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(11) **EP 0 729 844 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
04.09.1996 Bulletin 1996/36

(51) Int. Cl.⁶: **B41J 25/34**

(21) Application number: **95307796.3**

(22) Date of filing: **01.11.1995**

(84) Designated Contracting States:
DE GB IT

(30) Priority: **02.03.1995 US 399244**

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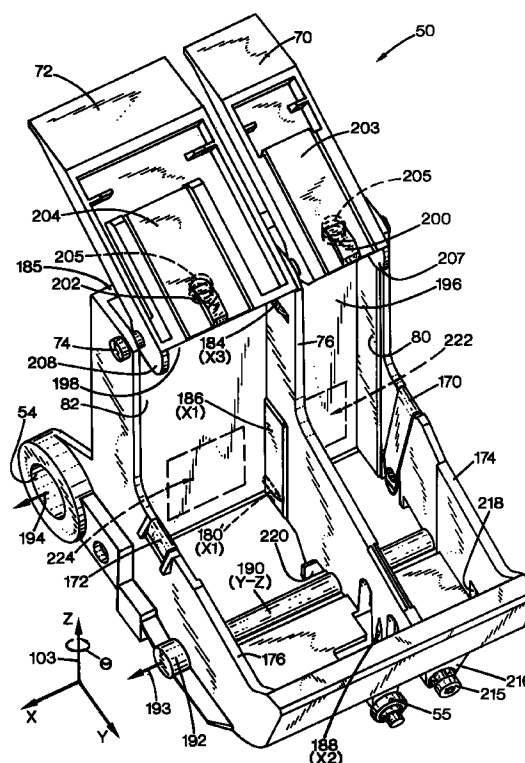
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(54) **Dual inkjet pen carriage system**

(57) A dual pen carriage system (50) supports a pair of inkjet pens (60, 62) in an inkjet printing mechanism (20). A carriage body (75) defines a pair of pen chambers (80, 82), separated by a main alignment wall (76), for receiving the pens (60, 62). The main wall (76) defines at least one first direction alignment datum (180, 180', 182, 184; 180', 184, 186, 188) in each chamber (80, 82). A reference rod (190) extends through both chambers (80, 82) to define pen alignment datums in two orthogonal directions, which are orthogonal to the first direction. The body (75) supports an adjustment member (215) that selectively engages a rotational registration member (214) along the main wall (76) to simultaneously adjust the angular alignment of each pen chamber (80, 82). A latch mechanism (70, 72) coupled to the carriage body (75) applies, upon closing, a controlled force to a latching land (115, 155) on each pen (60, 62) to push the pens into contact with the datums (180, 180', 182, 184, 190, 196; 180', 184, 186, 188, 190, 198). A method is also provided for aligning a pair of inkjet pens (60, 62) in an inkjet printing mechanism (20).

FIG. 6



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Description

Field of the Invention

This invention relates generally to an inkjet printing mechanism, and more particularly to a dual inkjet pen carriage system that accurately aligns two pens for scanning across a printzone of the mechanism to print high quality images.

Background of the Invention

Inkjet printing mechanisms use pens which shoot drops of liquid colorant, referred to generally herein as "ink," onto a page. Each pen has a printhead formed with very small nozzles through which the ink drops are fired. To print an image, the printhead is propelled back and forth across the page, shooting drops of ink in a desired pattern as it moves. The particular ink ejection mechanism within the printhead may take on a variety of different forms known to those skilled in the art, such as those using piezo-electric or thermal printhead technology. For instance, two earlier thermal ink ejection mechanisms are shown in U.S. Patent Nos. 5,278,584 and 4,683,481, both assigned to the present assignee, Hewlett-Packard Company. In a thermal system, a barrier layer containing ink channels and vaporization chambers is located between a nozzle orifice plate and a substrate layer. This substrate layer typically contains linear arrays of heater elements, such as resistors, which are energized to heat ink within the vaporization chambers. Upon heating, an ink droplet is ejected from a nozzle associated with the energized resistor. By selectively energizing the resistors as the printhead moves across the page, the ink is expelled in a pattern on the print media to form a desired image (e.g., picture, chart or text).

To clean and protect the printhead, typically a "service station" mechanism is mounted within the printer chassis so the printhead can be moved over the station for maintenance. For storage, or during non-printing periods, the service stations usually include a capping system which humidically seals the printhead nozzles from contaminants and drying. Some caps are also designed to facilitate priming, such as by being connected to a pumping unit that draws a vacuum on the printhead. During operation, clogs in the printhead are periodically cleared by firing a number of drops of ink through each of the nozzles in a process known as "spitting," with the waste ink being collected in a "spittoon" reservoir portion of the service station. After spitting, uncapping, or occasionally during printing, most service stations have an elastomeric wiper that wipes the printhead surface to remove ink residue, as well as any paper dust or other debris that has collected on the printhead.

To improve the clarity and contrast of the printed image, recent research has focused on improving the ink itself. To provide faster, more waterfast printing with

darker blacks, pigment based black inks have been developed. These pigment based inks have a higher solid content than the earlier dye based inks. Both types of ink dry quickly, which allows inkjet printing mechanisms to use plain paper. To provide high quality hard copy printed images with both dark blacks and vivid colors, current printer designs employ a black pen, and a single tri-color pen, or a black pen in combination with four monochrome color pens.

One earlier printer employs four discrete pens that carry black, cyan, magenta and yellow inks. The carriage structure for aligning these four pens has six datums that match associated datums on each pen. The datums required to control the pen registration are in the following three orthogonal directions:

1. A printhead scanning direction (X axis),
2. A paper advance direction (Y axis), and
3. An upright direction (Z axis).

Another pen misalignment is known as a theta-Z (θ -Z) error, which refers to an angular twist of the pens around the Z axis. A theta-Z error manifests itself as a saw tooth error in the printed image, as a result of the printhead columns of nozzles not being parallel to the Y axis paper advance direction.

To maintain proper pen alignment, the earlier four-pen printer design required both the pens and the carriage to have very close tolerances. Unfortunately, the required tolerances could not be obtained using economical molded parts. Instead, all of the carriage datums had to be machined, and for each pen, three of the six datums required machining. These secondary machining operations are labor intensive and costly, as opposed to merely molding a datum.

This earlier four-pen carriage located the pens against the X datums using an X-biasing spring and a flexure member with an insert molded cam that applied the necessary force against the clamping surface of the pen to seat it securely against the X, Y, and Z datums. Unfortunately, the X-biasing springs used in this earlier four-pen design required costly secondary manufacturing operations, including heat treating and plating, to obtain the desired performance levels. This earlier carriage used the electrical interconnect mechanism, which communicates the firing signals from the carriage to the pens, to supply the force necessary to seat the pens securely against one of the Y axis datums.

For pen installation, the clamping system employed by this earlier four-pen printer required an operator to push and rotate each pen until it snapped into place. This snap-in design required an operator to overcome frictional forces within the carriage, which often resulted in uneven or lateral forces being applied to the pens during insertion. Unfortunately, these installation difficulties can prevent the pen datums from properly seating on their corresponding carriage datums. Such improper seating of the pens degraded print quality, because the

nozzles were no longer aligned with respect to the other pens in the carriage.

In a two pen system, employing one black pen and a second tri-color pen, the carriage must provide precise and repeatable positioning of the pens relative to each other and to the entire printing system. Accurate positioning of the pens is one of the primary variables to control the registration of the ink dots on the paper, which directly affects print quality. Furthermore, there is a need for a carriage clamping system that allows easy replacement of the pens, while assuring a high degree of repeatability in the seating of the pen datums against the carriage datums. Moreover, there is a need for a more economical carriage system that achieves pen positioning tolerances comparable to the earlier four-pen printer design, without secondary machining operations. Thus, a need exists for an improved dual inkjet pen carriage system for maintaining printhead alignment during printing.

Summary of the Invention

According to one aspect of the present invention, a dual pen carriage system is provided for scanning a pair of inkjet pens across a printzone of an inkjet printing mechanism. The carriage system has a carriage body with a main wall configured to be sandwiched between the pair of pens. The main wall has two opposing side surfaces each defining at least one datum. The carriage system also has a bias mechanism supported by the body to push each pen into contact with the main wall datums.

According to another aspect of the present invention, a dual pen carriage system has a carriage body that defines two side walls to receive therebetween the pair of pens. The carriage system also has a reference rod extending between the two side walls to contact and align the pens in two orthogonal directions.

According to a further aspect of the present invention, a dual pen carriage system has a carriage body that defines a pair of pen chambers for receiving the pair of pens. The chambers are separated by a main wall that has having a rotational registration portion. The carriage system also has an adjustment member supported by the body to selectively engage the registration portion to simultaneously adjust the alignment of each pen chamber in an angular direction.

According to yet another aspect of the present invention, a dual pen carriage system is provided for scanning a pair of inkjet pens across a printzone of an inkjet printing mechanism, with each pen having a printhead and a surface opposite the printhead that supports a latching land. The carriage system has a carriage body configured to receive the pair of pens, with the pen body defining plural datums to contact and align each pen. The carriage system also has a latch mechanism coupled to the carriage body to apply a controlled force in a selected direction upon closing to the latching land

of each pen to push each pen into contact with the datums.

In the illustrated embodiment, each of the aspects described above are combined into a unique dual pen carriage system, such as may be used in an inkjet printer.

According to another aspect of the invention, a method is provided of aligning a pair of inkjet pens in an inkjet printing mechanism. Preferably, the pens are provided with a datum side surface defining at least one first direction pen datum, and an under surface defining second and third direction pen datums, with the first, second and third directions being orthogonal. The method includes the step of inserting the pens into a carriage system having a body that defines a main wall. The main wall has opposing sides, each defining at least one first direction datum. The carriage system also has a reference rod that defines second and third direction datums. In a sandwiching step, the main wall is sandwiched between the datum side surfaces of the pens. In a pushing step, the pens are pushed against the first, second and third direction pen datums.

