(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 669 557 A2**

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **95107088.7**

(51) Int. Cl.^{6}: **G03G 15/00**, B42C 9/00

(22) Date of filing: **24.10.91**

This application was filed on 10 - 05 - 1995 as a divisional application to the application mentioned under INID code 60.

(30) Priority: **25.10.90 JP 289784/90**
06.11.90 JP 301272/90
29.10.90 JP 292772/90

(43) Date of publication of application:
30.08.95 Bulletin 95/35

(60) Publication number of the earlier application in accordance with Art.76 EPC: **0 482 644**

(84) Designated Contracting States:
DE FR GB IT

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(54) Image forming apparatus equipped with a binding function.

(57) An image forming apparatus is provided which has a binding unit (30) provided adjacent to an image forming means (8) located within the copy machine body (1). First and second instructing means (22, 53) are provided for issuing commands for operating the image forming means and the binding means respectively. Control means (60) are adapted to execute either the image forming operation or the binding operation on the basis of the command signals. When one operation is being executed, the control means (60) can prevent execution of the other operation.

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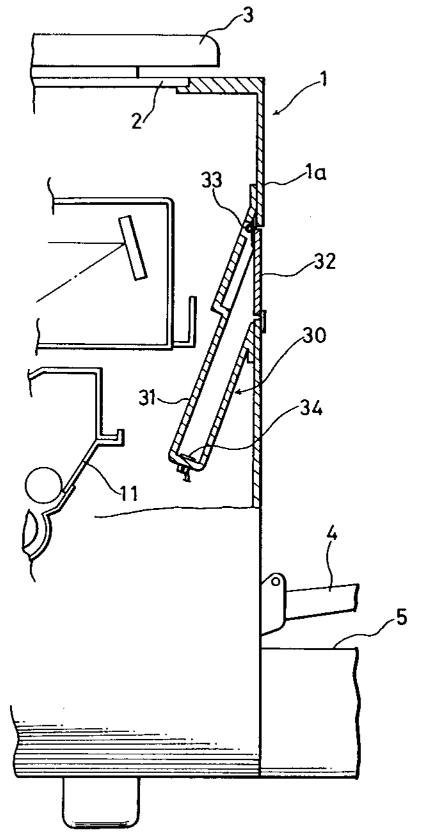
F I G. 1



The present invention relates generally to an image forming apparatus, and particularly to an image forming apparatus equipped with a binding function.

Japanese Utility Model Laying-Open No. 41261/1986 discloses a copying machine provided with a binding device adjacent to the heating rollers of its fixing unit. In this copying machine, discharged sheets of paper are bound by utilizing the heat generated from the fixing unit. However, the heat utilized during a binding operation in this machine is solely that of the fixing unit, and the consequently unstable and insufficient heating can result in unsatisfactorily bound sheets.

Japanese Utility Model Laying-Open No. 121456/1986 discloses another copying machine with a binding device incorporated in a sorter provided adjacent to the copying machine body. This copying machine has a binding operation heater, and addresses the above-mentioned problem.

In this copying machine, however, an operator cannot accurately observe the operating condition of the binding unit. That is, the operator is not readily apprised of complete information on the status of a binding operation, including its ending time. Furthermore, in this machine, since a copying operation cannot be carried out while a binding operation is underway, if the operator wants to start a copying operation he must await the finish of a binding operation by the binding unit. In addition, a binding operation is relatively long, and since the operator cannot know the binding end time, he must wait the duration, and perhaps must approach the copying machine several times awaiting the end of the binding operation. Such a conventional machine thus does not afford smooth switching from a binding operation to a copying operation.

The thermoplastic resin used as an adhesive in binding a plurality of sheets has the following disadvantage. The time required for the resin to melt and the time required for the melted resin to cool and to solidify are dependent upon binding conditions such as the ambient temperature. Conventional machines cannot take into account changes in binding conditions, therefore if changes should arise the binding quality deteriorates.

An object of the present invention is to enable accurate and rapid binding of sheets by an image forming apparatus equipped with a binding function, and to facilitate the observation of binding conditions by an operator.

Another object is to allow an image forming apparatus equipped with a binding function to carry out image forming and binding operations independently, in such a manner as not to consume excessive electric power at any time.

Still another object of the present invention is to enable an image forming apparatus equipped with a binding function to carry out copying and binding operations both efficiently and without an excessive consumption of power.

A further object is to enable an image forming apparatus equipped with a binding function to switch smoothly and rapidly from its binding operation to its copying operation.

A further object of the present invention is to ensure satisfactory binding of sheets by an image forming apparatus equipped with a binding function despite changes, such as ambient temperature fluctuations in binding conditions.

(1) An image forming apparatus according to an aspect of the present invention includes an image forming unit for forming an image onto a sheet, a binding unit adjacent to the image forming unit, and an indicator for indicating operating conditions of the image forming unit and the binding unit.

In this apparatus, the indicator indicates not only the operating conditions of the image forming unit but also those of the binding unit, whereby an operator may easily observe the binding conditions. Consequently, the operator may more efficiently operate the apparatus.

(2) An image forming apparatus according to another aspect of the present invention includes an image forming unit for forming an image onto a sheet, a binding unit adjacent to the image forming unit, a timer for measuring the binding operation time of the binding unit, and an associated monitor which functions as a timer display.

In this apparatus, the binding operation time of the binding unit is measured by the timer, and the result is displayed on the monitor. As a result, the operator is able to efficiently operate the apparatus through observation of the binding processes by reference to the monitor.

(3) According to a further aspect of the present invention, an image forming apparatus includes an image forming unit for forming an image onto a sheet, a binding unit adjacent to the image forming unit, and an indicator. Heating and cooling of material to be bound take place. The indicator so indicates that the binding unit is in the cooling stage.

In this apparatus, when the binding unit is cooling the material being bound, the indicator indicates this fact, so that the operator is informed that the cooling operation has begun in the binding unit subsequent to the heating stage. This affords more efficient operation of the apparatus by the operator.

(4) An image forming apparatus according to still another aspect includes an image forming unit for forming an image onto a sheet, a binding unit adjacent to the image forming unit, a

first instructing unit for commanding the operation of the image forming unit, a second instructing unit for commanding operation of the binding unit, and a control unit which prevents either one of the first or the second instructing units from executing commands during the operation of the other in response to the command under executions.

The control unit function to inhibit either the image forming operation or the binding operation while the other operation is performed. Consequently, excessive consumption of electric power which would occur if the two operations are simultaneously performed is prevented.

(5) In another aspect of the present invention an image forming apparatus includes an image forming unit for forming an image onto a sheet, a binding unit adjacent to the image forming unit, and a control unit. The binding unit heats material to be bound and allows it to cool. The control unit forbids image forming operation in the image forming unit during the heating stage of the heating unit, and permits image forming operation after the heating stage is complete.

In this apparatus, the control unit affords the prevention of an excessive consumption of electric power which would otherwise result if the heating stage were to occur simultaneously with the image forming operation. When the heating stage in the binding unit is complete, the control unit permits the image forming unit to execute its image forming operation. The image forming operation can thus be carried out during the cooling stage in the binding unit. Hence, copying and binding operations are performed with efficiency.

(6) An image forming apparatus according to a further aspect includes an image forming unit for forming an image onto a sheet, a binding unit adjacent to the image forming unit, a first control unit, a second control unit, and a memory.

The binding unit heats and cools material to be bound. The first control unit forbids image forming operation in the image forming unit at minimum for the duration of the heating stage of the binding unit. The memory accepts and stores an image forming operation instruction from an operator meanwhile the first control unit forestalls its execution. If the memory has stored an image forming operation instruction, the second control unit starts the operation of the image forming unit after the first control unit allows the operation. In consequence, switching occurs smoothly and sequentially from the binding operation to the image forming operation, and the operator is not required to await the end of the binding operation.

(7) According to the invention in still another aspect an image forming apparatus includes an image forming unit for forming an image onto a sheet, a binding unit adjacent to the image forming unit, an instructing unit for commanding the start of a binding operation, a memory for storing an instruction issued from the instructing unit during an image forming operation of the image forming unit, and a start unit for beginning the operation of the binding unit. The start unit begins the operation of the binding unit after the end of an image forming operation if the memory has stored an instruction to do so.

In this apparatus, if a binding operation start is commanded by the instructing unit while an image forming operation is underway, the instruction is stored in the memory. At the end of the image forming operation the starting unit then begins the operation of the binding unit by the instruction stored in the memory. Thus, a binding operation start instruction can be accepted even if an image forming operation is being carried out in the image forming unit, and the binding operation will be automatically started at the end of the image forming operation. As a result, switching from an image forming operation to a binding operation takes palace sequentially and smoothly, and the operator is not required to await the end of the image forming operation.

(8) An image forming apparatus in one further aspect of the present invention includes an image forming unit for forming an image onto a sheet, a binding unit adjacent to the image forming unit, a temperature monitoring unit for measuring a reference temperature for the binding unit, and a time setter which adjusts the operation time of the binding unit based upon the measurement of the temperature monitoring.

A given time period for which the binding unit will operate relative to the ambient temperature is set in this apparatus. The time setter adjusts the operation time calculated according to a reference temperature provided by the temperature monitoring unit, thus effecting good quality binding, despite changes in ambient temperature.

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

Fig. 1 is a partly in sectional view of an image forming apparatus according to an embodiment of the present invention;

Fig. 2 is a perspective view of the apparatus;

Fig. 3 is a schematic sectional view of the apparatus;

Fig. 4 is a schematic block diagram of a control unit of the apparatus;

Fig. 5 is a circuit diagram of a binding unit of the apparatus;

Fig. 6 is a partial perspective view of an operation panel of the apparatus;

Figs. 7A to 7F are control process flow charts;

Figs. 8 and 9 are perspective views of a binding cover;

Figs. 10, 11 and 12 are partly in sectional views showing the binding unit during operation;

Figs. 13A to 13C are control process flow charts according to another embodiment of the invention;

Figs. 14A and 14B are control process flow charts according to still another embodiment of the invention;

Fig. 15 is a control circuit diagram of an apparatus according to a further embodiment of the invention;

Fig. 16 is a control process flow chart according to the embodiment of Fig. 15;

Fig. 17 is a timing graph according to the embodiment of Fig. 15;

Fig. 18 is a block diagram of a control circuit of an apparatus according to a further embodiment of the invention;

Fig. 19 is a control process flow chart according to the embodiment of Fig. 18;

Fig. 20 is a schematic diagram of a control circuit of an apparatus according to yet another embodiment of the invention;

Fig. 21 is a control process flow chart according to the embodiment of Fig. 18;

Fig. 22 is a table displaying examples of power supply time in the embodiment of Fig. 18;

Fig. 23 is a schematic diagram of a control circuit of an apparatus according to a still further embodiment of the invention; and

Fig. 24 is a control process flow chart according to the embodiment of Fig. 23.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

I. First Embodiment

Figs. 2 and 3 show a copying machine according to the first embodiment of the invention.

Referring to these figures, a copying machine body 1 has an original support 2 in its upper surface with an original cover 3 disposed openably on the original support 2. On the right of the body 1 in the figures, a feed tray 4 and a feed cassette 5 are detachably mounted. On the left of the body 1, a copy tray 6 is disposed into which copy-processed sheets are discharged.

An optical exposure system 7 for scanning an original is provided in an upper portion of the interior of the copying machine body 1. This optical exposure system 7 includes a light source and mirrors. An image forming unit 8 is provided in a central portion of the copying machine body 1. A photoconductive drum 9 onto which an electrostatic latent image of the original is formed is disposed in the middle of the image forming unit 8. A main charger 10, a developing unit 11, a transfer charger 12, a separation charger 13, a cleaning unit 14 and other associated elements are disposed around the photoconductive drum 9. A sheet transporting path 15 including a plurality of transport rollers extends from the feed tray 4 and feed cassette 5 to the image forming unit 8. A sheet discharging system 16 and a fixing unit 17 are provided between the image forming unit 8 and the copy tray 6. A thermistor 19 for monitoring temperature within the machine is provided on an upper surface of the developing unit 11. The main charger 10, the optical exposure system 7, the developing unit 11, etc. are subject to control based upon the measured temperature.

A binding unit 30 is provided in a right upper portion of the body 1, adjacent to the image forming unit 8. Referring to Fig. 1, the binding unit 30 includes a container 31 having an upper open end in a side wall 1a of the body 1 and extending obliquely downward from the side wall 1a. The opening of the container is shut by a cover 32. The cover 32 is openable on a hinge 33 along its upper edge. A pair of electrodes 34 for supplying electric current to a binder cover (described afterwards) are provided on the inner bottom surface of the container 31.

A control circuit 35 as shown in Fig. 5 governs the binding unit 30. Referring to Fig. 5, a +24V power supply is connected to one of the two electrodes 34. An oscillating circuit 41 is connected between the +24V power supply and the electrode 34 through a capacitor 40. A storage capacitor 42 for storing electric charge is also connected therebetween. A power transistor 43 is provided, the collector of which is connected to the second of the two electrodes 34.

The emitter of the power transistor 43 is connected to the collectors of a pair of power transistors 48a and 48b provided in parallel. The emitters of the power transistors 48a and 48b are grounded through resistors 49a and 49b, respectively. The resistors 49a and 49b are of different resistance values; for example, the resistance value of the resistor 49a may be one tenth that of the resistor 49b. The bases of the power transistors 48a and 48b are connected to a high-speed heating terminal 50a and a low-speed heating terminal 50b, respectively.

The base of the power transistor 43 is connected with the output terminal of a comparator 45. The non-inverting terminal of the comparator 45 is connected to a remote terminal 46. The inverting terminal of the comparator 45 is connected with the emitter of the power transistor 43 through a resistor 45a.

A malfunction detection circuit 47 and a start detection circuit 48 are provided between the power transistor 43 and the second of the two electrodes 34. The malfunction detection circuit 47 comprises a pair of comparators 49 and 50, and generates a high level output at an "NG" terminal 51 only when the collector voltage of the power transistor 43 is within a prescribed normal range. This normal range is defined by the values of voltages which are applied to the input terminals of the comparators 49 and 50. The voltage values are determined by voltage-dividing resistors 47a, 47b and 47c. The malfunction detection circuit 47 generates a low level output upon detection of malfunction in the binding operation such as an abnormal resistance of the electric heater of the binder cover (described afterwards), or a defective contact made with the electrodes 34. The start detection circuit 48 includes a comparator 52, and generates a high level output at a start terminal 53 upon detection of an increase in the collector voltage of the power transistor 43.

As shown in Fig. 2, an operation panel 20 is provided on the right front corner of the upper surface of the copying machine body 1. The operation panel 20 includes a liquid crystal display (LCD) 21 for displaying with alphanumeric characters operation conditions including copy number and operation time. The liquid crystal display 21 may be substituted by 7-segment LEDs.

The operation panel 20 further includes a print key 22 for instructing a copy start, a ten-key board 23 for designating the number of copies, a heating-state lamp 24 for indicating a heating state of the binding unit 30, and a cooling-state lamp 25 for indicating a cooling state thereof. The print key 22 contains an LED which is illuminated when the copying operation is enabled. Each of the lamps 24 and 25 contains a blue LED element and a red LED element.

The operation panel 20 further includes an image density selector 26. As shown in Fig. 6, the image density selector 26 includes a window 26a having a border provided with a numerical index, a lever 26b slidable in the window 26a, and an end plate 26c on one end of the window 26a. The lever 26b and the end plate 26c are disposed in parallel. As shown in Fig. 4, a movable terminal 28a of a variable resistor 28 is fixed to the lever 26b.

The copying machine has a control unit 60 as shown in Fig. 4. The control unit 60 includes a microcomputer consisting of a CPU 61, a ROM 62, a RAM 63 and other related devices. The control unit 60 has an I/O port 64 connected with the image forming unit 8, the liquid crystal display 21, the print key 22, the ten-key board 23, a copy number setting key 27, the heating-state lamp 24 and the cooling-state lamp 25. Further connected with the I/O port 64 are the thermistor 19 for monitoring temperature, the remote terminal 46, the high-speed heating terminal 50a, the low-speed heating terminal 50b, the NG terminal 51 and the start terminal 53 of the control circuit 35 of the binding unit 30, and a buzzer 26 which is activated in response to the detection of a malfunction. The movable terminal 28a of the variable resistor 28 is also connected with the I/O port 64 through an A/D converter 29. One end of the variable resistor 28 is connected to a +V power supply and the other end is grounded.

The ROM 62 includes a table TT into which data are written for the calculation of heating and cooling times in the binding unit 30 based on the temperature within the machine and on the thickness of material to be bound (or the number of sheets). The data written into this table TT are those obtained by advance experiment. According to the data, the thicker the material to be bound is, the longer the time required for binding is; and consequently both the heating time and the cooling time increase. Conversely, the thinner the material to be bound is, the shorter are the heating time and the cooling time. When the temperature within the copy machine rises, the heating time must decrease and the cooling time increase, since the adhesive material in the binder cover melts more easily. Conversely, if the temperature within the machine is low, the heating time is longer and the cooling time is reduced.

A binder 70 shown in Fig. 8 is used in the binding operation of this embodiment. The binder 70 includes an electric heater 72 and an adhesive layer 73 along the inner surface of its spine 71. The adhesive layer 73 consists, for example, of thermoplastic resin. Electrodes 74 of a pair are provided on either end of the electric heater 72. The electrodes 74 are exposed on the outer surface (lower surface in the figure) of the spine 71.

The operation of this embodiment will hereinafter be described with reference to the control process flow charts in Figs. 7A to 7F.

When the program starts, initialization is carried out, in which, for example, the fixing unit 17 is heated to a prescribed temperature During initialization, the various flags are set to their OFF state.

After the initialization, an interrupt process is started with a timer which is up in 1 to 2msec. Referring to Fig. 7A showing the timer interrupt process, at step S1 it is determined with reference to a scanning table which process branch is to be selected. Among the scanning table branches which may be selected in the determination at step

S1, branch B1 is a process following from key input. Branch B2 is a copying process. Branch B3 is a process which ensues at the start of a binding operation. Branch B4 is a process which follows from the end of the heating stage of a binding operation. Branch B5 is a process which follows from the end of the cooling stage of a binding operation. Branches B6, etc. are conventional processes and need not be described here.

Key Input Process

In the key input process of branch B1, the control program of Fig. 7B is executed. Referring to Fig. 7B, it is determined at step S2 whether a copying start instruction has been issued through the print key 22. If an instruction has not been issued, the program proceeds to step S3, at which it is determined whether an instruction setting a given number of copies has been issued through the ten-key board 23. If not, the program proceeds to step S4, at which miscellaneous key-input processes may be executed. The program then returns to the process shown in Fig. 7A.

If a number has been entered at the ten-key board 23 is pressed to set the copy quantity, the program proceeds from step S3 to step S5, at which the numerical value of the input is stored as the number of copies. At step S6, the copy number is displayed on the liquid crystal display 21. The program then returns to the main routine.

If the print key 22 has been pressed, the program proceeds from step S2 to step S7. At step S7, a print flag is set to its ON state. Then, the program returns to the main routine.

Copying Process

The procedure for the copying process of branch B2 is shown in Fig. 7C.

Referring to Fig. 7C, it is determined at step S8 whether the print flag is in its ON state or not. If the print key 22 at step S2 (in Fig. 7B) has not been pressed, the print flag will be in the OFF state and the remaining processes of branch B2 will not be carried out. If the print flag is in the ON state, however, the program proceeds to step S9. At step S9, it is determined whether a copying operation as described below is in progress. If a copying operation is underway, the remaining processes of branch B2 are not carried out.

If a copying operation has not begun, the program proceeds to step S10. At step S10, it is determined whether the displayed or remaining copy number is "0" or not. If it is not "0", the sum of the copying operations performed has not reached the given number of sheets, and the program proceeds to step S11. At step S11, "1" is subtracted from the copy number shown by the liquid crystal display 21 and the calculated value is displayed therein. At step S12, the copying operation starts. The program then returns to the process shown in Fig. 7A.

