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European Patent Office  
Office européen des brevets



(11) Publication number:

**0 448 039 A2**

(12)

## EUROPEAN PATENT APPLICATION

(21) Application number: **91104237.2**

(51) Int. Cl.<sup>5</sup>: **G03G 15/08, G03G 15/01**

(22) Date of filing: **19.03.91**

(30) Priority: **19.03.90 JP 68765/90**

(43) Date of publication of application:  
**25.09.91 Bulletin 91/39**

(84) Designated Contracting States:  
**DE FR GB IT**

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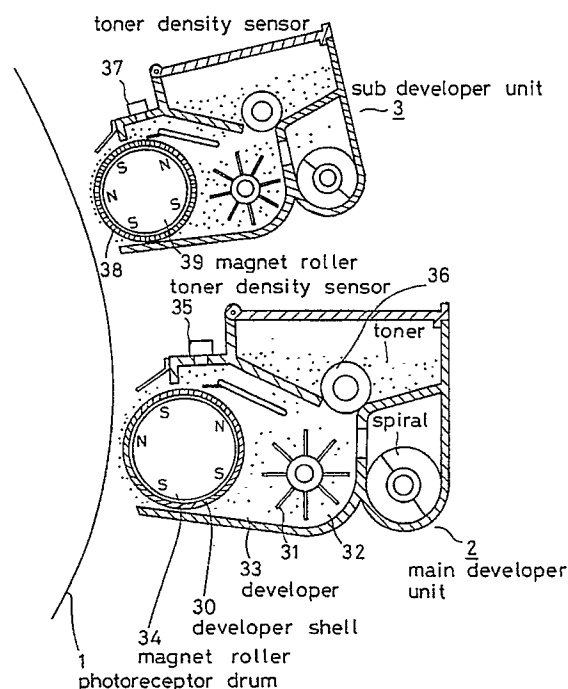
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(54) **Image forming apparatus.**

(57) An image forming apparatus comprises a photoreceptor (1); plural developer units (2, 3) for giving toner alternatively to the photoreceptor (1) to develop a latent image formed on the photoreceptor (1); toner density sensors (35, 37) for detecting the toner density of the developer units (2, 3); toner supplier for supplying toner to the developer units (2, 3) according to the output of the toner density sensor (35, 37); detector (35, 47) for detecting whether said developer units (2, 3) are attached with respect to the periphery of the photoreceptor (1); and controller (40) for so controlling the image forming operation as to be performed only when a predetermined plural number of developer units (2, 3) are attached.

According to the image forming apparatus, it is possible to correct the output of the toner density sensor (35).

Fig. 2



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## BACK GROUND OF THE INVENTION

The present invention relates to an image forming apparatus such as an electrographic copying machine and a printer, etc. More particularly, the present invention relates to an image forming apparatus With a toner density controller.

Recently, electrographic copying machines have been used in which a latent image formed on the photoreceptor is developed by using plural different colors of toner as well as one color of toner. In such electrographic copying machines, a main developer unit and a sub developer unit are arranged with respect to the periphery of the photoreceptor drum, and these developer units are selectively activated.

Since the toner density changes as the developer units are used, a toner density controlling mechanism is provided in electrographic copying machines to maintain the toner density at a fixed level. To detect toner density, a toner density sensor is provided on each developer unit, and the toner density detected by the toner density sensor is compared with the predetermined toner density by a microcomputer. Then, by controlling the toner supply with a toner supply roller in response to the control signal outputted according to the above comparison, toner density is maintained at an appropriate fixed level. Generally, in a toner density control, the initial value is used as the reference value. The difference between the detected toner density and the reference value is calculated to control toner supply. The initial value is the ratio  $T/D$  of toner to carrier in the initial condition, and the detected toner density is also the ratio of toner to carrier. Correction data for the output of the toner density sensor are prepared in consideration of the influence of a magnet roller in a developer shell of the developer unit since it is affected by the magnet roller. In a case where the initial value of each of main and sub developer units attached to the copying machine is detected and a copying operation is performed after detaching one of the developer units, the correction, which is based on the data, is not accurately performed since the toner density sensor of the other developer unit is not affected by the magnet roller of the above detached developer unit. Moreover, when correction data for the output of the toner density sensor are prepared in the condition where the initial value of each developer unit is predetermined without considering the influence of the other developer unit and where the two developer units are attached, if the copying operation is performed with one developer unit and the output of the toner density sensor is corrected in accordance with the prepared data, the same problem is arisen.

