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

(11) Publication number: **0 656 571 A1**

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **93309647.1**

(51) Int. Cl.[6]: **G03G 15/08**

(22) Date of filing: **02.12.93**

(43) Date of publication of application:
07.06.95 Bulletin 95/23

(84) Designated Contracting States:
DE GB

(71) Applicant: **MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.**
1006, Oaza Kadoma
Kadoma-shi,
Osaka-fu, 571 (JP)

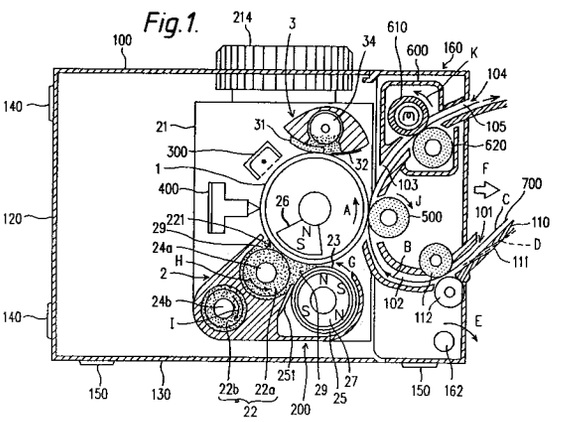
(72) Inventor: **Katakabe, Noboru**
2-6-29, Myojo-cho
Uji-shi,
Kyoto (JP)

(74) Representative: **Senior, Alan Murray et al**
J.A. KEMP & CO.,
14 South Square,
Gray's Inn
London WC1R 5LX (GB)

(54) A developing device and an image forming apparatus using the same.

(57) A developing device (2) according to the present invention is provided along a photosensitive body (1). The developing device comprises: a hopper for accommodating and supplying a developer; a recovering roller (23) which serves as a developer carrier member for transporting the developer carried on a surface therof to a developing place; and a developer circulating path (22) for circulating the developer between the hopper and the recovering roller. The developer circulating path includes a part of the hopper and a forward path (22a) and a backward path (22b) both of which extend from the hopper along the photosensitive body, the forward path and the backward path repectively have spaces independent of each other, and in each of the spaces a screw is provided for holding the developer therein and transporting the developer.

Fig.1.



EP 0 656 571 A1

BACKGROUND OF THE INVENTION

1. Field of the Invention:

The present invention relates to an electrophotographic image forming apparatus for use in a copying machine, a laser printer, or the like.

2. Description of the Related Art:

A developing device or an image forming apparatus of this type is disclosed in Japanese Laid-Open Patent Publication No. 3-101784 and Japanese Laid-Open Patent Publication No. 3-282488.

Figure **12** shows an image forming apparatus disclosed in Japanese Laid-Open Patent Publication No. 3-101784. As shown in Figure **12**, this image forming apparatus has a hopper **309** for accommodating a toner. The hopper **309** is positioned behind a developing sleeve **308** in the vicinity of a photosensitive body **301**. The toner in the hopper **309** is stirred by a toner stirrer **311** provided in the hopper **309**, scraped up to a toner supply hole **309a** disposed on the side of the developing sleeve **308**, and supplied to the developing sleeve **308** via the toner supply hole **309a**. The developing sleeve **308** carries a supplied toner on its surface. After the thickness of the toner is regulated by pressure of an elastic blade, the toner is opposed to the surface of the photosensitive body **301** which has been exposed to light, and an electrostatic latent image formed on the surface of the photosensitive body **301** is developed with the toner.

The hopper **309** for accommodating the developer occupies a large portion of the developing device **303**. Therefore, the diameter of the developing device **303** can be shortened only to a limited extent. As a result, an image forming section becomes a large one, together with the above developing device **303** and other numerous image developing elements disposed around the hopper **309**. This is disadvantageous in arranging a compact apparatus required especially for personal uses.

Further, an image developing unit pulled out of the main body is handled in various positions, such as the axial line of the developing sleeve **308** is turned vertically, or the upper portion of the developing device **303** is inclined transversally or downwards.

On the other hand, as an image forming apparatus with a more compact body is popularly produced, the apparatus is not necessarily used in one specified position. In such a case, the developing device **303** is turned in various directions as above.

If the direction of developing device **303** is different in individual uses or handling, the density of developer particles becomes uneven.

That is, the particles of the developer concentrate in the lower side by the gravity effect, if the axial line of the developing sleeve **308** inclines or turns vertically, because the developer can move freely in the hopper **309** and about the developing sleeve **308**.

If this is caused by a temporary handling, it is required to set the developing device **303** in a proper position so as to perform a smoothing drive so that developer particles extend evenly. Accordingly, an operator has to wait for the elapse of a stand-by time period.

Additionally, in the case of selecting the direction of setting a main body for continuous use, the problem of uneven developer is not solved. The developing efficiency is unstable depending on the direction of setting, which results in a poorly developed image or failure of development in some cases.

Figure **13** shows an image forming apparatus disclosed in the Japanese Laid-Open Patent Publication No. 3-282488. The image forming apparatus has a circulating transporting path for transporting circularly the developer, behind a developing sleeve **402**. The circulating transporting path comprises a developer transporting path **408** and a developer transporting path **409**. The developer transporting path **408** is disposed along the developing sleeve **402**. A toner supply path **420** extending from a hopper **417** located in a rear portion is connected with a part of the developer transporting path **409**. Additionally, a screw which can hold the developer well is adopted as a developer transporting body in the circulating transporting path for distributing the developer circularly.

However, a large space is opened about the developing sleeve **402** in a portion facing the developing sleeve **402** of the circulating transporting path. Accordingly, a large idle space is formed between the screw and the developing sleeve **402** of the developer transporting path **408**, where the developer can move freely without being held by the screw or the developing sleeve **402**. In such a space, the particles of developer concentrate in the lower side depending on the changes of position of developing device, resulting in a poorly developed image or a failure of development.

Further, the developer once supplied in the developer circulating path from the hopper **417** is continued to be transported in the developer transporting path until it is used for development. This makes a part of developer deteriorate suddenly, which makes a stable development impossible. Also, in the case where the amount of developer consummation in a developing place differs extremely in one developing operation from another, the developer clogs in the course of developer

circulating path.

In addition, the developer is poured into the hopper **417** from a developer refill container when the developer in the hopper **417** is used up. In order to refill the hopper with developer to continue the operation, the developer refill container is attached to the hopper, or a mouth of the developer refill container is put over a developer supply opening of the hopper **417**. In this case, a stable development is possible only when the supplied developer reaches uniformly in the whole range of a portion along the developing sleeve **402**, while being transported gradually in the developer transporting path. Accordingly, it is arranged to perform an initializing operation for driving the developing device for a predetermined time period after the developer is supplied.

However, in the above conventional method, the time period is needed for the initializing operation in addition to supply of developer. It is inconvenient for the operator to wait for the start of the image forming operation for the predetermined time period after the supply of the developer.

SUMMARY OF THE INVENTION

According to one aspect of the invention, a developing device provided along a photosensitive body, includes: a hopper for accommodating and supplying a developer; a developer carrier member for transporting the developer carried on a surface thereof to a developing place; and a developer circulating path for circulating the developer between the hopper and the developer carrier member. The developer circulating path includes a part of the hopper and a forward path and a backward path both of which extend from the hopper along the photosensitive body, the forward path and the backward path respectively have spaces independent of each other, and in each of the spaces a developer transporting unit is provided for holding the developer therein and transporting the developer.

In one embodiment of the invention, a developer transporting ability for feeding the developer from the hopper to the forward path is larger than a developer transporting ability of the developer carrier member.

In another embodiment of the invention, each of the developer transporting unit includes a screw, and the screw located in the forward path extends in the hopper.

In still another embodiment of the invention, the developer transporting unit of the forward path does not reach a connecting portion for connecting one end of the forward path to one end of the backward path, and the developer transporting unit of the backward path reaches the connecting portion.

In still another embodiment of the invention, the developer includes a magnetic toner, the developing device further includes a magnetic field forming unit for forming a magnetic field between the developer circulating path and the developing place, and the magnetic field is strong enough to cause a magnetic force at least capable of holding the developer against the gravity.

In still another embodiment of the invention the magnetic field formed by the magnetic field forming unit reaches at least a space including the developer transporting unit on the side of the developer carrier member.

In still another embodiment of the invention, the magnetic field forming unit is a magnet for development located in the developer carrier member.

In still another embodiment of the invention, the hopper includes a refill port to which a developer refill container for refilling the developer into the hopper is attached, and a stirrer, located in the hopper, for stirring the developer in conjunction with the developer transporting unit; and the developing device includes a control circuit for controlling the stirrer to stir the developer in the hopper when the developer is refilled from the developer refill container, and for controlling the developer transporting unit to transport the developer in the developer circulating path to a developer supply opening through which the developer is supplied from the developer circulating path to the developer carrier member.

In still another embodiment of the invention the developer refill container includes: a stirring member therein; and a coupling portion for connecting a rotation axis of the stirring member and a rotation axis of the stirrer of the hopper to each other by attaching the developer refill container to the refill port and for disconnecting the rotation axis of the stirring member and the rotation axis of the stirrer of the hopper from each other by detaching the developer refill container from the refill port.

According to another aspect of the invention, an image forming apparatus includes: a photosensitive body on a surface of which an electrostatic latent image is formed; a developing device for developing the electrostatic latent image, including: a hopper for accommodating a developer and supplying the developer, located at one end of the photosensitive body in the longitudinal direction; a developer carrier member for transporting the developer carried on a surface thereof to a developing place; and a developer circulating path, including a part of the hopper, for circulating the developer between the hopper and the developing place; a cleaner for removing a residual developer from the surface of the photosensitive body, the cleaner

being in contact with the surface of the photosensitive body; and a residual developer restoring unit for restoring the residual developer removed by the cleaner to the hopper.

According to still another aspect of the invention, an image forming apparatus includes: a photosensitive body on a surface of which an electrostatic latent image is formed; a developing device for developing the electrostatic latent image, including: a hopper for accommodating a developer and supplying the developer, located at one end of the photosensitive body in the longitudinal direction; and a developer circulating path, including a part of the hopper, for circulating the developer between the hopper and a part of the surface of the photosensitive body, the part of the surface functioning as a developer carrier member for transporting the developer carried on a surface thereof to a developing place; a cleaner for removing a residual developer from the surface of the photosensitive body, the cleaner being in contact with the surface of the photosensitive body; and a residual developer restoring unit for restoring the residual developer removed by the cleaner to the hopper.

In the developing device according to the present invention, the forward path and the backward path of the developer circulating path have respective spaces independent of each other. In each of the spaces a developer transporting unit is provided for holding the developer therein and transporting it. In this way, the particles of the developer in the developer transporting unit do not flow freely or gather unevenly, even if the device is inclined in various directions. So, the proper transportation of the developer to the developing place is maintained in this way. Also, the developer is returned to the hopper and released therein by the developer transporting unit at each time having completed one circulation. Accordingly, the developer does not clog in the course of circulation, without being affected by the variance of the amount of developer consumed in the developing place.

Further, in the idle space between the developer circulating path and the developer carrier member, where the developer can not be held, the magnetic field is formed by the magnetic field forming unit so that the developer is held by magnetic force. Accordingly, even if the apparatus body is rocked or if the position of the body is changed, the developer does not gather in one side.