An overall goal of the present invention is to provide an inkjet printing mechanism which uses a pair inkjet pens to provide a high quality hardcopy output.

Another goal of the present invention is to provide a dual inkjet pen carriage system for pens made of molded parts, without sacrificing print quality, to provide an economical inkjet printing mechanism.

A further goal of the present invention is to provide a method of accurately aligning a pair of inkjet pens in a printing mechanism.

Brief Description of the Drawing

FIG. 1 is a partially cut away perspective view of an inkjet printing mechanism incorporating one form of a dual inkjet pen carriage system of the present invention.

FIG. 2 is a front perspective view of the dual inkjet pen carriage system of FIG. 1, shown holding two pens, with the pen latches open.

FIG. 3 is a rear perspective view of the two pens of FIG. 1, shown side-by-side as oriented within the carriage system.

FIG. 4 is a front perspective view of the two pens of FIG. 1, shown side-by-side as oriented within the carriage system.

FIGS. 5 and 6 are front perspective views of the carriage system of FIG. 1 taken from different angles, with the pens removed to show different features of the pen receiving chambers.

FIG. 7 is a bottom perspective view of the carriage system of FIG. 1, with the pens removed.

FIG. 8 is a bottom perspective view of the carriage system of FIG. 1, shown holding two pens with the pen latches closed for printing.

Detailed Description of a Preferred Embodiment

FIG. 1 illustrates an embodiment of an inkjet printing mechanism, here shown as an inkjet printer 20, constructed in accordance with the present invention, which may be used for printing for business reports, correspondence, desktop publishing, and the like, in an industrial, office, home or other environment. A variety of inkjet printing mechanisms are commercially available. For instance, some of the printing mechanisms that may embody the present invention include plotters, portable printing units, copiers, cameras, video printers, and facsimile machines, to name a few. For convenience the concepts of the present invention are illustrated in the environment of an inkjet printer 20.

While it is apparent that the printer components may vary from model to model, the typical inkjet printer 20 includes a chassis 22 surrounded by a housing, casing or enclosure 24, typically of a plastic material. Sheets of print media are fed through a print zone 25 by a print media handling system 26. The print media may be any type of suitable sheet material, such as paper, card-stock, transparencies, mylar, and the like, but for convenience, the illustrated embodiment is described using paper as the print medium. The print media handling system 26 has a feed tray 28 for storing sheets of paper before printing. A series of conventional paper drive rollers (not shown), driven by a stepper motor 30 and drive gear assembly 32, may be used to move the print media from tray 28 under a paper guide member 34 into the print zone 25, as shown for sheet 35, for printing. After printing, the motor 30 drives the printed sheet 35 onto a pair of retractable output drying wing members 36. The wings 36 momentarily hold the newly printed sheet above any previously printed sheets still drying in an output tray portion 38 before retracting to the sides to drop the newly printed sheet into the output tray 38. The media handling system 26 may include a series of adjustment mechanisms for accommodating different sizes of print media, including letter, legal, A-4, envelopes, etc., such as a sliding length adjustment lever 40, a sliding width adjustment lever 42, and a sliding envelope feed plate 44.

The printer 20 also has a printer controller, illustrated schematically as a microprocessor 45, that receives instructions from a host device, typically a computer, such as a personal computer (not shown). The printer controller 45 may also operate in response to user inputs provided through a key pad 46 located on the exterior of the casing 24. A monitor coupled to the computer host may be used to display visual information to an operator, such as the printer status or a particular program being run on the host computer. Personal computers, their input devices, such as a keyboard and/or a mouse device, and monitors are all well known to those skilled in the art.

A carriage guide rod 48 is supported by the chassis 22 to slideably support a dual inkjet pen carriage system 50 constructed in accordance with the present

invention for travel back and forth across the print zone 25. The carriage 50 is also propelled along guide rod 48 into a servicing region, as indicated generally by arrow 52, located within the interior of the housing 24. As shown in FIG. 2, the carriage 50 has a pair of bearings 54 which slideably support the carriage as it travels along the guide rod 48. The carriage also has a roller member 55 which rolls along a lateral surface of the chassis 22. The roller 55 in combination with the pair of bearings 54 provides a three-point carriage support system. Preferably, bearings 54 are V-groove type bearings, such as those disclosed in U.S. Patent No. 5,366,305, assigned to Hewlett-Packard Company, the assignee of the present invention. A carriage DC motor 56 is coupled by a drive gear 57 to drive an endless belt 58. The motor 56 operates in response to control signals received from the controller 45. The belt 58 may be secured in a conventional manner to the carriage 50 to incrementally advance the carriage along guide rod 48 in response to rotation of motor 56.

In the print zone 25, the media sheet 35 receives ink from an inkjet cartridge, such as a black ink cartridge 60 and/or a color ink cartridge 62. The cartridges 60 and 62 are often called "pens" by those in the art. The illustrated color pen 62 is a tri-color pen, although in some embodiments, a pair of discrete monochrome pens may be used. While the color pen 62 may contain a pigment based ink, for the purposes of illustration, pen 62 is described as containing three dye based ink colors, such as cyan, yellow and magenta. The black ink pen 60 is illustrated herein as containing a pigment based ink. It is apparent that other types of inks may also be used in pens 60, 62, such as paraffin based inks, as well as hybrid or composite inks having both dye and pigment characteristics.

The illustrated pens 60, 62 each include reservoirs for storing a supply of ink therein. The pens 60, 62 have printheads 64, 66 respectively, each of which have an orifice plate with a plurality of nozzles formed there-through in a manner well known to those skilled in the art. The illustrated printheads 64, 66 are thermal inkjet printheads, although other types of printheads may be used, such as piezoelectric printheads. The printheads 64, 66 typically include a plurality of resistors which are associated with the nozzles. Upon energizing a selected resistor, a bubble of gas is formed ejecting a droplet of ink from the nozzle and onto a sheet of paper in the print zone 25 under the nozzle. The printhead resistors are selectively energized in response to firing command control signals delivered by a multi-conductor strip 68 from the controller 45 to the printhead carriage 50.

Referring to FIG. 2, the carriage 50 includes a latch mechanism, illustrated as two clamping levers, latch members or lids 70 and 72, which are pivotally attached by a hinge 74 to a body portion 75 of the carriage. The carriage body 75 preferably also defines a thin alignment web or main wall 76, which may be between 1.0-6.0 mm (millimeters) thick, but more preferably is on the

order of a nominal 3.5 mm thick. The main wall 76 divides an interior portion of the body 75 into a black pen chamber 80, and a color pen chamber 82. Before discussing the manner in which the carriage 50 clamps and aligns the pens, it is helpful to understand the various datum points and cam surfaces which are conveniently molded into the exterior of the pens 60, 62.

FIGS. 3 and 4 show respective back and front views of the pens 60, 62 from the bottom, whereas FIG. 2 shows a front top view of the pens. The black pen 60 has a hollow body 84 which forms a reservoir for storing a supply of ink, which is selectively ejected through nozzles within the printhead 64. The pen body 84 includes an outer perimeter member 85, within which are seated an outboard side wall 86 and an inboard side wall 88. An insertion handle or gripping surface 90 is conveniently located between a front wall 92 and an upper wall 94 for use in installing and removing pen 60 from carriage 50. A bottom wall 95 extends between the front wall 92 and a nose portion 96 which houses the printhead 64. A rear wall 98 extends downwardly from the upper wall 94 to form a portion of nose 96.

The rear wall 98 supports a conventional flex tab circuit 100 having a plurality of electrical interconnect pads (omitted for clarity), which may be constructed as described in U.S. Patent No. 4,907,018, assigned to the present assignee, Hewlett-Packard Company. In this location, the flex tab circuit 100 may be conveniently extended to make electrical contact with the printhead 64. Preferably, the handle 90, the perimeter walls 92, 94, 96, 95 and 98, as well as a printhead mounting wall 102 which receives printhead 64, are all molded as a single unitary part 85. This is particularly advantageous because a group of pen locating datums may also be defined by this single pen perimeter member 85.

In the illustrated embodiment, the outer perimeter member 85 defines a plurality of X, Y, Z coordinate axes locating members or datums. For the purposes of illustration, an X, Y, Z coordinate axis system 103 is shown in FIGS. 1-8, with the X axis pointing in the scan direction parallel to the scanning axis of the carriage 50 defined by guide rod 48. The Y axis is parallel to the paper advance path through the printer 20. The Z points in an upright direction and is used as a reference for pen-to-paper spacing, which is one critical component to providing high quality hard copy images.

To locate the pen 60 with respect to the X axis, the perimeter member 85 is preferably contoured during molding to define three X-axis direction positioning lands or datums, specifically: an X1 datum 104 located near the pen nose 96, an X2 datum 106 located along the bottom wall 95 near front wall 92, and an X3 datum 108 located at the upper back corner. To orient the pen 60 with respect to the Z axis, the perimeter member 85 defines a Z datum 110, located along the bottom wall 95. Two datums are used to orient the pen 60 with respect to the Y axis, specifically: a Y1 datum 112 is offset from the nose portion 96 and extends downwardly from the bottom wall 95, and a Y2 datum 114 projects

from the rear wall 98. While in the illustrated embodiment the X datums 104, 106, 108 are all located along the same side wall 88, it is apparent that for some implementations, the outer perimeter member 85 may also define similarly located datums next to the outboard wall 86.

The outer perimeter member 85 also defines a latching land 115, which is sculpted by molding member 85 to include a contour having a sloped cam surface. The latching land 115 is useful in securely seating pen 60 within carriage 50, as described further below. The latching land 115 lies adjacent a buttress member 116, which advantageously is used to provide a support surface for the X3 datum 108. In the illustrated embodiment, the sloped cam surface 115 slopes upwardly (positive Z direction) when traversing in a negative Y direction away from the perimeter member 85. The cam surface 115 also slopes downwardly (negative Z direction) when traversing in a positive X direction from the side where it joins the buttress member 116. The latching land cam structure 115 is located along an upper rear corner or shoulder 118 of the perimeter member 85, and below the upper wall 90. The shoulder surface 118 is particularly useful for installing and extracting the pen 60 from carriage 50, as described further below.

