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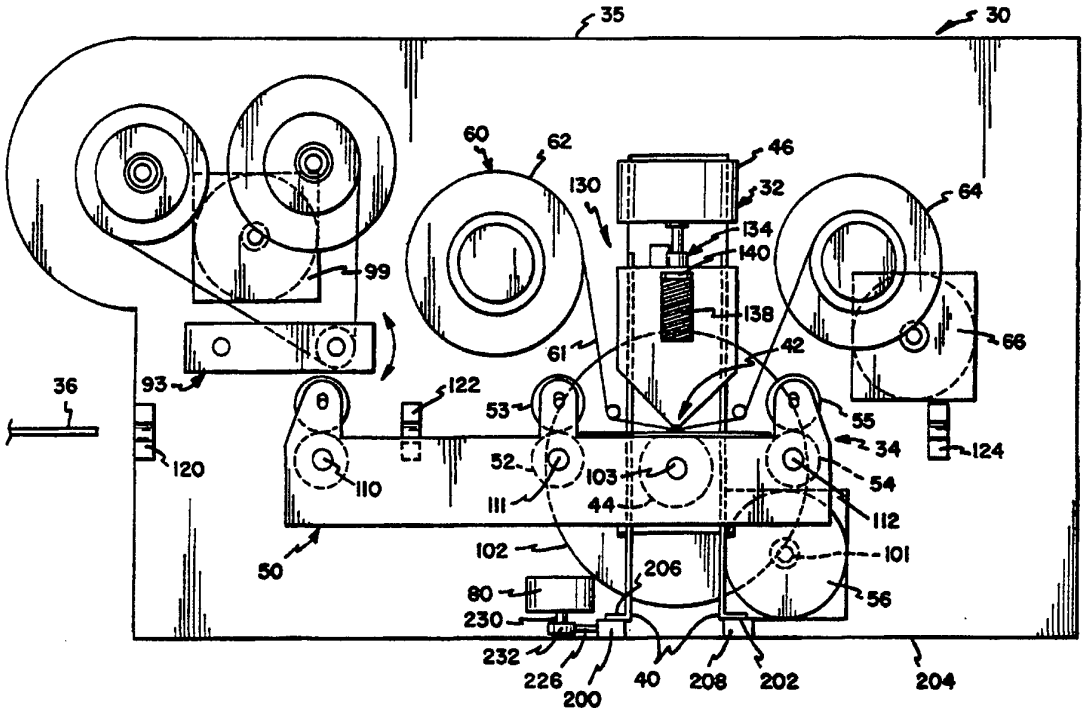
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(54) Title: GRAPHICS PRINTER ROLLER TRANSPORT APPARATUS AND METHOD




(57) Abstract

A graphics printer apparatus and method using sensors to detect the position of a work piece relative to a print head. A single drive motor driving the feed rollers and a print roller.

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# GRAPHICS PRINTER ROLLER TRANSPORT APPARATUS AND METHOD

## Background of the Invention

The present invention pertains to a graphics printer roller transport apparatus and method for transporting workpieces through a multi-pass graphics printer apparatus.

Currently, graphics printers are used to print images onto a work item such as plastic cards. One frequently used application is to create photo identification (ID) cards bearing an image of the card holder. Card holder images are captured by use of such apparatus as video cameras or scanners. Once the card holder images are digitized they are typically displayed on a display monitor where the image is edited; e.g., sized and cropped, for use on the ID card. Once the images are suitably adjusted for use on the ID card, they are electronically stored for subsequent printing onto an ID card using a graphics printer apparatus.

There are various graphics printing apparatus and methods for printing images onto workpieces such as ID cars. The existing systems are usually rather expensive and complicated. In addition, many systems do not provide the desired resolution. A typical method for printing a color image on a workpiece is to use a color ribbon having three different primary color panels; yellow, magenta, and cyan. To create a color image, the printer apparatus sequentially prints each of the three primary colors onto the workpiece to create a composite color image. This is typically referred to as multipass printing. Multipass printing requires that the printer apparatus be accurately positioned relative to the workpiece for the printing of each primary color. Unless the printer apparatus and workpiece are properly positioned unwanted blurring will occur due to misalignment of the three primary colors in the color

image.

In an effort to provide the desired image clarity, existing printer apparatus are often expensive and complex in their structure. One of the most expensive and complex aspects of these printer apparatus is the transport mechanism used to transport the workpiece past the print head and then reposition the workpiece and/or print head for subsequent passes during the multipass printing process.

Single pass printers have used roller transport systems to transport the workpiece past the printer. However, these roller transport systems are typically deemed inaccurate for multipass printing. Typically roller transport systems use a sensor to locate either the leading or trailing edge of the workpiece. The workpiece is typically moved under the print head at a rate equal to the print resolution by a stepper motor rotating one motor step per print line. Gears and/or belts are used to produce an acceptable ratio so that a single motor step movement equals a print line. The maximum sensing error in such a system is a single motor step or one print line. For multipass printing, this is usually considered an unacceptable error.

The present invention provides a low cost graphics printer apparatus using a roller transport system which provides desired image quality. In addition, various embodiments of the present invention solves many other problems associated with existing graphics printers.

## Summary of the Invention

The present invention relates to a graphics printer apparatus and method.

An advantage of one embodiment of the present invention is that it provides a relatively inexpensive graphics printer apparatus and method.

Yet another advantage of one embodiment of the present invention is that it provides a graphics printer apparatus and method which provides the resolution desired in photo ID card applications.

These and various other advantages and features of novelty which characterize the invention are pointed out with particularity in the claims annexed hereto and forming a part hereof. However, for a better understanding of the invention, its advantages, and the objects obtain by its use, reference should be made to the accompanying drawings and descriptive matter, which form a further part hereof, and in which there is illustrated and described a preferred embodiment of the invention.

## Brief Description of the Drawings

In the drawings, wherein like reference numerals generally indicate corresponding parts throughout the various views,

Figure 1 is a side elevational view of an embodiment of a graphics printer apparatus, including a print mechanism and a roller transport mechanism, in accordance with the principles of the present invention;
Figure 2 is a side elevational view of the printer apparatus embodiment shown in Figure 1, illustrating the drive connection between the feed rollers and the printer roller;
Figure 3 is an end view of the printer apparatus;

Figure 4 is an isometric view of an embodiment of the drive connection between the transport motor and the feed rollers and printer roller;

Figure 5 is an enlarged perspective view of an embodiment of a lift apparatus for the print head;

Figure 6 is an end view of the printer apparatus illustrating placement of the print head lift apparatus;

Figure 7 is a functional block diagram of an embodiment of a control system;

Figure 8 is a functional block diagram of an embodiment of a sine drive control for the transport motor; and

Figures 9 - 14 are diagrammatic illustrations of workpiece positioning during a printing process.

Figure 15A is a side elevational view of the carriage assembly;

Figure 15B is a bottom view of the carriage assembly;

Figure 15C is a view as seen generally along line 15C-15C of Figure 15B;

Figure 16A is a perspective view of the rotary encoder mechanism;

Figure 16B is a perspective view of the rotary encoder mounting bracket and print head support frame;

Figure 17A is a schematic view illustrating engagement of the wheel with the print ribbon roll;

Figure 17B is a schematic view illustrating disengagement of the wheel from the print ribbon roll; and Figure 17C is a schematic view illustrating the wheel pivoted into a third position.

## Detailed Description of a Preferred Embodiment of the Present Invention

Illustrated in Figure 1 is an embodiment of a printer apparatus in accordance with the present invention, the printer apparatus being generally referred to by the reference numeral 30. As shown in Figure 1, the printer

apparatus 30 includes a printer carriage assembly 32 and a workpiece roller transport carriage assembly 34. A workpiece such as a plastic card 36, is illustrated prior to being fed into the printer apparatus 30. The printer carriage assembly 32 and the transport carriage assembly 34 are mounted onto a housing 35 for lateral movement thereof.

Referring now to Figures 1-6, the printer carriage assembly 32 includes a support frame 40, a thermal print head 42, a print roller 44, and a print head drive motor 46 for raising and lowering the print head 42. A print head home photocell 41 might be used to detect when the print head is raised above the print roller 44 into the home position and not in contact with the print roller 44.

The workpiece transport carriage assembly 34 includes a support frame 50, a feed roller 52 and an associated idler roller 53, a feed roller 54 and an associated idler roller 55, and a transport drive motor 56 for rotating the feed rollers 52,54 and the print roller 44. In the embodiment shown, the workpiece transport carriage assembly 34 is removably mounted onto the printer carriage assembly 32 by the use of spring clips 58 which attach to cylindrical pins 48 of the printer assembly.

In the embodiment shown, the printer apparatus 30 is capable of both printing an onto a workpiece such as a card and applying a protective overlay over the card. The printer apparatus 30 is shown including a color ribbon supply system 60 , including a color ribbon 61, a color ribbon supply spool 62, a color ribbon take-up spool 64, and a color ribbon drive motor 66. In addition, the printer apparatus shown includes an overlay ribbon supply 70, including an overlay ribbon

71, an overlay ribbon supply spool 72, an overlay ribbon take-up spool 74, and a overlay ribbon drive motor 76. In the embodiment shown, the print ribbon and overlay supply systems are disposed side by side. The printer apparatus 30 includes a carriage drive motor 80 for laterally moving the printer carriage assembly and transport carriage assembly laterally with respect to the ribbon supply systems so as to align the appropriate ribbon with the print head and workpiece. Guide pins 69 extend laterally of the printer apparatus on either side of the print head 42 for guiding the color ribbon 61 and the overlay ribbon 71 between the print head 42 and the print roller 44.

In the embodiment shown, a conventional three color ribbon might be used having the primary colors of yellow, magenta, and cyan disposed on discrete segments of the ribbon for conventional multipass color dye printing using a thermal print head. The location of the color segments is typically determined by appropriate placement of a ribbon sensor 63, such as a photocell, which senses where the color segments begin and/or end. In addition the ribbon might include a black segment for conventional mass transfer printing onto the workpiece using various pigments.

Multipass printing is typically used for printing images onto a workpiece whereas mass transfer printing is typically used for printing bar codes and the like. The overlay ribbon might be comprised of clear mass transfer material designed to resist mechanical & chemical abrasion. During the multipass printing process the print head applies a pressure of roughly ten to twelve pounds. During the overlay process and the mass transfer process, the print head applies a pressure of twenty pounds.

It will be appreciated that as opposed to a horizontal orientation of the workpiece, the workpiece might also have a vertical orientation during the printing process. In some embodiments of the present invention, the transport carriage and printer carriage will not be capable of lateral movement.