Also, the developer transporting unit is continuously operated in conjunction with the developer supply operation by the hopper till the developer supplied in the hopper reaches at least the developer supply opening. Accordingly, the developing operation can be started immediately after the developer is refilled.

Further, in the image forming apparatus of the present invention, the hopper is located at one end of the photosensitive body in the longitudinal direction, and the forward path and the backward path are located in parallel with and in contact with the photosensitive body. This arrangement makes it possible to make the apparatus body compact, and it is advantageous in that such a compact apparatus can be placed in various attitudes.

Moreover, in the image forming apparatus according to the present invention, the residual developer restoring unit is provided in the hopper. This residual developer restoring unit restores the residual developer collected by cleaning so as to reuse the developer. Accordingly, space for storing the recovered developer is not required.

Thus, the invention described herein makes possible the advantages of (1) providing a developing device and an image forming apparatus which are simply constructed and can be downsized easily, (2) providing a developing device and an image forming apparatus capable of performing stable image formation even immediately after the device body is inclined in various directions, (3) providing a developing device, in the case of making image forming elements like a photosensitive body and the developing device into a unit and making the unit detachable from the main body of the image forming apparatus, capable of performing proper image formation immediately after the unit is attached to the main body, irrespective of the attitude of the developing device outside the main body, (4) providing a developing device capable of performing development immediately after the developing device is refilled with a developer, and (5) providing a small-sized image forming apparatus having a simple structure and capable of recovering the developer remaining on a photosensitive body after transference and of reusing it.

These and other advantages of the present invention will become apparent to those skilled in the art upon reading and understanding the following detailed description with reference to the accompanying figures.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure **1** is a cross-sectional view showing an image forming apparatus or Example 1 according to the present invention.

Figure **2** is a perspective view of the image forming apparatus of Example 1.

Figure **3** is a partially cutaway perspective view of a developing device according to the present invention.

Figure **4A** is a cross sectional view of a developing device shown in Figure **3** seen from above.

Figure **4B** is a cross sectional view of another developing device according to the present invention seen from above.

Figure **5** is a top plan view showing a part of an image forming apparatus of Figure **3** on the hopper side.

Figure **6** is a longitudinal sectional view of a hopper of the image forming apparatus of Figure **3**.

Figure **7** is a longitudinal sectional view of a part of the image forming apparatus of Figure **3** seen from the front.

Figure **8A** is a cross-sectional view showing a developer refill container.

Figure **8B** is a top plan view showing the developer refill container.

Figure **9** is a cross-sectional view of an image forming unit of the image forming apparatus of Figure **1**.

Figure **10** is a block view of a control circuit of the image forming apparatus of Figure **1**.

Figure **11** is a cross-sectional view of an image forming unit of an image forming apparatus of Example 2 according to the present invention.

Figure **12** is a cross-sectional view of a conventional image forming apparatus.

Figure **13** is a cross-sectional view showing another conventional image forming apparatus.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Hereinafter, the present invention will be described by way of illustrative examples with reference to the drawings.

Example 1

The construction of an image forming apparatus of the present example will be described with reference to Figures **1** and **2**. Figure **1** is a cross-sectional view showing an image forming apparatus seen from the side, and Figure **2** is a perspective view showing the same. A developing device according to the present invention is provided in a simple and compact image forming apparatus suitable for personal uses, which is especially connected to a personal computer.

As shown in Figures **1** and **2** this image forming apparatus has a case **100**, an image forming unit **200**, a charger **300**, a printer head **400**, a transfer roller **500**, and a fixing device **600**. The image forming unit **200** includes a photosensitive body **1**, a developing device **2**, a cleaner **3** and a drive mechanism **4**. The photosensitive body **1** rotates in the direction of an arrow **A**. The charger **300**, the printer head **400**, the developing device **2**, the transfer roller **500** and the cleaner **3** are disposed in this order around the circumference of the photosensitive body **1** in the direction of the arrow **A**.

Hereinafter, an operation of the image forming apparatus constructed as above will be described.

When an output command is given to the image forming apparatus, the drive mechanism **4** including a motor (not shown) starts a driving operation, and each of the components connected to the drive mechanism **4** operates. First, the photosensitive body **1** starts rotating in the direction shown by the arrow **A**. As soon as the photosensitive body **1** starts rotating, the charger **300** is turned ON to supply a predetermined amount of charge to the photosensitive body **1**, and uniformly charges the photosensitive body **1** so that the surface potential thereof is approximately -550 V, for example.

When the charged surface of the photosensitive body **1** reaches the printer head **400**, an image signal is supplied to the printer head **400**. The charged surface is successively irradiated with light by the printer head **400** in accordance with the image signal. Thus, an electrostatic latent image is formed on the photosensitive body **1**.

The electrostatic latent image formed on the photosensitive body **1** is developed by the developing device **2**, whereby a developer image is formed on the photosensitive body **1**. This developing operation will be described later in detail.

In this developing operation, a recording paper **700**, sandwiched between the transfer roller **500** and the photosensitive body **1**, is fed one after another. A bias voltage (e.g., approximately +1 kv) is applied to the transfer roller **500**, and a negatively charged developer on the photosensitive body **1** is transferred onto the recording paper **700**.

Then, the recording paper **700** on which the developer image is transferred passes through the fixing device **600**, and the developer image is thermally fixed therein. Thereafter, the recording paper **700** is discharged from the image forming apparatus.

On the other hand, a part of a developer remaining on the photosensitive body **1** after the transfer operation is removed by the cleaner **3**. The photosensitive body **1** thus cleaned returns to the charge position again, and is ready to repeat the above-mentioned operation again. After completing an image forming operation for one sheet of recording paper **700**, the photosensitive body **1** stops. Further, according to the present example, the removed developer is collected and reused, as described later.

A construction and operation of each of the above-mentioned elements will be described in detail.

(Case **100**)

At a position corresponding to a transfer section between the photosensitive body **1** and the transfer roller **500** on the external surface of the case **100**, a paper supply slit **101** for manual feeding is disposed. The paper supply slit **101** has a paper guide **110** and a paper feeding rollers **112**. The paper feeding rollers **112** rotates so as to send the recording paper **700** to the transfer section with a predetermined timing in a series of operations of the image forming apparatus as described above. Between the image forming unit **200** and the external surface of the case **100** having the paper supply slit **101**, a paper feeding path **102** extending from the paper supply slit **101** is disposed. The recording paper **700**, supplied from the paper supply slit **101**, is transported to the transfer section via the paper feeding path **102**, as shown by an arrow **B**. On the downstream side of the transportation of the recording paper **700** of the transfer section, a transporting path **103** for transporting the recording paper **700** from the transfer section to the fixing device **600** is disposed. On the external surface of the case **100**, at a position corresponding to the fixing device **600**, a paper discharge slit **104** is disposed. On the downstream side of the transportation of the recording paper **700** of the fixing device **600**, a paper discharge path **105** for transporting the recording paper **700** from the fixing device **600** to the paper discharge slit **104** is disposed.

As shown in Figure **2**, the shape of the case **100** is substantially a rectangular parallelopiped and has six planes. According to the present invention, two planes can be selectively used for placing. That is, a plane **120** opposed to the plane on which the paper supply slit **101** is disposed and a plane **130**, which is adjacent to the plane **120**, among four planes surrounding an axis of the photosensitive body **1**. According to the present invention, the paper supply slit **101** is disposed on the side of the plane opposed to the plane **120** so as to be close to the plane **130**, and the paper discharge slit **104** is disposed on the plane opposite to the plane **120** so as to be away from the plane **130**. In this way, the recording paper **700** can be easily discharged irrespective of whether the plane **120** or **130** is made a placing plane.

The paper guide **110** has a slit **111** extending in parallel with an axial direction of the photosensitive body **1**. This makes it possible to supply and discharge the recording paper **700**, irrespective of whether the plane **120** or **130** is selected as a placing plane. In the case where the plane **120** is selected, the recording paper **700** is guided and fed in the direction shown by the solid line **C**. In the case where the plane **130** is selected, the recording paper **700** is guided and fed through the slit **111** in the direction shown by the broken line **D**.

The planes **120** and **130** respectively have projections at corners thereof. Because of this, the image forming apparatus is stably placed. These projections **140** and **150** are preferably made of rubber or the like, for preventing slip.

An open-and-close section **160** (upper right portion in Figure **1** has a paper feeding section including the paper feeding path **102**, the paper transporting path **103**, and the paper discharge path **105** and the like, in addition to the transfer roller **500**, and the fixing device **600**. This open-and-close section can be opened for removing jammed paper, repairing the apparatus in the event of a failure and the like. The open-and-close section **160** is rotatable in the direction of an arrow **E** around a shaft **162** extending in parallel with the axial direction of the photosensitive body **1**. Thus, the right hand side of the image forming unit **200** shown in Figure **1** (i.e., the open-and-close section **160**) is completely released therefrom, and the image forming unit **200** can be detached in the direction of an arrow **F** through the opening formed by this release. The detaching direction is freely set, depending on the arrangement of other elements and the open-and-close structure of each section of the case **100**.

(Image forming unit **200**)

(1) Photosensitive body **1**

A conventional photosensitive body is used in the present invention. However, there is no particular restriction in the type of the photosensitive body **1**.

(2) Developing device **2**

The construction of the developing device **2** will be described with reference to Figures **3** to **9**.

Figure **3** is a partially cutaway perspective view of the developing device **2**, and Figure **4A** is a cross-sectional view of the same seen from above. As shown in these figures, the developing device **2** has a hopper **21**, a developer transporting pipe **22**, and a recovering roller **25**. The hopper **21** accommodates and supplies the developer. The developer transporting pipe **22** for transporting the developer supplied from the hopper **21**. The recovering roller **25** forms a developer image by recovering the extra particles of developer.

The outline of a developing operation in the developing device **2** having the above-mentioned structure will be described.

The developer used for development is transported from the hopper **21** to the surface of the

photosensitive body **1** through the developer transporting pipe **22** and arbitrarily supplied both to an image area and a non-image area on the photosensitive body **1**. The developer supplied to the photosensitive body **1** is kept in a developing place **23**, a portion between the photosensitive body **1** and the recovering roller **25**. At the developing place, an AC electric field is formed in addition to a DC electric field. Because of this, the developer supplied to the non-image area and the extra part of developer supplied to the image area are recovered by the recovering roller **25**. Thus, the proper amount of developer is adhered only to the image area, whereby development is performed.

Hereinafter, a structure and operation of each member of the developing device **2** will be described.

(A) Hopper **21**

Figure **5** shows an enlarged view of the hopper **21** and its vicinity. Figure **6** is a longitudinal sectional view of the hopper **21** seen from the side. Figure **7** is a longitudinal sectional view of the hopper **21** portion, including the cleaner **3**, seen from the front.

As shown in these figures, the hopper **21** is arranged outside of the edge in the longitudinal direction of the photosensitive body **1**. The hopper **21** has a developer refill port **213** in its upper portion, through which the developer is supplied into the hopper **21**. On the internal side plane of the developer refill port **213**, a fit groove **215** in the shape of key is provided. In the hopper **21**, a stirring blade **211** which rotates around a rotation shaft **210** vertically extending is disposed. The rotation shaft **210** extends towards the lower outside of the hopper **21**. A gear **45** is disposed on the bottom edge of the rotation shaft **210**, and a coupling **216** is disposed on the top edge thereof. Over the developer refill port **213**, a cover **214** is disposed. As shown in Figure **5**, the hopper **21** has a developer outlet **212a** for supplying the developer to the developer transporting pipe **22**, and a developer inlet **212b** for receiving the developer returning to the hopper **21** from the developer transporting pipe **22** without being used for development.

