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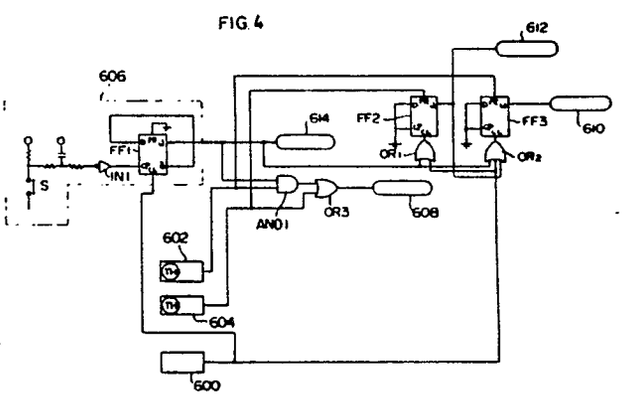
(54) Electrostatic copying apparatus.

(57) An electrostatic copying apparatus equipped with a heat fixing device, one of the fixing rollers being drivingly connected to a drive source and at least one of the fixing rollers including an electrical heating element. Said apparatus comprises a starting means (600) which produces a power supply closing signal when a power switch is closed, a first temperature detector (602) which detects the temperature of the fixing rollers and when the detected temperature reaches a first predetermined temperature T_1, produces a first temperature reaching signal, a second temperature detector (604) which detects the temperature of the fixing rollers and when the detected temperature reaches a second predetermined temperature T_2 suitable for fixing and higher than the first predetermined temperature T_1, produces a second temperature reaching signal, a condition setting means (606) which includes a preheating switch and produces either a normal condition signal or a pre-heated condition signal in response to the actuation of the pre-heating switch, a driving control means (610) for controlling the operation of the drive source (308), and a heating control means (608) for controlling the operation of the heating element (480).

FIG. 4



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ELECTROSTATIC COPYING APPARATUS

FIELD OF THE INVENTION

This invention relates to an improvement related to the fixing device of an electrostatic copying apparatus, particularly a shell-type electrostatic copying apparatus.

DESCRIPTION OF THE PRIOR ART

Generally, electrostatic copying apparatuses, not limited to those of the shell-type described above, include a fixing device for fixing a toner image on the surface of a sheet material such as a copying paper, a mechanism for conveying the sheet material as required, and a paper feeding device of the cassette type. Conventional electrostatic copying apparatuses also have problems to be solved with regard to these devices. The following are typical of these problems.

In a fixing device of the type including a pair of cooperating fixing rollers, the fixing rollers remain in press contact with each other even when the drive power source is deenergized and the fixing rollers are not rotating. Accordingly, if one of the fixing rollers is made of a flexible material, inconveniences such as the generation of localized strain in the fixing rollers occur.

In a fixing device of the type including a pair of fixing rollers at least one of which includes an electrical heating element, the heating element tends to consume power excessively and the fixing rollers tend to be adversely affected by the toner which remains adhering to the fixing rollers.

SUMMARY OF THE INVENTION

It is the object of this invention to provide an improved electrostatic copying apparatus in which excessive consumption of power by an electrical heating element in a fixing device is inhibited and fixing rollers are prevented from being adversely affected by a toner which remains adhering to the fixing rollers.

Other features of this invention will become apparent from the following description.

According to this invention, there is provided an electrostatic copying apparatus equipped with a heat fixing device having a pair of fixing rollers for cooperatively fixing a toner image to the surface of a sheet material, one of the fixing rollers being drivingly connected to a drive source and at least one of the fixing rollers including an electrical heating element; wherein

said apparatus comprises a starting means which produces a power supply closing signal when a power switch is closed, a first temperature detector which detects the temperature of the fixing rollers and when the detected temperature reaches a first predetermined temperature T_1, produces a first temperature reaching signal, a second temperature detector which detects the temperature of the fixing rollers and when the detected temperature reaches a second predetermined temperature T_2 suitable for fixing and higher than the first predetermined temperature T_1, produces a second temperature reaching signal, a condition setting means which includes a pre-heating switch and produces either a normal condition signal or a pre-heated condition signal in response to the actuation of the pre-heating switch, a driving control means for controlling the operation of the drive source, and a heating control means for controlling the operation of the heating element;

when the starting means produces the power supply closing signal, the heating control means begins to energize the heating element, and

in a condition in which the condition setting means is producing the normal condition signal, the heating control means energizes the heating element when the second temperature detector produces the second temperature reaching signal, and deenergizes it when the second temperature reaching signal disappears, and

in a condition in which the condition setting means is producing the pre-heated condition signal, the heating control means deenergizes the heating element when the first temperature detector produces the first temperature reaching signal and energizes it when the first temperature reaching signal disappears; and

when the condition setting means produces the normal condition signal and the first temperature detector produces the first temperature reaching signal, the driving control means energizes the drive source until the second temperature detector produces the second temperature reaching signal.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a simplified sectional view showing the general construction of an electrostatic copying apparatus to which the improvements in accordance with this invention are applicable;

Figure 2 is a sectional view showing the supporting structure of the copying apparatus according to Figure 1;

Figure 3 is a partial sectional view showing a fixing device in the copying apparatus shown in Figure 1;

Figure 4 is a diagram for illustrating the operation of the control system of the fixing device; and

Figure 5 is a partial sectional view showing a sheet material conveying mechanism in the copying apparatus shown in Figure 1.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS OUTLINE OF THE COPYING APPARATUS AS A WHOLE

First of all, the general construction of the copying apparatus is described with reference to Figure 1 which is a simplified sectional view of one embodiment of an electrostatic copying apparatus to which this invention is applicable.

The illustrated copying apparatus has a nearly rectangular parallelpipedal housing shown generally at 2. A transparent plate 4 on which to place a document to be copied is disposed on the upper surface of the housing 2. Furthermore, an openable and closable document holder 6 is mounted on the upper surface of the housing 2 for covering the transparent plate 4 and a document placed on it (in Figure 1, the document holder 6 is shown in a closed position at which it covers the transparent plate 4).

The inside of the housing 2 is divided into an upper space and a lower space by horizontal plates 8 and 10. A rotating drum 12 having a photosensitive material on its peripheral surface is rotatably mounted nearly centrally in the lower space. Around the rotating drum 12 to be rotated in the direction of an arrow 14 are disposed a charging zone 16, an exposing zone 18, a developing zone 20, a transfer zone 22, a peeling zone 24 and a cleaning zone 26 in this order as viewed in the rotating direction of the drum 12. A charging corona discharge device 28 is provided in the charging zone 16, and a suitable developing device 30 is provided in the developing zone 20. A transfer corona discharge device 32 is disposed in the transfer zone 22. A peeling corona discharge device 34 is disposed in the peeling zone 24. In the cleaning zone 26, there is provided a cleaning device 36 which as will be described in detail hereinafter includes a cleaning blade and a charge eliminating lamp.

A sheet material conveying device generally shown at 38 is disposed in the lower section of the housing 2. At one end (the right end in Figure 1) of the sheet material conveying device 38, a cassette-type copying paper feed device 40 and a manual sheet feeding device 42 located above it are provided. The paper feed device 40 is comprised of a combination of a paper cassette receiving section 46 having a feed roller 44 provided therein and a copying paper cassette 50 to be loaded in the cassette receiving section 46 through an opening 48 formed in the right wall of the housing 2, and copying paper sheets are fed one by one from a layer 52 of copying paper cassette 50 by the action of the feed roller 44.

The manual feeding device 42 includes a horizontal guide plate 56 projecting outwardly through an opening 54 formed in the right wall of the housing 2, a guide plate 58 located above the guide plate 56 and a pair of feed rollers 60 and 62 located downstream (left in Figure 1) of these guide plates 56 and 58. When a suitable sheet material such as a copying paper sheet is positioned on the horizontal guide plate 56 and advanced to the nipping position of the pair of feed rollers 60 and 62, the feed rollers 60 and 62 nip the sheet material and feed it. The copying paper fed between the guide plates 64 and 66 from the paper feed device 40 or the sheet material fed between the guide plates 64 and 68 from the manual feed device 42 is conveyed to the transfer zone 22 and the peeling zone 24 between guide plates 74 and 76 by the action of a pair of conveying rollers 70 and 72.