The illustrated color pen 62 includes an outer perimeter member 120, which in the illustrated embodiment is sandwiched between an inboard side wall 122, and an outboard side wall 124, which together define a hollow pen body 125. The hollow pen body 125 preferably defines or houses three reservoirs for storing a supply of three colors of ink (e.g. cyan, magenta, and yellow), which is selectively ejected through nozzles within the printhead 66. In the illustrated embodiment, the pen 62 has an insertion handle or gripping surface 126 conveniently located between front and upper walls 128, 130, respectively. The handle 126 is useful for installing and removing the pen 62 from carriage 50. A bottom wall 132 joins the front wall 128 with a nose portion 134 which houses the printhead 66. A rear wall 136 extends downwardly from the upper wall 130 to form a portion of nose 134.

A conventional flex tab circuit 138, such as described above for flex tab circuit 100 may have a plurality of electrical interconnect pads (omitted for clarity) which are supported by the rear wall 136 to make electrical contact with the printhead 66. Preferably, the handle 126, the perimeter walls 128, 130, 132, 134 and 136, as well as a printhead mounting wall 138 which receives printhead 66, are all molded as a single unitary part 120. This is particularly advantageous because a group of pen locating datums may also be defined by this single pen perimeter member 120.

In the illustrated embodiment, the outer perimeter member 120 defines a plurality of X, Y, Z coordinate axes locating members or datums. To locate pen 62 with respect to the X axis, the perimeter member 120 is preferably contoured during molding to define three X-axis direction positioning lands or datums, specifically: an X1

datum 140 located near the pen nose 134, an X2 datum 142 located along the bottom wall 95 near front wall 92, and an X3 datum 144 located at the upper back corner. To orient the pen 62 with respect to the Z axis, the perimeter member 120 defines a Z datum 145, located along the bottom wall 132. Two datums are used to orient the pen 62 with respect to the Y axis. First, a Y1 datum 146 is offset from an angular portion of the bottom wall 132 to extend downwardly from the bottom wall 132. Second, a Y2 datum 148 projects from the rear wall 98. While in the illustrated embodiment the X datums 140, 142, 144 are all located along the same side wall 122, it is apparent that for some implementations, the outer perimeter member 120 may also define similarly located datums adjacent the outboard wall 124. For instance, the illustrated pen 62 includes three datums for pen registration in the scanning axis (X) direction, specifically, an X1 datum 150, an X2 datum 152, and an X3 datum 154, all opposite their respective X1, X2 and X3 datums 140, 142 and 144.

A latching land 155, contoured to have a sloped cam surface, is joined to the outer perimeter member 120, for instance by bonding with adhesives, using ultrasonic welding techniques, or other comparable methods known to those skilled in the art. The latching land 155 is useful in securely seating pen 62 within the carriage 50, as described further below. In the illustrated embodiment, the sloped cam surface 155 slopes upwardly (positive Z direction) when traversing in a negative Y direction away from the perimeter member 120. The cam surface 155 also slopes downwardly (negative Z direction) when traversing in a negative X direction toward side wall 124. The latching land 155 lies adjacent a rounded shoulder surface 156 (see FIG. 2) formed along the top surface 130 of the perimeter member 120. The rounded shoulder 156 is useful in guiding the latch member 72 downwardly over the pen 62, as described further below. The latching land cam structure 155 is located along an upper rear corner or shoulder 158 of the perimeter member 120, and below the upper wall 130. The shoulder surface 158 is particularly useful for installing and extracting the pen 62 from carriage 50, as described further below.

For the illustrated pen 62, having Y and Z datums located substantially central to the pen body 125, and symmetrical X datums located along each side of the pen, it is apparent that pen 62 may be oriented in other implementations against an alignment wall beside the side wall 124. To aid in this symmetrical design, the latching land 155 is also symmetrically formed with a second sloped surface which joins the cam surface 155, which is of interest here. It is apparent that pen 60 may also be symmetrically designed for use in other implementations.

As shown in FIGS. 5-8, the carriage 50 includes a group of X, Y and Z datums or locator lands for both the black and color pens 60, 62. First considering alignment in the X axis direction, the pens 60, 62 are pushed toward the main wall by biasing members. Specifically,

the pen 60 is biased toward the main wall 76 by a spring-loaded flexure member 170, whereas the color cartridge 62 is biased toward wall 76 by spring-loaded flexure member 172. Preferably, each flexure member 170, 172 has a hooked portion that may be secured over an upper surface of the respective side walls 174, 176 of the carriage body 75. As shown in FIG. 7, the members 170, 172 are biased outwardly from the respective walls 174, 176 by coil springs 178. The spring members 170, 172 force the respective pens 60, 80 toward X axis locating datums located along main wall 76.

For the black pen 60, the X1 datum 104 is forced against an X1 datum 180, and the X2 datum 106 is forced against an X2 carriage datum 182. The X1 and X2 datums 180, 182 are shown as sculpted lands which are molded as an integral portion of main wall 76. To provide a desired pen separation near the top of black pen 60, the wall 76 defines a slot which surrounds an alignment pin 184, which serves as an X3 carriage datum to contact the black pen X3 datum 108. It is apparent that the X3 datum 184 may also be a molded sculpted land, such as shown for the X1 and X2 datums 180, 182; however, for ease of manufacturability, the X3 alignment pin 184 is preferred.

Indeed, preferably the X1 datum is a separate pin, shown as an X1 datum pin 180' (shown only in FIGS. 5 and 6), which is located closest to the printhead of all the X datums. Preferably, the X1 datum pin 180' and the X3 datum pin 184 are of a steel, which may be manufactured with close dimensional tolerances on the order of 0.0025 millimeters (+/- 0.0001 inches) in diametrical error. These tolerances are easily and economically attained with steel, although other materials may prove suitable in some implementations. In the illustrated embodiment, the X1 datum pin 180' and the X3 datum pin 184 are insert molded into a rear wall 185 of the carriage body 75, to extend into slots defined by the main wall 76. For convenience, in the remainder of the detailed description, only the X1 molded datum 180 will be referred to, although it is apparent that the X1 datum pin 180' may be substituted for the X1 land 180 in any given implementation.

For the color pen 62, along the interior of the color pen chamber 82, the main wall 76 has an X1 datum 186 and an X2 datum 188, which are shown as being integrally molded within wall 76. As described above for the X1 black carriage datum 180, the X1 color carriage datum is preferably a steel pin 180' (shown only in FIGS. 5 and 6), but for convenience in the following description, only the X1 molded datum 186 will be referred to, although it is apparent that the X1 datum pin 180' may be substituted for the X1 land 186 in any given implementation. The color pen X1 datum 140 engages the X1 carriage datum 186, and the X2 pen datum 142 engages the X2 color carriage datum 188. The portion of the X3 steel pin 184 extending into the color pen chamber 82 serves as an X3 alignment datum for the color pen 62. The X3 color pen datum 144 engages the

X3 alignment pen datum 184. In this manner, all of the X1, X2 and X3 datums in each pen chamber 80, 82 are uniformly formed during the molding process of manufacturing the carriage body 75 to assure repeatability for successive carriage bodies.

Now examining alignment in the remaining Y and Z directions, the carriage system 50 includes a Y-Z reference rod 190, which is preferably integrally molded within pockets 191, 192 defined by the carriage walls 174, 176, respectively. The rod 190 has a longitudinal axis 193 which is substantially parallel with a bore axis 194 through the carriage bearings 54. Along the underside of the black pen 60, the Y1 datum 112 and the Z datum 110 rest at 90° angles along the Y-Z reference rod 190, as shown in FIG. 8. Similarly, the Y1 datum 146 and the Z datum 145 on the color pen 62 also engage the Y-Z rod 190 as it extends through the interior of carriage chamber 82. A second Y2 carriage datum is provided by the rear carriage wall 185, along a Y2 datum region 196 for the black pen 60, and a Y2 datum region 198 for the color pen 62. The Y2 datum region 196 is intersected by the Y2 pen datum 114 for the black pen 60, while region 198 is intersected by the Y2 pen datum 148 for the color pen 62. Similarly, the back wall surface 198 within chamber 82 provides a Y2 datum surface for the color pen 62, which is aligned with Y2 color pen datum 148.

To provide a positive biasing force in each of the X, Y and Z directions, as well as to secure the pens, 60, 62, within carriage 50, the latching mechanism comprises the clamping levers 70, 72, which serve as a main body of the mechanism. The latching mechanism also has biased engagement members, such as spring loaded cam surfaces 200, 202 located along the lever undersides. The cam surface 202 on the black lever 70 engages the sloped cam surface 115 on pen 60, whereas, the cam surface 202 on the color lever 72 engages the sloped cam surface 155 of pen 62. The cam surfaces 200, 202 are preferably integrally molded to project from engagement members, such as spring board members 203, 204 respectively. Biasing members, such as coil springs 205 bias the spring boards 203, 204 away from the respective levers 70, 72. The illustrated levers, 70, 72 may each define a spring pocket 206 therein for receiving springs 205, with the exterior of the spring pocket extending above the upper surface of each lever 70, 72. Preferably, the spring boards 203, 204 are seated within the respective levers 70, 72 for travel toward the levers when the springs 205 are compressed during closing of the levers.

To close the latch mechanism when the pens 60, 62 are installed in the chambers 80, 82, the levers 70, 72 are pivoted at hinge 74 over the pens. While closing the latch mechanism, a controlled force is applied by cams 200, 202 in selected directions to the respective latching lands 115, 155, which pushes each pen 60, 62 into contact with the carriage X, Y and Z datums. The relative slants of the latch cam surfaces 200, 202, and the pen latching lands 115, 155 are configured to force the pens

60, 62 toward the X datums along the main wall 76, the X datums along the rear wall 185, and the Y-Z datums established by the reference rod 190. The levers 70, 72, the spring boards 203, 204, and the relative positioning of the springs 205 with respect to the hinge 74 are preferably arranged to function as an over-center clamping mechanism. In this manner, when closing the levers 70, 72 over the pens 60, 62 during the last centimeter or so of travel, the compression springs 205 actually begin to expand. This over-centering action advantageously clamps the pens in carriage 50 and keeps the levers in a closed position.

