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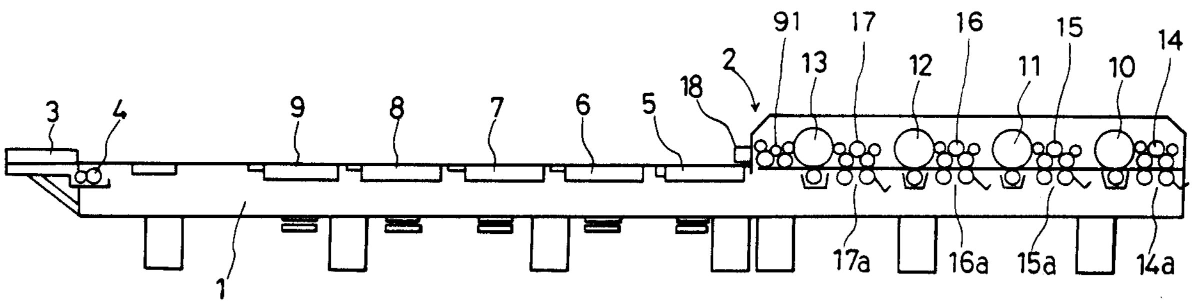
(54) Ink supply apparatus of a proofing press.

(57) An ink supply apparatus is for use in a proofing press which comprises plate tables (6) on which a printing plates (A) are set, a paper table (5) on which a printing paper (B) is set, and a carriage (2) which travels on the plate tables (6) and the paper table (5). The apparatus comprises an illuminating measurement unit (18) for measuring reflected light intensity, an ink control unit (50), and ink supply devices (22). The measurement unit (18) is installed on the carriage (2). The unit (18) obtains reflected light intensities from density reference charts (82) printed on the printing paper (B) set on the paper table (5), and measures the extent and location of the area of the image etched on each of the printing press plates (A) set on the plate tables (6), during travel of the carriage (2). The quantity of the ink supplied by the ink supply devices (22) is controlled in accordance with the print density and image areas.

F I G. 2



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BACKGROUND OF THE INVENTION

The present invention relates generally to an ink supply apparatus. More specifically, it relates to an ink supply apparatus in a proofing press machine which comprises plate tables on which a press plate are set, a paper table on which a printing paper is set, and an inking and printing carriage movable along the plate tables and the paper table.

An offset proofing press machine described in Japanese Patent Laying-Open No.312146/1988 employs a densitometer on a carriage which can travel along printing plate tables and a printing paper table. The densitometer measures the density of marks in a density reference chart, printed on a printing paper when the carriage travels over the paper table onto which the paper is set. The carriage thus equipped determines the quantity of ink supplied by the carriage according to the measurement by the densitometer.

In order to optimally control the ink supply quantity, however, the density measurements obtained from the density marks on the printing paper are not adequate. It is preferable that not only density data derived from the density reference chart, but also measurement of the photo-etched image area on the printing plates be utilized as control parameters for controlling the ink supply quantity.

Japanese Patent Laying-Open No.174159/1987 discloses a device for measuring the area of an image on a printing plate. The obtained data are utilized as a control parameter during ink supply in the carriage. However, the device occupies space in addition to that required for the proofing press machine itself, thus complicating the structure of entire system, and increasing the manufacturing cost.

SUMMARY OF THE INVENTION

It is an object of the present invention to optimally determine supply ink employing both a printing paper density reference chart and measurement of the image area etched on a press plate as control parameters, while maintaining simplicity of structure.

An automatic ink supply apparatus according to the present invention is for use in a proofing press machine which includes plate tables on which press plates are set, a paper table on which a printing paper is located, and an inking and printing carriage capable of traveling along the plate tables and the paper table.

The apparatus comprises means provided in the carriage for quantitatively detecting the intensity of source light sent from the means during the course of carriage travel and reflected from the material set on the tables, means for deriving printing density data from a density reference chart printed on the printing paper set on the paper table, means for measuring the image area of the printing plates set on the plate table, and means for controlling ink supply amount in the carriage. The printing density derivation means derives the printing density in accordance with information obtained from the reflected light intensity measurement means. The image area measurement means measures the area of the image etched on the printing plates in accordance with information obtained by the same means. Then, the ink supply means accordingly determines the ink supply quantity in the carriage based upon the printing density and image area data.

Thus the reflected light intensity measurement means is employed to obtain data pertaining to both the printing density and the image area measurement, whereby the ink maybe optimally supplied by means of a structure which does not necessitate added complexity.

The foregoing and other objects and advantages of the present invention will become more apparent from the following detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a plan view showing a proofing press machine to which an embodiment according to the present invention is applied;

Fig. 2 is an elevational view of the machine of Fig. 1;

Fig. 3 is a perspective view showing an inking carriage, a portion of which is cut away;

Fig. 4 is a perspective view diagraming an ink supply device;

Fig. 5 is a fragmentary perspective view showing a measuring unit;

Fig. 6 is a schematic diagram of a color patch sensor unit;

Fig. 7 is a schematic diagram of an light optical feedback sensor unit;

Fig. 8 is a schematic diagram of a white reference sensor unit;

Fig. 9 is a schematic block representation of a measurement unit of Fig. 5;

Fig. 10 is a schematic block diagram of machine control units;

Fig. 11 is an exemplary plan view of a printing plate;

Fig. 12 represents an example of a print;

Figs. 13-15 are main control unit control process flow charts; and main body control unit;

Figs. 16-19 are ink control unit control process flow charts.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The proofing press illustrated in Figs. 1 and 2 is principally composed of a horizontally extended frame 1, a horizontally conveyable carriage 2 disposed on the frame 1, a dampening device 4 located in one end (the left end in Figs. 1 and 2) of the frame 1, and first to fourth fixed ink rollers 14a, 15a, 16a and 17a located in the opposite end of the frame 1. A paper table 5, and first, second, third and fourth color plate tables 6, 7, 8, and 9, are mounted along the midportion of the frame 1 in that order, approaching the dampening device 4. Located adjacent the dampening device 4 is a registering device 3 which travels along the plate tables 6 to 9, registering printing plates installed therein. The carriage 2 incorporates water-dampening rollers 91, first to fourth color ink rollers 14, 15, 16 and 17, and first to fourth blanket cylinders 10, 11, 12 and 13. The dampening rollers 91 engage with the dampening device 4 when the carriage 2 reaches the leftward extent of its travel, and thereafter supply dampening water to the printing plates set on the plate tables 6 to 9 as the carriage 2 travels back along them. The first to fourth color ink rollers 14 to 17 contact fixed ink rollers 14a to 17a, respectively, when the carriage 2 is located in its "home" position, at the right end, and they supply ink to the printing plates as the carriage 2 travels along the plate tables 6 to 9. The first to fourth color blanket cylinders 10 to 13 transfer images obtained from the printing plates to a printing paper set on the paper table 5 as the carriage 2 travels along the plate tables 6 to 9 and the paper table 5. The carriage 2 additionally mounts a measurement unit 18 along the side which comes nearest the dampening device 4 in operation. As shown in Fig. 3, the carriage 2 further comprises an encoder 19 for detecting the transit location of the carriage 2, and an operation panel 21 including a display 20 and a keyboard (described later), and ink supply devices 22 for supplying ink to the ink rollers 14 to 17.

The ink supply devices 22 include an ink discharge unit 23 incorporating a nozzle, as shown in Fig. 4. Each ink discharge unit 23 is adapted so that its movement by means of a screw rod 24 is parallel with the corresponding ink roller 14 (15, 16 and 17). The screw rod 24 is connected to a motor 26 through a power transfer arrangement 25 composed of pulleys and a belt.

Located between each of the ink rollers 14 (15, 16 and 17) and the corresponding ink discharge unit 23 is an ink supply roller 27, which is swung from one to the other of the devices by means of a piston 29 through a pivoting rod 28. The ink rollers 14 (15, 16 and 17) are brought into contact with their respective fixed rollers 14a (15a, 16a and 17a) by a drive motor (not shown) provided in the frame 1 and rotate together with them, whereby ink is distributed over the rollers. It is feasible that the ink discharge unit 23 could supply ink directly to the ink rollers 14 (15, 16 and 17), wherein the ink supply rollers 27 could be omitted.

The measurement unit 18 is, as shown in Fig. 5, composed of a case 30 and a measurement assembly 31 disposed therein. The measurement assembly 31 includes a sensor unit 32, having an exterior exposure through a slot 33 formed along the underside of the case 30. The measurement assembly 31 includes optical fibers 34 adjacent to the sensor unit 32, in which arrangement reflected light sent from the optical fibers 34 is detected by the sensor unit 32. A halogen lamp (not shown) is provided at the base of the optical fibers 34 so that the ends of the optical fibers 34 adjacent to the sensor unit 32 illuminate. The tips of the optical fibers 34 are located at a pitch of 10 millimeters.

As shown in Fig. 9, the sensor unit 32 comprises a mother board 35 which is connected to an ink control unit 50 (described momentarily). The sensor unit 32 further comprises a white reference sensor 36, a first light-feedback sensor 37, a second light-feedback sensor 38, and a plurality of color patch sensors 39. These sensors 36 to 39 are connected to the mother board 35 through AMP boards 40 and A/D conversion boards 41.

As illustrated in Fig. 6, each of the color patch sensors 39 contains photodiodes 43 which are attached to an attachment plate 42 measure ink density of each of colors, yellow (Y), magenta (M), cyan (C) and black (BK). Complementary color filters 44 corresponding to these four colors respectively are located on the light-receive ends of the photodiodes 43. Both of the light-feedback sensors units 37 and 38, detailed in Fig. 7, include photodiodes 43a for which provide feedback in order to keep the light intensity of the light source constant, while the remainder of the structure is the same as that of a sensor 39. The white reference sensor unit 36 comprises, as shown in Fig. 8, a white reference photodiode 43b which detects a measurement signal mark (described later) on either the press plate or the printing paper and measures the light reflectance of the printing paper background. These photodiodes 43, 43a and 43b are each connected to a respective AMP board 40 (Fig. 9). The photodiodes 43, 43a and 43b are located at a 10 millimeter pitch as likewise are the tips of the optical fibers 34.

The proofing press is provided both with a main control unit 60 as diagramed in Fig. 10 which controls the overall operation of the proofing press, as well as the above-mentioned ink control unit 50. Both control units 50 and 60 contain a microcomputer comprising a CPU, a ROM, a RAM and so on. Various kinds of information is interchanged between the control units 50 and 60 in order to coordinate their operations.

The ink control unit 50 controls the ink supply operation and is connected to the aforedescribed measurement unit 18, the display 20 and the ink supply devices 22. The ink control unit 50 is also connected to a key panel 51 provided on the operation panel 21 for key input of commands, to a data input FD drive 52 into which floppy discs storing basic data are inserted, as well as to other input/output devices.

The main control unit 60 is connected with the encoder 19 and controls such operations of the proofing press main body as the travel of the carriage 2. A key panel 61, also provided on the operation panel 21 for input of commands by an operator, a carriage driving device 62 including a motor which reciprocates the carriage 2, and an ink roller driving device 63 including a motor which rotates the fixed ink rollers 14a to 17a, as well as other input/output devices, are connected to the main control unit 60.

Reference is now made to Fig. 11, showing a printing plate in use during operation of the proofing press, and to Fig. 12, showing an example of print material printed thereby. The press plate A of Fig. 11 is set on the first color (BK) plate table 6. In addition to an image 71, management patches 72 consisting of a number of rectangular patterns and a measurement signal mark 74 are photo-etched on the printing plate A. The management patches 72 are used for printing density management solid patches 82, and thus taken together constitute ink-receiving area in addition to the image area. The printing paper B of Fig. 12 is set on the paper table 5. The four printing colors have been already printed on the printing paper B, whereby an image 81, density management solid patches 82 in each of the four colors, and a start measurement mark 84 appear thereon. The start measurement mark 84 is printed by the measurement signal mark 74 etched on the printing plate A. The solid patches 82 which correspond to the color BK are printed by the management patches 72 (Fig. 11) on the printing plate A, and solid patches 82 corresponding to the other three colors Y, M and C are printed by the management patches 72 etched on to the respective printing plates A.