Then, the sheet material is conveyed by the action of a suitable conveyor belt mechanism 78 to a fixing device 80 (which will be described in greater detail hereinafter). Thereafter, it is discharged onto a receiving tray 84 through an opening 82 formed in the left wall of the housing 2.

In the upper space above the horizontal plates 8 and 10 in the housing 2, there is provided an optical unit generally shown at 86 for scanning and exposing a document placed on the transparent plate 4 and projecting an image of the document onto the photosensitive material on the rotating drum 12 in the exposing zone 18. The optical unit 86 includes a document illuminating lamp 88 for illuminating the document on the transparent plate 4, and a first reflecting mirror 90, a second reflecting mirror 92, a third reflecting mirror 94, a lens assembly 96 and a fourth reflecting mirror 98 for projecting the light reflected from the document onto the photosensitive material. In the scanning and exposing process, the document illuminating lamp 88 and the first reflecting mirror 90 are moved from a scanning exposure start position shown by a solid line substantially horizontally to a required position (for example, a maximum scanning exposure end position shown by a two-dot chain line) at a required velocity V, and the second reflecting mirror 92 and the third reflecting mirror 94 are moved from a scanning exposure start position shown by a solid line to a required position (for

example, a maximum scanning exposure end position shown by a two-dot chain line) at a velocity half of the aforesaid required velocity V (i.e., at $\frac{1}{2}$ V). At this time, the light reflected from the document illuminated by the document illuminating lamp 88 is successively reflected by the first reflecting mirror 90, the second reflecting mirror 92 and the third reflecting mirror 94, and reaches the lens assembly 96. Fron the lens assembly 96, the light is reflected by the fourth reflecting mirror 98 and reaches the photosensitive material in the exposure zone 18 through an opening 100 formed in the horizontal plate 8. When the scanning exposure is over, the document illuminating lamp 88, the first reflecting mirror 90, the second reflecting mirror 92 and the third reflecting mirror 94 are returned to the scanning exposure start position shown by the solid line.

In the copying apparatus described above, while the rotating drum 12 is rotated in the direction of arrow 14, the charging corona discharge device 28 charges the photosensitive material to a specified polarity substantially uniformly in the charging zone 16. Then, in the exposure zone 18, the optical unit 86 projects an image of the document to form a latent electrostatic image corresponding to the document on the charged photosensitive material. In the developing zone 20, the developing device 30 applies a toner to the latent electrostatic image on the photosensitive material to develop the latent electrostatic image to a toner image. Then, in the transfer zone 22, a sheet material such as a copying paper fed from the paper feed device 40 or the manual feeding device 42 is contacted with the photosensitive material, and by the action of the transfer corona discharge device 32, the toner image on the photosensitive material is transferred to the sheet material. Thereafter, in the peeling zone 24, the sheet material is peeled from the photosensitive material by the action of the peeling corona discharge device 34. The sheet material having the toner image transferred thereto is then conveyed to the fixing device 80 to fix the toner image, and then discharged into the receiving tray 84. In the meantime, the rotating drum continues to rotate, and in the cleaning zone 26, the toner and the static charge remaining on the photosensitive material after transfer are removed by the action of the cleaning device 36.

Shell-type supporting structure

With reference to Figure 2, the illustrated copying apparatus constructed in accordance with this invention is equipped with a so-called shell-type supporting structure constructed of a first supporting frame, or a lower supporting frame, 102 and a second supporting frame, or an upper supporting frame, 104 which are connected to each other for relative pivotal movement.

In the illustrated embodiment, a supporting leg 106 is formed on the lower surface of the lower supporting frame 102, and by positioning the supporting leg 106 on the upper surface of a supporting table (not shown) or the like, the lower supporting frame 102 is disposed in a required position. The lower supporting frame 102 has a vertical front base plate 108 and a vertical rear base plate 110 spaced from each other in the front-rear direction (a direction perpendicular in the sheet surface in Figure 2) (Figure 2 shows only the vertical front base plate 108).

To the right end portion of each of the vertical front base plate 108 and the vertical rear base plate 110 of the lower supporting frame 102, a supporting protruding portion 112 projecting upwardly is formed, and a pivotal supporting shaft 114 extending in the front-rear direction is mounted on the supporting protruding portion 112. The front end and the rear end of the supporting shaft 114 project somewhat forwardly and rearwardly of the supporting protruding portions 112 of the vertical front base plate 108 and the vertical rear base plate 110, respectively.

The upper supporting frame 104 also includes a vertical front base plate 116 and a vertical rear base plate 118 which are disposed in spaced-apart relationship in the front-rear direction (a direction perpendicular to the sheet surface in Figure 2) (Figure 2 shows only the vertical front base plate 116.).

The distance in the front-rear direction between the vertical front base plate 116 and the vertical rear base plate 118 of the supporting frame 104 is slightly larger than the distance in the front-rear direction between the vertical front base plate 108 and the vertical rear base plate 110 of the lower supporting frame 102. The vertical front base plate 116 and the vertical rear base plate 118 of the upper supporting frame 104 are located slightly forwardly and rearwardly of the vertical front base plate 108 and the vertical rear base plate 110 of the lower supporting frame 102, respectively. A downwardly projecting protruding support portion 120 is formed in the right end portion of each of the vertical front base plate 116 and the vertical rear base plate 118 of the upper supporting frame 104, and a nearly semicircular cut 122 is formed at the lower edge of protruding support portion 120. The cuts 122 formed in the lower edges of the protruding support portions 120 are engaged with the opposite end portions of the supporting shaft 114 (i.e., its front end portion and rear end portion projecting beyond the vertical front base plate 108 and the vertical rear base plate 110 of the lower

supporting frame 102 forwardly and rearwardly, respectively), and as a result, the supporting frame 104 is mounted on the lower supporting frame 102 for free pivotal movement about the support shaft 114. A restraining member (not shown) having a hole through which the supporting shaft 114 passes is fixed to each of the protruding support portion 120 of the supporting frame 104 thereby to prevent surely the upward movement of the protruding support portions 120.

Between the lower supporting frame 102 and the upper supporting frame 104 mounted on the lower supporting frame 102 for free pivotal movement about the supporting shaft 114, there is interposed a spring means 124 for elastically biasing the upper supporting frame 104 clockwise in Figure 2 about the supporting shaft 114 with respect to the lower supporting frame 102. In the illustrated embodiment, the spring means 124 is comprised of a pair of compression coil springs 126 disposed on the front and rear surfaces of the lower supporting frame 102 and the upper supporting frame 104. Linking pieces 128 and 130 are fixed to the opposite ends of each of the compression coil springs 126. Between the linking pieces 128 and 134 is disposed a stretchable member (not shown) extending within the compression coil springs 126. On the other hand, the linking piece 128 of one compression coil spring 126 is privotally connected to a pin 132 set firmly in the front surface of the vertical front base plate 108 of the lower supporting frame 102, and the linking piece 130 is connected pivotally to a pin 134 set firmly in the vertical front base plate 116 cf the upper supporting frame 104. The linking piece 128 of the other compression coil spring 126 is connected pivotally to a pin 132 set firmly in the rear surface of the vertical rear base plate 110 of the lower supporting frame 102, and the linking piece 130 is connected pivotally to a pin 134 firmly set in the rear surface of the vertical rear base plate 118 of the upper supporting frame 104. As stated above, the spring means 124 composed of a pair of compression springs elastically biases the supporting frame 104 clocIwise in Figure 2 about the supporting shaft 114 as a center. As can be easily understood, when the upper supporting frame 104 is pivoted clockwise in Figure 2 about the supporting shaft 114 from the closed position shown by solid line in Figure 2 by the elastic biasing action of the spring means 124, the elastic biasing action of the spring means 124 becomes gradually small as the upper supporting frame 104 pivots. When the upper supporting frame 104 is pivoted to the open position shown by a two-dot chain line in Figure 2, the elastic biasing action of the spring means 124 to pivot the upper supporting frame 104 clockwise in Figure 2 about the supporting shaft 114 is equilibrated with the moment acting to pivot the upper supporting frame 104 counterclockwise in Figure 2 about the supporting shaft 114 due to the own weight of the upper supporting frame 104 and the various constituent elements mounted on it. As a result, the upper supporting frame 104 is held at the open position shown by a two-dot chain line in Figure 2.