Each lever 70, 72 may include a helpful pen removal guide cam, such as cams 207, 208, respectively, preferably along the outboard edge of each lever. The guide cams 207, 208 push the pen shoulders 118, 158 away from the spring boards 203, 204, respectively, when extracting the pens 60, 62 from the carriage system 50. The action provided by the lever guide cams 207, 208 advantageously prevents jamming of the pens in the carriage 50 when removal is required.

Referring to FIGS. 7 and 8, an additional alignment adjustment is provided by a theta-Z (θ -Z) angular alignment or registration mechanism 210. The theta-Z adjuster 210 moves a lower portion of the main wall 76 with respect to the carriage body side walls 174, 176. The main wall 76 is spring biased away from the color chamber side wall 176 by a biasing member, such as a coil spring 212. The main wall 76 has a rotational registration member, which in the illustrated embodiment is formed by terminating the lower portion of wall 76, opposite spring 212, with an angled alignment foot 214. The foot 214 has a vertical wall which extends at an angle toward the positive X direction moving in a negative Y direction toward the back of the carriage 50 (see FIG. 5). The angled surface of foot 214 may be engaged at various points along its length by an adjustment member, such as a rotatable threaded member, for instance screw 215. The registration screw 215 extends through and threadably engages a threaded passageway defined by a threaded boss portion 216 located along the lower surface of the carriage body 75.

Rotating the angular registration screw 215 further into engagement with the foot 214 pushes the black and color X2 datums 182, 188 toward the color pen chamber 82. Rotation of the registration screw 215 out of the boss 216 allows the main wall 76 and X2 datums 182, 188 to move toward the black pen chamber 80 under the biasing force provided by the spring member 212. This theta-Z angular adjustment is typically performed at initial assembly, or during field service or maintenance.

Advantageously, the theta-Z adjustment system 210 may be activated by extending a probe (not shown) through a hole 218 formed within the carriage body side wall 174. Such a probe then intersects the black pen X2 datum 182 to measure the X axis offset of wall 76 with respect to the black X1 datum 180. The screw 215 may then be rotated until a desired theta-Z adjustment has been made, as measured by the probe. Through adjust-

ment of a single registration member, the theta-Z angular alignment of each pen chamber 80, 82 is adjusted simultaneously. Thus, the alignment of the nozzle columns of both the black and color printheads 64, 66 is trued with respect to the paper advance Y axis, which eliminates saw-tooth errors in the printed image.

The carriage body 75 also includes a pen nose guide portion 220, which may be configured as a generally T-shaped member 220 extending from the underside of the main wall 76. This T-shaped guide 220 advantageously positions the pens 60, 62 toward the carriage rear wall 185. During pen installation, the guide 220 pushes the pen noses 96, 134 rearwardly so the Y1 datums 112, 146 land behind the Y-Z reference rod 190, rather than on top of the rod.

The front-facing surface of the carriage rear wall 185 preferably has a series of spring-loaded interconnect pins (omitted for clarity from the figures) for delivering firing commands to the conductor pads of the pen flex-tab circuits 100, 138. For the black and color pens 60, 62, the carriage interconnect pins may be located in the regions indicated by arrows 222 and 224, respectively. Suitable types of interconnect pin arrangements are shown in U.S. Patent Nos. 4,706,097 and 5,295,839, assigned to the present assignee, Hewlett-Packard Company.

The rear-facing surface of the carriage rear wall 185 may provide a convenient mounting location for several different components. For example, the flexible conductor 68 delivering the firing commands to the pens may be connected to an electronics decoding board mounted to the back surface of the rear wall 185. To propel the carriage 50 across the print zone 25 and the service station area 52, the carriage drive belt 58 may be attached in a conventional manner to the rear of wall 185. Preferably, to aid in dynamic stability of the carriage 50, the drive belt 58 is attached to the carriage rear wall 185 as close as possible to the carriage bearings 54.

To provide carriage positional feedback information to printer controller 45, an encoder strip 225 (see FIG. 1) extends along the length of the print zone 25 and over the service station area 52. A conventional optical encoder reader (not shown) may also be mounted on the back surface of the carriage rear wall 185 to read positional information provided by the encoder strip 225. To provide accurate positional information, preferably the optical encoder reader is located as close as possible to the nozzle plates of the printheads 64, 66. The manner of attaching the belt 58 to the carriage, as well as the manner providing positional feedback information via the encoder strip reader, may be accomplished in a variety of different ways known to those skilled in the art.

In operation, with a printer housing lid 230 open (FIG. 2) the pens 60, 62 are inserted into the carriage 50 using handles 90 and 126. The tapered configuration of the carriage X2 and X3 datums 182, 184 and 188 facilitates the easy insertion of the pens into the pen

chambers. The clamping levers 70, 72 are then rotated downwardly to clamp the pens 60, 62 within carriage 50. The pen installation provided by carriage 50 is intuitively simple because the user actuated latches 70, 72 and cam surfaces 200, 202 help guide the pens 60, 62 into and out of the carriage 50. The carriage 50 is then moved from side to side along guide rod 48 through operation of motor 56 via the belt 58, as instructed by printer controller 45. The pens 60, 62 receive firing commands from the printer controller 45 via the flex circuit conductors 68. During periods of inactivity, the carriage returns the pens 60, 62 to the service station area 52 for servicing, maintenance, and capping (sealing) during periods of printer inactivity. The pens 60, 62 are easily removed from the carriage 50 by raising the clamping levers 70, 72 and lifting the pens by handles 90, 126 from the carriage. The lever guides 207, 208 push the pens away from the levers to avoid jamming during pen removal. Advantageously, when the printer lid 230 is opened, the controller 45 moves the carriage to a location along the print zone 25, for instance as shown in FIG. 1, where the pens may be easily replaced.

As used herein, the terms "alignment," "registration," "datum" and "reference" are all substantially synonymous. However, to aid in clarity, generally only one of these adjectives has been used in connection with a single carriage component. For instance, the Y-Z reference rod 190 could also be referred to as an "alignment rod," a "datum rod," or a "registration rod." Furthermore, while the chambers 80, 82 are illustrated as being enclosures, it is apparent that portions of the body, such as the side walls 174, 176, may be omitted and other types of biasing members may be used to force the pens 60, 62 into engagement with the main wall 76. Moreover, while the illustrated carriage 50 holds a pair of pens, it is apparent that these concepts may be easily expanded to two pair of pens, that is, a four pen system. Such a four pen carriage system may be constructed by doubling the carriage 50, for example, by constructing a substantial mirror image of the carriage 50, and making side walls 176 either joined, or more preferably, as a single unitary wall.

Advantages

To provide a high quality image on sheet 35 as a hardcopy output of printer 20, the positioning of the printheads 64, 66 must be precise, relative to each other, and to the entire printing system, as well as being repeatable. That is, when an empty pen is replaced by an operator, the alignment of the new full pen must be the same as the empty pen. The positioning of the pens 60, 62 is one of the primary variables that controls the registration of the ink droplets on the print medium. The carriage 50 positions the pens through a strategic selection of datums that reference the pens to the carriage, and the carriage to the printer.

The X axis positioning of pens 60, 62 is provided by orienting the pens so the X datums face each other. In

the illustrated carriage 50, the black pen X datums 104, 106, 108 face the color pen X datums 140, 142, 144, with the main wall 76 and the X3 alignment pin 184 sandwiched therebetween. By sandwiching the main wall 76 between the pens, the thickness of wall 76 may be more easily controlled than in earlier designs, such as the DeskJet® 1200, where the datums were all located to one side of the pen and effected by varying tolerances in pen thicknesses. Of the three X datums, the X1 datums 104, 140 (pens) and 182, 188 (carriage) are believed to be the most influential in affecting accurate drop placement, since these datums are closest to the nozzles of printheads 64, 66.

The Y axis positioning of pens 60, 62 is preferably accomplished by insert molding the Y-Z reference rod 190 into the carriage body 75, substantially parallel to the center line 194 of the insert molded bearings 54. In this manner, accurate alignment of the pens with respect to the Y and Z datums is provided relative to the carriage scanning axis, which is defined by carriage guide rod 48. Two carriage features contribute to the accurate alignment of the Y1 and Z datums for the pens. First, the V-groove bearings 54 are inserted molded into body 75 as zero-clearance bearings with a zero press fit error in the illustrated embodiment. Insert molding of bearings 54 eliminates common contributors to both Y position and theta-Z errors, which commonly occurred when using pressed-in cylindrical bushings in earlier printing mechanisms.

The second feature contributing to accurate alignment of the Y1 and Z datums concerns the concept of aligning the pen Y1 pen datums 112, 146 along the straight reference rod 190. The rod 190 preferably has a length approximately twice as long as the distance between the black and color Y1 datums 112, 146. Moreover, the Y-Z rod 190 is also accurately supported at both ends by the carriage body pockets 191, 192. Advantageously, the Y direction positional errors are approximately half of any positional errors which may occur at the ends of rod 190, since the distance between the supports 191, 192 are twice as long as the distance between the Y1 pen datums 112, 146.

The theta-Z positioning of the pens 60, 62 is advantageously controlled by adjusting a single registration mechanism 210. By making the theta-Z adjustment from the black pen chamber side of wall 76, alignment of the black nozzles of printhead 64 is optimized. Optimization of the black pen nozzles is preferred in the illustrated embodiment because the black pen 60 has a taller nozzle column or swath height, on the order of 1.27 cm (0.5 inches), relative to the swath height of each group of color nozzles of printhead 66, which are on the order of 0.53 cm (0.21 inches). It is apparent that any thickness error of the X2 color datum 188 may add to any theta-Z positional error for the color pen 60. However, the effect of any thickness error for the X2 datums 182, 188 is minimized through the use of cylindrically shaped members 182, 188. Moreover, using cylindrically shaped members 182, 188 advantageously mini-

mizes positional errors of the color pen 60, due to twisting of the X2 datum beam from theta-Z adjustments.

