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(54) **Developing unit.**

(57) There is provided a developing unit having the function to decide freshness/oldness of a developer by using a toner sensor. Toner concentration of the developer is detected by the toner sensor and when an output voltage of the toner sensor is higher than a reference voltage by a constant value or more, the developer is determined to be fresh and based on this result, a main motor is driven to rotate rollers in a developing tank, thus stirring the developer. On the other hand, when the developer is determined not to be fresh, not only the main motor but also a toner motor is rotated for toner replenishment so as to adjust the toner concentration.

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BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to improvements on means for performing initial control of a developing unit for use in an image formation apparatus when the developer of the developing unit is exchanged with a fresh one or the developing unit per se is exchanged with a new one.

Description of the Related Art

In a developing unit of an electrophotographic copier, a developer normally having a constant life is employed and therefore periodic maintenance is needed. The developer is consumption goods and it is necessary to keep the image quality and density of a copy constant by replenishing the developer with toner. Thus, for replacement of the developer in the developing unit, exchange of the developer or exchange of the developing unit is effected.

More particularly, in the developing unit of, for example, a printer, when the life of the developer expires, the developer is exchanged with a fresh one or the developing unit is exchanged with a new one.

The fresh developer has a small quantity of charge, a large apparent density and a small volume and when it is detected initially by means of a toner sensor realized with a magnetic permeability sensor, the toner sensor produces an initial high output voltage. As a magnet roller and a stirring roller rotate, charge on the developer increases to decrease the apparent density and increase the volume, so that the output voltage of the toner sensor decreases until it is saturated to have a constant level.

Incidentally, if the developing unit has no mechanism for checking whether or not the developer is fresh, the following disadvantages arise. More particularly, when the developer is fresh, the initial output voltage of the toner sensor becomes high as described above and accordingly a toner replenishing roller is rotated until the sensor output reaches a predetermined level, resulting in excessive replenishment of toner. As a result, the toner concentration increases, raising a problem that fog is amplified. In addition, rollers inclusive of the magnet roller of the developing unit are driven to rotate until a reference voltage is reached, raising another problem that the warm-up time of the unit is prolonged.

Under the circumstances, checking whether or not a developing unit mounted is new has hitherto been practiced in such a manner that the new developing unit is registered to be new when a maintenance man resets a sheet number managing counter of the developing unit a specified mode (simulation mode) or that reset means is provided at a developing unit mount portion of an image formation apparatus proper and when a new developing unit is mounted, a counter is reset to identify the new developing unit. In the latter case, in order to prevent the counter from being reset again during the use of the developing unit currently mounted, the counter reset means on the developing unit side is designed such that the second activation of the reset means is inhibited. The special counter reset operation or the use of the dedicated counter reset mechanism, however, raise problems of troublesome operation and high cost.

On the other hand, available as related literatures concerning initial control are Japanese Patent Application Laid-open Nos.62-229170 and 64-576.

Firstly, in Japanese Patent Application Laid-open No.62-229170, a developing unit is sealingly stored with a developer in advance and then packaged. More specifically, upon shipment, a predetermined amount of developer is thrown in the developing unit, followed by output adjustment of a magnetic permeability sensor (automatic toner adjustment). Under this condition, a toner feed opening and a developing opening are sealed and the developing unit is placed in a moisture-proof bag, which is then closed sealingly.

Upon installation, the developing unit is taken out of the moisture-proof bag, the sealed two openings are uncovered and the unit is attached to a predetermined site of an image formation apparatus. Thereafter, a power supply switch of the image formation apparatus is turned on and ordinary or normal initial operation (simulation by a maintenance man) is carried out to set up a state ready for copy.

This literature gives a description that the developer is sealingly stored in the developing unit in advance but absolutely fails to describe decision as to whether or not the developer is fresh. (Conventional treatment by the maintenance man)

In Japanese Patent Application Laid-open No.64-576, when a process kit including at least a developing unit is attached to a predetermined site of an image formation apparatus proper, control means featuring this literature operates a developer concentration detection sensor for a predetermined time to decide whether the output of the developer concentration detection sensor exceeds a predetermined level before the predetermined time has elapsed and determines the expiration of life of the process kit when the sensor output does not then falls below the predetermined level.

In this literature, when toner in the attached process kit runs out, the percentage of developer inside a developing tank increases and as a result the magnetic permeability increases. This literature describes that continuation of this state is determined as expiration of life of the process kit and a decrease in magnetic permeability after feed of toner is determined as normal toner feed, followed by normal processings but it in no way describes a processing for deciding whether or not the developer is fresh.

Then, there is a method to overcome the above-mentioned inconveniences by the provision of a fuse in a developing unit as specific means for checking whether or not a developer stored in the developing unit is fresh. Given that a small resistance of the fuse approximating zero is Ω1, the developing unit is determined to be new if upon turn-on of a main switch of an image formation apparatus attached with the developing unit, the fuse does not break and current conduction takes place, indicating that Ω = Ω1 stands.

Fig.1 is a flow chart for explaining the procedure. As will be seen from the figure, if upon turn-on of the main switch, Ω = Ω1 stands, that is, current conduction through the fuse is established (the Ω = Ω1 ? step issues YES), the developing unit is determined to be new and so, with a toner motor for driving a toner replenishing roller and the like turned off, a main motor for driving a magnet roller and a stirring roller is driven and after completion of rotation of the two rollers for 1 to 2 minutes, a series of operations ends. On the other hand, if no current conduction takes place and so the fuse of Ω1 breaks (the Ω = Ω1 ? step issues NO), indicating that the developing unit is not new any longer, the toner motor for drive of the toner replenishing roller and the like is turned on to rotate them continuously for 1 minute or less so as to effect toner replenishment when V1≧V2 stands (the V1≧V2 ? step issues YES), indicating that the toner concentration is low, where V2 represents a reference voltage of the toner sensor and V1 an output voltage upon start. In this phase, the continuation of rotation of the toner motor not exceeding 1 minute is normal (the "does toner-motor ON continue for 1min. ?" step issues NO) and if the toner motor is kept to be turned on for more than 1min. (the "does toner-motor ON continue for 1min. ?" step issues YES), the developing unit is determined to be abnormal and the controller carries out an error processing. On the other hand, if V1(V2 stands (the V1≧V2 ? step issues NO), indicating that the toner concentration is high, the toner motor for drive of the toner replenishing roller and the like is kept to be turned off and a series of operations ends.

With the above construction, the developing unit or the developer can be decided as to whether to be new.