The lower supporting frame 102 and the upper supporting frame 104 also have provided therein a locking mechanism for locking the upper supporting frame 104 at the closed position shown in Figure 2 against the elastic biasing action of the spring means 124. An engaging pin 136 is set firmly in the upper portion of the left end of the front surface of the vertical front base plate 108 of the lower supporting frame 102, and a supporting pin 138 is set firmly in the lower portion of the left end of the front surface of the vertical front base plate 116 of the upper supporting frame 104. A hook 140 to be engaged with the engaging pin 136 is mounted on the supporting pin 138. The hook 140 is mounted on the supporting pin 138 so that it can freely pivot clockwise in Figure 2 from the angular position shown in the drawing, and is elastically biased counter-clockwise in Figure 2 and elastically held at the angular position shown in the drawing by spring means (not shown). The lower end of the hook 140 is inclined upwardly to the right in the drawing. Furthermore, an operating piece 142 protruding outwardly beyond the left edge of the upper supporting frame 104 is provided in the hook 140. In the illustrated embodiment, an engaging pin 136 and a hook 140 are likewise provided in the top left end of the rear surface of the vertical rear base plate 110 of the lower supporting frame 102 and the left end bottom of the rear surface of the vertical rear base plate 118 of the supporting frame 104. If desired, the operating piece 142 of the hook 140 provided on the front surface may be linked with the operating piece 142 of the hook 140 provided on the rear surface by a suitable member extending in the front-rear direction (i.e., a direction perpendicular to the sheet surface in Figure 2) to interlock the two hooks 140.

When the upper supporting frame 104 is pivoted counterclockwise about the supporting shaft 114 from the open position shown by the two-dot chain line in Figure 2 to a point near the closed position shown by the solid line in Figure 2 against the elastic biasing action of the spring member 124, the inclined lower edge 141 of the hook 140 abuts against the engaging pin 136, thereby to pivot the hook 140 clockwise about the supporting pin 138 as a center. When the upper supporting frame 104 is pivoted to the closed position shown by the solid line in Figure 2, the inlined lower edge of the hook 140 goes past the engaging pin 136, and therefore,

the hook 140 is returned to the angular position shown in the drawing by the elastic biasing action of the spring means (not shown) and engaged with the engaging pin 136. Thus, the supporting frame 104 is surely locked at the closed position shown by the solid line in Figure 2 against the elastic biasing action of the spring means 124. On the other hand, when the operation piece 142 of the hook 140 is manually operated to pivot the hook 140 clockwise about the supporting pin 138 as a center and to disengage it from the engaging pin 136, the upper supporting frame 104 is pivoted about the supporting shaft 114 as a center to the open position shown by the two-dot chain line in Figure 2 by the elastic biasing action of the spring means 124.

With reference to Figure 1 taken in conjunction with Figure 2, in the illustrated copying apparatus, the constituent elements which are located below a one-dot chain line 144 in Figure 1 are mounted on the lower supporting frame 102, and the constituent elements located above the one-dot chain line 144 in Figure 1 are mounted on the upper supporting frame 104. Accordingly, as can be easily understood with reference to Figure 1, when the upper supporting frame 102 is pivoted from the closed position shown by the solid line in Figure 2 to the open position shown by the two-dot chain line in Figure 2, a greater portion of the sheet material conveying passage is opened. Hence, any sheet material which has jammed up in this portion can be easily taken out (it will be easily understood from Figure 1 that by only bringing the upper supporting frame 104 to the open position shown by the two-dot chain line in Figure 2, the sheet material conveying passage in the fixing device 80 is not opened).

Additionally, a front cover and a rear cover are also mounted on the lower supporting frame 102 and the upper supporting frame 104 (if further required, a right end cover for covering the right end surface thereof and a left end cover for covering the left end surface thereof may also be mounted). These covers are suitably divided into a lower section and an upper section. The lower sections are mounted on the lower supporting frame 102, and the upper sections are mounted on the upper supporting frame 104 and pivoted between the closed position and the open position together with the upper supporting frame 104.

Fixing device

Now, with reference to Figure 3, the construction of the fixing device shown generally at 80 will be described. The illustrated fixing device 80 includes a driven fixing roller 474 and a follower fixing roller 476. The driven fixing roller 474 is composed of a hollow cylindrical member 478 rotatably mounted and adapted to rotate in the direction shown by an arrow and an electrical heating element 480 disposed within the hollow cylindrical member 478. The hollow cylindrical member 478 can be made of a suitable metal such as an aluminum-base alloy having a suitable surface coating, such as a Teflon (trademark) coating, which effectively prevents adhesion of a toner. The electrical heating element 480 may be a resistance heater extending longitudinally of, and within, the hollow cylindrical member 478. On the other hand, the follower fixing roller 476 rotatably supported and adapted to be in press contact with the driving fixing roller 474 is conveniently formed of a suitable flexible material such as a synthetic rubber.

As already stated, the fixing device 80 is entirely mounted on the lower supporting frame 102. Hence, even when the upper supporting frame 104 is held at its open position, the conveying passage for a sheet material such as copying paper which passes through the fixing device 80 is not opened (see Figures 1 and 2 also). Thus, the illustrated embodiment is constructed such that after the upper supporting frame 104 is held at its open position, the conveying passage for a sheet material passing through the fixing device 80 can also be opened as required. This construction will be described in detail. The illustrated fixing device 80 has a movable supporting frame 484 mounted on the shaft 400 so that it can pivot freely between a closed position shown by a solid line in Figure 16 and an open position shown by a two-dot chain line in Figure 16. The shaft 400 itself is fixed to the vertical front base plate 108 and the vertical rear base plate 110 of the lower supporting frame 102.

The rear end portion of the shaft 400 projects rearwardly beyond the vertical rear base plate 110, and the interlocking input gear 336 is rotatably mounted on the shaft 400. The movable supporting frame 484 has a pair of end walls 486 (one of which is shown in Figure 3) spaced from each other a predetermined distance in the front-rear direction, and an upper wall 488. To the left end portion in Figure 3 of the movable supporting frame 484 is fixed a shaft 490 extending across the two end walls 486, and hooks 492 are respectively mounted pivotally on the opposite end portions of the shaft 490 (Figure 3 shows only the hook 492 mounted on the rear end portion of the shaft 490). A projecting portion 496 projecting upwardly through an opening 494 formed in the upper wall 488 of the movable supporting frame 484 is formed integrally in the hook 492. Conveniently, the hooks 492 mounted on the front and rear end portions of the shaft 490 respectively are connected to each other by a lateral member 498 extending across