If at step S12 a copying start instruction has been issued, an original on the original retainer 2 is scanned by the optical scanning system 7, and the image information obtained by the scanning is supplied to the image forming unit 8, wherein the image is transferred onto a sheet transported from the feed tray 4 or feed cassette 5. The density of this image has been determined according to the density setting of the image density selector 26. The transferred image is fixed onto the sheet by the fixing unit 17 and then the sheet is discharged into the copy tray 6. During the copying operation, the determination at step S9 is always "Yes".

After one sequence of copy operation, the program proceeds from step S9 to step S10. If the set number of copying operations has not been attained, the program proceeds from step S11 to step S12, restarting the copying operation. If the determination at step S10 is "Yes", the program proceeds to step S13. At step S13, the print flag is set to its OFF state, whereby the determination at step S8 in Fig. 7C is "No" and the copying operation is no longer repeated. After the operation of step S13, the program returns to the control process shown in Fig. 7A.

Binding Start Process

In order to start binding using the binding unit 30, sheets 75 are placed in the binder 70 and it is folded, as shown in Figs. 8 and 9, so that one side of the stack of sheets 75 is in contact with the adhesive layer 73 along the spine 71. Then, the binder 70 is loaded into the container 31, pressing against the cover 32 as shown in Fig. 10. As the binder 70 reaches the bottom of the container 31 as shown in Figs. 11 and 12, the pair of electrodes 34 come into electrical contact with the electric heater 72 of the binder 70 through the electrodes 74.

When the electrodes 34 are in contact with the electrodes 74, the potential at the non-inverting terminal of the comparator 52 of the start detection circuit 48 in Fig. 5 increases, and a high level signal is generated at the start terminal 53. The high level signal is detected by the control unit 60 (Fig. 4), and as a result the determination at step S14 in Fig.7D is "Yes".

Fig. 7D shows the specific control procedure of branch B3 in Fig. 7A. At step S14, it is determined by reference to the potential at the start terminal 53 whether a binding start instruction has been. If the instruction has not been issued, the remainder of the procedure in Fig. 7D is not executed. If the determination at step S14 is "Yes", the program proceeds to step S15. At step S15, it is determined whether a binding flag is set to the ON state. When the binding flag is in the OFF state, the program proceeds to step S16. At step S16, it is determined whether an error flag is set to the ON state. When the error flag is in the OFF state, the program proceeds to step S17.

At step S17, the binding flag is set to the ON state. Then, at step S18, the temperature in the machine is calculated based on a signal from the thermistor 19.

At step S19, it is determined whether the set number of copies has been designated through the copy number setting key 27 (shown in Fig. 2) as the number of sheets to be bound. If the key 27 has not been pressed, the program proceeds to step S20. At step S20, it is determined whether the number of sheets to be bound is newly entered. This determination is executed by determining whether or not the ten-key board 23 (in Fig. 2) has been pressed. If not, the program proceeds to step S21. At step S21, it is determined whether the thickness of the folded binder 70 should be used as a reference for determining the binding operation time. This determination depends on whether the resistance value of the variable resistor 28 has changed in response to handling of the lever 26b of the image density selector 26. Thus, the image density selector 26 is used also as a thickness measuring means. If the image density selector 26 has not been operated, the program returns to step S19. Thus, the program pauses until the determination at any of the steps S19 to S21 becomes "Yes".

In order to designate the number of copies as the number of sheets to be bound, the copy number setting key 27 is pressed. As a result, the program proceeds from step S19 to step S22. At step S22, the stored number of copies is in turn stored as the number of sheets to be bound. Then, the program proceeds to step S25.

In order to designate a changed number of sheets to be bound, the new number is entered at the ten-key board 23. In this case, the program proceeds from step S20 to step S23. At step S23, the value entered through the ten-key board 23 is stored as the number of sheets to be bound. Then, the program proceeds to step S25.

In order to measure the actual thickness of material to be bound, an operator pinches the folded binder 70 containing the sheets 75 between the lever 26b of the image density selector 26 and the holder plate 26c (Fig. 6). As a result, the movable terminal 28a of the variable resistor 28 shown in Fig. 4 is moved to a position relative to the thickness of the binder 70. Consequently, a voltage value relative to the thickness of the folded binder 70 is input to the control unit 60 through the A/D converter 29. At step S24, the number of sheets to be bound (i.e. the material thickness) is calculated based on the input voltage value. Then, the program proceeds to step S25.

At step S25, temperature, heating time, and cooling time values adequate to the thickness of the material to be bound are read from the table TT of the ROM 62 with reference to the temperature measured at step S18 and the stored number of sheets to be bound (material thickness).

At step S26, a timer starts, and at step S27, the liquid crystal display 21 begins to indicate the time remaining for the binding operation. The remaining time is a result decreased successively from the sum of the heating time and cooling time read from the table TT, whereby the operator easily can know how long it will take to complete a binding operation.

At step S28, the heating-state lamp 24 is illuminated in blue, whereby the operator is apprised that the binding unit 30 is in the heating state.

At step S29, both the remote terminal 46 and the low-speed heating terminal 50b receive high signals, while the high-speed heating terminal 50a receives a low signal. Consequently, the power transistor 43 and the power transistor 48b of the binding unit 30 are switched on, and electric current flows through the resistor 49b. Since the resistor 49b is of high resistance, a relatively small amount of current flows between the electrodes 34. Consequently, the electric heater 72 of the binder 70 heats gradually, and the adhesive material 73 is melted gradually. After the operation at step S29, the program returns to the control procedure of Fig. 7A.

Heating End Process

At the end of the heating stage in the binding unit 30, the process of branch B4 in the scanning table is performed.

Referring to Fig. 7E, which shows the specific procedure of branch B4, it is determined at step S30 whether the binding flag is in the ON state. If the binding flag is in the OFF state, meaning that a binding operation has not started, the remainder of the procedure in Fig. 7E is not carried out.

If the determination at step S30 is "Yes", the program proceeds to step S31. At step S31, it is determined whether the print flag is in the ON state. The ON state of the print flag indicates that a copying operation is being performed. Accordingly, if the print flag is in the ON state, the program proceeds from step S31 to step S32. At step S32, the low-speed heating terminal 50b shown in Fig. 5 receives a high signal, and the high-speed heating terminal 50a receives a low signal. Consequently, electric current flows through the high-resistance resistor 49b, whereby the electric heater 72 of the binder 70 heats gradually at a low rate of power consumption.

If it is determined at step S31 that the print flag is in the OFF state, i.e., that a copying operation is not underway, the program proceeds to step S33. In this case, no power is being consumed by a copying operation, and accordingly higher power can be used in order to perform binding operation at high speed. Accordingly, at step S33, the low-speed heating terminal 50b receives a low signal, and the high-speed heating terminal 50a receives a high signal. Consequently, electric current flows through the resistor 49a having a low resistance value, and a large current flows between the electrodes 34. As a result, the electric heater 72 of the binder 70 heats intensely and the adhesive material 73 melts rapidly.

The electric power supplied to the electric heater 72 during both high-speed and low-speed heating is regulated by a feedback circuit (comprising the resistor 45a) to the comparator 45.

After the operation at either step S32 or S33, the program proceeds to step S34. At step S34, the total quantity of heat supplied to the adhesive material 73 by the electric heater 72 of the binder 70 is calculated. The quantity of heat is calculated based on the high-speed and the low-speed heating times. Then, at step S35, it is determined whether sufficient heat has been supplied to the adhesive material 73 of the binder 70. If it is determined that the supplied heat is insufficient, heating by the binding unit 30 must continue, and the program proceeds from step S35 to S36.

At step S36, it is determined whether there are any malfunctions in the binding unit 30. If there is any indication of a malfunction, such as an abnormal resistance value of the electric heater 72 or a defective contact between the binder 70 and the electrodes 34, it is detected by the malfunction detecting circuit 47. Therein, if the potential at the collector of the power transistor 43 goes outside the normal range as defined by the pair of comparators 49 and 50, the output from the NG terminal 51 drops. The change in the output from the NG terminal 51 is detected at step S36. When a malfunction is thus detected, the program proceeds to step S37. At step S37, the remote terminal 46 generates a low output, thereby cutting off the electric current to the binder 70. At step S38, "ERROR" is represented on the liquid crystal display 21. At step S39, an error flag is set to an ON state, after which the program returns to the procedure of Fig. 7A. If the error flag is in the ON state, the determination at step S16 in Fig. 7D is "Yes" and the heating process does not restart.

If it is determined at step S35 that the heating process has terminated, the program proceeds to step S40. At step S40, a heating end flag is set to an ON state. At step S41, the remote terminal 46 receives a low output, thereby cutting of the electric current to the binding unit 30. At step S42, the heating-state lamp 24 switches off, after which the program returns to the procedure of Fig. 7A.

Cooling End Process

When the heating process starts at step S29 of Fig. 7D and subsequently terminates at step S41 of Fig. 7E, a cooling process then begins in the binding unit 30.

The cooling process is terminated through the operations of branch B5 of Fig. 7A. Referring to Fig. 7F, which shows the specific procedure of branch B5, it is determined at step S43 whether the heating process in the binding unit 30 has terminated. This determination depends on whether or not the heating end flag (at step S40 in Fig. 7E) is in the ON state. The determination at step S43 is "No" until the heating process terminates, and the remainder of the procedure of Fig. 7F meanwhile is not executed.

If the determination at step S43 is "Yes", the program proceeds to step S44. At step S44, the cooling-state lamp 25 is illuminated to indicate the cooling state. Then, at step S45, it is determined whether a predetermined cooling time has elapsed or not. If not, the determination at step S45 is "No", and the program returns to the procedure of Fig. 7A.

If the determination at step S45 is "Yes", the program proceeds to step S46. At step S46, the binding flag and the heating end flag are set to the OFF state. At step S47, the indication on the liquid crystal display 21 of the time elapsed since the start of the binding operation ceases, and the cooling-state lamp 25 is switched off. At step S48, the copy number is displayed in place of the time indication on the liquid crystal display 21. After the operation at step S48, the program returns to the procedure of Fig. 7A.

As described above, two resistors 49a and 49b having different resistance values are utilized in this embodiment in order to control the binding unit 30 so as to heat material to be bound at a low rate when copying operation and binding operation are simultaneously performed, and to heat the object at a high rate when only the binding operation is performed. Consequently, excessive power consumption does not occur even when the copying and binding operations are performed simultaneously.

In addition, the end of the heating stage and the end of the cooling stage at steps S43 and S45 respectively are determined based upon the appropriate heating and cooling times defined at step S25 relative to the ambient temperature and the thickness of the material to be bound. Consequently, accurate binding operations are performed in accordance with changes in ambient temperature and material thickness.

II. Second Embodiment

The control process of Figs. 7A to 7F may be replaced by the control process of Figs. 13A to 13C.

Referring to the program illustrated in Figs. 13A to 13C of the control process in this embodiment starts with an initialization performed at step S101 by setting, for example, the fixing unit 17 to a prescribed temperature, and a print flag which serves as a reference for storing a copying request to an OFF state. When the copying operation is enabled, the LED of the print key 22 is illuminated.

After the initialization, it is determined at step S102 whether a copying start instruction has been issued through the print key 22. If the instruction has not been issued, the program proceeds to step S103 to determine whether or not the print flag is in the ON state. If the print flag is in the OFF state, the program proceeds to step S104 at which it is determined based on a signal from the start terminal 53 whether the binding mode is to be started or not. If the binding mode is not to be started, the program proceeds to step S105. At step S105, it is determined whether a copy number setting instruction has been issued through the ten-key board 23. If not, the program proceeds to step S106. At step S106, it is determined whether the cooling stage of the binding unit 30 (to be described afterwards) has finished. If the determination is "No", miscellaneous processes are performed at step S107, and then the program returns to step S102.

If the number of copies has been set through the ten-key board 23, the program proceeds from step S105 to step S108, at which the input numerical value is stored as the number of copies. At step S109, the number is displayed on the liquid crystal display 21. Then, the program returns to its main routine.

Before the operation of the binding unit 30, the sheets 75 are placed into the binder 70 and it is folded, as shown in Figs. 8 and 9, so that one side of the stack of sheets 75 is in contact with the adhesive layer 73 along the spine 71. Then, the binder 70 is loaded into the container 31, pressing against the cover 32 as shown in Fig. 10. When the binder 70 reaches the bottom of the container 31 as shown in Figs. 11 and 12, the pair of electrodes 34 come into electrical contact with the electric heater 72 of the binder 70 through the electrodes 74.

When the electrodes 34 are in electrical contact with the electrodes 74, the potential at the non-inverting terminal of the comparator 52 of the start detection circuit 48 increases, and a high signal is generated at the start terminal 53. As a result, the program proceeds from step S104 to step S110 of Fig. 13A to enter a binding mode subroutine whereby the binding mode is executed.

In the binding mode subroutine shown in Fig. 13B, the print flag is set to the OFF state at step S111. At step S112, a timer starts which serves as a reference for the measurement of the binding operation time. At step S113, the heating-state lamp 24 is illuminated in blue. At step S115, the print key 22 switches off to indicate that a copying operation is forbidden. Consequently, the operator finds that a heating operation has begun in the binding unit 30 and that a copying operation is not permitted.

At step S116, the remote terminal 46 receives a high output. As a result, the power transistor 43 of the binding unit 30 switches on, and electric current flows between the pair of electrodes 34. The electric heater 72 of the binder 70 heats, melting the adhesive material 73. In consequence, the side of the stack of sheets 75 is adhered to the binder cover 70 by the adhesive material 73.

The electric power supplied to the electric heater 72 is regulated by a feedback circuit to the comparator 46 which comprises the resistor 45a. The malfunction detecting circuit 47 detects the presence of any malfunction, such as an abnormal resistance value of the electric heater or a defective contact between the binder 70 and the electrodes 34 that might occurs. Specifically, when the potential at the collector of the power transistor 43 goes outside the normal range as defined by the pair of comparators 49 and 50, the output from the NG terminal 51 drops. The change in output at the NG terminal 51 is detected at step S117 of Fig. 13B. When a malfunction is thus detected, the program proceeds from step S117 to step S118. At step S118, the remote terminal 46 generates a low output, thereby cutting off the supply of electric current to the binding unit 30. At step S119, "ERROR" is represented on the liquid crystal display 21. At step S120, both the heating-state lamp 24 and the cooling-state lamp 25 are illuminated in red. At step S121, a buzzer 26 is activated. By the operations of steps S119 to S121, the operator is readily and reliably alerted to any trouble with the binding unit 30. After the execution of step S121, the program proceeds to step S122 (to be described afterwards).

If no malfunction is detected at step S117, the program proceeds to step S123. At step S123, it is determined whether the print key 22 has been pressed by the operator. If not, the program proceeds to step S124. If it is determined at step S123 that the print key 22 has been pressed, the program proceeds to step S123a. At step S123a, the print flag is set to the ON state. As a result, a request for a copying operation is stored into memory. At step S124, it is determined whether a prescribed heating time has elapsed, by reference to the timing by the timer begun at step S112. If the heating time has not elapsed, the program returns to step S117. Thus, during the heating process, it is possible to detect malfunction through step S117 and to receive a request for a copying operation into memory through step S123.

If the predetermined heating time has elapsed, the program proceeds from step S124 to step S125, at which tee supply of electric power to the binding unit 30 is cut off. At step S126, the heating-state lamp 24 switches off. At step S127, the cooling-state lamp 25 is illuminated in blue. Consequently, the operator is apprised that the cooling process has started in the binding unit 30. After the operation of step S127, the program proceeds to step S122.

At step S122, the indication by the liquid crystal display 21 switches to an indication of the copy number. Then, at step S128, the print key 22 is enabled. Consequently, the operator finds that a copying operation can be started without awaiting the end of the cooling process in the binding unit 30. After the operation of step S128, the program returns to the main routine of Fig. 13A.

When the print key 22 is pressed, the program proceeds from step S102 to step S129, at which a copying operation subroutine as outlined in Fig. 13C is executed. If the print flag is set to the ON state at step S123a in Fig. 13B (that is, a request for a copying operation is stored in memory), the program proceeds from step S103 to step S130, at which the copy operation subroutine is executed.

Referring now to Fig. 13C, the print key 22 switches off at step S131. At step S132, "1" is subtracted from the value corresponding to the copy number displayed on the liquid crystal display 21, and the value thus obtained is displayed therein. At step S133, the print flag is set to the OFF state. At step S134, a start copying operation instruction is issued. In the copying operation thus started, an original on the original retainer 2 is scanned by the optical scanning system 7, and image information obtained by the scanning is supplied to the image forming unit 8, whereby an image is transferred onto a sheet transported from the feed tray 4 or feed cassette 5. The transferred image is fixed onto the sheet by the fixing unit 17 and then the sheet is discharged into the copy tray 6.

During a given sequence of copying operations, it is determined at step S135 whether the cooling process in the binding unit 30 is completed, by reference to the timer started at step S112 in Fig. 13B. If the cooling process is not yet complete, the program proceeds to step S136. When it is determined at step S135 that the cooling process is completed, the cooling-state lamp 25 turns off at step S137, and the program proceeds to step S136. At step S136, miscellaneous processes in the copying operation are executed. After these operations, the program proceeds to step S138. At step S138, it is determined whether or not the sequence of copying operations has terminated. While the sequence of copying operations is still underway, the program returns to step S135 to repeat the subsequent processes. If it is determined at step S138 that the sequence of copying operations has terminated, the program proceeds to step S139, at which it is determined whether or not the displayed copy number is "0". If it is not "0", which indicates that the copying operation for the preset number has not been completed, the operations starting at step S134 are repeated. If the determination at step S139 is "Yes", the print key 22 then switches on at step S140, and then the program returns to the main routine of Fig. 13A.

According to this embodiment, a copying operation is not permitted while the heating process in the binding unit 30 is in progress, thus averting an excessive consumption of power. If the heating process in the binding unit 30 is completed, the copying operation is immediately enabled, permitting efficient performance of the binding and the copying operations. In addition, according to this embodiment, even if the binding unit 30 is in the heating process, a copying operation request is stored into memory such that the copying operation is started immediately after the end of a heating process. Thus, the apparatus of this embodiment can smoothly and rapidly switch from the binding operation to the copy operation.

III. Third Embodiment

The control process of in Figs. 7A to 7F and the control process of Figs. 13A to 13C may be replaced by the control process of Figs. 14A and 14B.

When the program starts, initialization is performed at step S201, wherein, for example, the fixing unit 17 is set to a prescribed temperature. During the initialization, a binding flag BF provided in the RAM 63 is set to an OFF state.

After the initialization, it is determined at step S202 whether a copy start instruction has been issued through the print key 22. If the determination is "No", the program proceeds to step S203 where it is determined by reference to the binding flag BF and a signal from the start terminal 53 whether the binding mode is to be started or not. If the binding mode is not to be started, the program proceeds to step S204. At step S204, it is determined whether a copy number setting instruction has been issued through the ten-key board 23. If the determination is "No", miscellaneous processes are performed at step S225, and then the program returns to step S202.

If the ten-key board has been pressed to designate a number of copies, the program proceeds from step S204 to step S205, at which the numerical value of the input is stored as the number of copies. At step S206, the number is displayed on the liquid crystal display 21. After the operation of step S206, the program returns to the main routine.

If the print key 22 has been pressed, the program proceeds from step S202 to step S207. At step S207, "1" is subtracted from the value corresponding to the copy number displayed on the liquid crystal display 21, and the value thus obtained is displayed therein. Upon a copy start instruction at step S208, the copying operation begins, wherein an original on the original support is scanned by the optical scanning system 7 in the copying machine body 1, and image information obtained by the scanning is supplied to the image forming unit 8. Therein an image is transferred onto a sheet transported from the feed tray 4 or feed cassette 5. The transferred image is fixed by the fixing unit 17 onto the sheet and then the sheet is discharged into the copy tray 6.

After the copying start instruction is issued at step S208, it is determined at step S209 whether a binding start has been requested or not, by reference to the signal from the start terminal 53 and the signal from the binding start key 26. If the determination is "No", the program proceeds to step S210, at which it is determined whether the sequence of copying operations has been completed. If it has not, the program returns to step S209. If the determination at step S209 is "Yes", specifically, if the output at the start terminal 53 of the control circuit 35 is high or the binding start key 26 has been pressed, the program proceeds to step S211, whereby the binding flag BF is set to the ON state. The potential at the start terminal 53 changes when the binder 70 is loaded into the binding unit 30, as described afterwards in connection with the binding mode (at step S213).