To this end, however, such an electrical part as fuse must be added and the additional mount work and an increase in the number of parts raise costs inevitably.

SUMMARY OF THE INVENTION

The present invention contemplates elimination of the aforementioned problems and it is an object of the invention to provide a developing unit which can determine whether or not the developer is fresh without resort to additional parts for detecting a fresh developer.

According to an aspect of the invention, in a developing unit comprising a developing tank, rollers rotatably mounted in the developing tank, a toner sensor adapted to detect concentration of toner inside the developing tank and having such a characteristic that a detection output level decreases gradually as the toner concentration increases, toner replenishing means for replenishing the developing tank with toner, and a controller responsive to an output signal from the toner sensor to control driving of the rollers and the toner replenishing means, the controller includes comparator means for comparing an output level of the toner sensor with a reference level, and developer discriminating means for determining that a developer is fresh when the output level of the toner sensor is larger than the reference level by a constant value.

Effectually, in this case, the controller includes stirrer means for driving only the rollers when the developer is determined to be fresh by the developer discriminating means, and normal drive means for driving the rollers and toner replenishing means until the output level of the toner sensor reaches the reference level when the developer is determined not to be fresh.

According to another aspect of the invention, in a developing unit comprising a developing tank, rollers rotatably mounted in the developing tank, a toner sensor adapted to detect concentration of toner inside the developing tank and having such a characteristic that a detection output level decreases gradually as the toner concentration increases, toner replenishing means for replenishing the developing tank with toner, and a controller responsive to an output signal from the toner sensor to control driving of the rollers and the toner replenishing means, the controller includes comparator means for comparing an output level of the toner sensor with a reference level when a power supply is turned on, developer discriminating means for determining that a developer is fresh

when the output level of the toner sensor is larger than the reference level by a constant value, preparation means for performing warm-up to set up a wait state ready for image formation when the developer is determined to be fresh by the developer discriminating means, and normal drive means for driving the rollers and toner replenishing means until the output level of the toner sensor reaches the reference level when the developer is determined not to be fresh.

In connection with the first aspect of the invention, when the toner sensor detects toner concentration of the developer and delivers a detection signal to the controller, output level V1 of the toner sensor is compared with reference level V2 by the comparator means. If the developer is fresh, the output level V1 takes virgin level V3 which is larger than V2.

Then, the developer is determined to be fresh by the developer discriminating means and the stirrer means responds to this result of decision to rotate the magnetroller and stirring roller. As the two rollers rotate,the developer is stirred and friction among particles of the developer increases electric charge on the developer, so that the output level V1 of the toner sensor decreases and the output voltage stabilizes at the reference level V2.

In this manner, the state of developer can be discriminated by the output of the toner sensor during the initial operation of the developing unit.

In connection with the second aspect, when the developer is fresh, the magnet roller and stirring roller are rotated unconditionally regardless of the output of the toner sensor for a time necessary for warm-up. Then a wait state ready for print is set up.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig.1 is a flow chart useful to explain the steps for practicing the initial detection of a developer in the prior art.

Fig.2 is a functional block diagram of a developing unit according to an embodiment of the invention.

Fig.3 is a sectional view of the developing unit.

Fig.4 is a schematic diagram of a laser printer provided with the developing unit of the invention.

Fig.5 is a wave form diagram showing the output of a toner sensor.

Fig.6 is a flow chart useful to explain an example of the steps for practicing the initial detection of a developer in the present invention.

Fig.7 is a functional diagram of a developing unit according to another embodiment of the invention.

Fig.8 is a flow chart useful to explain another example of the steps for practicing the initial detection of a developer in the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The invention will now be described by way of example with reference to the accompanying drawings. Fig.2 is a functional block diagram of a developing unit according to an embodiment of the invention, and Fig.3 is a sectional view of the developing unit of the Fig.2 embodiment.

The developing unit of the present embodiment comprises, as shown in Fig.3, a developing tank 1, rollers 2 and 3 rotatably mounted in the developing tank 1, a toner sensor 4 adapted to detect concentration of toner inside the developing tank 1 and having such a characteristic that a detection output level V1 decreases gradually as the toner concentration increases and toner replenishing means 5 for replenishing the developing tank 1 with toner and as shown in Fig.2, it further comprises a controller 6 responsive to an output signal from the toner sensor 4 to control driving of the rollers 2 and 3 as well as the toner replenishing means 5.

Of the aforementioned rollers, the magnet roller 2 is arranged near an opening 7 of the developing tank 1 to oppose a photosensitive drum 8 and the stirring roller 3 is arranged under a toner replenishing opening 9, these rollers 2 and 3 being driven to rotate by means of a main motor 10 shown in Fig.2.

The toner sensor 4 is mounted to the tank wall of the developing tank 1 as best seen in Fig.3 and a known magnetic permeability sensor for converting the magnetic permeability of a developer into a voltage and delivering the voltage is used as the toner sensor.

On the other hand, the toner replenishing means 5 includes a toner hopper 11 mounted to the developing tank 1, a toner stirrer 12 rotatably mounted in the toner hopper 11 and a toner replenishing roller 13 arranged at the toner replenishing inlet 9 and it further includes, as shown in Fig.2, the toner motor 14 for driving the toner replenishing roller 13 and toner stirrer 12. In Fig.3, reference numeral 15 designates a shutter member made of polyethylene terephthalate (PET) and 16 a lid of the toner hopper 11.

The developing unit constructed as above takes the form of a cartridge which is detachably mounted to a laser printer proper 20 as shown in Fig.4. In the figure, the photosensitive drum 8, a charger provided with a high voltage power supply and a cleaning device are united to form a process unit 21, and reference numeral 22 designates an optical unit provided with a semiconductor laser, a polygon mirror for deflecting a laser beam at uniform angular velocity and lenses, 23 a paper feed

cassette, 24 a paper feed roller, 25 PS rollers, 26 fixing rollers and 27 paper discharge rollers.

The image formation process and the paper conveying process in the laser printer are known and will not be described in particular.

Next, the theory of control means for discriminating whether or not a mounted developing unit is new on the basis of a developing concentration signal from the developing unit mounted at a predetermined site of the image formation apparatus will be described briefly in connection with the apparatus of the present invention constructed as above. More particularly, when the developer is a fresh one which is not stirred sufficiently and is in a consolidatory state, the magnetic permeability sensor produces an output signal representative of a developer concentration level which is of a high level of V3 in accordance with the characteristic of the magnetic permeability sensor.

