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(54) Ink ribbon shift control.

(57) A compact printer capable using any of a plurality of printing tracks or colors of an ink ribbon is disclosed in which line drive means for driving a print head (1) are also used for operating ribbon shift means in order to select a desired printing track or color. Preferably, the stroke of a reciprocating movement of the print head is divided into a printing region within which printing on a recording paper (7) is performed, and two non-printing end regions. The ribbon shift means is operated in response to the line drive means moving the print head into a non-printing end region. Moving the print head into one end region causes a track setting mechanism to set a desired printing track, whereas moving the print head into the opposite end region causes a track resetting mechanism (50) to release the track setting by the track setting mechanism. A cam member having a stepped cam face provided on a pivotally supported setting lever which is operated by engagement with the print head is used as the track setting mechanism. Also disclosed is a control method for controlling this printer such as to allow multi-color printing.

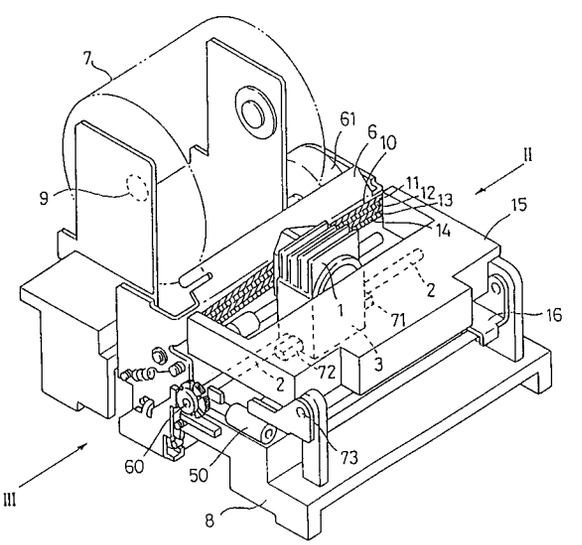

FIG. 1

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The invention relates to a printer, especially to a compact printer adapted to use an ink ribbon having a plurality of printing tracks and ribbon shift means for selecting a desired one of such printing tracks. The invention also relates to a method for controlling multi-color printing with such printer.

A printer of such kind is disclosed in JP-A-41356/91 and shown in Fig. 14. This printer is capable of multi-color printing by using an ink ribbon 90 having three different printing tracks 91, 92 and 93 each of a different color, namely black, red and blue, respectively. The three printing tracks extend in parallel to each other along the lengthwise direction of the ink ribbon 90.

The printer shown in Fig. 14 is a dot matrix printer having a print head 81 which is fixed to a carriage 83 slidably supported on a main guide shaft 82. The carriage 83 is reciprocated along the main guide shaft 82 by means of a carriage drive motor 85 via timing belt 84 in order to perform printing on a line by line basis on a recording paper 87 set on a platen 86. The ink ribbon 90 is housed in an ink ribbon cassette 95 which is set on a box-shaped ribbon frame 96. The ribbon frame 96 is supported by a shift arm 23 to be movable in a vertical direction in Fig. 14 with respect to a printer base 88 and guided by a guide 22. Moving the ribbon frame 96 up or down changes the relative position between the print head 81 and the ribbon 90 in the widthwise direction of the ribbon and thus selects any of the three printing tracks 91 to 93. The shift arm 23 is moved up and down by a cam wheel 25 driven by a shift motor 21 via a gear 24. A position sensor 26 is arranged to detect the position of the cam wheel to confirm the selected printing track.

Another printer shown in Fig. 15 uses an ink ribbon with two printing tracks 91 and 92 colored black and red, respectively, and a print head 81 of this printer is driven along a guide shaft 82 by means of a drive arm 30 which is rotated by a carriage drive motor 85. The ribbon 90 used in this printer is also housed in a ribbon cassette 95 which is set on a ribbon frame 96. A track setting mechanism in this printer is formed by a solenoid 31 acting upon a setting arm 34 protruding from the ribbon frame 96 via a two-armed lever 33. When the solenoid 31 is energized, lever 33 is turned to pull the ribbon frame 96 into the lower one of its two positions. When the ribbon frame 96 is pulled down, a spring 36 causes a setting hook 35 to engage the ribbon frame 96 to latch it in the lower position. A second solenoid 32 forms a track release mechanism which, when energized turns the setting hook 35 against the force of the spring 36 to release the latched condition of the ribbon frame 96 so that the latter will move to its upper position under the action of a spring or other biasing means. In the lower position of the ribbon frame 96 the black printing track 91 is used whereas in the upper position the red printing track 92 is used.

The document EP-A-0 202 039 discloses an electronically controlled typewriter having an ink ribbon shift mechanism driven by means of a paper feed motor. However, in this prior art the ribbon is not shifted in order to select one of a plurality of printing tracks or colors. Instead, as is usual with typewriters, the ribbon is lifted prior to printing each character and then lowered again. Also, an electromagnetic clutch is required in this prior art to select whether the paper feed motor is to perform paper feed or operate the ribbon shift mechanism.

Recently, printers are becoming more and more compact and many have a multi-color printing function. Compact printers must be particularly lightweight, consume little power and have low production costs. However, in the prior art in which switching between ink ribbon printing tracks is performed as described above by using a motor, solenoid or other dedicated drive device, the weight and power consumption of the device is increased by such drive device employing a heavy, power-consuming motor or solenoid, the reliability is decreased and the production costs increased due to an increased number of parts such as levers, hooks and gears. The same holds true with respect to the above mentioned prior art printing device that, though not requiring a dedicated drive device for ink ribbon shifting requires an electromagnetic clutch introducing the same drawbacks as solenoids.

Further, in multi-color printing there is a demand for three or more colors instead of just two and at least some of the prior art printers are not capable of meeting this demand. Also, the prior printers using a dedicated drive device for ink ribbon shifting or electromagnetic clutch means require a special control system to allow selection among various printing tracks, especially with an ink ribbon having three or more printing tracks, thus further aggravating the above problems.

The present invention is intended to solve the above problems and its purpose is to provide a low-cost compact printer capable of easily switching between the printing tracks of an ink ribbon with three or more printing tracks without requiring a dedicated drive device for such switching operation. Another purpose of the invention is to provide a control method for controlling the printer such as to achieve multi-color printing.

These purposes of the invention are achieved with a printer as claimed in claim 1 and a control method as claimed in claim 12, respectively.

Specific embodiments of the invention are subject matter of dependent claims.

According to the invention, the line drive or carriage drive means of the printer is also used for operating the ribbon shift mechanism, thereby avoiding the necessity of a dedicated shift drive means.

In a specific embodiment of the present invention the stroke of the reciprocating movement of the print head is divided into a printing region where the print head is capable of printing on a recording paper and at least one end region not used for printing. In such embodiment the print head is moved to the non-printing end region in order to operate the ribbon shift means and to select a desired printing track. Such non-printing end region(s) avoids the necessity of selecting whether the line drive means is to drive either the print head or the ribbon shift means. As long as the print head reciprocates within its printing region any drive connection between the line drive means and the ribbon shift means is disabled. When the print head enters the non-printing end region(s) the drive connection between the line drive means and the ribbon shift means is enabled but the drive connection between the line drive means and the print head need not be disabled.

Printers normally have a control system for controlling the line drive means in order to exactly position the print head to perform the desired printing. Since the line drive means is also used to operate the ribbon shift means according to the present invention, the control system for positioning the print head need only be modifyed to additionally allow selection of a desired printing track.

Further details, advantages and features of the present invention will become apparent from the following description of an embodiment in conjunction with the drawings, in which:

FIG. 1 is a perspective view showing an outline of an embodiment of a printer according to the invention;

FIG. 2 is a side view showing side II of the printer in FIG. 1;

FIG. 3 is a side view showing side III of the printer in FIG. 1;

FIG. 4 is a perspective view showing the printer in FIG. 1 with the ribbon cassette removed;

FIG. 5 is a plan view as seen from above the printer in FIG. 4;

FIG. 6 is an explanatory diagram showing the configuration of the track setting mechanism of this embodiment;

FIG. 7 is an explanatory diagram showing the configuration of the track release mechanism of this embodiment;

FIG. 8 is an explanatory diagram showing operations for setting the printing tracks in this embodiment;

FIG. 9 is an explanatory diagram showing the operations for releasing the printing track setting in this embodiment;

FIG. 10 is a block diagram of a control device of the printer of this embodiment;

FIG. 11 is a flowchart of a printing track selection control method;

FIG. 12 is a flowchart of a printing position initialization process;

FIG. 13 is a flowchart of a print head position confirmation process;

FIG. 14 is a generalized diagram showing the switching mechanism for printing tracks in a prior art printer; and

FIG. 15 is a generalized diagram showing another example of the switching mechanism for printing tracks in a prior art printer.

The basic structure of an example of a printer embodying the present invention will first be described with reference to the diagrammatic views shown in Figs. 1 to 5.

Fig. 1 is a perspective view of the printer and Figs. 2 and 3 are side views corresponding to arrows II and III in Fig. 1, respectively. Fig. 4, which corresponds to Fig. 1, shows the printer with an ink ribbon cassette being removed. Fig. 5 is a top plan view of the printer according to Fig. 4.

The printer comprises a plastics printer base 8 on which a platen 6, a carriage 3 carrying a print head 1, a ribbon frame 16 for accommodating an ink ribbon cassette 15 and a holder 9 for holding a roll of recording paper 7 are disposed. The carriage 3 is slidably supported on a main guide shaft 2 extending in parallel to the platen 6. The print head opposes the platen 6 via an exposed portion of an ink ribbon 10 housed in the ink ribbon cassette 15. Recording paper 7 from the roll of paper is fed through a gap between the exposed portion of the ink ribbon 10 and the platen 6. Printing is performed on the recording paper by means of print head 1 and ink ribbon 10 while reciprocating carriage 3 along the main guide shaft 2. As is best shown in Fig. 5, the carriage 3 is connected to a timing belt 4 driven by a carriage drive motor 5 for reciprocating the print head 1 in the line direction of the recording paper. In this embodiment, the carriage 3, the carriage drive motor 5, the timing belt 4 and the main guide shaft 2 form a line drive means.

A gap control mechanism 60 shown in Fig. 1 and 2 is employed for maintaining the platen gap between the platen 6 and the print head 1 constant irrespective of a thermal deformation etc. of the plastics printer base 8.

A feed motor 61 for feeding the recording paper 7 from the roll of paper is disposed on the right side (as viewed in Fig. 1) or side II of the printer in this embodiment, and it turns a paper feed shaft 64 via gears 62 and 63.

In the present embodiment an ink ribbon 10 having four printing tracks 11 to 14 extending in parallel in the lengthwise direction of the ink ribbon is used. Any of the four printing tracks 11 to 14 can be selected by shifting the ink ribbon in the direction of its width such that the selected printing track is set at the height of a printing area of the print head. When each printing track of the ink ribbon 10 has a different color, for instance a black printing track 11, a red printing track 12, a blue printing track 13 and a green printing track 14, a four-color printing is possible. In the present embodiment, the ink ribbon can be shifted by moving up or down the ribbon frame 16 on which the ink ribbon cassette 15 is disposed. A ribbon shift means used for moving the ribbon frame 16 up or down and, thus, for shifting the ink ribbon 10, comprises a track setting mechanism 40 and a track resetting mechanism 50. In the embodiment shown, the track setting mechanism 40 is disposed on the right side (as viewed in Fig. 1), namely side II, whereas the track resetting mechanism 50 is disposed on the left side or side III of the printer. The track setting mechanism 40 serves to push up the ribbon frame 16 and thus to select a desired one of the printing tracks. The track resetting mechanism 50 is used to release a setting condition of the track setting mechanism and causes the ribbon frame 16 to be pulled down once it has been pushed up by the track setting mechanism. On the lower part of the right side face of the carriage 3 a setting protrusion 71 is provided which protrudes towards side II of the printer in parallel to the main guide shaft 2. A similar resetting protrusion 72 is provided on the opposite side of the carriage 3. As will be explained in more detail later, the setting protrusion 71 is used to actuate the track setting mechanism 40 whereas the resetting protrusion 72 is used to actuate the track resetting mechanism 50.

