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(54) Inkjet printhead service station

(57) A timing cam driven service station services a pair of inkjet cartridges, such as interchangeable first and second inkjet cartridges when installed with a third inkjet cartridge, in a dual-cartridge carriage of an inkjet printing mechanism. The interchangeable cartridge system uses a black ink cartridge and a full color cartridge with full-colorant concentrations of colored ink for printing graphics and text. For printing photographic type images, the black cartridge is replaced with an imaging cartridge that carries ink formulations having reduced colorant concentrations to provide near photographic quality images. The service station has a timing cam drive that selectively translationally moves caps and wipers to service the installed printheads, including the capability to independently wipe each printhead for optimum servicing, as well as the capability to simultaneously wipe both installed printheads to speed servicing during a print job. The timing cam drive also drives a carriage lock to secure a carriage carrying the printheads in a fixed position when the printheads are capped. A method is also provided of servicing inkjet printheads installed in the printing mechanism.

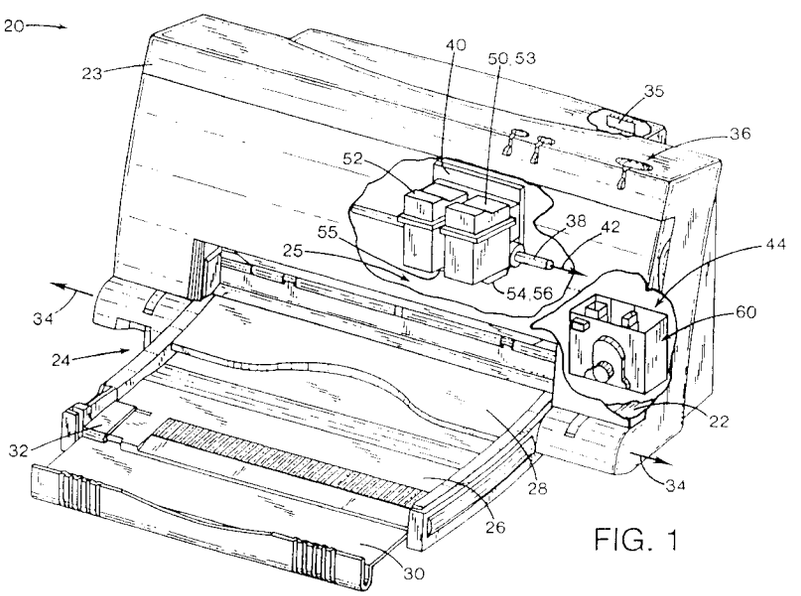

FIG. 1

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Description

[0001] The present invention relates generally to inkjet printing mechanisms, and more particularly to a timing cam driven service station for a triple-cartridge inkjet printing mechanism that receives a first inkjet cartridge and interchangeably receives one of at least two different types of inkjet cartridges, such as a black ink cartridge or a multi-color ink cartridge, each of which has different servicing needs.

[0002] Inkjet printing mechanisms use cartridges or "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 or slits 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 thennal 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).

[0003] To clean and protect the printhead, typically a "service station" mechanism is mounted within the printer chassis. For storage, or during non-printing periods, service stations usually include a capping system which 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." Typically, the waste ink is collected in a stationary reservoir portion of the service station, which is often referred to as a "spittoon. " 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.

[0004] Early inkjet printers used a single monochromatic pen, typically carrying black ink. Later generations of inkjet printing mechanisms used a black pen which was interchangeable with a tri-color pen, typically one carrying the colors of cyan, magenta and yellow within a single cartridge. The tri-color pen was capable of printing a "process" or "composite" black image, by depositing a drop of a cyan, a drop of magenta, and a drop of yellow ink all at the same location. Two of these earlier single-pen, interchangeable inkjet printing mechanisms were sold by the Hewlett-Packard Company of Palo Alto, California, the present assignee, as the DeskJet® 310 portable inkjet printer and the DeskJet® 400 desktop inkjet printer. Unfortunately, images printed with the composite black usually had rough edges, and the overall image, even the color portions, often had a non-black hue or cast, depending for instance, upon the type of paper used.

[0005] The next generation of printers further enhanced the images by using a dual pen system. These dual pen printers provided a black pen along with a tri-color pen, both of which were mounted in a single carriage. These dual pen devices had the ability to print crisp, clear black text while providing full color images. One earlier dual pen inkjet printing mechanism was sold by the Hewlett-Packard Company of Palo Alto, California, the present assignee, as the DeskJet® 320 portable inkjet printer. As another answer to the dissatisfaction with the composite black images, a quad pen printing mechanism was developed which carried four cartridges in a single carriage. These quad pen printing mechanisms had a first pen carrying black ink, a second pen carrying cyan ink, a third pen carrying magenta ink, and a fourth pen carrying yellow ink.

[0006] Unfortunately, both the quad pen printers and the dual pen printers produced images, such as photographic images, which had a "grainy" appearance. For example, when printing a light colored portion of an image, such as a flesh tone, yellow dots were printed and lightly interspersed with magenta dots. When viewed at a distance, these magenta dots provided a flesh tone appearance; however, upon closer inspection the magenta dots were quite visible, giving the image an undesirable grainy appearance. This grainy appearance was similar to the graininess seen in newspaper photographs, or in photos taken using the wrong speed ("ASA" or "ISO" rating) of photographic film in low light conditions. Inkjet printing mechanisms are known as "binary drop devices" because they form images either by firing to place a drop of ink on the print medium, or by not firing. Not firing a droplet leaves either the print medium, or a previously printed drop(s), exposed to view. Unfortunately, such binary drop devices give inherently grainy images due to the visual "step" between the "drop on" and "drop off" regions. Worse yet, the larger the drops printed, the more grainy the resulting image appears, whether printing color or gray-scale images.

[0007] These earlier inkjet printers provided crisp black text and bright vivid graphics and charts, yet they failed to provide images of near photographic type quality, such as portraits, scenic landscapes, and other natural appearing images. Other devices have heen used to provide high quality images, such as continuous tone devices some of which use a dye sublimation processes. Unfortunately, these continuous tone devices are expensive, and very unlikely to be viable within the small office and home printer markets, which currently sell printers to consumers within the price range

of $200-$1,000 dollars.

[0008] Another printing system, known as an "imaging" printing system, has been proposed. Using a basic dual pen printer platform, typically constructed for a monochrome (e.g. black) cartridge and a tri-color (e.g. cyan, magenta, yellow) cartridge, the monochrome cartridge is replaced with a tri-chamber "imaging cartridge." While the normally installed tri-color cartridge carries full colorant concentrations of inks, the imaging cartridge typically carries ink formulations having reduced colorant concentrations. For instance, the imaging cartridge may contain reduced colorant concentrations of cyan and magenta, and a full concentration of black ink. By interspersing droplets of reduced colorant concentration with droplets of the full colorant concentrations, the resulting images have a near photographic quality.

[0009] Unfortunately, in a dual pen inkjet printer, this ability to interchange the monochrome and imaging cartridges presents a unique set of problems when it comes to servicing of both types of cartridges. Two earlier imaging inkjet printing mechanisms were the models 690C and 693C DeskJet® inkjet printers sold by the Hewlett-Packard Company of Palo Alto, California, the present assignee. This system used dye-based color inks and a pigment-based back ink, which had different servicing needs than the dye-based color inks. In this earlier imaging system, the same wiper was used to service either the black pen or the imaging pen, with the wiper being of a rigid upright profile, mounted on a spring-loaded anti to avoid excessive wiping forces which may otherwise damage the printheads. Another wiper was constructed in the same manner for the full color inkjet cartridge. Both wipers were mounted on the same support platform for simultaneously wiping the two pens installed in the carriage.

[0010] Indeed, keeping the nozzle face plate clean for cartridges using pigment based inks has proven quite challenging. In the past, multiple inkjet printheads were wiped simultaneously, all at the same speed, which was fine when all the cartridges contained the same type (albeit different colors) of ink. However, these pigment based inks are less viscous than the dye based inks, so the pigment based inks require a slower wiping speed than that previously needed for dye based inks. Yet, there is an lower limit to the wiping speed because too slow a wipe wicks excessive amounts of ink from the dye based full color and imaging pens. This excess dye based ink eventually builds-up a residue on the wiper, leading to less effective wiping in the future, as well as other problems.

[0011] For instance, excess residue around the wipers may lead to ink build-up around the service station, which could contaminate the caps. Printhead cap contamination may lead to shorter cartridge life because ineffective capping may induce failures in the cartridge. Other problems caused by this residue on the full color wiper include puddling of ink on the orifice plate, which can lead to undesirable color mixing or misdirected nozzles. As a further complication, the cartridges are equipped with wiper scrapers located along the left and right side edged of the pen snout, which houses the printhead. This excess color ink, extracted during the slow wiping strokes required for the black pen, is deposited on these wiper scrapers, which leads to a problem known as "fiber tracking." The accumulated ink on the color printhead wiper scrapers remains wet and sticky, creating an ideal trap for all sorts of debris and fibers, ranging from paper fibers and dust, to clothing lint and carpet fibers. The longer fibers often contact the paper as the carriage moves through the printzone, trailing through the freshly primed ink, leaving ink streaks and smearing the image. This fiber tracking problem is particularly prevalent when printing with large volumes of black ink, which many consumers do when primarily printing text, indeed, many consumers use four or five black cartridges before replacing the full color cartridge.

[0012] Actually, a scrubbing type of wiping routine is preferred to clean the tar-like pigment ink residue from the printheads. If a faster wipe was used to accommodate the dye based inks, the wiper for the pigment based ink is prevented from making full contact with the residue. Instead, the wiper skips over bumps formed from the tar-like pigment based ink residue in a jerking or stuttering type of motion, which failed to remove the residue from the printhead. In some cases, during this faster wiping stroke the wiper for the pigment based ink flexed and skimmed over the tar-like residue, which smeared the ink over the orifice plate rather than removing it. Thus, any compromise in attempting to accommodate the wiping needs of one pen was at the sacrifice of meeting the needs of the other type of pen.

[0013] One wiping system proposed by inventors at the Hewlett-Packard Company used off-set wipers, which were spaced apart a distance different than the printhead-to-printhead spacing, with the original proposal being for a wider wiper spacing. The advantage realized by this unique configuration was the ability to wipe each printhead independently, without simultaneously wiping the other one. By using this staggered spacing for the wipers, one printhead may be wiped at one speed, while the other printhead may be wiped at another different speed. This feature allowed this proposed wiper system to accommodate the diverse wiping needs of two very different printheads, here, the pigment based black ink printhead, and the dye based tri-color printhead. Unfortunately, this wiping scheme consumed more servicing time, because it could not quickly wipe both pens simultaneously between print swaths. An increase in servicing time translates to a decrease in throughput, which is a printer performance rating measured in terms of pages-per-minute, an important factor to many consumers. Thus, while this proposed servicing system met the individual servicing needs of each type of printhead, it did so at the expense of printing speed throughput.

[0014] According to one aspect of the present invention, a service station is provided for servicing an inkjet printhead of an inkjet printing mechanism. The service station includes a frame and a cap cam follower slideably mounted to the frame for translational motion toward the printhead into a capping position. A cap is supported by the cap cam follower

to seal the printhead in the capping position. A wiper cam follower is slideably mounted to the frame for translational motion toward the printhead into a wiping position, with a wiper being supported by the wiper cam follower to clean the printhead in the wiping position. The service station also has a timing cam drive which includes a drive shaft with a cap cam, and a wiper cam mounted on the drive shaft. The cap cam engages the cap cam follower for movement between the capping position and a rest position, while the wiper cam engages the wiper cam follower for movement between the wiping position and a rest position.

[0015] Preferably the service station is also for servicing a second inkjet printhead of the inkjet printing mechanism, with the service station further comprising:

a second cap cam follower slideably mounted to the frame for transitional motion toward the second printhead into the capping position;
a second cap supported by the second cap cam follower to seal the second printhead in the capping position;
a second wiper cam follower slideably mounted to the frame for transitional motion toward the second printhead into a second wiping position;
a second wiper supported by the second wiper cam follower to clean the second printhead in the second wiping position; and
wherein the timing cam drive has a second cap cam and a second wiper cam supported by the drive shaft, with the second cap cam engaging the second cap cam follower for movement between the capping position and a rest position, and with the second wiper cam engaging the second wiper can follower for movement between the second wiping position and a rest position.