When the developing unit is mounted in an ordinary image formation apparatus and used for developing process, an electrostatic latent image on the photosensitive member is developed while keeping the concentration level of developer constant and therefore an amount of toner corresponding to an amount of toner in the developer consumed in the developing tank is fed from a toner feeder and stirred. Thus, a control reference for keeping the toner concentration constant is used and it is represented as V2 in terms of the output of the permeability sensor.

Also, with the developing unit mounted in the ordinary image formation apparatus and used for developing process, each time an electrostatic image on the photosensitive member is developed, the developing concentration is decreased by an amount of toner consumed for one sheet of copy to provide a decreased toner concentration level which slightly depends on a percentage of area occupied by black on a copy paper. At that time, the permeability sensor delivers an output which is V1. The output V1 of the permeability sensor causes the toner feed as described previously to perform control such that the output of the permeability sensor becomes V2.

In the above case, the outputs of the permeability sensor are related to each other by $V2<V1<V3$. In accordance with this correlative expression, when the permeability sensor produces a concentration signal of V3, a developing unit mounted to the image formation apparatus is considered to be one which accommodates a new developer and handled accordingly but when V2 or V1 is obtained with a mounted developing unit, this developing unit is considered to be one which has already been in use and handled accordingly.

Specific control means based on the above theory will now be described with reference to the drawing. When a developing unit is mounted in the printer proper 20 and the power supply is turned on by turning on a main switch, initial detection is carried out to check whether or not a developer is fresh. To this end, the controller 6 of the developing unit includes, as shown in Fig.2, comparator means 30 for comparing output voltage V1 of the toner sensor 4 with reference voltage V2, developer discriminating means 31 for determining that the developer is fresh when the output voltage V1 of the toner sensor 4 is larger than the reference voltage V2 by a constant voltage, stirrer means 32 for driving the magnet roller 2 and stirring roller 3 when the developer is determined to be fresh by the developer discriminating means 31, and normal drive means 33 for driving the rollers 2 and 3 and toner replenishing means5 until the output voltage V1 of toner sensor 4 reaches the reference voltage V2 when the developer is determined not to be fresh.

The relation between the output voltage and the time is indicated in an output wave form diagram as shown in Fig.5.

In Fig.5, the time axis on abscissa is changed in scale magnification for a range between 1sec. and 16sec. and a range beyond 16sec. in such a manner that an interval corresponding to 1sec. within the former range is made to equal 30sec. within the latter range, that is, the scale of time axis is reduced by 1/30 within the range beyond 16sec.

When the developer is fresh, output voltage V1 of the toner sensor 4 is initially high as shown in Fig.5 and decreases gradually as the developer is stirred to take, in one to two minutes, a stationary state in which constant voltage V2 is reached.

Therefore, a voltage which is higher by ΔV than V2 or the reference voltage is defined as virgin voltage V3.

It should be understood that ΔV is set based on a voltage which does not occur during the ordinary process but does only when the developer is fresh.

More particularly, when print is carried out to,for example, blacken the entire area of a paper sheet, the amount of toner consumed is 0.5 grams (g) or less and the consumed toner amount can be recovered or compensated for in about 6 seconds if the toner dropping amount is 5g/min. Since the toner replenishment is effected even during print, an once increased output voltage of the toner sensor can recover the reference voltage during print.

When the sensor sensitivity is 0.3V/WT , the ΔV, if set to 0.3V, corresponds to a change of 1% in toner concentration. However, in the case where the toner concentration is 4% and the developer

amount is 200g, indicating that the developer contains the toner by 8g, toner is consumed by 0.5g when print is carried out to blacken the entire area of a paper sheet and the toner concentration becomes 3.75%, demonstrating that a change in toner concentration which is 1% does not occur during ordinary process.

The developer discriminating means 31 determines that the developer is fresh when the output voltage of toner sensor 4 is represented by $V1 \geqq V3$ ($= V2 + \Delta V$), and that the developer is not fresh when $V1 < V3$ stands.

The developer discriminating means also has the function of comparing V1 and V2 to discriminate high or low level of the toner concentration from the magnitude of a difference from V2.

Fig.6 is a flow chart useful to explain the steps for carrying out the initial detection in the previously-described embodiment of the invention. The steps in Fig.6 will now be described below by making reference to Figs.2 and 3.

Referring first to Fig. 2, the stirrer means 32 has the function to drive the main motor 10 with a toner motor 14 kept to be turned off, and the normal drive means 33 has the function to drive the toner motor 14 for one minute at the most for replenishment of toner when the output voltage of the toner sensor 4 meets $V1 \geqq V2$ and hence the toner concentration is low but to keep the toner motor 14 turned off when $V1 < V2$ stands and hence the toner concentration is high.

With the above construction, when the main switch is turned on as shown in Fig.6, the toner sensor 4 detects a toner concentration level of the developer to deliver a detection signal to the controller 6 and if the output of the toner sensor 4 meets $V1 \geqq V3$ (the $V1 \geqq V3$? step issues YES), the developing unit determines, by means of the developer discriminating means 31, that the developer is fresh. The comparison in this phase is effected by the comparator means 30. It is to be noted that a critical output voltage to be obtained with a fresh developer contained in a newly mounted developing unit is a virgin voltage which is V3 as described previously.

When the developer is determined to be fresh in the manner described as above, the stirrer means 32 delivers a drive signal to the main motor 10 in order to rotate the magnet roller 2 and stirring roller 3 while keeping the toner motor 14 turned off. Each of the rollers 2 and 3 is rotated for one to two minutes to stirr the developer. This causes friction among particles of the developer to thereby increase charge on the developer and the output voltage V1 of the toner sensor 4 decreases so as to be stabilized at the reference voltage V2. Subsequently, the program proceeds to a wait state indicative of the end of a series of operations.

On the other hand, in the case of a used or old developing unit, the output voltage V1 of the toner sensor 4 becomes smaller than V3 (the $V1 \geqq V3$? step issues NO) in the flow chart of Fig. 6, so that the V1 is compared with the reference voltage V2 by the comparator means 30 to cause the developer discriminating means 31 to determine that the developer is not fresh.

If the output voltage V1 exceeds the reference voltage V2 (the $V1 \geqq V2$? step issues YES), indicating that the toner concentration is low, the normal drive means 33 drives (turns on) the toner motor 14 and main motor 10 to replenish toner. As a result, the toner replenishing roller 13 is rotated to feed toner from the toner hopper 11 to the developing tank 1 and the magnet roller 2 and stirring roller 3 are rotated to stirr developer and toner.

As the output voltage V1 of the toner sensor 4 equals the reference voltage V2 (the "does toner-motor ON continue for 1min. ? " step issues NO), the toner motor 14 is turned off to stop the toner replenishment and the program proceeds to the wait state for image formation process.