A workpiece cleaning system might be incorporated into the printer apparatus of the present invention. In the embodiment shown, there is a card cleaning assembly 90 including two cleaning rollers 91,92 with the cleaning rollers being driven by the transport motor 56. In addition, the card cleaning assembly includes cleaning ribbon supply system 95 for cleaning the cleaning rollers. The cleaning ribbon supply system 95 includes a supply spool 96, a take-up spool 97, a cleaning ribbon 98, and a cleaning ribbon motor 99 for driving the take-up spool 97. A cleaning ribbon engagement assembly 93 which is actuated by a solenoid 94 selectively engages the cleaning ribbon against the surface of the cleaning roller 91 as desired during operation. It will be appreciated that the present invention need not include the card cleaning assembly.

As illustrated in Figure 4, the workpiece transport motor 56 is part of an integrated drive mechanism 100 for directly driving the feed rollers 52,54 and the print roller 44 without the benefit of any clutches. The drive mechanism includes a motor drive shaft 101 which drives a gear reducer 102 by a friction drive interface. The gear reducer 102 provides roughly a 9.425 to 1 gear reduction ratio. A main drive shaft 103 extends from the gear reducer 102. A gear 104 and the print roller 44 are mounted on the main drive shaft 103. The gear 104 is connected by gears 107 to gears 105,106 mounted on drive shafts 111,112 of the input feed roller 52 and the output feed roller 54, respectively. Thus it

will be appreciated that a single drive motor drives the feed rollers and the printer roller so as to transport the workpiece through the printer apparatus. In the embodiment shown, the cleaning roller is also driven by the transport motor by use of a plurality of gears 108 or the like interconnecting gear 105 to a gear 109 mounted on a shaft 110 of the cleaning roller. It will be appreciated that various configurations of gears might be used and that some of the gears might be replaced by drive belts or other drive connections. There are no clutches in this arrangement. The feed rollers and printer roller are all directly driven in unison by the transport motor.

Illustrated in Figures 5 and 6, is an embodiment of a print head lift apparatus 130. The lift apparatus 130 is used to raise the print head into the home position when not printing and/or when moving the printer carriage and the transport carriage laterally. In addition the lift apparatus is capable of applying differing forces on the print head 42 so that various printing pressures can be used. For example, roughly 10 to 12 pounds when color image printing and 20 pounds when overlaying the workpiece with an overlay. The print head motor 46 is connected by an elongated drive shaft 134 to one of two pivotal arm members 132 mounted on opposite sides of the print head 42. The pivotal arm members are connected by two elongated members 131 pivotally mounted to each of the arm members 132. The pivotal arm members 132 are pivotally mounted on the printer carriage frame for pivotal movement about point 133. The lift apparatus 130 includes a support framework 136 which is slidably mounted with respect to the printer carriage support framework 140 for relative movement thereof. The print head 42 is mounted onto the elongate member 131 for vertical movement therewith. As the print head motor 46 forces down on the arm members

132, the lift apparatus pivots about points 133 and the print head 42 is raised. Typically the total lift distance might be 1/4 inch. When the print head motor 46 retracts the drive shaft 134 the print head 42 is lowered. Compression springs 138 are disposed between the framework 136 and tab portions 140 of the pivotal arm members 132. Variable force can be applied by the lift apparatus 130 by further pivoting the tab portions 40 downwardly thereby compressing the compression springs 138 after the print head 42 has engaged the workpiece, thus increasing the force applied by the print head 42. This is illustrated by position line 141. The raised position is illustrated by position line 143, with position line 142 illustrating the color printing position.

The feed rollers 52,54 are spaced apart by a distance less than the length of the workpiece such that the output feed roller 54 engages the workpiece before the input feed roller 52 releases the workpiece and such that one of the feed rollers is engaging the workpiece at all times during the printing process. The print roller 44 is aligned with the print head 42.

Workpiece position is monitored during the printing process by the use of photocells or other suitable sensors. In the embodiment shown there is a workpiece present photocell 120 located upstream of the printer apparatus which detects when a workpiece has been manually fed or fed from an input hopper to the printer apparatus. A trailing edge photocell 122 located downstream of the photocell 120 and upstream of the input feed roller 52 is used to detect the trailing edge of the workpiece. A leading edge photocell 124 is located downstream of the output feed roller 54 for detecting the leading edge of the workpiece.

The drive motors used in the present invention are preferably stepper motors. Various conventional stepper motors can be used. One embodiment of the transport motor moves the workpiece 1.7 mils per step. An example of a commercially available stepper motor which might be used is the Astroysn, model 17PM-M008, made by NMB Corporation which is a 200 steps per revolution or 1.8 degree motor.

As illustrated in Figure 7, a suitable printer controller 130 receives input from the host computer system 131 and input from the various sensors and then activates the various motors and actuators used in the printer apparatus. In a preferred embodiment, the printer controller 130 samples the trailing edge sensor ever four or two steps of the transport motor to precisely locate the trailing edge of the workpiece. This rapid sampling allows for a very accurate determination of card position. The present embodiment is able to obtain resolutions of plus/minus 1/2 print column at two steps and 1/4 print column at four steps.

A typical printer apparatus using a roller transport system will use a stepper motor to drive the roller transport system with either full or half step control. Step resolutions are typically 1.8 degrees per full step and 0.9 degrees per half step. Microstep controllers of variable resolution are available to allow the current to the stepper motor windings to be controlled in smaller increments such that the motor can be stepped at finer resolutions than 0.9 degrees. These microcircuits are still designed to operate like traditional stepper motor circuits in that one step to the controller will yield one microstep to the motor. In one embodiment of the present invention, a sine control drive circuit 126 is used to produce a low cost circuit that produces sinusoidal current control in continuous fashion to each

of the windings of the transport motor. The produces a smoother velocity profile for the transport motor than typically observed with a conventional stepper motor control. In addition it removes the burden of stepping from the controlling microprocessor and places it on the sine control circuit. The reduced velocity shift in the transport motor increases the accuracy of printing because it reduces the positional uncertainty between motor poles. the sine drive circuit transmits positional information to the controlling microprocessor at a rate higher than its full step positional accuracy. This provides increased accuracy at reduced cost. The sine drive circuit also increases the accuracy of pass to pass registration during multipass printing.

In one embodiment the sine drive consists of a low cost bipolar stepper motor controller chip 150 and a low cost 16 pin embedded microcontroller 152. The stepper motor controller chip is driven in full step mode with its current limit controlled by the embedded microcontroller. The current limit is regulated sinusoidally so the currents at the A and B motor phases approximates a sine wave. The controlling microprocessor has directional control and an enable. The sine drive circuit returns positional information based on its current limit control and step control state. In operation the controlling microprocessor sets the direction and enables the sine drive microcontroller. The microprocessor then samples the degree detection sensor, and waits for an edge crossing to occur. From the time the edge crossing occurs the positional feedback is used to control the print placement. When the printing is completed, the direction is reversed and the card is recycled through the edge sensor where the motor direction is again reversed and the card is recycled through the edge sensor where the motor direction is again reversed and

the process is repeated for the next color. This process is repeated for as many passes as necessary to complete the printing. Note that for each pass, the card is located with respect to the sensor, and the referenced to the positional feedback from the sine drive circuit. The sensor is sampled once for each increment of the positional feedback from the drive circuit. In this embodiment that is four signaling events from the sine drive controller for each full step and eight signalling events for each print line. The printing rate is approximately six mS per line at 300 dots per inch. The print speed is about 0.5 inches per second.

Use of the roller transport during the printing process will now be described generally referring to figures 9-14. Prior to initiating printing, the print head is raised until the print head home photocell is blocked such that the print head is in the home position. The ribbon motor is run to properly position the ribbon color segments for printing. At this point in time, the printer is ready to print on the workpiece. When the workpiece present photocell is blocked, this indicates that a workpiece has been fed to the printer and is upstream of the cleaning rollers. The transport motor is turned on to pull in the workpiece past the cleaning roller (see figure 9). The transport motor is run until a trailing edge of the workpiece is detected (see figure 10). The transport motor is then run to move the card's leading edge to just beyond the print roller center line (see figure 11). The print head motor is then run to lower the print head onto the card. The transport motor is then run for approximately 30 steps while simultaneously running the ribbon drive motor before printing starts. At this point in time, the yellow pass printing begins. The transport motor and the ribbon motor are simultaneously run for the length of yellow

color to be printed and then the transport motor is run for approximately 167 steps while simultaneously running the ribbon motor an additional time so as to strip the ribbon from the card. The print head motor is then run to raise the print head (see figure 12). The ribbon motor is then run to position the magenta panel on the ribbon for the next printing series. The transport motor is then reversed to transport the workpiece back toward the trailing edge photocell. The trailing edge of the workpiece is transported slightly beyond the trailing edge sensor (see figure 14). Then the transport motor is again reversed to transport the workpiece toward the printer roller as was done during the previous pass such that the leading edge of the card is placed slightly beyond the center of the print roller (see figure 11). The print head is then lowered onto the workpiece. The transport motor is then run for approximately 30 steps while simultaneously running the ribbon drive before initiating printing. The magenta color pass is then printed in a fashion similar to that of the yellow pass. The printer apparatus then repeats the same steps so as to strip the ribbon from the card, raise the printer head, position the cyan panel and reposition the card at the print roller. The cyan printing pass is then performed to complete the printing of the composite color image.

After printing the cyan pass, the ribbon is again stripped from the card. If mass transfer printing of barcodes or the like is to be accomplished, the black segment might be printed, otherwise the yellow segment of the ribbon is positioned for printing, the printer head is raised, and the printer carriage and transport carriage are moved laterally into alignment with the overlay ribbon for application of the overlay if an overlay is to be applied. The workpiece is then transported by the feed rollers and the cleaning roller

back in the direction from which workpiece came for delivery to an output hopper or the like. Of course the workpiece might be transported linearly through the printer apparatus to its opposite end. The next workpiece is then moved into position and the color printing is initiated for that workpiece.