(Developer refill container **800**)

A developer refill container **800** shown in Figure **8A** is used for refilling the developer in the hopper **21**. The developer refill container **800** has a cylindrical shape. On the bottom thereof, two developer discharge outlets **820** are disposed in the circumferential direction as shown in Figure **8B**. Further, the developer refill container **800** has a cap **810** on its bottom, whereby these developer discharge outlets **820** are covered. The cap **810** has a stirring blade **812** rotatable around a rotation shaft **811** in the developer refill container **800**, and the cap **810** itself is rotatable around the rotation shaft **811**. The cap **810** has openings **813** corresponding to the developer discharge outlets **820**. When these openings **813** fit in the developer discharge outlets **820**, the developer in the developer refill container **800** can be discharged. On the outside of the cap **810**, a coupling **815** connected to the rotation shaft **811** is provided, and projections **814** are formed on the periphery of the cap **810**.

The hopper **21** has a developer refill container detecting sensor (not shown in Figure **8A**) for detecting that the developer refill container **800** is attached to the hopper **21**. Various kinds of sensors such as a photosensor and a limit switch are usable for this developer refill container detecting sensor, which makes it possible to detect the attachment of the developer refill container **800** to the hopper **21**, optically, electrically or mechanically.

Next, an operation of the developer refill container **800** will be described.

As shown in Figure **3**, at the time of refilling developer, the cover **214** is removed from the developer refill port **213**, and the developer refill container **800** is attached to the developer refill port **213**, whereby the developer is refilled in the hopper **21**. In the attachment of the developer refill container **800**, after the projections **814** of the developer refill container **800** is fit into the fit groove **215** of the hopper **21**, the developer refill container **800** is fully pushed and revolved. Since the cap **810** is fixed, the cap **810** rotates with respect to the developer refill container **800**, whereby the openings **813** of the cap **810** are aligned with the developer discharge outlets **820**. In this way, the developer in the developer refill container **800** falls into the hopper **21** through the developer discharge outlets **820** and openings **813**.

The coupling **815** on the rotation shaft **811** of the developer refill container **800** is automatically connected to the coupling **216** on the rotation shaft **210** of the hopper **21**. Thus, the stirring blade **812** in the developer refill container **800** is driven for rotation in association with the rotation of the stirring blade **211** in the hopper **21**. By the rotation of the stirring blade **812**, the developer is smoothly moved from the developer refill container **800** to the hopper **21**. This makes the time required for refilling the developer shorter. As a result, the standby time for image forming is shortened.

Further, since the stirring blade **812** and the stirring blade **211** in the hopper **21** are simultaneously driven, the developer can be successively

supplied to the hopper **21** and then transported to the developing place **23**. That is, the developer supplied to the hopper **21** is stirred and spread evenly by the stirring blade **211**. This stirred developer is smoothly fed out into the developer transporting pipe **22** by means of a screw **24a** disposed in a forward path **22a** extending into the hopper **21**. In this way, the developer is stably transported. Since the supply and transportation of the developer are completed in a short period of time, it is possible to stably supply the developer to the developing place **23** for development without an initializing operation after the supply of the developer or standby time required for this operation. Accordingly, there is an advantage that the image forming operation can be started immediately after the developer is supplied.

(B) Developer transporting pipe **22**

As shown in Figure **3**, the developer transporting pipe **22** has the forward path **22a** for forwarding the developer from the hopper **21**, a backward path **22b** for backwarding the developer once fed into this forward path **22a**, and a connecting path **22c** for connecting a first end of the forward path **22a** and a first end of the backward path **22b**. The forward path **22a** and the backward path **22b** extend in parallel with the axial direction of the photosensitive body **1**. The forward path **22a** and the backward path **22b** respectively have spaces independent of each other, and respectively extend from the hopper **21** in parallel with the axial direction of the photosensitive body **1**. A second end of the forward path **22a** is connected to the developer outlet **212a** of the hopper **21**, and a second end of the backward path **22b** is connected to the developer inlet **212b** of the hopper **21**. In this way, the forward path **22a**, the backward path **22b**, and the connecting path **22c** form a continuous path for circulating the developer, including the hopper **21** as a part thereof. Since the developer transporting pipe **22** forms a closed space together with the photosensitive body **1** and the recovering roller **25**, any particles of the developer does not scatter out of the closed space. The photosensitive body **1** functions as a developer carrier body for transporting the developer to the developing place **23**.

The forward path **22a** has a developer supply opening **221** in a position opposed to the photosensitive body **1**, for supplying the developer directly to the surface of the photosensitive body **1**. The developer supply opening **221** is large enough for the developer in a sufficient amount to be adhered both to an image area and a non-image area on the photosensitive body **1**.

As shown in Figures **1** and **9**, the forward path **22a** and the developer supply opening **221** are both provided beneath the photosensitive body **1** at an angle of about 45 degrees from the horizontal plane of the photosensitive body **1**. Due to this arrangement, the developer supplying condition remains almost the same, irrespective of whether the apparatus is placed on the plane **120** or on the plane **130** of the case **100**. Further, since the developer is always supplied to the photosensitive body **1** from below, whichever plane (i.e., the plane **120** or **130**) is selected for placing, the excess supply of the developer caused by gravity can be prevented. Also, it avoids clogging the space with the particles of developer and thus applying extreme pressure to the developer.

Further, it is possible to effectively supply the developer by utilizing the force of a magnetic field. Figure **9** is an enlarged longitudinal cross-sectional view of the developing device **2** and the vicinity thereof. As shown in Figure **9**, a sector-shaped magnet **26** is provided in the photosensitive body **1**. A magnetic field as shown by broken lines in Figure **9** is formed by means of the magnet **26** and a cylindrical magnet **27** (described later) located in the recovering roller **25**. The developer transported in the forward path **22a** is attracted and adhered to the surface of the photosensitive body **1**, by a magnetic force of the magnetic field of the magnet **26**. In the present example, a magnetic monocomponent developer is used.

A screw **24a** and a screw **24b** are provided in the forward path **22a** and the backward path **22b**, respectively. The screws **24a** and **24b** have a lead in the same direction with each other. The inner wall of the screws **22a** and **22b** are adjacent to the periphery of the screws **24a** and **24b**, respectively. Thus, it is possible to hold the particles of the developer in the spaces around the blades of the screws **24a** and **24b** against the influence of gravity, even when the developing device **2** is pulled out from the case **100**, or when the direction of operation or placement is changed. Accordingly, the developer is prevented from gathering in either end of the developer transporting pipe **22**, or in either side of the forward path **22a** or the backward path **22b**.

In the above-mentioned closed space, there is a developer idle space **29** free from the transporting force of the screw **24a**. The developer idle space **29** is formed among the screw **24a** in the forward path **22a**, the photosensitive body **1** and the recovering roller **25**. In the developer idle space **29**, the developer is likely to flow without being caught therein, because it is free from the transporting force of the screw **24a** or the carrying force of the photosensitive body **1** and the recovering roller **25**. In the present example, however, a magnetic field formed between the magnet **26** in the photosensitive body **1** and the magnet **27** in the

recovering roller **25** is formed in this developer idle space **29**, and the strength of the magnetic field is set to a magnetic force strong enough to hold the developer against gravity. Therefore, the above-mentioned gathering of the developer is reliably prevented, even if the direction of the apparatus is variously changed. It is also possible to dispose a magnet in the vicinity of the developer transporting pipe **22** in addition to the magnets **26** and **27** to form the magnetic field, which has the developer caught in the developer idle space **29**.

Also, by forming the magnetic field, which is caused by the magnets **26** and **27**, in the screws **24a** and **24b**, the developer is caught more reliably by the screws **24a** and **24b**. In order to form such a magnetic field, the magnets **26** and **27** may be strengthen, or another magnet may be provided.

As shown in Figure **4A**, a guide plane **220** (a sidewall having a slope) is provided at the first end of the forward path **22a**. This improves the transportation of the developer from the forward path **22a** to the backward path **22b**.

Also, as shown in Figure **4A**, the width of the connecting path **22c** connecting the forward path **22a** and the backward path **22b** is made larger than that of the forward path **22a**, and the screw **24a** is not provided in this portion. Accordingly, the developer transported to the first end of the forward path **22a** by the screw **24a** is pushed to the side of the backward path **22b**, and the pushed developer is caught by the screw **24b** and forwarded into the backward path **22b**. In the present example, since a part of the screw **24a** is removed at the first end of the forward path **22a** where a part of the wall separating the forward path **22a** from the backward path **22b** is removed, and the connecting path **22c** is widened therein, the developer forwarded to this place is smoothly delivered to the adjacent backward path **22b**. Thus, the transporting direction of the developer is reliably changed within a narrow space. If the screw **24a** extends further closer to the guide plane **220**, the developer is compressed to the side wall before being delivered to the backward path **22b**, causing the developer to clog.

In the present example, the leads of the screws **24a** and **24b** are gradually enlarged so as to be larger at downstream than at upstream. As a result, even in the case where the screws **24a** and **24b** are rotated at a constant speed, the developer transporting ability is appropriately made larger while being transported from the developer outlet **212a** of the hopper **21**, via the forward path **22a** and the backward path **22b**, to the developer inlet **212b** of the hopper **21**. That is, the developer receives more transporting force as it is traveling to the downstream, and finally released from the force when it is fed into the hopper **21** having a large capacity. Accordingly, it is possible to prevent the developer from clogging in the course of transportation or from being degraded under extreme stress due to high density similar to the clogging state. However, the lead of the screw **24a** is constant in a position corresponding to the developer supply opening **221**. If the lead is not constant, the amount of the developer supplied to the photosensitive body **1** varies in the axial direction of the photosensitive body **1**, due to the difference in the transporting speed of the developer.

If the leads of the screws **24a** and **24b** are large, the force of holding the developer is weak. Accordingly, the developer is not held sufficiently between the blades of the screw **24a** and the screw **24b**, and the above-mentioned effect of preventing the developer from gathering is reduced. Such a problem is solved by providing a number of blades.

The screw **24a** in the forward path **22a** is provided so that a part thereof extends in the hopper **21** at the developer outlet **212a**. This makes it possible to conveniently catch the developer in the hopper **21** and forward it reliably. At the developer outlet **212a** of the hopper **21**, the developer transporting ability of the screw **24a** is set so as to be larger than that of the photosensitive body **1** for transporting the developer to the developing place **23**. The reason for this setting is as follows:

In general, the developer transporting ability of the photosensitive body **1** is set so as to be sufficient for forming a whole surface solid black image. However, there is a possibility that the shortage of the developer supply amount is caused in the case where the developer transported through the developer transporting pipe **22** is decreased in amount while such a solid black image is repeatedly formed. The above-mentioned setting can avoid this shortage. Thus, an image density is stably maintained to be constant.

The setting of the developer transporting ability of the screws **24a** and **24b** can also be appropriately adjusted by modifying the diameter or driving speed of the screws **24a** and **24b**, in addition to the above-mentioned configuration of the leads.

As for the arrangement of the forward path **22a** and the backward path **22b**, the forward path **22a** is always located above the backward path **22b**, irrespective of whether the plane **120** or the plane **130** is selected for placing. Accordingly, it is possible to use gravity for changing the direction of transporting the developer in the connecting path **22c**, and there is an advantage in that the developer does not clog.