As shown in Figs. 4 and 5, the ribbon frame 16 in this embodiment is a roughly rectangular-shaped member that has one side pivotally connected to the printer base 8 by means of pivots 73. The pivot axis defined by pivots 73 is parallel to the main guide shaft 2. When the ribbon frame 16 is turned about the pivot axis in the clockwise direction in Fig. 4, the side of the ribbon frame 16 facing the carriage 3 is raised and, when the ribbon frame 16 is turned in the opposite direction, it is correspondingly lowered. A spring 74 is stretched between the printer base 8 and the ribbon frame 16 to bias the latter into its lowest position. A hole 75 formed in the ribbon frame 16 adjacent its side II end is part of a latch means for the track setting mechanism 40 as will be explained in detail below. A ribbon drive shaft 76 which upon insertion of the ribbon cassette 15 enters the latter to wind up the ink ribbon 10, passes through the ribbon frame 16 and is mounted to the printer base 8.

The stroke of the reciprocating movement of the carriage 3 along the main guide shaft 2 covers a printing region substantially corresponding to the width of the recording paper and first and second non-printing end regions on the right side and the left side of the printing region, respectively. When the carriage 3 is moved toward side II into the first end region, the setting protrusion 71 comes into contact and pushes an engagement member 41 of the track setting mechanism 40. This causes the ribbon frame 16 to be raised by an extent depending on how far the carriage 3 is moved into said first end region. As will be explained later, the ribbon frame 16 is latched in its raised position to keep this position when the carriage 3 returns to the printing region and the engagement between the setting protrusion 71 and the engagement member 41 is released.

When the carriage 3 is driven toward side III and into the second end region, the resetting protrusion 72 comes into contact and pushes an engagement member 51 of the track resetting mechanism 50. This releases the latched state between the track setting mechanism 40 and the ribbon frame 16 and allows the track setting mechanism either to assume another setting condition or to return to a reset state depending on how far the carriage is moved into the second end region. Then, when the carriage 3 returns to a position where the resetting protrusion 72 is no longer in contact with the engagement member 51, spring 74 pulls down the ribbon frame 16 into either its initial position or a new position defined by the track setting mechanism.

The configuration and operation of the track setting mechanism 40 and the track resetting mechanism 50 will now be explained with reference to Figs. 6 and 7.

Fig. 6 shows the track setting mechanism 40. In this embodiment, the track setting mechanism 40 comprises a setting lever 43 pivotally connected to the printer base 8 by means of a pivot 44 whose pivot axis extends vertically in Fig. 6. The setting lever 43 has a first arm 42a extending to one side of the pivot 44 and having the engagement member 41 formed at or affixed to its free end. A second arm 42b of the setting lever 43 extends to the opposite direction of the pivot 44 and is sector-shaped. A cam member 46 is formed at the free end of the second arm 42b to extend substantially in a circumferential direction concentric to the axis

of the pivot 44. The substantially wedge-shaped cam member 46 comprises an inclined front cam face 47d on the side facing the ribbon frame 16 and a stepped rear cam face on the opposite side with three steps 47a, 47b and 47c providing three different setting levels. The front cam face 47d inclines toward the rear, and the stepped rear cam face declines toward the rear. The three setting levels provided by the three steps 47a to 47c of the rear cam face correspond to the ink ribbon 10 of this embodiment having four printing tracks 11 to 14. A spring 48 is stretched between a hook 45 provided at the end of the second arm 42b and the printer base 8 and biases the setting lever 43 into its inactivated initial position shown in Fig. 6.

When the engagement member 41 is pushed by the setting protrusion 71, the setting lever 43 is turned and the cam member 46 of the setting lever 43 enters below the ribbon frame 16. The ribbon frame 16 is raised as it slides on the inclined front cam face 47d. When the raising portion in front of the first step 47a enters the hole 75 provided in the ribbon frame 16 as mentioned above, the ribbon frame 16 is lowered a bit until it comes to rest on the first and highest step 47a. This sets the ribbon frame 16 to the highest position or setting level. When the engagement member 41 is pushed further by the setting protrusion 71, the first step 47a of the rear cam face will enter the hole 75 so that the ribbon frame 16 is lowered again by means of spring 74 until it comes to rest on the second highest step 47b, thereby setting the ribbon frame 16 to the second setting level. As will be clear from the foregoing description, pushing the engagement member 41 even further will bring the ribbon frame 16 down to rest on the third and lowest step 47c corresponding to the third setting level of the ribbon frame 16.

Having been set to any of the three levels in this way, the ribbon frame 16 will remain in its thus set position, even if the carriage 3 is returned and the engagement between the engagement member 41 and the setting protrusion 71 released despite the spring 48 tending to pull the setting lever 43 back to its initial position. Due to the combined actions of springs 74 and 48, the raising portion in front of the respective step will be caught and locked by the edge of the hole 75, preventing the setting lever 43 to be turned back to its initial position. In other words, the stepped rear cam face the cam member 46, the hole 75 in the ribbon frame 16 and the two springs 74 and 48 form latch means locking the ribbon frame 16 at the set level until the latch is released by means of the track resetting mechanism 50 to allow spring 48 to turn the setting lever 43 back to its initial position.

Fig. 7 shows the track resetting mechanism 50 used in the printer of this embodiment. This track resetting mechanism 50 comprises a release shaft 53 rotatably supported by a protrusion 54 protruding from the printer base 8. The rotational axis of the release shaft 53 extends substantially in parallel to the printer base 8 and perpendicular to the main guide shaft 2. The engagement member 51 is formed at one end of the release shaft 53 such when it is pushed by the resetting protrusion 72, the release shaft 53 will be turned about its rotational axis. On the opposite end of the release shaft 53 a release lever 52 is formed to extend into the space between the printer base 8 and the ribbon frame 16. Due to this construction, when the resetting protrusion 72 pushes the engagement member 51 and, thus, turns the release shaft 53, the release lever 52 will push the ribbon frame 16 up thereby to release the locking engagement between the rear cam face and the ribbon frame. Depending on the current setting level and on the amount by which the release shaft is turned this release action will cause spring 48 to either completely reset the track setting mechanism 40 to its initial state or to reset it to one of the higher setting levels. Then, as the carriage 3 returns and the resetting protrusion 72 releases the engagement member 51, the spring 74 pulls down the ribbon frame 16 into its new setting position. When the track setting mechanism has been completely reset the new setting position of the ribbon frame is its lowest position where it rests on frame holders 77 and 78 provided for stabilization on the printer base 8 near the track setting mechanism 40 and the track resetting mechanism 50, respectively. When the track setting mechanism has been reset to any higher setting level the ribbon frame will come to rest on the second or the first step 47b, 47a of the rear cam face. At the same time, the release shaft 53 is rotated back to its initial position. As will be clear the lowest level defined by frame holders 77 and 78 is lower than the third or lowest setting level determined by step 47c of the track setting mechanism 40.

Next, the operation of the track setting mechanism 40 and the track resetting mechanism 50 will be explained with reference to Figs. 8 and 9.

Fig. 8 shows how the printing track is selected using the track setting mechanism. Fig. 8(a) shows the ribbon frame 16 in a stable condition at the lower-most position, where the ribbon frame 16 is resting on the frame holders 77 and 78. When the print head 1 moves back and forth in the printing region from P1 to P2 in this condition, the highest printing track 11 (black) is set at the height of the print head 1 and printing in black is performed.

As shown Fig. 8(b), when the print head 1 is moved to position P3 in the first end region (side II) by the line drive means described above, the setting protrusion 71 comes into contact with the

engagement member 41. This starts actuating the track setting mechanism 40 by turning the setting lever about the pivot 44 and raising the ribbon frame along the front cam face 47d. Next, as shown in Fig. 8(c), when the print head 1 moves up to position P4, the setting lever 43 is turned by an extent such that the cam member 46 enters the hole 75 up to the first step 47a. Therefore, the ribbon frame 16 is set at the highest position. Since the lower-most printing track 14 (green) is now set at the height of the print head 1, printing in green can be performed when the movement of the print head 1 toward side II ends at position P4 and printing is executed while the print head moves back toward side III and then reciprocates between position P1 and P2.

As shown in Fig. 8(d), when the print head 1 moves farther to position P6 on side II, the setting lever 43 will be further turned and the cam member 46 will be inserted in the hole 75 up to the third step 47c so that the ribbon frame 16 will come to rest on the third step 47c. In this condition, the ribbon frame 16 is set at the third highest level from the top (second from the bottom) and the second printing track 12 (red) from the top of the ink ribbon 10 is set at the height of the print head 1. Therefore, printing in red is performed in this condition. In Fig. 8(d) the print head 1 has moved to position P6. However, if movement is stopped at position P5 between positions P4 and P6, then the ribbon frame 16 will come to rest on the second step 47b, thereby selecting the printing track 13 (blue) which is the third from the top.

As mentioned before and explained in more detail with reference to Fig. 9, after a printing track of the ink ribbon 10 has been selected by means of the track setting mechanism 40, the track resetting mechanism 50 can be used either to completely reset the ribbon frame 16 down to its lowest position or, if the current position of the ribbon frame 16 is not in its highest position, to reset it into any of the higher positions still available.

To actuate the track resetting mechanism 50 the print head 1 is first moved by the line drive means toward side III until it reaches position P7 in the second end region, as shown in Fig. 9(a). At this position P7 the resetting protrusion 72 engages the engagement member 51 starting to rotate the release shaft 53 causing the release lever 52 to begin pushing up the ribbon frame 16. Assuming that at this time the setting of the ribbon frame 16 is that shown in Fig. 8(d), when the ribbon frame 16 is pushed up slightly above the second step 47b of the rear cam face, the engagement between the hole 75 and the rising portion connecting steps 47c and 47b (Fig. 6) is released and the setting lever 43 is turned back (counterclockwise in Fig. 6) by means of spring 48 until the rising portion between steps 47b and 47a engages the edge of the hole 75 to latch the setting lever 43 in this position. Then, as the print head 1 returns towards side II the ribbon frame 16 comes to rest the second step 47b, in other words, it has been raised from the third position from the top to the second position from the top, thereby selecting printing track 13. Therefore, if the print head executes printing in this condition, the printing will be in blue.

As shown in Fig. 9(b), when the print head 1 either immediately following the operation explained above with reference to Fig. 9(a) or after having performed an intermediate printing in blue, moves farther towards side III up to the position P8, the ribbon frame 16 is lifted to a position slightly higher than the first step 47a and, therefore, the setting lever 43 is pulled back until the rising portion in front of the first step 47a engages the edge of the hole 75, thereby latching the ribbon frame 16 at the first setting level. With this setting of the ribbon frame 16, the printing track 14 is selected and printing in green can be performed as described before.

As shown in Fig. 9(c), when the print head 1 is shifted into the second end region toward side III up to a position P9, the ribbon frame 16 is pushed higher than the highest part of the cam member 46. In such condition all of the cam member is withdrawn from the hole 75 so that the setting lever is pulled back by spring 48 to its initial position where it does not longer engage the ribbon frame 16. As a result, the ribbon frame 16 returns to its lowest position on the frame holders 77 and 78 upon return of the print head 1 into the printing region. The uppermost printing track 11 of the ink ribbon 10 is now selected and printing in black performed.

As described above, the printer of this embodiment allows to select a desired one of the printing tracks of the ink ribbon utilizing a movement of the print head into one of the end regions. Therefore, an independent motor, solenoid or other drive component for changing the printing track is not required allowing it to make the printer lighter and simplify its structure. Even ink ribbons with many tracks can be easily replaced and set in place since they are enclosed in a ribbon cartridge, and any of the printing tracks can be easily selected in short time by moving the print head into the respective end region.

In the embodiment described above, a protrusion for setting and a protrusion for resetting are formed on the carriage mounting the print head. It will be appreciated, however, that corresponding protrusions could also be formed on the engagement members of the track setting mechanism and the track resetting mechanism, i.e. the engagement members could be designed to directly contact a

part of the moving structure comprising the carriage and the print head.

The above embodiment has been explained as being capable of selecting any one of four printing tracks of the ink ribbon. It will be understood that by increasing or decreasing the number of steps of the stepped rear cam face, the structure may by easily modified to allow a selection among any realistic number of printing tracks of an ink ribbon.

Further, in the above embodiment a setting lever is used in the track setting mechanism, which is arranged to be rotatable about a substantially vertical axis. This setting lever is swung by the carriage in nearly the same plane as the ribbon frame whereby the ribbon is shifted by insertion of the setting cam. However, the invention is not limited to such swinging type setting lever. Instead, a rotary member having a configuration like the release lever and being rotated by the carriage in a plane substantially perpendicular to the ribbon frame can also be employed for moving the ribbon frame up and down. The same is true with the release lever in that a swinging type member similar to the setting lever may be used instead of the rotary type explained above.