## SUMMARY OF THE INVENTION

The object of the present invention is to provide an image forming apparatus in which the output of the toner density sensor of a developer unit is not varied according to the number of the developer units attached to the copying machine and thereby, the toner density control is correctly performed.

According to one feature of the present invention, an image forming apparatus comprises: a photoreceptor; plural developer units for giving toner alternatively to said photoreceptor to develop a latent image formed on said photoreceptor, comprising a developer shell and a toner density sensor, respectively, and which are attachable and detachable with respect to the periphery of said photoreceptor; toner supplier for supplying toner to said developer units according to the output of said toner density sensor; detection means for detecting whether said developer units are attached with respect to the periphery of said photoreceptor; and control means for so controlling the image forming operation as to be performed only when a predetermined plural number of developer units are attached.

In the above structure, malfunction of the correction is not generated, since the toner density control is performed only when a predetermined plural number of developer units are attached to an image forming apparatus body, and the output of the developer units are required to be corrected only when the developer units are attached. In other word, the output of the toner density sensor does not change according to the number of the attached developer unit.

Moreover, the control means in the image forming apparatus of the present invention have a function to control the initial setting of the developer in each developer unit so that the setting is performed only when a predetermined plural number of developer units are attached to the image forming apparatus body in the simulation mode.

With such control means, it is unnecessary to correct the toner density data since the output change of the toner density sensor in the initial setting is the same as that in the copying operation, and the structures of both the hardware and software are made simple.

## BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects and features of this invention Will become clear from the following description taken in conjunction with the preferred embodiments with reference to the accompanied drawings in which:

Fig. 1 is a composition diagram of an electrog-

raphic copying machine as an embodiment of the present invention that copies originals in plural colors.

Fig. 2 is an enlarged cross-sectional view of the developer units shown in Fig. 1.

Fig. 3 is a block circuit diagram of the principal section of the image forming apparatus shown in Fig. 1.

Fig. 4 is a circuit composition diagram of the dip switch shown in Fig. 3.

Fig. 5 is an external perspective view of a sub developer unit in which the dip switch is provided.

#### DETAILED DESCRIPTION OF THE EMBODIMENTS

The present invention will hereinafter be explained with reference to the accompanying drawings. In Fig. 1, the image of an original 6 placed on a contact glass 4, pressed by an original cover 5, is scanned by a scan optical system 7. The image information is transmitted on light via condenser lens 8 to a light receiving element 9 such as CCD (Charge Coupled Device). After converted into an electric signal at the light receiving element 9, it is processed in an image information processing circuit 10. Then, the image information is formed into a latent image on a photoreceptor drum 1 by a laser scanner unit 11. Before the latent image is formed, the surface of the photoreceptor drum 1 is charged by a main charger 100. The latent image on the photoreceptor drum 1 is developed by a main developer unit 2 or a sub developer unit 3 and is transferred to a paper at transfer position 13. In Fig. 1, 14 is a bypass table for feeding paper, 15 is an upper paper feed cassette, 16 is a lower paper feed cassette, 17 and 18 are paper feed rollers, 19 is a conveying roller, 20 is a resisting roller, 21 is a transferring charger, and 22 is a separating charger. The paper to which an image on the drum 1 is transferred is conveyed to a fixing unit 24 by a conveying belt 23. After fixed at the fixing unit 24, the paper is discharged on a discharge tray 26 through discharge rollers 25. The paper fixed at the fixing unit 24 can be led to a middle tray 28 through reverser 27 to be ready for the re-transferring of the image on the drum 1. The main developer unit 2 contains black toner to form black images. The sub developer unit 3 contains toner of another color to form images of another color. The developer units 2 and 3 can separately be attached to or detached from a copying machine body.

Fig. 2 is a cross-sectional view showing the details of the developer units 2 and 3. In this embodiment, the structure of only main developer unit 2 is described since the main developer unit 2

and the sub developer unit 3 have the same structure and they are different only in that they contain different colors of toner and that the sub developer unit 3 is smaller than the main developer unit 2. First, a developer 33 consisting of toner and carrier is supplied to the developer shell 30 after stirred by a paddle 32 that rotates on the axis parallel to that of the developer shell 30 and on which fins 31 are radially provided. The developer shell 30 is attached on the periphery of the magnet roller 34, and the toner on the developer shell 30 is provided to the surface of the photoreceptor drum 1 through the developer shell 30. In this process, the toner density of the developer 33 is detected by the toner density sensor 35, and the detected value and a predetermined reference value are compared at a control section 40 that comprises a microcomputer shown in Fig. 3.