Alternatively, the forward path **22a** and the backward path **22b** can be transposed with each other as shown in Figure **4B**. In such an arrangement, the forward path **22a** is always located below the backward path **22b**, irrespective of whether the

plane **120** or the plane **130** is selected for placing. Accordingly, it is possible to take the developer positioned at the bottom of the hopper **21** for development. Either the plane **120** or the plane **130** can be always used for placing.

The rotation direction of the screw **24a** and the screw **24b** is opposite to the rotation direction thereof shown in Figure **4A**. Accordingly, in the case shown in Figure **4B**, an idle gear **43** shown in Figure **4A** is unnecessary, and it is sufficient that the drive mechanism **4** directly drives a gear **44** by engaging a gear **42** connected to the screw **24b** of the forward path **22b** with a gear **44** connected to a rotation shaft of the recovering roller **25**. As shown in Figure **4B**, the lead of the screws **24a** and **24b** is smaller on the side of forward path **22a** and larger on the side of backward path **22b**, and thereby the developer transporting ability is optimized. Also, the guide plane **220** is provided on the side of the forward path **22a** in the connecting path **22c**.

As described above, in the developing device **2** of the present example, the hopper **21** is located at the first end of the longitudinal direction of the photosensitive body **1**, and the forward path **22a** and the backward path **22b** extend from the hopper **21** in parallel with the photosensitive body **1**. Accordingly, only the forward path **22a** and the backward path **22b** are located around the periphery of the photosensitive body **1**, and the hopper **21** is not located around the photosensitive body **1**. Further, the forward path **22a** and the backward path **22b** are formed at a distance as short as possible for transporting the developer. Therefore, the space occupied by the developing device **2** around the periphery of the photosensitive body **1** is greatly reduced, thus miniaturizing the image forming apparatus.

(C) Recovering roller **25**

A voltage is applied to the recovering roller **25** for forming the above-mentioned AC electric field with the DC electric field superimposed. In the present example, an AC voltage having a peak-to-peak voltage of 1.8 KV and a frequency of 1.5 kHz with a DC voltage of -300 V superimposed is supplied to the recovering roller **25**, the surface potential of the photosensitive body **1** being approximately -550 V. Thus, the developer on a non-image area is effectively attracted to be removed by using an electric force obtained by functioning as an AC electric field in addition to a DC electric field between the photosensitive body **1** and the recovering roller **25**. In the developer contacting the surface of the non-image area, the particles of the bottom part (i.e., the part which is directly in contact with the surface) are in a relatively stable condition. However, the particles of the upper part of the developer are in a relatively free condition or in a completely free condition. Therefore, the developer can be removed from the non-image area by vibrating the particles of the upper part of the developer by the electric field, and then colliding the particles against the stabilized particles of the bottom part. In this way, the developer adhering to the non-image area can be effectively attracted to the side of the recovering roller **25** and removed.

For improving the efficiency of recovering unnecessary developer, it is possible to use a force by the magnetic field in addition to the above electric force. As described in the foregoing, the magnetic field as shown in Figure **9** is formed by means of the magnet **26** in the photosensitive body **1** and the cylindrical magnet **27** in the recovering roller **25**. The developer adhering to the non-image area can be effectively attracted to the side of the recovering roller **25** and removed by means of this magnetic field.

The developer on the recovering roller **25** thus removed from the non-image area is recovered in the forward path **22a** by the rotation of the recovering roller **25**. The recovering roller **25** rotates in the direction shown by an arrow **G**. A recovering blade **251** is located between the recovering roller **25** and the forward path **22a**. The developer attracted by the recovering roller **25** is removed from the recovering roller **25** by the recovering blade **251**. The recovering blade **251** also seals the space between the developer supply opening **221** and the recovering roller **25** so as to prevent the developer from flowing out from this space.

Hereinafter, an operation of the developing device **2** will be described.

Referring to Figures **3** and **4A**, when the drive mechanism **4** starts driving, an idle gear **43** provided on the drive mechanism **4** rotates. As shown in these figures, the idle gear **43** is engaged with a gear **44** provided at one end of the shaft of the recovering roller **25**. The shaft of the recovering roller **25** rotates in the direction shown by the arrow **G** at a predetermined rotational ratio with respect to the idle gear **43**.

The idle gear **43** is engaged with the gear **42** provided at one end of the shaft of the screw **24a**, and the gear **42** is directly engaged with a gear **41** provided at one end of the shaft of the screw **24b**. Accordingly, by the rotation of the idle gear **43**, the shaft of the screw **24a** rotates in the direction shown by an arrow **H**, and the shaft of the screw **24b** rotates in the direction shown by an arrow **I**. Namely, these two shafts rotate in directions opposite to each other at a predetermined rotational ratio. The developer is transported in the opposite direction to each other by this rotation, since the direction of the lead of the screw **24a** is the same as that of the screw **24b**.

A gear **46** is provided at the other end of the shaft of the screw **24a**, as shown in Figures **3** and **4**. The gear **46** engages the gear **45** provided on the rotation shaft **210** of the hopper **21**, serving as a worm gear. Thus, the stirring blade **211** of the hopper **21** rotates simultaneously with the rotation of the shaft of the screw **24a**. Also, at the time of supplying the developer, as described above, the stirring blade **812** of the developer refill container **800** rotates simultaneously with the rotation of the stirring blade **211** of the hopper **21**.

When driven as described above, the developer in the hopper **21** is fed into the forward path **22a** by the screw **24a**, while being stirred by the stirring blade **211**. The developer thus fed into the forward path **22a** is always supplied to the recovering roller **25** and the photosensitive body **1** opposed to the forward path **22a** through the developer supply opening **221**. After the developing place **23**, facing the recovering roller **25** and the photosensitive body **1**, is filled with the developer, an extra portion of the developer is continuously forwarded by the screw **24a**, and fed into the backward path **22b** through the connecting path **22c** located opposite to the hopper **21**. Thereafter, the developer is transported in the backward path **22b** in the direction opposite to that of the developer supply path **22a**, and returns to the hopper **21** again.

In this way, the developer circulating in the developer transporting pipe **22** returns to the hopper **21** at each circulation and is mixed with the developer contained in the hopper **21**. Consequently, the developer can be supplied in a homogeneous state at all times. That is, the developer which is returned to the hopper **21** is mixed with the developer contained in the hopper **21** so as to have a homogeneous quality and the mixed developer is used for subsequent development. Because of this advantage, there is no possibility that a part of the developer rapidly deteriorates due to repeated use. In addition, repeatedly used developer is uniformly dispersed in the developer contained in the hopper **21**. Thus, stable development is ensured.

(3) Cleaner **3**

As shown in Figures **1** and **9**, the cleaner **3** has a cleaning blade **31** contacting the surface of the photosensitive body **1**. The cleaning blade **31** removes the residual developer after transfer operation from the surface of the photosensitive body **1**. The cleaner **3** also has a seal **32** for sealing the developer which is subject to cleaning and gathered. The cleaner **3** has a developer restoring path **33** extending in parallel with the axial direction of the photosensitive body **1**. In the developer restoring path **33**, a screw **34** for transporting the developer is provided adjacent to a side wall. Since the amount of developer transported by the screw **34** is extremely small, a simple structure using a coil spring or the like is adaptable for the screw **34**. The screw **34** is connected to the drive mechanism **4**. As shown in Figure **7**, one end of the developer restoring path **33** is connected to the hopper **21**, and the developer transported by the screw **34** is restored in the hopper **21**.

In the cleaner **3** having the above-mentioned structure, the developer recovered by the cleaning blade **31** is gathered to the developer restoring path **33**, sequentially transported by the screw **34** driven for rotation in conjunction with the photosensitive body **1** and the like, and then restored in the hopper **21**.

In this way, according to the present invention, a space for accommodating the residual developer gathered by the cleaner **3** is unnecessary, and this is effective for realizing a small-sized apparatus. Further, it is possible to effectively consume the developer in a simplified apparatus, since the troublesome process such as discarding the gathered residual developer is not required.

(4) Drive mechanism **4**

The drive mechanism **4** includes a motor (not shown). This motor drives and rotates the stirring blade **211** in the hopper **21**, the screws **24a** and the screw **24b** in the developer transporting pipe **22**, and the recovering roller **25,** in addition to the photosensitive body **1**, the transfer roller **500** and a heat roller **610** in the fixing device **600**.

(Charger **300**)

The type of the charger **300** is not particularly limited. The present invention employs a corona charger.

(Printer head **400**)

As for the printer head **400**, a solid image scanning method, in which an image exposure is performed by arranging light emitting elements (LED) or liquid crystal shutters, can be used. For example, a laser scanner which does not use mechanical scanning is used. However, in the case of a large-sized apparatus, a printer head which performs scanning by deflecting a laser beam can be used.

(Transfer roller **500**)

The transfer roller **500** is located on the side where the paper supply slit **101** and the like is

located, with respect to the photosensitive body **1**. The transfer roller **500** is always pressed so as to be in contact with the photosensitive body **1** so that a bias voltage for transfer is applied, if required. The transfer roller **500** rotates in the direction shown by an arrow **J** as shown in Figure **1**.

(Fixing device **600**)

The fixing device **600** has a heat roller **610** having a shaft which is in parallel with that of the photosensitive body **1**. A rotation roller **620** is provided opposed to the heat roller **610**. The recording paper **700** after the transfer operation is fed between the heat roller **610** and the rotation roller **620** via the transporting path **103**. The heat roller **620** is rotated in the direction shown by an arrow **K** by the drive mechanism **4**, as shown in Figure **1**.

The fixing device **600** is provided in a position which is away from the photosensitive body **1**, close to the paper discharge slit **104**, and between the paper discharge slit **104** and the transfer section. That is, the fixing device **600** is always located above the photosensitive body **1**, irrespective of whether the plane **120** or the plane **130** is selected for placing. In this way, the heat of the fixing device **600** does not influence the image forming section around the photosensitive body **1**.

(Control circuit **900**)

Figure **10** is a block diagram of the control circuit **900** of the present example.

The control circuit **900** which is provided on the case **100** or the developing device **2** has a CPU **910** and a drive circuit **920** for driving the drive mechanism **4**. An output signal from the developer refill container detecting sensor **170** is input to the CPU **910**.

The control operation at the time of refilling the developer will be described hereinafter.

When the developer refill container detecting sensor **170** detects that the developer refill container **800** is attached to the hopper **21**, an output signal indicating the attachment is input to the CPU **910**. Upon receiving the signal indicating the attachment, the CPU **910** supplies a command to the drive circuit **920** so that the drive mechanism **4** stops its operation after having worked for a predetermined period of time.

When the developer refill container **800** is attached to the hopper **21** for supplying the developer, the drive mechanism **4** is actuated simultaneously with the attachment of the developer refill container **800**, and then the screws **24a** and **24b** are driven. As a result, the stirring blade **211** of the hopper **21** and the stirring blade **812** in the developer refill container **800** rotate simultaneously.

The predetermined period of time for driving the drive mechanism **4** is set so as to be long enough for the developer in the hopper **21** to reach the far end of the developer supply opening **221** in the forward path **22a** facing the photosensitive body **1**. Also, if this predetermined period of time is set to be equal to or longer than the time required for the developer from the hopper **21** to be transported via the forward path **22a** and the backward path **22b** and returned to the hopper **21** again (i.e., the time required for the developer to complete at least one cycle of circulating through the developer transporting pipe **22**), the whole range of the developer transporting pipe **22** is filled with the developer, and the developer supply to the photosensitive body **1** is stably performed when an image forming operation is started or resumed.