When the copying operation is completed, the determination at step S210 becomes "Yes", and the program proceeds to step S212. At step S212, it is determined whether the displayed number is "0" or not. Not "0" means that the preset number of copies have not been obtained, and the operations of steps S207 to S210 are repeated. If the determination at step S212 is "Yes", the program returns to the main routine.

In order to bind sheet material using the binding unit 30, the sheets 75 are placed in the binder 70 as shown in Figs. 8 and 9, so that one side of the stack of sheets 75 is in contact with the adhesive material 73 along the spine 71. Then, the binder 70 is folded as shown in Fig. 9, and loaded into the container 31, pressing against the cover 32 as shown in Fig. 10. When the binder 70 reaches the bottom of the container 31 as shown in Figs. 11 and 12, the pair of electrodes 34 come into electrical contact with the electric heater 72 of the binder cover 70 through the electrodes 74.

When the electrodes 34 are in contact with the electrodes 74, the potential at the non-inverting terminal of the comparator 52 of the start detection circuit 48 increases, and a high output is generated at the start terminal 53. Accordingly, the program proceeds from step S203 to step S213, at which a binding mode subroutine is executed.

If the binder 70 has been loaded into the binding unit 30 during a copying operation, or if the binding flag BF has been set to the ON state by pressing a binding start key 26, the determination at step S203 becomes "Yes" immediately after the end of a copying operation, and the program proceeds to the binding mode subroutine of step S213. Thus, a command to switch to the binding mode can be preliminarily stored during a copying operation, permitting rapid switching from the copying operation to the binding operation. Thus, the efficiency of the copying machine operation is improved.

In the binding mode subroutine shown in Fig. 14B, a timer starts at step S214, and the liquid crystal display 21 starts to indicate the time remaining until the end of a binding operation. Accordingly, the operator readily can know how long it will take to complete a given binding operation. At step S216, the heating-state lamp 24 is illuminated, whereby the operator finds that the heating process has begun in the binding unit 30. At step S217, a high output is received at the remote terminal 46, whereby the power transistor 43 of the binding unit 30 switches on, causing electric current to flow between the electrodes 34. Consequently, the electric heater 72 of the binder 70 heats, melting the adhesive material 73, whereby the side of the sheets 75 is adhered to the binder 70.

The electric power supplied to the electric heater 72 is regulated by a feedback circuit comprising the resistor 45a to the comparator 46. If there is any indication of a malfunction, such as an abnormal resistance value of the electric heater 72 or a defective contact between the binder 70 and the electrodes 34 it is detected by the malfunction detecting circuit 47. More specifically, if the potential at the collector of the power transistor 43 goes outside the normal range as defined by the pair of comparators 49 and 50, the output at the NG terminal 51 drops. The change in output at the NG terminal 51 is detected at step S218 of Fig. 14B. When a malfunction is thus detected, the program proceeds from step S218 to step S219, performing error indicating processes including cut off of the supply of electric power to the electrodes 34 and indication of "ERROR" on the liquid crystal display 21. Then, at step S224, the binding flag BF is set to the OFF state, and the program returns to the main routine of Fig. 14A.

If no malfunction is detected by the malfunction detecting circuit 47 during the heating process begun at step S217 of Fig. 14B, the program proceeds from step S218 to step S220. At step S220, it is determined whether a predetermined heating time has elapsed, by reference to the timing of the timer started at step S214. Until the predetermined heating time has elapsed, the program returns to step S218. With the elapse of the heating period, the program proceeds from step S220 to step S221, at which a cooling process is carried out. This process includes cut off of electric power to the electrodes 34, switching the heating-state lamp 24 off, and illuminating the cooling-state lamp 25 in blue. As a result, the operator readily finds that the binding unit 30 has been brought into the cooling state.

At step S222, the program pauses until the predetermined cooling time has elapsed. With the elapse of the cooling period, the program proceeds to step S223, at which the time indication on the liquid crystal display 21 and the cooling-state lamp 25 are switched off. The liquid crystal display 21 turns to displaying the copy number. At step S224, the binding flag BF is set to the OFF state, and then the program returns to the main routine.

IV. Fourth Embodiment

According to this embodiment in the aspect shown in Fig. 15, the terminal electrodes 34 are connected with a power supply circuit 100 which includes a transistor 101 and a resistor 102. The terminal electrodes 34 make contact with the electrodes of the binder 70, and when the transistor 101 switches on, electric power is supplied to the electric heater 72. The container 31 has a thermistor 103 for detecting the temperature of the binder 70. This thermistor 103 is located in the vicinity of the terminal electrodes 34, such that when the binder 70 is loaded into the container 31, the thermistor 103 is located close to the spine 71, and therein detects the temperature of the adhesive material 73.

The power supply circuit 100 is controlled by an electricity control unit (ECU) 105. The control unit 105 begins to supply electric power to the electric heater 72 when the binder 70 has been loaded into the container 31 and the terminal electrodes 34 have made contact with the electrodes 74 of the binder 70. Then, with reference to the temperature of the binder 70 detected by the thermistor 103, the control unit 105 determines the end of the heating process, i.e., the timing when the transistor 101 switches off to stop the supply of electric power, as well as the end of the cooling process, which is displayed, for example, by switching off the cooling-state lamp 25.

Fig. 16 shows a flow chart of a specific example of the control process of the control unit 105. The control unit 105 determines first whether or not supply of electric power may be started (at step S301). When it may, as a result of the binder 70 having been loaded into the container 31, thus binding the electrodes 74 into contact with the terminal electrodes 34, the program proceeds to step S302.

At step S302, the transistor 101 switches on, supplying electricity to the electric heater 72. Subsequently, the temperature T of the binder 70 is read by means of the thermistor 103 (at step S303), and it is determined whether the temperature T is higher than a predetermined temperature Ta required to effect the heating process (at step S304). The value of this predetermined temperature Ta (about 90°C) corresponds to the melting point of the adhesive material 73, and is stored in advance in the control unit 105. Electric power is supplied until the temperature T attains the preset temperature Ta, and when it begins to become higher than the predetermined temperature Ta, the transistor 101 switches off, thereby cutting off the supply of electric power (at step S305). Subsequently, the temperature T in the binder 70 is read (at step S306), whereby it is determined when the temperature T has become lower than a predetermined temperature Tb, signaling the completion of cooling (at step S307). The value of this predetermined temperature Tb (about 50°C) corresponds to the coagulation point of the adhesive material 73, and is stored in advance in the control unit 105. When the temperature T has become lower than the predetermined temperature Tb, the cooling-state lamp 25 (in Fig. 4) switches off, indicating that the binding process is completed (at step S308).

The above-described procedure is shown in a timing chart in Fig. 17. With reference to Fig. 17, at time t_1, the supply of electric power to the electric heater 72 is begun through the loading of the binder cover 70 containing the sheets 75 into the container 31, whereby the adhesive material 73 heats, and the temperature of the adhesive material

73 gradually rises. At time t_2 when the temperature of the adhesive material 73 attains the predetermined temperature Ta corresponding to the melting point thereof, the supply of electricity is cut off. Consequently, the adhesive material 73 is unfalteringly heated until it is melted, even if the temperature of the adhesive should rise inconsistently due to various irregular factors. Thus, a well-performed binding operation is ensured. The adhesive material 73 is not excessively heated and the heating time can be reduced to within the range necessary for melting. Since unnecessary increases of temperature are avoided, the cooling time may also be reduced.

After the cut off of the supply of electricity, the temperature in the binder 70 lowers to the predetermined temperature Tb at time t_3. This drop is detected, whereupon the lamp 25 switches off, indicating the completion of the binding operation.

V. Fifth Embodiment

Figs. 18 and 19 show the fifth embodiment. According to this embodiment, a limit switch 106 is provided which detects the thickness of the folded binder cover 70. The limit switch 106 is located for example in the container 31 of the binding unit 30. It is switched on when the thickness of the binder 70 is larger than a predetermined thickness, whereas it remains off otherwise. Thus, whether or not the thickness of the binder 70 is larger than the predetermined thickness is detected by the limit switch 106.

A control unit 107 for controlling a power supply circuit 100 has means 108 for setting the time power supply is on independency upon the thickness detected by the limit switch 106, and means 109 for supplying electric power for the set time.

The process of the control unit 107 will be described with reference to the flow chart in Fig. 19. It is determined whether supply of electric power may be started (at step S401). When a binder 70 has been properly loaded into the container 31, enabling the start of the supply of electric power, the power supply time is set (at steps S402 to S404). Then, a timer starts clocking (at step S405), and electric power is supplied to the electric heater (at step S406).

The power supply time setting depends upon whether the limit switch 106 is on or off (at step S402). If the limit switch 106 is off, the first time TM1 is selected as the power supply time TMset (at step S403). If the limit switch 106 is on, the second time TM2 is selected as the power supply time TMset (at step S404). The first time TM1 is a period adequate for the adhesive material 33 in a relatively thin binder 70 to heat to the melting point. The second time TM2 is longer than the first time TM1. These times TM1 and TM2 are stored in advance in the control unit 107.

When the supply of electric power begins, the timer operates to determine whether or not the predetermined power supply time TMset has elapsed (at step S407). The supply of power continues until the elapse of the predetermined power supply time TMset, at which the transistor 101 of the power supply circuit 100 switches off, thereby cutting off the supply of electric power (at step S408). Afterwards, it is determined whether the predetermined cooling time has elapsed (at step S409). If so, the end of the binding operation is indicated (at step S410). The predetermined cooling time is constant in this case; however, it may be made to depend upon the thickness of the binder 70 (i.e., the on/off state of the limit switch 106).

According to this embodiment, the heating time for the adhesive material 73 (i.e., the power supply time to the electric heater 72) is regulated depending on the thickness of the folded binder 70 which varies according to the number of sheets 75. If there is a large number of sheets 75 and the binder 70 is thick, the temperature in the binder 70 will rise slowly; consequently it takes longer for the adhesive material 73 to attain the melting point, compared to the case in which the binder 70 is thin. The heating time is accordingly regulated, that is, the heating time is set relatively short if the binder 70 is thin, and it is set relatively long if the binder 70 is thick, whereby the temperature of the adhesive material 73 unfalteringly attains the melting point and excessive heating does not occur.

VI. Sixth Embodiment

According to this embodiment as shown in Fig. 20, the terminal electrodes 34 are connected with a transistor 121 and a resistor 122. When the electrodes 74 of the binder cover 70 are in contact with the terminal electrodes 34 switching on the transistor 121, supply of electric power to the electric heater 72 begins.

A circuit 123 which detects the electrical resistance of the electric heater 72 is provided adjacent to the power supply circuit 120. The detecting circuit 123 detects a voltage level which depends on the value of the resistance of the electric heater 72. The detecting circuit 123 comprises comparators, and detects a potential V, the potential between resistors 124 and 125 connected in parallel with the transistor 121 and the resistor 122, through comparison with a plurality of reference potentials provided by circuits having a plurality of voltage dividing resistors 126 to 130.

More specifically, the detecting circuit 123 includes four comparators 131 to 134 for comparing the detected potential V with the first to fourth reference potentials V_1 to V_4. The reference potentials are defined such that $V_1 < V_2 < V_3 < V_4$, and set to, for example, 1V, 2V, 3V and 4V, respectively. If the detected potential V is lower than the first reference potential V_1, all the outputs of the comparators 131 to 134 are high. If the detected potential V is between the first and second reference potentials V_1 and V_2, only the output of the first comparator 131 goes low. If the detected potential V is between the second and third reference potentials V_2 and V_3, the outputs of the first and second comparators 131 and 132 go low. If the detected potential V is between the third and fourth reference potentials V_3 and V_4, the outputs of the first to third comparators 131 to 133 go low. If it is higher than the fourth reference potential V_4, all of the outputs of the comparators 131 to 134 go low. Thus, the detected potential V is determined by the five levels.

The power supply circuit 120 is controlled by the control unit (ECU) 140. The control unit 140 receives the output signals from the comparators 131 to 134 of the detecting circuit 123 and provides a signal for driving the transistor 121. The control unit 140 has means 141 for setting the power supply time to the electric heater 32 in accordance with the output signals of the comparators 131 to 134, and means 142 for driving the power supply circuit 120 to supply electric power to the electric heater 72 for the time set by the means 141.

A specific example of control by the control unit 140 will be described with reference to the flow chart in Fig. 21. The control unit 140 determines first whether or not the supply of electric power may be started (at step S501). When a binder 70 is loaded into the container 31, bringing the electrodes 34 into contact with the electrodes 74, it is determined that the supply of electricity may be started, and the program proceeds to step S502.

The output signals of the comparators 131 to 134 of the detecting circuit 123 are then read (at step S502), and the power supply time TMset is set relative to the signals (at step S503). In this case, the larger the electric resistance value of the electric heater 72 is, the longer the power supply time will be. The power supply time is read from a table stored in the control unit 140. Higher values of the resistance of the electric heater 72 correspond to lower values of the detected potential V. Thus the power supply timings may for example be set as shown in Fig. 22 according to the level of the detected potential V determined by the outputs of the comparators 131 to 134. In this case, the lower the detected potential V is, the longer the power supply time will be.

After the power supply time is set (at step S503), a timer starts (at step S504), and the transistor 121 switches on, supplying electric power to the electric heater (at step S505). The power supply timing is clocked by the timer whereby it is determined whether the set power supply time TMset has elapsed or not (at step S506). Electric power is supplied until the elapse of the set power supply time TMset. When it is determined that the set power supply time TMset has elapsed, the transistor 121 of the power supply circuit 120 switches off, cutting off the supply of electric power (at step S507). Afterwards it is determined whether a preset cooling time has elapsed (at step S508). Upon determination of the elapse of the preset cooling time, the cooling-state lamp 25 switches off, indicating the end of the binding process (at step S509).

According to this embodiment, even if the resistance value of the electric heater 72 varies with each given binder 70, the power supply time TMset can be regulated accordingly, thereby adjusting the time set to melt the adhesive material 33. The adhesive material 73 is always thus adequately heated. Specifically, if the resistance value of the electric heater 72 is large, a lower quantity of heat is generated per unit time, thus the temperature is the binder 70 rises slowly. In this case, the power supply time TMset is set long so that the adhesive material 73 is heated sufficiently to melt. If the resistance value of the electric heater 72 is relatively small and a higher quantity of heat is thus generated per unit time, the power supply time TMset is set short, thereby preventing excessive heating.

VII. Seventh Embodiment

According to this embodiment as shown in Fig. 23, the terminal electrodes 34 are connected with a power supply circuit 150 comprising a transistor 151 and a resistor 152. When the terminal electrodes 34 are in contact with the electrodes 74 of the binder 70, the transistor 151 thus switches on, and electric power is supplied to the electric heater 72.

The power supply circuit 150 is controlled by a control unit (ECU) 170. The control unit 170 receives a selection signal from a binding condition setting keyboard 160 provided on the operation panel 20. The control unit 170 supplied a signal for driving the transistor 151. The control unit 170 includes means 171 for setting the timing of the power supplied to the electric heater 72 in accordance with the selection signal through the keyboard 160, and means 172 for driving the power supply circuit 150 to supply electric power to the electric heater 72 for the power supply timing, whereby binding conditions (the power supply timing in this case) can be regulated according to the type of binder 70. The power supply timing set means 171 reads a corresponding set time from the stored table in accordance with the selection signal from the keyboard 160, and sets the time for an incorporated timer. When the binder 70 is loaded, the power supply circuit drive means 172 turns on the power supply circuit 150 for the set time.

The keyboard 160 transmits four kinds of selection signals indicating the type of binder 70 to be processed to the control unit 170. The keyboard 160 has four switches 161 to 164 for selecting any one of four types of binder 70, and lamps L_A to L_D associated with the four switches and which illuminate when the corresponding switch is operated. The characters A to D attached to "L" for the lamps indicate types of binder 70. For example, type A is a binder which contains a small number of sheets size B5 or smaller and is provided with an electric heater 72 having a small resistance value and requiring a relatively small quantity of heat, and type D is a binder which contains a large number of B4 size sheet and is provided with an electric heater 72 having a large resistance value. In this embodiment, type A is a standard type, for which the power supply timing is set to 60 sec. The power supply times for types B, C and D are set to 80 sec., 100 sec., and 120 sec., respectively. Thus, the power supply timing can be set according to the quantity of heat required for the binders 70, and it is possible to set the optimal binding conditions for each case.

The control procedure of the control unit 170 will now be described with reference to the flow chart in Fig. 24.

First, at step S601, there is a pause for a binding start instruction. When a binding start instruction is received, the program proceeds from step S602 to S605 in order to wait for a selection by means of the binding condition setting keyboard 160.

If type A is selected, the program proceeds from step S602 to step S606, whereby the power supply timing of the power supply circuit 8 is set to the standard value of 60 sec. If type B is selected, the power supply timing is set to 80 sec. (through steps S603 and S607). If type C is selected, the power supply timing is set to 100 sec. (through steps S604 and S608). If type D is selected, the power supply timing is set to 120 sec. (through steps S605 and S609). After that, when the binder 70 has been loaded into the container 31 (at step S610), the power supply circuit 150 switches on to supply electric power for the set time (at step S611). The heating-state lamp 24 is illuminated during the supply of power.

After electric power has been supplied by the power supply circuit 150 for the set time, the cooling-state lamp 25 is illuminated for a cooling period preset to correspond to the power supply time, and the heated binder 70 together with the bound sheets 75 cools. After the elapse of the cooling period, the cooling-state lamp 25 switches off, thereby indicating that the binding process has ended.

Since a condition of the binding operation (i.e., the power supply timing to the electric heater 72 of the binder 70) is regulated according to the type of the binder 70 to be processed, the sheets do not fail to adhere to the binder cover 70 satisfactorily, and the quality of the binding operation is improved.

Modifications

(a) A binding mode key on the operation panel 20 or a detector which is activated when the cover 32 is opened may be provided to manually start the binding operation of the binding unit 30. In this case, the start detecting circuit 48 in Fig. 5 would not be necessary.

(b) The binding operation time displayed may be divided into two parts, namely, both the heating and the cooling times remaining. In addition, the binding operation time may be displayed, for example, by a magnification indicator or an exposure indicator apart from the liquid crystal display 21. Further, a series of LEDs, for example, may be used to display the remaining time a graduated adjustment in the number of illuminated LEDs.

(c) In the above-described embodiments, only the low-speed heating process may be accomplished during a copying operation. Instead, in instances wherein the copying operation consumes little power, the heating process in the binding unit 30 may be effected at high speed.

(d) The table TT of the ROM 62 comprising heating and cooling times relative to ambient temperature and the thickness of the material to be bound, may be replaced by approximating equations used for calculating the heating and cooling times in accordance with ambient temperature and the thickness of the material to be bound.

The parameter therein may be either ambient temperature or the thickness of the material to be bound or both. Using the thermistor 19 located as shown in Fig. 3, the heating time is preferably set at 60 seconds at under 30°C, 52 seconds at 30°C to 50°C, and 45 seconds at over 50°C.

(e) In each of the above-described embodiments, the conventional thermistor 19 is used as

a temperature monitoring means. In lieu of this arrangement, a thermistor for monitoring of temperature may be provided in the binding unit 30.
(f) In each of the above-described embodiments, the conventional image density selector 26 is also used as means for measuring the thickness of the material to be bound. This image density selector 26 may be replaced by a special instrument

Claims

1. An image forming apparatus equipped with a binding function, comprising:
means (8) for forming an image onto a sheet;
means (30) for binding sheets by heat, said binding means (30) provided adjacent to said image forming means (8);
first instructing means (22) for commanding operation of said image forming means;
second instructing means (53) for commanding operation of said binding means (30); and
control means (60) for executing either one of said image forming operation or said binding operation according to the corresponding command of said first or second instructing means (22, 53), and preventing the execution of the other operation.