The mechanism for laterally moving the printer carriage assembly and transport carriage assembly with respect to the ribbon supply system so as to align the appropriate ribbon with the print head and workpiece is illustrated in more detail in Figures 15-17. In Fig. 15A carriage drive motor 80 is mounted on support frame 40. A pair of guide tracks 200 and 202 as seen In Fig. 15B are secured to a floor of printer apparatus 30. Support frame 40 has a pair of flange members 206 and 208 which are mounted on guide tracks 200 and 202 for lateral movement of support frame 40. The following is a description of the specific attachment of flange member 206 to guide track 200. It should be understood that the attachment of flange member 208 to guide track 202 is the same. Specifically, as seen in Fig. 15B, guide track 200 has a pair of elongated openings 210 and 212 and guide track 202 has a similar pair of elongated openings 211 and 213. Flange member 206 is mounted to guide track 200 by fastening hardware that permits lateral motion of support frame 40 on guide tracks 200 and 208. The fastening hardware will be described with reference to the attachment of flange member 206 at elongated opening 212, it being understood that identical fastening hardware is used to attach flange member 206 at elongated opening 210. As seen in Fig. 15C, the fastening hardware includes a guide washer 214 slidably received within elongated opening 212. Guide washer 214 has an opening 216 for receiving a threaded screw 218. A corresponding opening is provided in flange member 206. Thus, to secure flange member 206 on

guide track 200, a screw 218 is inserted through the opening in flange member 206 and through opening 216 in guide washer 214 which is mounted in elongated opening 212. A lock washer 220 and washers 222 and 224 serve to slidably secure flange member 206 to guide track 200.

Lateral movement of frame 40 is accomplished by motor 80 and an associated rack and pinion mechanism. A toothed rack 226 is mounted on a sidewall 228 of guide track 200. Motor 80 has a drive shaft 230 with a pinion 232 having teeth which mesh with and engage the teeth of rack 226. Thus, when motor 80 is turned on, rotation of pinion 232 causes frame 40 to move laterally due to the rack and pinion construction.

In a preferred embodiment of the print roller transport apparatus, a rotary encoder mechanism 234 is provided. As seen in Fig. 16A, mechanism 234 includes a rotary encoder 236 mounted on a bracket 238 which is itself attached to print head lift apparatus 130 as will be described in more detail hereafter. Encoder 236 is a stepper motor having a ribbon roller engagement wheel 240 affixed to the motor shaft. As seen in Fig. 16B, bracket 238 has a base member 242, a pair of leg members 244 and 246, a wing member 248 and a rotary encoder mounting member 250. As previously described, rotary encoder 236 is mounted to member 250. Bracket 238 is pivotally mounted to a pair of print head support frame members 252 and 254. A pair of pivot pins 256 and 258 are received within apertures 260 and 262 in leg members 244 and 246, respectively. A pair of positioning and preloading springs 264 and 266 are also connected between bracket 238 and frame members 252 and 254. More specifically, spring 264 is hooked into a recess 268 on wing member 248. The opposite end of spring 264 is connected to a pin (not shown) on frame member 254. One end of spring 266 is attached to an ear 268 extending

from leg member 246. The opposite end of spring 266 is attached to a pin (not shown) on frame member 252. Leg members 244 and 246 have extension arms 270 and 272 that are received within openings 274 and 276 in a sidewall 280 of support frame 40 as seen in Fig. 15A. Springs 264 and 266 are over center springs which normally bias bracket 238 and encoder 236 toward the print position with wheel 240 in engagement with a print ribbon roll as shown schematically in Figure 17A and in phanton in Figure 16A. In this print position, extension arms 270 and 272 are loosely received within openings 274 and 276. As print head 42 is returned to its home position as described in more detail above, extension arms 270 and 272 are caused to engage sidewall 280 at the top end of openings 274 and 276. This causes bracket 238 to be pivoted on frame members 252 and 254 to position shown in Figure 16A and schematically in Figure 17B where engagement wheel 240 is rotated out of engagement with the print ribbon roller. Bracket 238 can be pivoted to a third position as shown in Figure 17C. When pivoted to this position over center springs 264 and 266 function to retain bracket 238 in the third position until it is manually rotated toward the second position.

In operation, rotary encoder 236 serves several functions. Each function involves the measurement of the amount of ribbon being used. As ribbon is fed from the supply spool such as spool 62 as shown in Figure 1, rotary encoder 236 is in engagement with the supply spool and pulses are generated. Each pulse corresponds to approximately .05 inch of ribbon. Pulses from the rotary encoder 236 are fed to the microprocessor printer controller which is illustrated in block diagram form in Figure 7. Printer controller also monitors signals from a photocell ribbon sensor 63. Photocell 63 is blind to the primary color panels yellow, magenta, cyan, and tonal black (D2T2 material). Photocell 63 can detect

the index mark on the ribbon and solid pigment thermal transfer materials. The signal from the photocell in combination with the pulse count from the encoder allows the microprocessor print controller to perform a number of functions. The presence of three panel D2T2 (yellow, magenta and cyan) is determined by finding the index mark, counting pulses and measuring the distance between the next index mark. In other words, the index mark plus 15.9 inches equals three panel D2T2. The presence of four panel D2T2 (yellow, magenta, cyan, and black thermal transfer is determined by finding the index mark and counting pulses and measuring a distance between the next index mark. The black thermal transfer panel is detected by the photocell. A signal from photocell 63 and ribbon motion indicate to the microprocessor that the black thermal transfer panel is present. The presence of tonal black is determined by motion of the ribbon and no detectable index marks by photocell 63. The presence of thermal transfer is detected by motion and a continuously blocked index mark. Presence of the overlay panel is detected by motion and no detectable index marks. A lack of motion during operation is considered a break in the media and generates a fault signal condition. Encoder 236 thus measures the surface and therefore the actual length of the material used. With regard to variable panel lengths, the encoder 236 allows the printer controller to position the three panel D2T2 and four panel D2T2 panels in the correct position for each particular printing pass. The operator inputs into the microprocessor print controller the panel the length that is used in the printer. Rotary encoder 236 is manually pivoted to its third position shown in Figure 17C for replacement or changing of the print ribbon on supply spool 62.

Having read the foregoing description, it is to be understood, that even though numerous characteristics

and advantages of various embodiments in accordance with the principles of the invention have been set forth in the foregoing description, together with details of the structure and function of the invention, the disclosure is illustrative only, and changes may be made in detail, especially matters of shape, size and arrangement of the parts within the principles of the invention to the full extent indicated by the broad general meaning of the term in which the appended claims are expressed.

What Is Claimed Is:

1. A workpiece transport apparatus used with a graphics printer having a print head, the transport apparatus comprising:

input feed roller means for feeding the workpiece toward the print head and output feed roller means for feeding the workpiece away from the print head, the input feed roller means and output feed roller means both engaging the workpiece prior to the input feed roller means disengaging from the workpiece;

printer roller means aligned with the print head and disposed intermediate of the input and output feed rollers for supporting the workpiece intermediate of the print roller means and the print head;

a single drive motor driving the input and output feed roller means and the printer roller means;

sensor means for sensing the position of the work piece relative to the print head; and

control means responsive to signals received from the sensor means for controlling operation of the drive motor.

2. An apparatus in accordance with claim 1, wherein the drive motor is a stepper motor with multiple steps per print line.

3. An apparatus in accordance with claim 2, wherein the stepper motor has two steps per print line.

4. An apparatus in accordance with claim 1 wherein the sensor means includes a trailing edge sensor means disposed upstream of the input feed roller means for sensing a trailing edge of the workpiece and a leading edge sensor means disposed downstream of the output feed roller means for sensing a leading edge of the workpiece.

5. An apparatus in accordance with claim 1, wherein the drive motor includes a stepper motor having a drive shaft connected to a friction driven gear reducer.

6. An apparatus in accordance with claim 1, including sine wave drive means for sinusoidally driving the drive motor.

7. An apparatus in accordance with claim 1, including cleaning roller means for cleaning a surface of the workpiece, the cleaning roller means being driven by the drive motor.

8. An apparatus in accordance with claim 1, including lateral drive means for moving the transport apparatus laterally whereby the transport apparatus can be moved out of alignment with a first ribbon and into alignment with a second ribbon.

9. A method of transporting a workpiece past a printhead, comprising:

transporting the workpiece using feed rollers; and

sensing an edge of the workpiece to determine its position.

10. A method in accordance with claim 9, wherein the step of transporting includes advancing the card less than a column per interval of movement.

11. A graphics printer comprising:

a print head;

a print ribbon supply spool and print ribbon take up spool adapted to feed a print ribbon into position between said print head and a workpiece;

input feed roller means for feeding the workpiece toward said print head and output feed roller means for

feeding the workpiece away from said print head, said input feed roller means and said output feed roller means both engaging workpiece prior to said input feed roller means disengaging from the workpiece;

printer roller means aligned with said print head and disposed intermediate of said input and said output feed rollers for supporting the workpiece intermediate of said print roller means and said print head;

a single drive motor driving said input and said output feed roller means and said printer roller means;

sensor means for sensing the position of the workpiece relative to said print head;

control means responsive to signals received from said sensor means for controlling operation of said drive motor;

rotary encoder means cooperating with said print ribbon supply spool for generating control signals representing the length of print ribbon fed from said supply spool;

control means responsive to said signals from said rotary encoder means for controlling the operation of the printer.

12. A workpiece transport apparatus in accordance with claim 1 wherein said transport apparatus is mounted on a support frame in a graphics printer housing and further comprising means for moving said support frame laterally whereby the transport apparatus can be moved out of alignment with a first ribbon and into alignment with a second ribbon.

13. A workpiece transport apparatus in accordance with claim 12 wherein said means for laterally moving said support frame further comprises:

guide means affixed to the printer housing and on which said support frame is mounted for lateral movement;

rack and pinion drive means connected to said support frame and said guide means for moving said support frame laterally on said guide means.