[0016] In a preferred arrangement, said wiper cam and the second wiper cam are configured and driven by the drive shaft for selectively:

(a) simultaneously wiping both said printhead and said second printhead;
(b) independently wiping only said printhead; and
(c) independently wiping only said second printhead.

[0017] In another preferred arrangement, the printhead is reciprocated by a carriage of the inkjet printing mechanism, with the service station further comprising: a carriage lock cam follower slideably mounted to the frame for transitional motion toward the carriage into a locking position; a carriage lock supported by the carriage lock cam follower to latch the carriage in a fixed position when the carriage lock cam follower is in the locking position; and wherein the timing cam drive has a carriage lock cam supported by the drive shaft to latch the carriage when the cap cam follower is in the capping position, with the carriage lock cam engaging the carriage lock cam follower for movement between the locking position and a rest position.

[0018] The service station may further comprise a carriage lock biasing member that urges carriage lock and carriage lock cam follower away form the locking position.

[0019] In another preferred arrangement, the service station comprises: a cap base that joins the cap to the cap cam follower for gamballing motion of the cap with respect to the cap cam follower; a cap biasing member that urges the cap toward the printhead; a wiper base that joins the wiper to the wiper cam follower for gambling motion of the wiper with respect to the wiper cam follower; and a wiper biasing member that urges the wiper toward the printhead; preferably, a cap biasing member is sandwiched between the cap base and the cap cam follower; and a wiper biasing member is sandwiched between the wiper base and the wiper cam follower.

[0020] According to another aspect of the present invention, a service station is provided for servicing a pair of inkjet printheads of an inkjet printing mechanism. Here, the service station has first, second, third and fourth cam followers each slideably mounted to a frame for transitional motion into servicing positions for the inkjet printheads. The service station also has a pair of wipers and a pair of caps.

[0021] One wiper is supported by the first cam follower for movement to a first servicing position to wipe one printhead. The other wiper is supported by the second cam follower for movement to a second servicing position to wipe the other printhead. One cap is supported by the third cam follower for movement to a capping position to seal one printhead, while the other cap supported by the fourth cam follower for movement to a capping position to seal the other printhead. The service station also has a timing cam drive having a drive shaft with first, second, third and fourth cams mounted on the shaft to engage the respective first, second, third and fourth cam followers for selectively moving the pair of wipers and the pair of caps into their servicing positions.

[0022] Preferably, the third and fourth cams are configured to simultaneously move the pair of caps into the capping position to seal the pair of printheads. In preferred arrangements, the pair of inkjet printheads are reciprocated by a carriage of the inkjet printing mechanism, with the service station further comprising:

a fifth cam follower slideably mounted to the frame for translational motion into a locking position;
a carriage lock supported by the fifth cam follower to latch the carriage in a fixed position when the fifth cam follower is in the locking position; and
wherein the timing cam drive has a fifth cam supported by the drive shaft to move the fifth cam follower between the locking position and a rest position.

[0023] In another preferred arrangement, the first and second cams are configured to:

(a) independently move said one wiper to the first servicing position.
(b) independently move said other wiper to the second servicing position; and
(c) to simultaneously move the pair of wipers to the first and second servicing positions.

[0024] According to a further aspect of the present invention, an inkjet printing mechanism is provided which may have a service station as described above.

[0025] According to yet another aspect of the present invention, a method of servicing an inkjet printhead of an inkjet printing mechanism is provided. The method includes the step of providing a cap supported by a cap cam follower, a wiper supported by a wiper cam follower, and a timing cam drive having a drive shaft with a cap cam and a wiper cam mounted thereon. In a sealing step, the inkjet printhead is sealed by translationally moving the cap into a capping position by engaging the cap cam with the cap cam follower. In a cleaning step, the inkjet printhead is cleaned by translationally moving the wiper into a wiper position by engaging the wiper cam with the wiper cam follower, and thereafter, by moving the inkjet printhead across the wiper.

[0026] Preferably, the providing step comprises providing a carriage lock supported by a carriage lock cam follower, and providing a carriage lock cam mounted on the drive shaft; and

the method further includes the step of locking the inkjet printhead in a fixed position by translationally moving the carriage lock into a locking position by engaging the carriage lock cam with the carriage lock cam follower.

[0027] According to an additional aspect of the present invention, a method of servicing a pair of inkjet printheads of an inkjet printing mechanism is provided. The method includes the step of providing first, second and third and fourth cam followers supporting respective first, second, third and fourth servicing components, and providing a timing cam drive having a drive shaft with first, second, third and fourth cams mounted thereon. In a moving step, at least one of hte first, second, third and fourth servicing components is selectively moved into a servicing position through rotation of the drive shaft and engagement of the first, second, third and fourth cam followers with respective first, second, third and fourth cams. In a servicing step, the inkjet printheads are serviced with at least one of the first, second, third and fourth servicing components when in the servicing position.

[0028] Preferably, the providing step comprises providing said first and second servicing components as a pair of wipers;

the moving step comprises the step of first moving one wiper of said pair of wipers into a first wiping position for wiping one printhead of said pair of printheads; and
the servicing step comprises the step of, after said first moving step, first wiping said one printhead with said one wiper. A preferred method further comprises the step of removing said one wiper from the first wiping position after the first wiping step;
the moving step further comprises the step of, after said first wiping step, secondly moving the other wiper of said pair of wipers into a second wiping position for wiping the other printhead of said pair of printheads; and
the servicing step further comprises the step of, after said secondly moving step, secondly wiping said other printhead with said other wiper.

Preferably, the method further comprises the step of removing said other wiper from the second wiping position after the first wiping step;

the moving step further comprises the step of, after said secondly wiping step, simultaneously moving the pair of wipers into the first and second wiping positions for wiping the pair of printheads; and
the servicing step further comprises the step of, after said simultaneously moving step, simultaneously wiping the pair of printheads with the pair of wipers.

[0029] In another preferred method, the providing step comprises providing said first and second servicing components as a pair of wipers;

the moving step comprises the step of simultaneously moving the pair of wipers into servicing positions for wiping the pair of printheads; and
the servicing step further comprises the step of, after said simultaneously moving step, simultaneously wiping the pair of printheads with the pair of wipers.

[0030] In another preferred method, the providing step comprises providing said third and fourth servicing components as a pair of caps; and

the servicing step comprises the step of sealing the pair of printheads with the pair of caps. Preferably the providing step comprises providing a carriage lock supported by a fifth cam follower, and providing a fifth cam mounted on the drive shaft; and
the method further includes the step of locking said pair of inkjet printheads in a fixed position through rotation of the drive shaft and engagement of the fifth cam follower with the fifth cam during the sealing step.

[0031] An overall goal of the present invention is to maintain cartridge health and provide a inkjet printing mechanism which prints sharp vivid images when using either a monochrome inkjet cartridge or a multi-color imaging inkjet cartridge in combination with full color cartridge.

[0032] Another goal of the present invention is to provide a robust wiping system capable of reliably cleaning the nozzle face plates of inkjet printheads having different wiping needs, such as one dispensing a fast drying pigment based ink and one dispensing a fast drying dye based ink, without sacrificing printing speed or throughput rating.

[0033] FIG. 1 is a partially cut away, perspective view of one form of an inkjet printing mechanism, here an inkjet printer, incorporating one form of a timing cam driven inkjet printhead service station of the present invention.

[0034] FIG. 2 is an exploded perspective view of the service station of FIG. 1, showing a drive motor, transfer gear, and microswitch removed.

[0035] FIG. 3 is an enlarged, cut away perspective view of the service station of FIG. 1.

[0036] FIG. 4 is an exploded perspective view of several servicing components, cam followers, and a timing cam drive of the service station of FIG. 1.

[0037] FIG. 5 is a side elevational view of one of the capping assemblies of the service station of FIG. 1.

[0038] FIG. 6 is an exploded perspective view of the capping components and cam follower support of FIG. 5.

[0039] FIG. 7 is a side elevational view of one of the wiping assemblied of the service station of FIG. 1.

[0040] FIG. 8 is an exploded perspective view of the wiping components and cam follower support of FIG. 7.

[0041] FIG. 9 is a front elevational view of the capping position of the timing cam drive, with both capping assemblies and both wiping assemblies of the service station of FIG. 1 assembled thereon, used as a reference for several side elevational views thereof, specifically :

FIG. 9A is an elevational view taken along lines A--A of FIG. 9;
FIG. 9B is an elevational view taken along lines B--B of FIG. 9;
FIG. 9C is an elevational view taken along lines C--C of FIG. 9;
FIG. 9D is an elevational view taken along lines D--D of FIG. 9; and
FIG. 9E is an elevational view taken along lines E--E of FIG. 9.

[0042] FIG. 10 is a front elevational view of the combination wiper wiping position of the timing cam drive, with both capping assemblies and both wiping assemblies of the service station of FIG. 1 assembled thereon, used as a reference for several side elevational views thereof, specifically:

FIG. 10A is an elevational view taken along lines A--A of FIG. 10;
FIG. 10B is an elevational view taken along lines B--B of FIG. 10;
FIG. 10C is an elevational view taken along lines C--C of FIG. 10;
FIG. 10D is an elevational view taken along lines D--D of FIG. 10; and
FIG. 10E is an elevational view taken along lines E--E of FIG. 10.

[0043] FIG. 11 is a front elevational view of the simultaneous wiping position of the timing cam drive, with both capping assemblies and both wiping assemblies of the service station of FIG. 1 assembled thereon, used as a reference for several side elevational views thereof, specifically:

FIG. 11 A is an elevational view taken along lines A--A of FIG. 11;
FIG. 11B is an elevational view taken along lines B--B of FIG. 11;
FIG. 11C is an elevational view taken along lines C--C of FIG. 11;

FIG. 11D is an elevational view taken along lines D--D of FIG. 11; and
FIG. 11E is an elevational view taken along lines E--E of FIG. 11.

[0044] FIG. 12 is a front elevational view of the full color wiper wiping position of the timing cam drive, with both capping assemblies and both wiping assemblies of the service station of FIG. 1 assembled thereon, used as a reference for several side elevational views thereof, specifically:

FIG. 12A is an elevational view taken along lines A--A of FIG. 12;
FIG. 12B is an elevational view taken along lines B--B of FIG. 12;
FIG. 12C is an elevational view taken along lines C--C of FIG. 12;
FIG. 12D is an elevational view taken along lines D--D of FIG. 12; and
FIG. 12E is an elevational view taken along lines E--E of FIG. 12.

[0045] 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.

[0046] While it is apparent that the printer components may vary from model to model, the typical inkjet printer 20 includes a chassis 22 which may be surrounded by a casing, housing or enclosure 23, preferably of a plastic material. The printer 20 also includes a print medium handling system 24 for supplying sheets of print media to the printer 20. Using a series of conventional motor-driven rollers (not shown), the media handling system 24 moves a sheet or page of print media through a printzone 25 from an input feed tray 26, inside the housing 23 for printing, then to an output tray 28. The print media may be any type of suitable sheet material, such as paper, card-stock, transparencies, mylar, foils, fabric, and the like, but for convenience, the illustrated embodiment is described using paper as the print medium. The media handling system 24 may include a series of adjustment mechanims for accommodating different sizes of print media, including letter, legal, A-4, envelopes, etc., such as a sliding length adjustment portion 30 of the output tray 28, and a sliding width adjustment lever 32. In the illustrated embodiment, the output tray 28, 40 pivots around axis 34 to fold up against the exterior of the casing 23 for storage.

[0047] The printer 20 also has a printer controller, illustrated schematically as a microprocessor 35, that receives instructions from a host device, typically a computer, such as a personal computer (not shown). The printer controller 35 may also operate in response to user inputs provided through a key pad 16 located on the exterior of the casing 23. 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 an.

[0048] A carriage guide rod 38 is mounted to the printer chassis 22 to slideably support a dual inkjet pen carriage 40 for travel back and forth across the printzone 25 along a scanning axis 42 that extends over the printzone 25 and a servicing region 44. A conventional carriage drive gear and DC motor assembly (not shown) may be coupled to drive an endless belt (not shown), secured to the carriage 40 in a conventional manner, to incrementally advance the carriage along guide rod 38 in response to rotation of the motor. The motor may operate in response to control signals received from the controller 35 to position the carriage 40 at selected locations over the printzone 25 and into the servicing region 44. To provide carriage positional feedback information to printer controller 45, an encoder strip (not shown) may extend along the length of the printzone 25 and over the servicing region 44, with a conventional optical encoder reader (not shown) mounted on the back surface of printhead carriage 40 to read positional information provided by the encoder strip. The manner of attaching the endless belt to the carriage 40, 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.