2. An apparatus according to Claim 1, further comprising first means for accepting and storing a first command to operate said image forming means (8), meanwhile said control means (60) forbids the operation of said image forming means (8), and for commanding the operation of said image forming means (8) after said control means (60) allows the operation of said image forming means (8) in case said first command has been stored.

3. An apparatus according to Claim 2, further comprising second means for accepting and storing a second command to operate said binding means (30), meanwhile said control means (60) forbids the operation of said binding means (30), and for commanding an operation of said binding means (30) after said control means (60) allows the operation of said binding means (30) in case said second command has been stored.

4. An apparatus according to Claim 3, wherein said second means receives said second command initiated through loading of the material to be bound in said binding means (30), or by an operator input to said second means.

5. An apparatus according to any one of Claims 1 to 4, wherein said control means (60) includes means for detecting said image forming operation of said image forming means (8), and means for detecting said binding operation of said binding means (30).

6. An apparatus according to any one of Claims 1 to 5, further comprising means (24, 25) for indicating operation conditions of said image forming means (8) and said binding means (30).

7. An apparatus according to Claim 6, wherein said indicating means (24, 25) indicates that said control means (60) forbids one of said instructing means (22, 53) from executing a command.

8. An apparatus according to Claim 1, wherein the binding operation comprises a heating process and a cooling process, and said control means (60) are adapted to forbid the image forming operation of said image forming means (8) during said heating process.

9. An apparatus according to Claim 8, further comprising first indicating means (23) for indicating that an image forming operation is enabled after completion of said heating process in said binding means (30).

10. An apparatus according to Claim 9, further comprising second indicating means (24) for indicating that a binding operation is enabled after completion of said image forming operation in said image forming means (8).

11. An apparatus according to Claim 10, wherein said second indicating means (24) includes a heating indicator which emits light during said heating process, and a cooling indicator which emits light during said cooling process.

12. An apparatus according to any one of Claims 8 to 11, further comprising first means for accepting and storing a first command to operate said image forming means (8), meanwhile said control means (60) forbids said image forming operation, and for operating said image forming means (8) after said control means (60) allows said image forming operation, in case said first command has been stored.

13. An apparatus according to any one of Claims 8 to 12, further comprising second means for accepting and storing a second command to operate said binding means (30) during the image forming operation of said image forming means (8) and for operating said binding means (30) after said image forming operation of said image forming means (8) in case said second command has been stored.

14. An apparatus according to any one of Claims 8 to 13, wherein said storing means accepts said second command initiated through loading of the material to be bound into said binding means (30), or by an operator input to said second means.

15. An apparatus according to Claim 1, further comprising:
means for storing a start command for binding issued by said second instructing means (53) during an image forming operation of said image forming means (8); and
means for starting the operation of said binding means (30) after completion of the image forming operation, in case said storing means stores said command.

16. An apparatus according to Claim 15, further comprising means (24) for indicating that a binding operation is enabled after completion of the image forming operation of said image forming means (8).

17. An apparatus according to Claim 16, wherein the binding operation of said binding means (30) includes a heating process and a cooling process, and said indicating means (24, 25) has a heating indicator illuminated during said heating process and a cooling indicator illuminated during said cooling process.

18. An apparatus according to any one of Claims 1 to 17, wherein said binding means (30) performs the binding operation in a binder (70) including an electric heater (72) and a thermoplastic adhesive layer (73) along a spine (71) of said binder (70).

19. An apparatus according to any one of Claims 15 to 18, wherein said binding operation is initiated by loading of material to be bound into said binding means (30), or by an operator.

20. An apparatus according to Claim 19, further comprising means for accepting and storing an instruction to operate said image forming means (8) during a binding operation of said binding means (30), and for operating said image forming means (8) after said operation of said binding means (30), in case said command has been stored.

21. An apparatus according to Claim 1, wherein the control means (60) controls the binding means (30) to effect a binding operation at a relatively low electric power level at a time when said image forming means (8) operates at a relatively high electric power level.

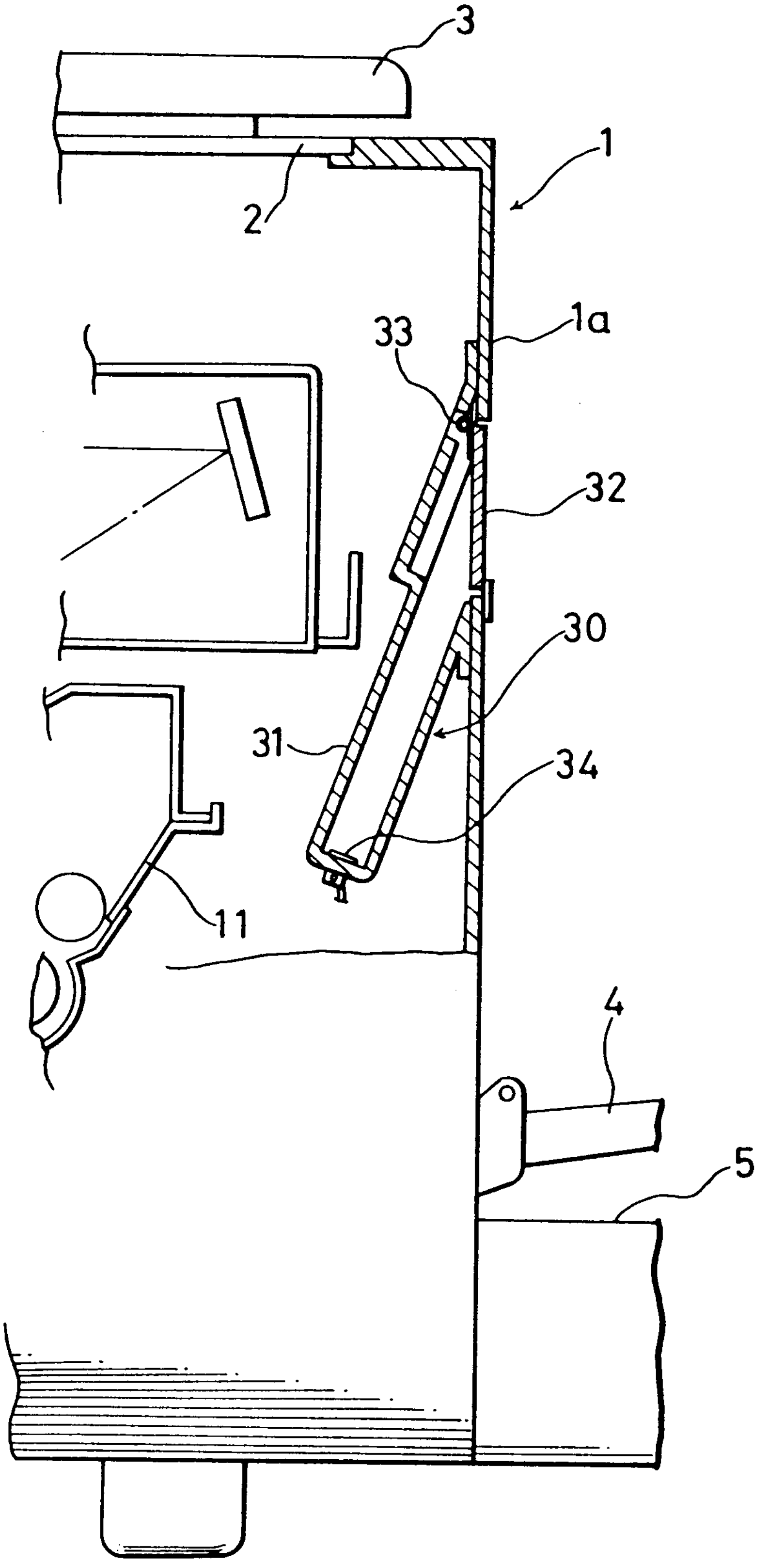
22. An apparatus according to Claim 21, wherein said binding means (30) includes a high-speed binding means (50a) which binds sheets at relatively higher level of electric power, and a low-speed binding means (50b) which binds sheets at relatively lower level of electric power.

23. An apparatus according to Claim 22, wherein said control means (60) operates said low-speed binding means (50b) while the image forming operation is being performed, and operates said high-speed binding means (50a) while the image forming operation is not being performed.

24. An apparatus according to any one of Claims 21 to 23, further comprising means (47) for detecting malfunction in an operation of said binding means (30), means for detecting a start of the operation of said binding means (30), and means (26) for indicating results of the detections by said malfunction detecting means (47) and said start detecting means.

25. An apparatus according to Claim 24, further comprising means for forbidding heating in said binding means (30) when said malfunction detecting means (47) detects a malfunction.

F I G. 1



F I G. 2

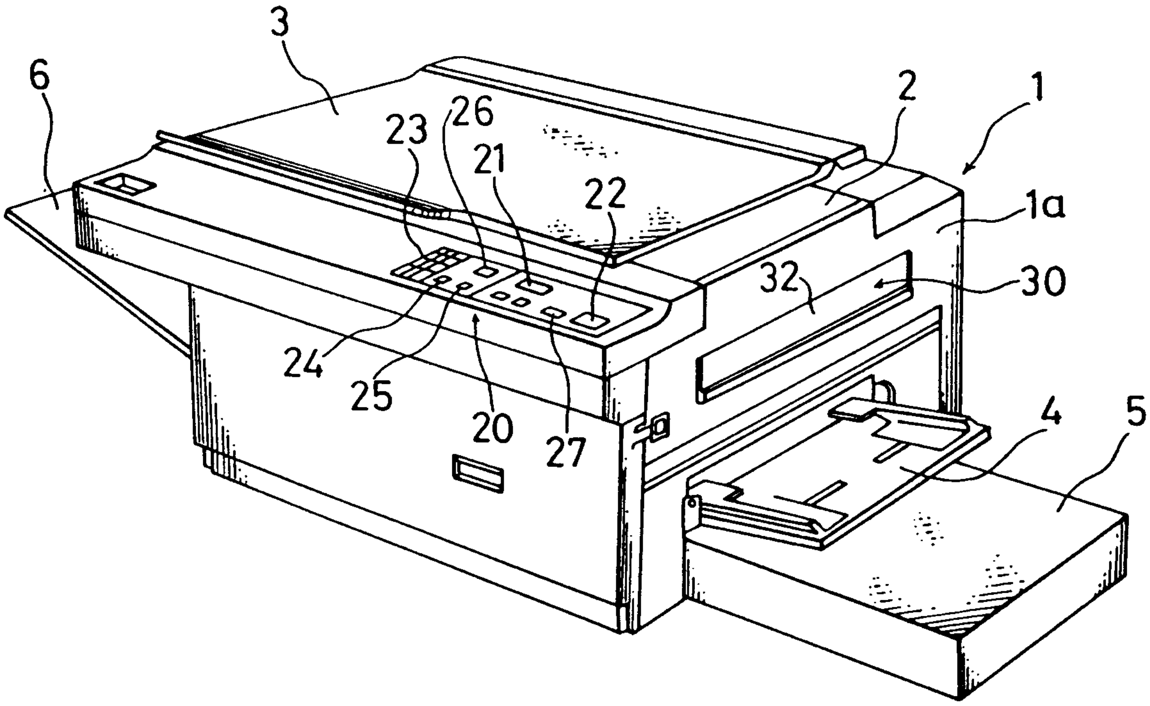


FIG. 3

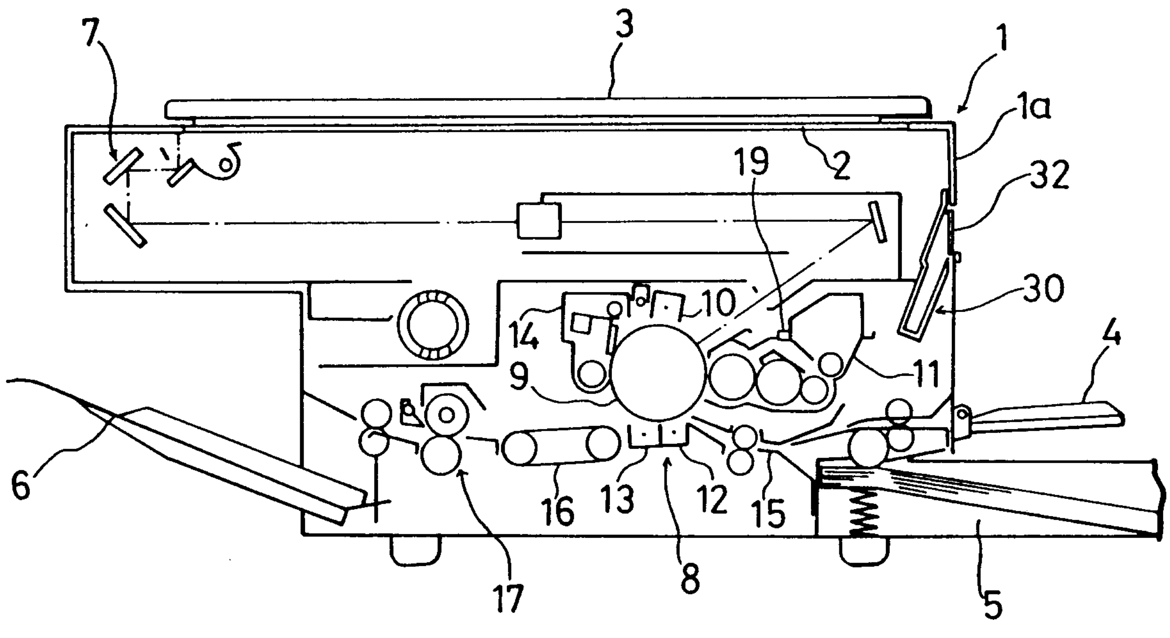
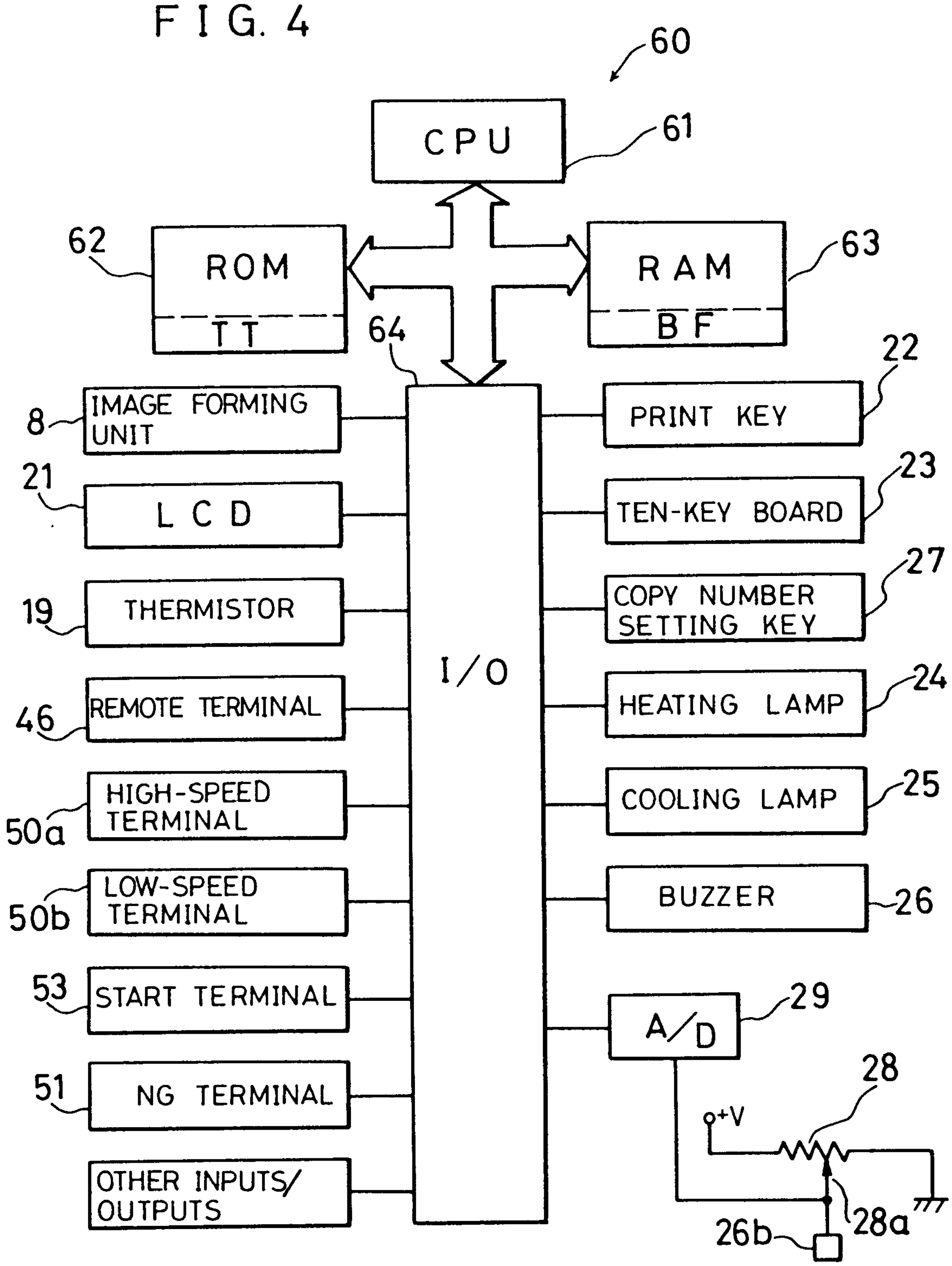
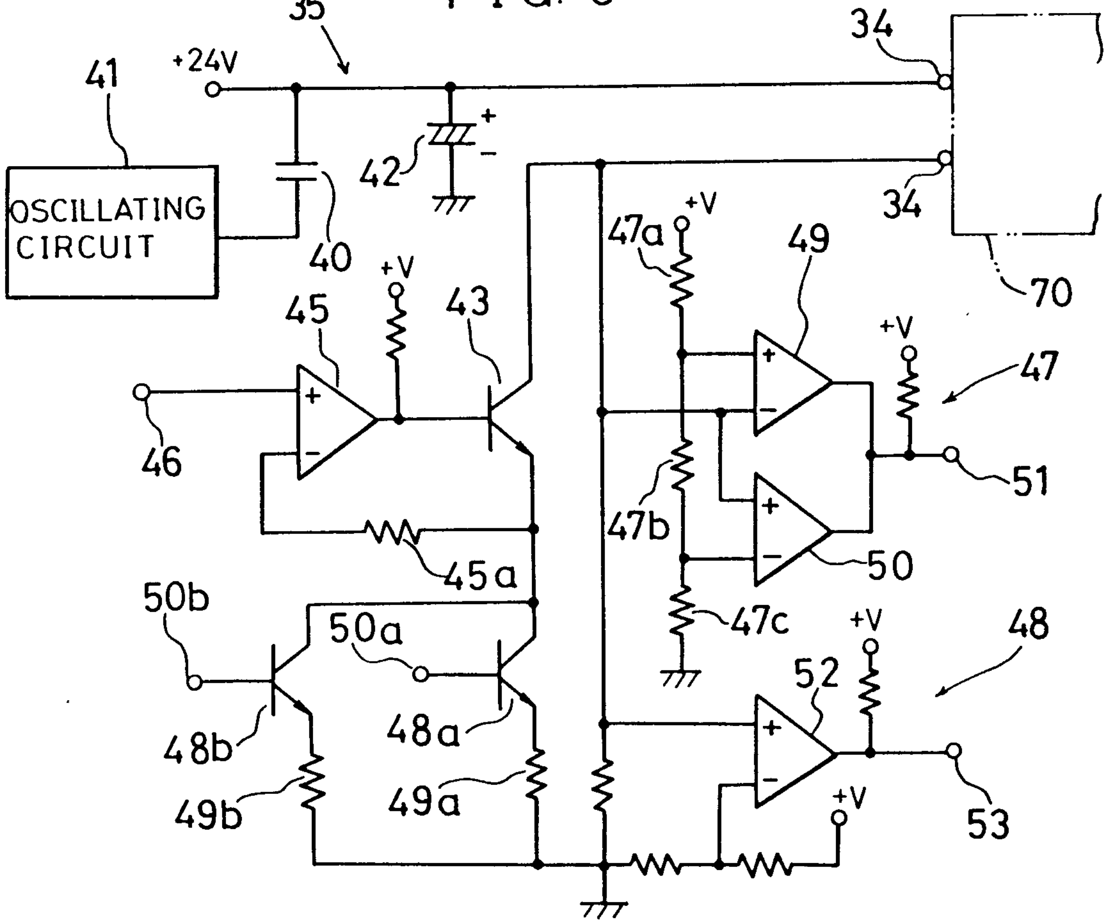