In the developer transporting pipe **22**, the forward path **22a** and the backward path **22b** are located adjacent to each other along the photosensitive body **1**, and the developer is supplied from the developer supply opening **221** to the developing place **23** in the state of the developer keeping in contact with the photosensitive body **1**. In such an arrangement, the developer is supplied via the shortest route to the developing place **23**. The standby time for starting or resuming the image formation is also shortened.

The drive of the screws **24a** and **24b**, accompanied by the above-mentioned developer supply, is also started by an operator's switch operation.

Example 2

An image forming apparatus of the second example according to the present invention will be described. Figure **11** is a partially cross-sectional view showing the image forming apparatus of the present example. The second example differs from the first example only in developing method. The image forming apparatus of the second example has the same construction as that of first example, except for a developing device **2**. Therefore, the description of elements identical to those in the first example will be omitted.

A developing device **2** of the present example will be described.

As shown in Figure **11**, the developing device **2** has a hopper **21** for accommodating and supplying a developer, a developer transporting pipe **22** for transporting the developer from the hopper **21**, a developing sleeve **51**, a magnet **52** disposed in the developing sleeve **51**, an elastic blade **53**, and a seal **54** for preventing the leakage of the developer. The developing sleeve **51**, serving as a developer carrier, rotates in the direction of the arrow **K**. A thin layer of developer is formed on the surface of the developing sleeve **51** by the elastic blade **53**.

The development of the thus constructed developing device **2** will be described.

The developer transported in a forward path **22a** through a developer supply opening **221** is attracted by the magnet **52** and adhered to the surface of the developing sleeve **51**. The developer thus supplied on the developing sleeve **51** is regulated by the elastic blade **53**, and then a thin layer of developer is formed on the developer sleeve **51**. In the developing place **23**, the thin layer of developer is attracted only to an image area of an electrostatic latent image on a photosensitive body **1**, whereby the latent image is developed.

A developer idle space in the forward path **22a**, wherein the developer is not held by a screw **24a**, is formed into two portions: a portion **55a** where the developing sleeve **51** is opposed to the screw **24a**, and a portion **55b** where the screw **24a** is opposed to the elastic blade **53**. In this idle space including the portions **55a** and **55b**, a magnetic field is formed by the magnet **52**. The magnetic developer in the portions **55a** and **55b** is held against the gravity, being restrained by the magnetic force that is at least stronger than the gravity. Therefore, even if an operator variously changes the direction of the apparatus, the developer in these portions **55a** and **55b** does not freely flow or thickly gather in one direction.

Various other modifications will be apparent to and can be readily made by those skilled in the art without departing from the scope and spirit of this invention. Accordingly, it is not intended that the scope of the claims appended hereto be limited to the description as set forth herein, but rather that the claims be broadly construed.

Claims

1. A developing device provided along a photosensitive body, comprising:

hopper means for accommodating and supplying a developer;

developer carrier means for transporting the developer carried on a surface thereof to a developing place; and

developer circulating means for circulating the developer between the hopper means and the developer carrier means;

wherein the developer circulating means includes a part of the hopper means and forward means and backward means both of which extend from the hopper means along the photosensitive body, the forward means and backward means respectively have spaces independent of each other, and in each of the spaces developer transporting means is provided for holding the developer therein and transporting the developer.

2. A developing device according to claim 1, wherein a developer transporting ability for feeding the developer from the hopper means to the forward means is larger than a developer transporting ability of the developer carrier means.

3. A developing device according to claim 1, wherein each of the developer transporting means includes a screw, and the screw located in the forward means extends in the hopper means.

4. A developing device according to claim 1, wherein the developer transporting means of the forward means does not reach a connecting portion for connecting one end of the forward means to one end of the backward means, and the developer transporting means of the backward means reaches the connecting portion.

5. A developing device according to claim 1, wherein the developer includes a magnetic toner, the developing device further comprises magnetic field forming means for forming a magnetic field between the developer circulating means and the developing place, and the magnetic field is strong enough to cause a magnetic force at least capable of holding the developer against the gravity.

6. A developing device according to claim 5, wherein the magnetic field formed by the magnetic field forming means reaches at least a space including the developer transporting means on the side of the developer carrier means.

7. A developing device according to claim 5, wherein the magnetic field forming means is a magnet for development located in the developer carrier means.

8. A developing device according to claim 1, wherein:

the hopper means comprises a refill port to which a developer refill container for refilling the developer into the hopper means is attached, and stirring means, located in the hopper means, for stirring the developer in conjunction with the developer transporting means; and

the developing device comprises control means for controlling the stirring means to stir the developer in the hopper means when the developer is refilled from the developer refill container, and for controlling the developer

transporting means to transport the developer in the developer circulating means to a developer supply opening through which the developer is supplied from the developer circulating means to the developer carrier means.

9. A developing device according to claim 8, wherein the developer refill container comprises:

a stirring member therein; and

a coupling portion for connecting a rotation axis of the stirring member and a rotation axis of the stirring means of the hopper means to each other by attaching the developer refill container to the refill port and for disconnecting the rotation axis of the stirring member and the rotation axis of the stirring means of the hopper means from each other by detaching the developer refill container from the refill port.

10. An image forming apparatus comprising:

a photosensitive body on a surface of which an electrostatic latent image is formed;

developing means for developing the electrostatic latent image, comprising:

hopper means for accommodating a developer and supplying the developer, located at one end of the photosensitive body in the longitudinal direction;

developer carrier means for transporting the developer carried on a surface thereof to a developing place; and

developer circulating means, including a part of the hopper means, for circulating the developer between the hopper means and the developing place;

cleaning means for removing a residual developer from the surface of the photosensitive body, the cleaning means being in contact with the surface of the photosensitive body; and

residual developer restoring means for restoring the residual developer removed by the cleaning means to the hopper means.

11. An image forming apparatus comprising:

a photosensitive body on a surface of which an electrostatic latent image is formed;

developing means for developing the electrostatic latent image, comprising:

hopper means for accommodating a developer and supplying the developer, located at one end of the photosensitive body in the longitudinal direction; and

developer circulating means, including a part of the hopper means, for circulating the developer between the hopper means and a part of the surface of the photosensitive body, the part of the surface functioning as developer carrier means for transporting the developer carried on a surface thereof to a developing place;

cleaning means for removing a residual developer from the surface of the photosensitive body, the cleaning means being in contact with the surface of the photosensitive body; and

residual developer restoring means for restoring the residual developer removed by the cleaning means to the hopper means.

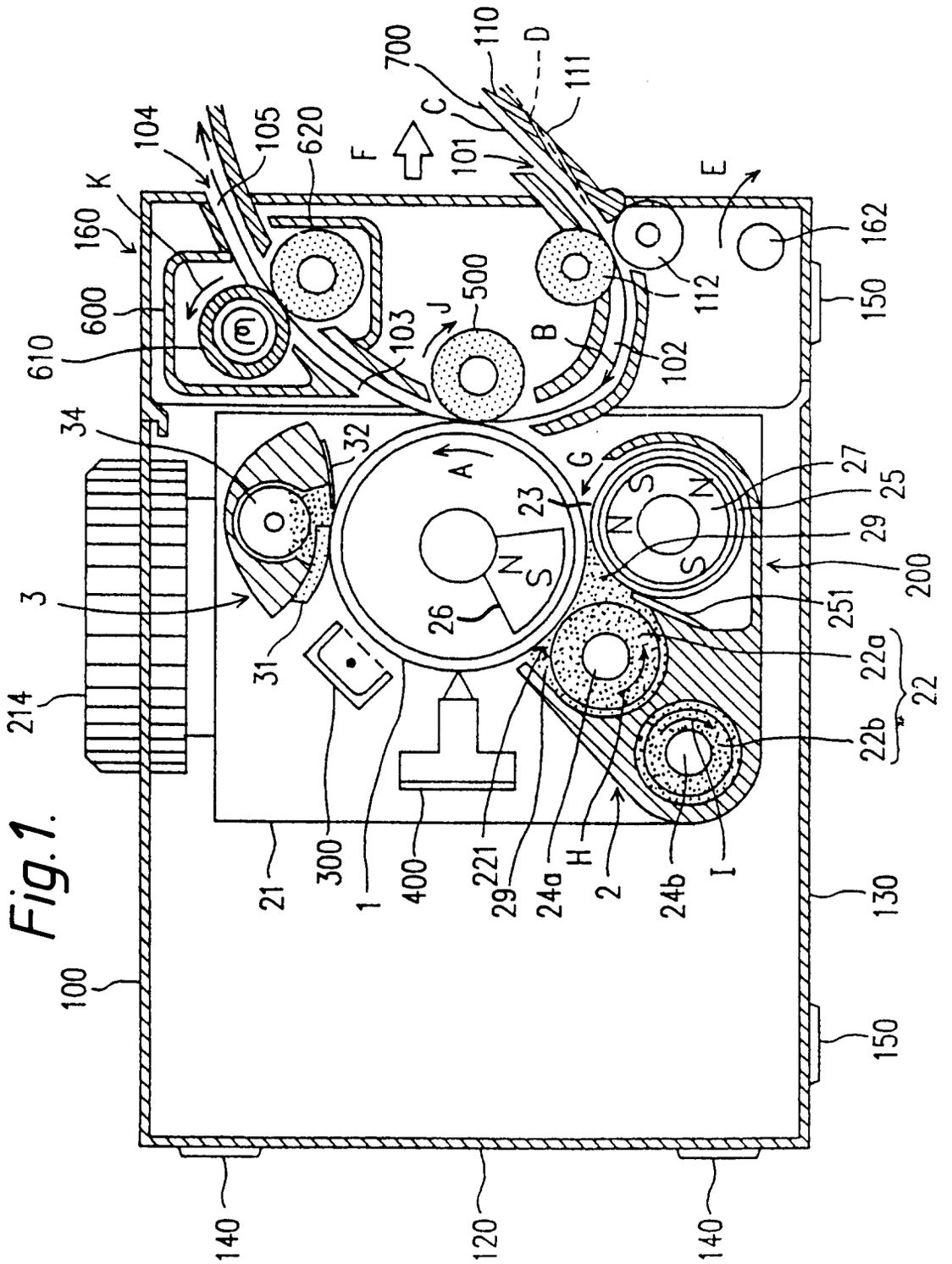
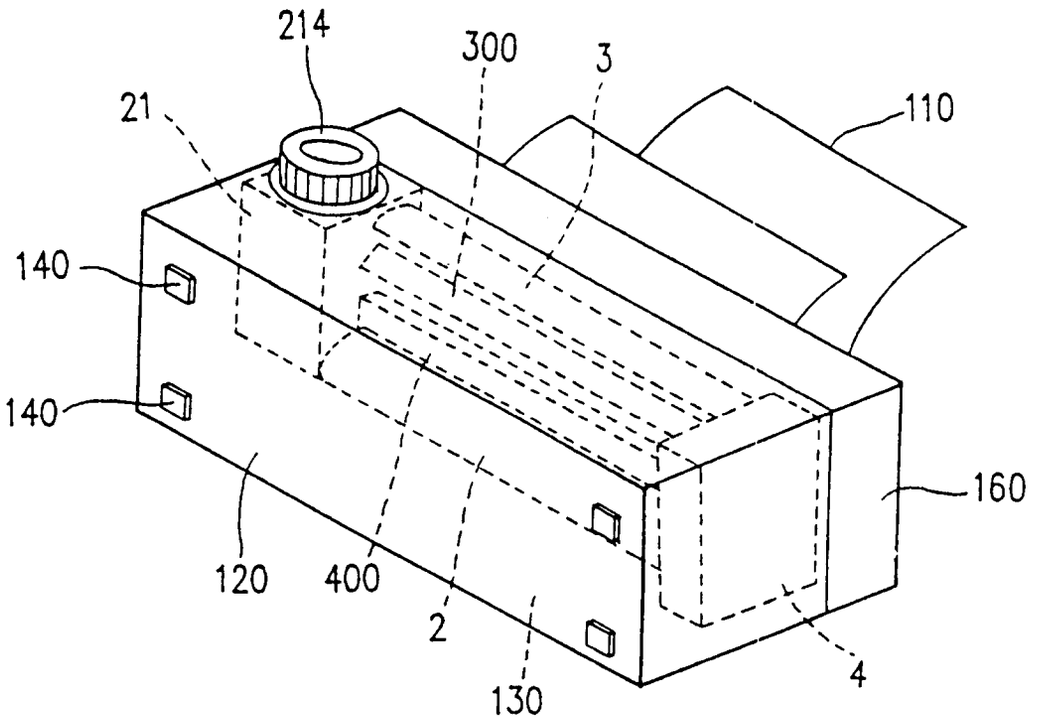