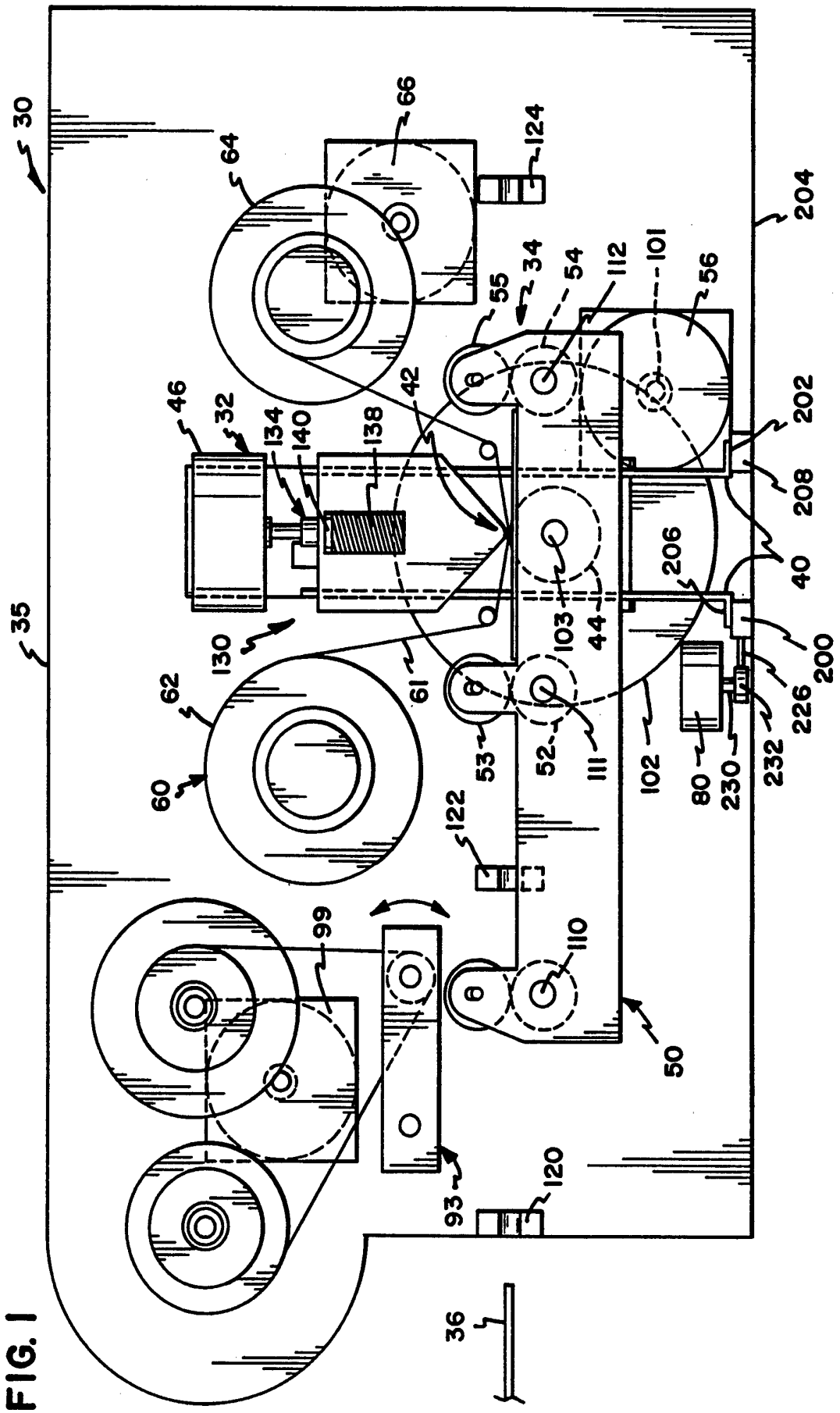

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FIG. 1

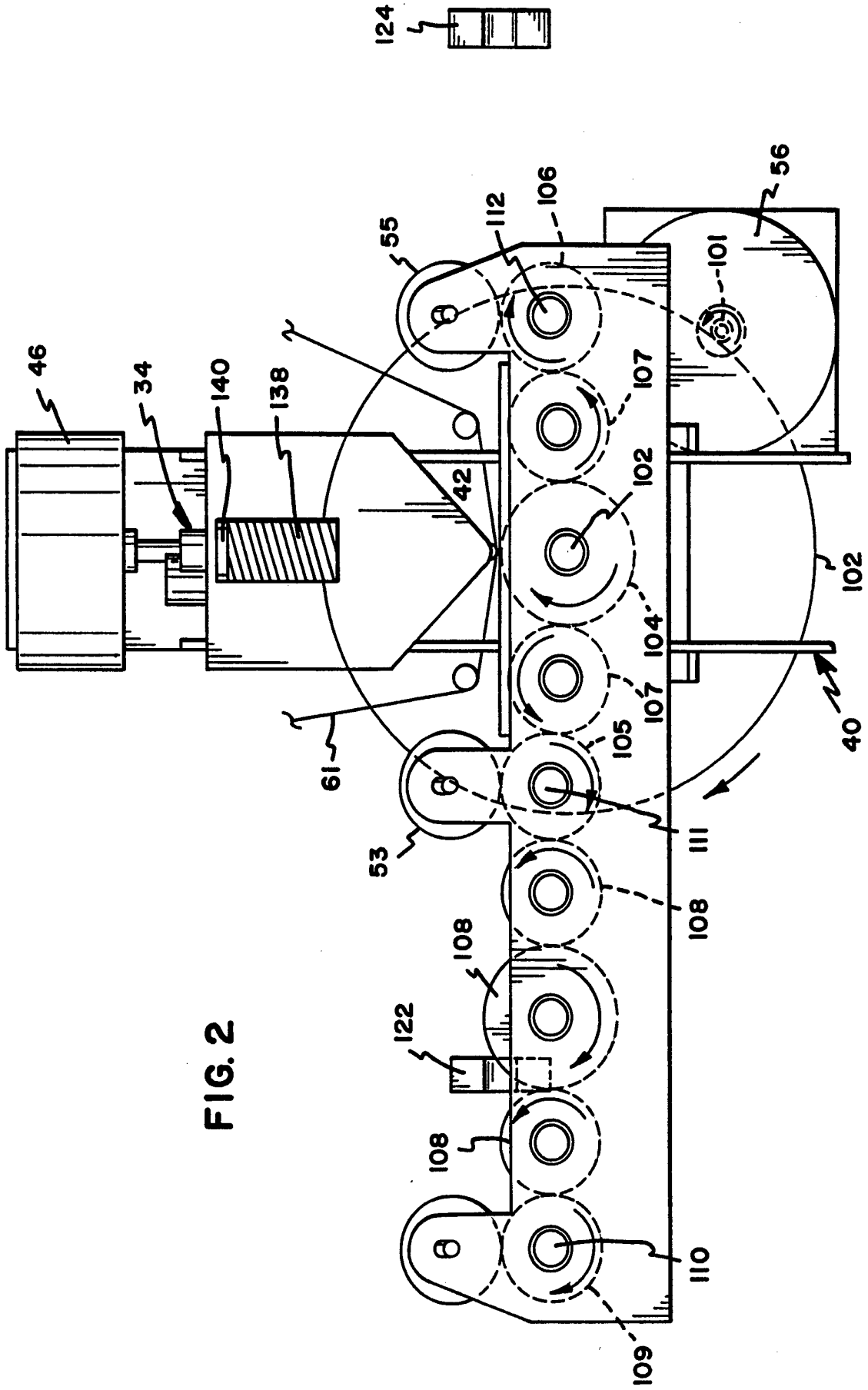

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FIG. 2

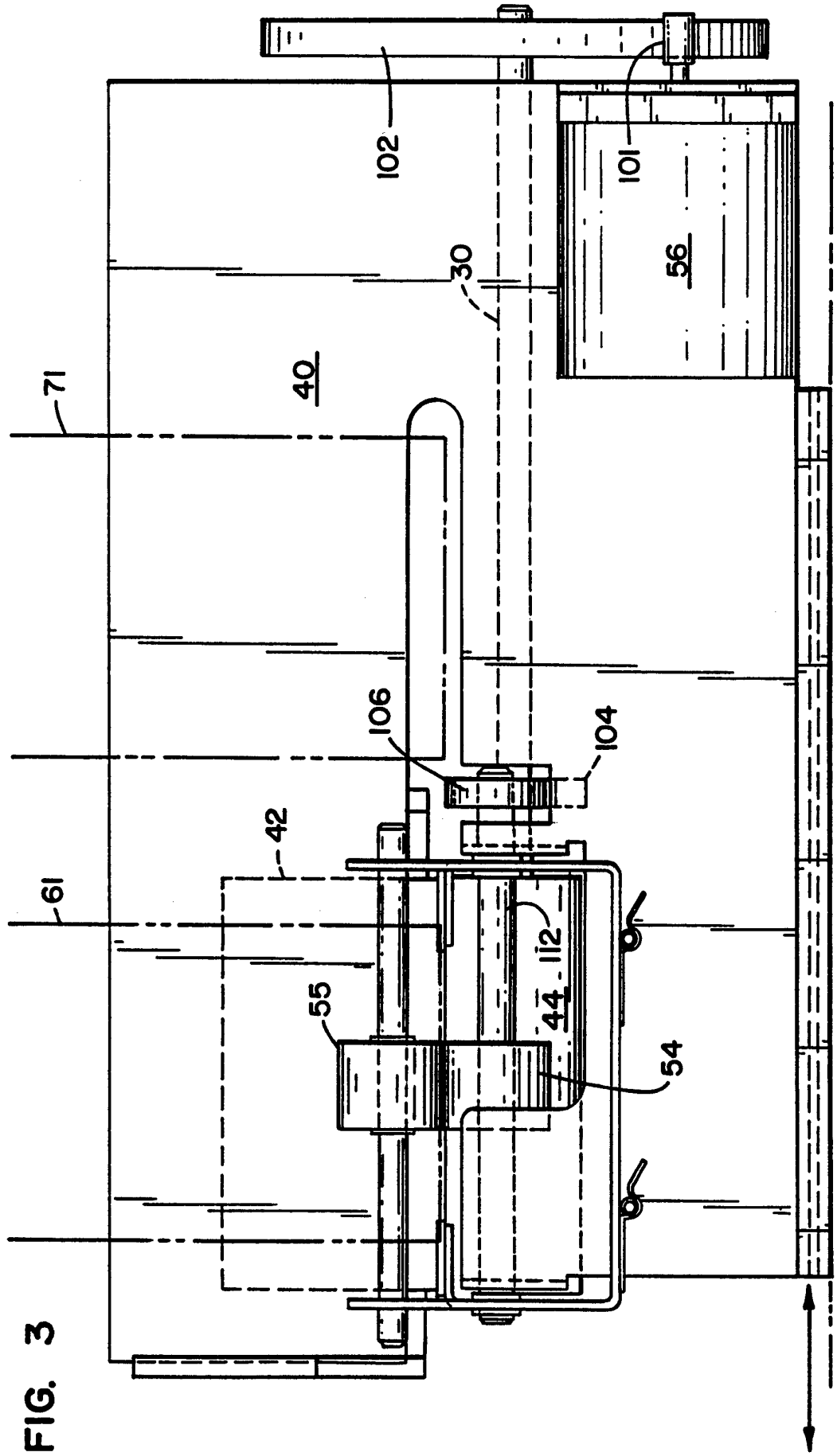



FIG. 3

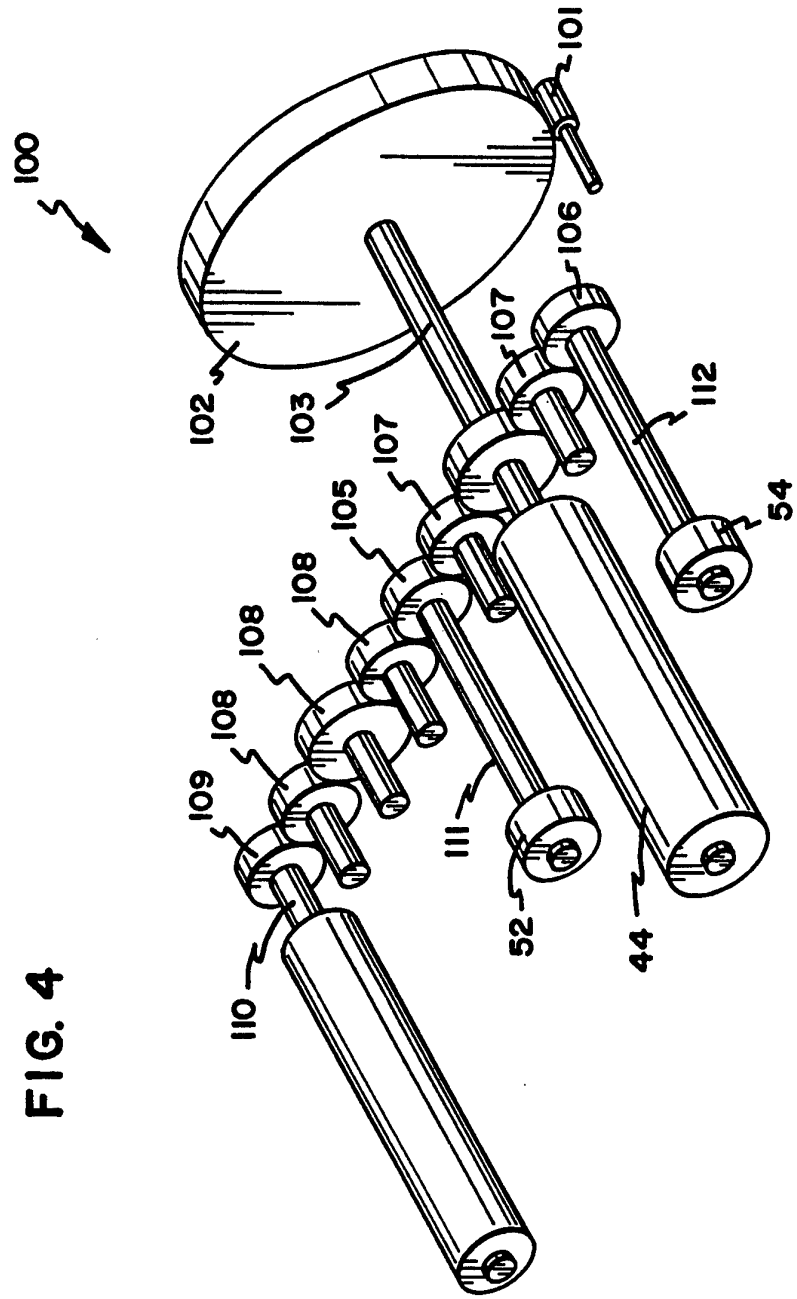

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FIG. 4