If the toner motor 14 continues running for one minute or more (the "does toner-motor ON continue for 1 min. ? " step issues YES), the developing unit is determined to be abnormal and the controller executes an error processing.

If the output voltage V1 of the toner sensor 4 is lower than the reference voltage V2 (the $V1 \geqq V2$? step issues NO), indicating that the toner concentration is sufficiently high, toner replenishment is not needed and the developing unit is placed in the wait state (END) while the toner motor 14 being kept to be off.

Since in this manner the state of developer can be discriminated using the output of the toner sensor 4 during the initial operation of the developing unit, the developer state discrimination can be accomplished with the existing parts without resort to the separate provision of a fuse as in the case of the prior art, leading to cost reduction.

Incidentally, in the foregoing embodiment, when the main switch is turned on and the developer is determined to be fresh, the magnet roller 2 and stirring roller 3 are driven for a sufficient time to decrease and stabilize the output voltage of the toner sensor 4, thus raising a problem that the warm-up time is prolonged.

Preparation means 41 as shown in Fig.7 functions to control the developing unit such that the printer can be warmed up within a short period of time regardless of the output of the toner sensor 4 to print a sheet of paper unconditionally without fail and in the phase of print of a second and ensuing paper sheets, the output voltage V1 of the toner sensor 4 is rendered, as ordinarily, to equal the

reference voltage V2.

Then, in another embodiment, a controller 40 is adapted to make the state ready to print within a short period of time when the developer is fresh and the controller 40 of the developing unit comprises, as shown in Fig. 7, comparator means 30 for comparing output voltage V1 of the toner sensor 4 with reference voltage V2 when the power supply is turned on, developer discriminating means 31 for determining that the developer is fresh when the output voltage V1 of the toner sensor 4 is larger than the reference voltage V2 by a constant voltage, the preparation means 41 for performing warm-up to set up a wait state ready for image formation when the developer is determined to be fresh by the developer discriminating means 31, and normal drive means 33 for driving the rollers 2 and 3 and toner replenishing means 5 until the output voltage V1 of toner sensor 4 decreases to the reference voltage V2 when the developer is determined not to be fresh.

The minimum time required for warm-up consists of the time for turning and locking the polygon mirror built in the optical unit using a semiconductor laser, the time for turning on the laser beam and main motor and performing high voltage check to check whether or not high voltage used for charging the photosensitive drum by means of the charger is normal and performing toner concentration check and the time for turning off the main motor and laser beam, and it amounts to 4 to 6 seconds. During this interval of time beginning with turn-on of the main motor and ending in turn-off thereof, the magnet roller 2 and stirring roller 3 are driven.

In Fig. 7, components other than the above-described ones are the same as those of the Fig.2 embodiments.

Fig.8 is a flow chart useful to explain the steps for carrying out the initial detection in the second embodiment constructed as shown in Fig.7.

When the main switch is turned on as shown in Fig.8, the magnet roller 2 and stirring roller 3 are rotated for a time necessary for warm-up unconditionally regardless of the output of the toner sensor 4 in contrast to the case of Fig.6 if the developer is fresh (the V1≧V3 ? step issues YES). Then the program proceeds to the wait state (END) ready for print processing. In this case where the developer is fresh and the output voltage of the toner sensor 4 is high (V1≧V3), it takes a long time, in the foregoing embodiment, for the toner concentration to reach the reference level (V2), resulting in a prolonged warm-up time and disadvantageously the time for the initial print processing is retarded but in the embodiment shown in Figs.7 and 8, such a problem can be eliminated.

In the phase of print of a second and ensuing paper sheets, control based on the reference value of toner concentration proceeds, thereby ensuring that the influence of print concentration of the first paper sheet can be eliminated and the output of the toner sensor 4 can be stabilized to minimize irregularity in toner concentration.

If the developing unit is not new (the V1≧V3 ? step issues NO) and output voltage V1 is larger than the reference voltage V2 (the V1>V2 ? step issues YES), the toner motor 14 is driven (ON) to replenish toner as in the case of Fig.6, whereby if rotation within one minute makes the output voltage reach the reference voltage (the V1>V2 ? step issues NO), the toner replenishment is stopped. As the output voltage V1 falls below the reference voltage V2 (the V1>V2 ? step issues NO), indicating that the toner concentration is sufficiently high to permit the print processing without resort to toner replenishment, the program proceeds to the wait state for image formation process. If the toner motor 14 continues rotating for a time of more than one minute (the V1>V2 ? step issues YES), the developing unit is determined abnormal and the error processing by the controller follows similarly to the case of Fig.6.

The present invention is in no way limited to the foregoing embodiments and obviously the foregoing embodiments can be modified and changed in various ways within the framework of the invention.

In the foregoing embodiments, the magnetic permeability sensor is used as the toner sensor 4 but a sensor having an inverting characteristic by which the output is in direct proportion to the toner concentration may be used as the toner sensor 4 and in this case, the virgin output is set to a level which is lower by a constant value than the reference level.

As is clear from the foregoing, since according to the invention, the toner concentration in the developer tank is detected by the toner sensor having such a characteristic that its output (detection output)decreases gradually as the toner concentration increases and the output level of the toner sensor is compared with the reference level to determine that the developer is fresh when the output level of the toner sensor exceeds the reference level by a constant value, the developer state discrimination can be accomplished with the existing parts without resort to the separate provision of a fuse as in the case of the prior art, leading to cost reduction.

Also, by driving only the rollers when the developer is determined to be fresh, the toner replenishment can be prevented during the initial operation of the developing unit, with the result that the toner concentration will not rise excessively and

can be brought into the reference concentration rapidly.

Further, according to the present invention, the output level of the toner sensor is compared with the reference level when the power supply is turned on to determine that the developer is fresh when the output level of the toner sensor is larger than the reference level and warm-up is then effected by rotating the rollers for a time necessary for the warm-up unconditionally regardless of the output of the toner sensor, thereby eliminating the problem that it takes a long time for the toner concentration of a fresh developer to take the reference level or the warm-up time is prolonged and the initial print is retarded.

Claims

1. A developing unit comprising a developing tank, rollers rotatably mounted in said developing tank,a toner sensor adapted to detect concentration of toner inside said developing tank and having such a characteristic that a detection output value decreases gradually as the toner concentration increases, toner replenishing means for replenishing said developing tank with toner, and a controller responsive to an output signal from said toner sensor to control driving of said rollers and said toner replenishing means, said controller including comparator means for comparing an output level of said toner sensor with a reference level, and developer discriminating means for determining that a developer is fresh when the output level of said toner sensor is larger than the reference level by a constant value.