FIG. 4


60
CPU
61
62
ROM
TT
64
RAM
BF
63
8
IMAGE FORMING UNIT
21
LCD
19
THERMISTOR
46
REMOTE TERMINAL
50a
HIGH-SPEED TERMINAL
50b
LOW-SPEED TERMINAL
53
START TERMINAL
51
NG TERMINAL
OTHER INPUTS/ OUTPUTS
I/O
22
PRINT KEY
23
TEN-KEY BOARD
27
COPY NUMBER SETTING KEY
24
HEATING LAMP
25
COOLING LAMP
BUZZER
26
A/D
29
28
+V
28a
26b

F I G. 5


35
34
+24V
41
42
OSCILLATING CIRCUIT
40
34
70
47a
+V
49
+V
45
43
+V
47
46
51
47b
45a
50
50b
50a
47c
+V
48
52
48b
48a
+V
49b
49a
53

F I G. 6

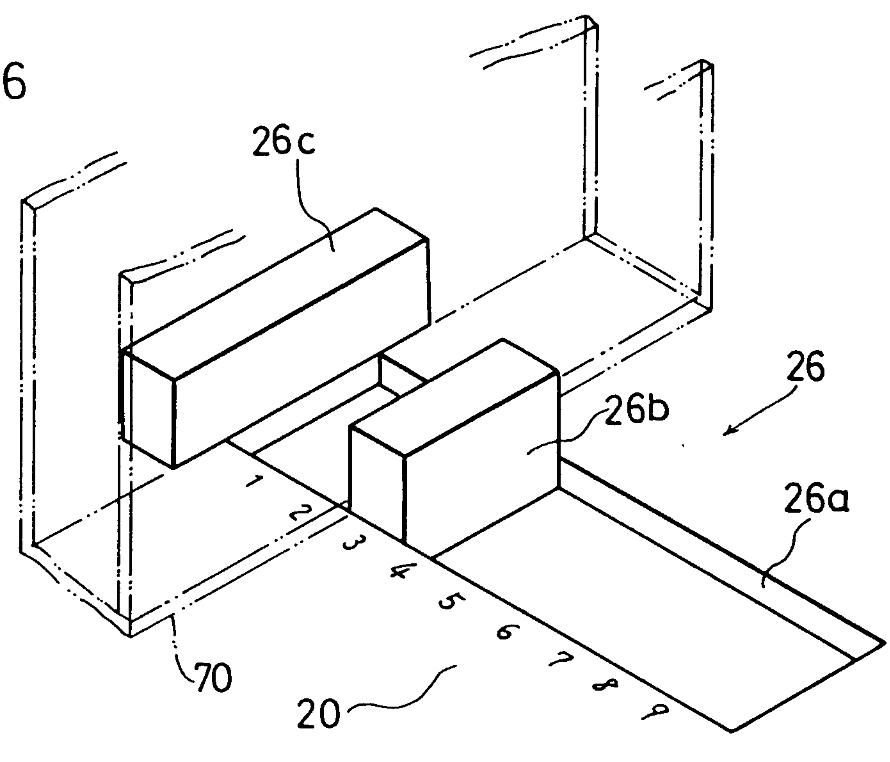

26c
26
26b
26a
1
2
3
4
5
6
7
8
9
70
20

FIG. 7A

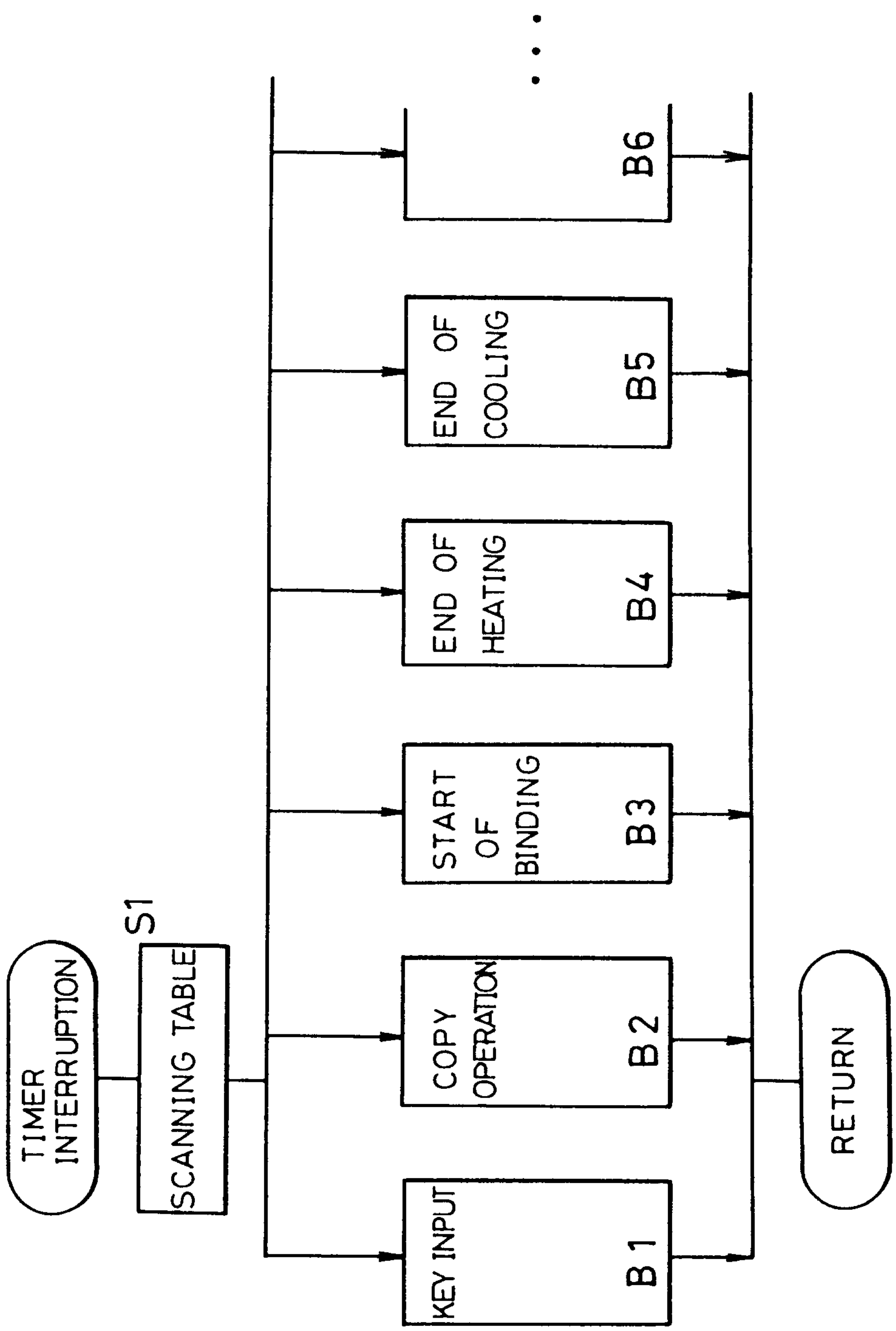

TIMER INTERRUPTION
S1
SCANNING TABLE
KEY INPUT
B1
COPY OPERATION
B2
START OF BINDING
B3
END OF HEATING
B4
END OF COOLING
B5
B6
RETURN

FIG. 7B

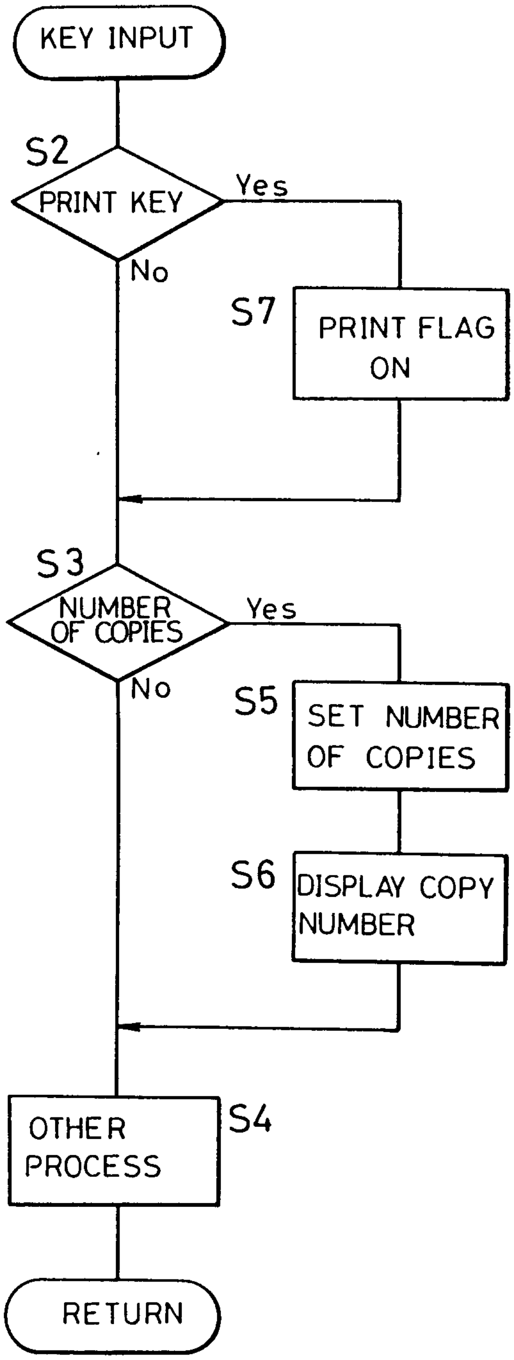
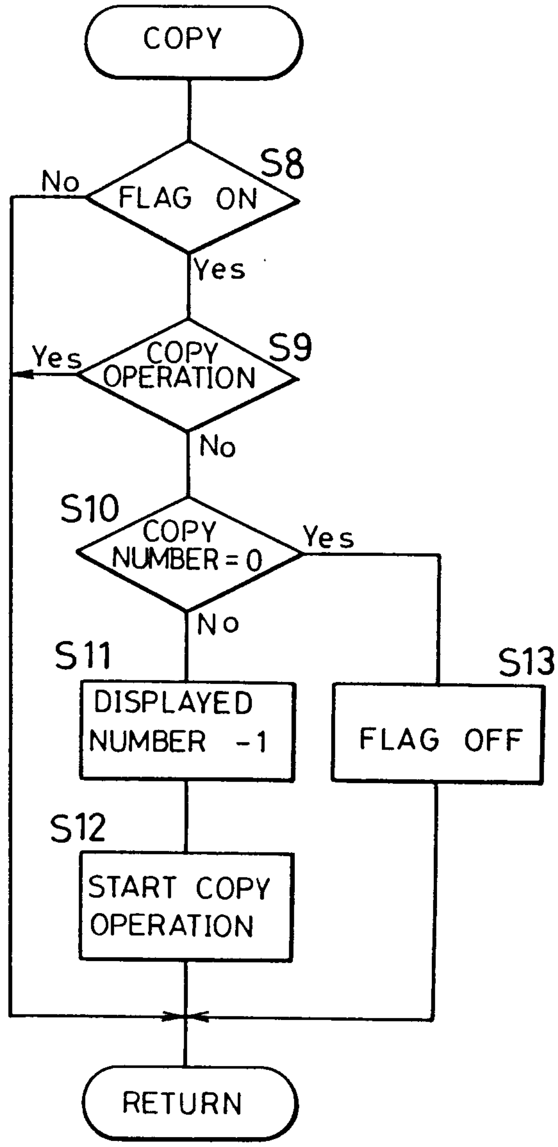

KEY INPUT
S2
PRINT KEY
Yes
No
S7
PRINT FLAG ON
S3
NUMBER OF COPIES
Yes
No
S5
SET NUMBER OF COPIES
S6
DISPLAY COPY NUMBER
OTHER PROCESS
S4
RETURN

FIG. 7C


COPY
S8
FLAG ON
No
Yes
S9
COPY OPERATION
Yes
No
S10
COPY NUMBER = 0
Yes
No
S11
DISPLAYED NUMBER -1
S13
FLAG OFF
S12
START COPY OPERATION
RETURN

F I G. 7D

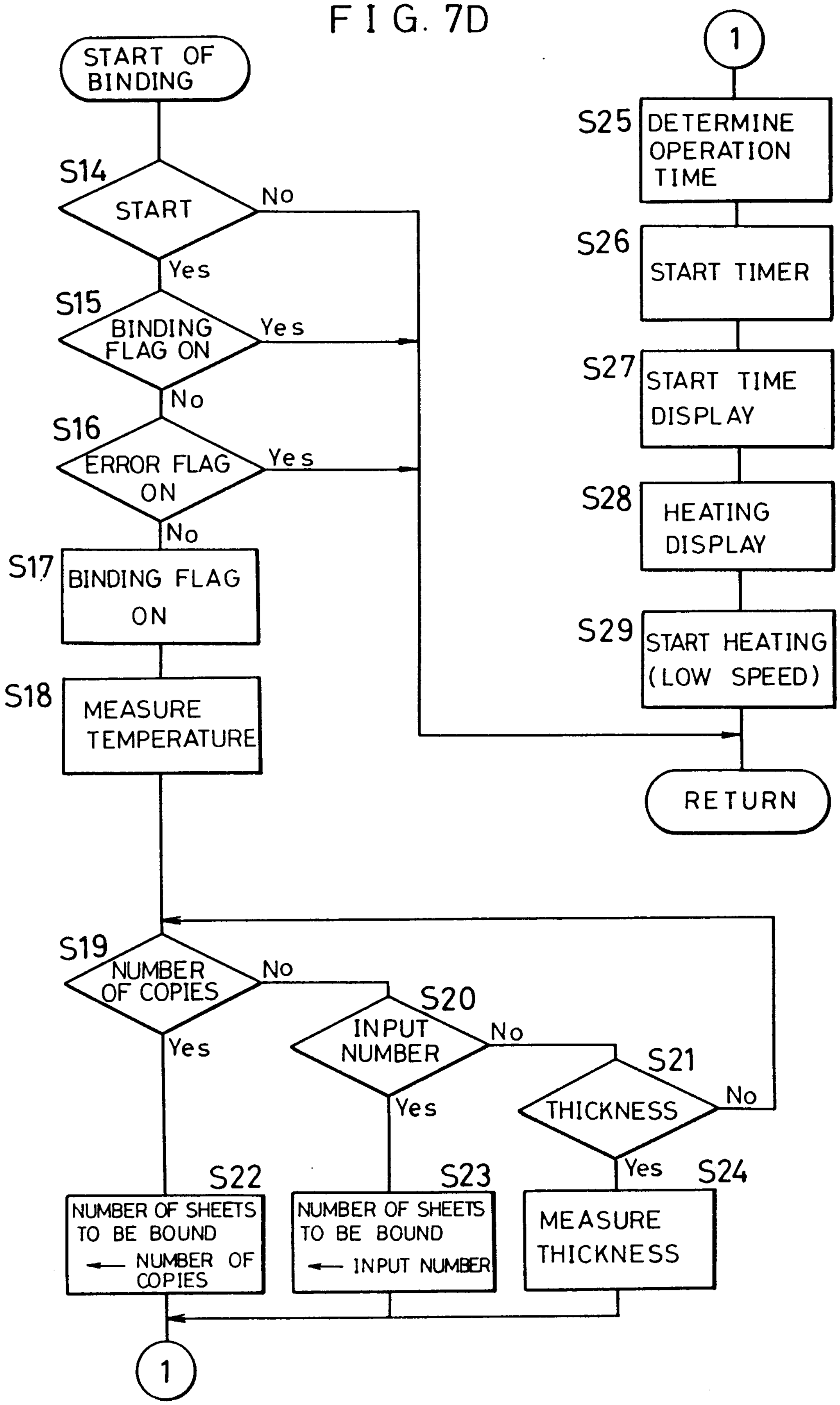

START OF BINDING
S14
START
No
Yes
S15
BINDING FLAG ON
Yes
No
S16
ERROR FLAG ON
Yes
No
S17
BINDING FLAG ON
S18
MEASURE TEMPERATURE
S19
NUMBER OF COPIES
No
Yes
S20
INPUT NUMBER
No
Yes
S21
THICKNESS
No
Yes
S22
NUMBER OF SHEETS TO BE BOUND ← NUMBER OF COPIES
S23
NUMBER OF SHEETS TO BE BOUND ← INPUT NUMBER
S24
MEASURE THICKNESS
1
1
S25
DETERMINE OPERATION TIME
S26
START TIMER
S27
START TIME DISPLAY
S28
HEATING DISPLAY
S29
START HEATING (LOW SPEED)
RETURN

FIG. 7E

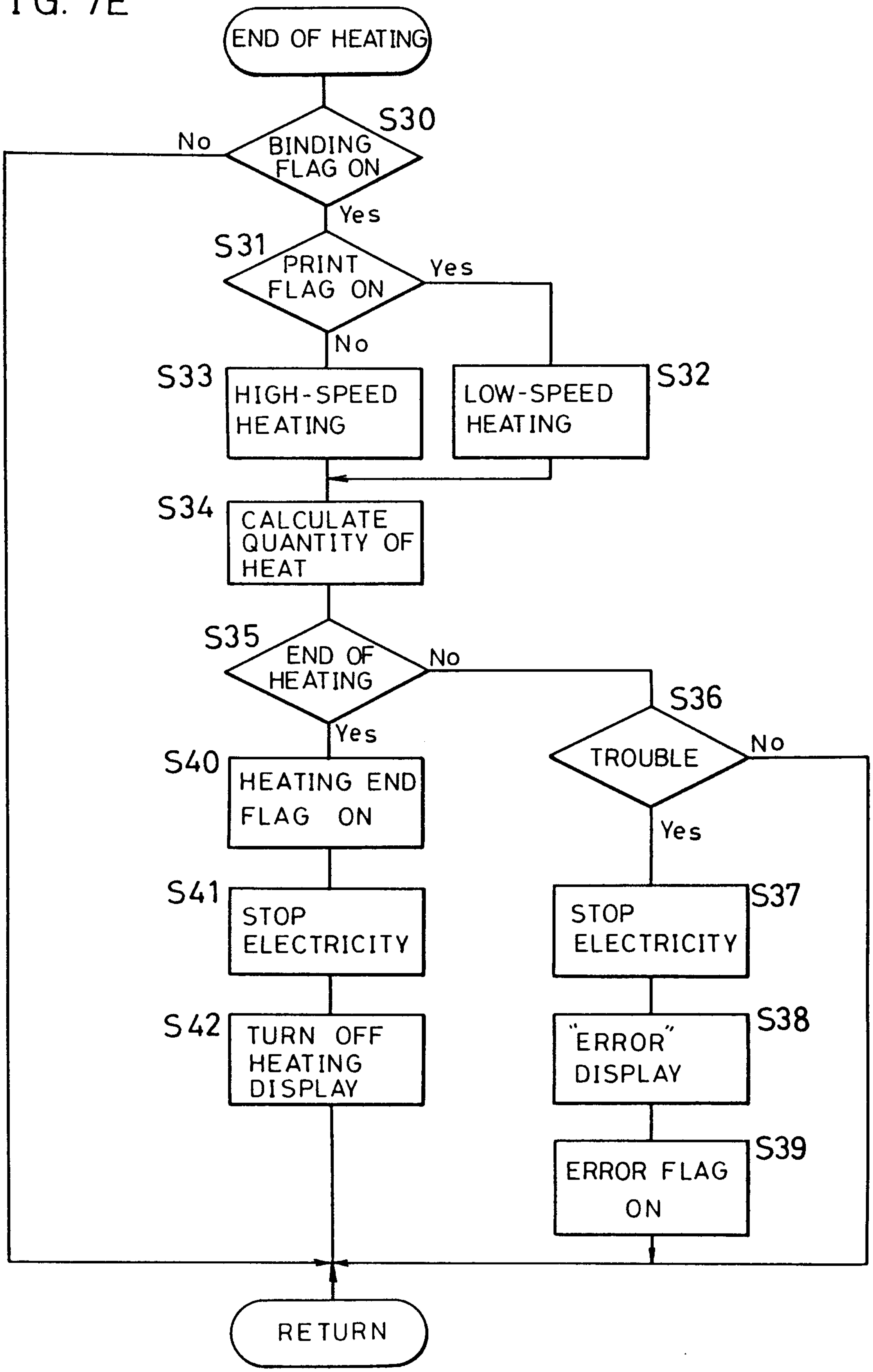

END OF HEATING
S30
BINDING FLAG ON
No
Yes
S31
PRINT FLAG ON
Yes
No
S33
HIGH-SPEED HEATING
S32
LOW-SPEED HEATING
S34
CALCULATE QUANTITY OF HEAT
S35
END OF HEATING
No
Yes
S36
TROUBLE
No
Yes
S40
HEATING END FLAG ON
S41
STOP ELECTRICITY
S42
TURN OFF HEATING DISPLAY
S37
STOP ELECTRICITY
S38
"ERROR" DISPLAY
S39
ERROR FLAG ON
RETURN

