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

(11) EP 0 819 993 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
21.01.1998 Bulletin 1998/04

(51) Int. Cl.[6]: **G03G 15/08**, G03G 15/09, G03G 15/01

(21) Application number: **97111965.6**

(22) Date of filing: **14.07.1997**

(84) Designated Contracting States:
AT BE CH DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE

(30) Priority: **15.07.1996 JP 184855/96**

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(54) A developing apparatus and an image forming apparatus

(57) A developing apparatus comprises a magnet roller (45) for supplying a developing agent consisting of toner and a carrier to a portion to be developed, an upper screw (42) opposed to the magnet roller (45), for stirring/transporting the developing agent in a first direction, and a lower screw (43) provided below the upper screw (42) in parallel with the upper screw (42), for receiving/transporting the developing agent from/to the upper screw (42) and for sending the developing agent to the magnet roller (45), while stirring/transporting the developing agent in a second direction opposite to the first direction. The magnet roller (45) includes a supply portion (45a) having a plurality of magnetic poles (53a to 53e) arranged in a first magnetic pole arrangement, for supplying the developing agent to the portion to be developed, and a transport portion (45b) having a plurality of magnetic poles (55a to 55e) arranged in a second magnetic pole arrangement different from the first magnetic pole arrangement, for transporting the developing agent transported by the lower screw (43), to the upper screw (42).

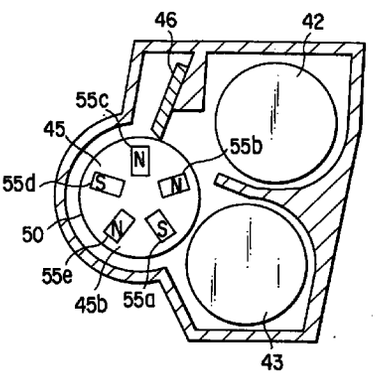

FIG. 2

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Description

The present invention relates to a develop ing apparatus and an image forming apparatus comprised in electronic copying machine, in which an electrostatic latent image formed on a photosensitive member is supplied with toner, thereby to image the latent image.

In this kind of developing apparatus, a two-component developing agent consisting of toner and a carrier is contained in a developing container. By means of rotation of a magnet roller, the developing agent is supplied onto an electrostatic latent image on a photosensitive drum, to forming an image.

Further, in a developing apparatus adopting a two-component developing method, two screws are provided in a horizontal plane in the developing container, and a developing agent are stirred and circulated between the two screws. By thus stirring the developing agent between the two screws, a carrier and toner are stirred to electrically charge the toner and to send the toner to a magnet roller.

However, in a conventional apparatus, since two screws are placed in a horizontal plane, the developing apparatus is large in the lateral direction in its cross-section, resulting in a drawback that the space occupied by the developing apparatus in an electronic photographic copying machine is considerably large.

In particular, in case of a tetrad tandem method in which a plurality of photosensitive drums are provided at a predetermined interval and developing apparatuses are respectively provided for and opposed to the photosensitive drums, the distance between adjacent photosensitive drums must be set to be long and accordingly, the outer size of the electronic photographic copying machine must be large, if the size of the developing apparatus in the lateral direction is large.

Hence, developments have been made to an apparatus in which two screws are arranged in the longitudinal direction in a developing container, to reduce the lateral size of the developing apparatus.

However, in this apparatus having two screws arranged in the longitudinal direction, a developing agent is transported from a lower screw toward an upper screw against the gravity force. Consequently, a portion of the developing agent stays at the portion of transporting the developing agent.

If the staying portion of the developing agent occurs at a portion corresponding to an image printing region on a screw, the thickness of a layer of a developing agent which is to be formed on a magnet roller, resulting in a drawback that the density of an image is rendered uneven.

In addition, at the staying portion of the developing agent, the developing agent receives a large stress so that the developing agent is deteriorated.

Therefore, the present invention has an object of providing a developing apparatus and an image forming apparatus which achieve excellent transportation of a developing agent from a second stir/transport means positioned at a lower position to a first stir/transport means positioned at a higher position, so that staying of the developing agent is reduced.

A developing apparatus according to the present invention comprises: developing agent supply means for supplying a developing agent consisting of toner and a carrier to a portion to be developed; first stir/ transport means opposed to the developing agent supply means, for stirring/transporting the developing agent in a first direction; and second stir/transport means provided below the first stir/transport means in parallel with the first stir/transport means, for receiving/transporting the developing agent from/to the first stir/transport means, and for sending the developing agent to the developing agent supply means, while stirring/transporting the developing agent in a second direction opposite to the first direction, wherein the developing agent supply means includes a supply portion having a plurality of magnetic poles arranged in a first magnetic pole arrangement, for supplying the developing agent to the portion to be developed, and a transport portion having a plurality of magnetic poles arranged in a second magnetic pole arrangement different from the first magnetic pole arrangement, for transporting the developing agent transported by the second stir/transport means, to the first stir/transport means.