the projecting portions 496 so that they are interlocked with each other. In relation to each of the hooks 492 is provided a spring means 500 composed of a torsion coil spring one end of which is engaged with the shaft 490 and the other end of which is engaged with the hook 492. The spring means 500 elastically biases the hook 492 counterclockwise in Figure 3 . When the movable supporting frame 484 is at its open position shown by the two dot chain line in Figure 16, the engaging end 502 of the hook 492 abuts against the edge of the end wall 486 of the movable supporting frame 484 thereby preventing the hook 492 from further pivoting counterclockwise, and the hook 492 is elastically held at this angular position by the spring means 500. On the other hand, in relation to the hook 492, an engaged member 504 is fixed between the vertical front base plate 108 and the vertical rear base plate 110 of the lower supporting frame 102. When the movable supporting frame 484 is pivoted counterclockwise from the open position shown by the two-dot chain line in Figure 3 to a point near the closed position shown by the solid line in Figure 3 , the inclined lower edge 506 of the hook 492 abuts against the engaged member 504, and after that, the hook 492 is privoted clockwise against the elastic biasing action of the spring means 500 in response to the counterclockwise pivoting of the movable supporting frame 484. When the engaging end 502 goes past the engaged member 504, the hook 492 is pivoted counterclockwise about the shaft 492 as a center by the elastic biasing action of the spring member 500, whereby the movable supporting frame 484 is surely locked in the closed position shown by the solid line in Figure 3 . When the hook 492 is in engagement with the engaged member 504, some space is conveniently formed between the engaging end 502 of the hook 492 and the edge of the end wall. To hold the movable supporting frame 484 at the closed position shown by the two-dot chain line in Figure 3 , the projecting portion 496 of the hook 492 or the laterial member 498 is operated to pivot the hook 492 clockwise against the elastic biasing action of the spring means 500 and to detach it from the engaged member 504 and thereafter, the movable supporting frame 484 is pivoted counterclockwise. If desired, when the movable supporting frame 484 is pivoted to the open position shown by the two-dot chain line in Figure 3 , a stationary stop piece (not shown) against which the upper wall 488 or the end wall 486 abuts is fixed to the vertical front base plate 108 and/or the vertical rear base plate 110 of the lower supporting frame 102, whereby the movable supporting frame 484 is prevented from pivoting further beyond the open position.

The driven fixing roller 474 in the fixing device 80 is mounted on the movable supporting frame 484 described above. More specifically, shaft portions 506 (see Figure 4) formed on the opposite ends of the hollow cylindrical member 478 of the driven fixed roller 474 are respectively mounted rotatably on the two end walls 486 of the movable supporting frame 484. As can be understood from Figure 4, the shaft portion 506 formed at the rear end of the hollow cylindrical member 478 of the driven fixing roller 474 projects rearwardly beyond the vertical rear base plate 110 of the lower supporting frame 102 together with the rear end wall 486 of the movable supporting frame 484 (therefore, the vertical rear base plate 110 has formed therein a cut which permits the movement of the shaft portion 506 when the movable supporting frame 484 is pivoted between the closed position and the open position, although the cut is not shown in the drawings). To such a projecting portion of the shaft portion 506 is fixed the gear 356 engaged with the interlocking input gear 336 mounted rotatably on the shaft 400 (since the movable supporting frame 484 is pivoted about the shaft 400 on which the interlocking input gear 336 is mounted, the pivoting of the movable supporting frame 484 does not obstruct the engagement between the interlocking input gear 336 and the gear 356). Accordingly, the hollow cylindrical member 478 of the driven fixing roller 474 is drivingly connected to the output shaft 314 of the drive source 308 (Figure 1) through the interlocking input gear 336, the interlocking linking gear 334 and the interlocking output gear 332, and is rotated in the direction shown by an arrow when the drive source 308 is energized. The movable supporting frame 484 further has a supporting plate 508 fixed to, and between the two end walls 486, and a plurality of suspending guide plates 510 (see Figure 10 also) are fixed to the lower surface of the supporting plate 508 at intervals in the front-rear direction (a direction perpendicular to the sheet surface in Figure 3). On the other hand, a guide plate 512 located below the suspending guide plate 510 is mounted between the vertical front base plate 108 and the vertical base plate 110 of the lower supporting frame 102 (see Figure 10 also).

In the fixing device 80 described above, a sheet material such as copying paper having a transferred toner image on its upper surface is guided by a guide plate 511 disposed on the inlet side of the fixing device 80, introduced into the nip position between the driven fixing roller 474 and the follower fixing roller 476, and conveyed by the cooperative movement of the driven fixing roller 474 and the follower fixing roller 476 rotating in the direction of arrows. During this time, the toner image is heat-fixed onto the surface of the sheet material. Then, the sheet material having the heat-

fixed toner image is advanced between the suspending guide plates 510 and the guide plate 512, and sent to a sheet material conveying mechanism shown generally at 514.

Thereafter, it is discharged onto the receiving tray 84 through the opening 82 formed in the left wall of the housing 2 by the action of the sheet material conveying mechanism 514.

When it becomes necessary to open the conveying passage for the sheet material in the fixing device 80 in order to repair, inspect or clean the driving fixing roller 474 and/or the follower fixing roller 476 or to remove the sheet material that has jammed up in the fixing device 80, or for other reasons, the upper supporting frame 104 is held at its open position (see Figure 2) and then the movable supporting frame 484 is moved from its closed position shown by the solid line in Figure 3 to its open position shown by the two-dot chain line in Figure 3 .

Selective press-contacting of the follower fixing roller

In the fixing device 80 described with reference to Figure 3 , when the drive source 308 (Figure 3) is energized, the driven fixing roller 474 and the follower fixing roller 476 to be brought into press contact with it are rotated in the direction of an arrow, and stopped upon deenergization of the drive source 308. As already stated hereinabove, the follower fixing roller 476 is desirably made of a flexible and soft material such as a synthetic rubber. If the follower fixing roller 476 made of such a flexible and soft material contines to be in press contact with the driven fixing roller 474 when the driven fixing roller 474 and the follower fixing roller 476 are stopped by the deenergization of the drive source 308, the following problem arises. Specifically, when the follower fixing roller 476 remains in press contact with the driven fixing roller 474 during stoppage of these rollers 474 and 476, a specified angular position of the follower fixing roller 476 continues to be in press contact with the driven fixing roller 474. Consequently, the follower fixing roller 476 made of the flexible material is deformed locally at the aforesaid specified angular position, and this leads to an adverse effect on the fixing action of the roller afterward. To avoid this problem, in the fixing device 80 in the copying apparatus improved in accordance with this invention, at least one end (preferably both ends) of the follower fixing roller 476 is mounted so that it can move between a press-contacting position and an isolated position. When the drive source 308 is energized, that end of the follower fixing roller 476 is held at the press-contacting position whereby the follower fixing roller 476 is brought into press contact with the driven fixing roller 474. When the drive source 308 is deenergized, that end of the follower fixing roller 476 is moved to the isolated postion whereby the follower fixing roller 476, at least over a greater portion of its longitudinal direction, preferably over its entire longitudinal portion, is completely separated from, or maintained out of press contact with (maintained in light contact with), the driven fixing roller 474, and consequently, the pressure between them is substantially released.

Control system relating to the fixing device

In the illustrated copying apparatus improved in accordance with this invention, a control system shown in a simplified form in Figure 4 is provided in relation to the fixing device 80 (Figure 3). The control system includes a starting means 600), a first temperature detector 602, a second temperature detector 604, a condition setting means 606, a heating control means 608, a drive control mean 610, a display means 612 for indicating that the apparatus is ready for copying, and a pre-heated condition display means 614. The starting means 610 instantaneously produces a power supply closing signal "H" when a power supply switch (not shown) provided in the copying apparatus is closed. The first temperature detector 602 includes a thermistor TH located in contact with, or in proximity to, the surface of the driven fixing roller 474 (Figure 3) in the fixing device 80 for detecting the temperature of the surface or its vicinity of the driven roller 474. The first temperature detector 602 produces a first temperature reaching signal "H" when the temperature detected by the thermistor has reached a first predetermined temperature T_1. The second temperature detector 604 also includes a thermistor TH located in contact with, or in proximity to, the surface of the driven fixing roller 474 for detecting the temperature of the surface or its vicinity of the driven roller 474. The thermistor TH in the first temperature detector 602 and the thermistor TH in the second temperature detector 604 may be separate from each other, or one thermistor may be used as a common thermistor for the two temperature detectors. The second temperature detector 604 produces a second temperature reaching signal "H" when the temperature detected by the thermistor TH has reached a second predetermined temperature T_2. The second predetermined temperature T_2 is higher than the first predetermined temperature T_1 - ($T_2 > T_1$) and is set at a temperature (for example, 180 °C) suitable for heat-fixing a toner image on a sheet material. The first predetermined temperature

T_1 can be prescribed at a suitable point (for example, 170° C) higher than the softening temperature of the toner. The condition setting means 606 includes a preheating switch S adapted for manual operation. When the power supply switch of the copying machine is closed, the heating control means 608 for controlling the electrical heating element 480 provided in the driving fixing roller 474 energizes the electrical heating element 480 unless a signal "H" is fed into it. When the signal "H" is fed, it deenergizes the electrical heating element 480. The drive control means 610 for controlling the drive source 308 energizes the drive source 308 when the signal "H" is fed into it. The display means 612 conveniently having a display lamp, when the signal "H" is fed, indicates that the apparatus is ready for copying. The preheating condition display means 614 conveniently having a display lamp displays a pre-heating condition when the signal "H" is fed into it.