The area indicated by reference numeral 83 in Fig. 12 is a white reference area which is measured by the white reference sensor 36 in order to compute the light reflectance of the printing paper B. An area 73 (Fig. 11) on the printing plate A corresponding to the white reference area 83 contains no image. A blank area 75 along the gripped edge of the printing plate A in Fig. 11 is utilized for calibration when the image area 71 is measured. The area 75 is skipped when the printing plates A are etched, and thus contains no image.

The operation of this embodiment will hereinafter be described with reference to the flow charts of Figs. 13 to 15, illustrating the control process of the main control unit 60, and to those of Figs. 16 to 19 illustrating the control process of the ink control unit 50.

General Flow

When the program in the main control unit 60 begins, an initialization is carried out at step S1 of Fig. 13, in which, inter alia, the carriage 2 is set home along the frame 1. After the initialization, the program proceeds to step S2. At step S2, it is determined whether or not initial ink supply is commanded through input at the key panel 61. If not, the program proceeds to step S3. At step S3, it is determined whether or not additional ink supply is commanded through input at the key panel 61. If not, the program proceeds to step S4. At step S4, it is determined whether or not a print start command has been input through the key panel 61. If the command has not been received, the program returns to step S2. That is, the program waits for the command through input at the key panel 61 at steps S2 to S4.

Meanwhile, when the program in the ink control unit 50 starts, an initialization is carried out at step P1 of Fig. 16, in which, inter alia, the ink supply devices 22 are set into their initial positions. After the initialization, the program proceeds to step P2, at which it is determined whether new ink supply conditions have been input through the key panel 51. If no such conditions have been input, the program proceeds to step P3, at which it is determined whether the ink initial supply operation has been instructed by the main control unit 60 or not. If the determination is "No", the program proceeds to step P4. At step P4, it is determined whether the additional ink supply operation has been instructed by the main control unit 60. If the determination is "No", the program proceeds to step P5, at which it is determined whether an automatic ink supply instruction is has been given by the main control unit 60 or not. At step P5, if the determination is "No", the program returns to step P2. That is, the program awaits the issuance of various instructions at steps P2 to P5.

Wherein an operator inputs information through the key panel 51 into the ink control unit 50 pertaining to paper quality, printing plate type, inks type, desired density, and color designation conditions, the program proceeds from step P2 to step P6 of Fig. 16. At step P6, the ink control unit 50 stores the input conditions, whereupon the program returns to the main routine.

Initial Supply

If an operator has input the initial ink supply command into the main control unit 60 through the key panel 61, the program therein proceeds from step S2 to step S5 of Fig. 13. At step S5, the main control unit 60 sends the initial ink supply instruction to the ink control unit 50. At step S6, an ink rolling-up subroutine as shown in Fig. 14 is carried out.

At step S7 of Fig. 14, the carriage 2 is driven toward the dampening device 4. Then, at step S8, the program awaits the detection of the carriage 2 at the limit of its travel path. Once the carriage 2 reaches the extent of its travel toward the dampening device 4, it is driven reversely through direction at step S9.

At step S10, it is determined whether an await period prior to the switching-on of the light source (halogen lamp) used for the measurement taken by the measurement unit 18 has elapsed. At step S11, it is determined whether a pause until the measurement unit 18 is to begin start measurement has elapsed. The determinations at step S10 and step S11 are made according to the travel location of the carriage 2 as detected by the encoder 19. At step S12, it is determined whether a roller driving instruction (described later) has been given by the ink control unit 50. If the determination is "No", the program proceeds to step S13, at which miscellaneous processes may be executed, then it returns to step S10.

When the await period at step S10 has elapsed, the determination therein becomes "Yes" and the program proceeds to step S14. At step S14, the main control unit 60 sends a switch on exposure lamp instruction to the ink control unit 50. Upon execution of the process at step S14, the program returns to step S11. Then, wherein the time awaiting the start of measurement has elapsed, the determination at step S11 becomes "Yes" and the program proceeds to step S15, at which the main control unit 60 gives a start measurement instruction to the ink control unit 50.

When the ink control unit 50 receives the initial supply instruction (step S5) from the main control unit 60, the program proceeds from step P3 to step P7 of Fig. 16, wherein the initial supply subroutine of Fig. 17 is executed. At step P8 of Fig. 17, the program in the ink control unit 50 awaits the switch on exposure lamp instruction sent by the main control unit 60, upon receipt of which the light exposure source in the measurement unit 18 is lighted at step P9. Then, at step P10, it is determined whether or not the start measurement instruction has been sent from the main control unit 60, and at step P11 it is determined whether or not an interval prior to exposure lamp switch-off has elapsed.

When the start measurement instruction (step S15) has been sent by the main control unit 60, the program proceeds from step P10 to step P12. At step P12, a zeroing process to calibrate measurement scale is carried out as each of the photodiodes 43 of the color patch sensors 39 measure the intensity of the light reflected by the blank area 75. After the zeroing process, the program proceeds to step P13. At step P13, the area of the image 71 inked on the printing plate A is measured. The color patch sensors 39 are also employed to obtain this measurement. The photodiodes 43 measure the reflected light intensity from the printing plate A at 10 millimeter pitch as the measurement unit 18 scans the surface of the printing plate A when the carriage 2 travels over it. As a result, voltage data measured by each of the photodiodes 43 are stored in the ink control unit 50.

At step P14, the white reference sensor 36 detects the measurement signal mark 74 whereby the finish of the scanning of image 71 is concluded. Thereupon, the determination becomes "Yes" at step P14 and the program proceeds to step P15. At step P15, clocking the lag after the detection of the measurement signal mark 74, the program awaits the arrival of the measurement unit 18 at the management patches 72 on the printing plate A, whereupon the program proceeds to step P16, at which 100 % value for calibration of the measurement scale is obtained as the photodiodes 43 corresponding to the respective color on the presently-scanned of the printing plates A measure the intensity of the light reflected by the management patches 72. The measurement signal mark 74 is employed in order to detect the boundary of the image 71 relative to the location of the management patches 72, since these positions vary according to the size of the printing plates A.

At step P17, it is determined whether or not a next printing plate exists. The program returns from step P17 to step P12, repeating the same measurement operation until the measurement of all four color printing plates is completed. After the completion of all of the measurements, the determination at step P17 becomes "No" and then the program returns to step P10.

When a given interval has elapsed thereafter, it is concluded that the time until the exposure lamp may be switched off has expired, and the program proceeds from step P11 to step P18. At step P18, calibrations are carried out in accordance with data obtained from the zeroing process at step P12 and the 100 % value measured at step P16 for each of the color printing plates A (Y, M, C and BK), then the image areas on each of the four printing plates are calculated based upon the respective calibrated scales of measurement.

In calculating the image areas, the extent of the image existing on the printing plates is determined according to changes detected in the voltages measured by the sensors. Voltages thus measured by each sensor along its scanning line are stored and integrated. Each of the integrated amounts is converted into image area per sensor scanning line. The image area is calculated relative to the voltage values obtained through a given instance of measurement with respect to the calibrated 0 % to 100 % measurement scale.

The scanning-line measurement scale calibrations are carried out in order to compensate for those differences in the voltages converted from the intensity of the reflected light at the different photodiodes 43 which result from such non-image factors as dispersion of the exposure light intensity at the optical fibers 34 luminance ends and variations in the performance characteristics of the photodiodes 43, as well as from the fact that different color complementary filters 44 are installed an the photodiodes 43 to measure the density of the respective solid patches 82. These calibrations must be made in accordance with the reflected light intensity of both an area where no image exists and an area where 100 % image exists on the actual printing plate A by which printing is carried out, because every given printing plate A has a different light reflectance stemming from differences among the kinds of printing plates and changes in sensitivity brought about by use in etching.

The blank area 75 used to determine the 0 % calibration is provided on every printing plate A, for each of the colors Y, M, C and BK, as a non-etched area on the printing plate gripped side, so that zeroing processes may be performed through each of the photodiodes 43 as aligned at 10 millimeter pitch on each of the printing plates A. Meanwhile, the management patches 72 are etched at 40 millimeter pitch, being at such alternation on each of the respective printing plates A pitch that the solid patches 82 will be printed on the printing paper B at unique locations according to the different colors. Consequently, in the case of the printing plate A for the color BK as shown in Fig. 11, the photodiodes 43 for measuring the density of the solid BK patch 82 may carry out measurements for both the 0 % and the 100 % calibrations, but the other photodiodes 43 for the colors Y, M and C cannot carry out their respective measurements for 100 % calibration.

It is therefore necessary to derive assumed 100 % measurement values corresponding to those remaining photodiodes 43. The virtual 100 % measurement value V for each of the areas measured by the sensors for Y, M and C is calculated as follows according to the 0 % measurement value V_o obtained by the sensors of a given color, and the 0 % measurement value V_{oB} and the 100 % measurement value V_{1B} obtained by the BK sensors;

$$V = (V_o / V_{oB}) \times V_{1B}.$$

Thus no special 100 % reference area is needed in order to calibrate measurement scales for the scanning lines wherein management patches 72 do not exist. Particularly, the image areas are thus precisely measured at 10 millimeter pitch without the additional requirement of special printing plates.

Following the process at step P18, the program proceeds to step p19, wherein initial ink supply amounts for each of the colors are calculated in accordance with the image areas calculated at step P18. The amounts of image area on each of the printing plates A calculated at step P18 are converted into the ink supply quantities for each of the respective colors according to a function whose parameters are color, paper quality, kind of ink, target density, plate type, etc. The ink supply quantities are set so as to correspond to the image area, amounts--greater for these regions in which the image is prevalent and lesser in those regions in which it is more scarce.

The data from the image areas exists as derived along the scanning lines at the 10 millimeter pitch at which the sensors are located, but the ink is supplied at 40 millimeter pitch, which corresponds to the pitch of the density measurement solid patches 82 (hereinafter described). Therefore, at the ink discharge unit 23 first supply point, the average between supply amounts calculated from the BK and C scanning lines along one end is defined as the ink supply quantity; and at the ink discharge unit 23 last supply point, the supply amount averaged from the values calculated from the M and Y scanning lines along the other end is defined as the ink supply amount; and finally at each of the 40 millimeter pitch supply points between both end supply points, the defined supply amount is averaged from the values calculated along the scanning lines for all of the colors Y, M, C and BK through each of the corresponding photodiodes 43.

After the calculation of the ink supply amounts, at step P20 initial ink rolling-up data for each color are displayed on the display 20. Afterwards, the ink control unit 50 instructs the main control unit 60 to drive the fixed ink rollers 14a to 17a. In the main control unit 60, the determination at step S12 in Fig. 14 thus becomes "Yes" and the program proceeds to step S16. At step S16, the fixed ink rollers 14a to 17a and the ink rollers 14 to 17 are driven synchronously. At step S17, the main control unit 60 awaits a signal of the ink rolling-up operation termination from the ink control unit 50.

The ink control unit 50, at step P22 of Fig. 17, controls operation of the ink supply device 22 in accordance with the outcome of the calculations at step P19 and carries out the initial ink rolling-up operation. The ink discharge unit 23 is driven as indicated in Fig. 4 in the longitudinal direction of the ink rollers 14 (15, 16 and 17), and accordingly applies the correctly sufficient amount of ink to the respective points along the ink supply roller 27. Then, the ink supply roller 27 is driven toward the ink rollers 14 (15, 16 and 17) sideways by the piston 29, whereby applied ink is supplied to the ink rollers 14 (15, 16 and 17) from the ink supply roller 27.

After the initial ink rolling-up operation, at step P23, the ink control unit 50 notifies the main control unit 60 of the termination of the operation. Subsequently, the program returns to the main routine of Fig. 16. Meanwhile, in the main control unit 60, the determination at step S17 of Fig. 13 becomes "Yes" and then the program returns to the main routine therein.