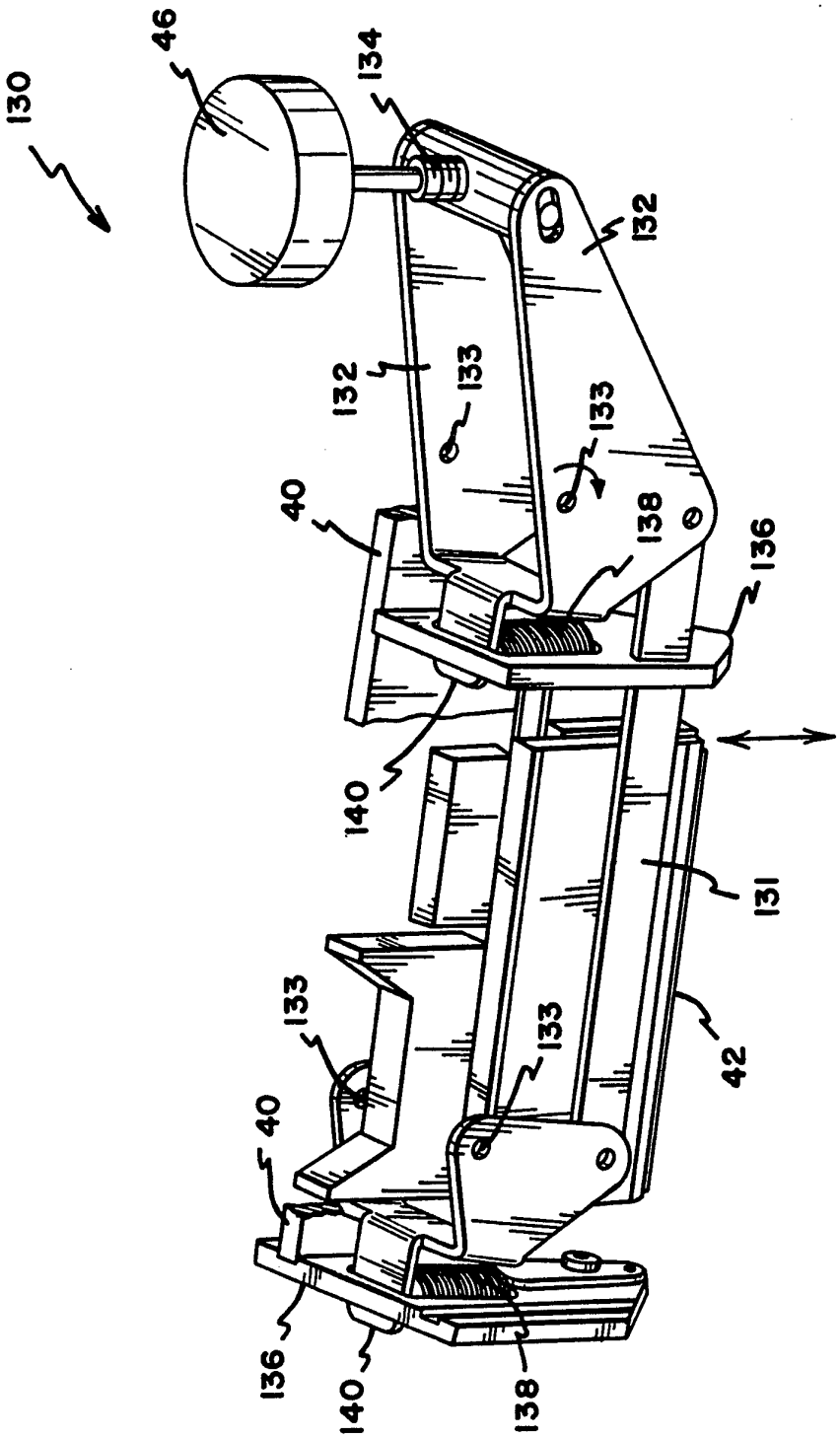

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FIG. 5

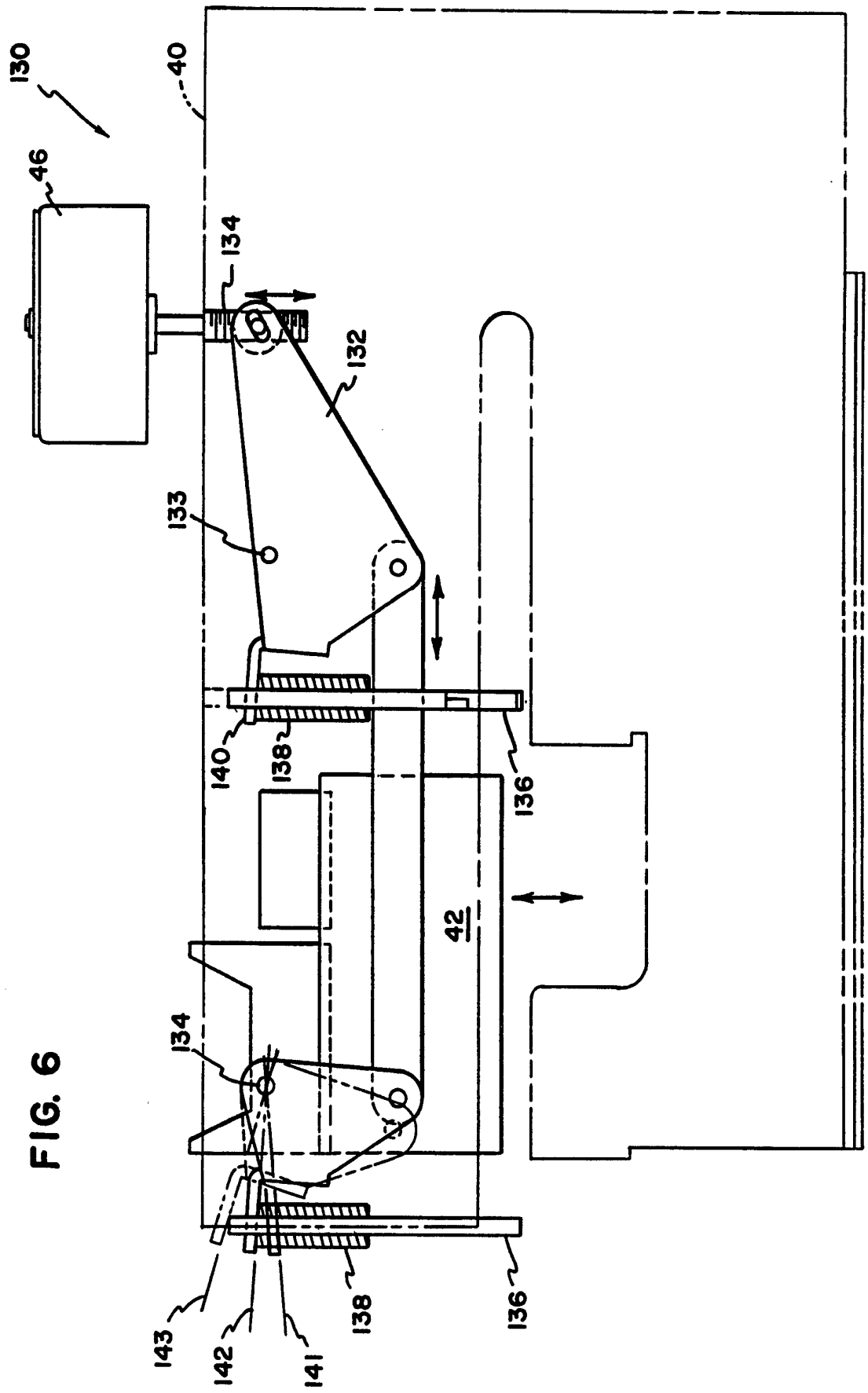
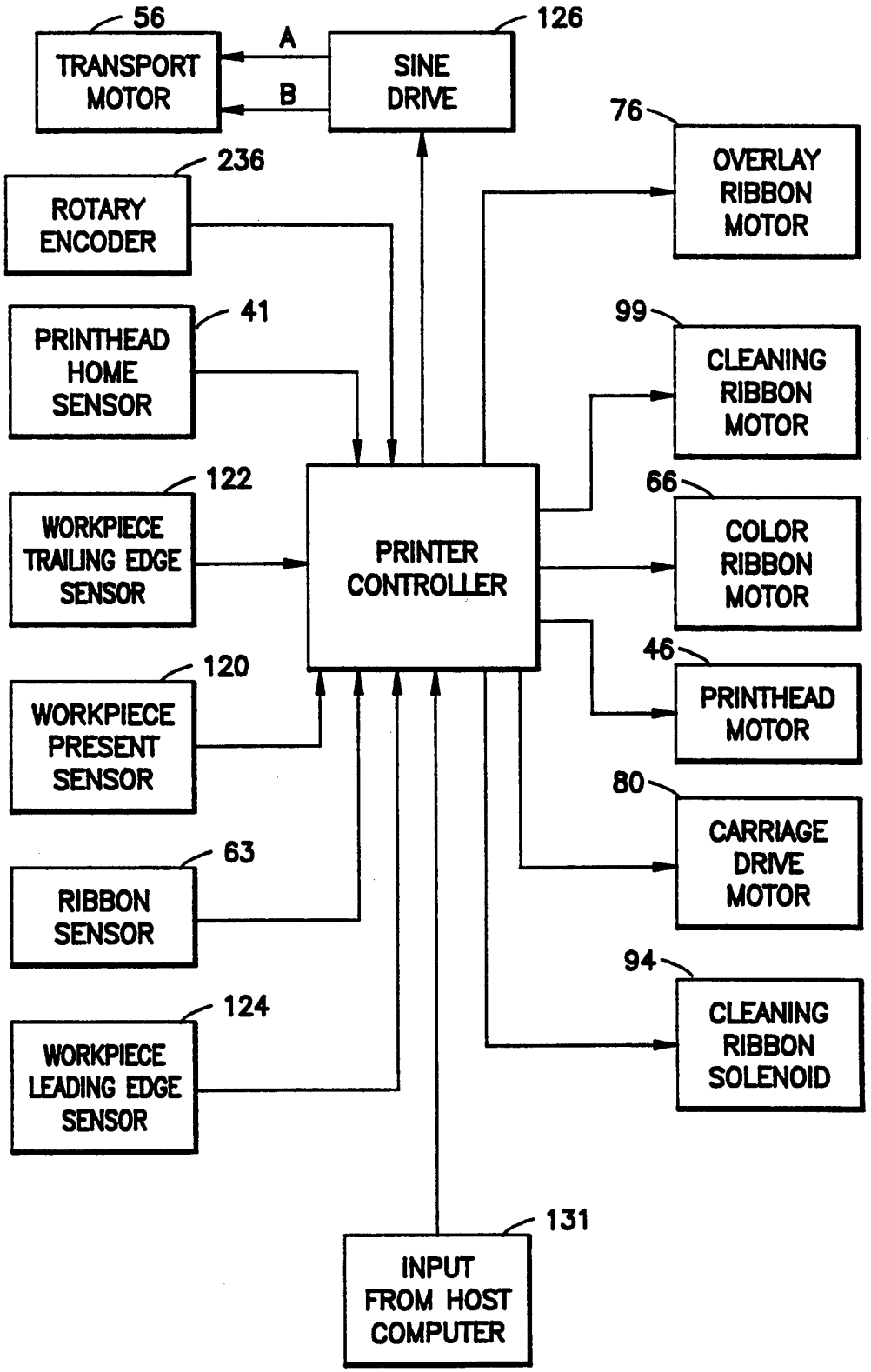



FIG. 6

FIG. 7


56
TRANSPORT MOTOR
A
B
126
SINE DRIVE
76
OVERLAY RIBBON MOTOR
236
ROTARY ENCODER
41
PRINTHEAD HOME SENSOR
99
CLEANING RIBBON MOTOR
122
WORKPIECE TRAILING EDGE SENSOR
PRINTER CONTROLLER
66