In the above embodiment, the initial position of the ribbon frame corresponds to its lowest position and the track setting mechanism is used to act from below the ribbon frame to move it up. However, the invention is not limited to this and the explained embodiment could be modified to have the initial position of the ribbon frame corresponding to its uppermost position and the track setting mechanism acting from above for moving the ribbon frame down.

Further, in this embodiment, the setting lever 43 is latched in the position set by means of the carriage by engagement with a hole formed in the ribbon frame, and the latch is released by further lifting up the ribbon frame. However, the printer is not limited to this and the setting lever may be latched by using a cam or other temporary stop member, in which case it is easy to drive this cam or other temporary stop member using a release lever.

Also, in the above embodiment, the track setting mechanism and the track resetting mechanism are driven by the line drive means via the carriage. As will be understood, it is also possible to drive these mechanisms from the carriage drive motor via gears, cams, belts, etc., i.e. without the intermediate of the carriage. In this case, as well, since the amount of rotation of the carriage drive motor has a linear relationship with the amount of movement of the carriage, the track setting mechanism and the track resetting mechanism can be driven in concert with the carriage moving outside the printing region. Of course, the invention is not limited to printers in which the carriage is driven along a guide shaft by a carriage drive belt, and the shift mechanism according to the present invention can also be applied to printers, etc., that drive the carriage via a drive arm which is a way of driving the carriage known in the prior art.

Using an ink ribbon with differently colored printing tracks, the present invention allows multi-color printing. However, the present invention can also be used with single-color multi-track ink ribbons that have a longer lifetime than single-track ribbons. By using such kind of ribbon, a compact, lightweight printer can be realized that requires no maintenance other than resupplying recording paper for long periods.

In the above embodiment the ribbon frame is pivotally supported on the printer base and moving up or down does in fact refer to a rotary or swinging movement of the ribbon frame rather than a translatory shift. However, without requiring any substantial change, the present invention can also be applied to a printer in which the ribbon frame or other element capable of causing a ribbon shift is supported to be moved up or down by a translatory shift.

Having thus explained the configuration of one embodiment of the present invention, an embodiment of a control method for controlling the ribbon shift will be explained next.

Fig. 10 is a block diagram of a control device for controlling the printer. In the Figure, 121 is a CPU which performs overall control of the printer. 122 is a ROM in which the control program and various types of data are stored. 123 is a RAM which includes a printing color memory section for use as a printing color memory means. 120 is an interface connecting the control device to a host computer or other control device and receiving print data and commands from the host computer or other device. I/O ports 124, 125 and 126 output signals for driving a paper feed (PF) motor driver 127, a carriage (CR) motor driver 128 and a head driver 129, respectively. The PF motor driver 127, the CR motor driver 128 and the head driver 129 are connected to the PF motor 61, the CR motor 5 and the print head 1, respectively, of the printer unit designated 130 in Fig. 10, and drive them based on signals from the CPU. A reference position signal generating circuit 132 processes a signal from a reference position detection means mounted in the printer unit 130 and sends a reference position signal to an I/O port 131 from which the CPU receives that reference position signal.

Fig. 11 is a flow chart of a control method for selecting a desired color by selecting the corresponding printing track in the above explained embodiment of the printer.

In Fig. 11, a block 156 shows the relationship between printing track numbers of a multi-color ink ribbon used in this embodiment and printing colors. For convenience sake the printing track numbers are the same as those used in the above explanation.

When is printer is powered on, the control method 140 starts. In the printer initialisation step 141 the CR motor 5 is driven and the print head 1 is moved to position P9, whereby the printing color (black) is selected and the corresponding track number 11 is stored in the printing track memory section, after which the print head 1 is moved to the printing start position P1 on the left side. The process then proceeds to step 142 bringing the control device into a standby condition waiting for the receipt of data or commands.

When print data or commands are received from the host computer via the interface 120, track number comparison is performed in steps 143 to 145 first to determine the new printing color from the received print data or commands and then to compare the track number corresponding to the new printing color (referred to as new track number below) with the track number corresponding to the currently set printing color (referred to as old track number below) and stored in the printing track memory section. If the two are the same, then processing proceeds to printing control in step 151.

When the two track numbers are not the same, the new track number and the track number corresponding to black are compared in step 144, and when the two are the same, i.e., when the new printing color is black, processing skips step 145 for selection of one of the non-printing end regions and proceeds to step 146 for setting the second end region (end region III). This processing is an exception processing specific to the shape of the member used for the track setting in this embodiment, and when black is newly selected, it initializes the track setting mechanism.

When the new printing color is other than black, the new and old track numbers are compared in step 145 for selection of the end region. Namely, when the new track number is larger than the old track number, processing proceeds to step 146 for setting the second end region. Otherwise the processing proceeds to step 152 for setting the first end region (end region II).

In step 146, the position in the second end region corresponding to the new track number is set based on table 148, and the track resetting mechanism 50 is operated to set the new printing track at the height of the print head by moving the print head to the thus set position.

Generally, a printer has a home position for the print head, e.g., the print head is set to this home position when the printer is powered on and operation related to subsequent movement of the print head is performed using this home position as a reference. Therefore, since the position of the print head relative to its home position is already known, the direction and distance the print head is to be driven can be easily obtained by making the positions provided in tables 148 and 154 relative positions to the home position.

When the ribbon shift has been completed, the print head is moved to P1, which is the side III printing start position, in step 149, and processing proceeds to step 150 updating the printing track memory section.

In step 152, the position in the first end region corresponding to the new track number is set based on table 154, and by moving the print head to the set position, the track setting mechanism 40 is operated to set the new printing track at the height of the print head. Following this, in step 155 the print head is moved to P2, which is the printing start position near side II, and processing then proceeds to step 150.

Printing is then executed in the color selected and set by the above processing. Upon completion of printing control, processing proceeds to step 142, i.e. the standby condition.

The above explanation concerns an embodiment of the control method related to the printer configuration described above. An increase or decrease in the number of printing colors can be easily accommodated by correspondingly adapting the tables 148 and 154.

Next an embodiment related to a correction of the position of the print head will be explained. In this embodiment, the printing start position P1 near the side III side of the printing region is assumed to be the home position, and the process that positions the print head at this position is referred to as the printing position initialization process. Correction of the position of the print head is performed using this printing position initialization process, which is explained below.

A non-contact light-blocking detector structure shown in Fig. 6 as being made up of a shield plate 58 formed on one side of the carriage and a photodetector 57 fixed to the printer base 8, is used as reference position detection means for initializing the printing position. The photodetector 57 is a general-use U shaped photointerrupter having a light-emitting element on one side and a photodetecting element on the opposite side. When the shield plate 58 is inserted to block the light path between the light-emitting element and the photo-detecting element, a current change (current decrease) occurs in the output signal of the photodetector 57. The reference position signal generation circuit 132 receives this signal from the reference position detection means and converts it

to a voltage signal (from a non-active level to an active level in the case of this embodiment) and then sends a reference position signal to the I/O port 131, from which the CPU 121 receives the reference position signal, whereby it knows that the print head is at the reference position. Generally, the reference position and the home position may be the same but in the present embodiment they are assumed to be different.

FIG. 12 is a flowchart of the printing position initialization process. The reference position signal assumes an active level when the shield plate 58 blocks the light path of the photodetector 57.

When the printing position initialization process 100 is started, the reference position signal is checked in step 101, and if it has its active level, then the print head is moved toward side II for only a unit amount in step 102 and the process returns to step 101 where the reference position signal is checked again. The unit amount corresponds to one step or one cycle of an excitation phase of a stepper motor, or to one encoder pulse in the case of an encoder equipped DC motor used as the motor 5.

If the result of the check in step 101 shows the signal to have a non-active level, then the print head is moved toward side III for only the unit amount in step 103 and the reference position signal is checked again in step 104. Steps 103 and 104 are repeated until the signal has its active level.

If an active level of the signal is detected when checking the reference position signal in step 104, then a value Pr representing the reference position relative to the home position is stored in a head position memory section of the RAM 123 in step 105. When the print head is subsequently moved, a value indicating the current position of the print head can be continually retained in the head position memory section by either adding or subtracting a value corresponding to the amount of movement from the currently stored value. Then the print head is moved to the home position P1 by being moved from the reference position (Pr) toward side II for only the distance between Pr and P1, and the printing position initialization process is completed.

By including the above printing position initialization process in the resetting operation step 149 (Fig. 11) after the step 146 has been executed as mentioned above, any error in the position of the print head will be corrected and printing will start at the correct position even if step 146 or movement of the print head in processing performed prior to this was completed with errors.

The above explained printing position initialization process sets the print head to a correct position, namely a position correctly corresponding to the value stored in the head position memory section of the RAM 123 irrespective to nay position error that might have occurred prior to performing this process. Next, an embodiment related to a confirmation of the position of the print head for detecting any position error and the management of an abnormal condition is explained.

FIG. 13 is a flowchart of a print head position confirmation process 110. In the following, a case is explained in which the printing position initialization process is included in step 149 for the resetting to position P1 operation after the end region III setting step 146 has been executed, but almost the same algorithm can be used when the printing position initialization process is included in step 155 for the resetting to position P2 operation after the end region II setting step 152 has been executed.

The head position confirmation process 110 is started after the end region III setting step 146 has been executed, and the print head is moved toward side II in step 111 by only the amount represented by Pr - Px. Px is the position determined according to the printing color, which is set according to table 148, e.g., P9 if after selecting black. As a result, the print head should have reached the reference position Pr. Therefore, if the reference position signal does not have the active level when it is checked in step 112, movement of the print head is judged to be completed with an error and the process proceeds to a management of an abnormal condition (step 115 and subsequent steps).

If step 112 reveals the active level, then the print head is moved toward side II by only the unit amount in step 113. If movement of the print head is completed without error, then that position should differ from position Pr toward side II by only one unit amount, and therefore if a non-active level is obtained by checking the reference position signal in step 114, it is judged to be normal and the head position confirmation process is completed.

When the active level is obtained by checking the reference position signal in step 114, however, movement of the print head is judged to be completed with an error and abnormal condition management in step 115 is started. Retrying is performed as the abnormal condition management when movement of the print head is completed with error in this embodiment. That is, first the position of the print head is initialised by executing the printing position initialisation process 100, and following this the print head is moved toward side III for only the amount obtained by subtracting Px from Pr and processing proceeds to the processing 111 at the beginning of the head position confirmation process.

A photointerrupter and shield plate are used as the reference position detection means in this em-

bodiment, but the invention is not limited to these, and a photoreflector and reflector plate, a reed switch and magnet, or other non-contact detection mechanism, or a limit switch or other contact switch can be used.

Also, though retrying is performed to manage an abnormal condition when movement of the print head is completed with errors in this embodiment, the invention is not limited to this, and a signal indicating an abnormal condition or status information may be sent to the host computer via the interface, or if a display means is provided on the printer, this can be used to notify the user. Further, when retrying, it is extremely effective to increase the drive torque by changing the drive current of the motor or the drive method. It is also possible to perform retrying for a predetermined number of times and to stop the process and issue an error indication if even after those number of times a position error is detected.

As described above, in the printer of the invention, switching of the printing tracks of the ink ribbon is realized in concert with the movement of the print head in non-printing regions, and a dedicated drive system for switching the printing tracks can be eliminated. Therefore, a compact, lightweight printer can be realized by omitting the heavy drive system. Further, by eliminating the drive system, the switching mechanism for the ink ribbon can be simplified, which reduces the number of parts and lowers the production cost of the printer. Due to these advantages, the configuration can be simplified more and more compared to the prior art as the number of colors of the multi-color ribbon increases.

Also, even in printers that use single-color multitrack ink ribbons, the respective tracks can be easily selected in concert with the amount of movement of the print head. Therefore, even in cases in which multitrack ink ribbons are used, a lightweight, compact printer can be realized without having to add a drive system.

A Möbius type ink ribbon can be used as the ink ribbon in combination with the above ribbon shift mechanism to realize longer life of printing without changing the ink ribbon.

Further, even if the movement of the carriage is completed with errors due to a stepping out of the stepper motor, etc., when selecting printing tracks, position confirmation by means of a reference position detector is performed, as the result of which restarting or other abnormal condition management is performed, and therefore a printer can be realized in which there is no position error in the printing position due to improper movement at the time of printing track selection.