700
110
D
111
C
101
F
104
105
620
E
K
160
600
610
103
J
500
B
102
112
162
150
34
32
A
G
27
25
29
200
3
23
N
S
N
S
N
S
26
251
31
22a
22
214
22b
21
300
1
400
221
29
24a
H
2
24b
I
130
150
100
140
120
140

Fig.1.

Fig. 2.



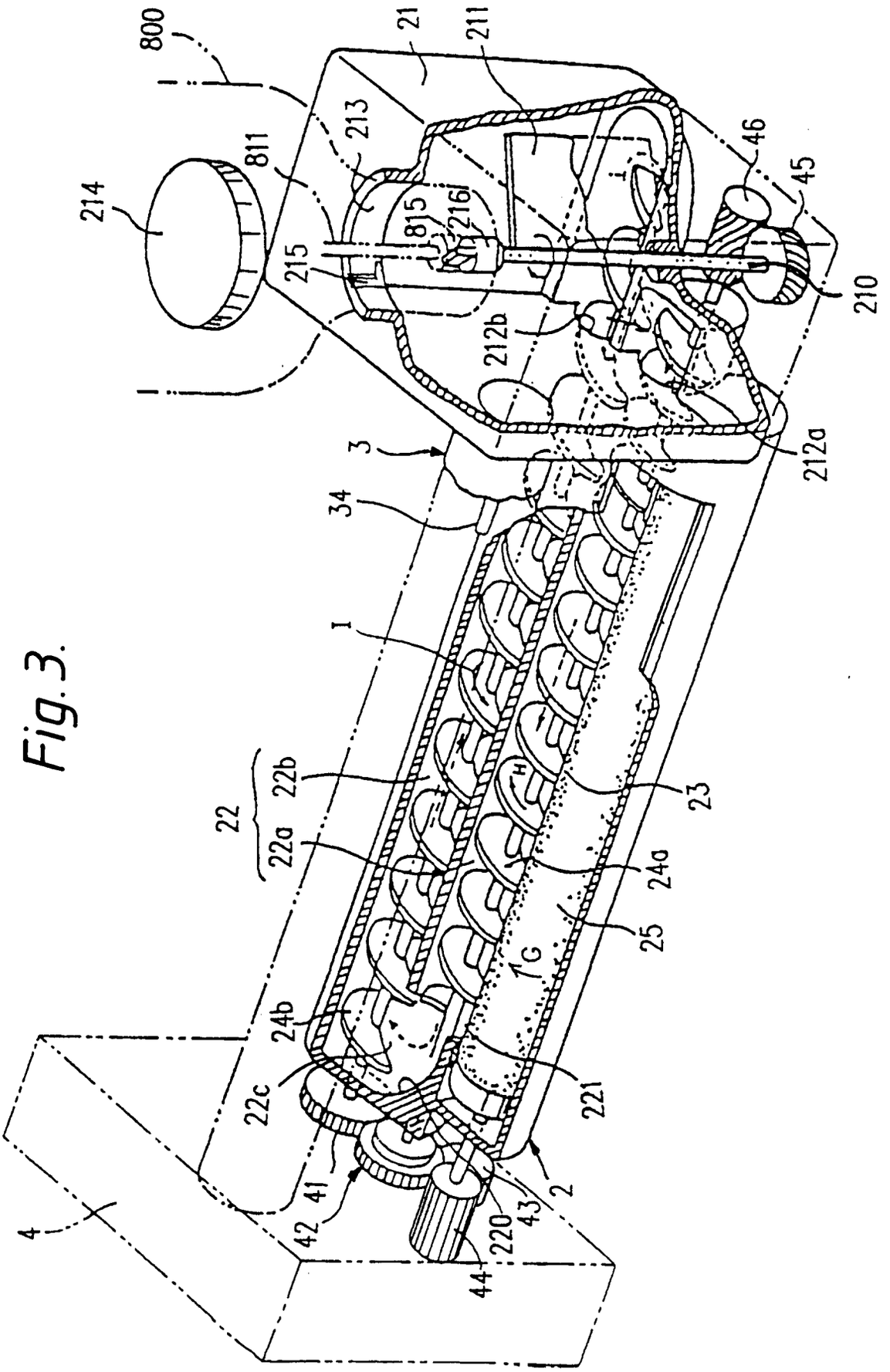

800
21
211
213
811
214
46
45
815
216
215
210
212b
212a
3
34
1
22
22b
22a
23
24a
25
1C
24b
22c
221
41
42
220
43
44
2
4

Fig. 3.

Fig.4A.

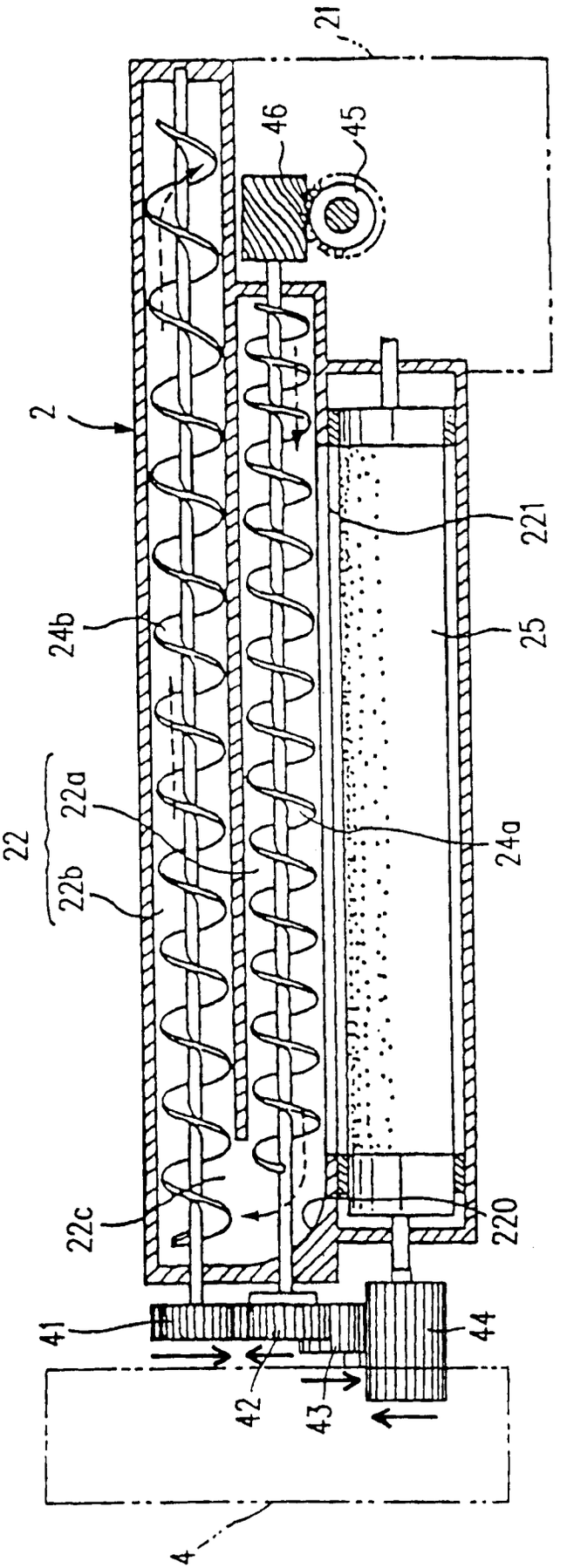


Fig.4B.

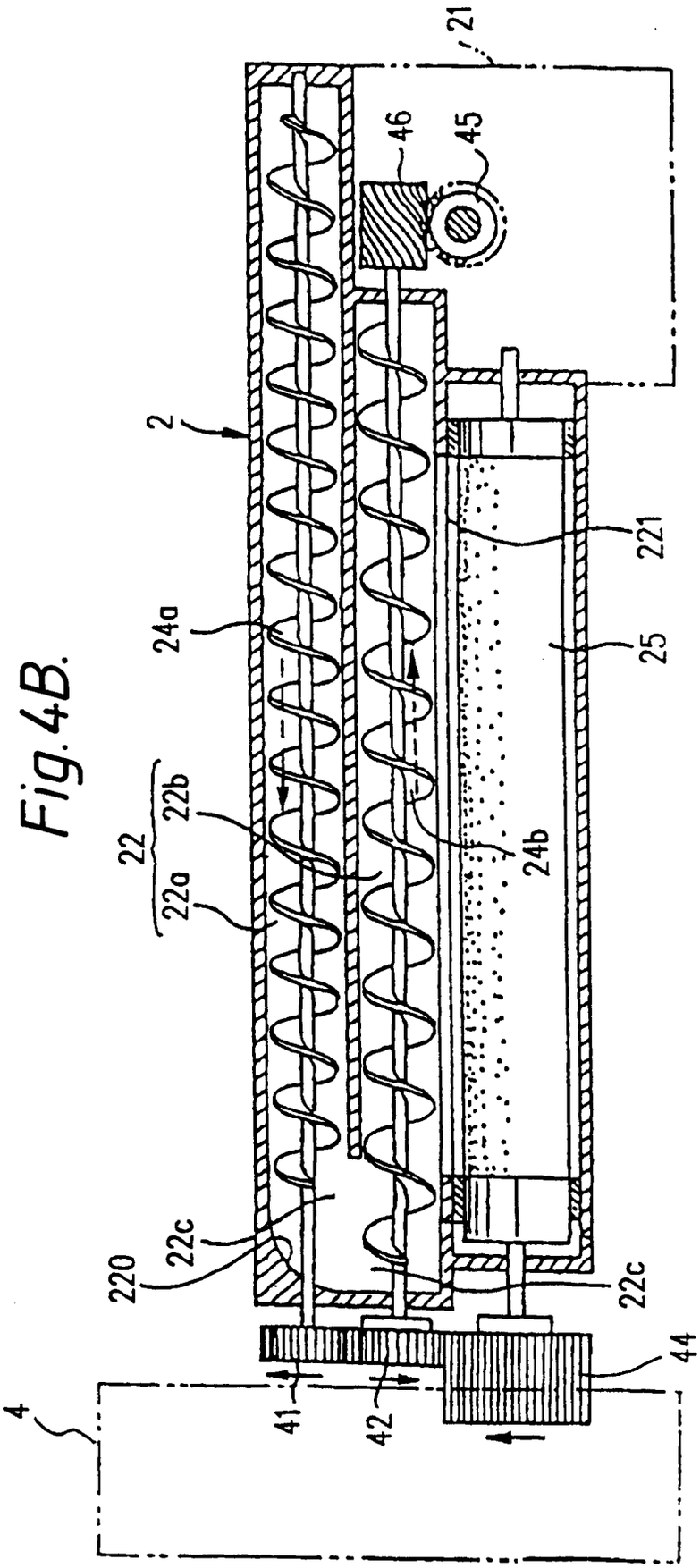


Fig.5.