[0049] In the printzone 25, the media sheet receives ink from an inkjet cartridge, such as a single-chamber style monochrome, black ink cartridge 50, and/or a multi-chamber style, full color ink cartridge 52. As mentioned in the background portion above, an imaging printing system has been proposed where the single-chamber black pen 50 is replaced with a multi-chamber imaging cartridge 53, as shown in FIG. 2. The imaging cartridge 53 illustrated herein has the same general construction as the full color pen 52, but instead may carry reduced colorant concentrations of ink, as described further below. These inkjet cartridges 50, 52 and 53 are also often called "pens" by those in the art. For the purposes of discussion, pen 50 is referred to herein as either the "monochrome pen" or the "black pen," pen 52 is called the "full color pen" referring to the full dye loads contained therein, and pen 53 is called the "imaging pen" because it may be used in conjunction with the full color pen 52 to print superior, near photographic quality images, such as portraits, landscapes, and the like.

[0050] The illustrated pens 50, 52 and 53 each include reservoirs or chambers for storing a supply of ink, and printheads 54, 55 and 56 respectively, for selectively ejecting the ink. The illustrated full color pen 52 is a multi-chamber pen having three reservoirs or chambers containing three dye-based ink colors, such as full colorant concentrations of cyan, yellow and magenta inks. The black ink pen 50 is illustrated herein as a single-chamber cartridge containing a dye-based ink. It is apparent that other types of inks may also be used in the illustrated cartridges, such as pigment-based inks, paraffin-based inks, as well as hybrid or composite inks having both dye and pigment characteristics. While the black and color pens may be of different sizes, in the illustrated embodiment, the pens 50, 52 are of substantially the same size. The carriage 40 may be modified to interchangeably accommodate narrow and wider pens, for instance, by using the concepts disclosed in U.S. Patent No. 5,208,610, assigned to the present assignee Hewlett-Packard Company.

[0051] Each printhead 54-56 has an orifice plate with a plurality of nozzles formed therethrough in a manner well known to those skilled in the art. The illustrated printheads 54-56 are thermal inkjet printheads, although other types of printheads may be used, such as piezoelectric printheads. The printheads 54-56 typically include a substrate layer having a plurality of resistors which are associated with the nozzles. Upon energizing a selected resistor, a bubble of gas is formed to eject a droplet of ink from the nozzle and onto the page in the printzone 25 to form a selected image. The printhead resistors are selectively energized in response to firing command control signals which may be delivered by a conventional multi-conductor strip (not shown) from the printer controller 35 to the printhead carriage 40.

[0052] As mentioned in the Background section, graininess was experienced in printing photographic type images with the earlier dual pen systems when using only a black pen 50 and a full color pen 52 which carries full colorant concentrations of cyan, yellow and magenta inks. To eliminate this graininess, an imaging printing system has been proposed where the single-chamber black pen 50 is replaced with the multi-chamber imaging cartridge 53, which may have substantially the same external dimensions as the black pen 50 for interchangeable installation in the carriage 40. The imaging pen 53 illustrated herein has the same general internal construction as the full color pen 52, but instead carries at least some reduced colorant concentrations of ink.

[0053] For instance, a reduced colorant concentration may be composed by maintaining the same amount of solvent or carrier for a given pen capacity while reducing the amount of dye in the concentration from that conventionally used for a full concentration. Reduced colorant concentrations of cyan and magenta are often preferred, rather than yellow because visually, yellows is a low contrast color, and any graininess of the yellow ink is not visually detectable to the human eye. Yet, in other embodiments, the third chamber may contain an ink formulation of either a reduced or full concentration of yellow colored ink, or a full or reduced concentration of black ink. For instance, a reduced yellow concentration may enhance transition regions in areas of flesh tones. However, use of the imaging cartridge 53 without yellow has been found to significantly enhance the visual appearance of light tones and mid-tones in photographic type images, particularly when compared to the earlier dual pen printers, which had only full colorant concentrations. Allowing replacement of an imaging cartridge 53 with the full colorant concentration of black ink in pen 50 is advantageous for printing clear, crisp black text, while reduced colorant concentration black in the imaging cartridge provides better, photographic-type images.

[0054] Table 1 lists a variety of different interchangeable pen and ink formulation combinations, which may be implemented to provide a dual (or multiple) personality printer, capable of producing a variety of different types of output, each with outstanding print quality.

Table 1: Two Pen Carriage Ink Formulation Combinations

	Interchangeable Carriage Position		Other Position
Options	First Cartridge (Pen 50)	Second ("Imaging") Cartridge (Pen 53)	Third Cartridge (Pen 52)
Business	True Black	Partial C, M & Gray	Full C, M, Y
Imaging 1	-	Partial C, M & True Black	Full C, M, Y
Imaging 2	-	Partial C, M, Y	Full C, M, Y
Imaging 3	-	Partial R, G, B	Full C, M, Y
Imaging 4	-	Full R, G, B	Full C, M, Y
Imaging 5	-	Gray	Full C, M, Y

[0055] In Table 1, the following abbreviations are used: C for cyan, M for magenta, Y for yellow, R for red, G for green, and B for blue, with "full" indicating a full colorant concentration, and "partial" indicating a partial or reduced colorant concentration. "Gray" as used herein is considered to be a reduced colorant concentration of black colorant. The "first cartridge" corresponds to the single-chamber style monochrome pen 50, the "second cartridge" is the imaging cartridge 53 having the same multi-chamber construction as pen 52, and the "third cartridge" has the multi-chamher construction of the full color pen 52. The first and second cartridges are illustrated as being interchangeable, which leads to the problem of how to adequately service two different styles of inkjet cartridge printheads without contaminating one with ink residue remaining from the other.

[0056] For the printer 20 and controller 45 to distinguish whether the black pen 60 or the imaging pen 53 is installed in carriage 40, the pens may each have a unique identifier for automatic recognition by the controller 35, such as a distinct binary code and/or resistors of different resistances. These identifiers are decodeable by the software or firmware of the printer controller 35, and/or the software of a printer driver, located in a host computer or device which communicates with printer 20. One suitable identification scheme for interchangeable printheads is disclosed in U.S. Patent No. 4,872,027, also assigned to the present assignee, Hewlett-Packard Company. Alternatively, an operator may indicate which cartridge is installed, by making an appropriate entry into a host computer or by merely pressing a button on the keypad 46. Upon communication of which pen is installed in carriage 40, the software driver within the host computer or printer then uses an appropriate rendering scheme suitable to which ever pen is installed. The printer controller 35 then employs suitable print modes and control parameters to generate firing signals to properly fire the installed cartridges 52, and either 50 or 53.

Timing Cam Driven Inkjet

Printhead Servicing System

[0057] FIGS. 2-12E show one embodiment of a timing cam driven printhead service station 60, constructed in accordance with the present invention, for servicing the single-chamber monochrome inkjet cartridge 50, and the multi-chamber color inkjet cartridges, specifically the full color cartridge 52 and the imaging cartridge 53. The service station 60 includes a frame 62 which is supported by the printer chassis 22 in the servicing region 44. The frame 62 is configured to define a spittoon portion 64 of the service station 60, into which ink is ejected or "spit" to clear any clogs or blockages from the nozzles of printheads 54-56. The spittoon 64 may be constructed in a conventional manner, including a liner

(not shown) of an absorvent material to absorb liquid ink residue.

[0058] As shown in FIG. 2, the service station 60 includes a motor 65, such as a conventional stepper motor, housed within the frame 62. The motor 65 has a pinion gear 66, mounted to an output shaft of the motor, and extending through a slot 67 defined by an outboard side wall 68 of the service station frame 62. The motor 65 may be secured to the frame side wall 68 by a pair of screws as shown, or by other fasteners or attachment schemes known to those skilled in the art. The motor 65 may operate bi-directionally in response to control signals receipted from the printer controller 35 to drive an intermediate transfer or idler gear 70, and in particular, a bull gear portion 72 of gear 70. The idler gear 70 may be mounted to the service station frame wall 68 in a variety of different ways, such as by press-fitting a flanged shaft 74 into a mounting hole 75 defined by the frame side wall 68. The idler gear 70 has an output pinion portion 76 which drives a bull gear 78, described in further detail below.

[0059] FIG. 3 shows the service station 60 as including a combination wiper 80 for wiping either (1) the black printhead 54 when the black cartridge 50 is installed in carriage 40, or (2) the imaging printhead 56 when the imaging cartridge 53 is installed in carriage 40. The service station 60 also has a color wiper 82 for wiping the color printhead 55 of the full color inkjet cartridge 52. The service station 60 also has a combination cap 84 for sealing printheads 54, 56, and a color cap 85 for sealing the color printhead 55.

[0060] Opposite the outboard side wall 68, the service station frame 62 has an inboard side wall 86 and a rear wall 87. The inboard and outboard side walls 86, 68 each have bushing or bearing surfaces which rotatably support a shaft 88 of a timing cam drive assembly 90, constructed in accordance with the present invention. The cam drive assembly 90 has a plurality of cams mounted to shaft 88, specifically, (1) a color wiper cam 91, (2) a color cap cam 92, (3) a combination wiper cam 93, (4) a combination cap cam 94, and (5) a carriage lock cam 95. The bulk gear 78 is mounted to the outboard end of shaft 88, which through engagement with the idler gear 70, allows the cam assembly 90 to be rotated by motor 65, in response to control signals received from the printer controller 35. As shown in FIG. 4, the cam drive shaft 88 is rotatably received within a mounting hole or slot 96 defined by the inboard wall 86, and slot 98 defined by the outboard wall 68 of the service station frame 62. Each of the slots 96, 98 terminate in a cup-like portion which provides a bushing or bearing surface for the shaft 88.

[0061] The service station 60 also includes a carriage lock 100, which secures the carriage 40 in a fixed position when the caps 84, 85 are sealing the printheads 54 or 56, and 55. By locking the carriage 40 in place when the printheads are capped, a tight hermetic seal is maintained around the printhead nozzles, even during moving or transport of the printer 20, whether under power or turned off. Having the carriage lock 100 engage carriage 40 when the printheads are sealed by caps 84, 85 also prevents carriage movement away from the sealing position if the printer should be accidentally bumped while resting on a work surface or desk. The operation of the carriage lock 100 is described in greater detail below.

[0062] The service station 60 also includes a series of cam followers, including, (1) a color wiper cam follower 101, (2) a color cap wiper cam follower 102, (3) a combination wiper cam follower 103, (4) a combination cap cam follower 104, and (5) a carriage lock cam follower 105. The cam followers 101, 102, 103, 104 and 105 engage the respective cams 91, 92, 93, 94 and 95 of the timing cam drive assembly 90, for printhead servicing operation as described further below with respect to FIGS. 9-12E.

[0063] FIGS. 5 and 6 illustrate one manner of constructing a cap assembly 110 in accordance with the present invention, which may be used for both the combination cap 84 and the full color cap 85, as well as the color and combination cap cam followers 102, 104. Use of the same cap assembly 110 for both the color and combination caps 84, 85 advantageously decreases the number of different parts required to construct the service station 60, leading to economies in component part costs, and manufacturing efficiencies in assembling the service station 60. The illustrated cap assembly 100 includes a cap base 112 that has an upwardly extending neck or pedestal portion 114, which is hollowed out to define a cup 115 therein. The caps 84, 85 each have a hollow interior which fits over the pedestal 114 of the cap base 112. The caps 84, 85 also have a series of upwardly projecting sealing lips 116, which engage the orifice plates of printheads 54-56. The caps 84, 85 also define a hole 118 extending therethrough, that allows air to flow from a sealing chamber defined by the lips 116 as they contact printheads 55-56, through to the cup portion 115 of the cap base 112. A groove 119 in the base 112 is used to define a vent passageway between the caps 84, 85 and the pedestal 114. During sealing of the printheads 55, 56, this vent passageway allows air trapped inside the sealing chamber and cup 115 to escape to prevent depriming the printheads 54-56, which may otherwise occur if air was forced up into the printhead nozzles.