Since ribbon shifting is performed using the movement of the print head to non-printing regions, it is possible to control ribbon shifting independently of printing control of the print head, thus facilitating a simple control system.

Claims

1. A printer for use with an ink ribbon having a plurality of printing tracks, said printer comprising

a print head (1),

line drive means (4, 5) for reciprocating said print head in the direction of a printing line,

ribbon shift means (40, 50) for selecting a desired one of said plurality of printing tracks (11 - 14), and

shift drive means for operating the ribbon shift means,

characterized in that

said line drive means (4, 5) is also used as the shift drive means.

2. The printer of claim 1 wherein the stroke of the reciprocating movement of the print head (1) comprises a printing region where printing is performed and a non-printing end region, means being provided to operate said ribbon shift means (40, 50) when the print head (1) is in said end region.

3. The printer of claim 2 wherein said non-printing end region includes first and second end regions on either side of the printing region and the ribbon shift means comprises

a track setting mechanism (40) capable of assuming different setting conditions in response to the amount by which said line drive means drives said print head (1) into the first end region each setting condition for selecting another one of said printing tracks (12 - 14),

latch means for latching said track setting mechanism in its respective setting condition and

a track resetting mechanism (50) for releasing a latched condition of said track setting mechanism (40) in response to said line drive means driving said print head into the second end region.

4. The printer of any of claims 1 to 3 further comprising

a ribbon frame (16) for mounting thereon a ribbon cassette (15) housing the ink ribbon (10), the ribbon frame being movably supported on a printer base (8) and the ribbon shift means (40, 50) acting upon the ribbon frame (16) to move it into any of a number of different heights the number corresponding to

the number of selectable printing tracks (11 - 14).

5. The printer of claims 3 and 4 further comprising means (74) for elastically biasing the ribbon frame (16) into the highest or the lowest of said different heights, said track setting mechanism (40) including cam means (46) engageable with the ribbon frame to move it against the force of said biasing means into any other of said different heights.

6. The printer of claim 5 wherein means (48) are provided to elastically urge the cam means (46) toward an inactive position where it does not act upon the ribbon frame (16) and wherein said latch means comprises mutually engaging portions (47a - 47c; 75) of said cam means (46) and said ribbon frame (16), said track resetting mechanism (50) being adapted to move the ribbon frame (16) such as to disengage said engaging portions from each other.

7. The printer of any of claims 3 to 6 wherein said track setting mechanism (40) comprises

a track setting member (43) having at one end a setting drive end portion (41) to be engaged and driven by said print head (1) or a carriage (3) carrying the print head when said print head moves to said first end region, and at another end a shift end portion (46) capable of selecting a printing track (12 - 14) of said ink ribbon (10) according to the amount of movement of the print head (1) into said first end region, and

a shift end setting member (16, 75) that engages said track setting member (43) and retains said amount of movement of said shift end portion (46) upon return of the print head into said printing region;

and

said track resetting mechanism (50) comprises

a shift end release member (51, 52, 53) having a release drive end portion (51) to be engaged and driven by said print head (1) or a carriage (3) carrying the print head when said print head moves into said second end region, and a shift end release end portion (52) that engages said shift end setting member in response to the driving force acting on the release drive end portion (51) and releases engagement between said shift end setting member (16) and said printing track setting member (43) thereby to reduce said amount of movement of said shift end portion (46).

8. The printer of claims 4 and 7 wherein

said printing track setting member (43) is a printing track setting lever that is equipped with a wedge-shaped shift end portion (46) that changes the height of said ribbon frame (16) by being inserted below the ribbon frame (16), and whose wedge-shaped shift end portion is capable of swinging in concert with the movement of said setting drive end portion (41);

said shift end setting member is said ribbon frame (16) that has a latch hole (75) that latches said printing track setting lever (43) by engaging said wedge-shaped shift end portion (46) from above ; and

said shift end release end portion (52) is a release lever that pushes said ribbon frame (16) up and releases engagement between said printing track setting lever (43) and said ribbon frame (16).

9. The printer of any of claims 3 to 8 further comprising

an interface (120) for receiving data and commands from a computer or other external device,

printing track determination means (121) for interpreting said commands and determining the printing track to be selected,

movement amount determination means (121) responsive to said printing track determination means (121) for selecting either said first or said second end region and for determining the amount of movement of said print head (1) in the selected end region, and

line drive control means (121, 125, 128) for controlling said line drive means (4, 5) such as to move said print head (1) by said determined amount into the selected end region.

10. The printer of claim 9 further comprising

printing track memory means (123) for storing the printing track determined by said printing track determination means (121), and

track number comparison means (121) for comparing a new track number corresponding to the printing track to be selected with an old track number stored in said printing track memory means (123) and corresponding to the currently selected printing track.

11. The printer of claim 9 or 10 further comprising

reference position detection means (57, 58, 131, 132) for detecting a reference position of said print head (1).

12. A control method for multi-color printing with the printer defined in any of claims 9 to 11 comprising the steps

a) determining the printing track to be selected,

b) selecting either the first or the second end region and determining the amount by which the print head (1) is to be moved into the selected end region, and

c1) if the first end region is selected, controlling said line drive means (4, 5) such as to move said print head (1) by said determined amount into the first end region thereby operating said track setting mechanism and selecting the printing track, or

c2) if the second end region is selected, controlling said line drive means (4, 5) such as to move said print head (1) by said determined amount into the second end region thereby operating said track resetting mechanism and selecting the printing track.

13. The control method of claim 12 further comprising after step a) and prior to step b) the step

d) comparing a new track number corresponding to the determined printing track with an old track number corresponding to the currently set printing track,

wherein steps b) and c1) or c2) are performed only when the new track number differs from the old track number and, if so, in step b) the first end region is selected when the new track number is smaller than the old track number whereas the second end region is selected when the new track number is larger than the old track number.

14. The control method of claim 12 or 13 further comprising

e) a printing position initialization step for initialising the position of said print head, the initialization step being performed at least after step c2).

15. The control method of 13 or 14 further comprising at least after step c2)

f) a head position confirmation step for checking whether or not the print head is in an expected position, and

if step f) reveals the print head is not in the expected position

g) an abnormal condition management step including initializing the position of said print head to a reference position, re-executing print head movement and repeating step f).