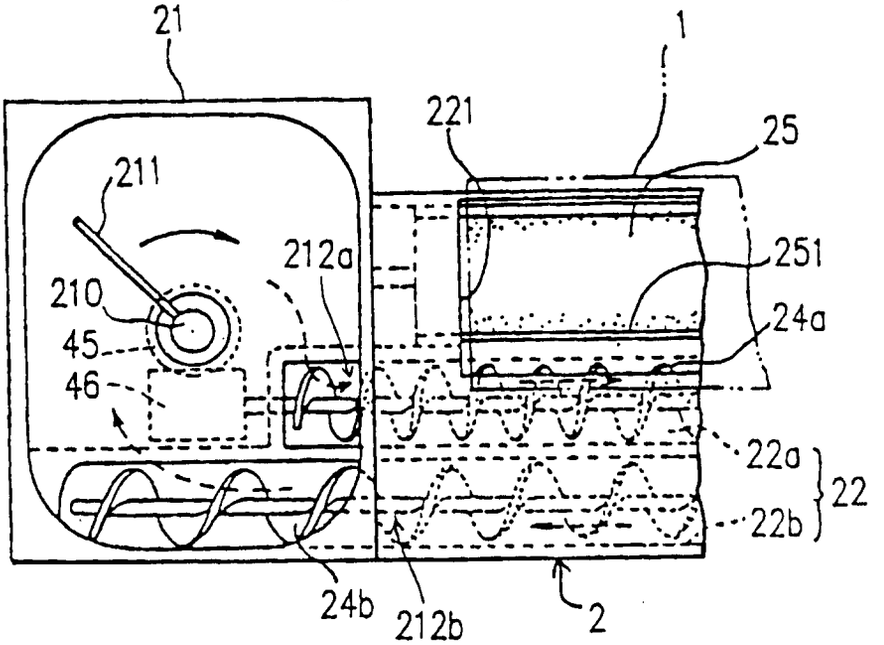

21
1
221
25
211
212a
251
210
24a
45
46
22a
22
22b
24b
212b
2

Fig.6.

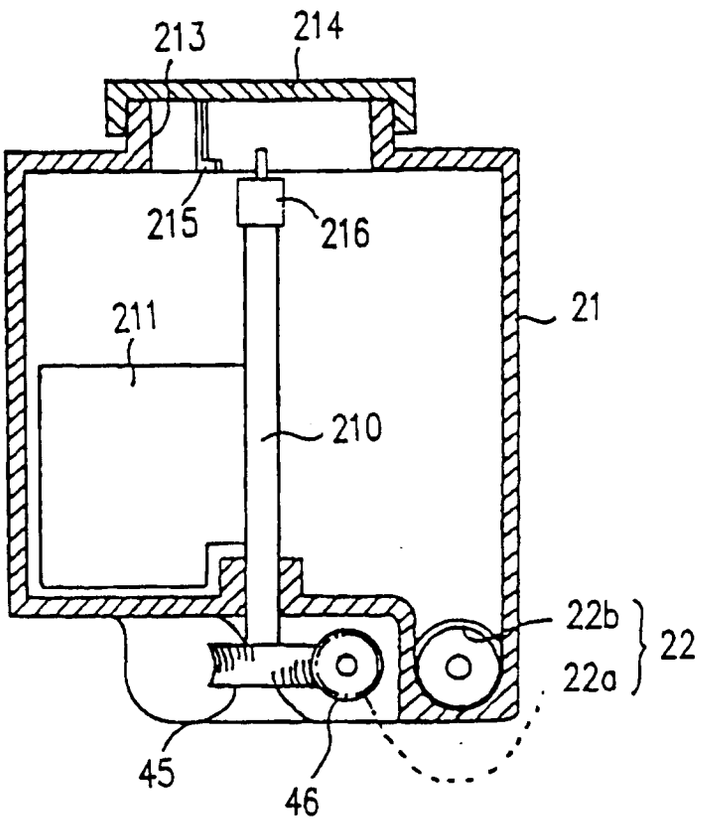

213
214
215
216
211
21
210
22b
22
22a
45
46

Fig.7.

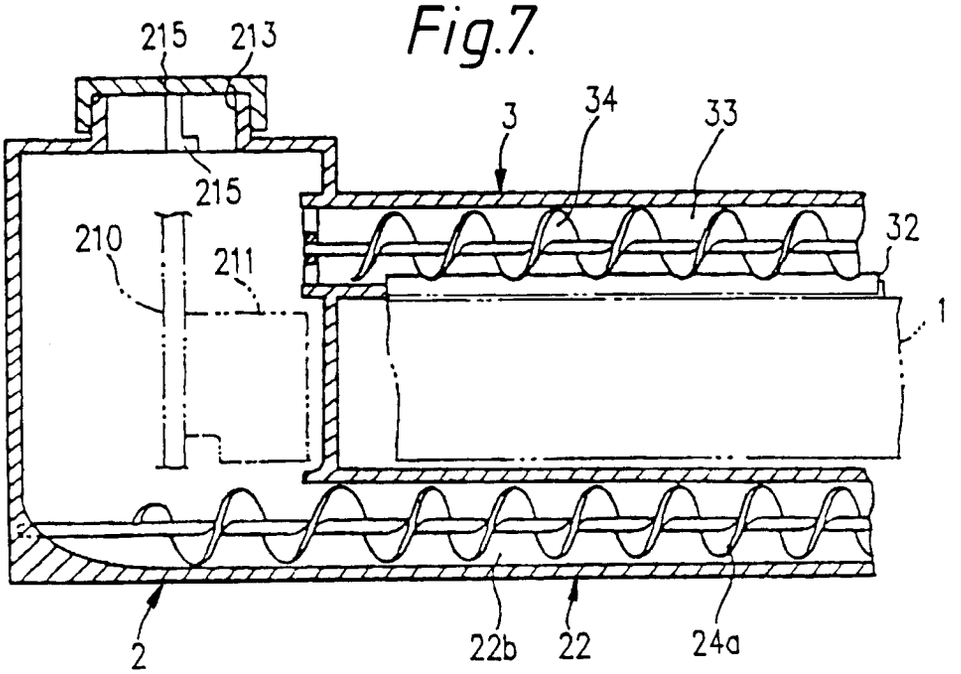


Fig.8A.

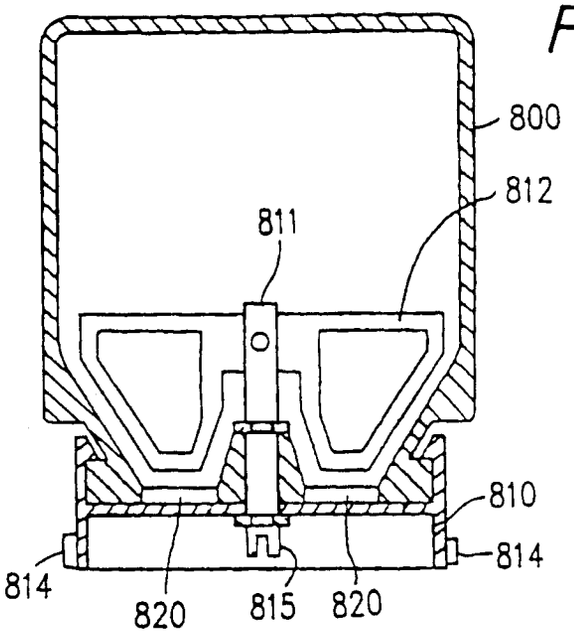


Fig.8B.

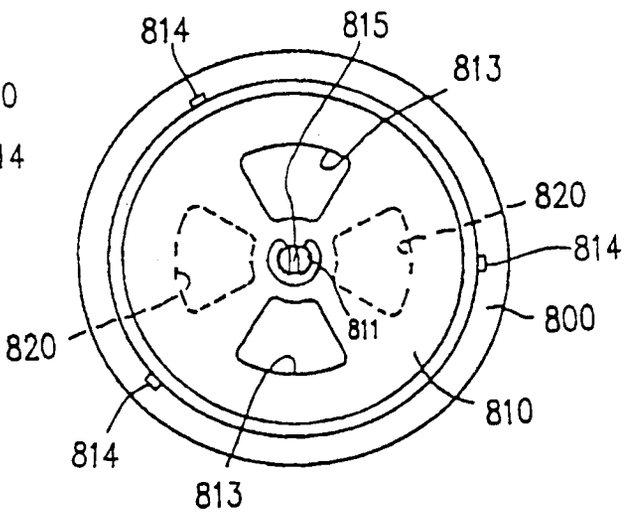


Fig.9.

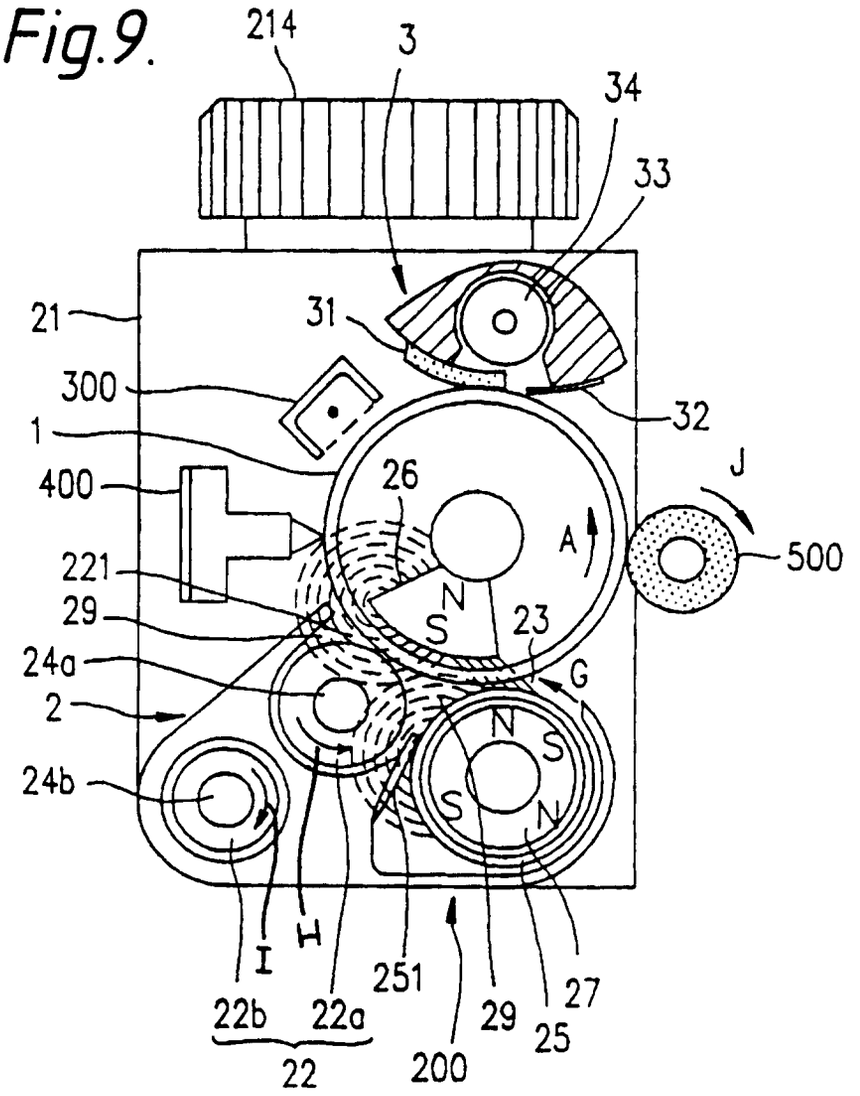

214
3
34
33
21
31
300
32
1
26
J
400
A
500
221
N
29
S
23
24a
G
2
N
S
24b
S
N
I
H
251
22b
22a
29
27
25
22
200

Fig. 10.