[0064] Each of the cap cam followers 102, 104 includes a capping sled portion 120. To join the cap base 112 to the sled 120, the cap base 112 has a pair of retainer posts 122 projecting downwardly from an undersurface of the cap base 112. Preferably, each of the retainer posts 122 is separated in two halves to define a slot 124 therebetween. A pair of biasing members, such as coil springs 125, are received over each of the retainer posts 122. Each post 122 has a pointed head 126 with an outer diameter greater than that of the portion of the retainer post which is surrounded by spring 125. The slot 124 allows two halves of each retainer post 122 to be compressed together, to receive spring 125, and to slip through a pair of mounting holes 128 defined by the cap sled 120. After slipping the retainer posts 122

through the mounting holes 128, the halves of the retainer posts 122 then expand allowing the heads 126 to secure the cap base 112 to the cap sled 120.

[0065] The springs 125 allow the cap base 112 and the caps 84, 85 to adjust the lips 116 vertically to accommodate different heights of the printheads 55-56 which may be installed in the carriage 40. Additionally, there is often a lack of parallelism experienced between the plane which in the printheads 54-56 reside and the plane defined by the upper portion of the cap lips 116. To accommodate for this lack of parallelism of the printheads 54-56, the cap sled 112 has a T-shaped rocker post 130, which is received within a pair of U-shaped slots, such as slot 132, defined by the cap sled 120. Thus, by providing the cap mounting holes 128 to be of a slightly larger diameter than the mounting posts 122, and by providing the slots 132 to be deep enough to allow the T-shaped post 130 to sink into the slots 132, the cap base 112, and thus the cap lips 116, are allowed to toggle, gimbal or tilt with respect to the cap sled 120. This tilting movement allows the lips 116 to provide a secure seal around printheads 54-56 by accommodating any lack of parallelism with the printheads, while an upward capping force is provided by the biasing springs 125 pushing the base 112 away from the sled 120. Preferably, the springs 125 have a diameter larger than the mounting holes 128, which allows the springs 125 to push against an upper surface of the cap sled 120 and against the undersurface of the cap base 112.

[0066] The cap cam follower 102, 104 defines a cam receiving pocket 134 into which a cam follower shoulder 135 extends. The cap cam follower 102, 104 is basically a C-shaped member, albeit a backwards C-shape in the views of FIGS. 5 and 6, with a mouth portion 136 of the C-shaped member defining a channel within which the timing cam drive shaft 88 is received upon assembly. Each of the cam followers 102, 104 also includes a lower portion 138, which limits the maximum upward travel of the caps 84, 85 when raised into the capping position (see FIGS. 9B and 9D).

[0067] As seen in the view of FIG. 4, the cap assemblies 110 are assembled into the service station frame 62 by sliding the cam followers 102, 104 upwardly through the open bottom of the service station frame 62. To allow the cam followers 102, 104 to move freely in a vertical direction toward and away from the printheads 54-56, and to maintain alignment of the caps 84, 85 with the printheads 54-56, the service station frame 62 defines a pair of T-guides 140, which have a T-shaped cross section with the base of the T-shape secured to a vertical surface of an interior partition of the frame 62. Each T-shaped guide 140 is received within a rectangular slot 142 defined by the cap base 120. To provide further alignment of the cap base 112 with the service station frame 67, the cap base 112 includes a pair notches 144, which slideably receive a pair of projections 146 extending from the service station frame 62, as shown FIG. 4. During assembly, the cap cam followers 102, 104 are inserted through the bottom of the service station frame 62 and the cap bases 112 with caps 84, 85 and springs 125 assembled thereon, are installed through the top of the service station frame 62. To complete the assembly, the heads 126 of the pivot posts 122 are pushed through the mounting holes 128 of each cap sled 120.

[0068] FIGS. 7 and 8 illustrate one form of a wiper assembly 150, constructed in accordance with the present invention as including a wiper base 152, which may be used to mount the color wiper 82 to the color wiper cam follower 101, and the combination wiper 50 to combination wiper cam follower 103. The wiper 80, 82 may be secured within a wiper pocket 154 of the wiper base 152 using a press fit, adhesive, bonding, or other gripping means known to those skilled in the art, as well as onsert molding techniques and the like. Each of the cam followers 101, 103 includes a wiper sled portion 155. The wiper sled 155 defines a pair of opposing rectangular slots or runner guides 156, which slideably receive a pair of runner members 158 protruding outwardly from the wiper base 152. Preferably, the upper portions of the cap base above the runner guides 156 have slanted surfaces, and the lower surface of each runner 155 also has a slanted surface, with these slanted surfaces meeting during assembly to push portions of the cap base 155 adjacent the guide slots 156 outwardly, to receive the cap base 152 in a snap fit.

[0069] The wiper assembly 150 also includes a biasing member, such as a coil spring 160, which is preferably received around a post 162 extending upwardly from the wiper sled 155. Preferably, a recessed pocket 164 is defined by the base 155 to extend around the post 162, with the pocket 164 receiving the lower portion of spring 160. The cap base 152 defines a hollow pocket 166 which receives the upper portion of the biasing spring 160 and a portion of the support post 162, as shown in FIG. 7. The spring 160 serves to push the wiper base 152, and thus wipers 80, 82, away from the wiper sled 155, and into contact with the printheads 54-56. During wiping the biasing spring 160 is compressed, allowing the wiper blades 80, 82 to tilt and move vertically as runners 158 traverse slots 156, which accommodates for any lack of parallelism between the printheads 54-56 and the wipers 80, 82 during wiping.

[0070] As show in FIG. 4, the wiper assemblies 150 are inserted into the service station frame 62 through the open top of the frame 62. The service station frame 62 defines a pair of rectangular slots 170, which each slideably receive a T-shaped runner member 172 of the cam followers 101, 103. The T-shaped runners 172, when installed in then respective guides 170, provide linear motion of the wipers 80, 82 toward and away from the printheads 54-56. Referring again to FIGS. 7 and 8, the wiper cam followers 101 and 103 each define a cam follower pocket 174. The cam followers 101, 103 each have a cam follower shoulder 175 that protects downwardly into pocket 174. As described above for the cap cam followers 102, 104, the wiper cam followers 101, 103 are roughly of a C-shape, although shown as a reversed C-shape in FIGS. 7 and 8, to define a mouth 176 which receives the timing cam drive shaft 88 during operation. The cam followers 101, 103 also include a lower cam follower surface 178 which serves to lower the wipers from a

wiping position, through engagement with the respective cams 91 and 93 (see FIGS. 9C and 10A).

[0071] Returning to FIG. 4, the carriage lock 100 is shown being supported by the cam follower 105. A biasing member, such as a U-shaped leaf spring 180 may be received through a snap fit within a slot defined along a lower surface of the cam follower 105. The U-shaped spring 180 includes a pair of feet 182 which slideably rest against a pair of lower surfaces 184 defined by a ledge 185 of the service station frame 62. Indeed, preferably each of the feel 182 has an upwardly projecting dimple formed thereon, which reduces the contact friction to facilitate this sliding action of the feet 182 along the ledger lower surfaces 184. In FIGS. 9E, 10E, 11E and 12E, the ledge 185 and its lower surfaces 184 are shown schematically. To assemble the carriage lock 180 to the service station frame 62, the frame 62 defines a rectangular guide slot 186 which slideably receives a T-shaped runner member 185 of the carriage lock 100, allowing the lock 100 to move vertically into and out of engagement with the carriage 40.

[0072] The service station 60 is preferably assembled by sliding the T-guides into the rectangular guide slots to install each cam follower 101-105 into the service station frame 62. The wiper assemblies 150 for the wipers 80, 82 may be installed through the top of the service station frame 62. The cap cam followers 102, 104 are installed through the bottom of service station frame and attached using a snap fit to the cap bases 112 of the respective caps 85, 84. The carriage lock 100 is assembled from the bottom of the frame 62, then the timing cam drive assembly 90 is inserted through the front portion of the service station frame 62. The drive shaft 88 rests within the bearing slots 96 and 98 and is received within the mouths 136 of the cap cam followers 102, 104 and within mouths 176 of the wiper cam followers 101, 103.

[0073] The service station 60 also includes a microswitch 190, which is mounted to a support 191 located along the exterior surface of the outboard wall 68 of the service station frame 62, as shown in FIG. 2. The microswitch 190 includes an activation plunger 192, which when depressed sends a control signal 194 to the printer controller 35. To activate the plunger 192 of microswitch 190, an interior surface of the bull gear 78 is provided with a trigger finger 195, shown activating the microswitch 190 in FIG. 9E.

[0074] In operation, as shown in FIGS. 9-12E, the service station 60 caps and wipes the printheads 54-56, including steps for simultaneously wiping and for independently wiping the full color printhead 55 and either the black printhead 54, or the imaging printhead 56, depending upon which pen 50 or 53 is currently installed in carriage 40. Thus, the service station 60 advantageously provides independent wiping of the printheads 54-56 at desired wiping speeds (FIGS. 10-10E and 12-12E) while also providing for simultaneous wiping (FIGS. 11 - 11E) of the installed printheads 54-56, such as between print swaths or passes of the carriage 40 over the printzone 25. Moreover, the service station 60 advantageously provides this independent servicing of pens 54-56 without sacrificing printing speed or throughput (rated in pages per minute).

[0075] The capping position of FIG. 9 may be considered as a home position, where the actuator member 192 of microswitch 190 has been compressed by the trigger 195 on the idler gear 78. In comparing the views of FIGS. 9A-9D with that of FIG. 9E, note that FIGS. 9A-9D are views of the right sides of the servicing components, whereas the view of FIG. 9E is taken from the left side. The curved arrows in FIGS. 9A-9E show the direction of rotation as the timing cam drive assembly 90 elevates caps 84, 85 into the capping position of FIG. 9, as well as indicating a direction of continued rotation for further servicing.

[0076] In FIGS. 9-9E, several service station compnents are shown removed from the service station frame 62, and located in a capping position. Here, the caps 84, 85 elevated to seal the printheads 54-56, with the wipers 80, 82 withdrawn to a retracted or rest position to allow free travel of the printheads 54-56 over the wipers. Indeed, with the cam drive assembly 90 rotated approximately 45 degrees counterclockwise, it is apparent that the wipers 80, 82 as well as the caps 84, 85 are all lowered beneath a nominal printhead reference plane, indicated by the long and short dashed line 196 in FIGS. 9A-9E. When these servicing components are all lowered, the carriage 40 is free to move into the servicing region 44 and to stop at a postion with the printheads 54-56 directly over the caps 84, 85. Of course, it may be desirable to wipe the printheads 54-56 a final time before capping, which can be easily accomplished by elevating the wipers 80, 82, as described below with respect to FIGS. 11-11E (simultaneous wipe), or FIGS. 10-10E and 12-12E (independent wipe).

[0077] Once the printheads 54-56 are in the capping position, the motor 65 rotates to the position shown in FIGS. 9-9E to elevate the caps 84, 85 into a position where the lips 116 surround the nozzles to seal the printheads 54-56. As shown in FIGS 9B and 9D, the sealing lips 116 extend slightly above the nominal printhead reference plane 196, which allows the springs 125 to be compressed upon capping. This arrangement provides an upward spring force to provide a tight seal of lips 116 against the orifice plates of printhead 54-56. Also in FIGS. 9 and 9E, the carriage lock 100 is shown engaging a carriage latch 198, which may extend downwardly from the printhead carriage 40. As shown in the FIG. 4, the carriage lock 100 is configured as a U-shaped channel, which advantageously grips the carriage latch 198 to prevent motion of the carriage 40 to either side.

[0078] To elevate the carriage lock 100 to the locking position of FIGS. 9 and 9E the cam 195 pushes the cam follower 105 into an elevated position. Raising the cam follower 105 causes the feet 182 of the U-shaped spring 180 to transition from a rest position shown in dashed lines, to a locked position shown in solid lines as feet 182 slide outwardly toward

the front and back of the printer along the undersurface 184 of the ledge 185. In the view of FIG. 9E, the carriage lock 100 is shown extending above the nominal printhead reference plane 196 to engage the carriage latch 198, as shown in FIG. 9.

[0079] Thus, this construction of the service station 60 allows each of the servicing components 80, 82, 84 and 85 to be moved translationally by the timing cam drive assembly 90, that is, linearly to be elevated into servicing positions for servicing the printheads 54-56, as well as to be lowered to rest positions. By configuring the cams 91-95, and through the orientation of each cam to one another on the drive shaft 88, the drive assembly 90 serves to independently index each servicing component 80, 82, 84 and 85 between servicing and rest positions, as well as to lock the carriage 40 in a fixed position when the printheads 54-56 are sealed.