The operation of the control system described above is described below with reference to Figure 5 taken in conjunction with Figure 9 . When the power supply switch (not shown) of the copying apparatus is closed, the starting means 600 instantaneously produces a power supply closing signal "H". The signal "H" is fed into a CL input of a flip-flop FF1 in the condition setting means 606. Hence, the output signal of the condition setting means 606 (i.e., the signal of the Q output of the flip-flop FF1) becomes a normal condtion signal "L", and therefore, the pre-heated condition display means 614 is not operated. The power supply closing signal produced by the starting means 600 is fed into the CL input of a flip-flop FF2 through an OR gate OR1, and also into the CL input of a flip-flop FF3 through an OR gate OR2, and thus, clears the flip-flop FF2 and the flip-flop FF3. Hence, the Q output of the flip-flop FF2 is "L", and the display means 612 for indicating that the apparatus is ready for copying is not operated. Furthermore, the Q output of the flip-flop FF2 is also "L", and the drive control means 610 does not energize the drive source 308. On the other hand, since the signal "H" is not fed into the heating control means 608, the heating control means 608 energizes the heating element 480 (Figure 3) in the driven fixing roller 474.

When the temperature of the driven fixing roller 474 rises by the heating action of the energized heating element 480 and the temperature detected by the thermistor TH becomes a first predetermined temperature T1 or above, the first temperature detector 602 produces a first temperature reaching signal "H". This signal "H" is fed into the PR input of the flip-flop FF3 to preset the flip-flop FF3. Hence, from the Q output of the flip-flop FF3, a signal "H" is fed into the drive control means 610. As a result, the drive source 308 is energized to rotate the driven fixing roller 474 and the follower fixing roller 476 in press contact with the driven fixing roller 474. Ceonsequently, the temperature of the surface of the driven fixing roller 474 is made sufficiently uniform over the entire peripheral surface and non-uniformity in temperature is removed. It may be possible to start energization of the drive source 308 at the time of closing the power supply switch. But this is likely to give rise to the following problem. Sometimes, the toner adhering to the previous cycle of heat fixing remains on the surface of the driven fixing roller 474. The remaining toner is not in the softened state but in the hardened state at the time of closing the power supply switch. When the driven fixing roller 474 having the solid toner remaining thereon and the follower fixing roller 476 in press contact therewith are rotated, considerable noises will be generated, or the driven fixing roller 474 and/or the follower fixing roller 476 may be damaged. In contrast, when the surface temperature of the driven fixing roller 474 has attained the first predetermined temperature T_1, the toner remaining fixed to the surface of the roller 474 is softened, and the above problem is obviated.

When the temperature of the driven fixing roller 474 further rises by the heating action of the energized heating element 480 and the temperature detected by the thermistor TH reaches the second predetermined temperature T_2, the second temperature detector 604 produces a second temperature reaching signal "H". This signal "H" is fed into the PR input of the flip-flop FF2 to pre-set the flip-flop FF2. As a result, the signal "H" is fed into the display means 612 from the Q output of the flip-flop FF2, and the display means 612 indicates that the apparatus is ready for starting the copying cycle. The signal from the Q output of the flip-flop FF2 is also fed into the CL input of the flip-flop FF3 via the OR gate OR2, whereby the flip-flop FF3 is cleared and the signal of its Q output becomes "L".

Accordingly, the drive control means 610 stops energizing the drive source 308. When the surface temperature of the driven fixing roller 474 has attained the second predetermined temperature T_2, the ambient temperature of the fixing device 80 has also risen sufficiently. Hence, without rotating the driven fixing roller 474, no great uneveness in temperature occures on the surface of the driven fixing roller 474. When, for example, a copying cycle start switch (not shown) is closed, the drive source 308 is energized irrespective of the drive control means 610. On the pther hand, the second temperature reaching signal "H" produced by the second temperature detector 604 is also fed into the heating control means 608 via an OR gate OR3

to deenergize the heating element 480. When the temperature of the driven fixing roller 474 is lowered by the deenergization of the heating element 480 and the temperature detected by the thermistor TH becomes lower than the second predetermined temperature T_2, the second temperature detector 604 no longer produces the second temperature reaching signal "H", and therefore, the heating control means 608 resumes energization of the heating element 480. Thus, the energization and deenergization of the heating element 480 are repeated on the basis of the second predetermined temperature T_2, and the temperature of the driven fixing roller 474 is maintained substantially at the second predetermined temperature T_2.

On the other hand, when no copying cycle is performed over a relatively long period of time, the pre-heating switch S of the condition setting means 606 is instantaneously closed by manual operation. As a result, the output signal of an inverter INI becomes "H", and this signal "H" is fed into the CP input of the flip-flop FF1 to set the flip-flop FF1. Consequently, the signal at the Q output of the flip-flop FF1, i.e. the output of the condition setting means 606, becomes a preheated condition signal "H". The preheated condition signal "H" is fed into the preheated condition display means 614 which then indicates that a preheated condition has been attained. The preheated condition signal "H" is also fed into the CL input of the flip-flop FF3 through the OR gate OR2. Therefore, the first temperature detector 602 produces the first temperature reaching signal "H" and thus, even when this signal "H" is fed into the PR input of the flip-flop FF3, the flip-flop FF3 is prevented from being preset. Consequently, the drive control means 610 is prevented from energizing the drive source 308. The preheated condition signal "H" is also fed into one input terminal of an AND gate AND1. Into the other input terminal of the AND gate AND1, the output signal of the first temperature detector 602 is fed. Accordingly, when the preheated condition signal "H" is produced and the first temperature detector 602 produces the first temperature reaching signal "H", the output signal of the AND gate AND1 becomes "H" and this signal "H" is fed into the heating control means 608 via the OR gate OR3 to deenergize the heating element 480. When the temperature of the driven fixing roller 474 is lowered by the deenergization of the heating element 480 and the temperature detected by the thermistor TH becomes lower than the first predetermined temperature T_1, the first temperature detector 602 fails to produce the first temperature reaching signal "H". Hence, the output of the AND gate AND1 becomes "L", and the energization of the heating element 480 is resumed. Thus, when the condition setting means 606 is producing the preheated condition signal "H", the energization and deenergization of the heating element 480 are repeated on the basis of the first predetermined temperature T_1, and the temperature of the driven fixing roller 474 is maintained substantially at the first predetermined temperature T_1. The first predetermined temperature T_1 is lower than the second predetermined temperature T_2. Accordingly, when the condition setting means 606 is put in condition for producing the preheated condition signal "H", the power consumed by the energization of the heating element 480 is saved. But since the heating element 480 is not kept deenergized but its energization and deenergization are controlled on the basis of the first predetermined temperature T_1 and the temperature of the driven fixing roller 474 is maintained substantially at the first predetermined temperature T_1, the copying apparatus is returned very rapidly to a condition permitting copying when the copying cycle is resumed.

In resuming the copying cycle, the preheating switch S of the condition setting means 606 is again manually operated to close it instantaneously. As a result, the output signal of the inverter INI becomes "H", and the signal "H" is fed into the CP input of the flip-flop FF1. Since at this time the flip-flop FF1 is set and the signal to be fed from its $\overline{Q}$ output into its D input is "L", the flip-flop FF1 is reset by the feeding of the signal "H" into the CP input. Hence, the Q output of the flip-flop FF1, i.e. the output of the condition setting means 606, is returned to a normal condition signal "L". As a result, the signal fed into the preheated condition display means 614 becomes "L", and the operation of the preheated condition display means 614 is stopped.