The control section 40 operates based on the program stored in a ROM42. In the black-and-white image forming mode in which the main developer unit 2 operates, the control section 40 A/D (analog-to-digital) -converts the toner density detection signal generated by the toner density sensor 35 of the main developer unit 2, and after comparing the detected value with the reference value pre-memorised in RAM43, outputs a control signal. At this time, to maintain the toner density of the main developer unit 2 at a fixed level, when the detected value is larger than the reference value, the control section 40 controls the toner supply roller driving motor so that the toner supply decreases, and when the detection value is smaller than the reference value, it controls the toner supply roller driving motor so that the toner supply increases. In the color image forming mode in which the sub developer unit 3 operates, the control section 40 controls the toner supply in the same manner to maintain the toner density of the sub developer unit 3 at a fixed level. However, it is only when both of the main and sub developer units 2 and 3 are attached to the copying machine that the control section 40 performs the above-described toner density control operation, the copying operation and an initial setting of developer. When either of the developer units is detached, the control section 40 does not perform the above operations. Therefore, it is necessary to detect whether the developer units 2 and 3 are attached or not. The detection is performed as hereinafter described.

First, the main developer unit 2 is judged to be attached when the toner density sensor 35 outputs voltage data of 0V to 5V. At this time, generally, the toner density sensor 35 does not output voltage data of nearly 0V since the main developer unit 2 contains approximately 1kg of developer and never becomes vacant. If it should become nearly vacant, the voltage of, for example, 2V or 3V is normally

outputted. On the other hand, whether the sub developer unit 3 is attached or not is judged by using the output of a dip switch 47 instead of that of the toner density sensor 37. Since the entire body of the sub developer unit 3 is smaller than that of the main developer unit 2 and, normally, only approximately 200g of developer is contained in the sub developer unit 3, the output of the toner density sensor 37 is unstable and sometimes reaches nearly 0V. Therefore, whether the sub developer unit 3 is attached or not cannot be judged by the output of the toner density sensor 37. The sub developer unit 3 generally comprises a dip switch 47 with a circuit composition as shown in Fig. 4 for indicating the color of the toner the sub developer unit 3 contains. The color of the toner is identified by detecting the setting condition of the dip switch 47. For example, the color is identified by setting the dip switch 47 in the conditions (a), (b) or (c) shown in Fig. 4, where, for example, the color of the toner is red when the switch is set in the condition (a), blue, in the condition (b), and green, in the condition (c).

The dip switch 47 is attached to the sub developer unit 3 as shown in Fig. 5, and is set as described above by rotating its rotation driving portion 48 with, for example, a screwdriver. By detecting the output of the dip switch 47, whether the sub developer unit 3 is attached or not is detected. When the sub developer unit 3 is attached to a copying machine body, the terminals T1 to T4 shown in Fig. 4 are connected to a circuit provided in the copying machine body, and the control section 40 judges which of the terminals T1 to T3 is connected to the terminal T4 through the dip switch 47.

The above judgment by the control section 40 is an identification of the color of the toner. However, it represents the sub developer unit 3 is attached to the copying machine body that the above judgment can be performed. Therefore, the control section 40 detects whether the developer units are attached or not based on the above judgment. The detection of whether the main developer unit 2 and the sub developer unit 3 are attached or not is not necessarily performed in the above-described manner; it can be performed in other appropriate manners. For example, the detection can be also performed by providing a switch which is turned on or off when a developer unit is attached to a copying machine body, on a developer unit attaching section of the copying machine body, so that the control section 40 can perform the judgment with the output of the switch.

The control section 40 detects whether the main and sub developer units 2 and 3 are attached or not in the above-described manner. The control section 40 makes a copying mechanism section 46

operationable when both of the main and sub developer units 2 and 3 are attached; when either of the developer units is not attached, it makes the copying mechanism section 46 unoperationable.

Since the toner density control is performed only when a predetermined plural number of developer units are attached to an image forming apparatus body and the output data of the developer units are required to be corrected only when the developer units are attached, malfunction of the correction is not generated.