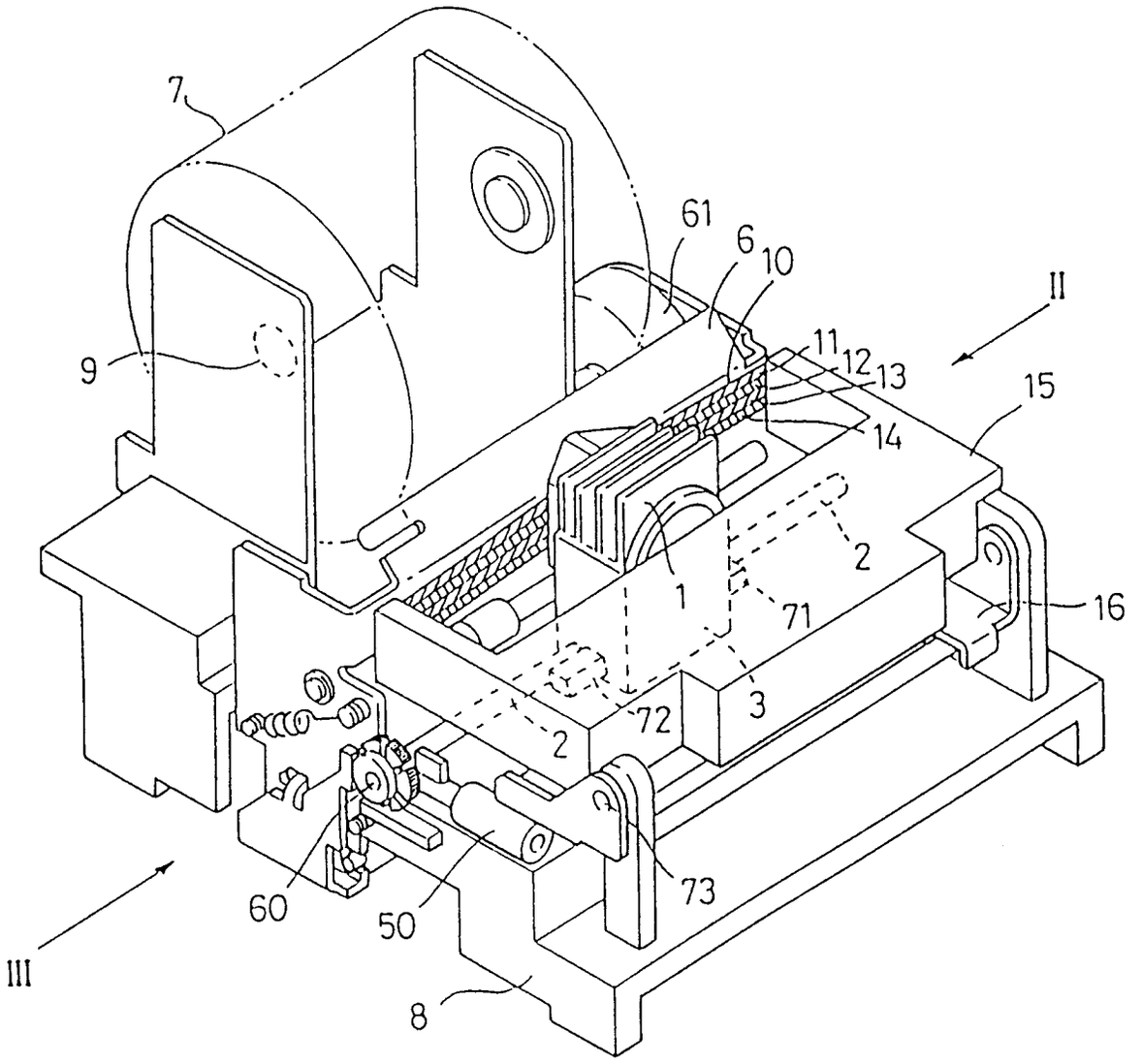

FIG. 1

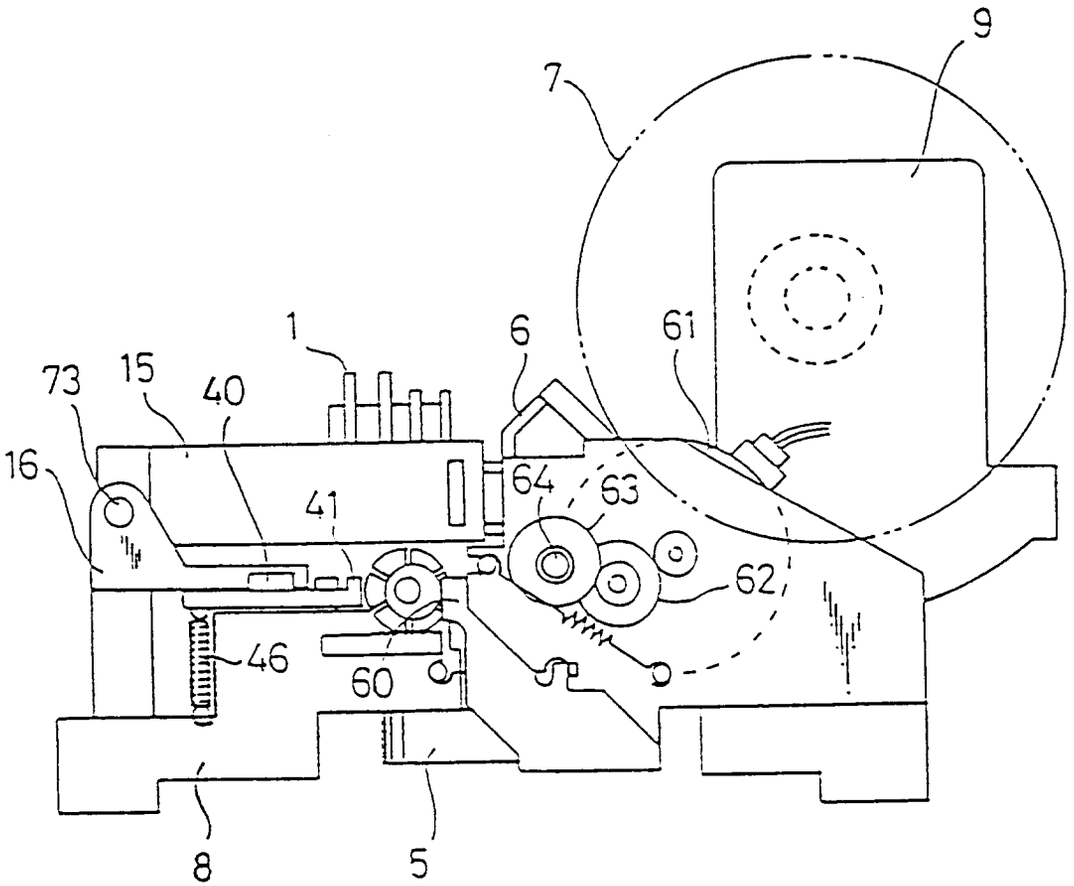

FIG. 2

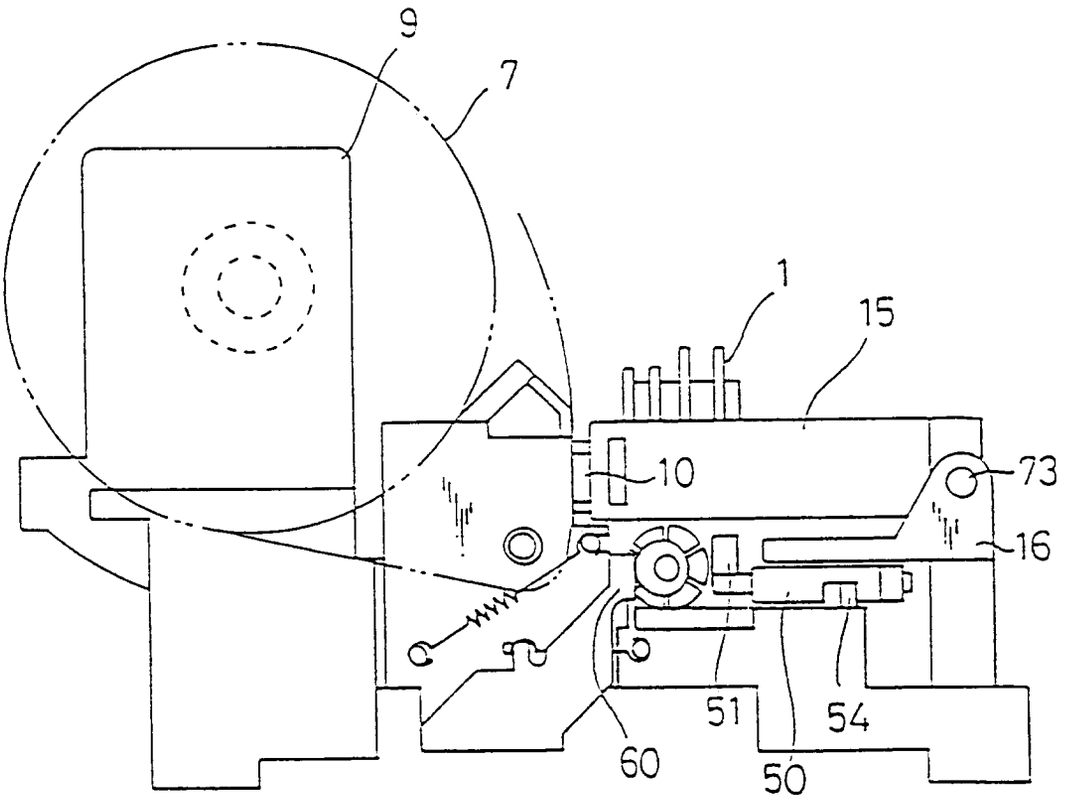

FIG. 3

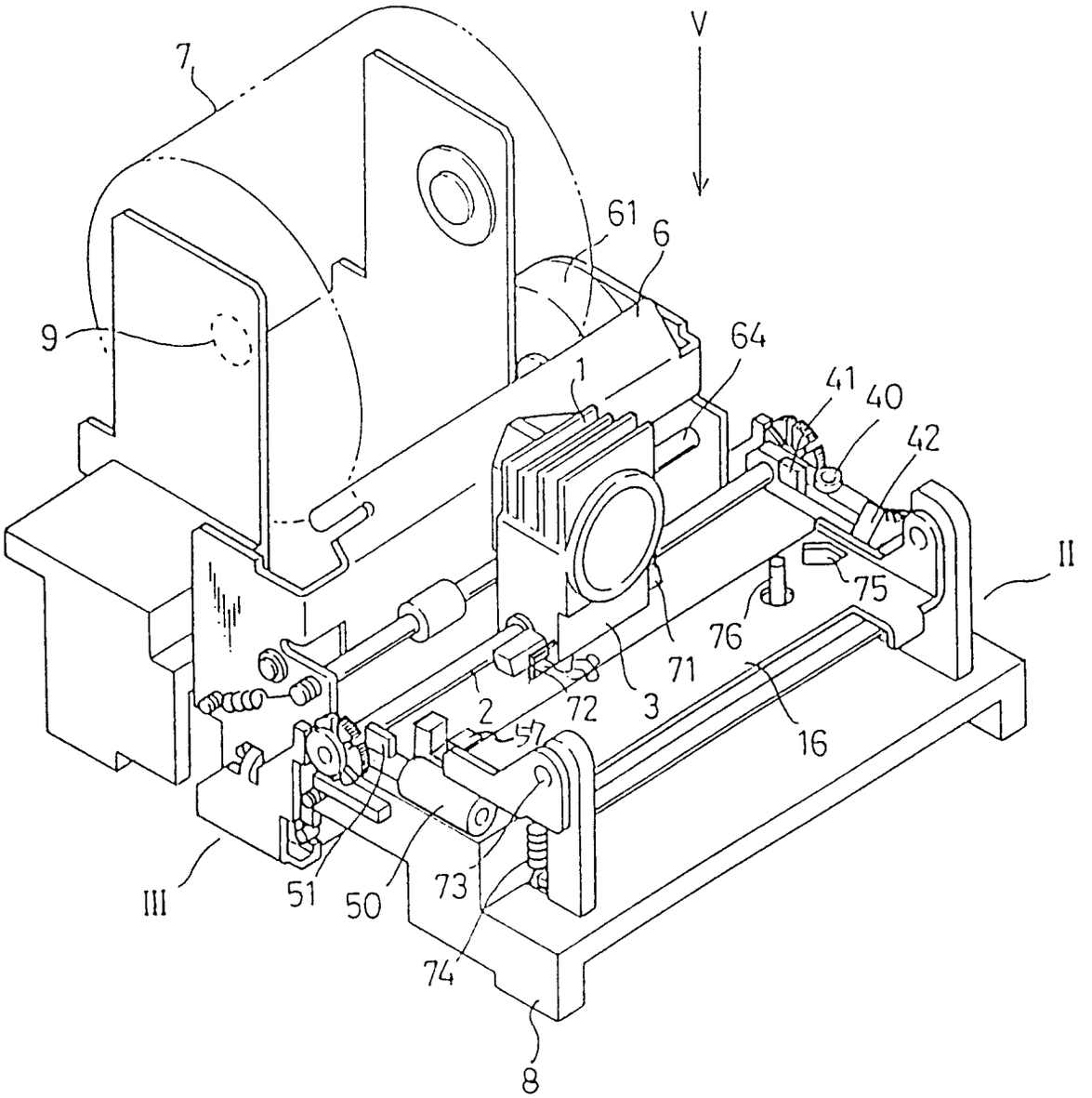

FIG. 4

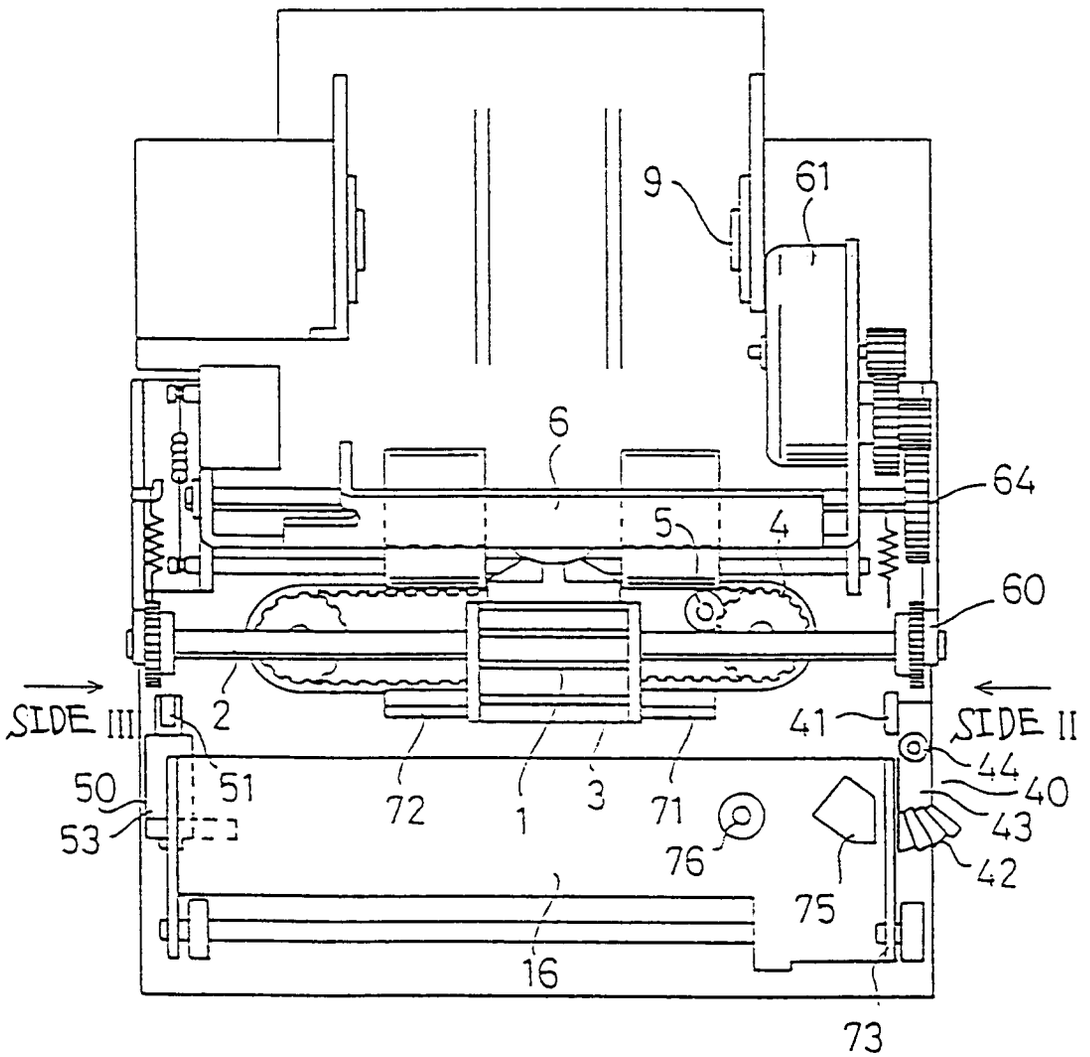
9
61
6
64
5
4
60
SIDE III
2
41
SIDE II
44
40
50
51
72
1
3
71
43
53
76
42
75
16
73