Furthermore, the signal fed into one input of the AND gate AND1 also becomes "L". Thus, even when the first temperature detector 602 produces the first temperature arrival signal "H", the output signal of the AND gate AND1 does not become "H", and therefore, the heating element 480 is not deenergized. Furthermore, since the signal fed into the CL input of the flip-flop FF3 via the OR gate OR2 becomes "L", when the first temperature detector 602 produces the first temperature arrival signal "H", this signal "H" is fed into the PR input of the flip-flop FF3 to preset the flip-flop FF3. Consequently, the drive control means 610 energized the drive source 308. When the temperature of the driven fixing roller 474 rises as a result of the continued energization of the heating element 480 and the temperature detected by the thermistor TH becomes the second predetermined temperature T_2 and the second temperature detector 604 produces the second temperature reaching signal "H", the display means 612 for indicating

the readiness of starting the copying cycle is operated as described above, and the drive source 308 is deenergized to deenergize the heating element 480.

Although not shown in the drawing, it is possible, if desired, to provide in relation to the preheating switch S of the condition setting means 606 a suitable detecting means which, when the copying cycle is not performed for a period longer than a predetermined one while the output signal of the condition setting means 606 is a normal condition signal "L", detects this condition and instantaneously closes the preheating switch S automatically, thus changes the condition of the condition setting means 606, and converting its output signal to a preheated condition signal "H".

Claims

1. An electrostatic copying apparatus equipped with a heat fixing device having a pair of fixing rollers for cooperatively fixing a toner image to the surface of a sheet material, one of the fixing rollers being drivingly connected to a drive source and at least one of the fixing rollers including an electrical heating element;
wherein said apparatus comprises a starting means (600) which produces a power supply closing signal when a power switch is closed, a first temperature detector (602) which detects the temperature of the fixing rollers and when the detected temperature reaches a first predetermined temperature T_1, produces a first temperature reaching signal, a second temperature detector (604) which detects the temperature of the fixing rollers and when the detected temperature reaches a second predetermined temperature T_2 suitable for fixing and higher than the first predetermined temperature T_1, produces a second temperature reaching signal, a condition setting means (606) which includes a preheating switch and produces either a normal condition signal or a pre-heated condition signal in response to the actuation of the pre-heating switch, a driving control means (610) for controlling the operation of the drive source (308), and a heating control means (608) for controlling the operation of the heating element (480);
when the starting means (600) produces the power supply closing signal, the heating control means (608) begins to energize the heating element (480), and
in a condition in which the condition setting means (606) is producing the normal condition signal, the heating control means (608) energizes the heating element (480) when the second temperature detector (604) produces the second temperature reaching signal and deenergizes it when the second temperature reaching signal disappears, and
in a condition in which the condition setting means (606) is producing the pre-heated condition signal, the heating control means (608) deenergizes the heating element (480) when the first temperature detector (602) produces the first temperature reaching signal and energizes it when the first temperature reaching signal disappears; and
when the condition setting means (606) produces the normal condition signal and the first temperature detector (602) produces the first temperature reaching signal, the driving control means (610) energizes the drive source (308) until the second temperature detector (604) produces the second temperature reaching signal.

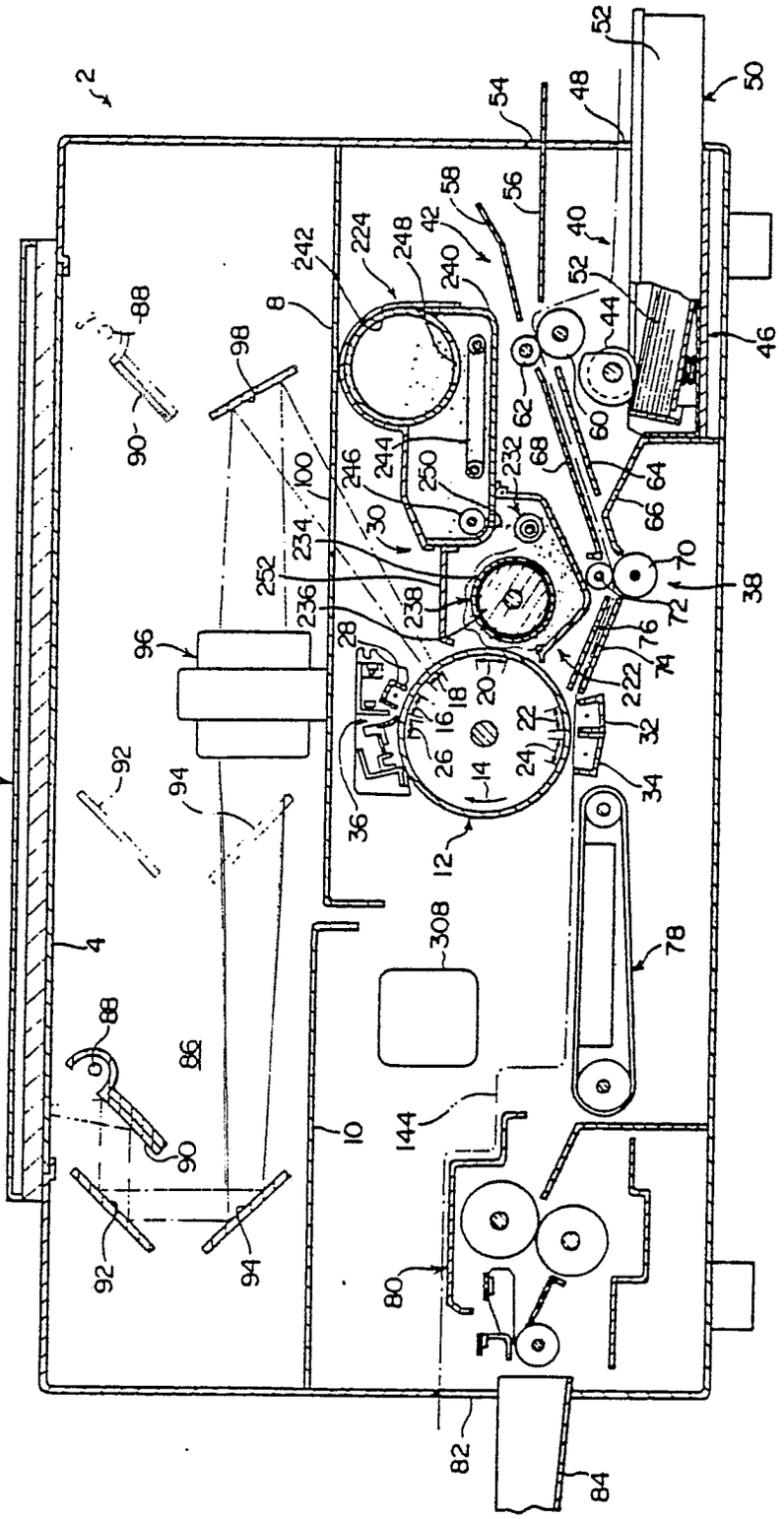
2. The electrostatic copying apparatus of claim 1, wherein the first and second temperature detectors (602, 604) detect the temperature of the surface of that fixing roller (474) which contains said heating element (480) or its vicinity.

3. The electrostatic copying apparatus of claim 1 or 2, wherein the first predetermined temperature T_1 is higher than the softening temperature of the toner.

4. The electrostatic copying apparatus of any of claims 1 to 3, which further includes a display means (612) for indicating that the apparatus is ready for performing a copying cycle, said display means being adapted to be energized when the condition setting means (606) is producing the normal condition signal and the second temperature detector (604) produces the second temperature reaching signal.

5. The electrostatic copying apparatus of any of claims 1 to 4, which further includes a preheated condition display means (614) which is adapted to be energized when the condition setting means (606) produces the pre-heated condition signal.