COLOR RIBBON MOTOR
120
WORKPIECE PRESENT SENSOR
46
PRINTHEAD MOTOR
80
CARRIAGE DRIVE MOTOR
63
RIBBON SENSOR
94
CLEANING RIBBON SOLENOID
124
WORKPIECE LEADING EDGE SENSOR
131
INPUT FROM HOST COMPUTER

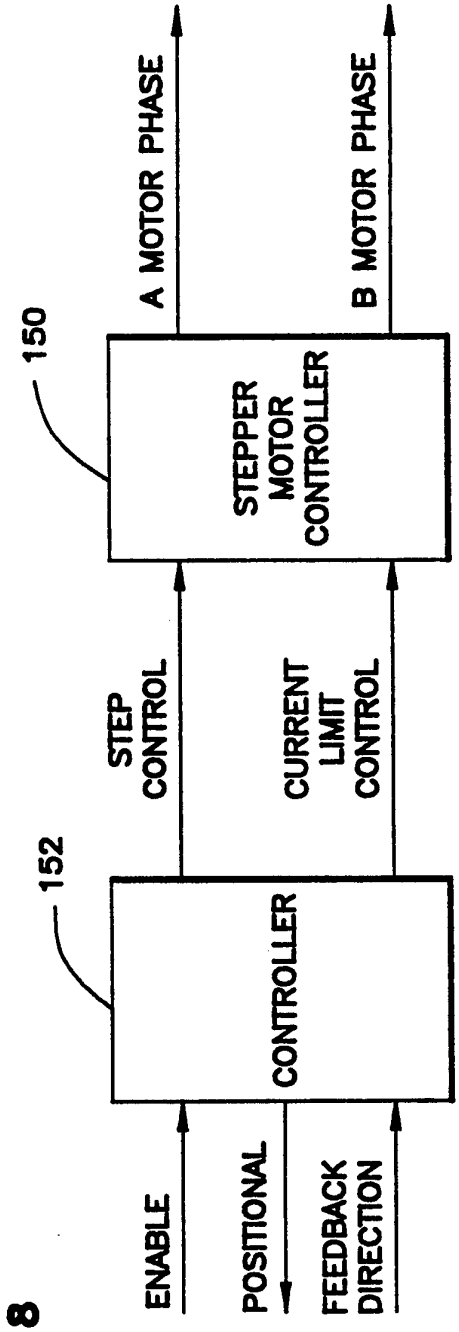

150
STEPPER MOTOR CONTROLLER
A MOTOR PHASE
B MOTOR PHASE
STEP CONTROL
CURRENT LIMIT CONTROL
152
CONTROLLER
ENABLE
POSITIONAL
FEEDBACK DIRECTION