FIG. 7F

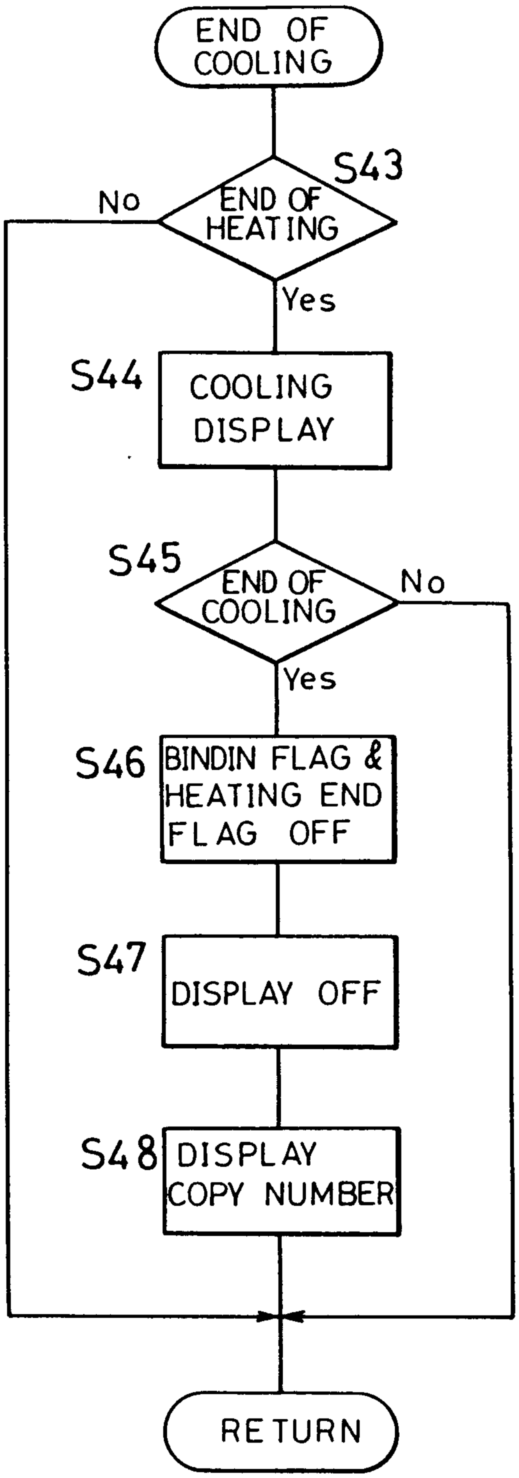

END OF COOLING
S43
END OF HEATING
No
Yes
S44
COOLING DISPLAY
S45
END OF COOLING
No
Yes
S46
BINDIN FLAG & HEATING END FLAG OFF
S47
DISPLAY OFF
S48
DISPLAY COPY NUMBER
RETURN

FIG. 8

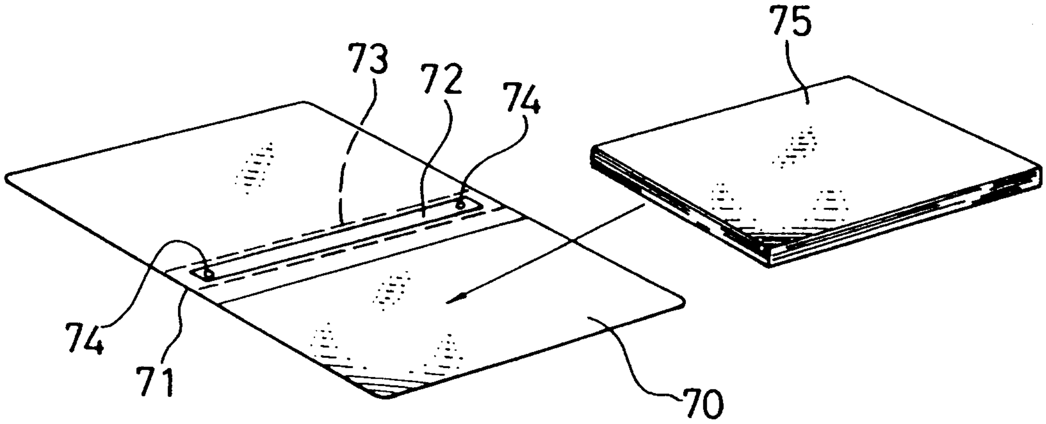


FIG. 9

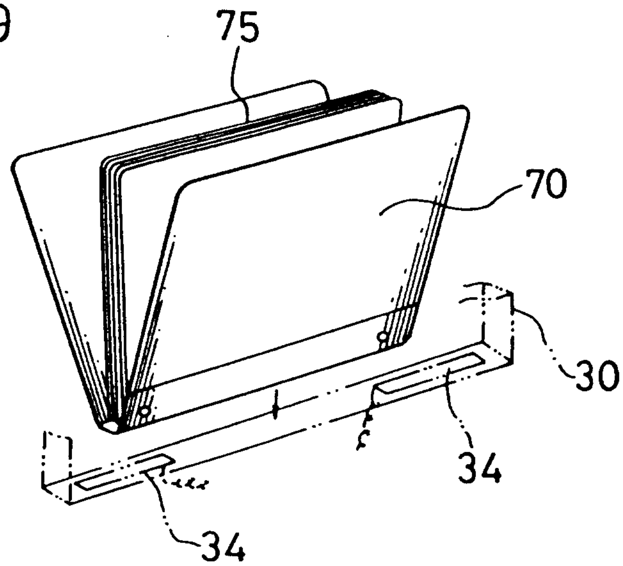
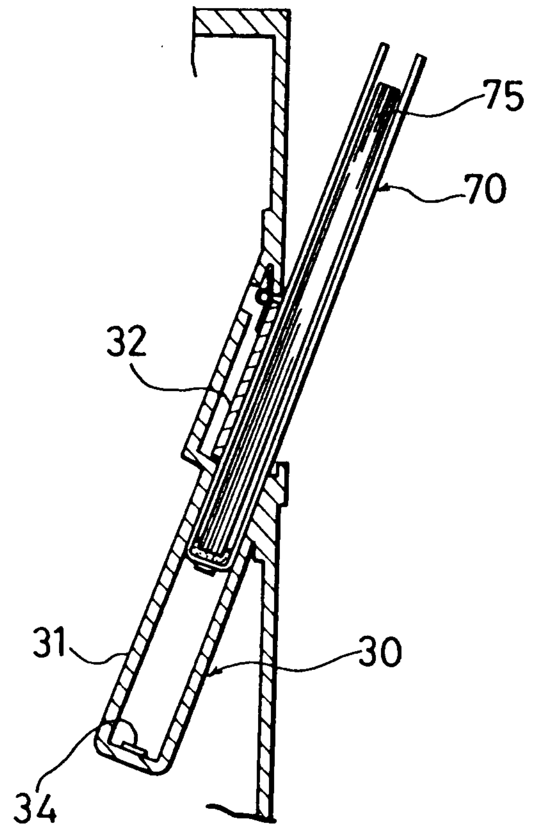
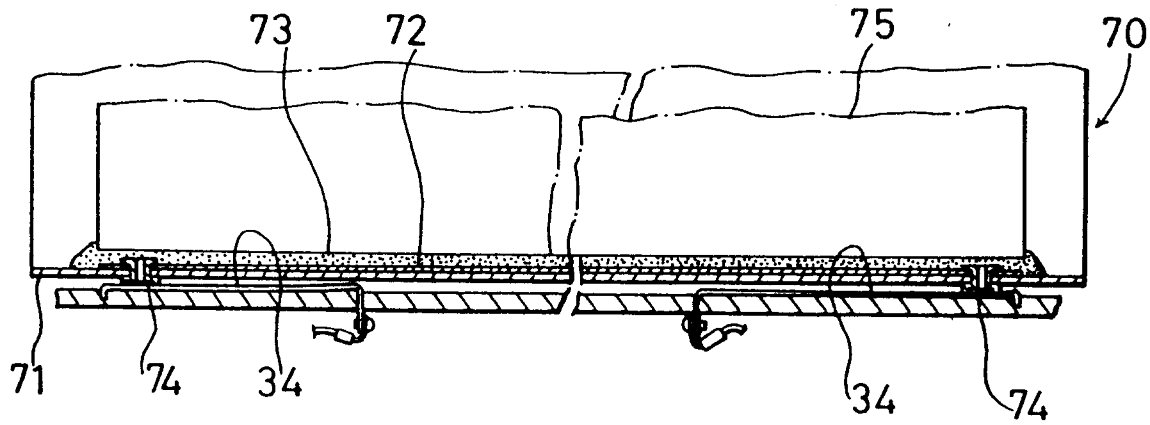


FIG. 10



F I G. 11



F I G. 12

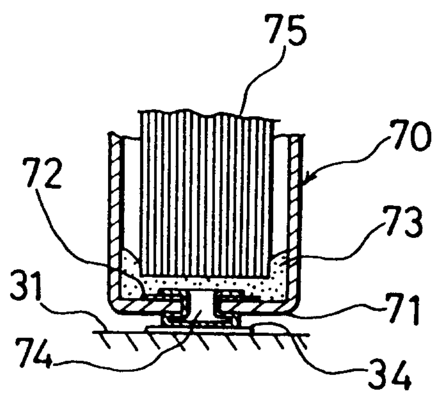
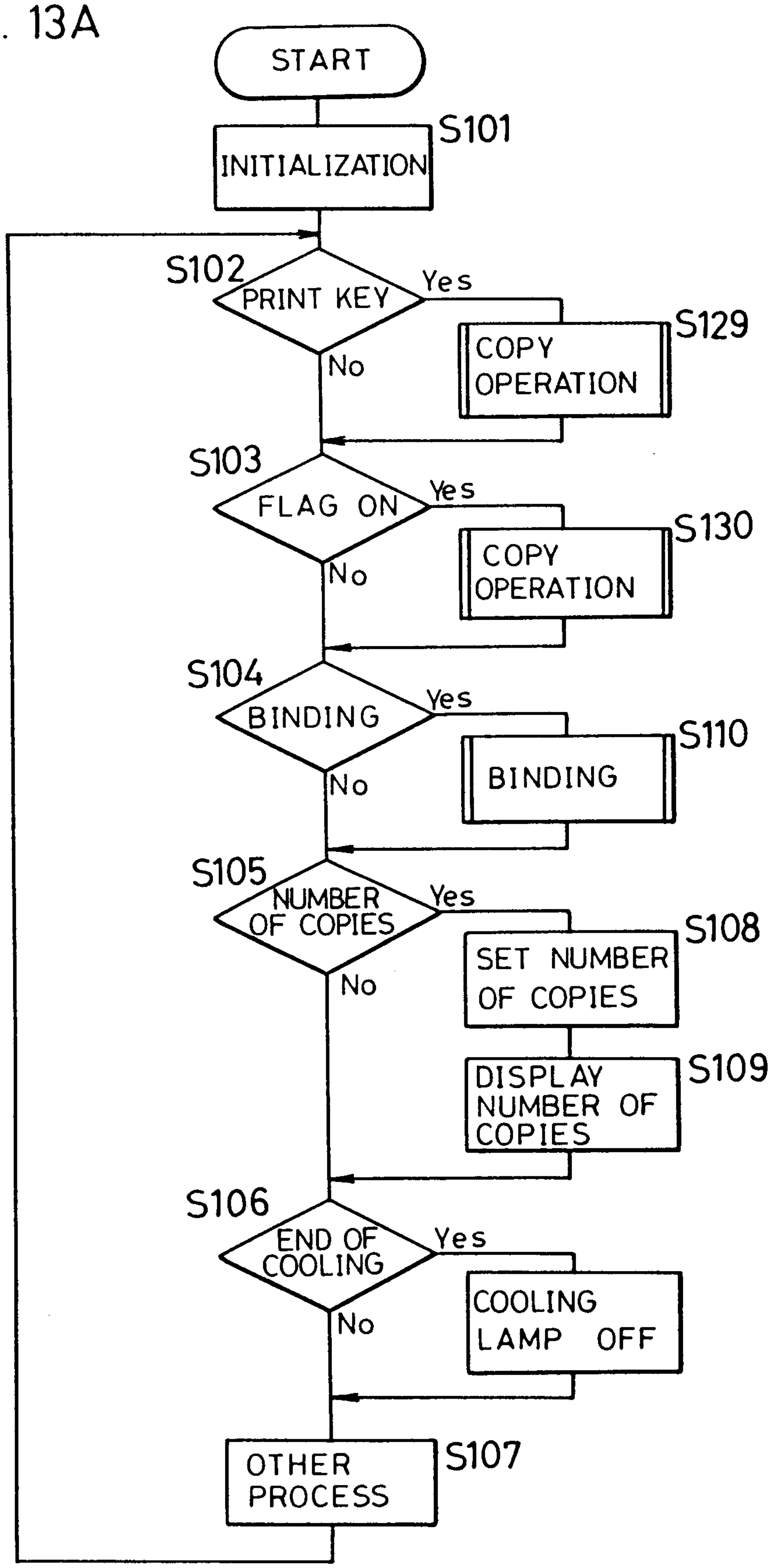


FIG. 13A


START
INITIALIZATION
S101
S102
PRINT KEY
Yes
No
COPY OPERATION
S129
S103
FLAG ON
Yes
No
COPY OPERATION
S130
S104
BINDING
Yes
No
BINDING
S110
S105
NUMBER OF COPIES
Yes
No
SET NUMBER OF COPIES
S108
DISPLAY NUMBER OF COPIES
S109
S106
END OF COOLING
Yes
No
COOLING LAMP OFF
OTHER PROCESS
S107

F I G. 13B

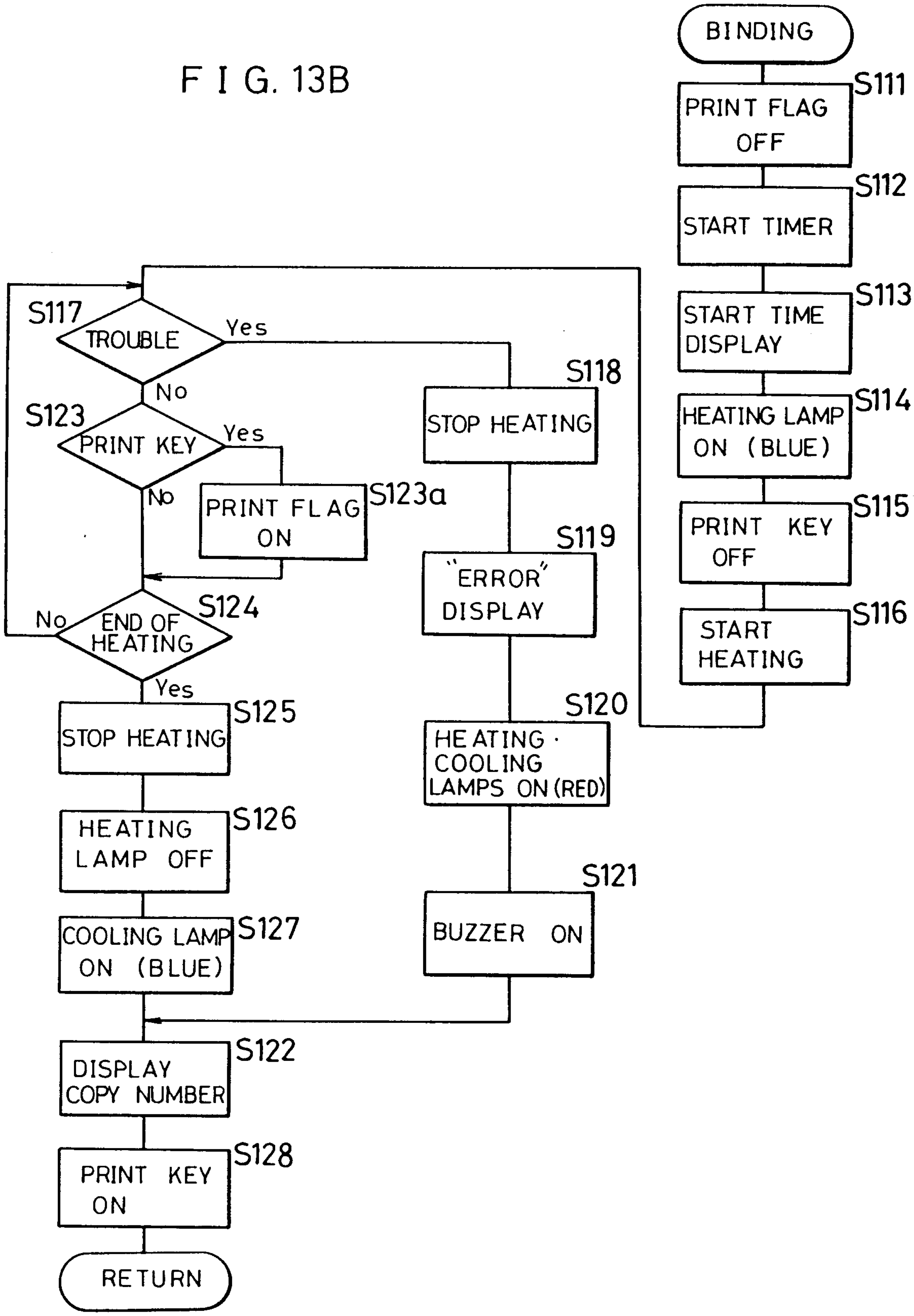

BINDING
S111
PRINT FLAG OFF
S112
START TIMER
S113
START TIME DISPLAY
S114
HEATING LAMP ON (BLUE)
S115
PRINT KEY OFF
S116
START HEATING
S117
TROUBLE
Yes
No
S118
STOP HEATING
S119
"ERROR" DISPLAY
S120
HEATING · COOLING LAMPS ON (RED)
S121
BUZZER ON
S123
PRINT KEY
Yes
No
S123a
PRINT FLAG ON
S124
END OF HEATING
No
Yes
S125
STOP HEATING
S126
HEATING LAMP OFF
S127
COOLING LAMP ON (BLUE)
S122
DISPLAY COPY NUMBER
S128
PRINT KEY ON
RETURN