Additional Supply

When a fresh printing plate is to be inked following a previously inked plate, the additional ink supply is commanded if necessary. If the main control unit 60 is given the command for additional supply from an operator through the key panel 21, the program proceeds from step S3 in Fig. 13 to step S26. At step S26, the main control unit 60 instructs the ink control unit 50 to supply additional ink. At step S27, the ink rolling-up subroutine of Fig. 14 is carried out. The operation of the ink rolling-up subroutine therein is the same as that during the initial ink supply operation and therefore need not be further explained.

When the ink control unit 50 receives the additional ink supply instruction from the main control unit 60 at step S26, the determination at step P4 of Fig. 16 becomes "Yes" and the program proceeds to the additional supply subroutine at step P27. In the additional ink supply subroutine diagramed in Fig. 18, the processes at step P28 to step P38 are the same as those at step P8 to step P18 of the initial ink supply subroutine (Fig. 17) and thus will not be elaborated upon.

At step P39, the additional ink supply quantity is calculated in accordance with the result of the image area calculations at step P38. In executing this calculation, an estimate of the quantity of ink having not been consumed by the previous printing operation is taken into account as well. That is, the quantity of ink rolled up during the previous printing operation and estimated to be remaining on the ink rollers is subtracted from the result obtained likewise as that for the calculation of the initial ink supply (based upon the scanning of the printing plate image areas) in order to determine the additional ink supply quantity.

Following the process at step P39, are processes at steps P40 to P43, which are the same the corresponding processes performed during the initial ink supply at steps P20 to P23 (Fig. 17).

Printing (Automatic Ink Supply)

If the main control unit 60 receives a printing operation start command through the key panel 61, the program therein proceeds from step S4 to step S36 of Fig. 13. At step S36, the printing subroutine diagramed in Fig. 15 is executed.

At step S37 in Fig. 15, the main control unit 60 sends an automatic ink supply instruction to the ink control unit 50 and at step S38 sends a printing operation start instruction. Accordingly, the printing operation to the printing paper B set on the paper table 5, employing the printing plates A located on each of the plate tables 6 to 9 and the blanket cylinders 10 to 13 within the carriage 2 is begun. During the printing operation, each of the printing plates A receives dampening water and its respective color of ink from the dampening water rollers 91 and the ink rollers 14 to 17, respectively. Then, the blanket cylinders 10 to 13 transfer in turn the ink from the printing plates A onto the printing paper B. At step S39, it is determined whether or not the await interval prior to switching on the exposure lamp in the measurement unit 18 has elapsed. At step S40, it is determined whether or not the interval until measurement start by the measurement unit 18 has expired. At step S41, it is determined whether the printing operation is finished or not. At step S42, additional processes involved in the printing operation are carried out, for example, halting the travel of the carriage 2 at the home position on the frame 1.

When the await time prior to switching on the exposure lamp in the measurement unit 18 has elapsed, the program proceeds from step S39 to step S43 and sends the switch-on instruction to the ink control unit 50. When the pause until measurement start by the measurement unit 18 is over, the program proceeds from step S40 to step S44 and sends the measurement start instruction to the ink control unit 50.

Meanwhile, if the ink control unit 50 receives the automatic ink supply instruction (step S37) from the main control unit 60, the program proceeds from step P5 to step P47 of Fig. 16 and carries out the automatic supply subroutine diagramed in Fig. 19. Therein, at step P48, the program awaits the exposure lamp switch-on instruction from the main control unit 60. Once the instruction has been received, at step P49 the exposure light source in the measurement unit 18 is lighted. At step P50, the program awaits the measurement start instruction (step S44) from the main control unit 60, and once received, the program proceeds to step P51.

At step P51, the program awaits the detection of the start measurement mark 84 on the printing paper B (Fig.12). Once the start mark 84 has been detected, the program proceeds to step P52 after a given time lag. At step P52, the photodiodes 43 within each of the color patch sensors 39 (Fig. 9) measure the density of each of the solid patches 82. Subsequently, the program proceeds to step P53 and pauses prior to switch-off of the exposure light source. The light source is switched off at step P54, then the program proceeds to step P55.

At step P55, the densities of each color, Y, M, C and BK in the image are calculated based upon the values of by the measurement of the solid patches 82 obtained at step P52, and the calculated densities data are displayed on the display 20 at step P56. At step P57, replenishment quantities of ink of each of the colors (Y, M, C and BK) are calculated based upon the image color densities determined at step P55. Because the voltages converted from light of uniform intensity reflected on each of the sensors are liable to vary due to such factors as dispersion of the intensity of the exposure light at the light-emitting portions of the optical fibers 34, and to differences in characteristics of the photodiodes 43, it is necessary to calibrate the measurement unit 18 to compensate these variable factors when the color density values are obtained from the voltages converted from the reflected light intensities. The calibration in this case differs from that performed during the aforedescribed process of measurement of the image area in that the purpose of the calibration herein is to compensate for material inconsistencies among the photodiodes 43 installed in complementary color filters 44 of the same color.

In performing this calibration, the solid patches 82 printed on the printing paper B cannot be used as a reference for the calibrations because their densities differ depending on their given quantities of ink. Therefore, reference voltages for desired densities and for white are measured and recorded beforehand by using printing papers on which the solid patches are printed as reference together with a base white paper. Calibration is then carried out with reference to the reference voltages, and the result is used to calculate the effective densities from the actually measured data.

The intensity of the light reflected by the solid patches 82 printed on the printing paper B vary depending on the light reflectance of the paper itself. It is therefore necessary to correct the result measured at step P52, in accordance with the value of the intensity of the light reflected from the white reference portion 83 measured by the white sensor 36, when the ink replenishment quantity is calculated. It is alternatively possible to measure the reflected light intensities at the non-image area 85 on the gripped side of the as shown in Fig. 12, by employing each of the color patch sensor units 39 in lieu of the presently-described measurement obtained from the white reference area 83 by the white reference sensor 36.

At step P58, it is determined whether the ink consumed during the printing operation should be replenished in accordance with outcome of the calculation at step P57. If no replenishment is necessary, the program proceeds to step P59, wherein the ink control unit 50 sends a termination of operation notice to the main control unit 60. Meanwhile, at step P58 if it is determined that ink replenishment is necessary, the program proceeds to step P60. At step P60, the ink control unit 50 sends a roller drive instruction to the main control unit 60.

Following a printing operation, the program in the main control unit 60 awaits the roller drive instruction at step S45 and awaits the terminate operation notice at step S46 of Fig. 15. When the main control unit 60 receives the terminate operation notice before the roller drive instruction, the determination becomes "Yes" at step S46 and then the program returns to the main routine. Meanwhile, when the ink control unit 50 sends the roller drive instruction at step P60 (Fig. 19), the determination becomes "Yes" at step S45 in the main control unit 60 and then the program proceeds to step S47. At step S47, the fixed ink rollers 14a to 17a are driven synchronously with the ink rollers 14 to 17 in the carriage 2.

While the ink rollers 14 to 17 are being driven, step P61 is carried out in the ink control unit 50, at which the ink supply device 22 is controlled according to the result of the calculation at step P57, and each of the ink discharge portions 23 supplies ink in controlled quantities to specific locations along each of the ink rollers 14 to 17. Following the step P61 processes, the program proceeds to step P59 and sends the operation terminate notice to the main control unit 60, upon receipt of which in the main control unit 60, the determination becomes "Yes" at step S46 (Fig. 15) and then the program returns to the main routine.

The aforedescribed operation to automatically supply ink during the printing operation may be carried out following several paper printings.

Although the present invention has been described for the case of a four-color proofing press which prints in four colors at one step, the present invention may be applied to a monochrome proofing press which prints in one color at one step or to a two-color proofing press which prints in two colors at one step as well.

Various details of the present invention may be changed without departing from its spirit nor its scope. Furthermore, the foregoing description of the embodiments according to the present invention is provided for purpose of illustration only, and not for purpose of limiting the invention as defined by the appended claims or their equivalents.

The features disclosed in the foregoing description, in the claims and/or in the accompanying drawings may, both separately and in any combination thereof, be material for realising the invention in diverse forms thereof.

Claims

1. An ink supply apparatus installed in a proofing press which comprises a plate table (6) on which a printing plate (A) is set, a paper table (5) on which a printing paper (B) is set, a carriage which can travel on said plate table and paper table; said apparatus comprising means (18) installed in said carriage (2) for measuring reflected light intensity, means (50) for measuring color density from a density reference chart (82) printed on said printing paper (B) set on the paper table (5) through said reflected-light intensity measurement means (18) while the carriage (2) travels, and means (22) for supplying ink in said carriage (2) in accordance with measurement executed by said reference-chart density measurement means (50); said apparatus characterized in that:

   said apparatus further comprises means (50) for measuring an image area (71) etched on the printing plate (A) set on the plate table (6) through said reflected-light intensity measurement means (18) while said carriage (2) travels; wherein said ink supply means (22) supplies ink in accordance with the measurement by said reference-chart density measurement means (50) and said image-area measurement means (50).

2. An apparatus according to claim 1, wherein said ink supply means (22) has an ink discharge unit (23) having a nozzle, and means (50) for controlling the quantity of ink discharged from said ink discharge unit (23).

3. An apparatus according to claim 1 or 2, wherein said ink supply means (22) varies the ink supply amount in accordance with the image area data obtained by said image area measurement means (50), so as to supply higher volume wherein image is present to a greater extent, and lower volume wherein image is present to a lesser extent.

4. An apparatus according to any of claims 1 to 3, wherein said reflected-light intensity measurement means (18) includes sensors (43) for measuring printed each ink density of yellow (Y), magenta (M), cyan (C) and black (BK).

5. An apparatus according to claim 4, wherein said reflected-light intensity measurement means (18) further includes a feedback sensing means (43a) for maintaining constant intensity of source light, and a background reference sensor for measuring light reflectance of the printing paper (B).

6. An apparatus according to any of claims 1 to 5, further comprising means (60) for commanding said ink supply means (22) to execute an initial ink supply operation, an additional ink supply operation and an automatic ink supply operation.

7. An apparatus according to any of claims 4 to 6, wherein said image area measurement means (50) determines extent and location of the image area according to voltage changes produced in said ink density measuring sensors (43).

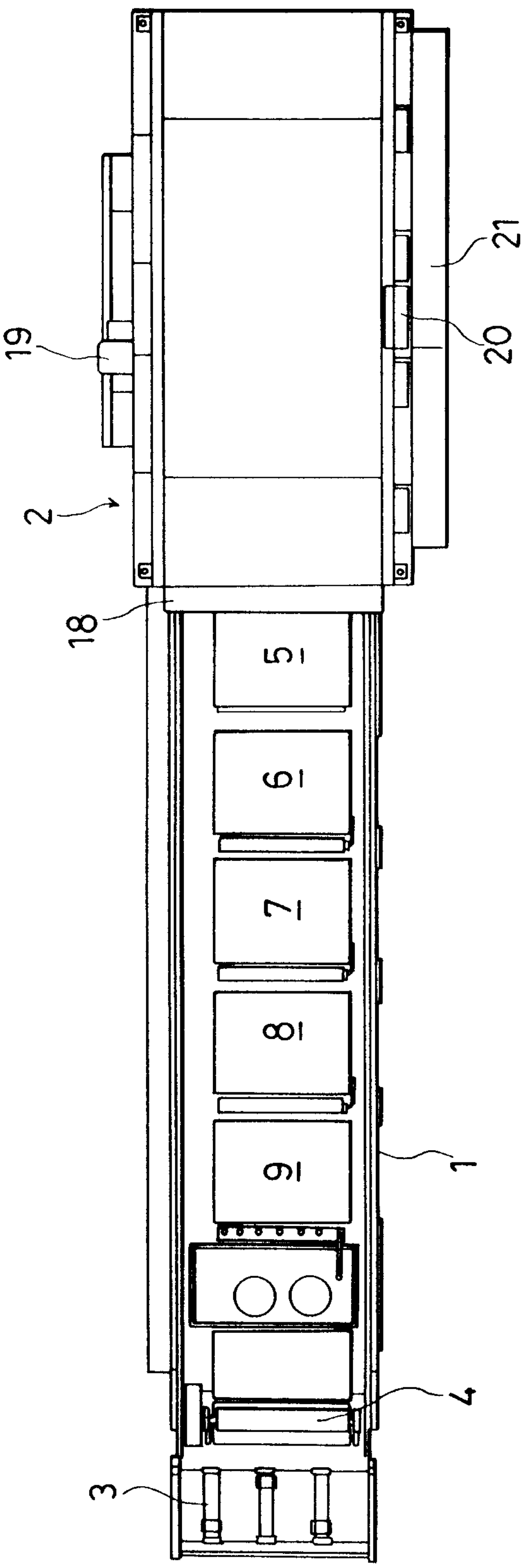
8. An apparatus according to any of claims 1 to 7, wherein said image area measurement means (50) is calibrated based upon zero percent and one hundred percent measurement data derived for each of said colors, yellow (Y), magenta (M), cyan (C) and black (BK), by said reflected-light intensity measurement means (18), and calculates area values corresponding to the extent and location of images etched on printing plates for each of said colors, yellow (Y), magenta (M), cyan (C) and black (BK) scaled according to said calibration.