[0080] FIG. 10 illustrates the independent wiping position of service station 60 which allows the combination wiper 80 to wipe either the black printhead 54 when the black pen 50 is installed in the carriage 40, or the imaging printhead 56 when the imaging pen 53 is in carriage 40. In FIG. 10C, the combination wiper cam 93 has elevated the wiper 80 above the nominal printhead reference plane 196, allowing the biasing spring 160 to be compressed upon contacting the printhead 54, 56 during wiping. To assure that the color wiper 82 is fully retracted, the cam 91 is shown engaging the lower cam surface 178 of the color cam follower 101.

[0081] In transitioning from capping to wiping, the cap assemblies 110 have been lowered from plane 196 under the force of their own weight, as the shoulders 135 of cam followers 102, 104 ride along the surfaces of cams 92 and 94, respectively. It is apparent that a biasing member, such as a leaf spring may be added to push the cap assemblies 110 into the lowered rest position shown in FIGS. 10B and 10D, or the cams 92, 94 and followers 102, 104 may be modified to actively drive the caps 85, 84 down to this rest position. Also in this independent wiping position for the combination wiper 80, the carriage lock 100 is shown in a retracted position, being withdrawn from engagement with the printhead carriage 40 under the force of the U-shaped spring 180 which pushes the cam follower 105 into contact with the surface of cam 95. In the independent wiping position of FIG. 10, the black printhead 54 may be wiped at a slower wiper speed than required for wiping the full color printhead 55. Furthermore, when the imaging cartridge 53 is installed in carriage 40, an optimal wiping speed may also be used for the imaging printhead 56.

[0082] FIG. 11 illustrates a dual or simultaneous wiping position where both wipers 80 and 82 are extended above the reference plane 196 to engage the printheads 54-56, as shown in FIGS. 11A and 11C. FIGS. 11B and 11D show the caps 85, 84 in a fully retracted position, now forced downwardly by engagement of the cams 92 and 94 with the lower surfaces 138 of cam followers 102 and 104, respectively. This simultaneous or dual wipe position of the service station shown in FIG. 11 advantageously allows for quick wipes of both the full color printhead 55, and either the imaging or black printhead 56, 54 installed in carriage 40.

[0083] This simultaneous wiping position of FIGS. 11-11E may be particularly useful for performing quick wipes to clean both installed printheads between printing swaths. Furthermore, in some embodiments, the imaging cartridge 53 may carry inks which have similar servicing requirements to the inks of the full color cartridge 52. In this case, allowing for simultaneous wiping at the same speed advantageously speeds all levels of servicing, while still allowing for different optimal wiping speeds of the full color printhead 55 and the black printhead 54 when the black cartridge 50 is installed in carriage 40. In FIG. 11E, the carriage lock 100 is shown remaining a retracted position, to allow the carriage 40 to reciprocate back and forth over wipers 80 and 82 to facilitate this selective wiping routine.

[0084] FIG. 12 illustrates the independent wipe position for cleaning the full color printhead 55. As best shown in FIG. 12A, the full color wiper 82 is elevated above the nominal printhead reference plane 196, while the combination wiper 80, as well as caps 84 and 85 remained retracted below the reference plane 196. To facilitate carriage travel 40 over the wiper 82 at the selected wiping speed, the carriage lock 100 also remains retracted, as shown in FIG. 12E. Further rotation of the timing cam assembly 90 in the direction indicated by the curved arrows returns the service station to the capping position of FIG. 9, whereas rotation in the opposite direction returns the service station 60 to the simultaneous wiping position of FIGS. 11-11E.

Conclusion

[0085] Several advantages are realized using the service station 60, over the earlier service stations discussed in the Background section above. For example, the number of wipes required for the full color pen 52 may now be different than, or the same as, that used for pens 50 or 53, depending upon whether the black cartridge 50 or the imaging cartridge 53 is installed in carriage 40. Thus, when pens installed in the carriage 40 have different optimum wiping speeds, the independent wiping positions shown in FIGS. 10C and 12A may be used to independently service each pen. However, by using the dual or simultaneous wiping positions shown in FIGS. 11A and 11C, both printheads installed in carriage 40 may be wiped at the same speed simultaneously, which speeds printing. Moreover, if the color pen 52 and the imaging pen 53 for instance, each had the same servicing needs, use of the simultaneous wiping configuration in FIGS. 11A and 11C advantageously speeds all printhead cleaning, not just wiping during printing.

[0086] The independent wiping scheme advantageously allows slower wiping of the black printhead 54 (FIG. 10C)

during a spree of predominately black printing, without the problem of drawing excess ink from the full color pen 52 during this slow wiping stroke, because now, the full color pen 52 may be wiped independently (FIG. 12A) using a faster wiping speed, which draws less ink from the full color pen. With less ink unnecessarily extracted from the full color printhead 55, less ink residue builds up along the wiper scrapers at each side of the pen snout. With less sticky ink residue accumulated along the printhead wiper scrapers, there is less chance of collecting fibers, and thus, undesirable fiber tracks are advantageously avoided. By providing independent wiping speeds for the printheads 54-56 using the timing cam driven service station 60, printhead servicing is optimized for each installed printhead, which speeds printing while providing a higher print quality in the resulting image printed.

Claims

1. A service station for servicing an inkjet printhead of an inkjet printing mechanism, comprising:

   a frame;
   a cap cam follower slideably mounted to the frame for translational motion toward the printhead into a capping position;
   a cap supported by the cap cam follower to seal the printhead in the capping position;
   a wiper cam follower slideably mounted to the frame for translational motion toward the printhead into a wiping position;
   a wiper supported by the wiper cam follower to clean the printhead in the wiping position; and
   a timing cam drive having a drive shaft with a cap cam and a wiper cam mounted thereon, with the cap cam engaging the cap cam follower for movement between the capping position and a rest position, and with the wiper cam engaging the wiper cam follower for movement between the wiping position and a rest position.

2. A service station according to claim 1 for also servicing a second inkjet printhead of the inkjet printing mechanism, with the service station further comprising:

   a second cap cam follower slideably mounted to the frame for translational motion toward the second printhead into the capping position;
   a second cap supported by the second cap cam follower to seal the second printhead in the capping position;
   a second wiper cam follower slideably mounted to the frame for translational motion toward the second printhead into a second wiping position;
   a second wiper supported by the second wiper cam follower to clean the second printhead in the second wiping position; and
   wherein the timing cam drive has a second cap cam and a second wiper cam supported by the drive shaft, with the second cap cam engaging the second cap cam follower for movement between the capping position and a rest position, and with the second wiper cam engaging the second wiper cam follower for movement between the second wiping position and a rest position.

3. A service station for servicing a pair of inkjet printheads of an inkjet printing mechanism, comprising:

   a frame;
   first, second, third and fourth cam followers each slideably mounted to the frame for translational motion into servicing positions for the inkjet printheads;
   a pair of wipers, with one wiper supported by the first cam follower for movement to a first servicing position to wipe one printhead of said pair of inkjet printheads, and with the other wiper supported by the second cam follower for movement to a second servicing position to wipe the other printhead of said pair of inkjet printheads;
   a pair of caps, with one cap supported by the third cam follower for movement to a capping position to seal said one printhead, and with the other cap supported by the fourth cam follower for movement to a capping position to seal said other printhead; and
   a timing cam drive having a drive shaft with first, second, third and fourth cams mounted thereon to engage the respective first, second, third and fourth cam followers for selectively moving the pair of wipers and the pair of caps into said servicing positions.

4. A method of servicing an inkjet printhead of an inkjet printing mechanism, comprising the steps of:

   providing a cap supported by a cap cam follower, a wiper supported by a wiper cam follower, and a timing cam

drive having a drive shaft with a cap cam and a wiper cam mounted thereon;
sealing the inkjet printhead by translationally moving the cap into a capping position by engaging the cap cam with the cap cam follower; and
cleaning the inkjet printhead by translationally moving the wiper into a wiping position by engaging the wiper cam with the wiper cam follower, and thereafter, moving the inkjet printhead across the wiper.

5. A method of servicing a pair of inkjet printheads of an inkjet printing mechanism, comprising the steps of:

providing first, second, third and fourth cam followers supporting respective first, second, third and fourth servicing components, and providing a timing cam drive having a dnve shaft with first, second, third and fourth cams mounted thereon;
selectively moving at least one of the first, second, third and fourth servicing components into a servicing position through rotation of the drive shaft and engagement of the first, second, third and fourth cam followers with the respective first, second, third and fourth cams; and
servicing said inkjet printheads with at least one of the first, second, third and fourth servicing components when in the servicing position.

6. An inkjet printing mechanism for printing an image, comprising:

a chassis;
a carriage supported by the chassis for reciprocal movement;
an inkjet printhead supported by the carriage;
a service station frame;
first and second cam followers each slideably mounted to the frame for translational motion into servicing positions for servicing the inkjet printhead;
a wiper supported by the first cam follower for movement to a first servicing position to wipe the printhead;
a cap supported by the second cam follower for movement to a capping servicing position to seal the printhead; and
a timing cam drive having a drive shaft with first and second cams mounted thereon to engage the respective first and second cam followers for selectively moving the wiper and the cap into said servicing positions.

7. An inkjet printing mechanism according to claim **6** further including:

a third cam follower mounted to the frame for movement into a locking position;
a carriage lock supported by the third cam follower for locking the carriage in a fixed position when the third cam follower is in the locking position; and
a third cam is mounted on the drive shaft to engage the third cam follower for movement into the locking position when said cap is moved into the capping servicing position.

8. An inkjet printing mechanism according to claim **6** further including:

another inkjet printhead supported by the carriage;
third and fourth cam followers each slideably mounted to the frame for translational motion into servicing positions for servicing the inkjet printhead;
another wiper supported by the third cam follower for movement to a second servicing position to wipe said another printhead;
another cap supported by the fourth cam follower for movement to a second capping servicing position to seal said another printhead; and
third and fourth cams mounted on the drive shaft to engage the respective third and fourth cam followers for selectively moving said another wiper and said another cap into said second servicing positions.

9. An inkjet printing mechanism according to claim **8** wherein the first and third cams are mounted on the drive shaft to engage the respective third and fourth cam followers to independently move said wiper into said servicing position, and thereafter to remove said wiper from said servicing position and to independently move said another wiper into said second servicing position.

10. An inkjet printing mechanism according to claim **9** wherein the first and third cams are also mounted on the drive shaft to engage the respective third and fourth cam followers to simultaneously move said wiper and said another

wiper into said servicing positions.