FIG. 13C

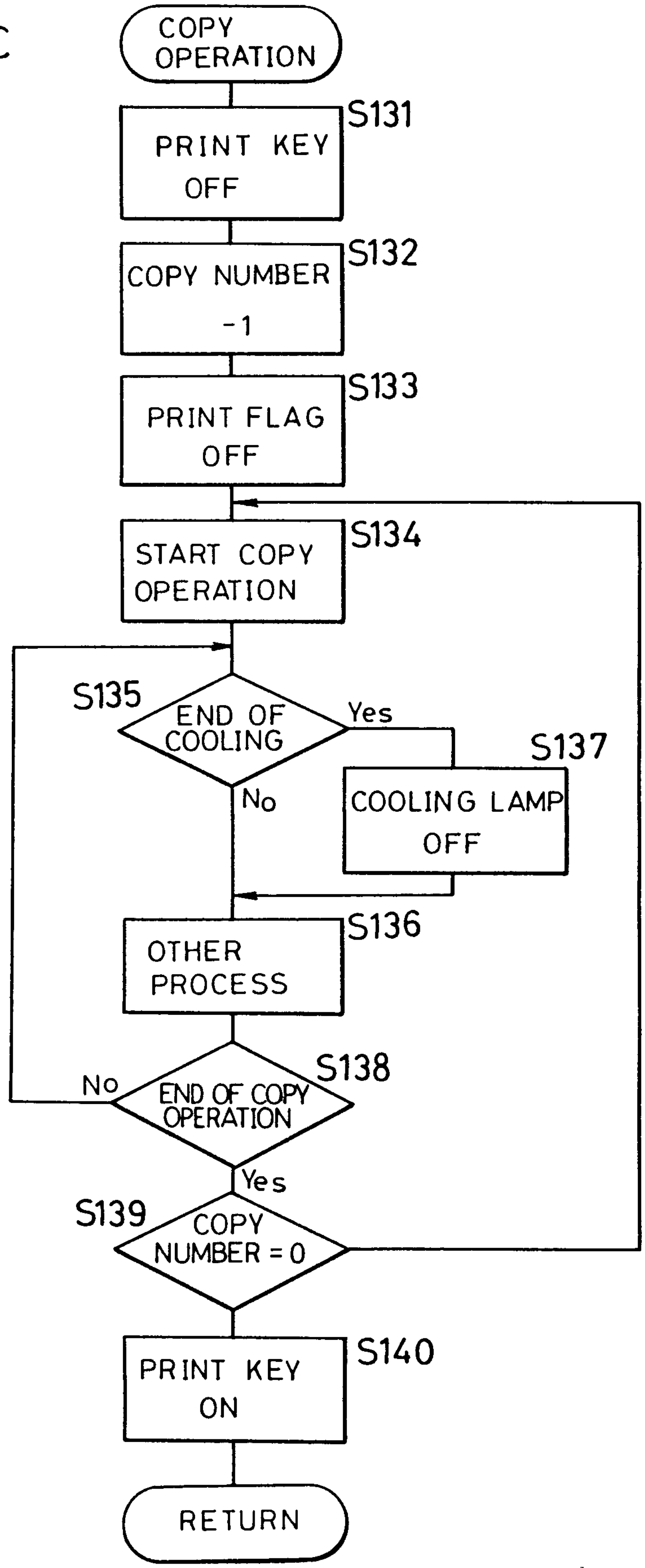

COPY OPERATION
S131
PRINT KEY OFF
S132
COPY NUMBER -1
S133
PRINT FLAG OFF
S134
START COPY OPERATION
S135
END OF COOLING
Yes
S137
COOLING LAMP OFF
No
S136
OTHER PROCESS
S138
No
END OF COPY OPERATION
Yes
S139
COPY NUMBER = 0
S140
PRINT KEY ON
RETURN

FIG. 14A

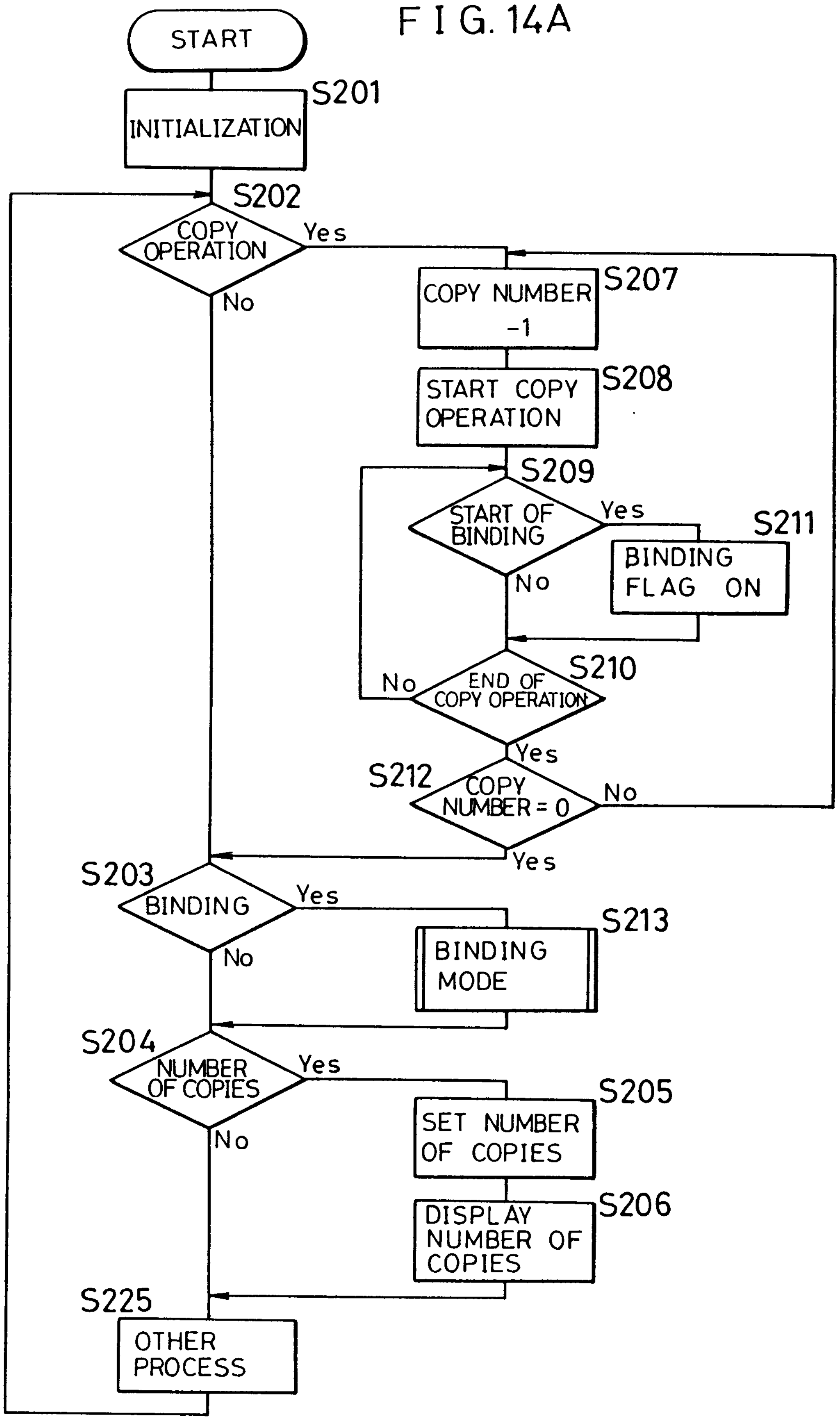

START
S201
INITIALIZATION
S202
COPY OPERATION
Yes
No
S207
COPY NUMBER -1
S208
START COPY OPERATION
S209
START OF BINDING
Yes
No
S211
BINDING FLAG ON
S210
END OF COPY OPERATION
No
Yes
S212
COPY NUMBER = 0
No
Yes
S203
BINDING
Yes
No
S213
BINDING MODE
S204
NUMBER OF COPIES
Yes
No
S205
SET NUMBER OF COPIES
S206
DISPLAY NUMBER OF COPIES
S225
OTHER PROCESS

FIG. 14B

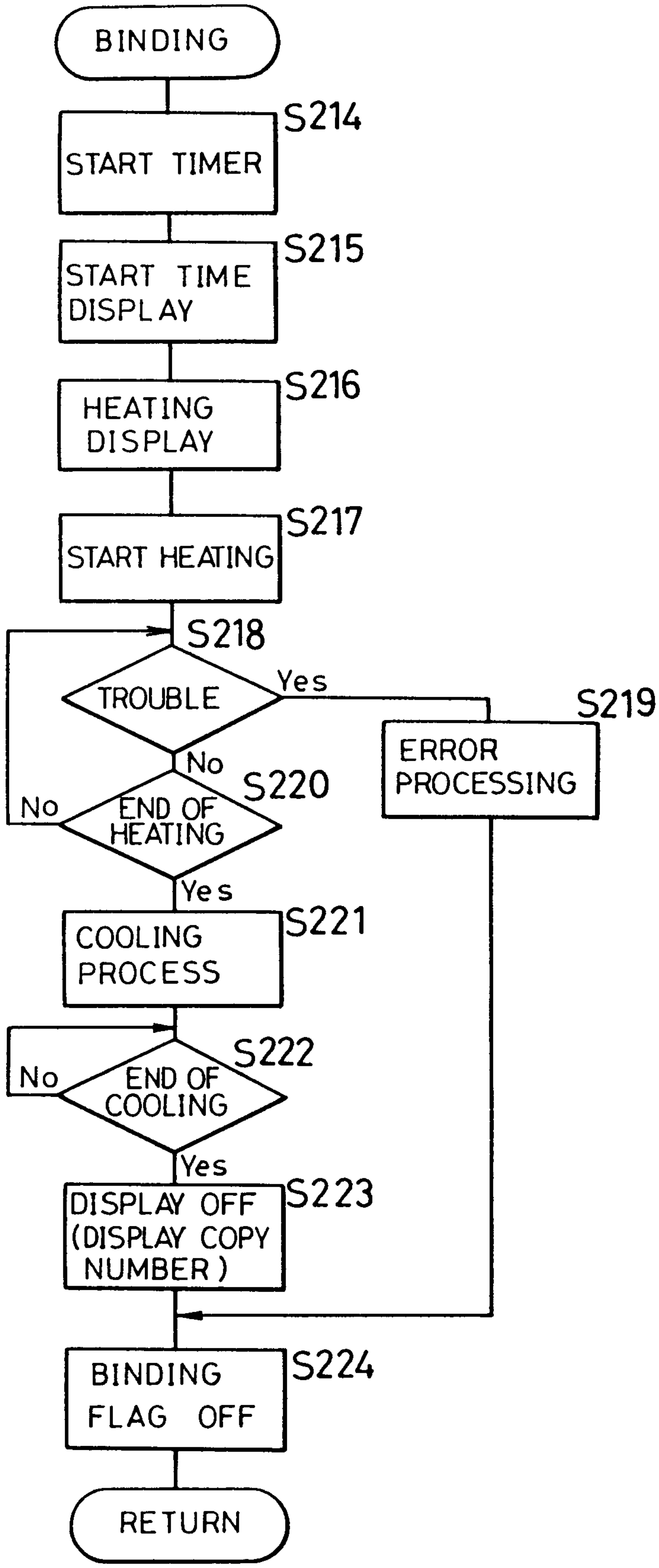
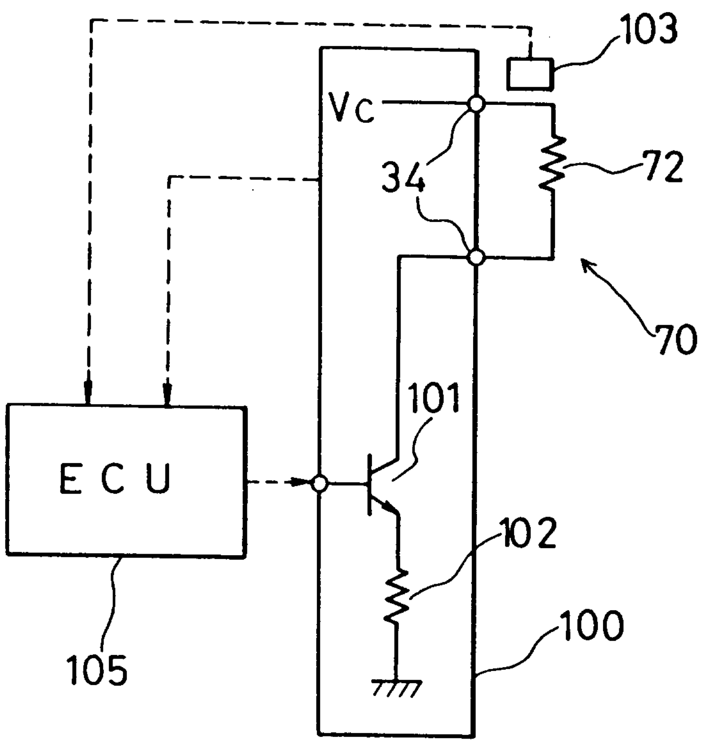

BINDING
S214
START TIMER
S215
START TIME DISPLAY
S216
HEATING DISPLAY
S217
START HEATING
S218
TROUBLE
Yes
S219
ERROR PROCESSING
No
S220
END OF HEATING
No
Yes
S221
COOLING PROCESS
S222
END OF COOLING
No
Yes
S223
DISPLAY OFF (DISPLAY COPY NUMBER)
S224
BINDING FLAG OFF
RETURN

FIG. 15



F I G. 16

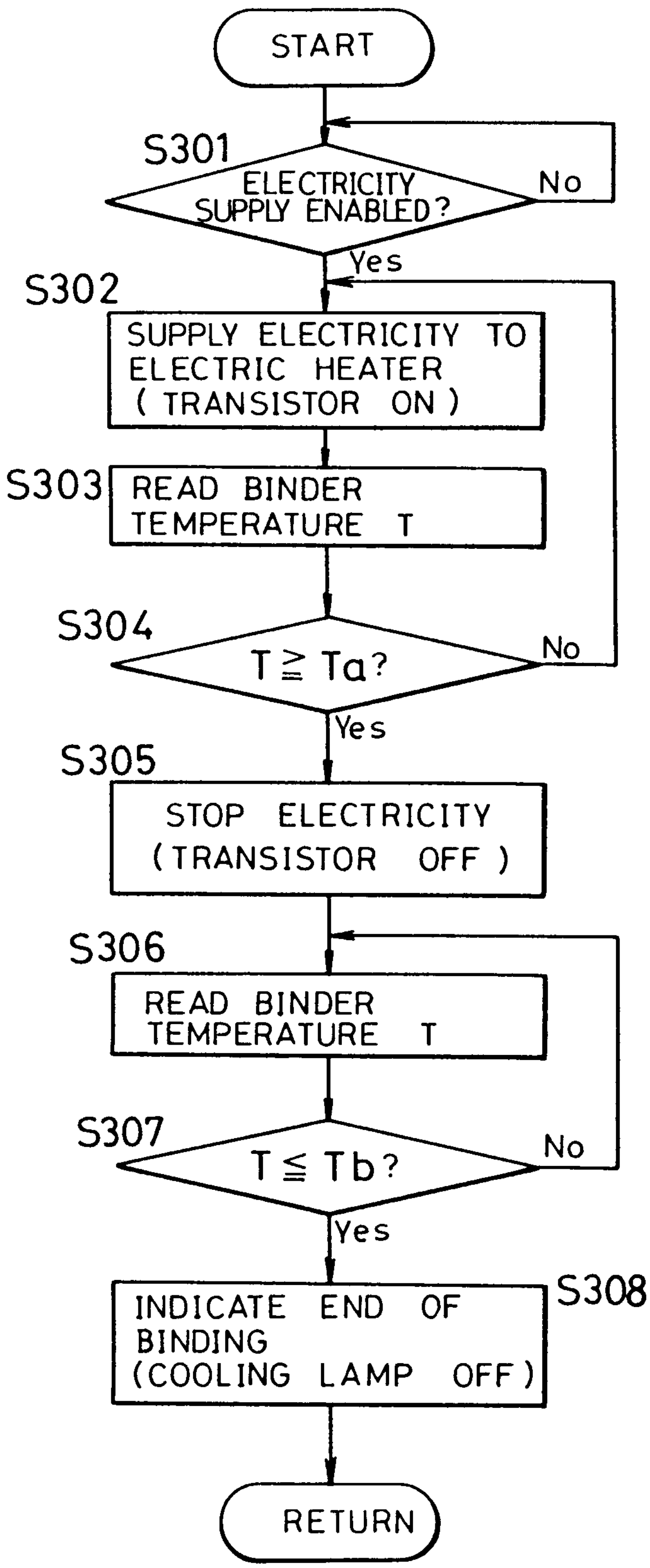

START
S301
ELECTRICITY SUPPLY ENABLED?
No
Yes
S302
SUPPLY ELECTRICITY TO ELECTRIC HEATER (TRANSISTOR ON)
S303
READ BINDER TEMPERATURE T
S304
T ≧ Ta?
No
Yes
S305
STOP ELECTRICITY (TRANSISTOR OFF)
S306
READ BINDER TEMPERATURE T
S307
T ≦ Tb?
No
Yes
S308
INDICATE END OF BINDING (COOLING LAMP OFF)
RETURN