FIG. 1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250
252
308

FIG. 2

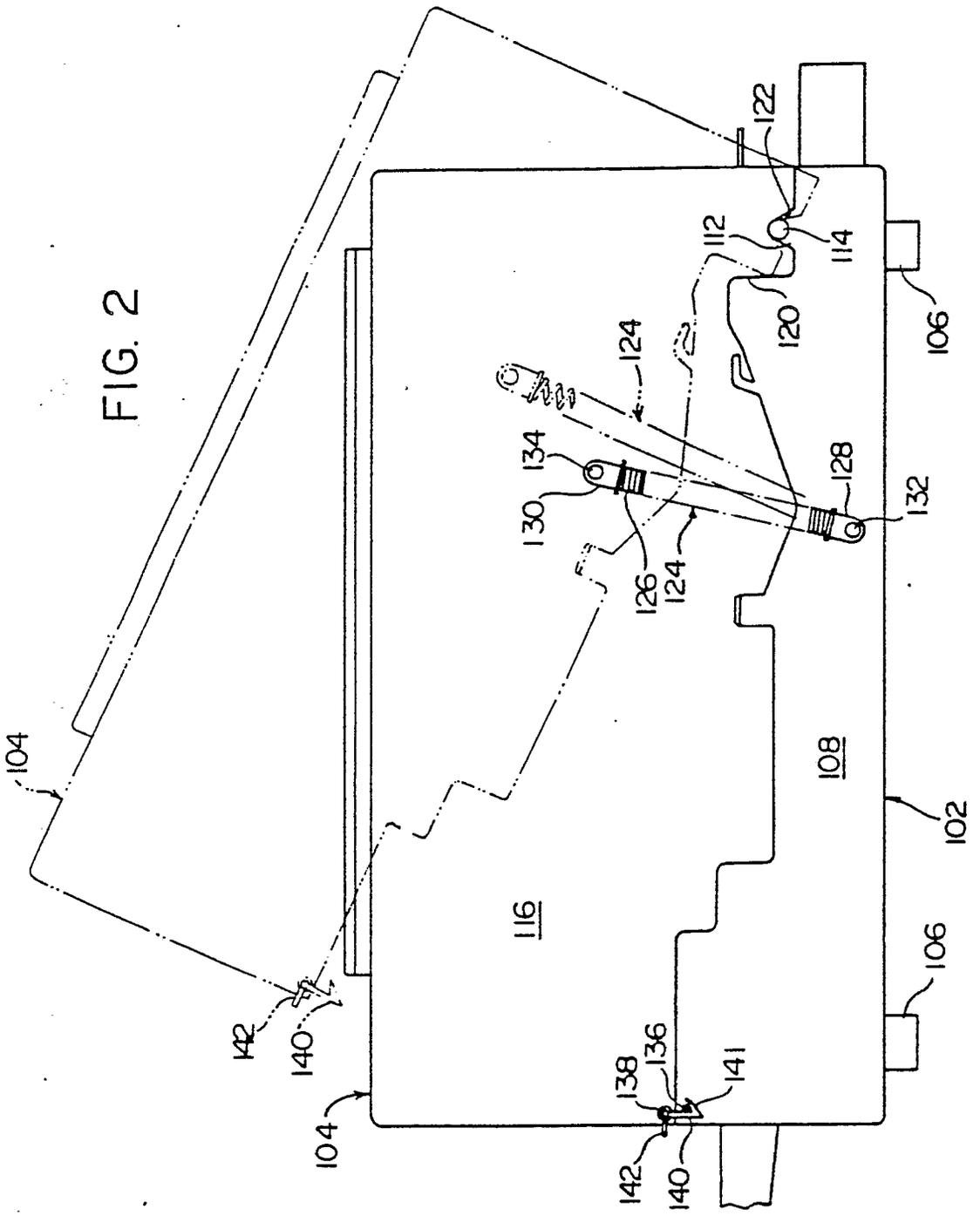
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FIG. 3

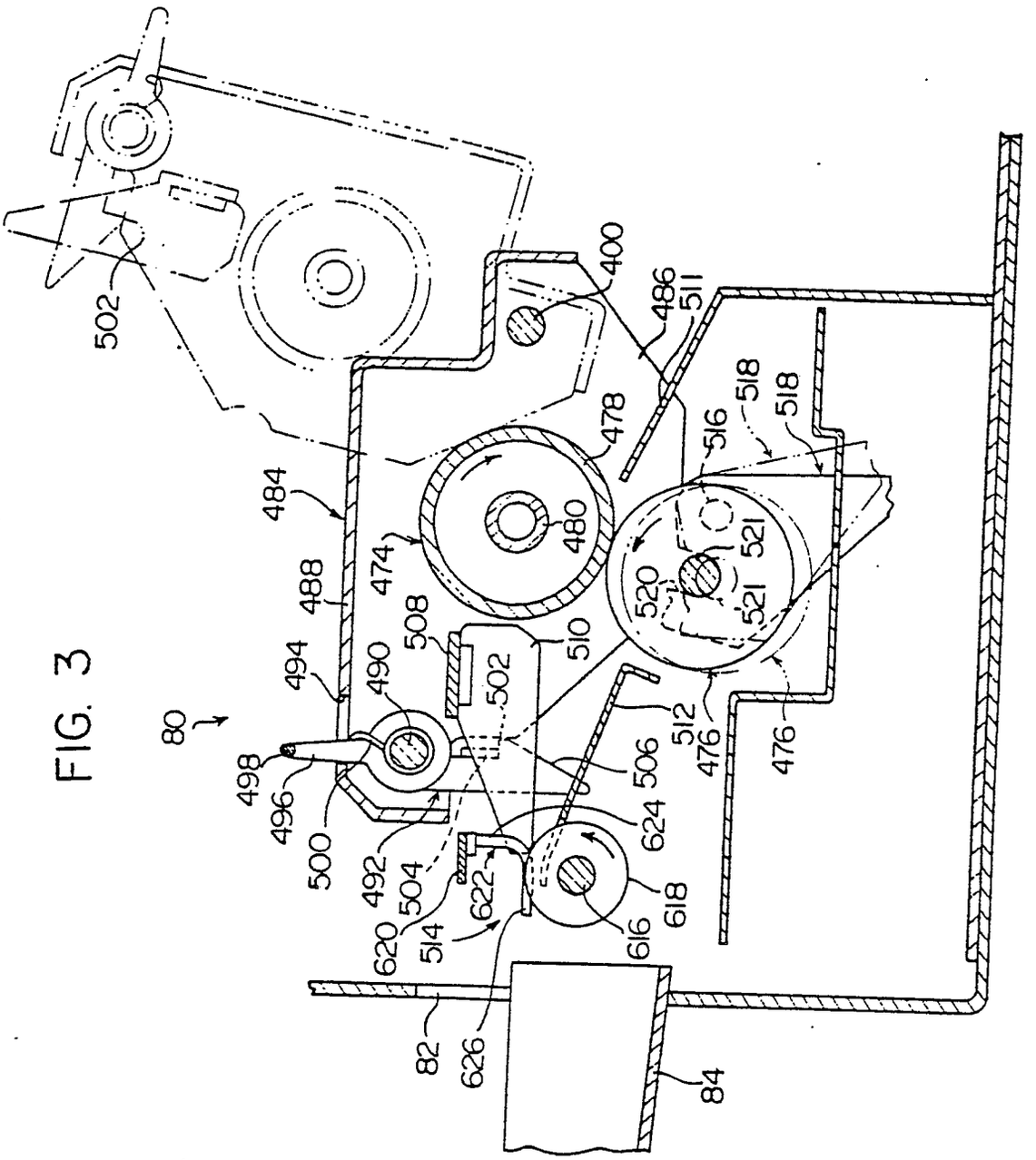
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FIG. 4