In the simulation mode, the initial value can be set in the condition where either of the developer units is attached or where both of the developer units are attached. Even when only one of the developer units is attached, correct data may be chosen in the correction of the toner density of both the developer units 2 and 3, since it is clear that, in the copying operation, the toner density control is performed only when both of the developer units are attached.

Moreover, in the simulation mode, it is possible to make the initial setting of the developer unoperationable when only one of the developer units is attached. In this case, it is not necessary to correct the toner density data since the output change of the toner density sensors 35 and 37 in the initial setting is the same as that in the copying operation.

The above-described is an embodiment when two developer units are provided. The same method is applicable to the copying machine with which three or more developer units are provided. Moreover, when more than three developer units are provided, the copying machine can be so constructed that the copying operation and the initial setting are operationable when predetermined plural number of developer units are attached as well as when all of them are attached. The above embodiment is an application of the present invention to a copying machine. The present invention is also applicable to a printer.

Obviously, many modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that within the scope of the appended claims, the invention may be practiced other than as specifically described.

## Claims

1. An image forming apparatus comprising: a photoreceptor (1); plural developer units (2, 3) for giving toner alternatively to said photoreceptor (1) to develop a latent image formed on said photoreceptor (1), comprising a developer shell (30, 38) and a toner density sensor (35, 37),

respectively, and which are attachable and detachable with respect to the periphery of said photoreceptor (1);

toner supply means (31, 36) for supplying toner to said developer units (2, 3) according to the output of said toner density sensor (35, 37); 5

detection means (35, 47) for detecting whether said developer units are attached with respect to the periphery of said photoreceptor (1); and 10

control means (40) for so controlling the image forming operation as to be performed only when a pre-determined plural number of developer units (2, 3) are attached. 15

2. An image forming apparatus according to claim 1, wherein said detection means (35) detects an attachment of said developer unit (2) in response to the presence of the output of the toner density sensor. 20
3. An image forming apparatus according to claim 1, wherein said detection means (47) detects an attachment of the developer unit (3) according to the condition of a switch that indicates the color of the toner in the corresponding developer unit (3). 25
4. An image forming apparatus according to claim 1, wherein said developer units (2, 3) comprise a main developer unit (2) for forming black image and a sub developer unit (3) for forming image of another color. 30
5. An image forming apparatus according to claim 1, wherein said developer units (2, 3) comprise a main developer unit (2) for forming image of a particular color and a sub developer unit (3) for forming image of another color, and said detection means (2, 3) detects an attachment of said main developer unit (2) in response to the presence of the output of the toner sensor (35) of the main developer unit (2) and an attachment of said sub developer unit (3) according to the output of the color identifying switch (47) that indicates the color of the toner in the sub developer unit (3). 35 40 45
6. An image forming apparatus according to claim 1, wherein said image forming apparatus has a simulation mode in which said control means (40) operate to control the initial setting of the developer of each developer unit (2, 3) so that the setting is performed only when a predetermined plural number of developer units (2, 3) are attached. 50 55