9. An apparatus according to claim 8, wherein said image area measurement means (50) performs reference zero-percent measurement and reference one-hundred-percent measurement by using one of said ink-density measurement sensors (43), and performs zero-percent measurement and calculates assumed one-hundred-percent measurement data corresponding to the other ink-density measurement sensors (43) by using data obtained by

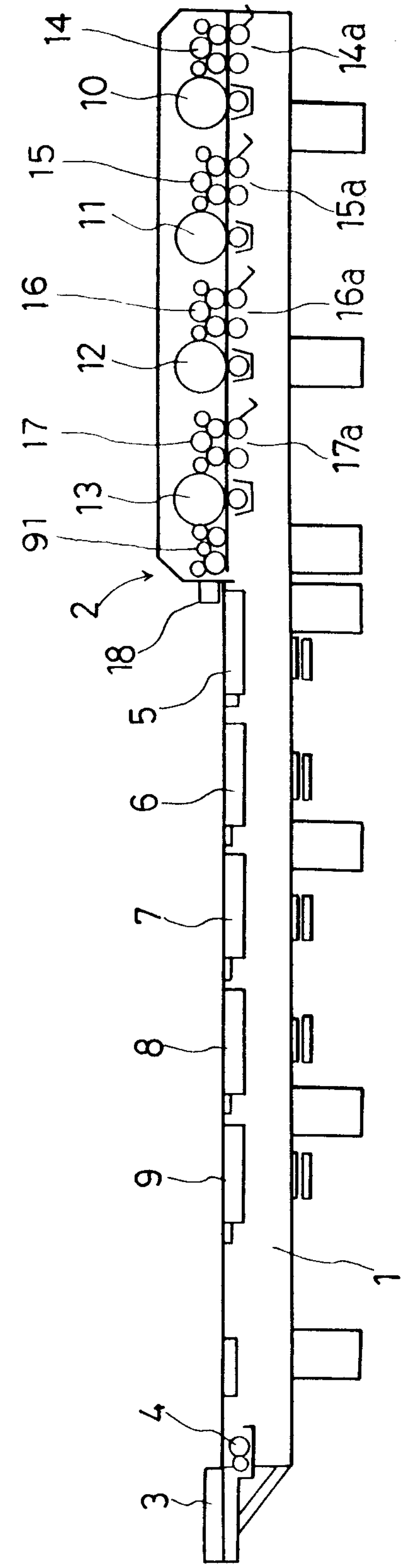
said other sensors zero-percent measurement and said reference zero-percent and reference one-hundred-percent measurements.

10. An apparatus according to claim 9, wherein said image area measurement means (50) calculates said assumed one-hundred-percent measurement data (V) based upon said zero-percent data (V_o) corresponding thereto, said reference zero-percent measured data (V_{oB}) and said reference one-hundred-percent measured data (V_{1B}), according to the following equation;