Another developing apparatus according to the present invention comprises: developing agent supply means for supplying a developing agent consisting of toner and a carrier to a portion to be developed; first stir/transport means opposed to the developing agent supply means, for stirring/transporting the developing agent in a first direction; and second stir/transport means provided below the first stir/transport means in parallel with the first stir/transport means, for receiving/transporting the developing agent from/to the first stir/transport means, and for sending the developing agent to the developing agent supply means, while stirring/transporting the developing agent in a second direction opposite to the first direction, wherein the second stir/transport means includes a transport portion having a plurality of magnetic poles arranged in a first magnetic pole arrangement, for transporting upwardly the developing agent transported by the second stir/transport means, and the first stir/transport means includes a receive portion opposed to the transport portion and having a plurality of magnetic poles arranged in a second magnetic pole arrangement different from the first magnetic pole arrangement, for receiving the developing agent transported upwardly by the transport portion.

Further, another developing apparatus according to the present invention comprises: developing agent supply

means for supplying a developing agent consisting of toner and a carrier to a portion to be developed; first stir/transport means opposed to the developing agent supply means, for stirring/transporting the developing agent in a first direction; and second stir/transport means provided below the first stir/transport means in parallel with the first stir/transport means, for receiving/transporting the developing agent from/to the first stir/transport means, and for sending the developing agent to the developing agent supply means, while stirring/transporting the developing agent in a second direction opposite to the first direction, wherein a magnetic pole is provided at an end portion of the second stir/transport means and a transport portion for sending the developing agent transported by the second stir/transport means by a magnetic force of the magnetic pole to the first stir/transport means is provided.

An image forming apparatus according to the present invention comprises: a plurality of image carriers provided at a predetermined interval, for carrying images; image forming means for forming a latent image on each of the image carriers; and a plurality of developing means respectively arranged to be opposed to the image carriers, for realizing the latent images on the image carriers, wherein each of the developing means includes developing agent supply means for supplying a developing agent consisting of toner and a carrier to a portion to be developed, first stir/transport means opposed to the developing agent supply means, for stirring/transporting the developing agent in a first direction, and second stir/transport means provided below the first stir/transport means in parallel with the first stir/transport means, for receiving/transporting the developing agent from/to the first stir/transport means, and for sending the developing agent to the developing agent supply means, while stirring/transporting the developing agent in a second direction opposite to the first direction, and wherein the developing agent supply means includes a supply portion having a plurality of magnetic poles arranged in a first magnetic pole arrangement, for supplying the developing agent to the portion to be developed, and a transport portion having a plurality of magnetic poles arranged in a second magnetic pole arrangement different from the first magnetic pole arrangement, for transporting the developing agent transported by the second stir/transport means, to the first stir/transport means.

Another image forming apparatus according to the present invention comprises: a plurality of image carriers provided at a predetermined interval, for carrying images; image forming means for forming a latent image on each of the image carriers; and a plurality of developing means respectively arranged to be opposed to the image carriers, for realizing the latent images on the image carriers, wherein each of the developing means includes developing agent supply means for supplying a developing agent consisting of toner and a carrier to a portion to be developed, first stir/transport means opposed to the developing agent supply means, for stirring/transporting the developing agent in a first direction, and second stir/transport means provided below the first stir/transport means in parallel with the first stir/transport means, for receiving/transporting the developing agent from/to the first stir/transport means, and for sending the developing agent to the developing agent supply means, while stirring/transporting the developing agent in a second direction opposite to the first direction, and wherein the second stir/transport means includes a transport portion having a plurality of magnetic poles arranged in a first magnetic pole arrangement, for transporting upwardly the developing agent transported by the second stir/transport means, and the first stir/transport means includes a receive portion opposed to the transport portion and having a plurality of magnetic poles arranged in a second magnetic pole arrangement different from the first magnetic pole arrangement, for receiving the developing agent transported upwardly by the transport portion.