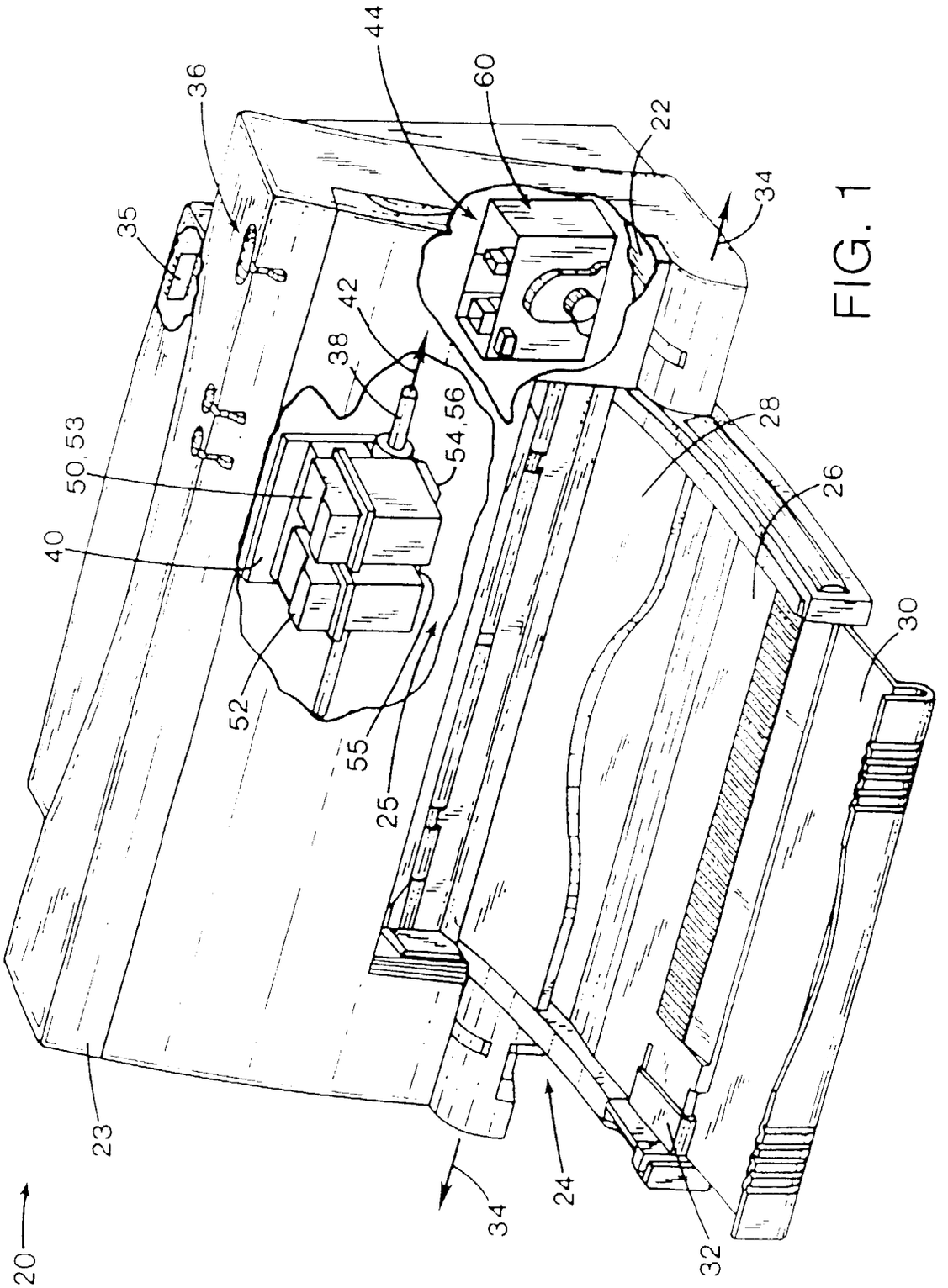
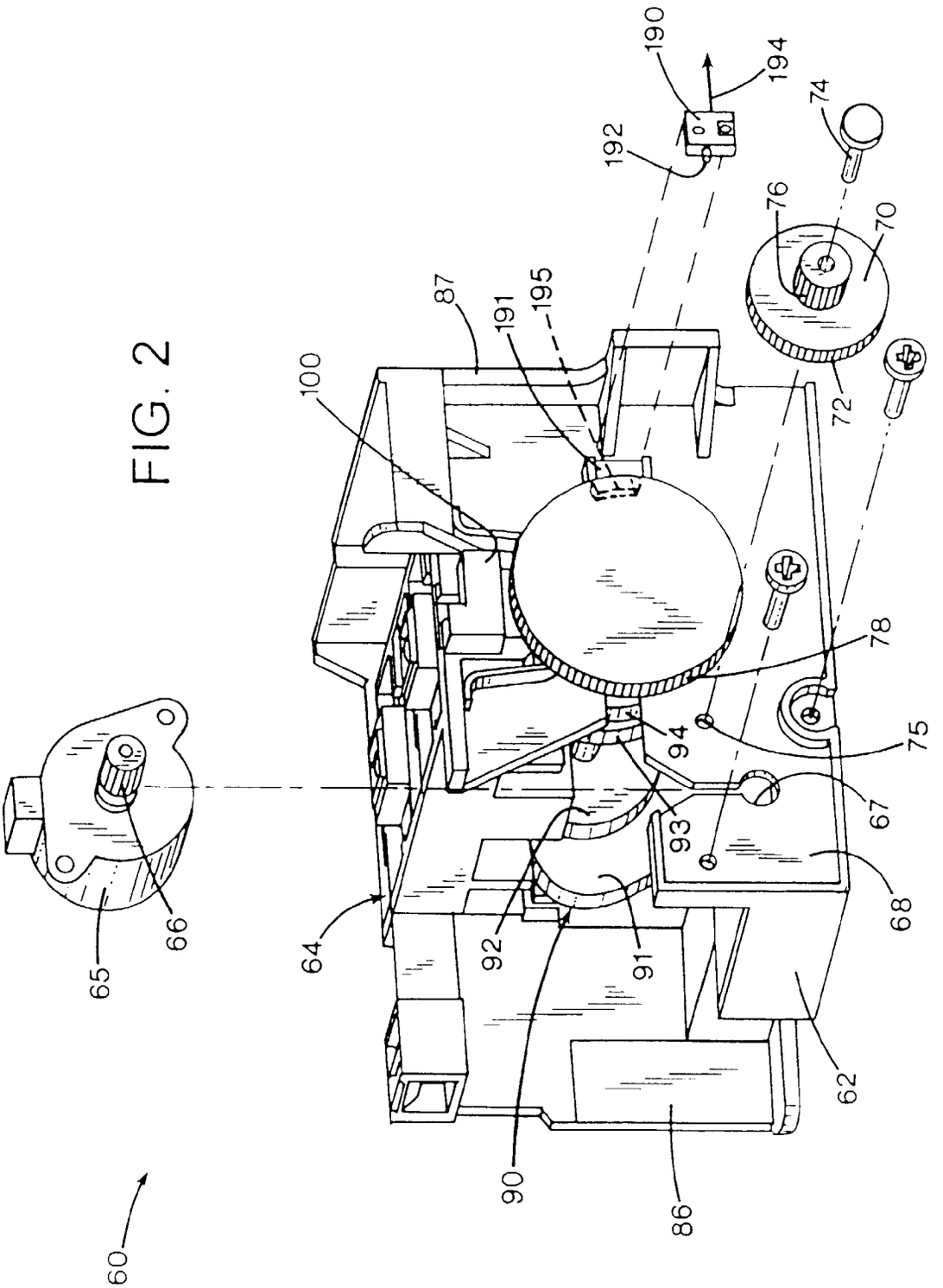


FIG. 1

FIG. 2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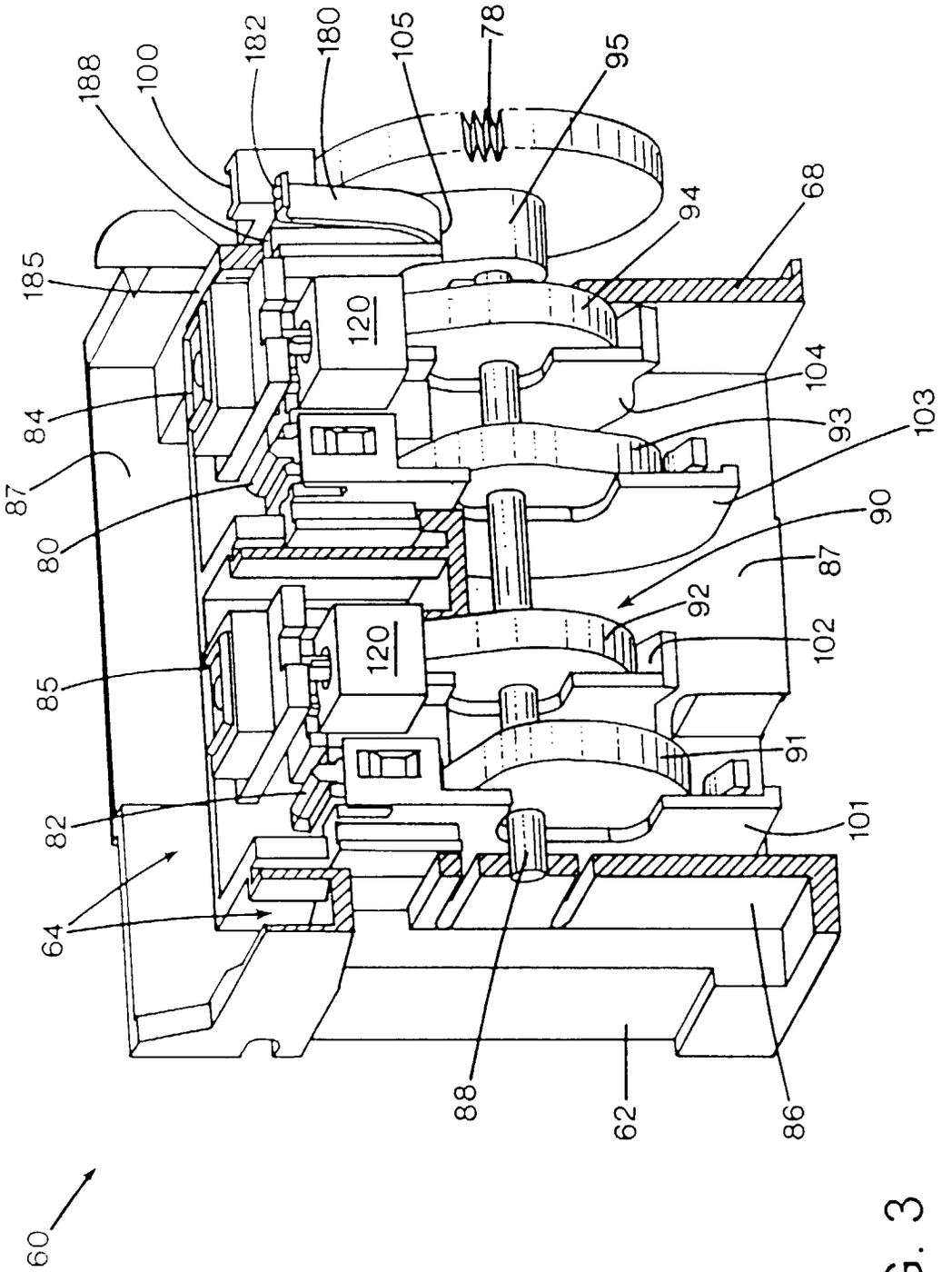
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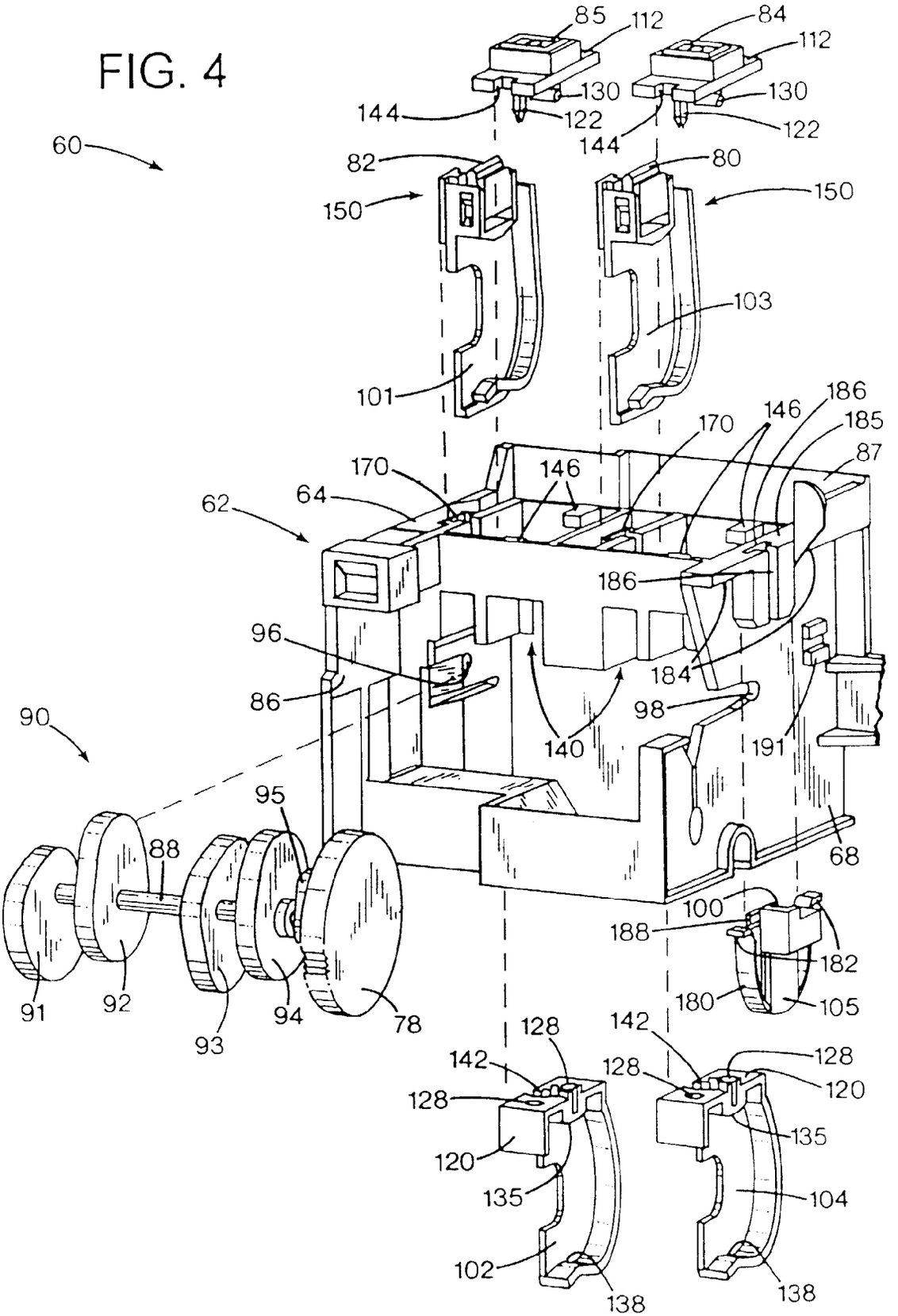
FIG. 3