Fig. 1

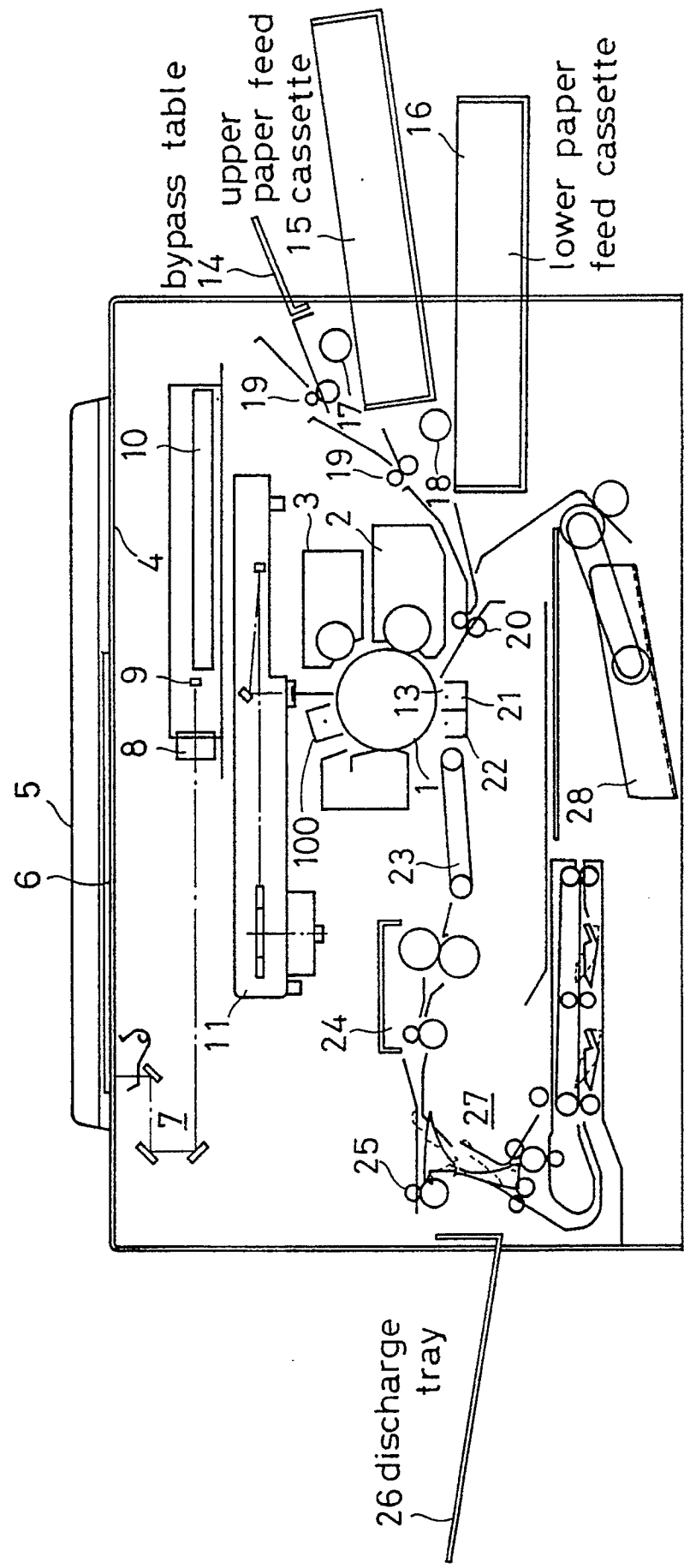


Fig. 2

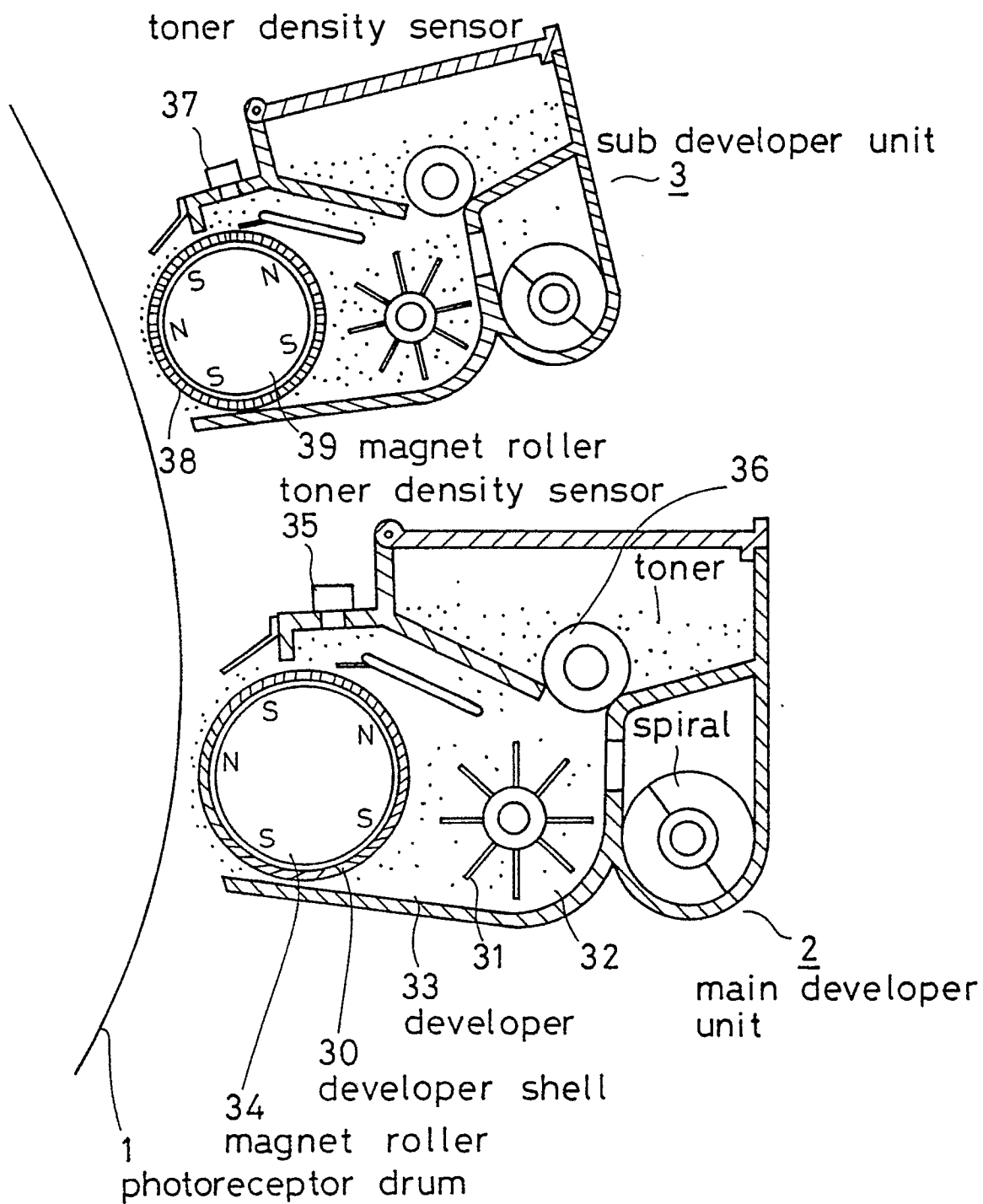