2. A developing unit according to claim 1 wherein said controller further includes stirrer means for driving only said rollers when the developer is determined to be fresh by said developer discriminating means, and normal drive means for driving said rollers and toner replenishing means until the output level of said toner sensor reaches the reference level when the developer is determined not to be fresh.

3. A developing unit comprising a developing tank, rollers rotatably mounted in said developing tank,a toner sensor adapted to detect concentration of toner inside said developing tank and having such a characteristic that a detection output value decreases gradually as the toner concentration increases, toner replenishing means for replenishing said developing tank with toner, and a controller responsive to an output signal from said toner sensor to control driving of said rollers and said toner replenishing means, said controller including comparator means for comparing an output level of said toner sensor with a reference level when a power supply is turned on, developer discriminating means for determining that a developer is fresh when the output level of said toner sensor is larger than the reference level by a constant value, preparation means for performing warm-up to set up a wait state ready for image formation when the developer is determined to be fresh by said developer discriminating means, and normal drive means for driving said rollers and toner replenishing means until the output level of said toner sensor reaches the reference level when the developer is determined not to be fresh.

Fig. 1

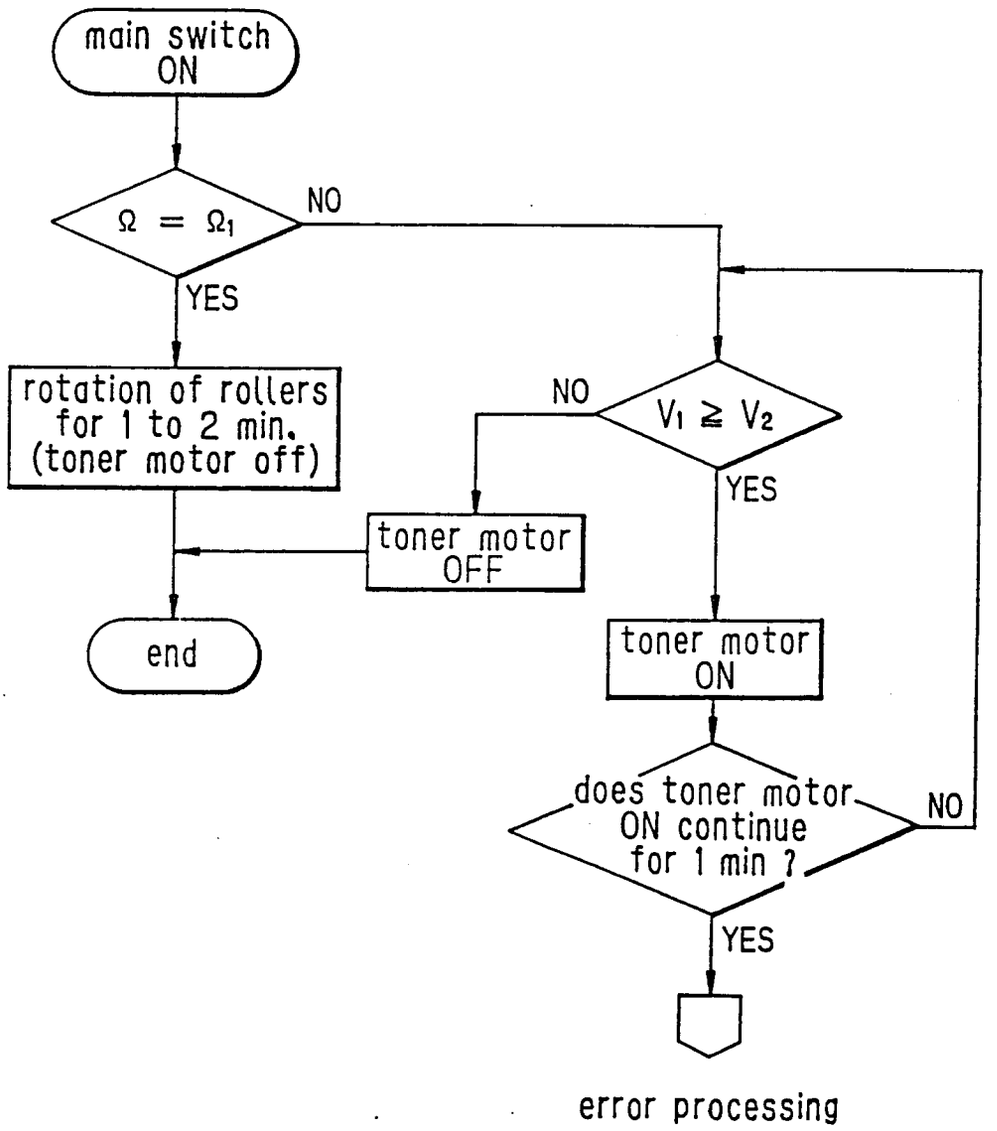

main switch ON
Ω = Ω1
NO
YES
rotation of rollers for 1 to 2 min. (toner motor off)
NO
V1 ≧ V2
YES
toner motor OFF
end
toner motor ON
does toner motor ON continue for 1 min ?
NO
YES
error processing