$$V = (V_o / V_{oB}) \times V_{1B}.$$

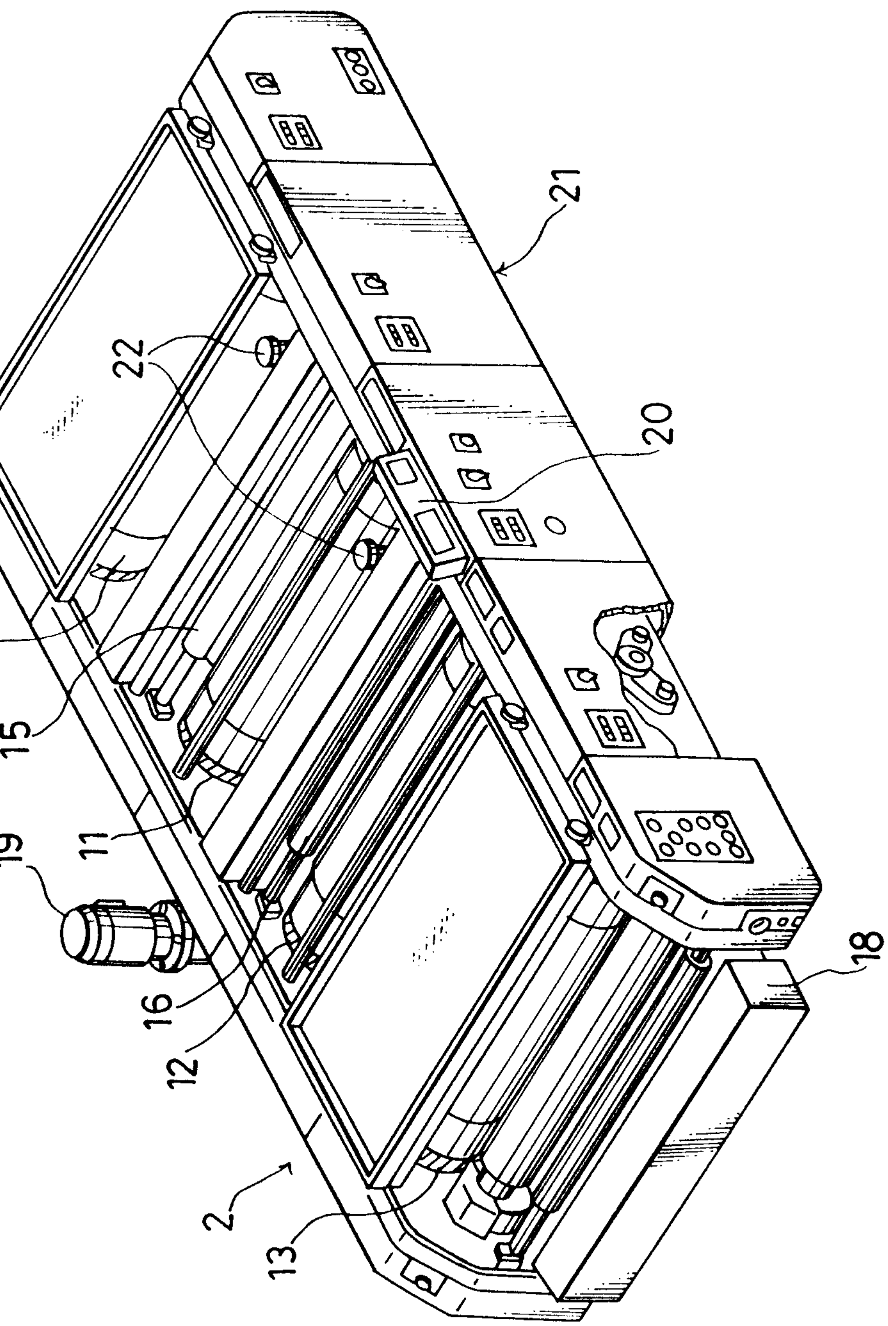


F I G. 1



F I G. 2

F I G. 3



F I G. 4

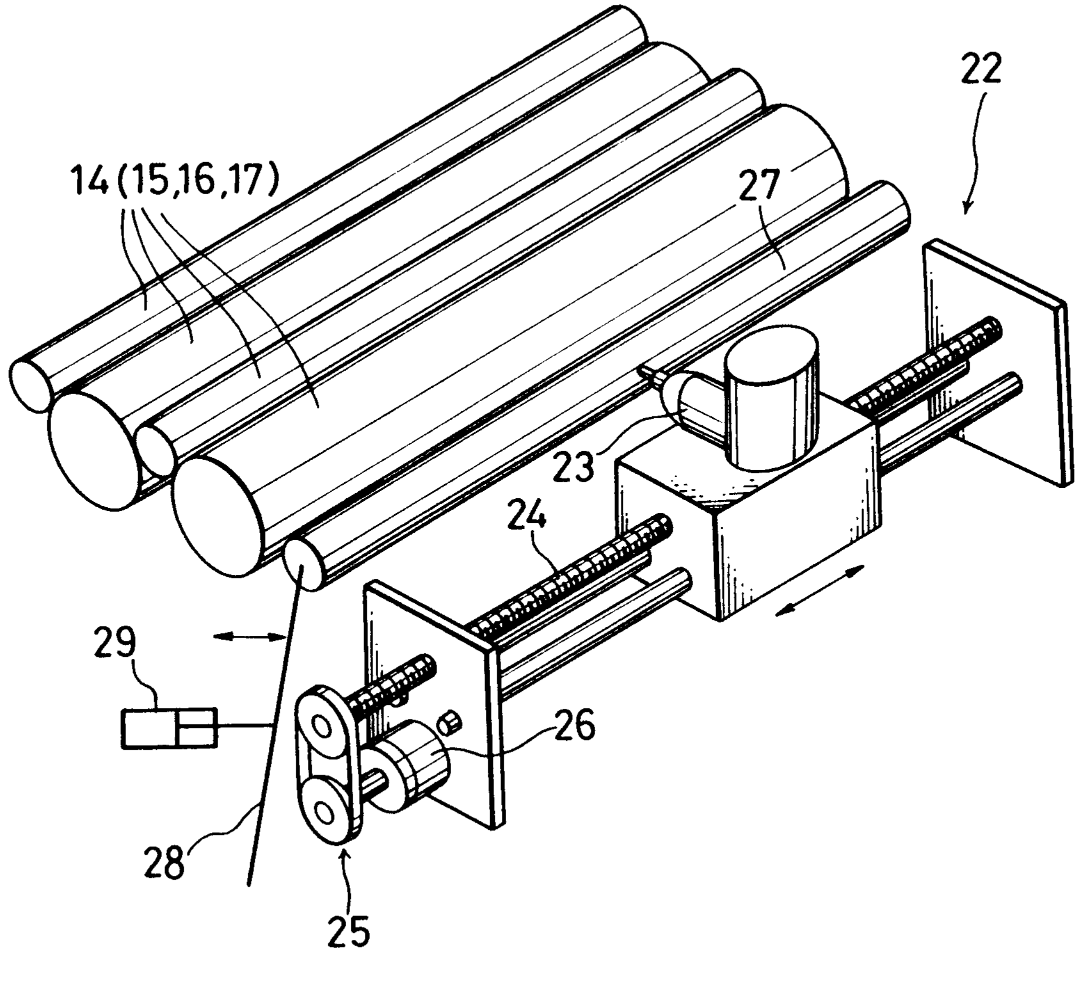


FIG. 5

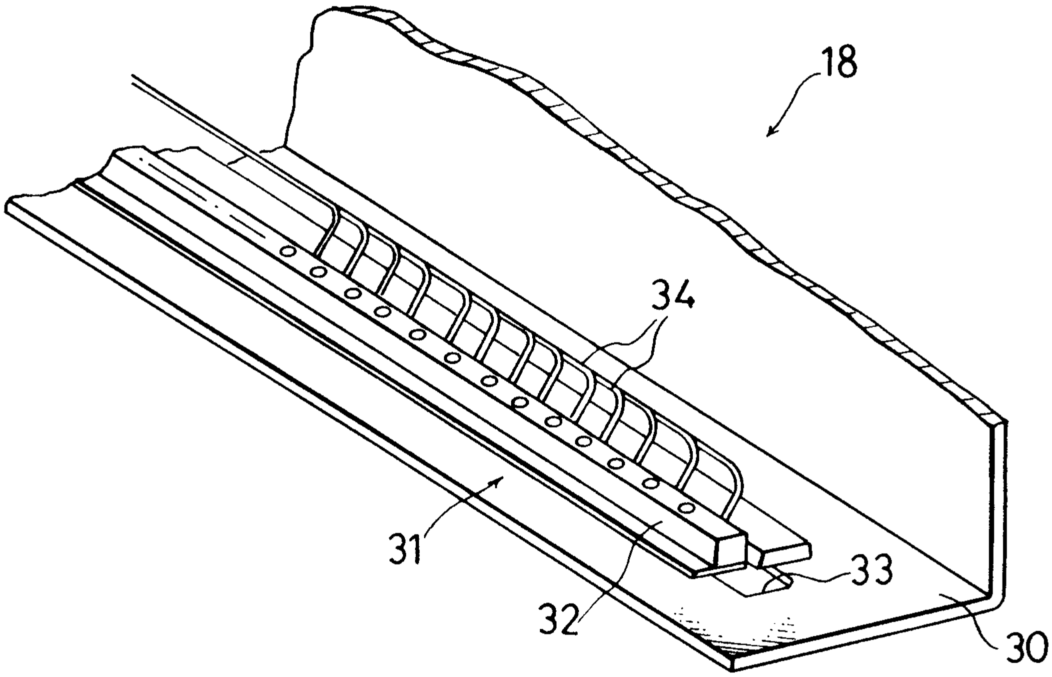


FIG. 6

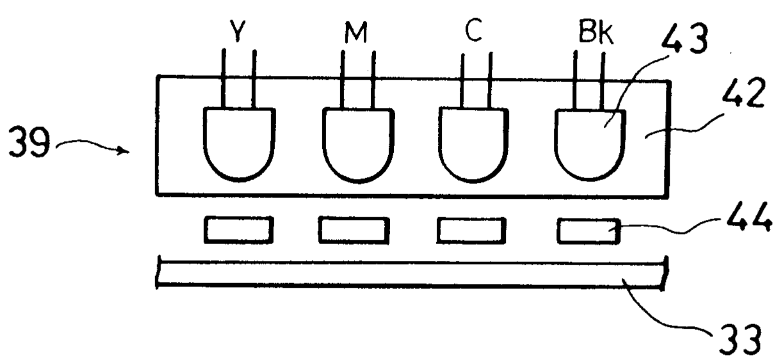


FIG. 7

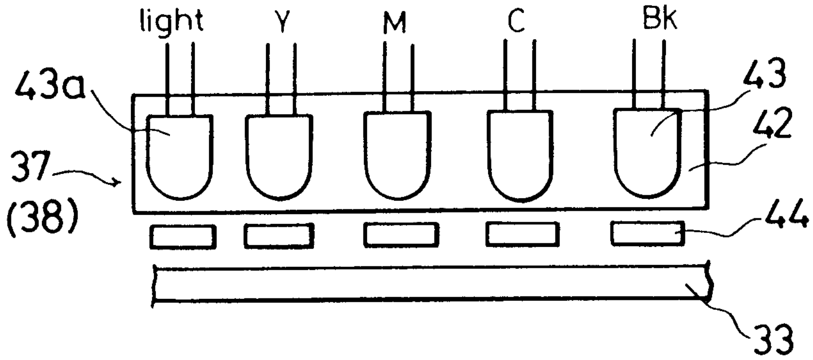
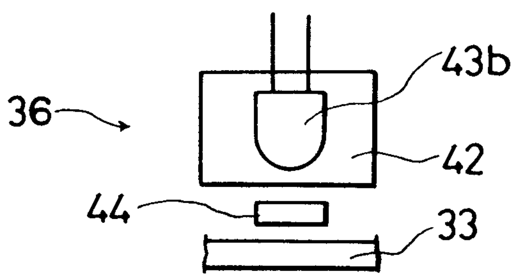


FIG. 8



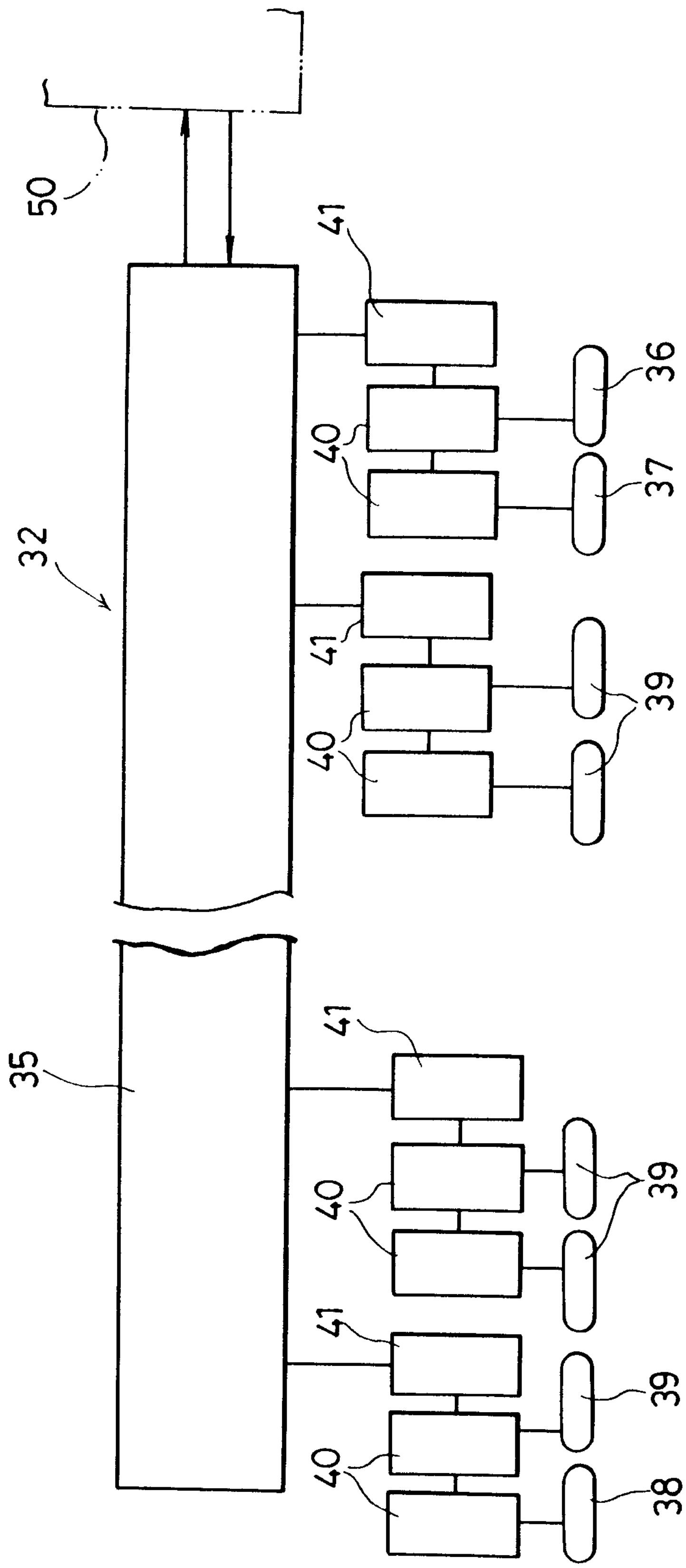
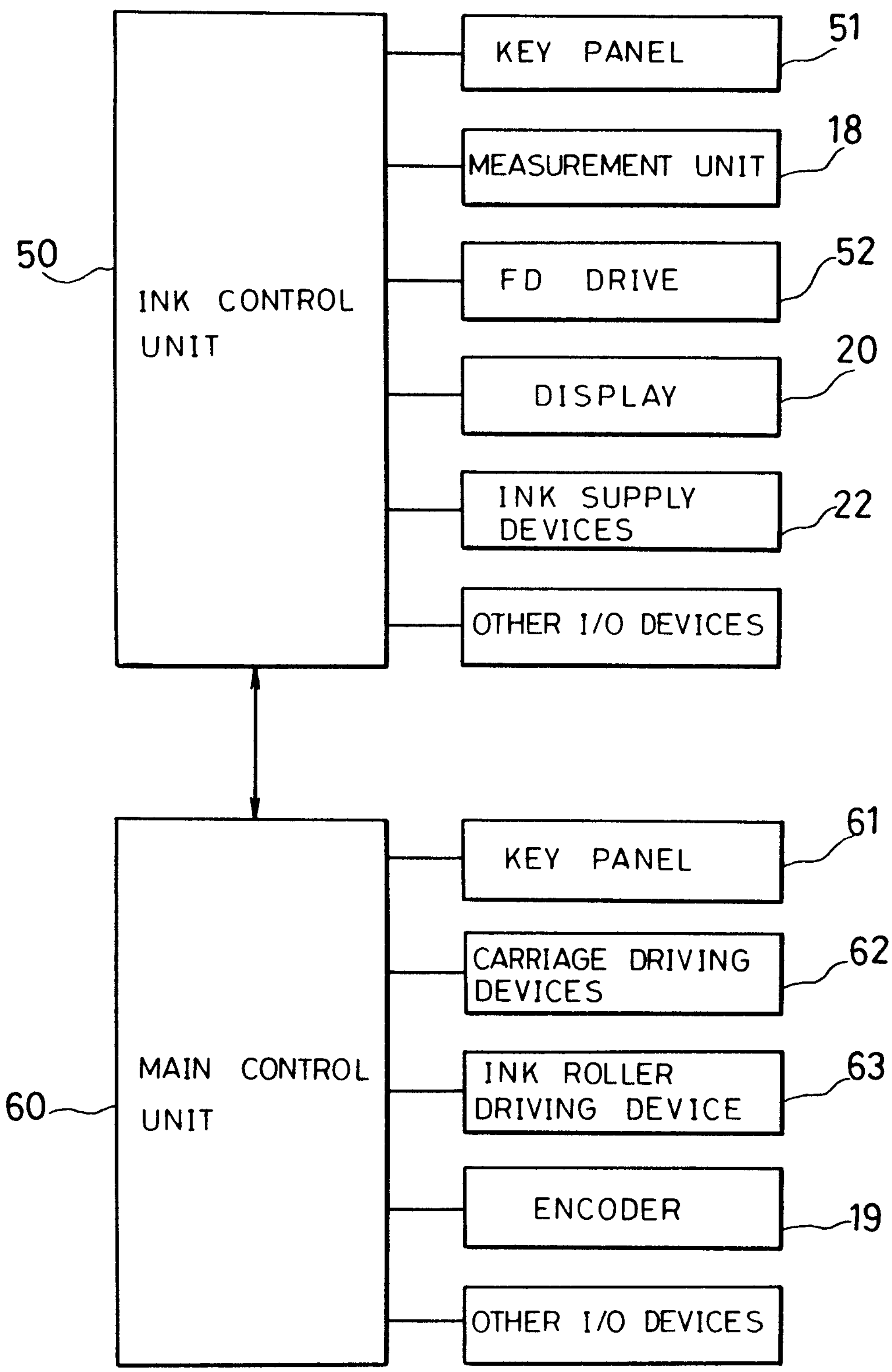
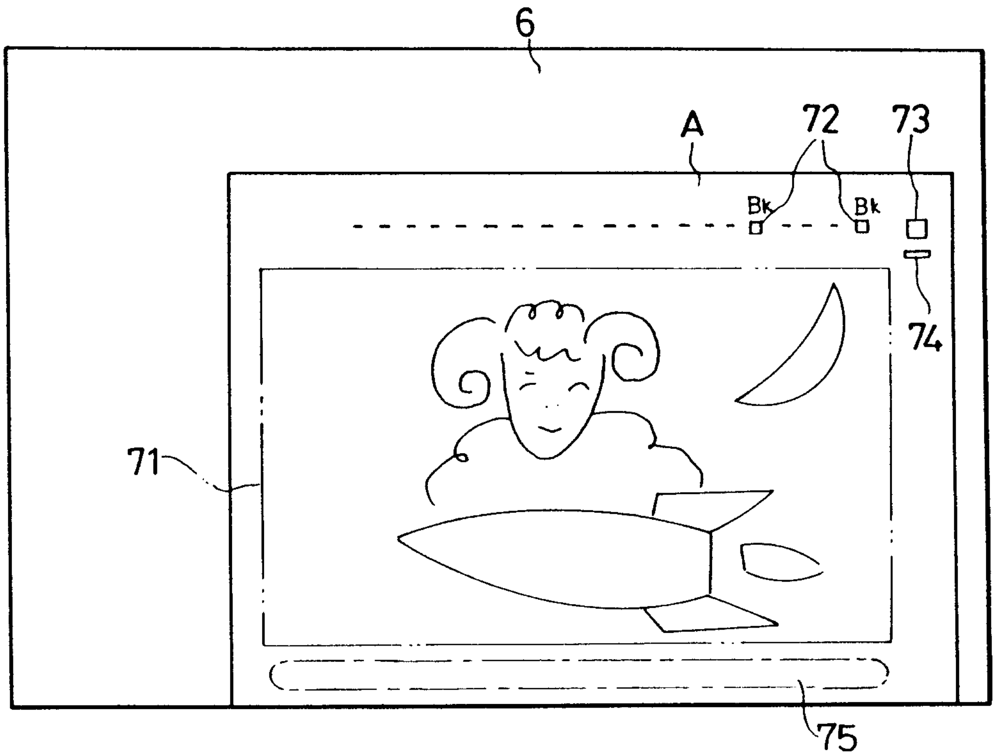