Fig. 3

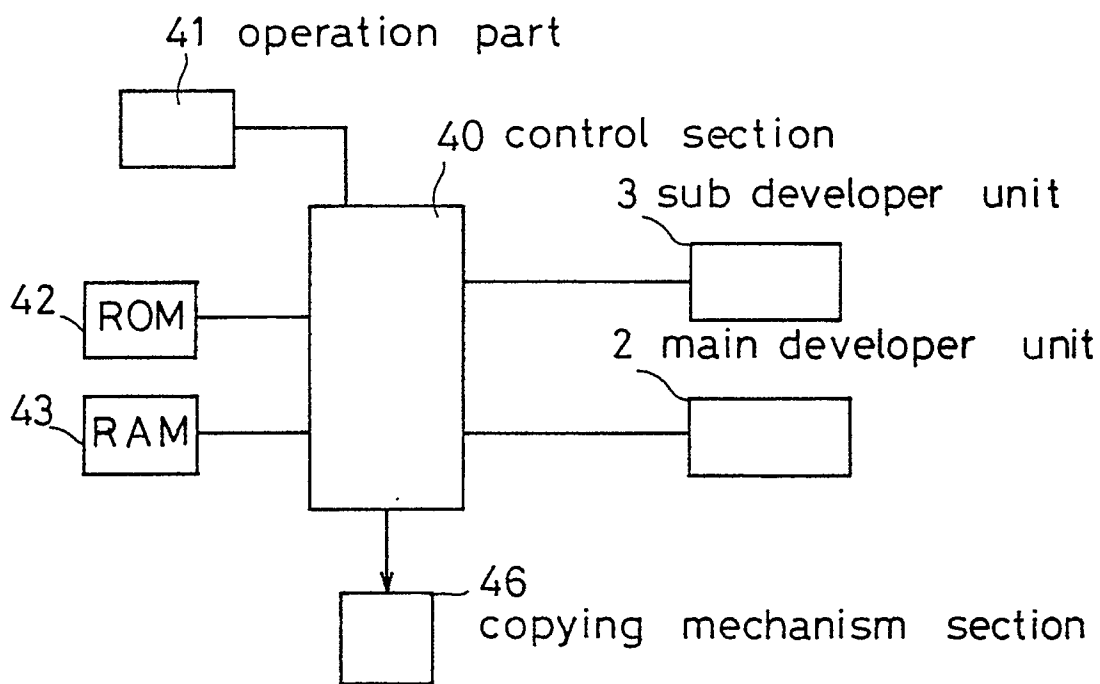


Fig. 4

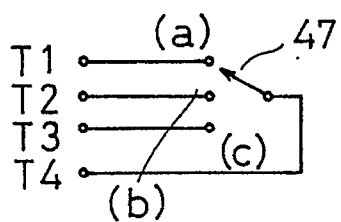


Fig. 5