Further, another image forming apparatus comprises: a plurality of image carriers provided at a predetermined interval, for carrying images; image forming means for forming a latent image on each of the image carriers; and a plurality of developing means respectively arranged to be opposed to the image carriers, for realizing the latent images on the image carriers, wherein each of the developing means includes developing agent supply means for supplying a developing agent consisting of toner and a carrier to a portion to be developed, first stir/transport means opposed to the developing agent supply means, for stirring/transporting the developing agent in a first direction, and second stir/transport means provided below the first stir/transport means in parallel with the first stir/transport means, for receiving/transporting the developing agent from/to the first stir/transport means, and for sending the developing agent to the developing agent supply means, while stirring/transporting the developing agent in a second direction opposite to the first direction, and wherein a magnetic pole is provided at an end portion of the second stir/transport means and a transport portion for sending the developing agent transported by the second stir/transport means by a magnetic force of the magnetic pole to the first stir/transport means is provided.

According to the structure as described above, a developing agent can be excellently transported from the second stir/transport means to the first stir/transport means, so that the developing agent can be prevented from staying.

As a result of this, unevenness in density of an image is prevented from occurring and a stress onto a developing agent is reduced, so that the developing agent is prevented from being degraded.

This invention can be more fully understood form the following detailed description when taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a view showing the structure of a tetrad tandem method color electronic photograph apparatus as an embodiment of the present invention;

FIG. 2 is a cross-section showing a developing apparatus cut at a transport portion of a magnet roller;

FIG. 3 is a cross-section showing a developing apparatus cut at a transport portion of a magnet roller;

FIG. 4 is a view showing an arrangement of upper and lower screws;

FIG. 5 is a view showing a magnet roller and a scratch blade;

FIG. 6 is a view showing an installation structure of a magnet in a magnet roller;

FIG. 7 is a view showing a developing apparatus as a second embodiment of the present invention;

FIG. 8 is a cross-section showing a developing apparatus;

FIG. 9 is a cross-section showing magnet rollers provided at end portions of upper and lower screws;

FIG. 10 is a view showing a magnet roller installed on a lower screw;

FIG. 11 is a view showing a state of a scratch blade in contact with a magnet roller of an upper screw, in correspondence with positions of magnets;

FIG. 12 is a view showing a developing apparatus as a third embodiment of the present invention;

FIG. 13 is a cross-section showing a developing apparatus;

FIG. 14 is a view showing an arrangement of poles of a magnet roller; and

FIG. 15 is a view showing a magnet roller installed on a lower screw.

In the following, the present invention will be explained with reference to an embodiment shown in FIGS. 1 to 6.

FIG. 1 shows the internal structure of a color electronic photograph apparatus of a tetrad tandem method.

In the figure, the reference 1 denotes an apparatus body, and an original document mount base 1a is provided on an upper surface portion of the apparatus body 1. An original document automatic feeder 2 for automatically feeding an original to the original document mount base 1a is provided on the original document mount base 1a.

An original scanner section 5 for exposing the original document to light is provided on the upper side in the apparatus body 1. The scanner section 5 comprises first and second carriage 6 and 7 which are movable, and the first cartridge 6 is provided with an exposure lamp 8 for irradiating light on the original document and a first reflection mirror 9 for reflecting light reflected by the original document. The second carriage 7 is provided with second and third reflection mirrors 10 and 11 for reflecting reflection light reflected by the first reflection mirror 9, to guide the reflection light in a predetermined direction. An optical lens 13 and a photoelectric conversion element 14 are provided on a light path of the reflection light reflected by the third reflection mirror 11.

A plurality of (four) photosensitive drums 31a to 31d each of which is used to carry an image are provided and disposed in the substantial center of the apparatus body 1 in the direction in which a paper sheet is conveyed, such that the photosensitive drums are rotatable.

In the periphery of each of the photosensitive drums 31a to 31d, an electrification charger 32 for uniformly charging the drum surface, a developing apparatus 34 for developing a latent image on the drum, a transfer device 35 for transferring an existing image on the drum onto a paper sheet, and a cleaner 36 for discharging electrons from remaining toner are provided in this order in the rotation direction of each photosensitive drum.

In addition, a laser light scanning unit (not shown) for emitting laser light corresponding to image data is provided in the apparatus body 1, and the laser light emitted from the laser light scanning unit is guided and irradiated onto each of the photosensitive drums 31a to 31d, to form an electrostatic latent image.

In the lower side of the photosensitive drums 31a to 31d, a paper sheet convey path 16 is provided in a substantially horizontal direction. On the paper sheet convey path 16, a sheet feed roller 21 for feeding paper sheets, a resist roller 22 for aligning a paper sheet, the transfer device 35 described above for transferring an existing image onto a paper sheet, a conveyer belt 27 for conveying a paper sheet, a fixing device 18 as a fixing means, a feed roller 28, and a feed-out roller 30 are provided and disposed in this order in the direction in which paper sheets are conveyed along the conveying direction of paper sheets.