The carriage system 50 is particularly advantageous in providing inherently accurate X axis referencing, through the use of the relatively thin main wall 76 and the high tolerance pin 184. Both the X axis and Y axis referencing schemes are able to approach machining tolerances without requiring costly secondary machining operations. The theta-Z registration scheme 210 accurately allows simultaneous adjustment of the pens to machined tolerances, using an economical molded alignment foot 214 and an adjustment screw 215.

The lever actuated clamping system 70, 72 provides a more controlled application of force to the pens during clamping than in earlier systems. Here, the operator interacts with the levers 70, 72 to seat the pens in a printing position, rather than interacting with the pens directly. In this manner, during clamping potentially damaging lateral forces to the pen are avoided, as was often encountered in earlier printer designs. Another advantage of carriage 50 is the use of the biasing coil springs 178 for the X biasing flexure members 170, 172. The coil springs 178 provide more accurate control of the biasing force than earlier flexure spring designs, which suffered greater force variations due to small manufacturing variations in the flexure thickness. Thus, the X biasing mechanism of carriage 50 provides a more accurate control of the biasing force.

Claims

1. A dual pen carriage system (50) for scanning a pair of inkjet pens (60, 62) across a print zone (25) of an inkjet printing mechanism (20), comprising:
 - a carriage body (75) having a main wall (76) configured to be sandwiched between the pair of pens (60, 62), the main wall (76) having two opposing side surfaces each defining at least one datum (180, 180', 182, 184; 180', 184, 186, 188); and
 - a bias mechanism (170; 172) supported by the body to push each pen (60, 62) into contact with the main wall datums (180, 180', 182, 184; 180', 184, 186, 188).
2. A dual pen carriage system (50) for scanning a pair of inkjet pens across a print zone (25) of an inkjet printing mechanism (20), comprising:
 - a carriage body (75) defining two side walls (174, 176) to receive therebetween the pair of pens (60, 62); and
 - a reference rod (190) extending between the two side walls (174, 176) to contact and align the pens (60, 62) in two orthogonal directions.
3. A dual pen carriage system (50) for scanning a pair of inkjet pens (60, 62) across a print zone (25) of an inkjet printing mechanism (20), comprising:

a carriage body (75) defining a pair of pen chambers (80, 82) for receiving the pair of pens (60, 62), with the chambers (80, 82) separated by a main wall (76) having a rotational registration portion (214); and

an adjustment member (215) supported by the body (75) to selectively engage the registration portion (214) to simultaneously adjust the alignment of each pen chamber (80, 82) in an angular direction.

4. A dual pen carriage system (50) for scanning a pair of inkjet pens (60, 62) across a print zone (25) of an inkjet printing mechanism (20), with each pen (60, 62) having a printhead (64, 66) and a surface (94, 130) opposite the printhead that supports a latching land (115, 155), the carriage system (50) comprising:

a carriage body (75) configured to receive the pair of pens (60, 62), with the carriage body (75) defining plural datums (180, 180', 182, 184, 190, 196; 180', 184, 186, 188, 190, 198) to contact and align each pen (60, 62); and

a latch mechanism (70, 72) coupled to the carriage body (75) to apply a controlled force in a selected direction upon closing to the latching land (115, 155) of each pen (60, 62) to push each pen into contact with the datums (180, 180', 182, 184, 190, 196; 180', 184, 186, 188, 190, 198).

5. A dual pen carriage system (50) for scanning a pair of inkjet pens (60, 62) across a print zone (25) of an inkjet printing mechanism (20), with each pen (60, 62) having an upper surface (94, 130) supporting a latching land (115, 155), the carriage system (50) comprising:

a carriage body (75) defining a pair of pen chambers (80, 82) between two side walls (174, 176) for receiving the pair of pens (60, 62), with the carriage body (75) also defining a main wall (76) that separates the chambers (80, 82) and defines at least one datum (180, 180', 182, 184; 180', 184, 186, 188) in each chamber (80, 82), with the main wall (76) having a rotational registration portion (214), and with the carriage body (75) also defining at least one other datum (196, 198) in each chamber (80, 82);

a pair of bias members (170, 172) supported by the body (75) with one bias member in each chamber (80, 82) to push each pen (60, 62) into contact with the main wall datums (180, 180', 182, 184; 180', 184, 186, 188);

a reference rod (190) extending between the two side walls (174, 176) and through both chambers (80, 82) to define datums that align the pens (60, 62) in two orthogonal directions;

an adjustment member (215) supported by the body (75) to selectively engage the rotational registration (214) portion to simultaneously adjust

the alignment of each pen chamber (80, 82) in an angular direction; and

a latch mechanism (70, 72) coupled to the carriage body (75) to apply, upon closing, a controlled force in a selected direction to the latching land (115, 155) of each pen (60, 62) to push each pen into contact with the datums (180, 180', 182, 184, 190, 196; 180', 184, 186, 188, 190, 198).

6. A dual pen carriage system (50) according to claims 1 or 5, wherein the main wall side surfaces each define at least two datums which may be either a convexly curved surface (180', 182, 184; 180', 184, 188) or a substantially flat surface (180; 186).

7. A dual pen carriage system (50) according to claims 1, 5 or 6, wherein:

the main wall side surfaces each define three datums (180, 180', 182, 184; 180', 184, 186, 188);

each pen (60; 62) has a printhead portion (64; 66) for selectively ejecting ink, and a side wall (88; 122) with three registration datums (104, 106, 108; 140, 142, 144) extending therefrom for contacting the main wall datums (180, 180', 182, 184; 180', 184, 186, 188) when installed in the carriage body (75); and

on each main wall side surface, a first datum (180, 180'; 180', 184) is located adjacent the printhead portion (96, 134), a second datum (182; 188) is located laterally from the first datum (180, 180'; 180', 184), and a third datum (184; 184) is located in an upright direction from the first datum (180, 180'; 180', 184).

8. A dual pen carriage system (50) according to claims 2 or 5, wherein:

the reference rod (190) has a first length to extend between the two side walls (174, 176);

each pen (60, 62) has a printhead portion (96, 134) and a set of rod datums (110, 112; 145, 146) comprising two orthogonal alignment datums located adjacent the printhead portion (96, 134) to seat against the reference rod (190); and

the body (75) is configured to hold the pens (60, 62) with the sets of rod datums (110, 112; 145, 146) for the pens being separated by a distance of 40-60% of the first length when the pens (60, 62) are installed in the body (75).

9. A dual pen carriage system (50) according to claims 2, 5 or 8, wherein:

the carriage body (75) is molded of a plastic material;

the carriage system (50) further includes a pair of bearing members (54) insert molded to the carriage body (75) to slidably engage a guide rod (48) to scan the pens (60, 62) along a scan axis (194) across the print zone (25); and

wherein the reference rod (190) is insert molded into the carriage body (75) at each side wall (174, 176) in a position substantially parallel to the scan axis (194).

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10. A dual pen carriage system (50) according to claims 3 or 5 wherein:

the pair of chambers (80, 82) comprises first and second chambers;

the registration portion (214) has an angled face that is angled toward the first chamber (80); 10

the carriage system (50) further includes a bias member (212) to bias the main wall (76) toward the first chamber (80); and

the adjustment member (215) engages the angled face to push the main wall (76) away from the first chamber (80) and toward the second chamber (82). 15

11. A dual pen carriage system (50) according to claims 4 or 5, wherein: 20

the carriage body (75) defines a pair of pen chambers (80, 82) to receive the pair of pens (60, 62); and

the latch mechanism comprises a pair of latch members (70, 72), each pivoted (74) to the carriage body (75) adjacent a respective one of the pair of chambers (80, 82). 25

12. A dual pen carriage system (50) according to claim 11, wherein each latch member (70, 72) comprises: 30

a main body;