FIG. 9

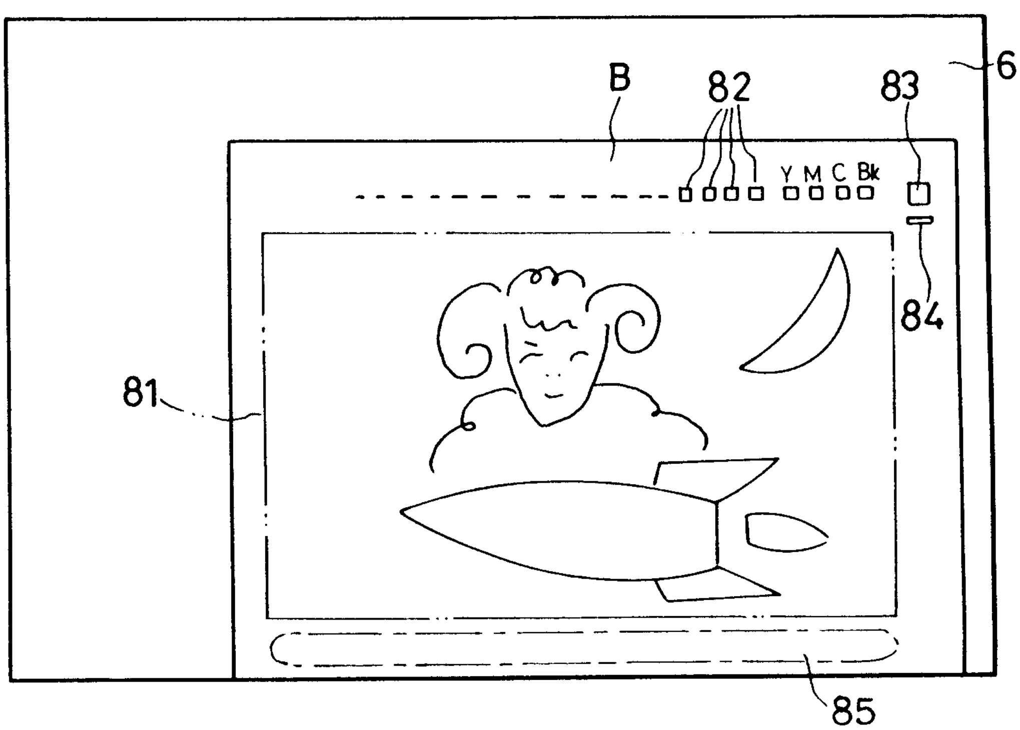
FIG. 10


INK CONTROL UNIT
50
KEY PANEL
51
MEASUREMENT UNIT
18
FD DRIVE
52
DISPLAY
20
INK SUPPLY DEVICES
22
OTHER I/O DEVICES
MAIN CONTROL UNIT
60
KEY PANEL
61
CARRIAGE DRIVING DEVICES
62
INK ROLLER DRIVING DEVICE
63
ENCODER
19
OTHER I/O DEVICES

F I G. 11



F I G. 12



F I G. 13

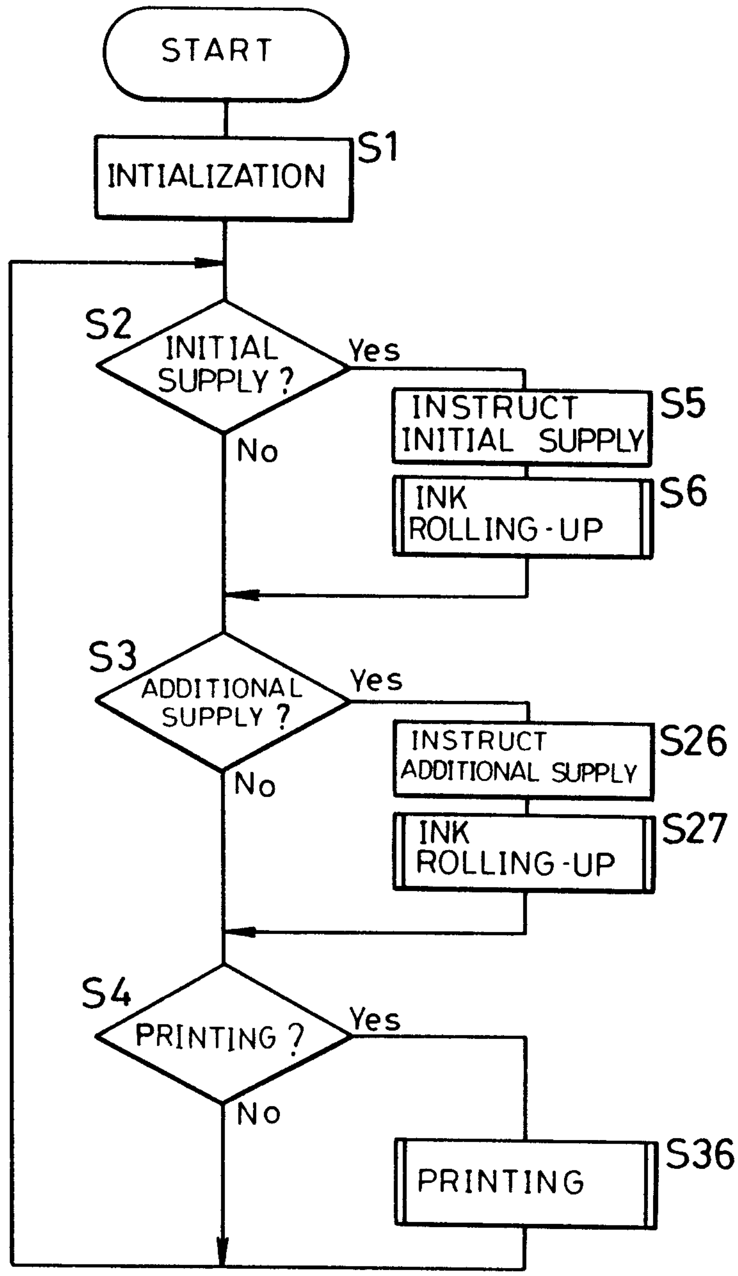
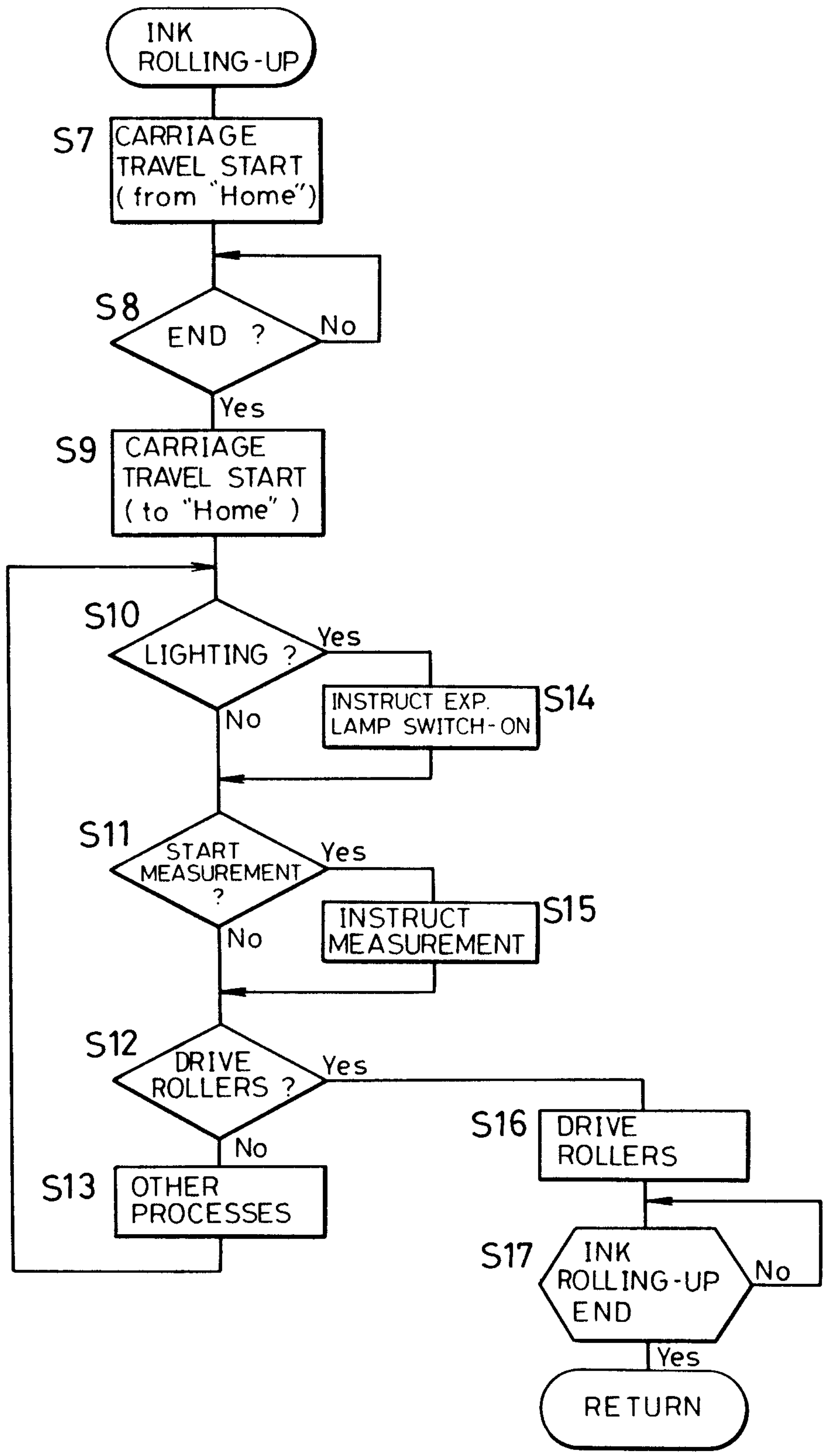
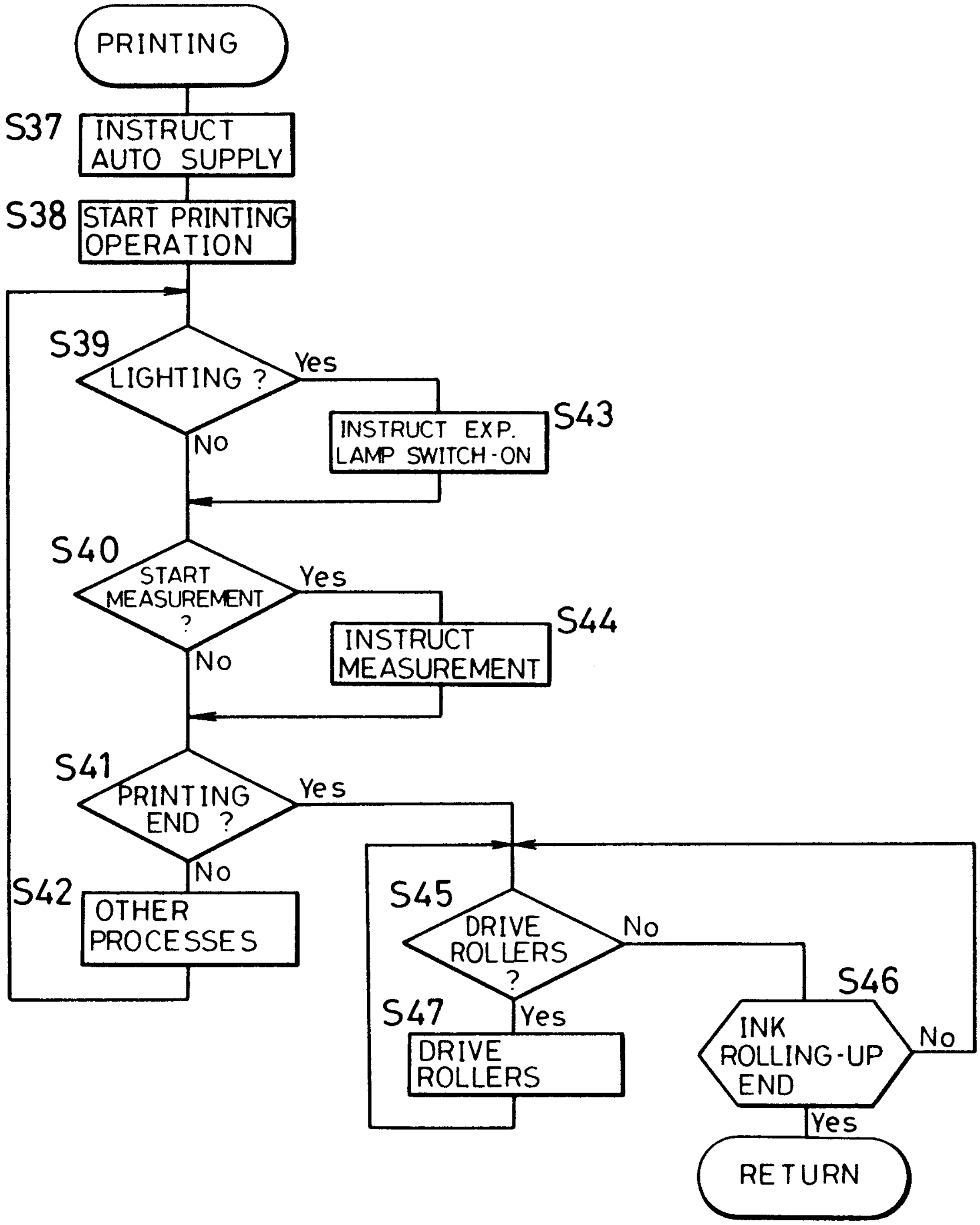