The fixing device 18 consists of a heat roller 18a and a press roller 18b pressed against the lower side of the heat roller 18a, thereby pressing a paper sheet.

A sheet feed tray 24 for supplying paper sheets is provided on one side of the apparatus body 1, while a feed-out tray 25 for receiving paper sheets fed out from the sheet feed roller 30 is provided on the other side of the apparatus body.

When forming an image, an original document is set on the original mount base 1a and a copy button (not shown) is turned on.

In this manner, an exposure lamp 8 is lightened and the first and second carriages 6 and 7 are made run so that the original document is scanned with light. In this scanning, reflection light reflected by the original document is received by a photoelectric conversion element 14 through first to third reflection mirrors 9 to 11 and an optical lens 13, and the light is then photoelectrically converted. By this photoelectric conversion, laser light corresponding to image data is emitted from a laser light scanning unit, and the laser light is subjected to scanning by a polygon mirror (not shown). The laser light thus used for scanning is guided and irradiated onto the photosensitive drums 31a to 31d through an optical system. The surfaces of the photosensitive drums 31a to 31d are uniformly charged by an electrifi-

cation charger 32, and an electrostatic latent image of the original document is formed by irradiation of the laser light. This electrostatic latent image is sent to the developing apparatus 34 by rotation of the photosensitive drums 31a to 31d and is opposed, and further, toner of respective colors is supplied thereby to form a color image.

Meanwhile, in this operation, a paper sheet is supplied from the paper feed tray 24 by rotation of the paper feed roller 21. This paper sheet is aligned by a resist roller 22 and then sent to the photosensitive drums 31a to 31d and the transfer device 35, to transfer a color image. After transferring the color image, toner remaining on the photosensitive drums 31a to 31d is scratched off and cleaned by a cleaner 36.

A paper sheet on which an image has thus been transferred is sent to the fixing roller 18 by running of the convey belt 27. The paper sheet is heated and pressed to fix the image. The paper sheet P onto which an image is fixed is fed out onto the feed-out tray 25 through the feed-out roller 30.

FIG. 3 is a longitudinal cross-section showing the developing apparatus as described above.

The developing apparatus 34 has a developing container 41 containing a two-component developing agent consisting of toner and a carrier. In the developing container 41, there is provided a magnet roller 45 as a developing agent supply means for supplying the photosensitive drums 31 with a developing agent, such that the magnet roller 45 is rotatable. Behind the magnet roller 45, upper and lower screws 42 and 43 as first and second stir/transport means for stirring/transporting a developing agent are provided in parallel. In the upper side of the magnet roller 45, a doctor blade 46 for limiting a developing agent layer on the magnet roller 45 is provided.

By rotation of the upper and lower screws 42 and 43, the developing agent in the developing container 41 is stirred, transported, and supplied to the magnet roller 45. The thickness of the layer of the developing agent is limited by the doctor blade 46 and is then supplied to the photosensitive drum 31.

FIG. 4 shows the upper and lower screws 42 and 43.

The upper and lower screws 42 and 43 are partitioned from each other by a partition plate 48. An end portion of the partition plate 48 is provided with a first opening portion 51 for allowing a developing agent transported by the upper screw 42 to fall down, and the other end portion of the partition plate 48 is provided with a second opening portion 52 for allowing the developing agent transported by the lower screw 43 to move up.

Toner to be charged for the developing container 41 is supplied from the vicinity of a point a of the upper screw 42. This toner is brought into contact with the carrier of the developing agent and is thereby electrified while the toner is transported from the point a to a point b by rotation of the upper screw 42. The developing agent thus sufficiently electrified falls into between a point d and a point e of the lower screw 43, from the first opening portion 51 positioned between the point b and a point c, by its dead weight, and is then transported from the point e to a point f. By thus transporting the developing agent by the lower screw 43, the magnet roller 45 is supplied with a developing agent.

FIG. 5 shows a magnet roller 45.

The magnet roller 45 comprises a sleeve 50 as a rotation member which is rotatable and magnets provided in the sleeve 50, as will be described later. The magnet roller 45 is arranged in a position in which the magnet roller 45 faces the screws 42 and 43 at a portion corresponding to the points d to g in the lengthwise direction of the developing apparatus 34, and includes a supply portion 45a as a portion corresponding to the area between the points e and f and a transport portion 45b as a portion corresponding to the area between the points f and g. The supply portion 45a of the magnet roller 45 faces the photosensitive drum 31 while the transport portion 45b does not face the drum.