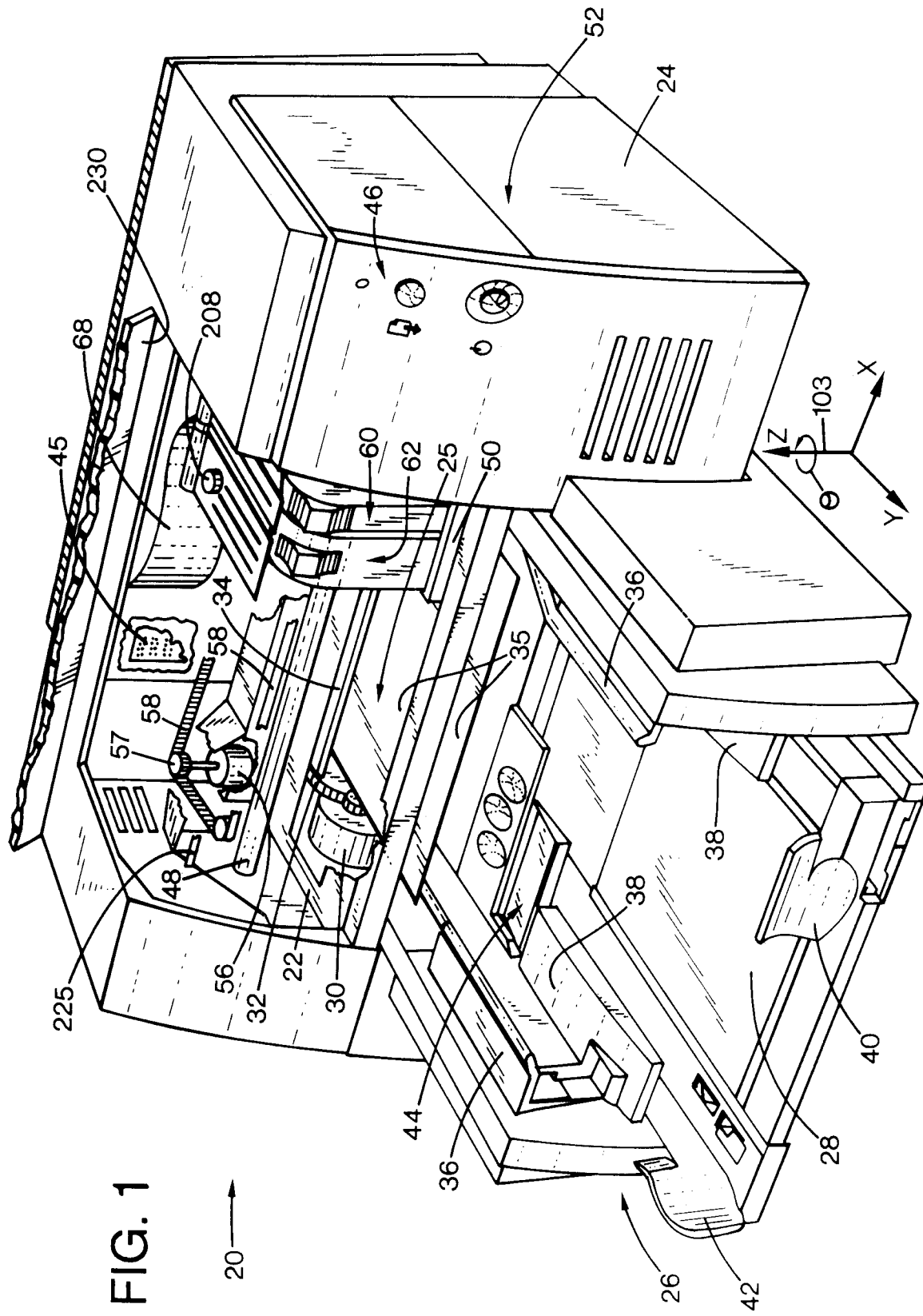
an engagement member (203, 204) having a cam surface (200, 202) for engaging the latching land (115, 155) of a pen (60, 62) installed in the carriage system (50) when the latch member (70, 72) is in a closed position; and 35

a biasing member (205, 205) for biasing the engagement member (203, 204) away from the main body. 40

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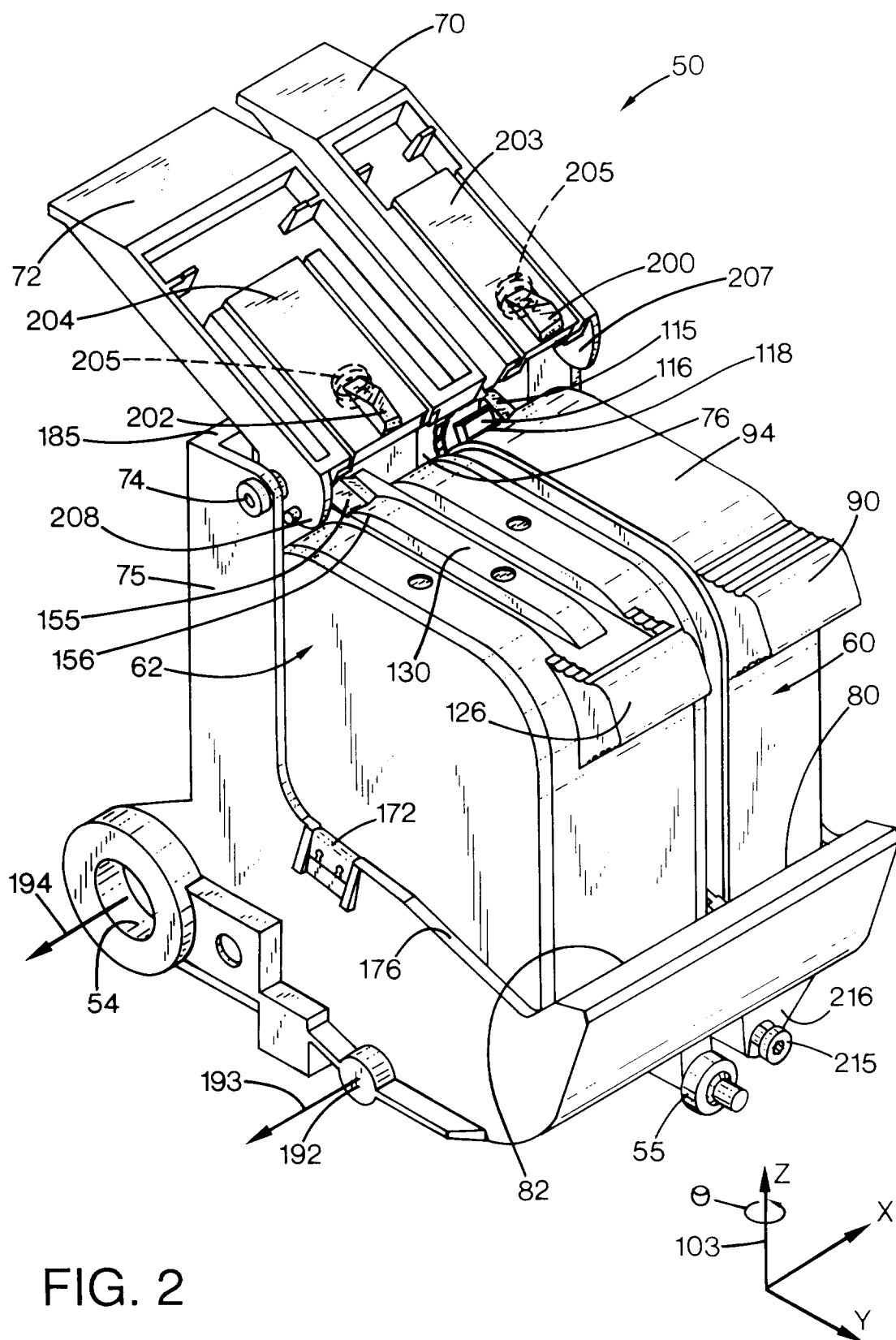