Fig. 2

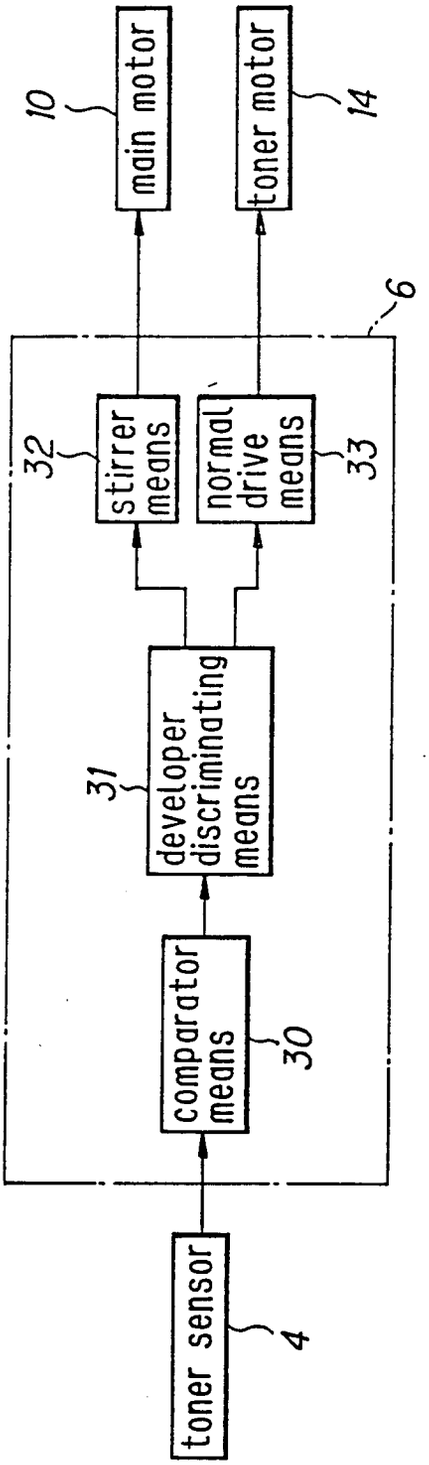

toner sensor
4
comparator means
30
developer discriminating means
31
stirrer means
32
normal drive means
33
6
main motor
10
toner motor
14