FIG. 8

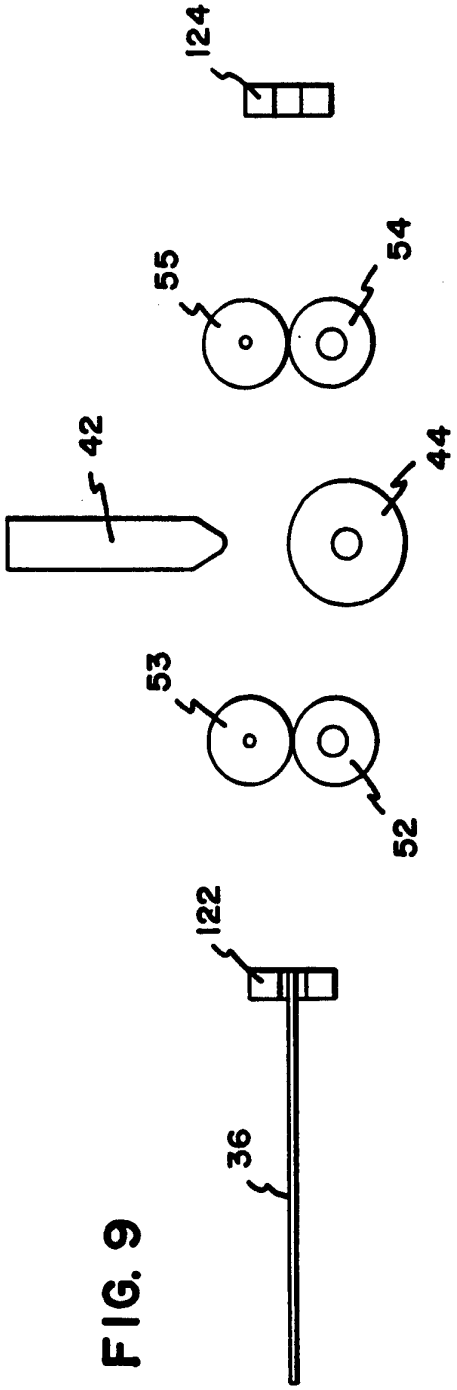



FIG. 9

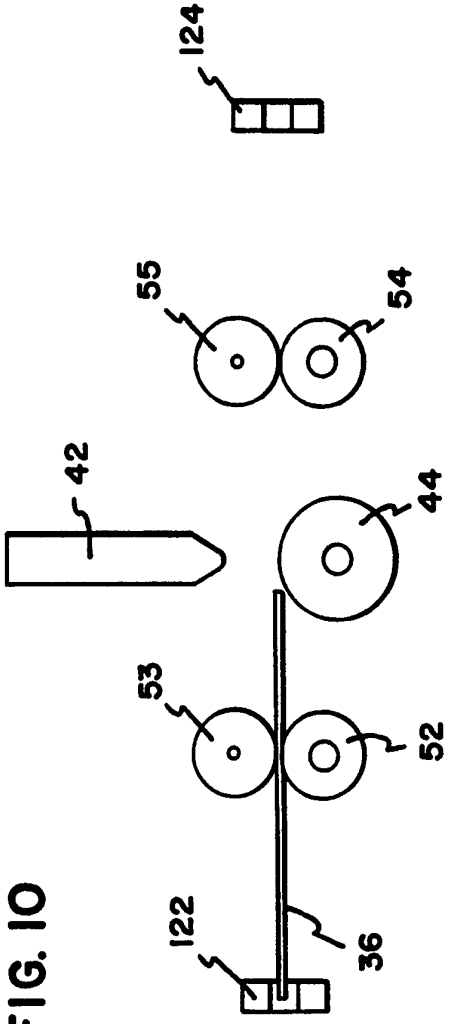



FIG. 10

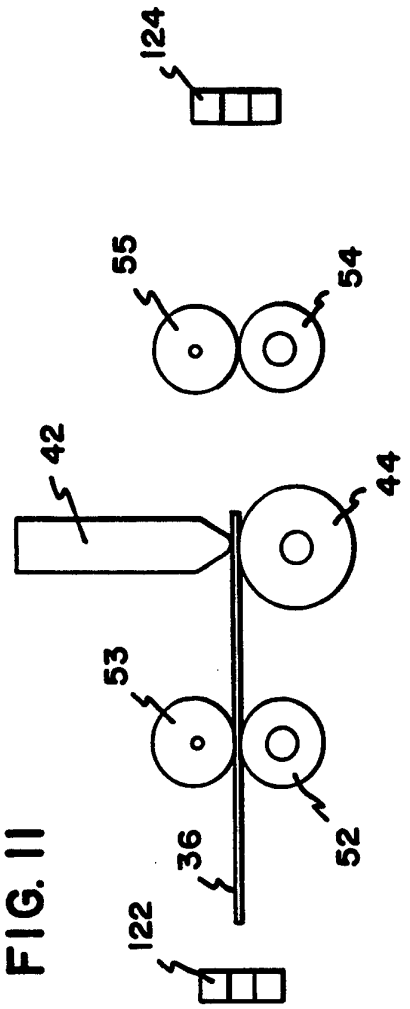



FIG. 11

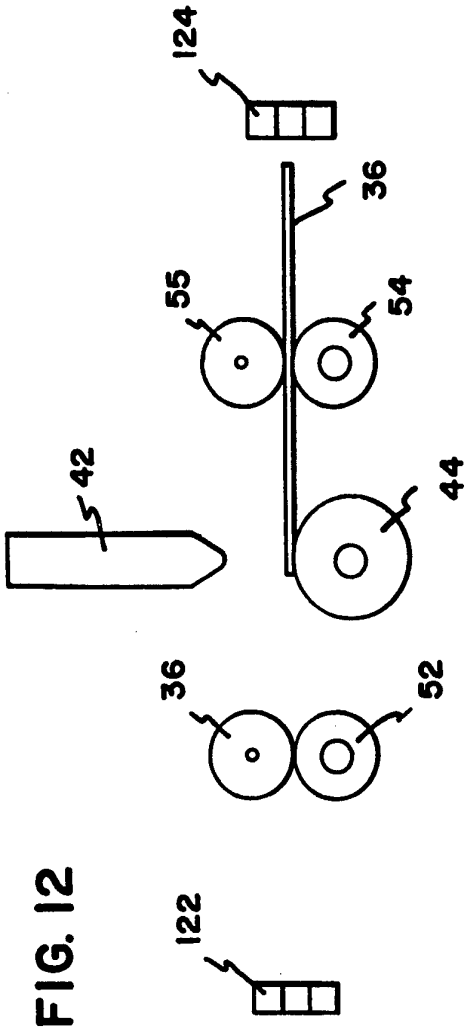



FIG. 12

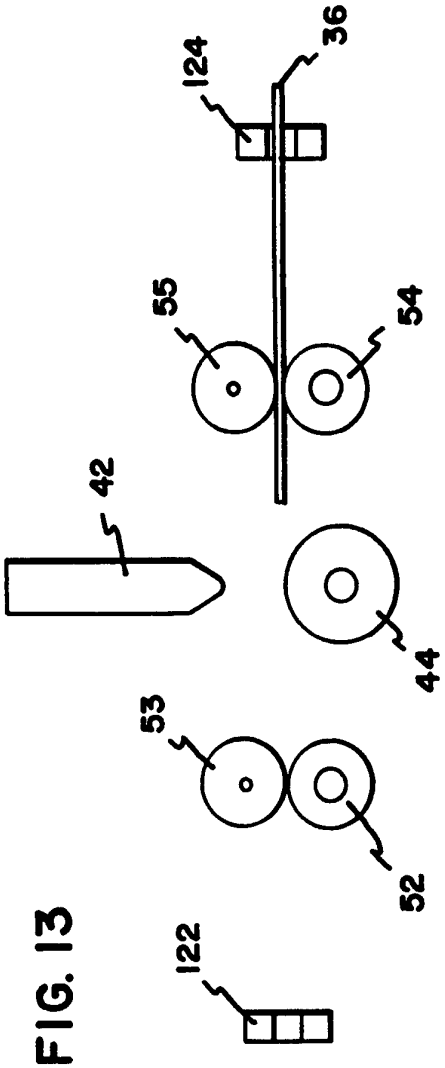



FIG. 13

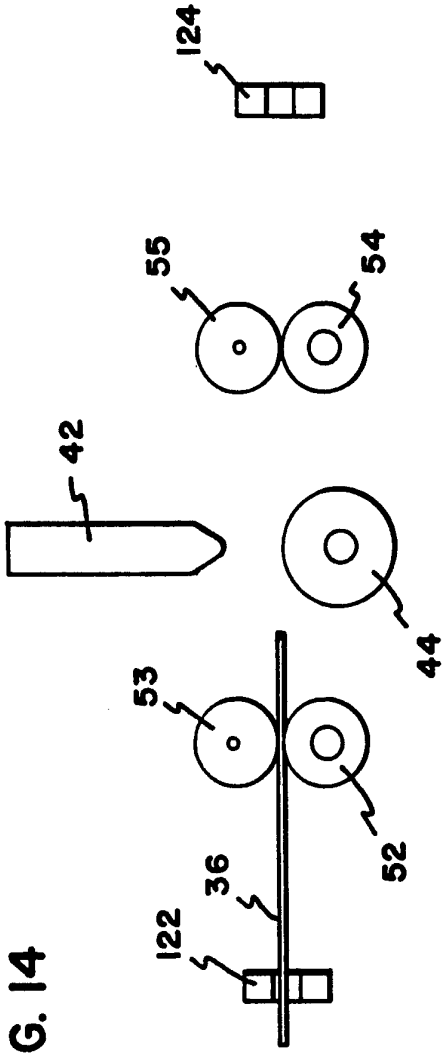



FIG. 14

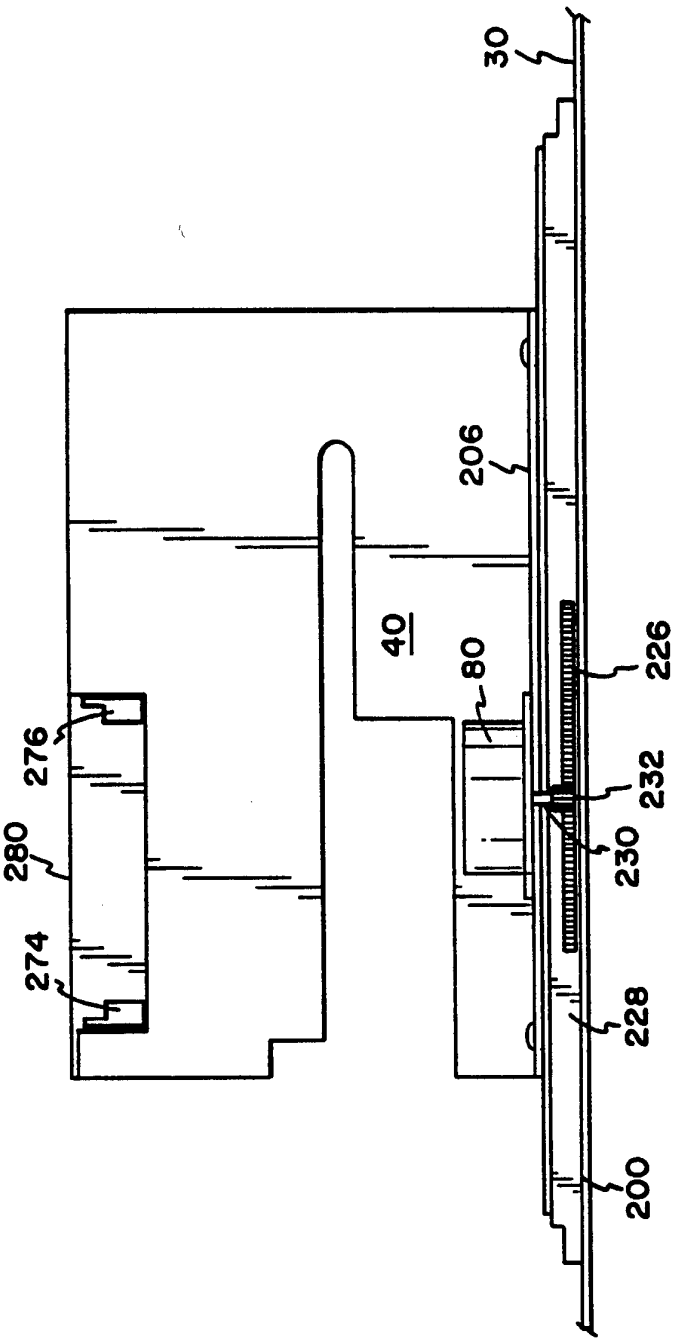



FIG. 15A

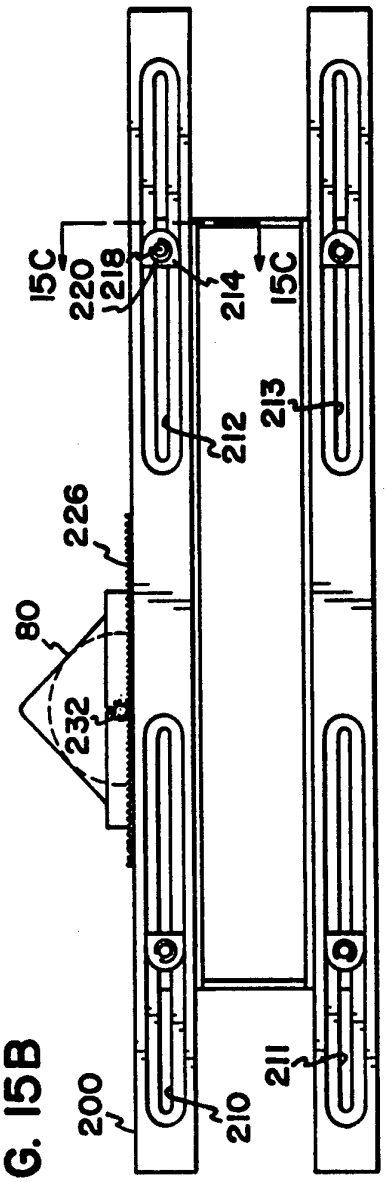



FIG. 15B

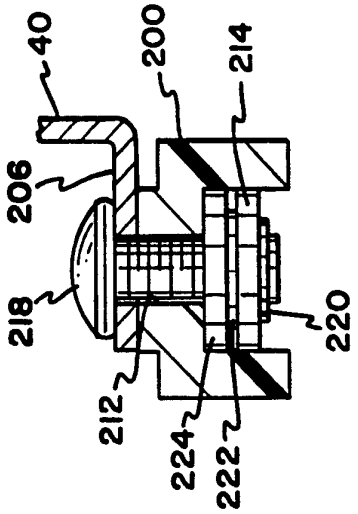
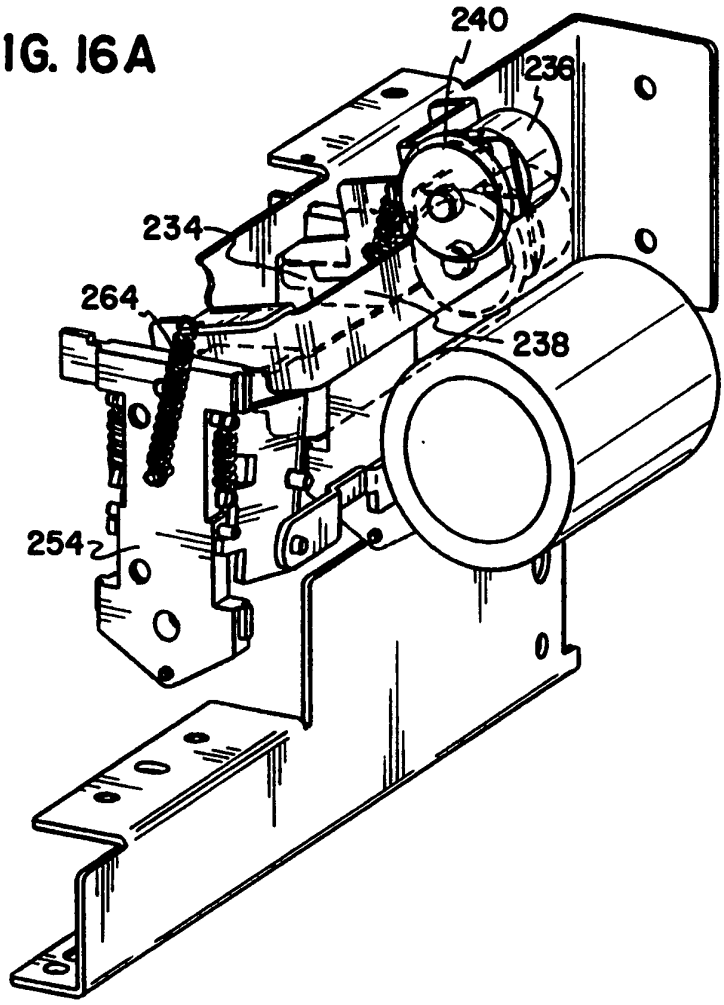
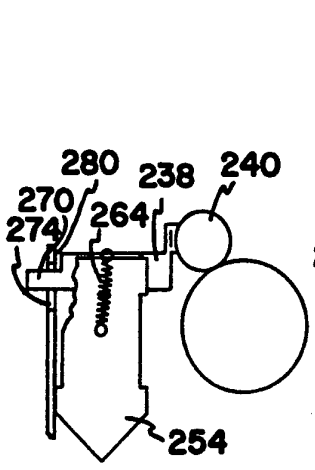
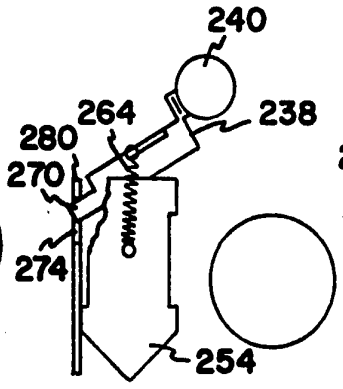



FIG. 15C

FIG. 16A



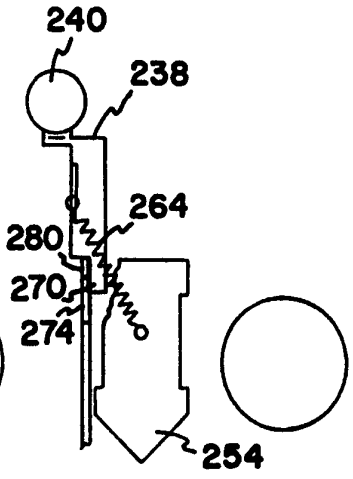




FIG. 17A FIG. 17B FIG. 17C

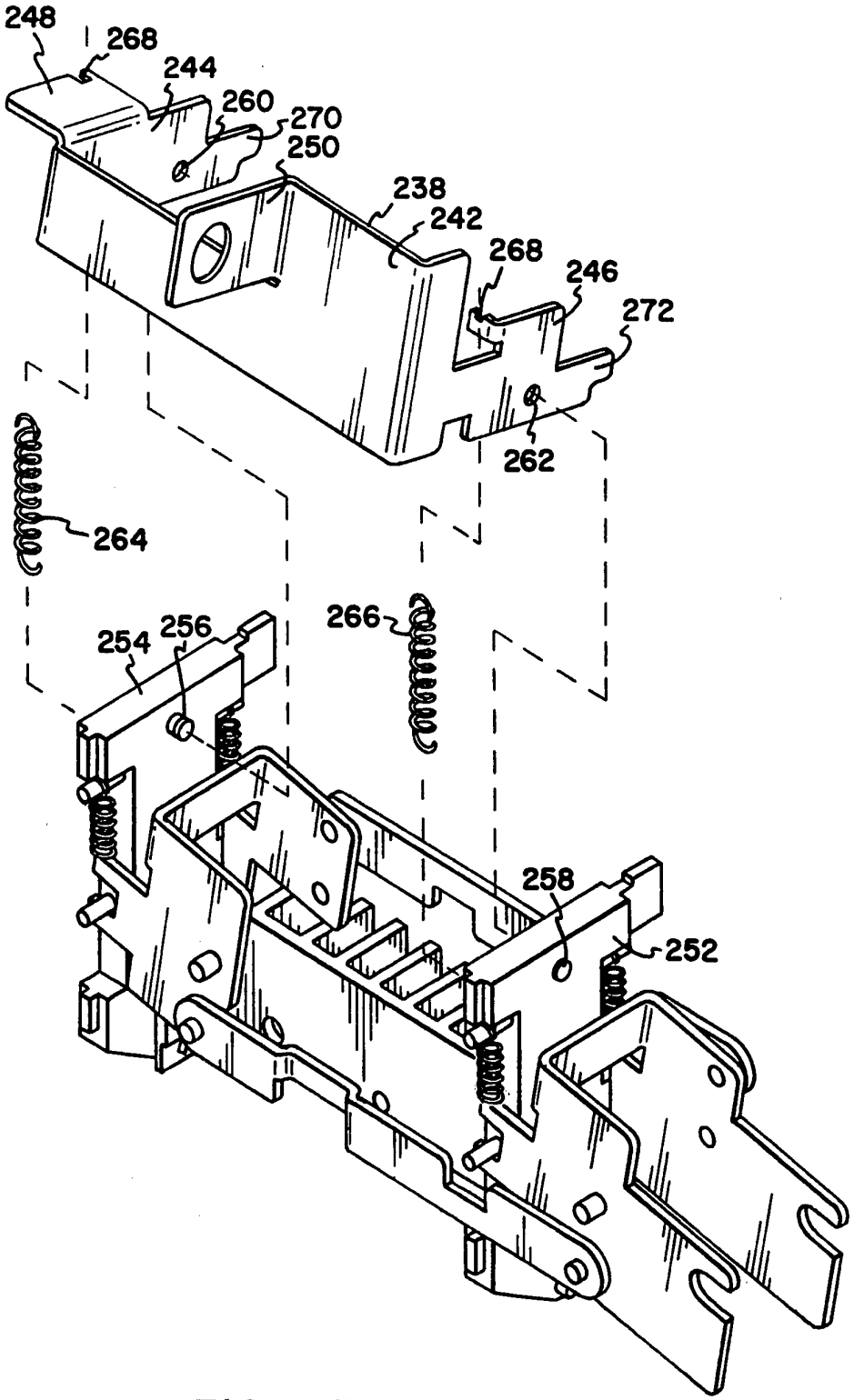

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FIG. 16B

# INTERNATIONAL SEARCH REPORT

Internati Application No
PCT/US 94/02954

A. CLASSIFICATION OF SUBJECT MATTER
IPC 5 H04N1/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 5 H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category * | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
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| Y | see column 3, line 9 - line 25 | 11 |
| A | see column 3, line 38 - column 5, line 15 | 2-6,10 |
| | --- | |