FIG. 5

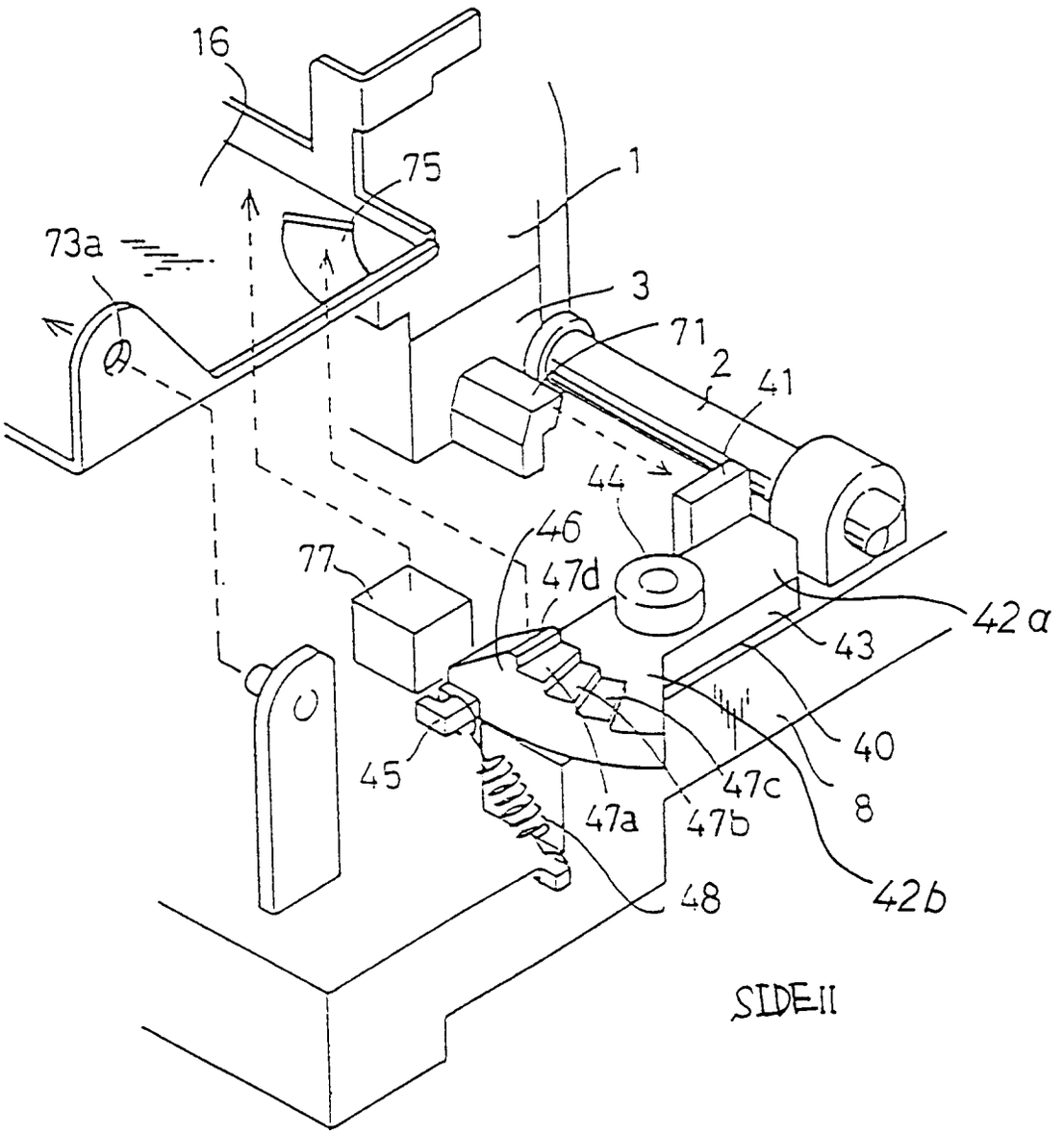
16
75
1
73a
3
71
2
41
44
46
77
47d
42a
43
40
45
47c
8
47a
47b
48
42b
SIDE II

FIG. 6

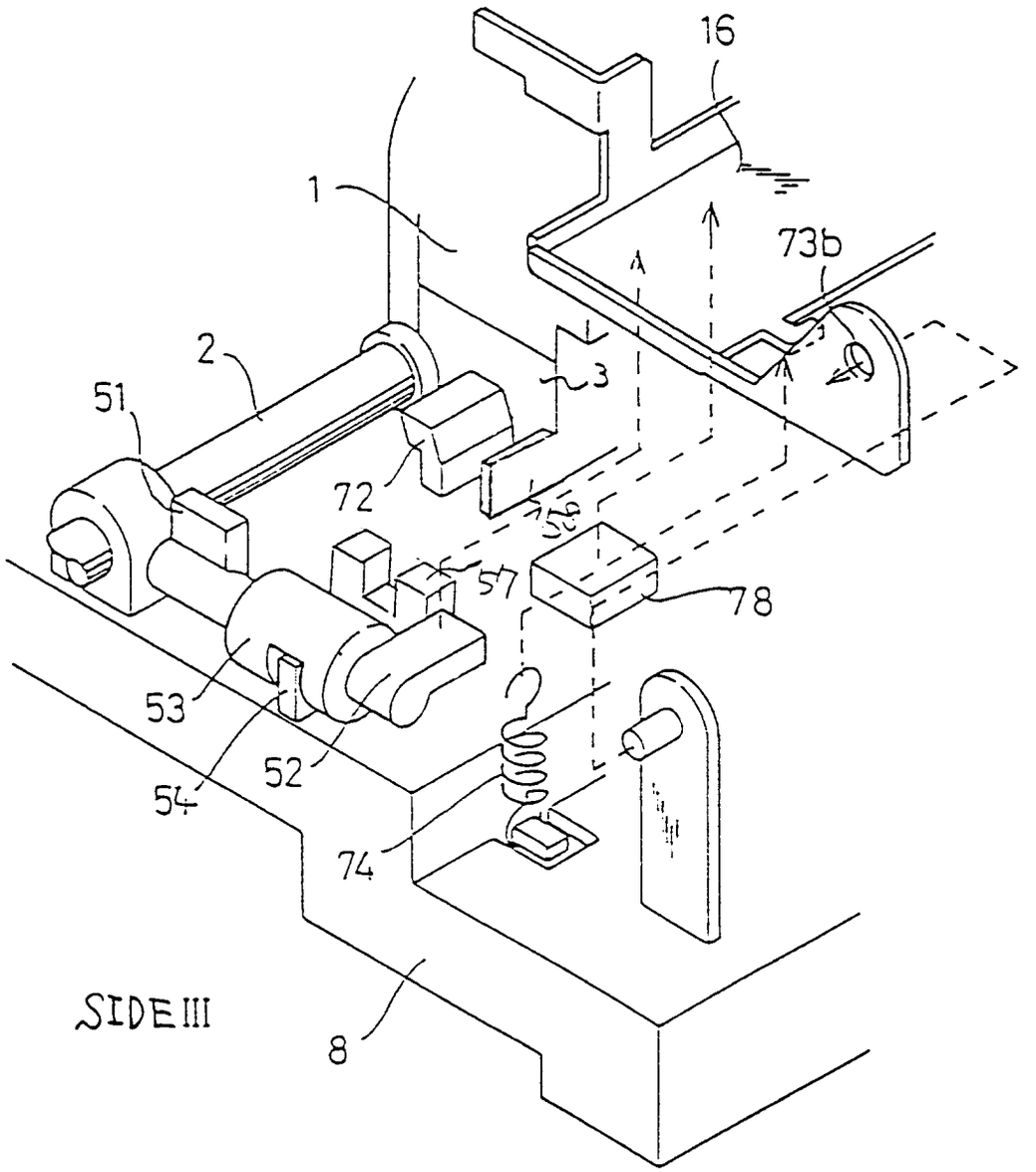

FIG. 7

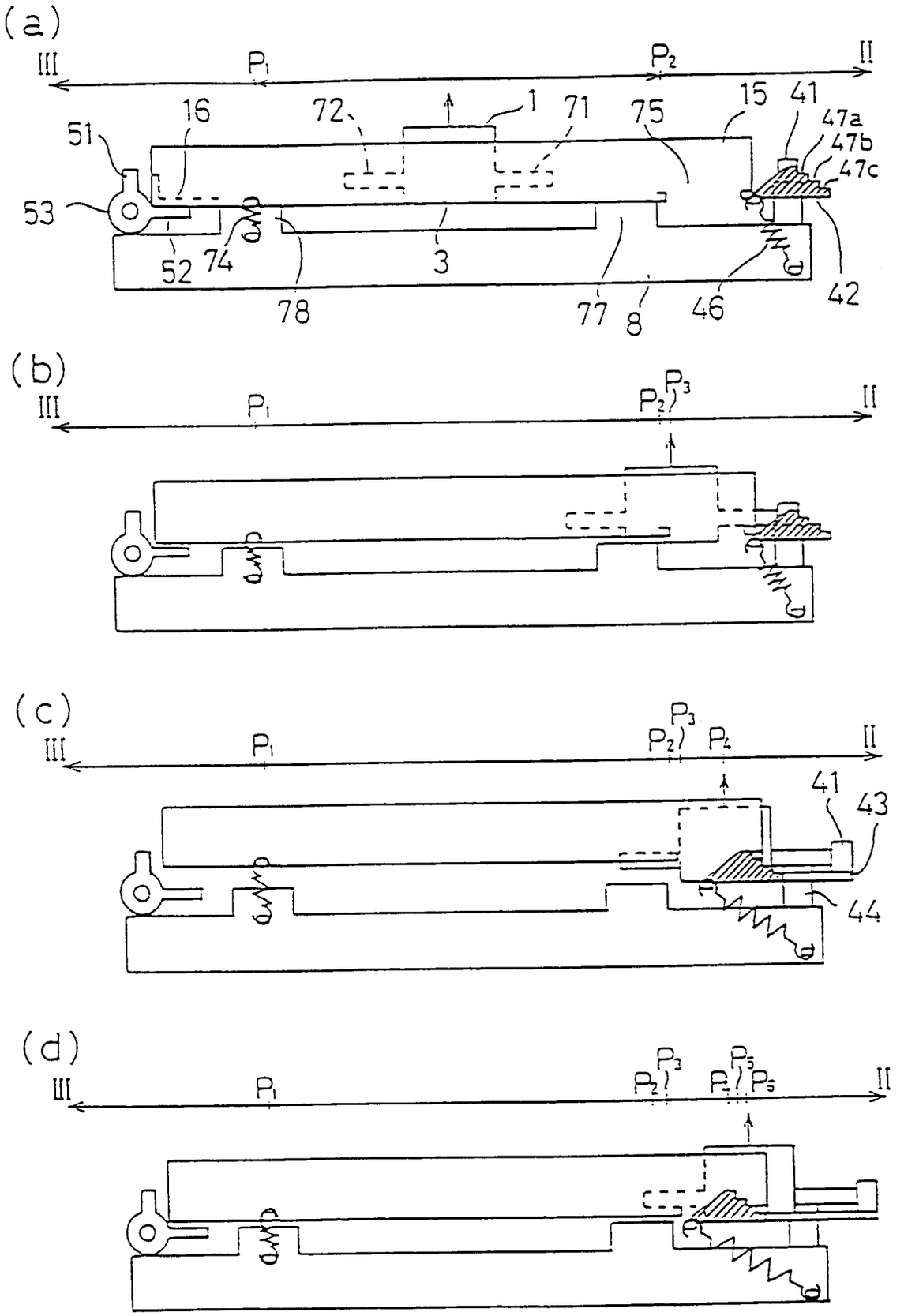
(a)
III
P1
P2
II
16
72
1
71
75
15
41
47a
47b
47c
51
53
52
74
3
78
77
8
46
42
(b)
III
P1
P2
P3
II
(c)
III
P1
P2
P3
P4
II
41
43
44
(d)
III
P1
P2
P3
P4
P5
II

