrical contact for the development roll **92**. The outer face **374** may be contacted with the power supply in any suitable fashion.

Referring now to FIG. **10**, waste toner housing **82** is shown. The waste toner housing **82** provides an electrical path from the face **374** of the conductive bearing support **300** to the power supply board **380**. An electrical contact **382** is positioned such that spring loaded contact **382** contacts the face **374** of the conductive bearing support **300**. An electrical contact made of a suitable material, i.e. stainless steel **384** interconnects contact **382** with the board **380**.

Referring now to FIG. **11**, a printing machine utilizing the conductive bearing support of the present invention is shown.

By providing an electrically conductive bearing support for a development roller, a low cost, simple bearing support may be provided to the development roll.

By providing an electrically conductive bearing support, a simple, reliable conductive path can be had from the development roll to a power supply.

By providing an electrically conductive bearing support including a centrally located hub extending therefrom, a simple, electrical connection may be had upon insertion of a development unit into a cartridge unit.

By providing an electrically conductive bearing support made of an electrically conductive plastic, a simple inexpensive and low cost recyclable bearing support may be provided.

While this invention has been described in conjunction with various embodiments, it is evident that many

alternatives, modifications, and variations will be apparent to those skilled in the art. Accordingly, it is intended to embrace all such alternatives, modifications, and variations as fall within the spirit and broad scope of the appended claims.

What is claimed is:

1. A bearing support for use in a process cartridge including a roll rotatably mounted to a housing, the roll for transporting marking particles to a latent image to form a developed image, said bearing support supporting the roll and providing an electrical path between the roll and a voltage source, said bearing support comprising a body including:

a first feature for cooperation with the roll;

a second feature for cooperation with the housing, at least one of said first feature and said second feature providing for rotatable motion between the housing and the roll; and

a third feature for providing an electrical path between the roll and the voltage source, *wherein said third feature is defined by an external face, said face providing an electrical path to the voltage source*.

2. A bearing support according to claim **1**, wherein said body comprises a generally cylindrical shape.

3. A bearing support according to claim **2**, wherein said first feature is defined by a bore in said body, said body operably secured to the roll at said bore.

4. A bearing support according to claim **1**, wherein said second feature is defined by an outer periphery of said body, said outer periphery fitted to the housing.

[5. A bearing support according to claim **1**, wherein said third feature is defined by an external face, said face providing an electrical path to the voltage source.**]**

6. A bearing support according to claim **1**, wherein said body comprises an electrically conductive plastic.

7. A bearing support according to claim **1**, wherein said body comprises carbon fibers.

8. A process cartridge for use in a printing machine **[**comprising**]**, said process cartridge for applying marking particles to a latent image to form a developed image, said cartridge comprising:

a housing;

a bearing support mounted to said housing;

a roll rotatably mounted to said bearing, said roll for transporting marking particles to the latent image to form the developed image and for receiving an electrical charge from a voltage source, said bearing support supporting the roll and providing an electrical path between the roll and the voltage source, said bearing support including a body having a first feature for cooperation with the roll, a second feature for cooperation with the housing, at least one of said first feature and said second feature providing for rotatable motion between the housing and the roll and a third feature for providing an electrical path between the roll and the voltage source, *wherein said third feature is defined by an external face, said face providing an electrical path to the voltage source*.

9. A cartridge according to claim **8**, wherein said body comprises a generally cylindrical shape.

10. A cartridge according to claim **8**, wherein said first feature is defined by a bore in said body, said body operably secured to the roll at said bore.

11. A cartridge according to claim **8**, wherein said second feature is defined by an outer periphery of said body, said outer periphery fitted to the housing.

[12. A cartridge according to claim **8**, wherein said third feature is defined by an external face, said face providing an electrical path to the voltage source.**]**

13. A cartridge according to claim **8**, wherein said body comprises an electrically conductive plastic.

14. A cartridge according to claim **8**, wherein said body comprises carbon fibers.

15. An electrophotographic printing machine of the type including a process cartridge for applying marking particles to a latent image to form a developed image, the process cartridge comprising:

a housing;

a bearing support mounted to said housing;

a roll rotatably mounted to said bearing, said roll for transporting marking particles to the latent image to form the developed image and for receiving an electrical charge from a voltage source, said bearing support supporting the roll and providing an electrical path between the roll and the voltage source, said bearing support including a body having a first feature for cooperation with the roll, a second feature for cooperation with the housing, at least one of said first feature and said second feature providing for rotatable motion between the housing and the roll and a third feature for providing an electrical path between the roll and the voltage source, *wherein said third feature is defined by an external face, said face providing an electrical path to the voltage source*.