FIG. 2

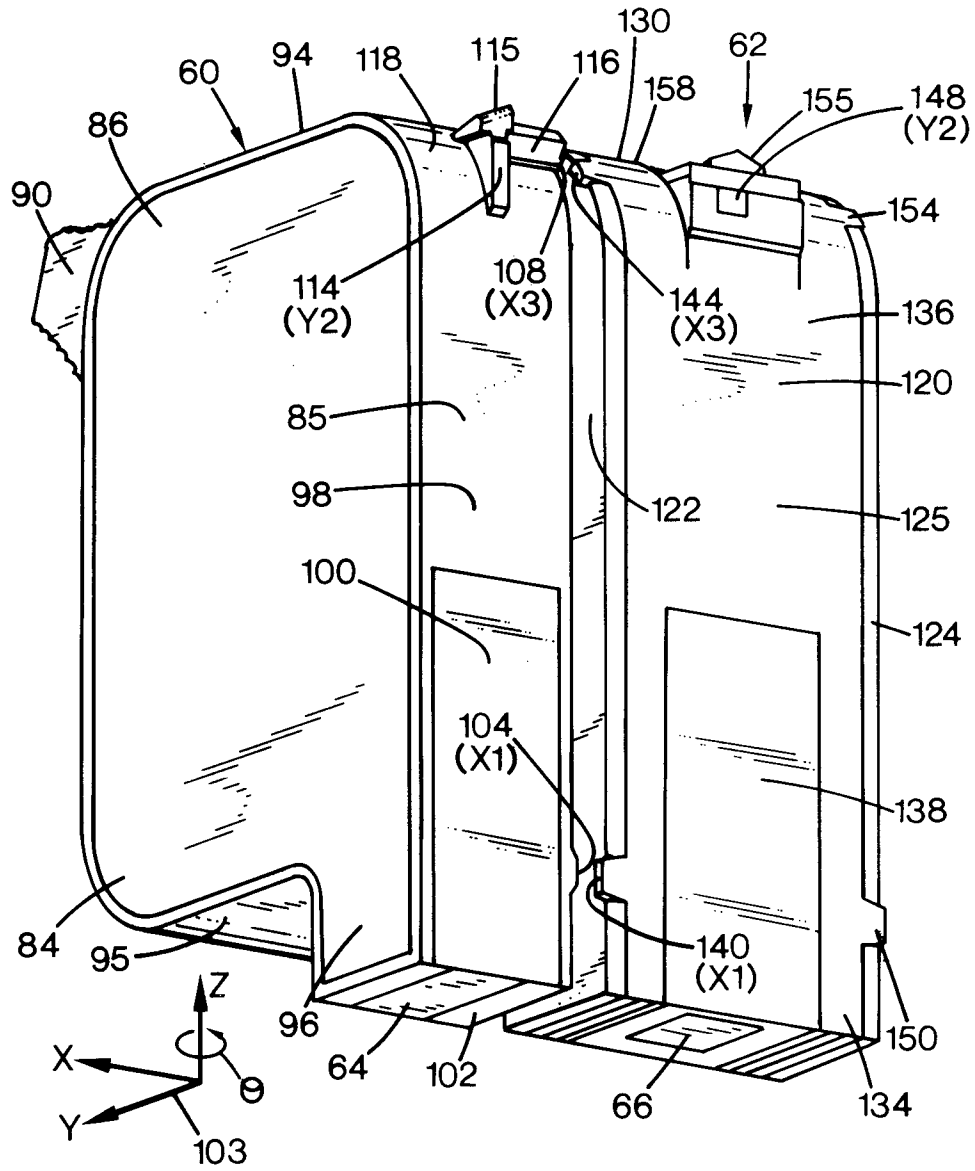


FIG. 3

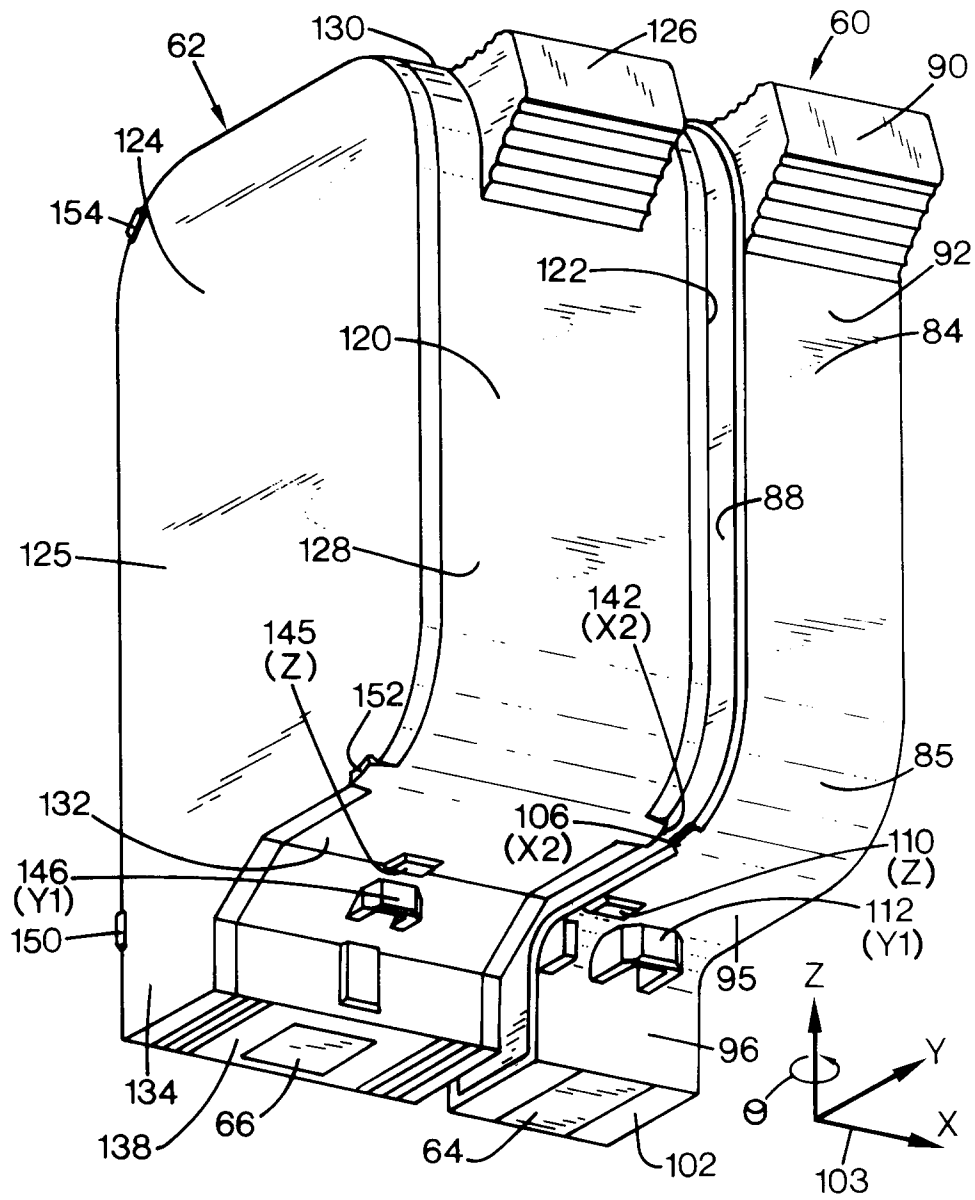


FIG. 4

FIG. 5

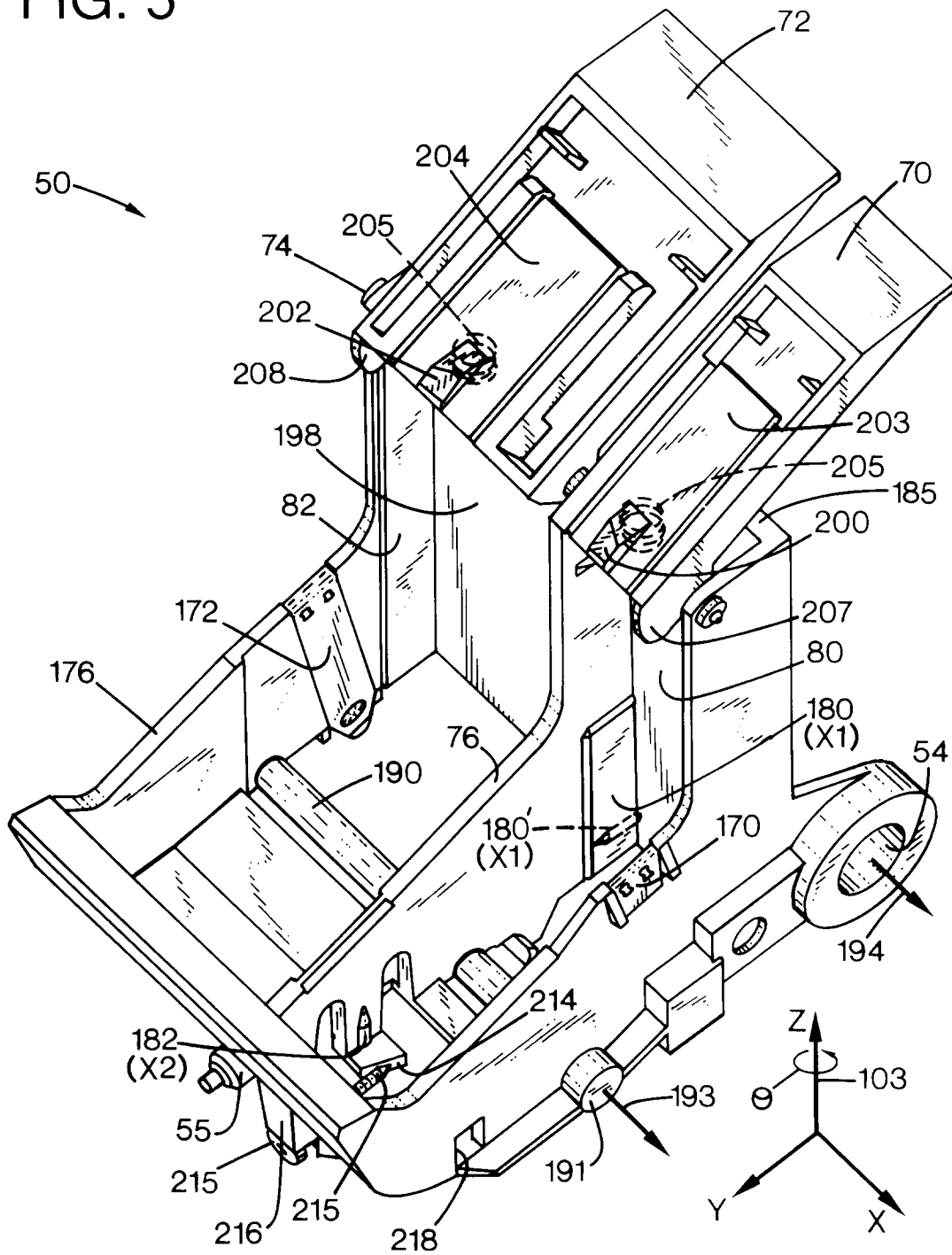


FIG. 6

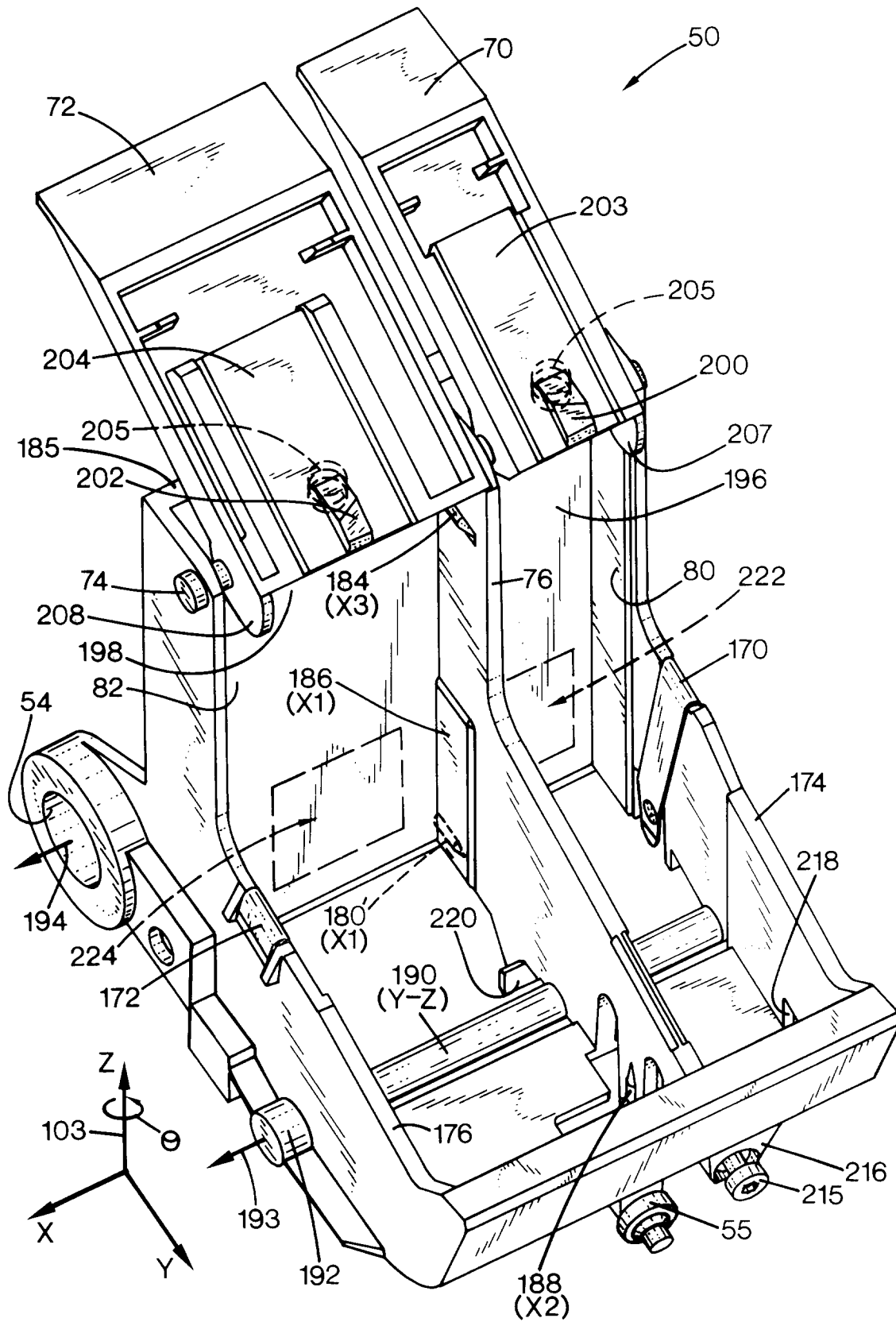


FIG. 7

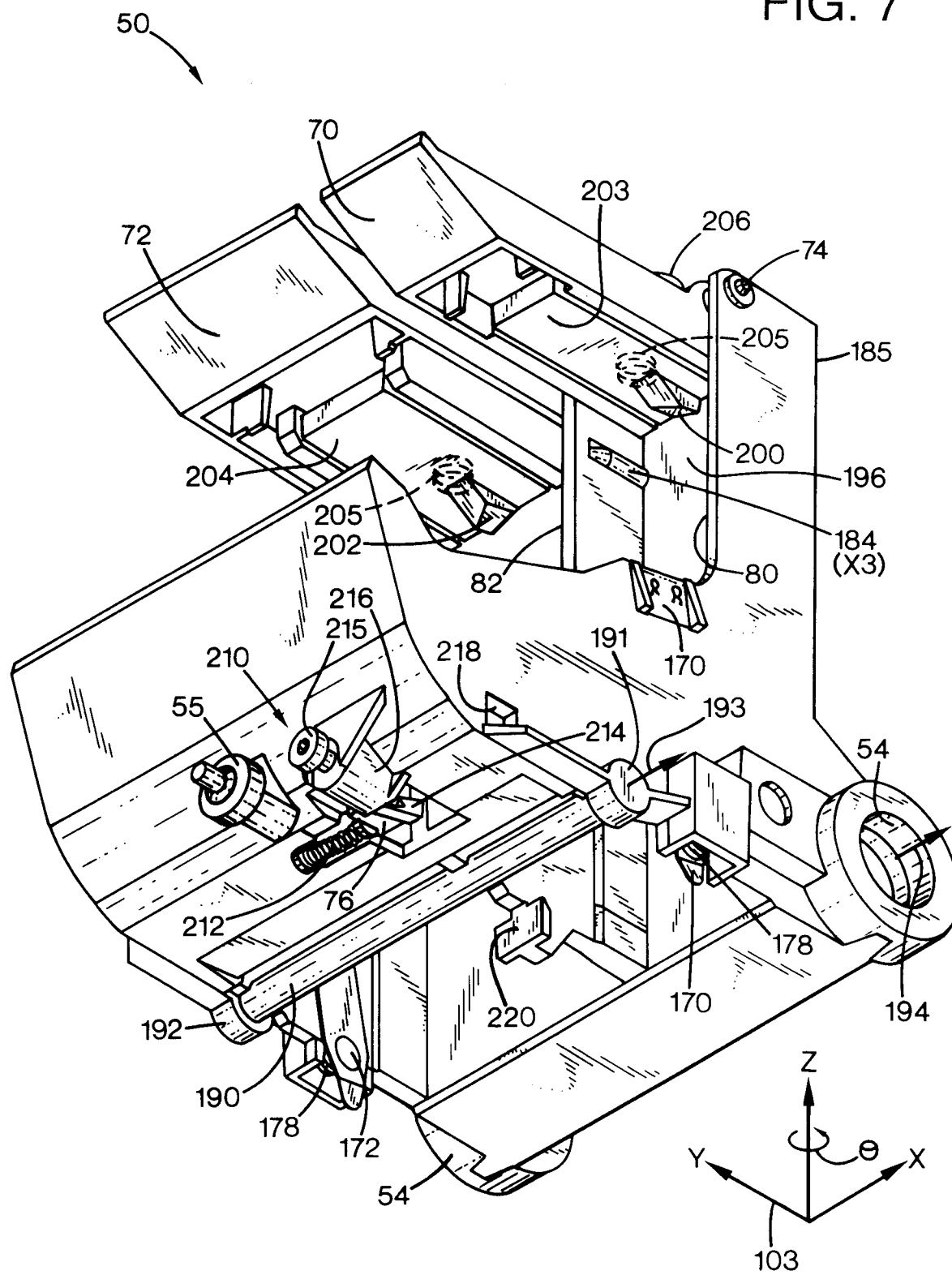
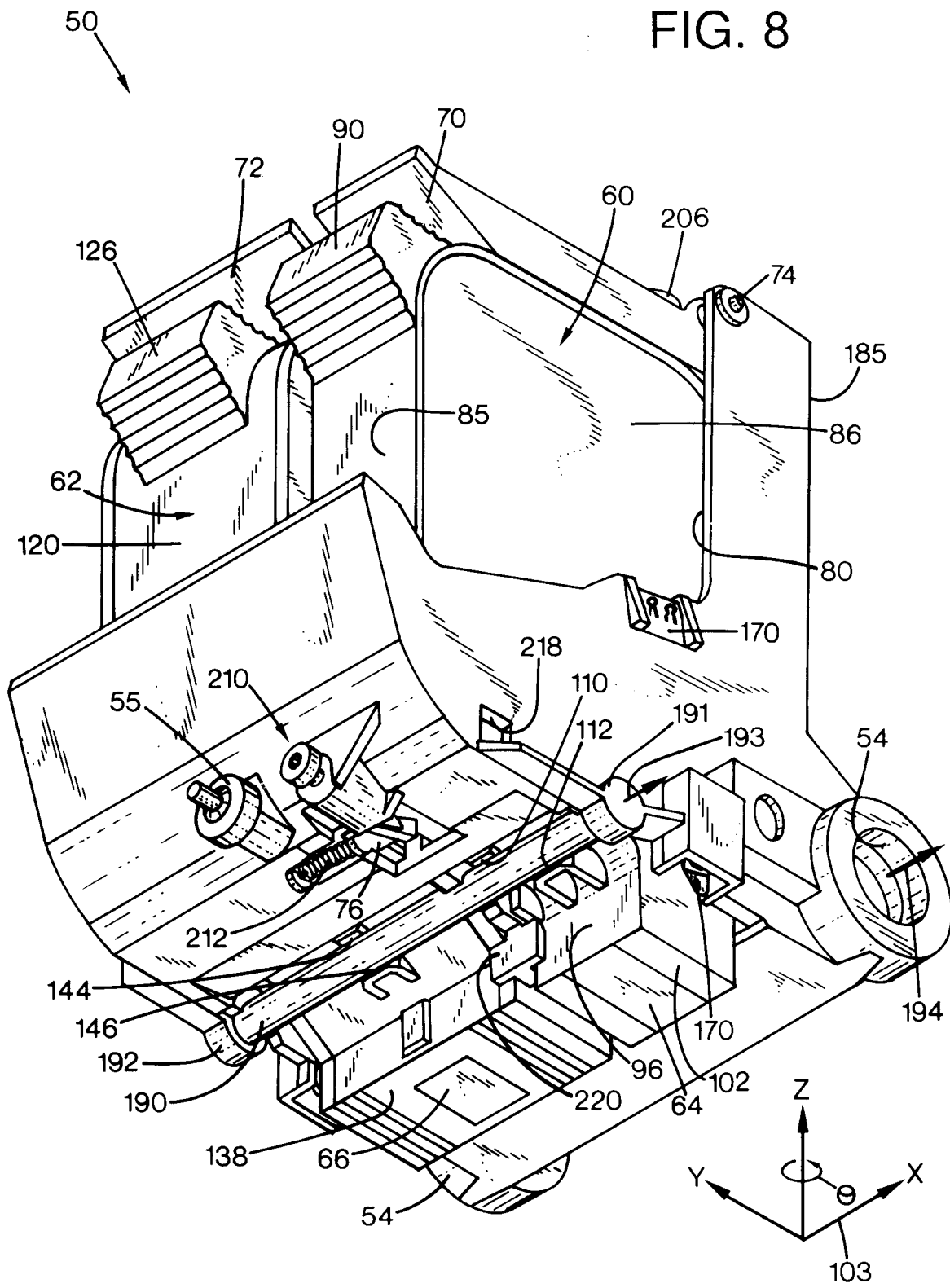


FIG. 8





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 95 30 7796

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	US-A-5 366 305 (CHRISTIANSON) * figure 1 *	1-12	B41J25/34
X	US-A-5 212 502 (BOWLING) * claim 1; figures 1,2 *	1,4,11	
D,A	US-A-4 907 018 (PINKERPELL ET AL.) * the whole document *	1-12	
A	EP-A-0 622 235 (HEWLETT-PACKARD COMPANY) * column 7, line 9 - column 8; claim 34; figures 5A,5B *	1-12	
A	HEWLETT-PACKARD JOURNAL, vol. 45, no. 1, February 1994, PALO ALTO US, pages 67-71, XP000426546 DANGELO, ET AL.: "Print Cartridge Fixturing and Maintenance in the HP DeskJet 1200C Printer" * page 67, left-hand column, last paragraph - right-hand column, paragraph 1 *	1-12	
X	EP-A-0 622 234 (HEWLETT-PACKARD COMPANY) * the whole document *	1,4,6	
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 15 May 1996	Examiner Joosting, T
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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