FIG. 4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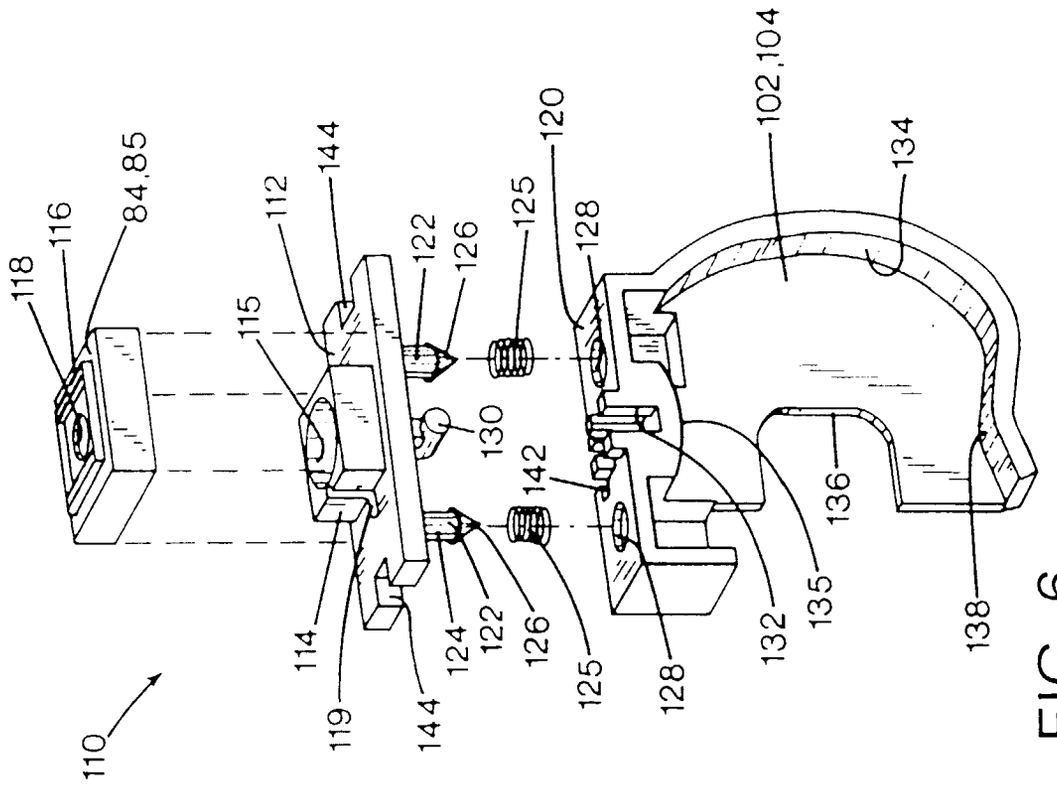
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FIG. 6

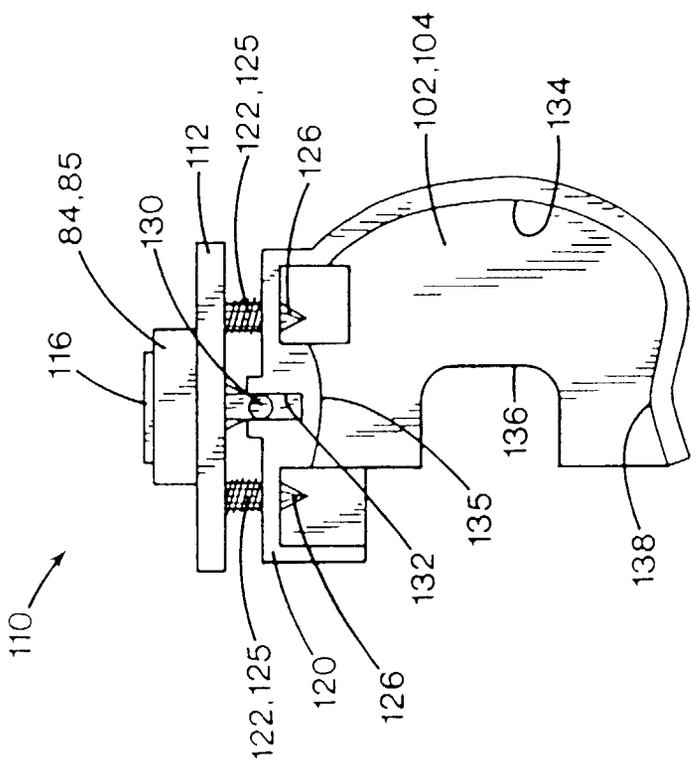
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FIG. 5

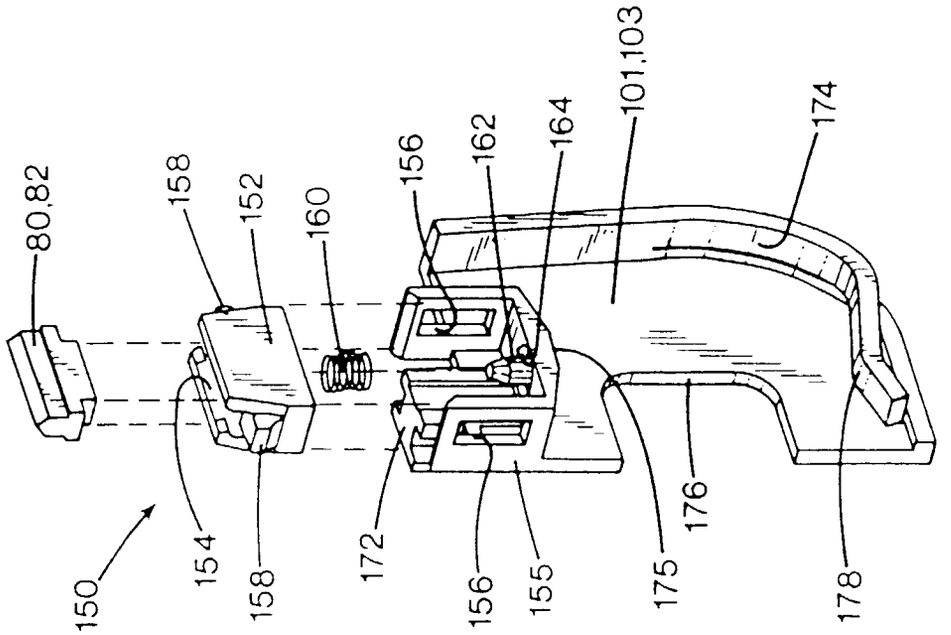
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FIG. 8

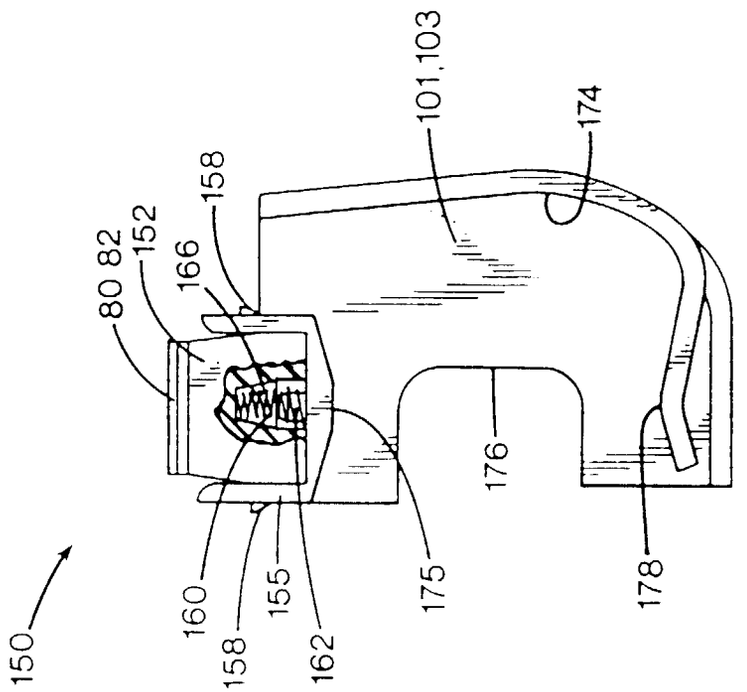
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FIG. 7