Fig.3

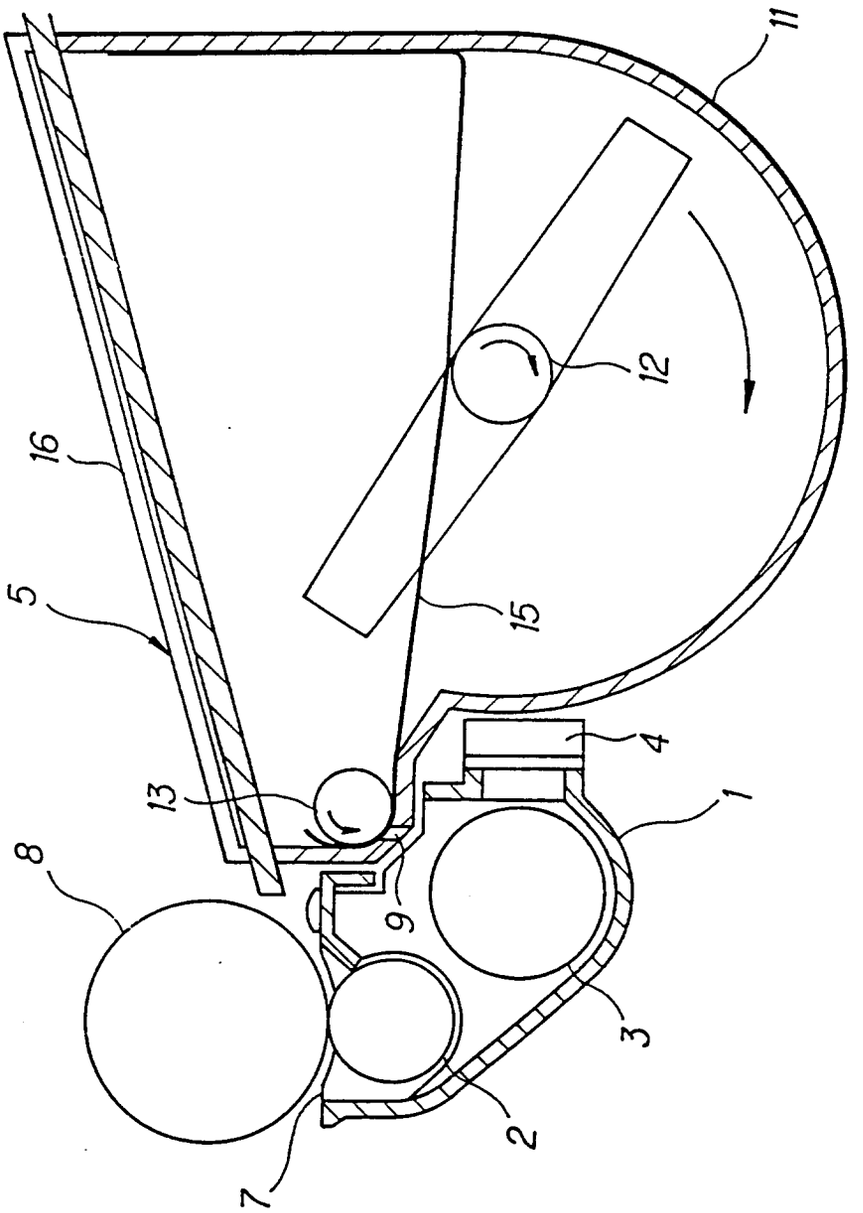


Fig.4

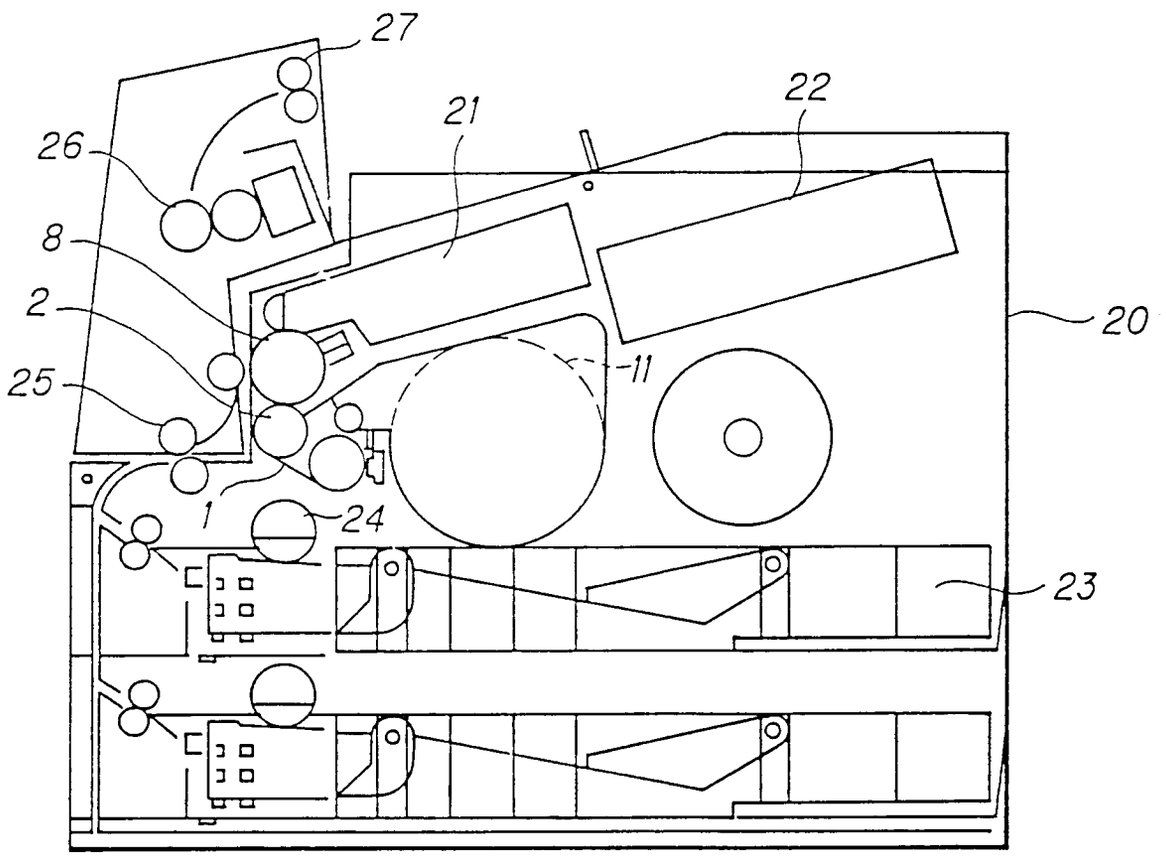


Fig.5

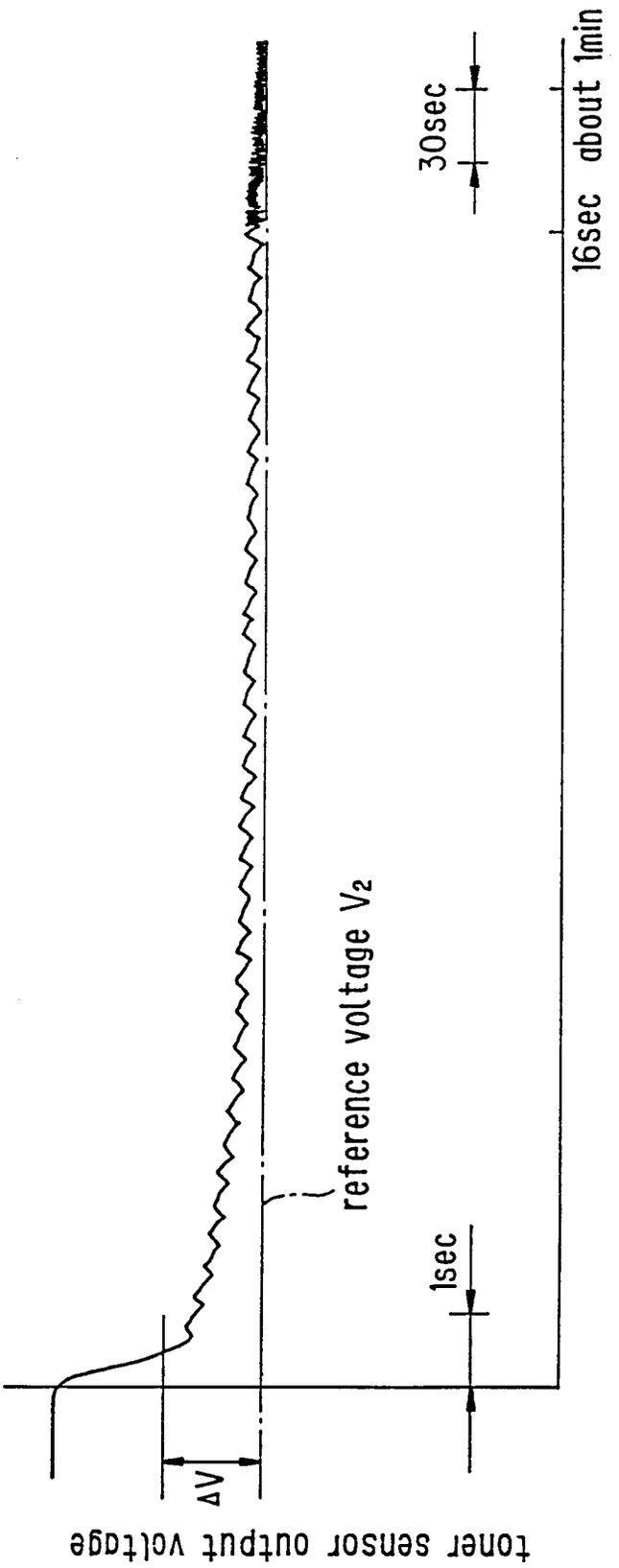

toner sensor output voltage
ΔV
reference voltage V2
1sec
30sec
16sec about 1min

Fig.6

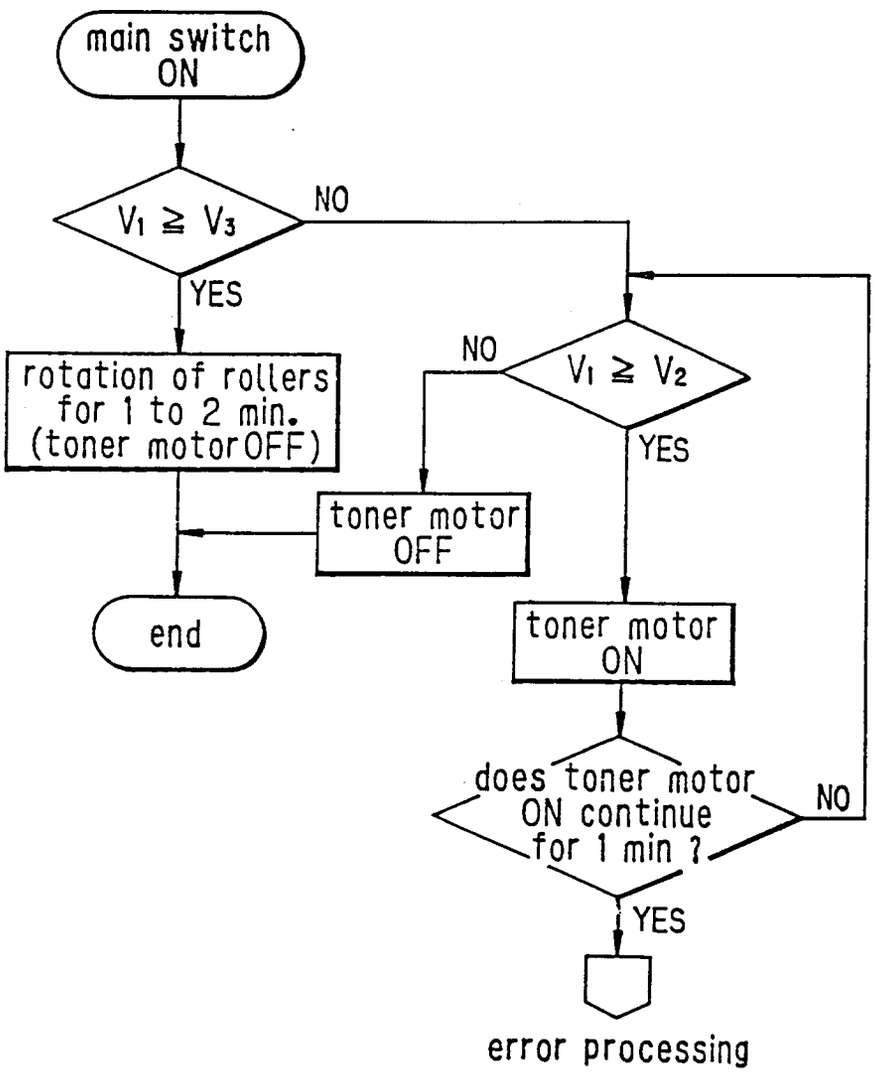

main switch ON
V1 ≧ V3
NO
YES
rotation of rollers for 1 to 2 min. (toner motor OFF)
NO
V1 ≧ V2
YES
toner motor OFF
end
toner motor ON
does toner motor ON continue for 1 min ?