FIG. 17

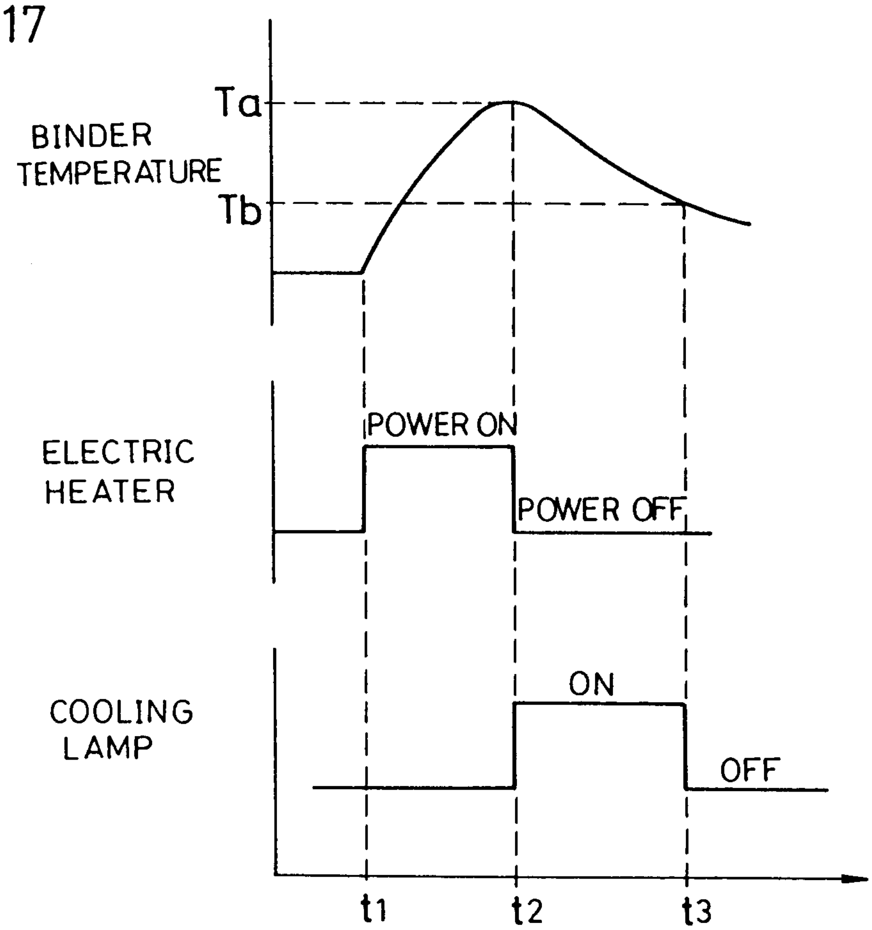

BINDER
TEMPERATURE
Ta
Tb
ELECTRIC
HEATER
POWER ON
POWER OFF
COOLING
LAMP
ON
OFF
t1
t2
t3

FIG. 18

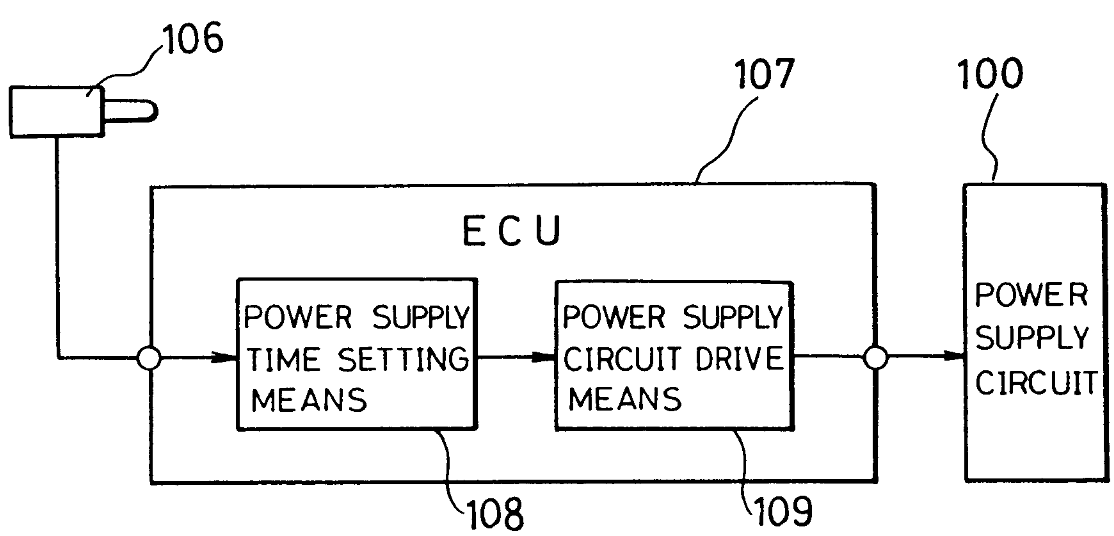

106
107
100
ECU
POWER SUPPLY TIME SETTING MEANS
POWER SUPPLY CIRCUIT DRIVE MEANS
POWER SUPPLY CIRCUIT
108
109

FIG.19

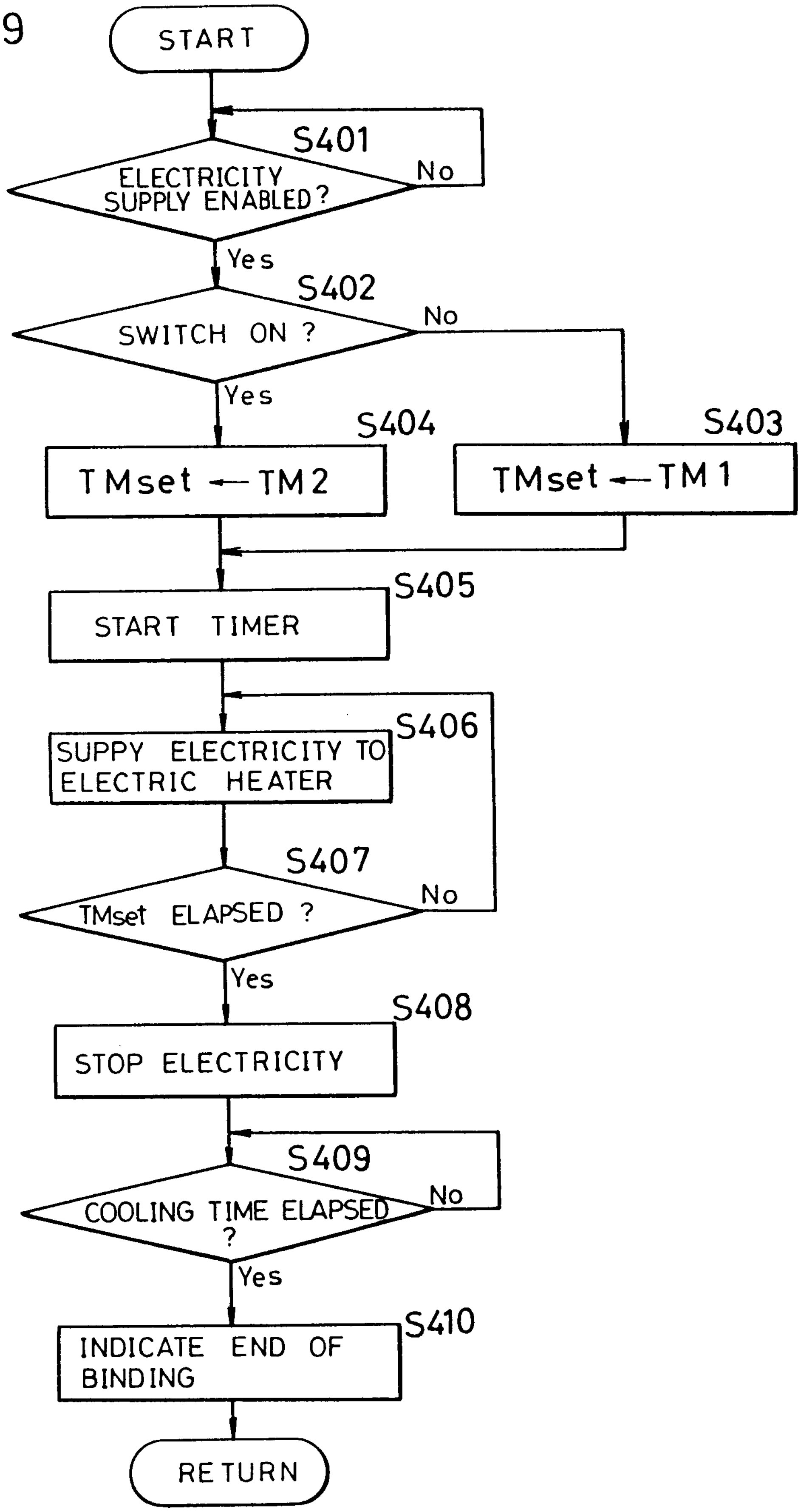

START
S401
ELECTRICITY SUPPLY ENABLED?
No
Yes
S402
SWITCH ON ?
No
Yes
S404
TMset ← TM2
S403
TMset ← TM1
S405
START TIMER
S406
SUPPY ELECTRICITY TO ELECTRIC HEATER
S407
TMset ELAPSED ?
No
Yes
S408
STOP ELECTRICITY
S409
COOLING TIME ELAPSED ?
No
Yes
S410
INDICATE END OF BINDING
RETURN

FIG. 20

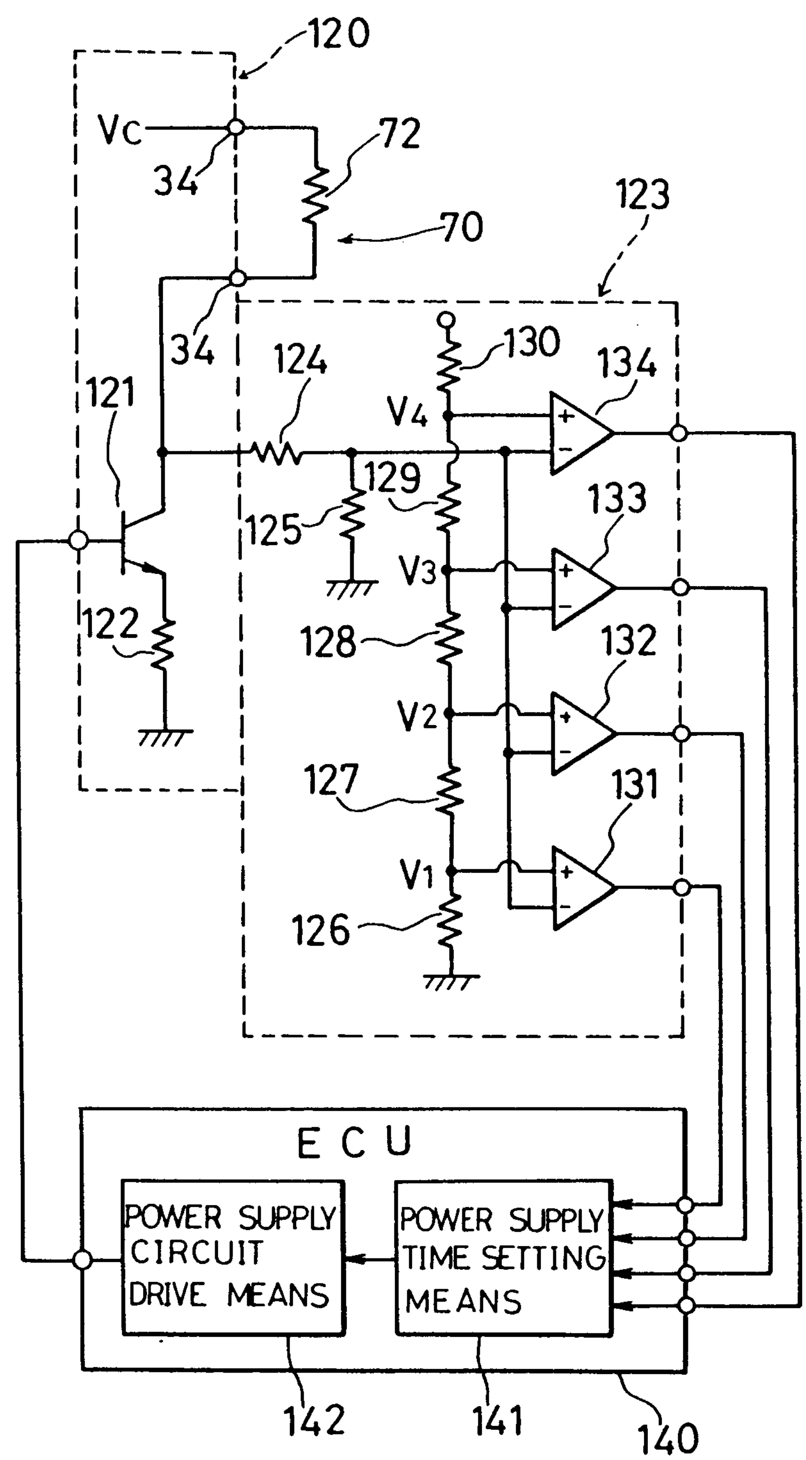

120
Vc
34
72
70
123
34
124
130
134
121
V4
129
125
133
V3
122
128
132
V2
127
131
V1
126
ECU
POWER SUPPLY CIRCUIT DRIVE MEANS
POWER SUPPLY TIME SETTING MEANS
142
141
140

FIG. 21

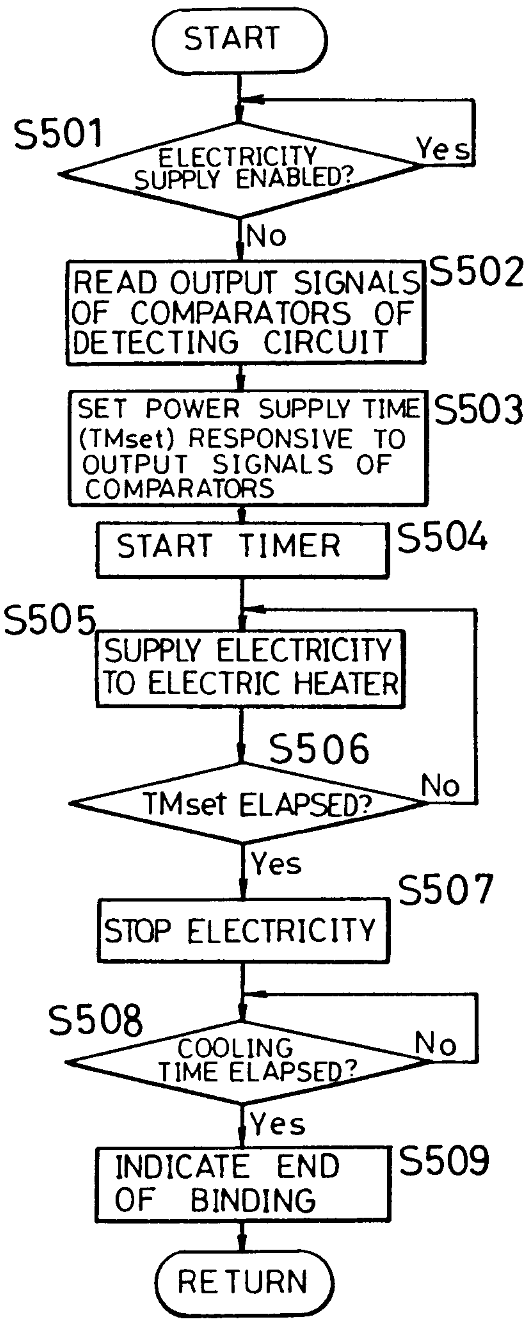


FIG. 22

POTENTIAL	OUTPUT OF COMPARATOR				POWER SUPPLY TIME (sec)
	1st	2nd	3rd	4th	
$V < V_1$	H	H	H	H	60
$V_1 \leqq V < V_2$	L	H	H	H	55
$V_2 \leqq V < V_3$	L	L	H	H	45
$V_3 \leqq V < V_4$	L	L	L	H	40
$V_4 \leqq V$	L	L	L	L	35

FIG. 23

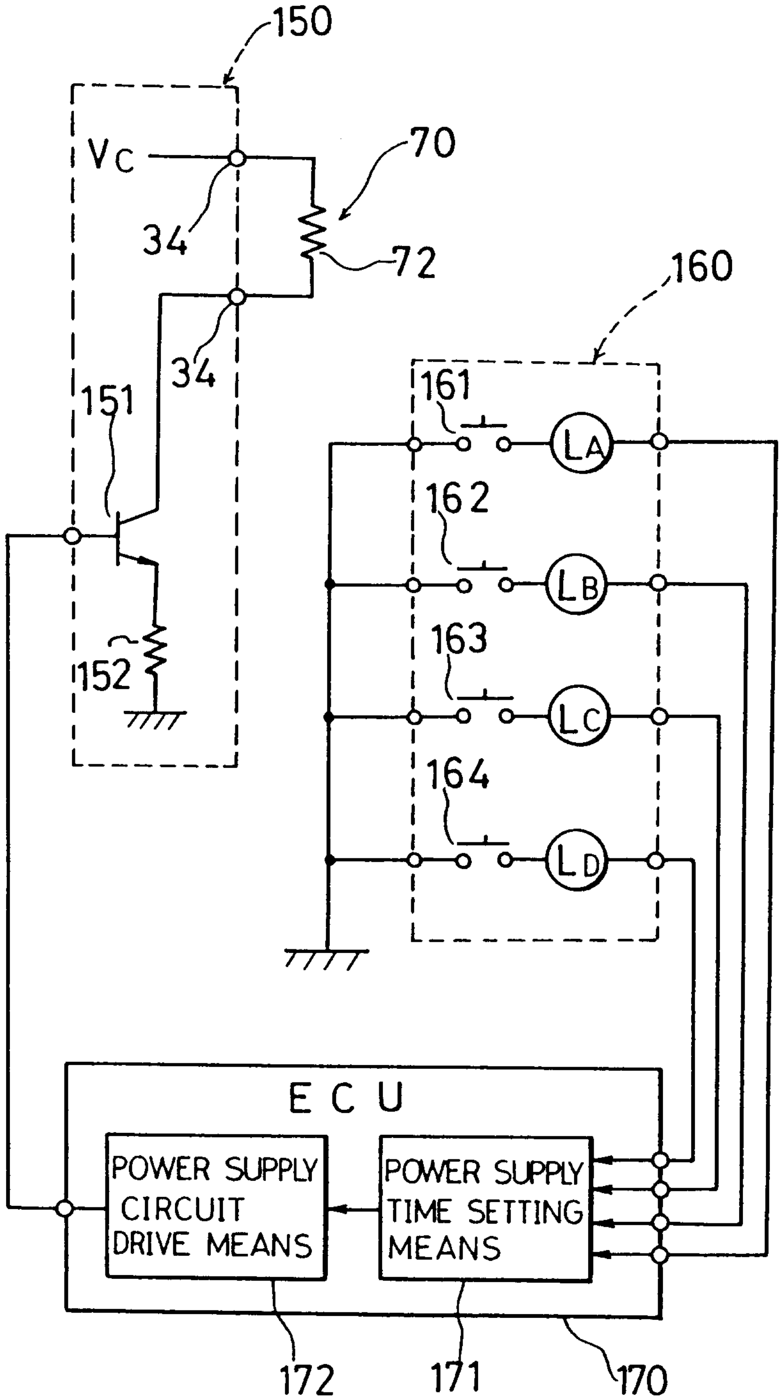
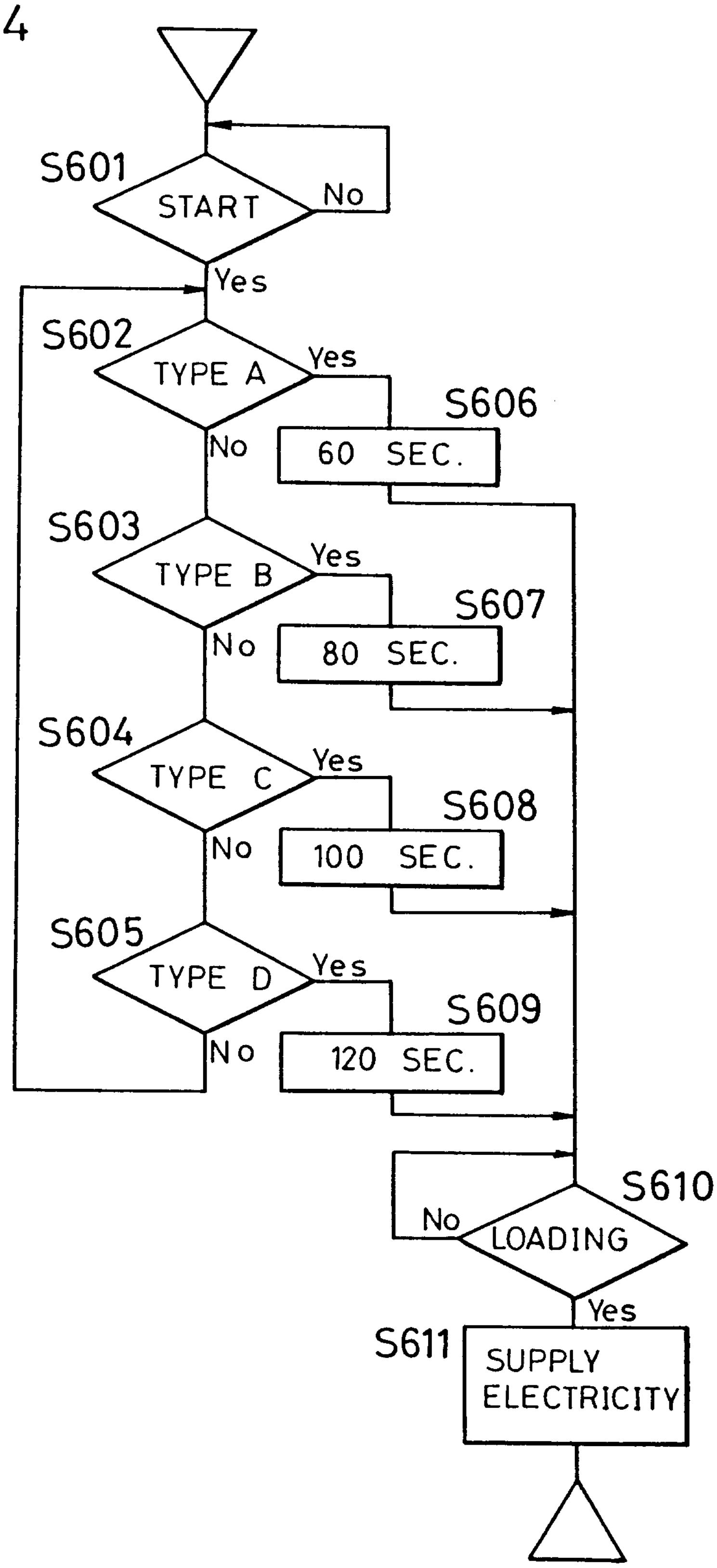

150
Vc
70
34
72
34
160
161
151
LA
162
LB
163
152
LC
164
LD
ECU
POWER SUPPLY CIRCUIT DRIVE MEANS
POWER SUPPLY TIME SETTING MEANS
172
171
170

FIG. 24


S601
START
No
Yes
S602
TYPE A
Yes
S606
60 SEC.
No
S603
TYPE B
Yes
S607
80 SEC.
No
S604
TYPE C
Yes
S608
100 SEC.
No
S605
TYPE D
Yes
S609
120 SEC.
No
S610
LOADING
No
Yes
S611
SUPPLY
ELECTRICITY