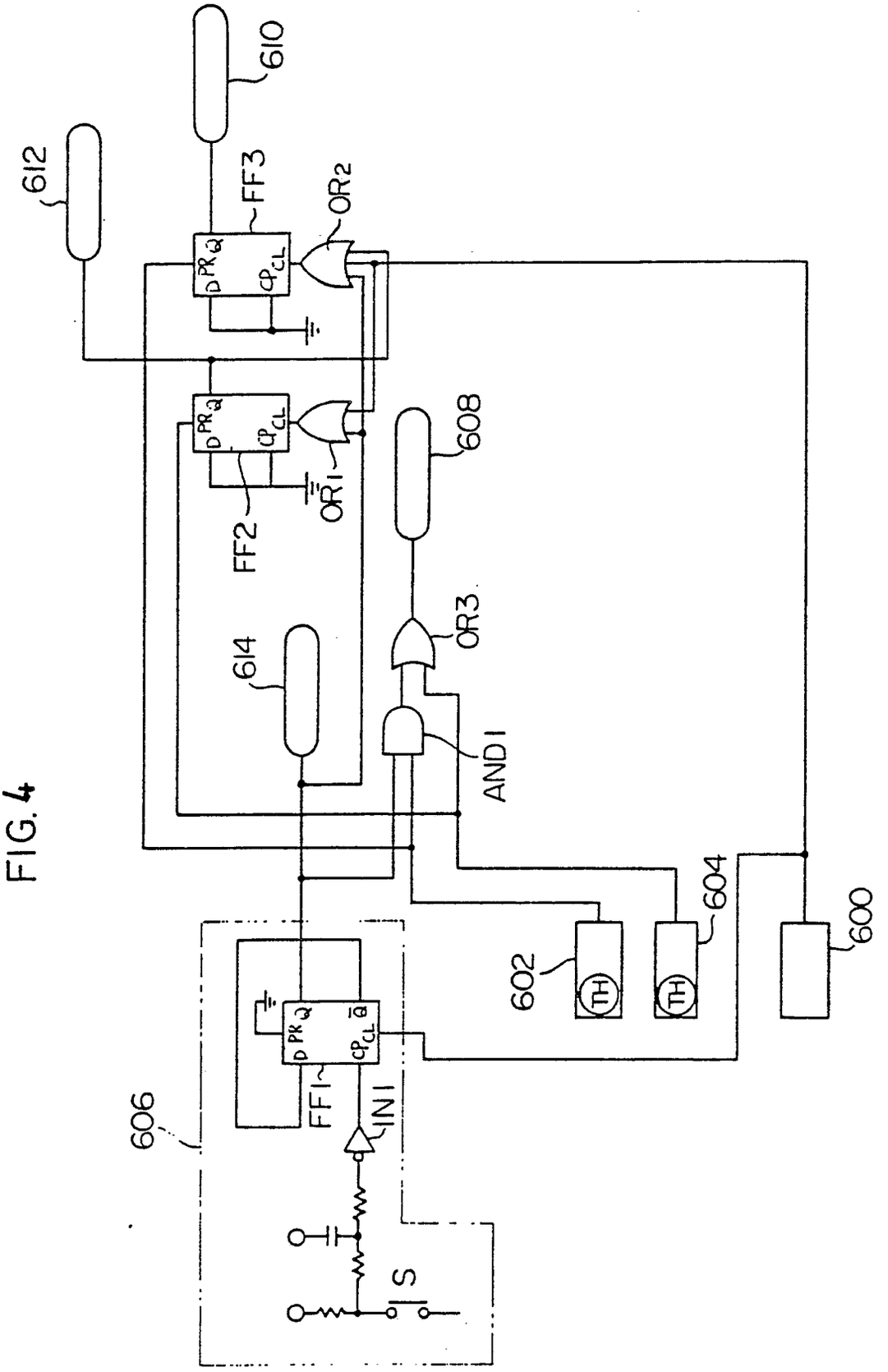
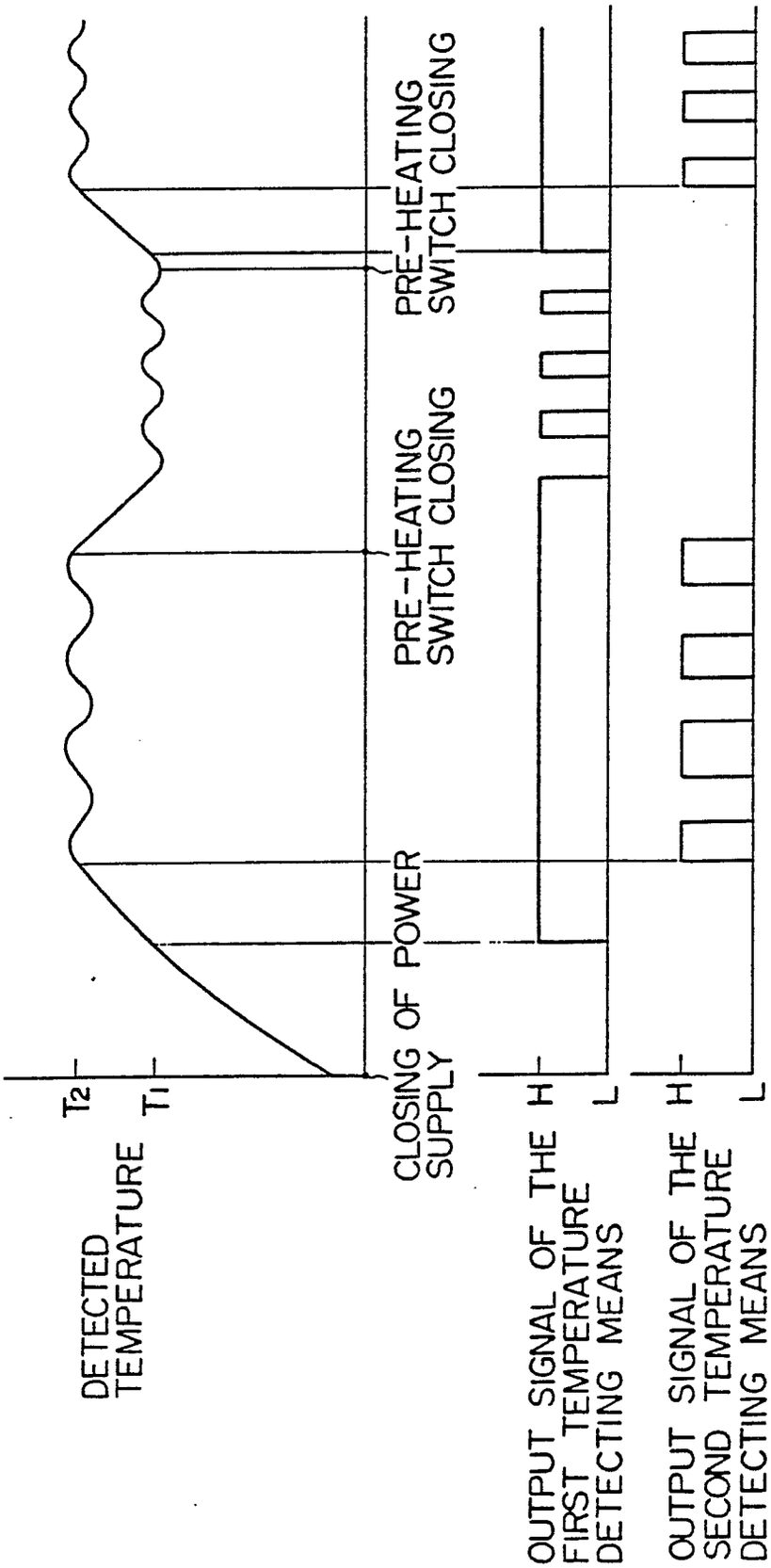

610
612
FF3
OR2
608
FF2
OR1
614
OR3
AND1
604
600
602
606
FF1
IN1
S

FIG. 5


DETECTED TEMPERATURE
T2
T1
CLOSING OF POWER SUPPLY
PRE-HEATING SWITCH CLOSING
PRE-HEATING SWITCH CLOSING
OUTPUT SIGNAL OF THE FIRST TEMPERATURE DETECTING MEANS
H
L
OUTPUT SIGNAL OF THE SECOND TEMPERATURE DETECTING MEANS
H
L