| Y | GB,A,2 202 492 (SONY CORPORATION) 28 September 1988 see abstract; figure 1 | 11 |
| | --- | |
| X | PATENT ABSTRACTS OF JAPAN vol. 14, no. 491 (M-1040) 25 October 1990 & JP,A,02 200 463 (RICOH) | 9 |
| Y | see abstract | 1 |
| | --- | |
| X | FR,A,2 536 551 (XEROX CORPORATION) 25 May 1984 | 9 |
| Y | see page 4, line 14 - page 7, line 24 | 1 |
| A | | 2-6 |
| | --- | |
| | -/-- | |

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 15 July 1994 | 03. 08. 94 |

| Name and mailing address of the ISA | Authorized officer |
|---|---|
| European Patent Office, P.B. 5818 Patentlaan 2<br>NL - 2280 HV Rijswijk<br>Tel. ( + 31-70) 340-2040, Tx. 31 651 epo nl,<br>Fax: ( + 31-70) 340-3016 | Pigniez, T |

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# INTERNATIONAL SEARCH REPORT

Internati Application No
PCT/US 94/02954

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

| Category ° | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| A | US,A,3 790 159 (HATZMANN & AL.) 5 February 1974<br>see abstract; figure 3<br>----- | 1,9,11 |

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Internati Application No
PCT/US 94/02954

| Patent document cited in search report | Publication date | Patent family member(s) | | Publication date |
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