START
S1
INTIALIZATION
S2
INITIAL SUPPLY ?
Yes
No
INSTRUCT INITIAL SUPPLY
S5
INK ROLLING-UP
S6
S3
ADDITIONAL SUPPLY ?
Yes
No
INSTRUCT ADDITIONAL SUPPLY
S26
INK ROLLING-UP
S27
S4
PRINTING ?
Yes
No
PRINTING
S36

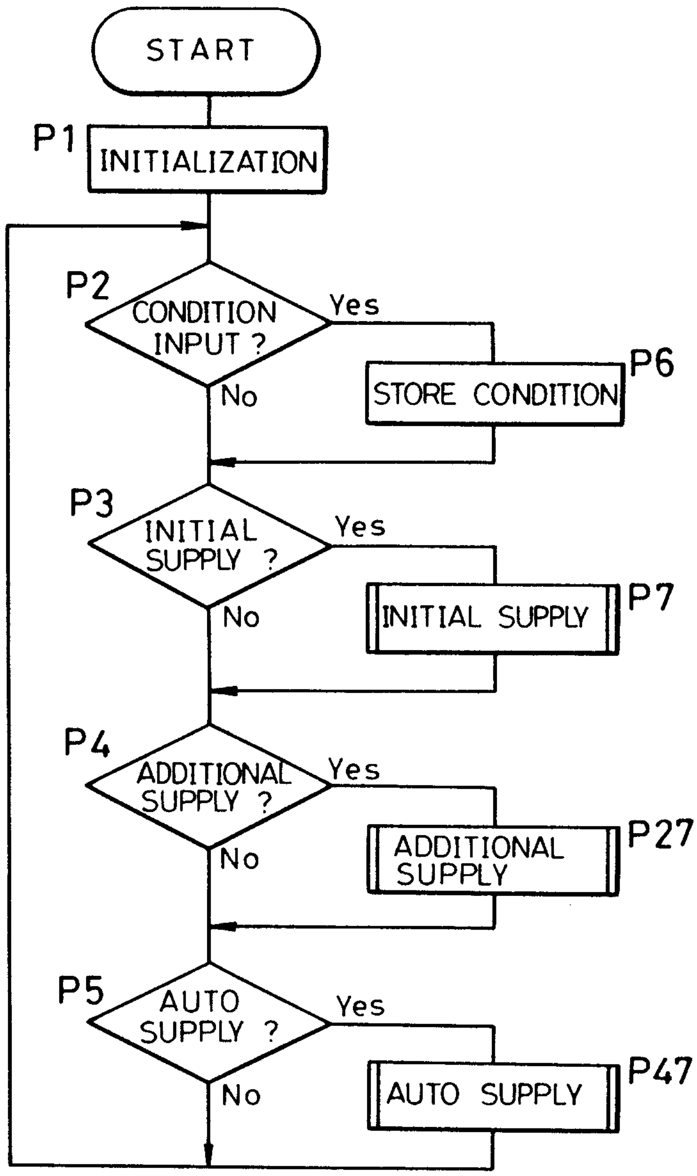
FIG. 14


INK ROLLING-UP
S7
CARRIAGE TRAVEL START (from "Home")
S8
END ?
No
Yes
S9
CARRIAGE TRAVEL START (to "Home")
S10
LIGHTING ?
Yes
No
INSTRUCT EXP. LAMP SWITCH-ON
S14
S11
START MEASUREMENT ?
Yes
No
INSTRUCT MEASUREMENT
S15
S12
DRIVE ROLLERS ?
Yes
No
S13
OTHER PROCESSES
S16
DRIVE ROLLERS
S17
INK ROLLING-UP END
No
Yes
RETURN

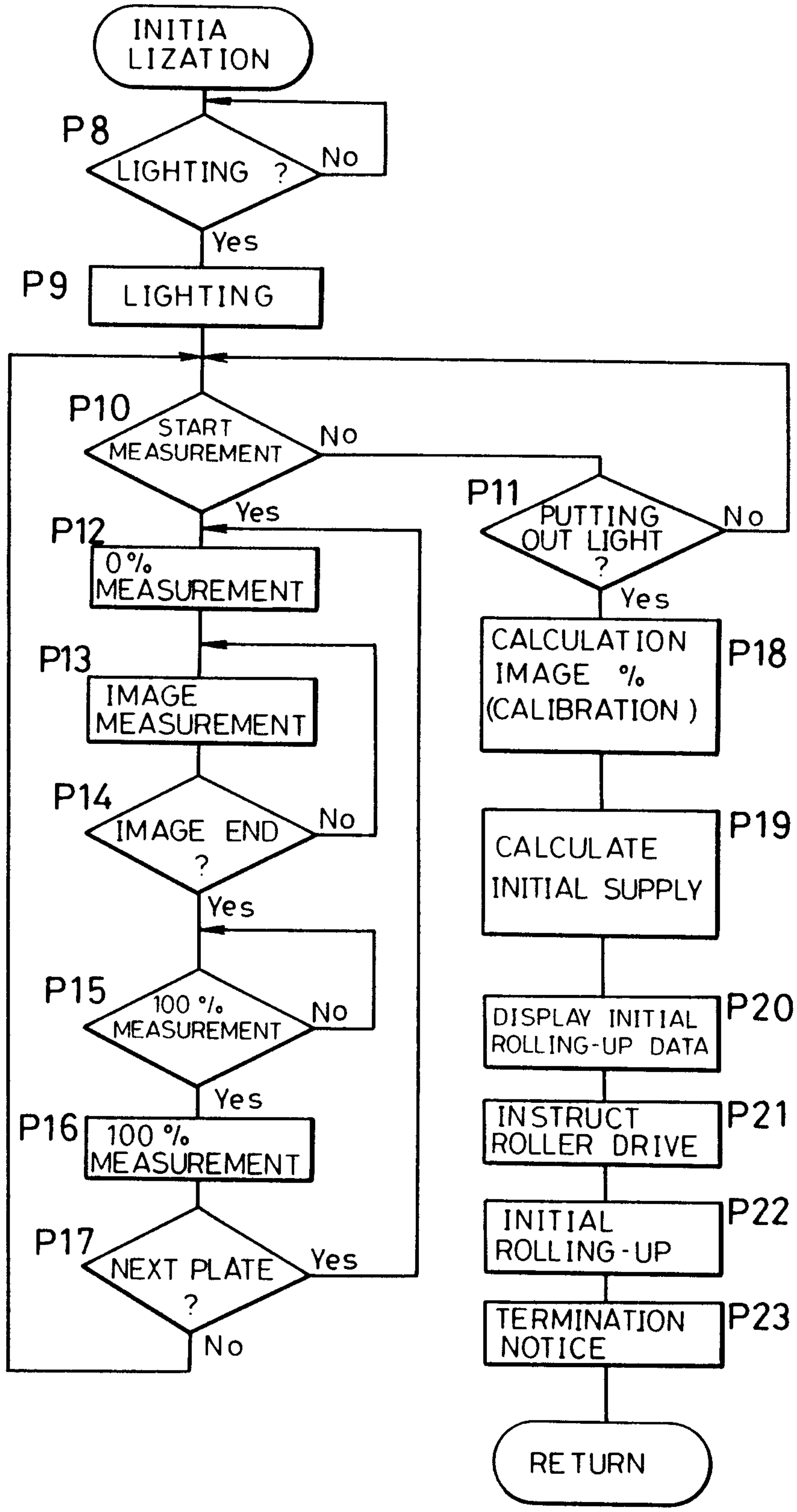
F I G. 15


PRINTING
S37
INSTRUCT AUTO SUPPLY
S38
START PRINTING OPERATION
S39
LIGHTING ?
Yes
No
S43
INSTRUCT EXP. LAMP SWITCH-ON
S40
START MEASUREMENT ?
Yes
No
S44
INSTRUCT MEASUREMENT
S41
PRINTING END ?
Yes
No
S42
OTHER PROCESSES
S45
DRIVE ROLLERS ?
No
Yes
S46
INK ROLLING-UP END
No
Yes
S47
DRIVE ROLLERS
RETURN