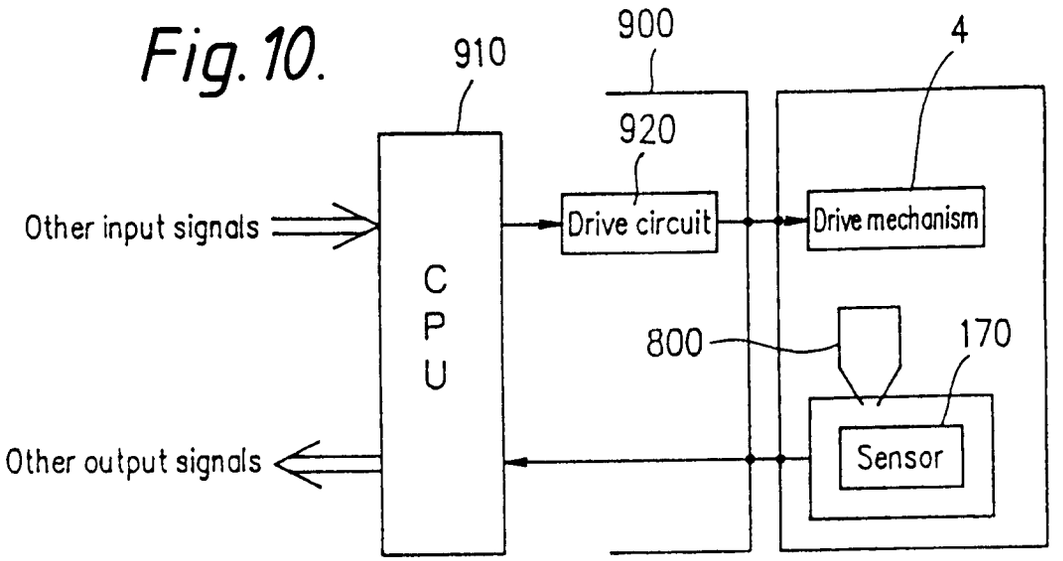

900
910
4
920
Other input signals
C
P
U
Drive circuit
Drive mechanism
800
170
Other output signals
Sensor

Fig. 12.

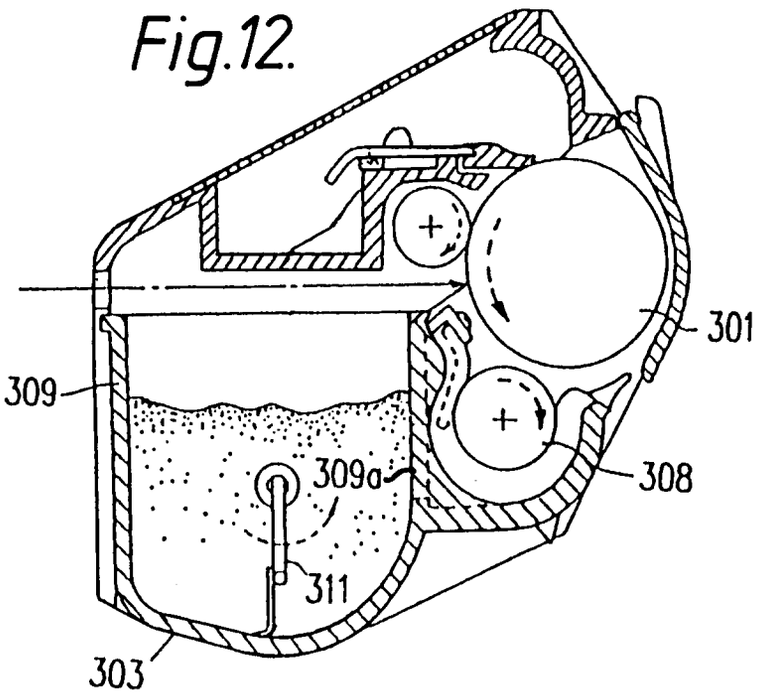

301
309
309a
308
311
303

Fig.11.

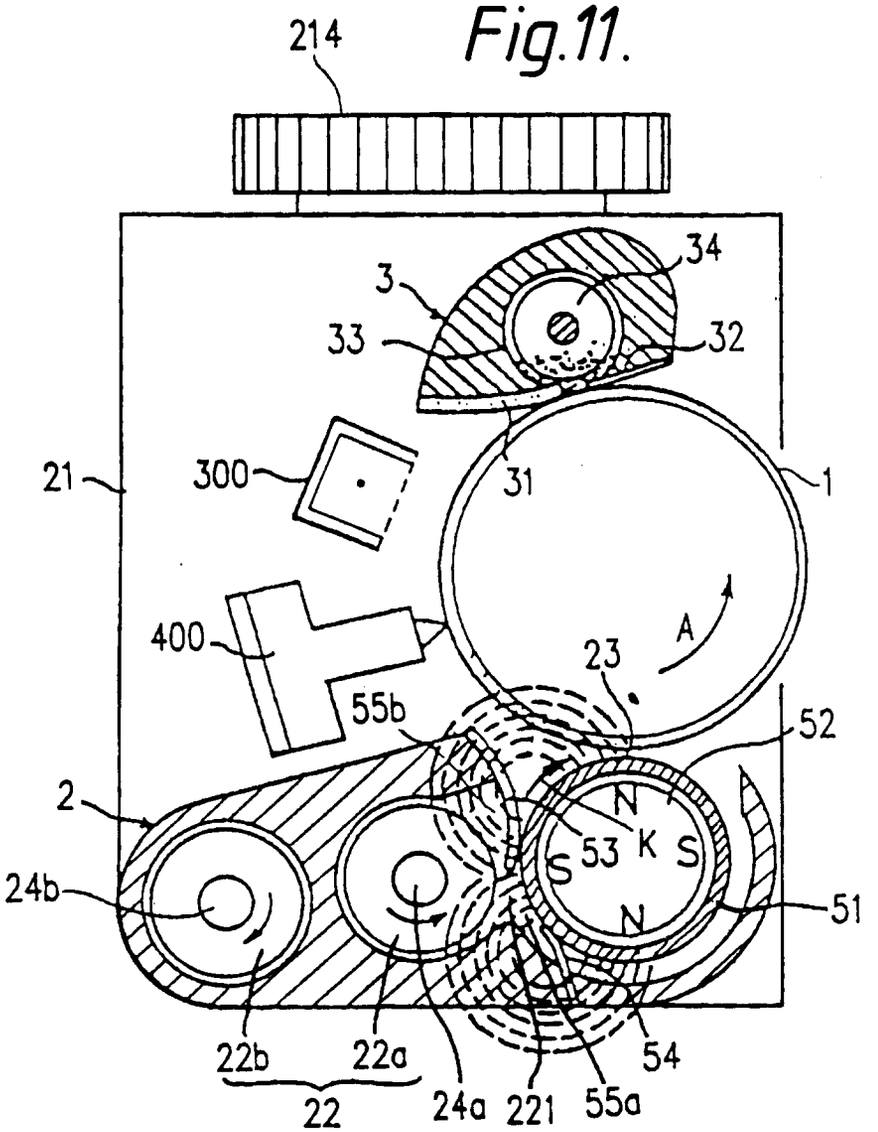
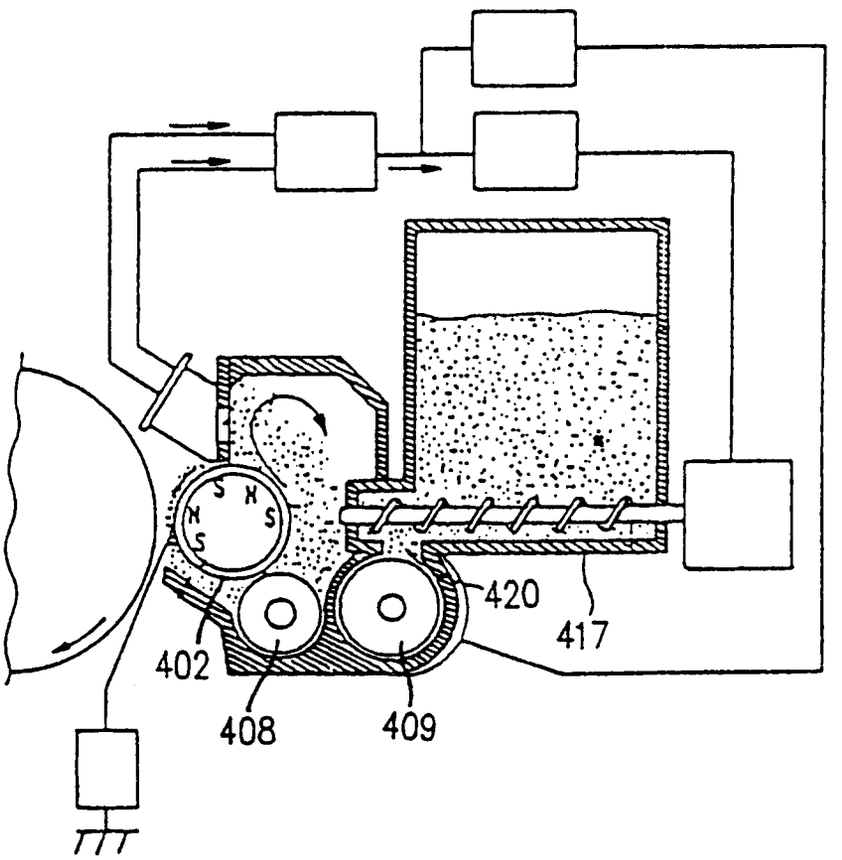

214
34
3
33
32
21
300
31
1
400
A
23
55b
52
2
N
S
53
K
S
N
24b
51
22b
22a
54
22
24a
221
55a

Fig.13.



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 93 30 9647

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	DE-A-19 00 803 (RANK XEROX) * figures 1-4 *	1,10,11	G03G15/08
A	DE-A-23 53 229 (PHILIPS PATENTVERWALTUNG) * figures 1,2 *	1,10,11	
A	EP-A-0 568 924 (RICOH) * figures 1-8 *	1,10,11	
A	EP-A-0 509 441 (MATSUSHITA ELECTRIC IND.) * figure 10 *	1,10,11	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

G03G

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	21 June 1994	Hoppe, H

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)