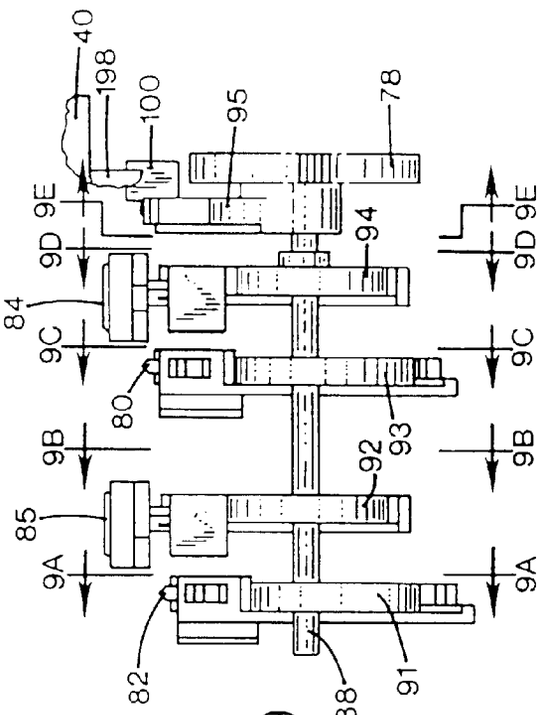

FIG. 9

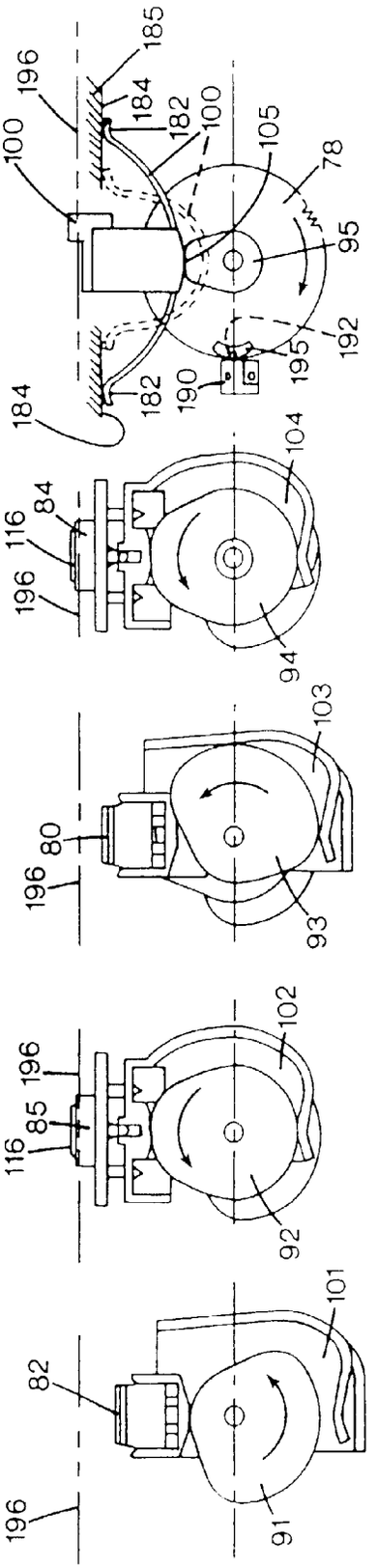

FIG. 9A FIG. 9B FIG. 9C FIG. 9D FIG. 9E

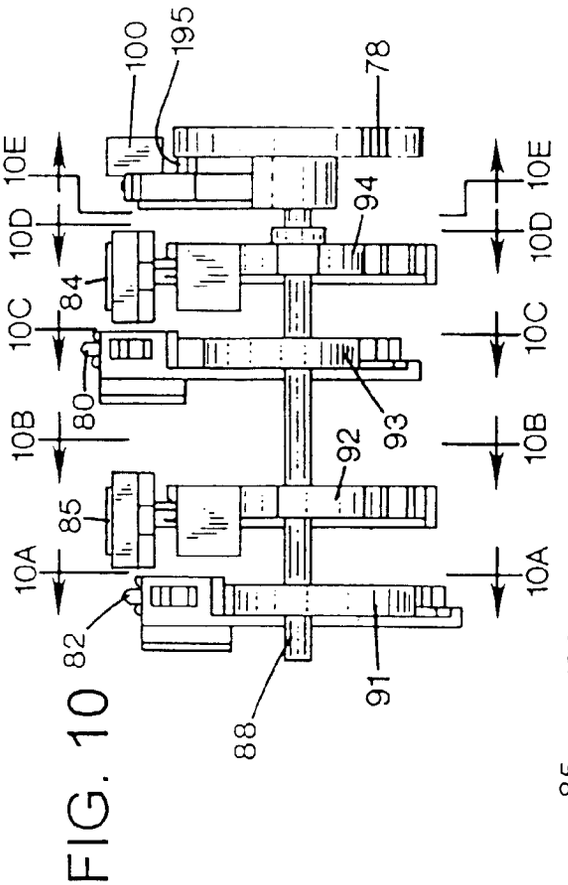

FIG. 10

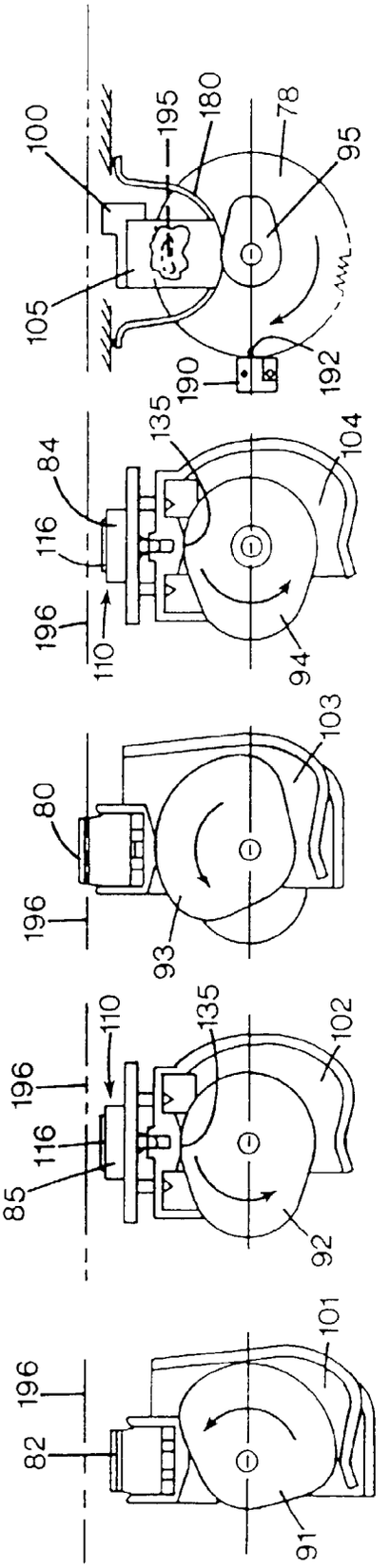

FIG. 10A FIG. 10B FIG. 10C FIG. 10D FIG. 10E

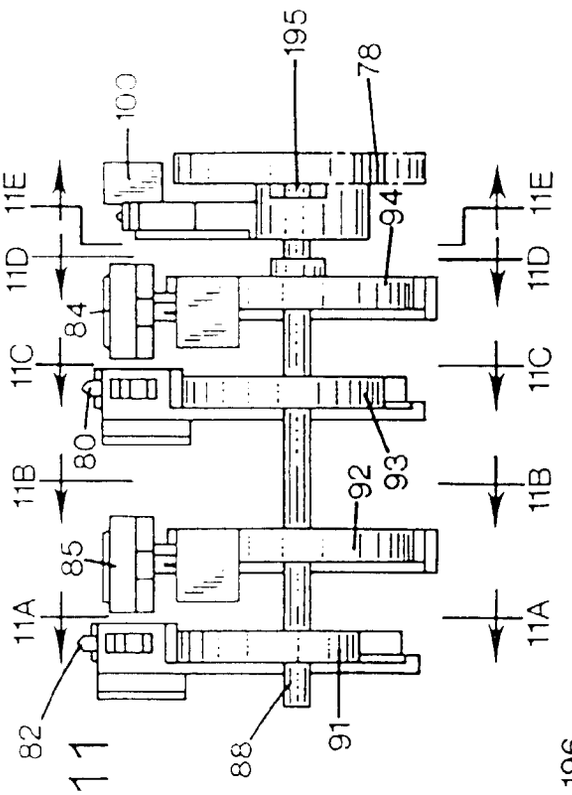

FIG. 11

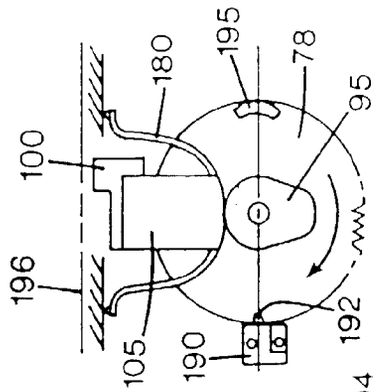

FIG. 11E

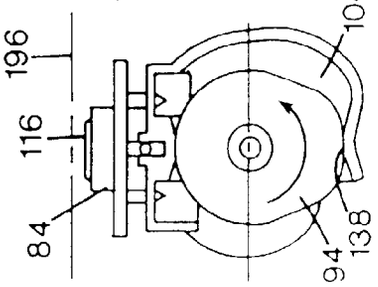

FIG. 11D

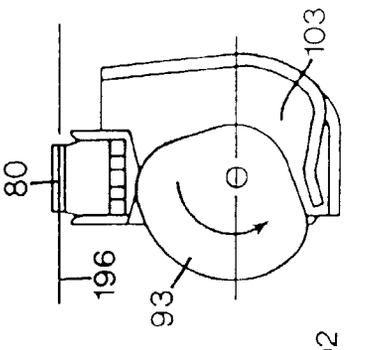

FIG. 11C

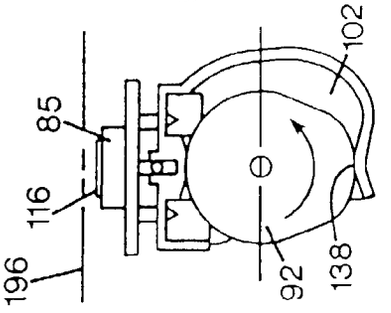

FIG. 11B

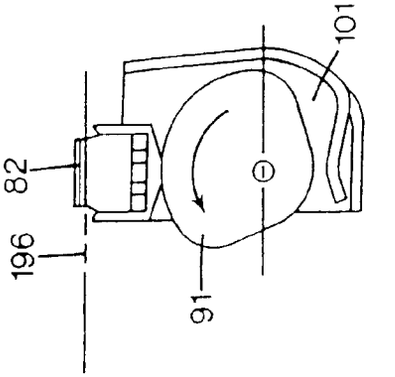

FIG. 11A

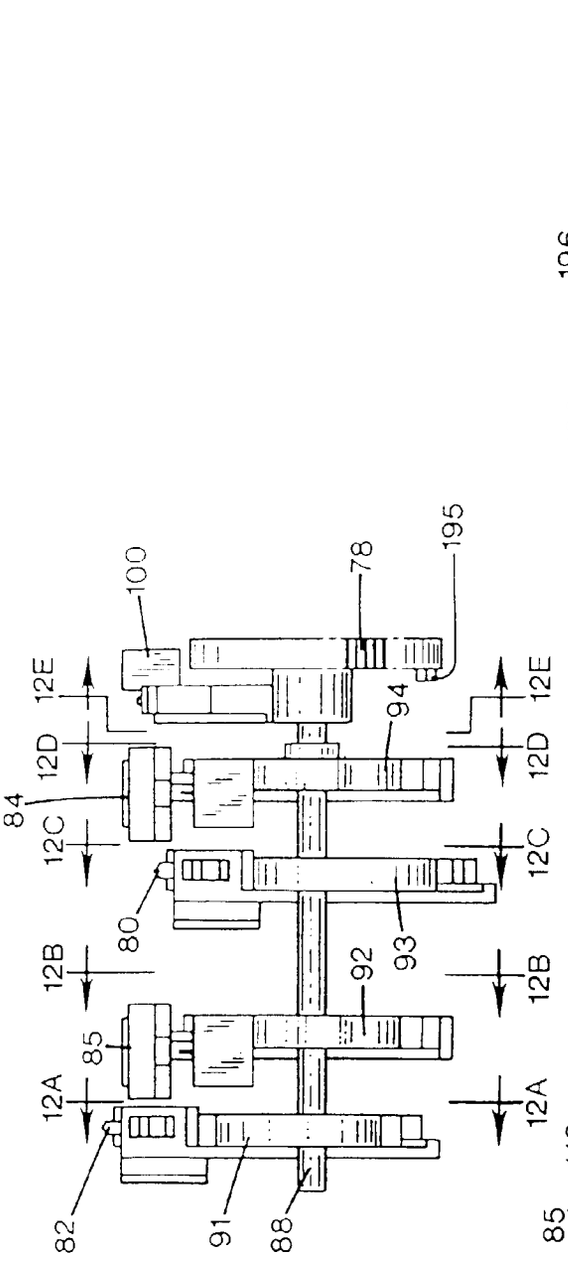

FIG. 12

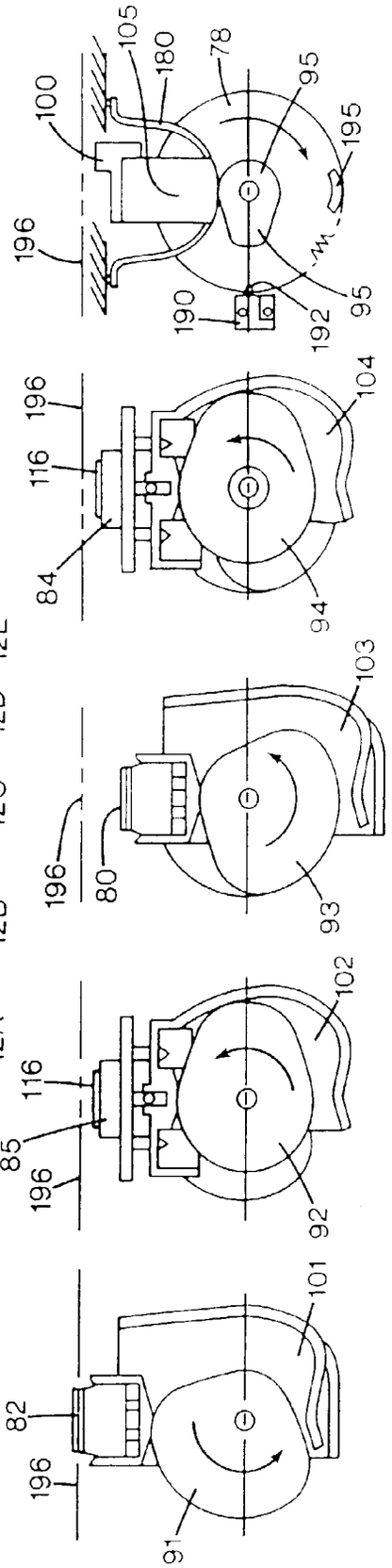

FIG. 12A FIG. 12B FIG. 12C FIG. 12D FIG. 12E