NO
YES
error processing

Fig. 7

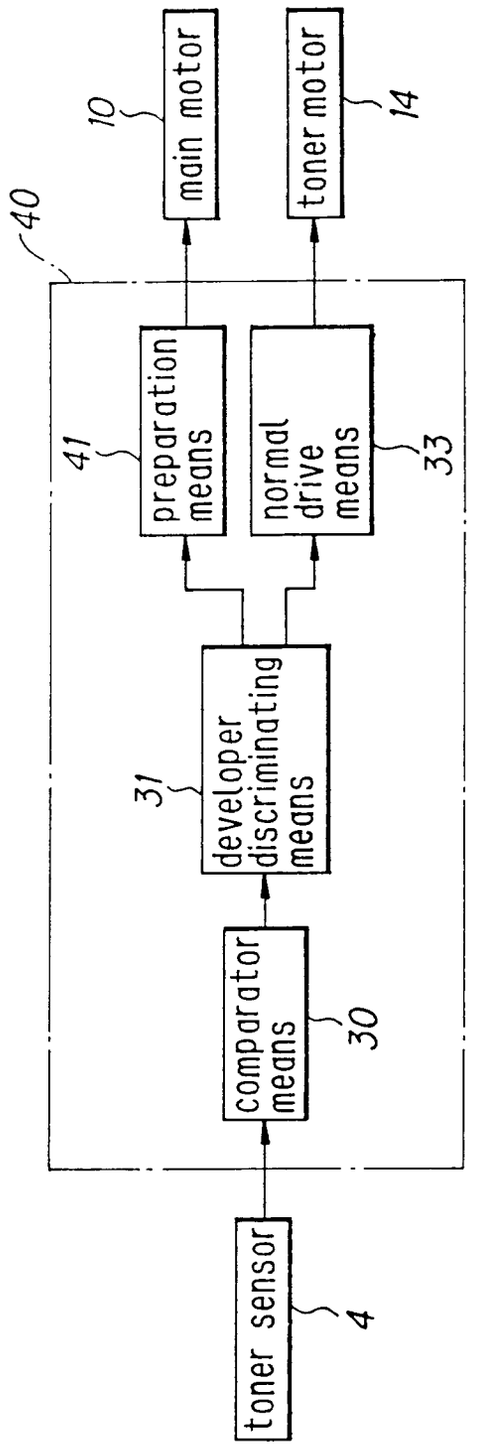
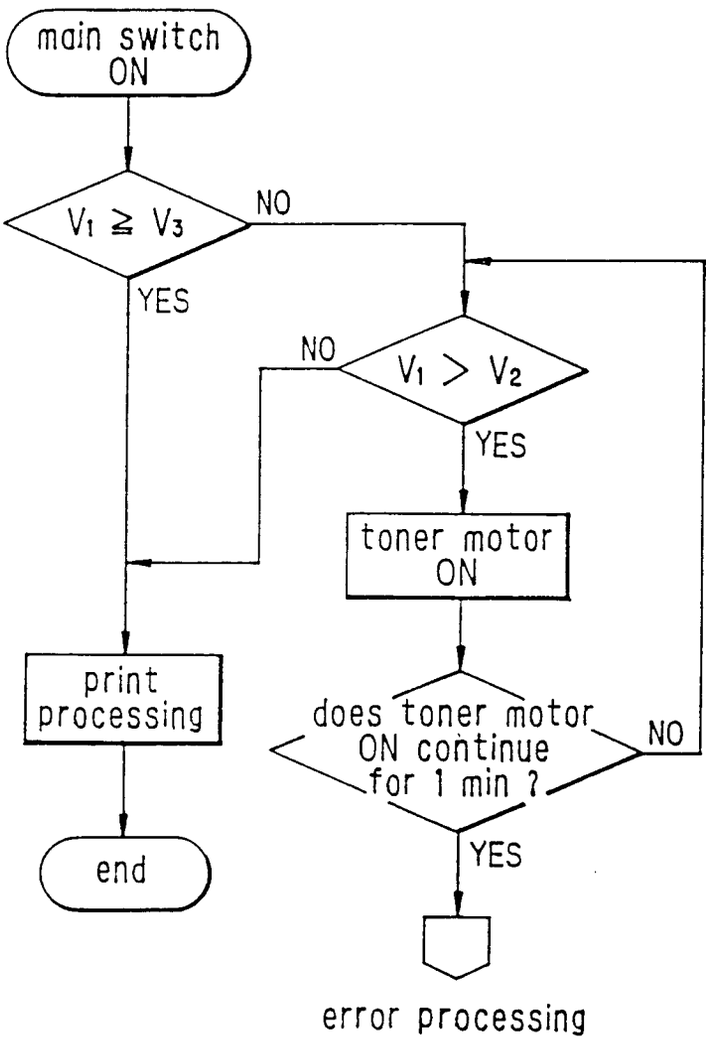

toner sensor
4
comparator means
30
developer discriminating means
31
preparation means
41
normal drive means
33
40
main motor
10
toner motor
14

Fig.8


main switch ON
$V_1 \geqq V_3$
NO
YES
$V_1 > V_2$
NO
YES
toner motor ON
print processing
does toner motor ON continue for 1 min ?
NO
YES
end
error processing