FIG. 8

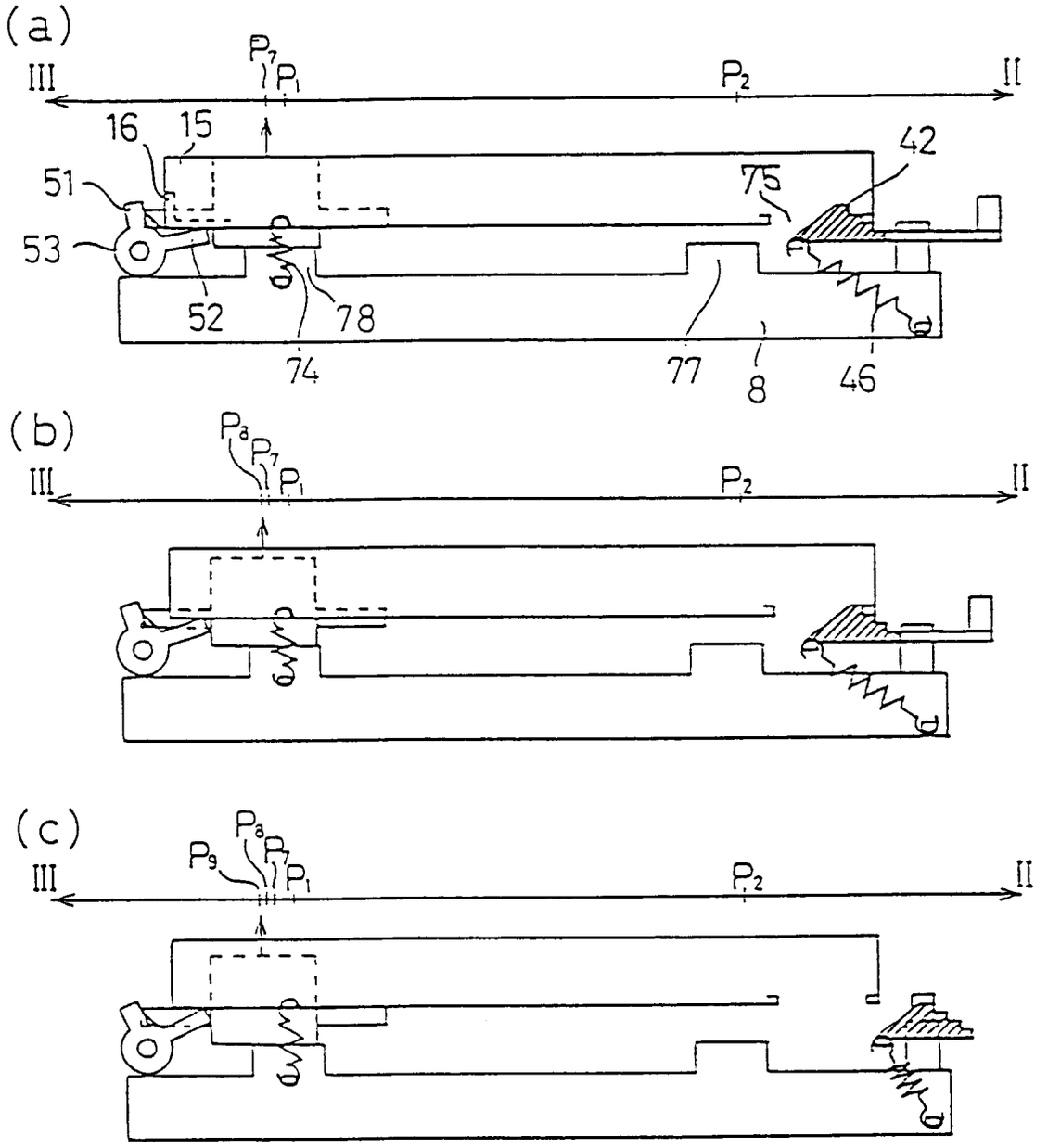
(a)
III
P7
P1
P2
II
16
15
42
51
75
53
52
78
74
77
8
46
(b)
P8
P7
P1
III
P2
II
(c)
P8
P9
P7
P1
III
P2
II

FIG. 9

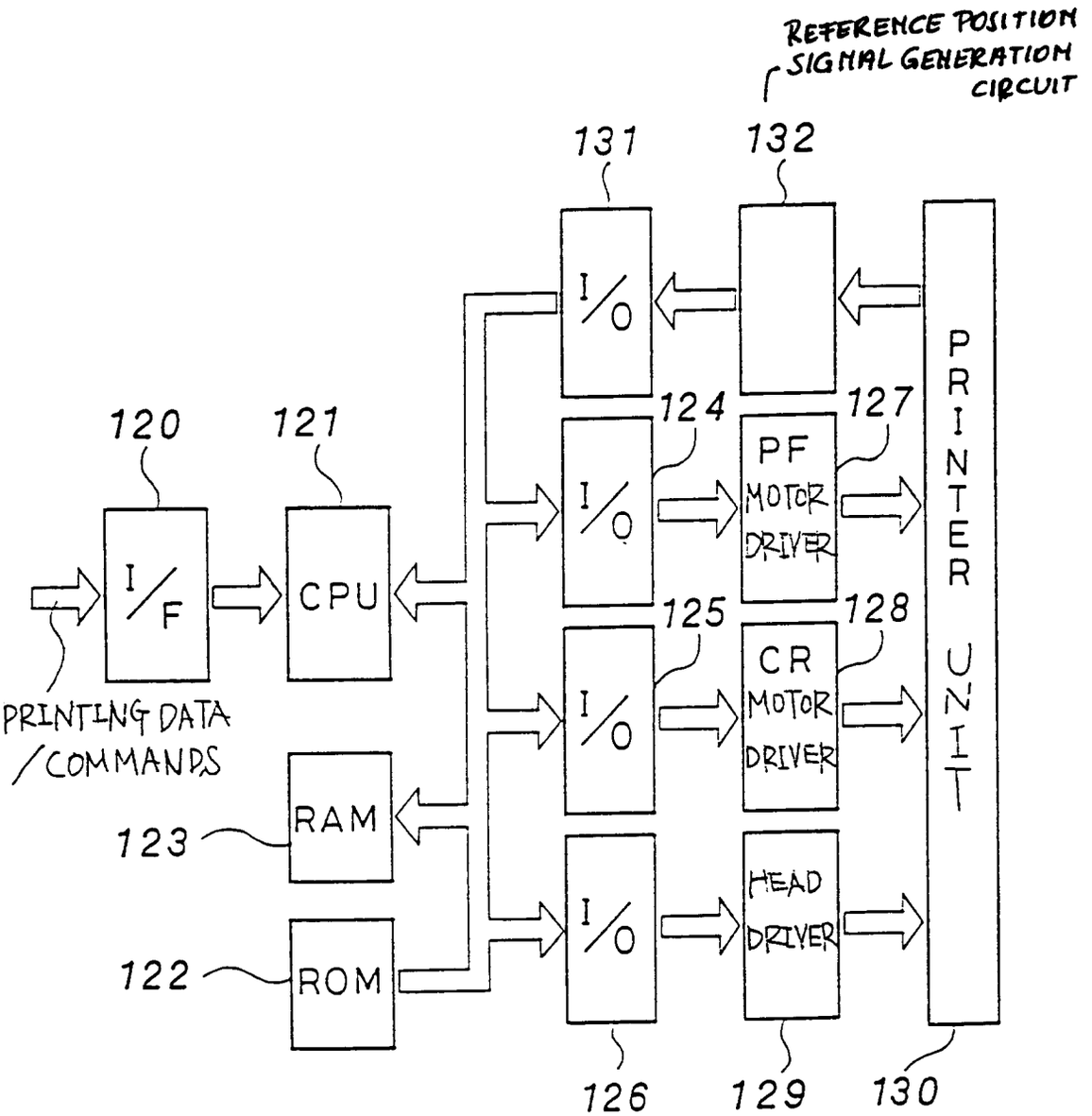
REFERENCE POSITION SIGNAL GENERATION CIRCUIT
131
132
120
121
124
127
I/O
I/O
PF MOTOR DRIVER
PRINTER UNIT
I/F
CPU
125
128
I/O
CR MOTOR DRIVER
PRINTING DATA /COMMANDS
RAM
123
I/O
HEAD DRIVER
122
ROM
126
129
130

FIG. 10

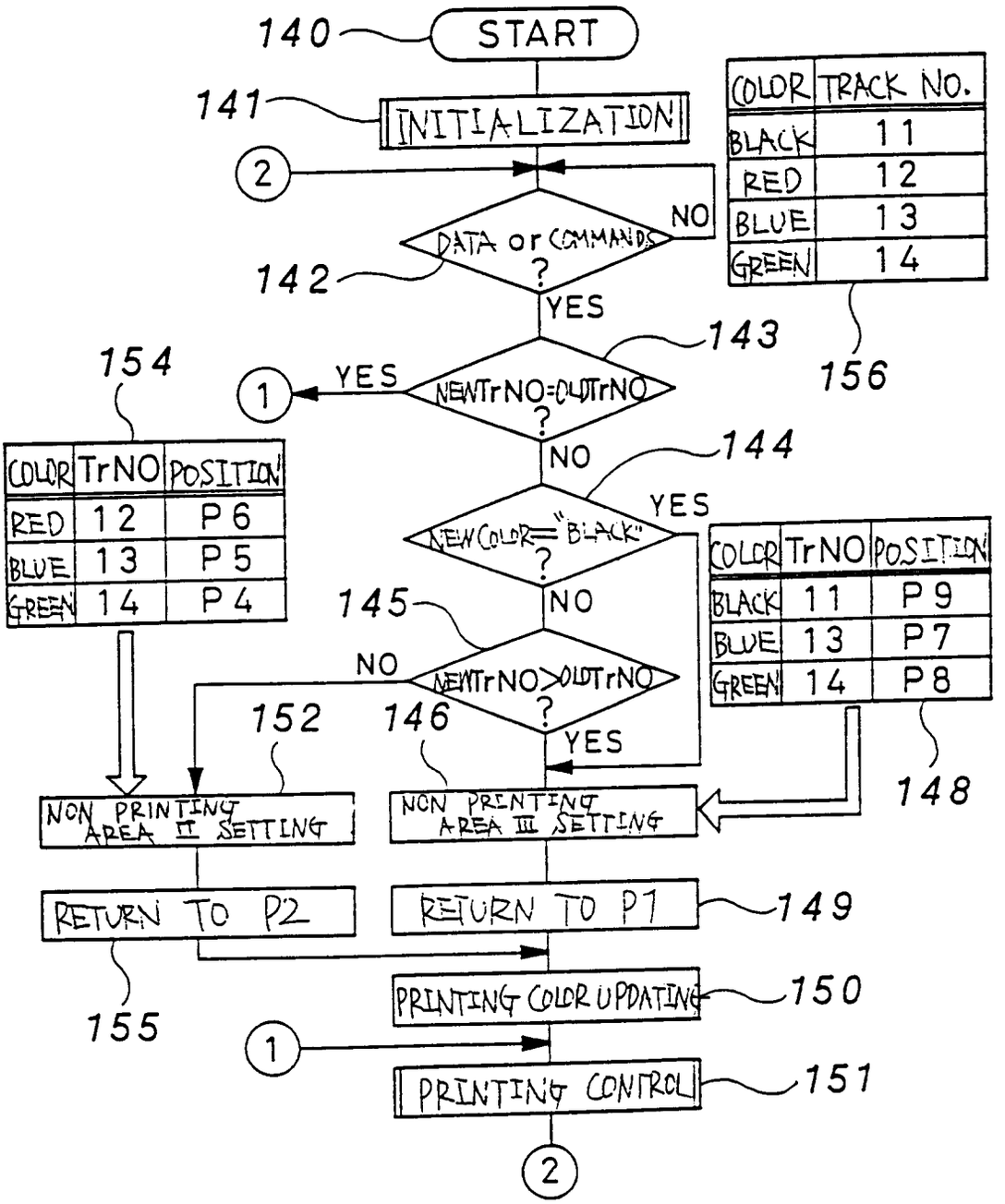
140
START
141
INITIALIZATION
2
DATA or COMMANDS ?
NO
142
YES
143
NEWTrNO=OLDTrNO ?
YES
1
NO
144
NEW COLOR = "BLACK" ?
YES
NO
145
NEWTrNO>OLDTrNO ?
NO
YES
146
152
NON PRINTING AREA II SETTING
NON PRENTING AREA III SETTING
RETURN TO P2
RETURN TO P1
149
155
PRINTING COLOR UPDATING
150
1
PRINTING CONTROL
151
2
COLOR | TRACK NO.
BLACK | 11
RED | 12
BLUE | 13
GREEN | 14
156
154
COLOR | TrNO | POSITION
RED | 12 | P6
BLUE | 13 | P5
GREEN | 14 | P4
COLOR | TrNO | POSITION
BLACK | 11 | P9
BLUE | 13 | P7
GREEN | 14 | P8
148