16. A printing machine according to claim **15**, wherein said body comprises a generally cylindrical shape.

17. A printing machine according to claim **16**, wherein said first feature is defined by a bore in said body, said body operably secured to the roll at said bore.

18. A printing machine according to claim **15**, wherein said second feature is defined by an outer periphery of said body, said outer periphery fitted to the housing.

[19. A printing machine according to claim **15**, wherein said third feature is defined by an external face, said face providing an electrical path to the voltage source.**]**

20. A printing machine according to claim **15**, wherein said body comprises an electrically conductive plastic.

21. A printing machine according to claim **15**, wherein said body comprises carbon fibers.

22. A bearing support for use in a process cartridge including a roll rotatably mounted to a housing, the roll for transporting marking particles to a latent image to form a developed image, said bearing support interfacing with the roll and providing an electrical path between the roll and a voltage source, said bearing support comprising a body including:

a first feature for cooperation with the roll;

a second feature for cooperation with the housing, at least one of said first feature and said second feature providing for rotatable motion between the housing and the roll; and

a third feature for providing an electrical path between the roll and the voltage source, wherein said third feature includes a surface contactable from outside the housing.

23. A bearing support as recited in claim 22, wherein said surface extends in an axial direction away from the first and second features.

24. A bearing support assembly for use in a process cartridge including a roll rotatably mounted to a housing, the roll for transporting marking particles to a latent image to form a developed image, said bearing support assembly interfacing with the roll and providing an electrical path between the roll and a voltage source, said bearing support assembly comprising:

a first surface that rotatably engages the roll and provides for rotatable motion between the housing and the roll;

a second surface that engages the housing; and

a conductive member that provides the electrical path between the voltage source and roll via the first and second surfaces, said conductive member extending at least partially through the housing.

25. A bearing support assembly for use in a process cartridge including a roll rotatably mounted to a housing, the roll for transporting marking particles to a latent image to form a developed image, said bearing support assembly interfacing with the roll and providing an electrical path between the roll and a voltage source, said bearing support assembly comprising:

a body having a first feature that rotatably engages the roll and a second feature that engages the housing, such that the first feature provides for rotatable motion between the housing and the roll; and

a conductive member that provides an electrical path between the roll and the voltage source;

said conductive member extending a least partially through the housing.

26. A bearing support assembly for use in a process cartridge including a roll rotatably mounted to a housing, the roll for transporting marking particles to a latent image to form a developed image, said bearing support assembly interfacing with the roll and providing an electrical path between the roll and a voltage source, said bearing support assembly comprising:

a first surface that rotatably engages the roll and provides for rotatable motion between the housing and the roll,

a second surface that engages the housing, and

a conductive assembly for providing an electrical path between the roll and the voltage source, said conductive assembly extending from inside the housing to at least partially through an opening in the housing and being contactable by the voltage source from outside the housing.

27. A bearing support for use in a process cartridge including a roll rotatably mounted to a housing, the roll for transporting marking particles to a latent image to form a developed image, said bearing support interfacing with the roll and providing an electrical path between the roll and a voltage source, said bearing support comprising:

a first surface that rotatably engages the roll and provides for rotatable motion between the housing and the roll,

a second surface that engages the housing, and

a feature for providing the electrical path between the roll and the voltage source, the feature having a third surface for contact with the voltage source to provide part of the electrical path, said third surface being coaxial with said first surface.

28. A bearing support for use in a process cartridge including a roll rotatably mounted to a housing, the roll for transporting marking particles to a latent image to form a developed image, said bearing support interfacing with the roll and providing an electrical path between the roll and a voltage source, said bearing support comprising:

a first surface that rotatably engages the roll and provides for rotatable motion between the housing and the roll,

a second surface that engages the housing, and

a feature for providing the electrical path between the roll and the voltage source, the feature having a third surface for contact with the voltage source to provide part of the electrical path, said third surface providing contact with the voltage source around the axis of the roll.

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