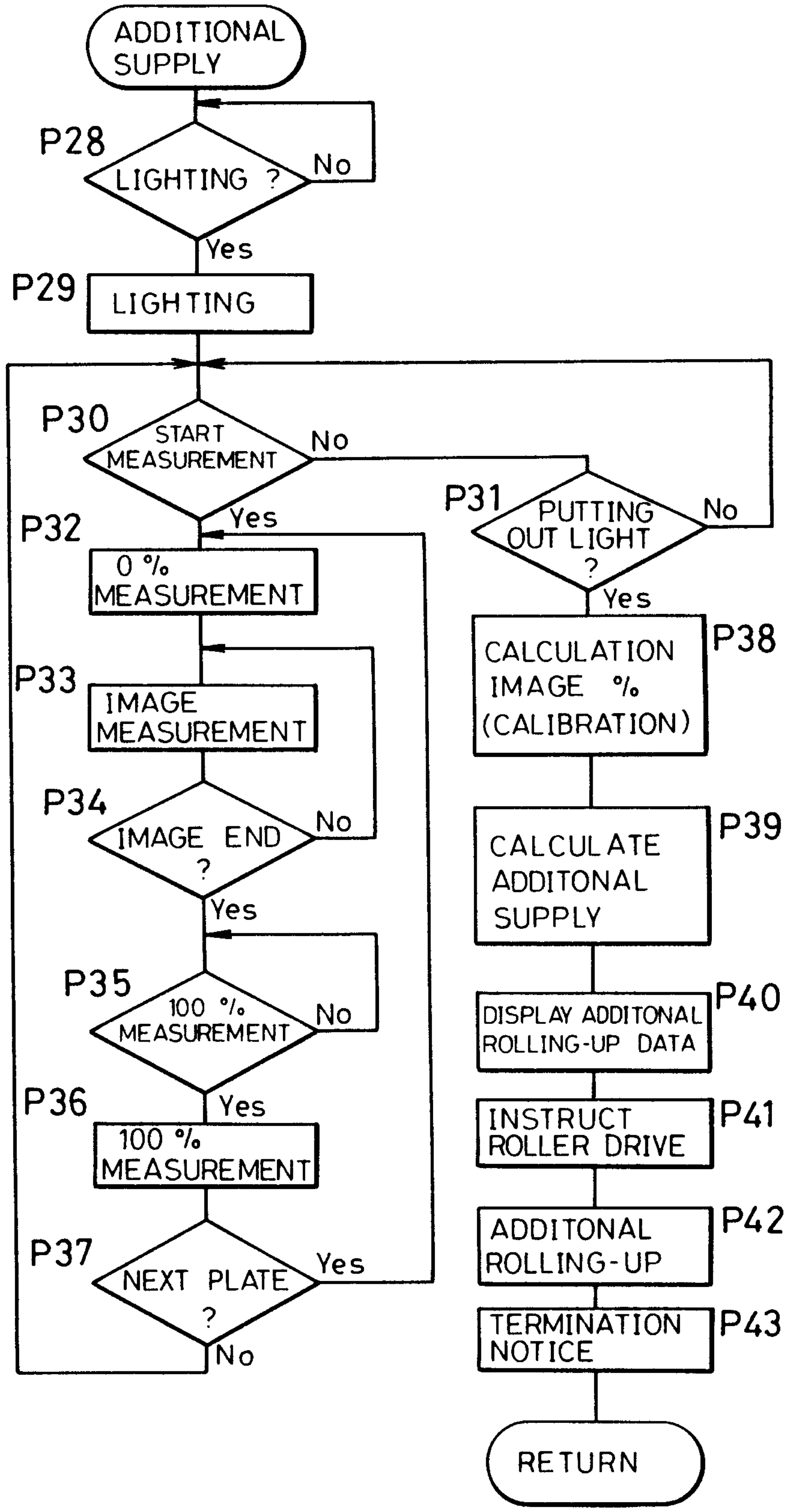
F I G. 16


START
P1
INITIALIZATION
P2
CONDITION INPUT ?
Yes
No
STORE CONDITION
P6
P3
INITIAL SUPPLY ?
Yes
No
INITIAL SUPPLY
P7
P4
ADDITIONAL SUPPLY ?
Yes
No
ADDITIONAL SUPPLY
P27
P5
AUTO SUPPLY ?
Yes
No
AUTO SUPPLY
P47

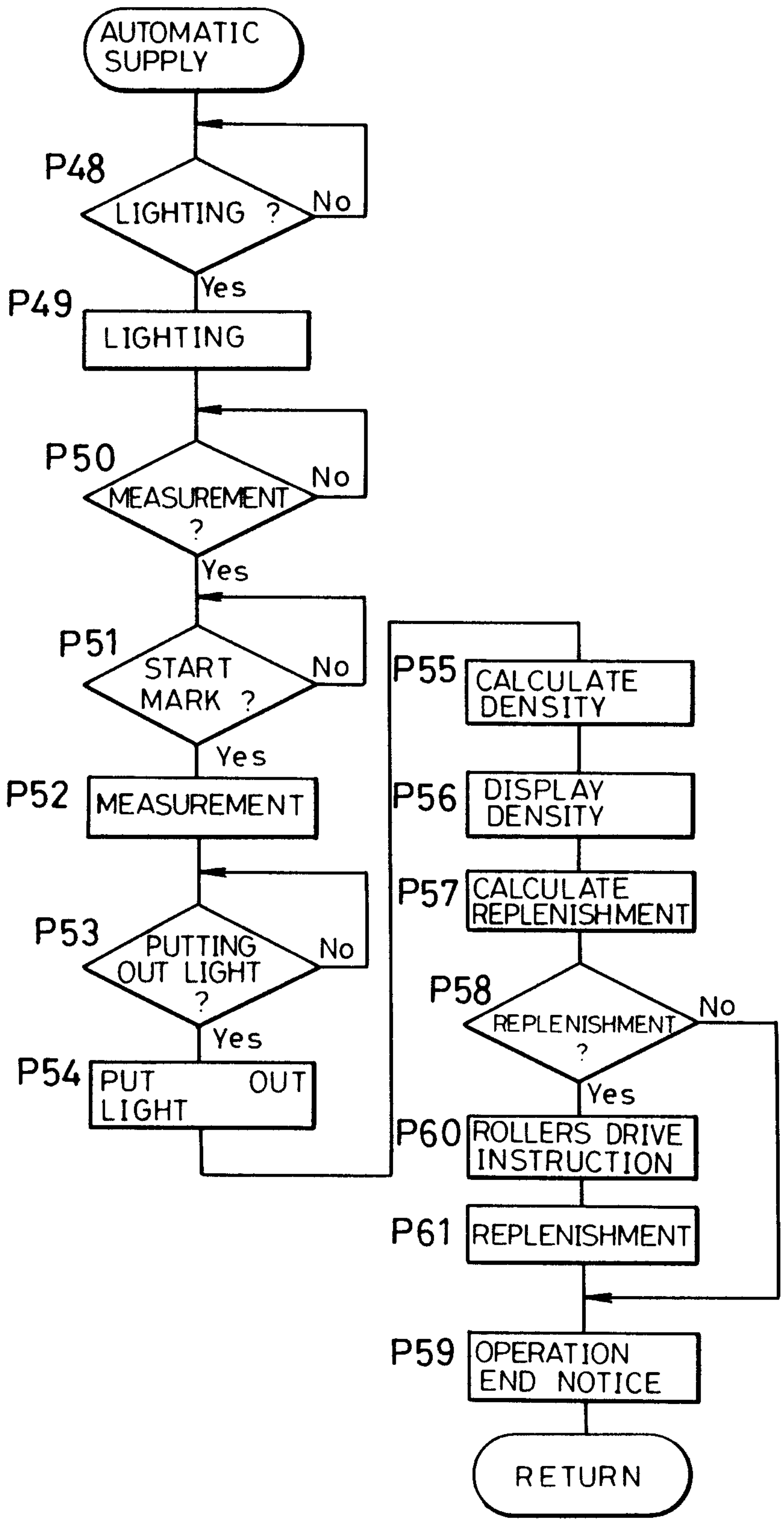
F I G. 17


INITIALIZATION
P8
LIGHTING ?
No
Yes
P9
LIGHTING
P10
START MEASUREMENT
No
Yes
P11
PUTTING OUT LIGHT ?
No
Yes
P12
0 % MEASUREMENT
P13
IMAGE MEASUREMENT
P14
IMAGE END ?
No
Yes
P15
100 % MEASUREMENT
No
Yes
P16
100 % MEASUREMENT
P17
NEXT PLATE ?
Yes
No
CALCULATION IMAGE % (CALIBRATION)
P18
CALCULATE INITIAL SUPPLY
P19
DISPLAY INITIAL ROLLING-UP DATA
P20
INSTRUCT ROLLER DRIVE
P21
INITIAL ROLLING-UP
P22
TERMINATION NOTICE
P23
RETURN

F I G. 18


ADDITIONAL SUPPLY
P28
LIGHTING ?
No
Yes
P29
LIGHTING
P30
START MEASUREMENT
No
Yes
P31
PUTTING OUT LIGHT ?
No
Yes
P32
0 % MEASUREMENT
P33
IMAGE MEASUREMENT
P34
IMAGE END ?
No
Yes
P35
100 % MEASUREMENT
No
Yes
P36
100 % MEASUREMENT
P37
NEXT PLATE ?
Yes
No
P38
CALCULATION IMAGE % (CALIBRATION)
P39
CALCULATE ADDITONAL SUPPLY
P40
DISPLAY ADDITONAL ROLLING-UP DATA
P41
INSTRUCT ROLLER DRIVE
P42
ADDITONAL ROLLING-UP
P43
TERMINATION NOTICE
RETURN

F I G. 19


AUTOMATIC SUPPLY
P48
LIGHTING ?
No
Yes
P49
LIGHTING
P50
MEASUREMENT ?
No
Yes
P51
START MARK ?
No
Yes
P52
MEASUREMENT
P53
PUTTING OUT LIGHT ?
No
Yes
P54
PUT OUT LIGHT
P55
CALCULATE DENSITY
P56
DISPLAY DENSITY
P57
CALCULATE REPLENISHMENT
P58
REPLENISHMENT ?
No
Yes
P60
ROLLERS DRIVE INSTRUCTION
P61
REPLENISHMENT
P59
OPERATION END NOTICE
RETURN

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 92 10 8840

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
D,Y	EP-A-0 295 606 (DAINIPPON SCREEN MFG. CO. LTD.) * the whole document *	1-4,6-10	B41F33/00 B41F31/02 B41F31/04
A		5,6	
Y	EP-A-0 095 606 (HEIDELBERGER DRUCKMASCHINEN AG) * the whole document *	1-4,6-10	
A		5,6	
Y	EP-A-0 357 986 (HEIDELBERGER DRUCKMASCHINEN AG) * column 4, line 46 - column 5, line 11; figure 5 *	4	
A		5	
Y	PATENT ABSTRACTS OF JAPAN vol. 15, no. 208 (M-1117)28 May 1991 & JP-A-3 057 650 (TOPPAN PRINTING CO. LTD.) 13 March 1991	7	
A	* abstract *		
A	GB-A-2 099 144 (STORAGE TECHNOLOGY CORPORATION) * the whole document *	5	TECHNICAL FIELDS SEARCHED (Int. Cl.5)
A	PATENT ABSTRACTS OF JAPAN vol. 14, no. 104 (P-1013)26 February 1990 & JP-A-1 307 875 (OMRON TATEISI ELECTRON CO.) 12 December 1989 * abstract *	7	B41F
A	PATENT ABSTRACTS OF JAPAN vol. 10, no. 70 (M-462)(2127) 19 March 1986 & JP-A-60 214 960 (TOPPAN INSATSU K. K.) 28 October 1985 * abstract *		

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	09 SEPTEMBER 1992	MADSEN P.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
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L : document cited for other reasons

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