FIG. 11

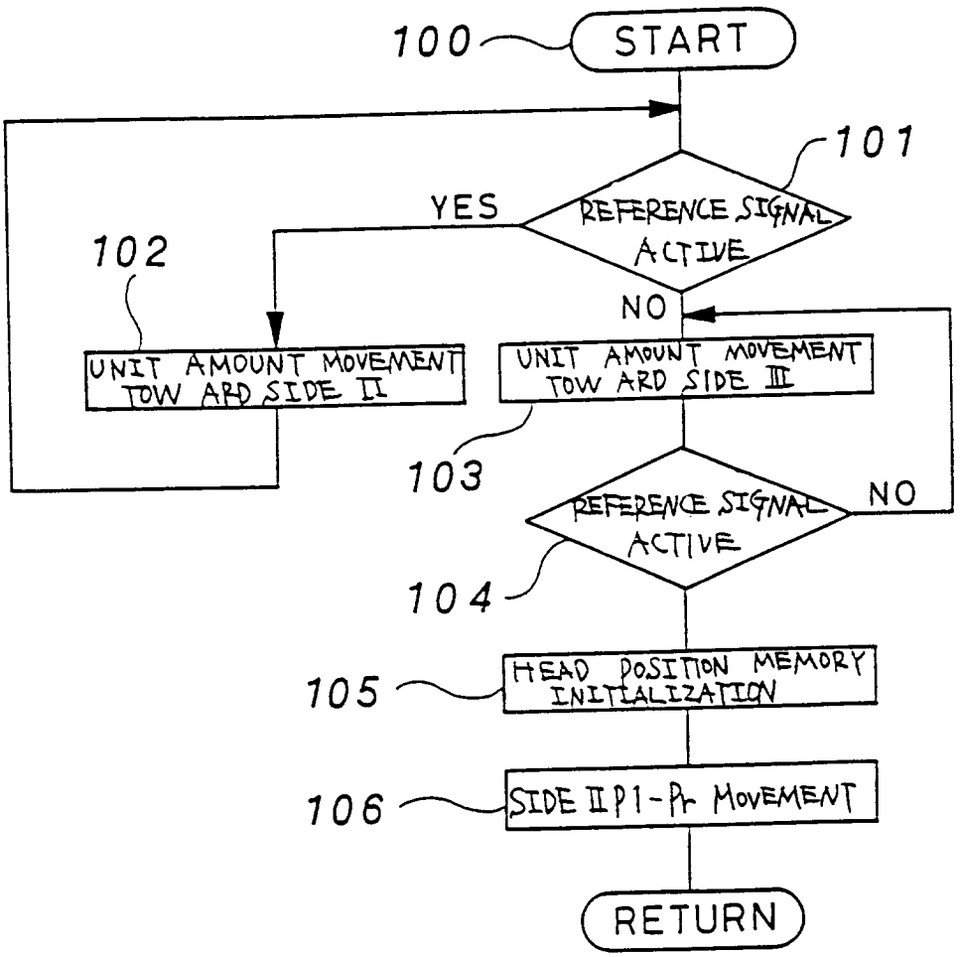
100
START
101
REFERENCE SIGNAL ACTIVE
YES
NO
102
UNIT AMOUNT MOVEMENT TOW ARD SIDE II
UNIT AMOUNT MOVEMENT TOW ARD SIDE III
103
REFERENCE SIGNAL ACTIVE
NO
104
105
HEAD POSITION MEMORY INITIALIZATION
106
SIDE II P1-Pr MOVEMENT
RETURN

FIG. 12

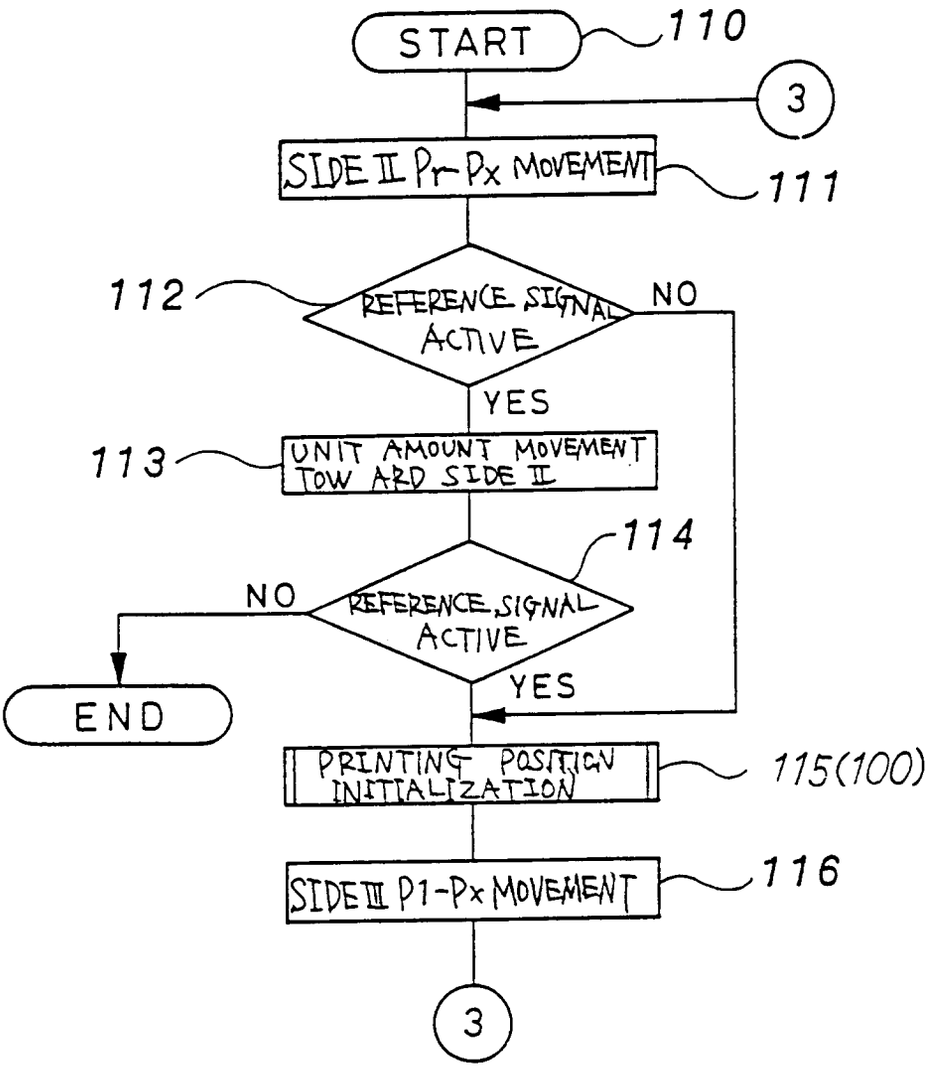
START
110
3
SIDE II Pr-Px MOVEMENT
111
112
REFERENCE SIGNAL ACTIVE
NO
YES
113
UNIT AMOUNT MOVEMENT TOW ARD SIDE II
114
NO
REFERENCE SIGNAL ACTIVE
YES
END
PRINTING POSITION INITIALIZATION
115(100)
SIDE III P1-Px MOVEMENT
116
3

FIG. 13

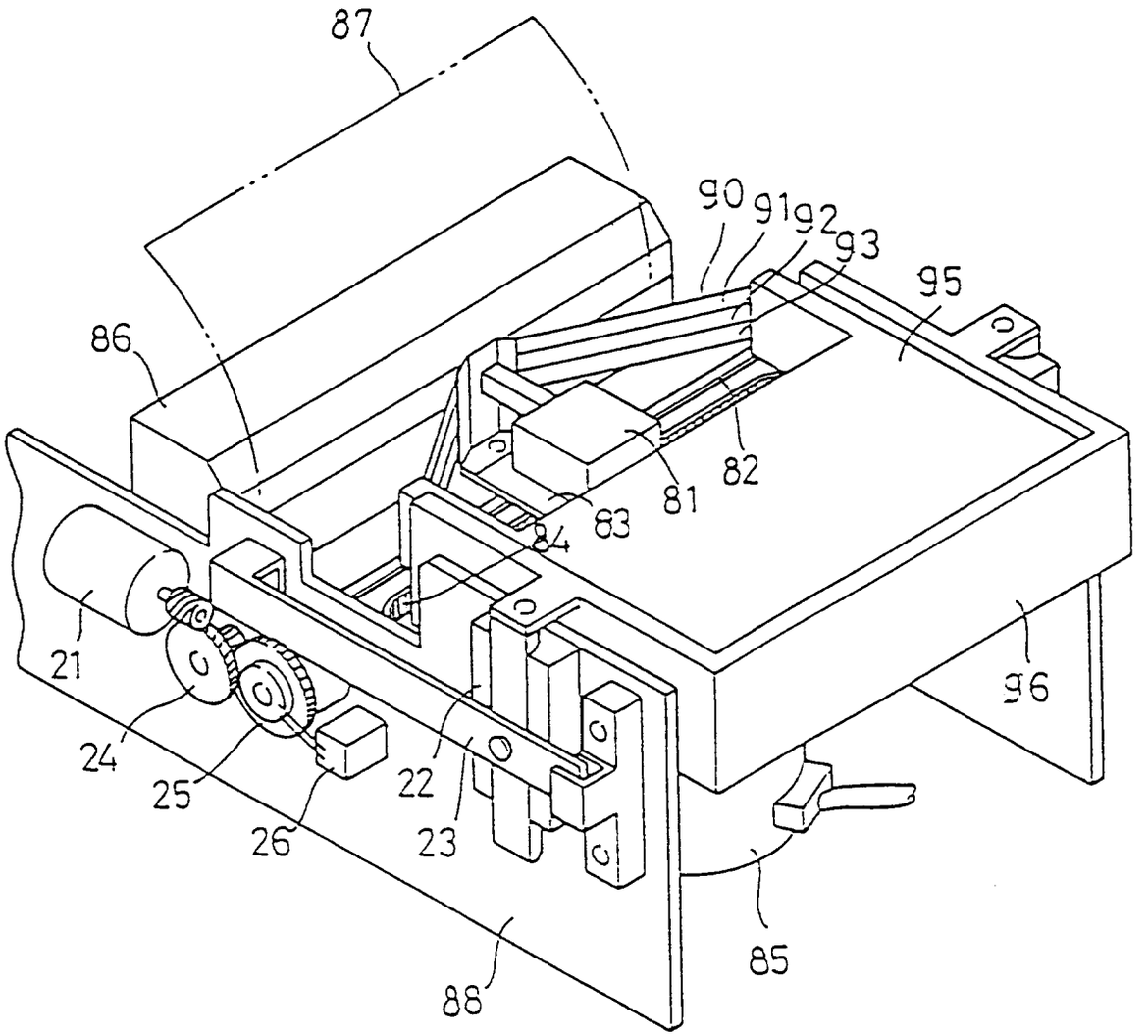

FIG. 14

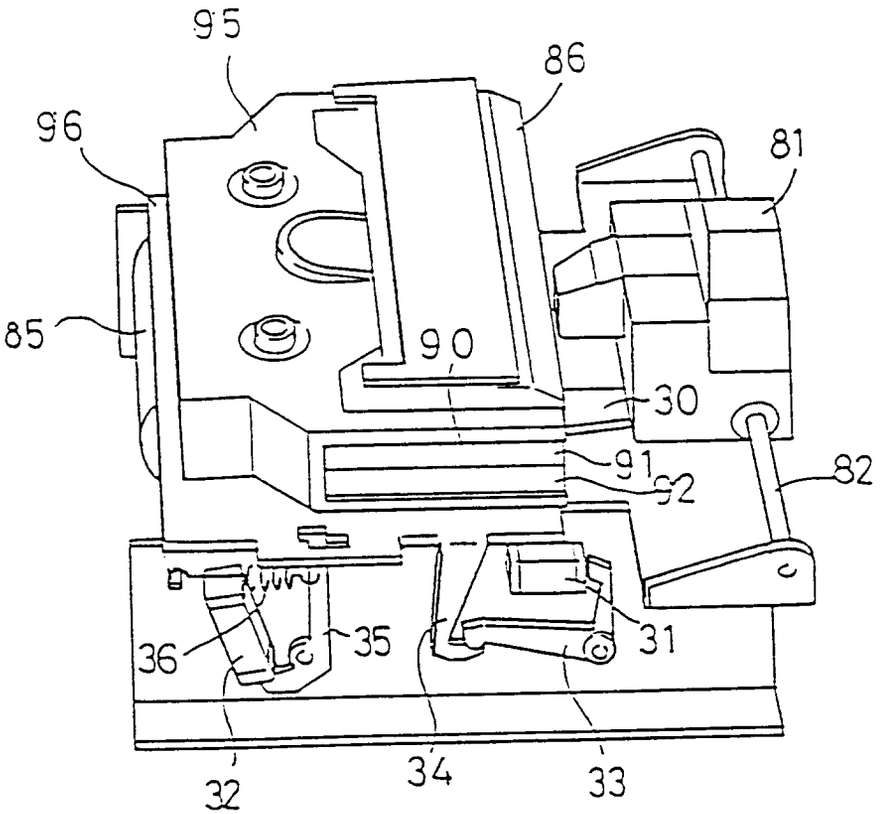

FIG. 15