As shown in FIG. 3, first to five magnets 53a to 53e are provided along the rotation direction of the sleeve 50. The first magnet 53a is set to have an S-polarity. The second magnet 53b has an N-polarity. The third magnet 53c has an S-polarity. The fourth magnet 53d has an N-polarity. The third magnet 53e has an S-polarity.

A portion of the developing agent transported from the point e to the point f by rotation of the lower screw 43 is attracted up in the cross-section direction of the developing apparatus 34 by a force applied from the magnetic field generated by the S-polarity of first magnet 53 and the N-polarity of the second magnet 53b. The developing agent is subjected to limitation of the developing agent layer by a doctor blade 46 provided in the vicinity of the second magnet 53b, and thereafter, the developing agent is transported to the third and fourth magnets 53c and 53d, where a portion of the toner is picked up by the photosensitive drum 31. The developing agent including toner the amount of which has thus been reduced is transported to the fifth magnet 53e, and thereafter, leaves the magnet sleeve 50 and falls between the fifth magnet 53e and the first magnet 53a set in an equal polarity (i.e., S-polarity). The developing agent is transported gain in the direction toward the point f by the lower screw 43.

When a developing agent thus transported reaches a position between the points f and g, the developing agent is taken up to between the points h and a of the upper screw 42, by rotation of the transport portion 45b of the magnet sleeve 45.

FIG. 2 shows a cross-section of the transport portion 45b of the magnet roller 45. In the sleeve (or rotation member) 50 of the transport portion 45b, first to fifth magnets 55a to 55e are provided in the rotation direction of the sleeve. The first magnet 55a has an S-polarity. The second magnet 55b has an N-polarity. The third magnet 55c has an N-polarity. The fourth magnet 55d has an S-polarity. The fifth magnet 55e has an N-polarity.

By rotation of the lower screw 43, a developing agent transported to between points f and g shown in FIG. 4 is

attracted up by a force applied from the magnetic field generated by the first and second magnets 55a and 55b. The developing agent thus attracted leaves from the magnet sleeve 50 between the second magnet 55b and the third magnet 55c, and is scratched off by the upper screw 42 between points h and a. The developing agent is again transported to the point b. A portion of the developing agent which did not leave the magnet sleeve 50 is interrupted by the doctor blade 46 and is pushed back toward the upper screw 42.

Note that the doctor blade 46 has first and second blade portions 46a and 46b corresponding to the Supply portion 45a and the transport portions 45b of the magnet sleeve 50. The gap between the supply portion 45a and the first blade portion 46a is set to 0.5 mm, while the gap between the transport portion 45b and the blade portion 46b of the second blade portion is set to 0.2 mm.

In the present invention, the developing agent flows as described above. Further, the magnet roller 45 as a main part of the present invention will be explained more specifically.

The magnet roller 45 consists of a supply portion 45a having a polarity arrangement for developing a toner image on the photosensitive drum 31, and a transport portion 45b for transporting a developing agent from the lower screw 43 toward the upper screw 42.

In the present embodiment of the invention, the supply portion 45a consists of first to fifth magnets 53a to 53f and the transport portion 45b consists of first to fifth magnets 55a to 55e. The intensity of the magnetic force of each magnet is shown in Table 1.

Table 1

MAGNET	POLARITY	INTENSITY	ANGLE
FIRST MAGNET 53a	S	400G	110°
SECOND MAGNET 53b	N	800G	25°
THIRD MAGNET 53c	S	900G	300°
FOURTH MAGNET 53d	N	900G	235°
FIFTH MAGNET 53e	S	600G	170°
FIRST MAGNET 55a	S	900G	165°
SECOND MAGNET 55b	N	600G	90°
THIRD MAGNET 55c	N	400G	15°
FOURTH MAGNET 55d	N	800G	305°
FIFTH MAGNET 55e	S	900G	230°
(The angle is indicated by an angle in the clockwise direction from the direction of 0 o'clock as 0°.)			

In particular, the transport portion 45b can transports a developing agent T as long as there are provided at least total three poles of the portion 45b has first and second magnets for attracting up the developing agent and second and third magnets 55b and 55c for making the developing agent leave the magnet roller 45.

The present embodiment adopts five poles in order to collect the developing agent coming around from the supply portion 45a.

A method of manufacturing a magnet sleeve 45 is realized by modifying a known method. For example, as shown in FIG. 6, it is possible to adopt a method of arranging magnets 53a to 53e (or 55e to 55e) around a shaft 61 with use of a fixing member 62 made of aluminum or the like, and covering the magnets with a sleeve 50.

In this case, the intensity and arrangement of each of the magnets 53a to 53e and 55a to 55e are changed such that the supply portion 45a and the transport portion 45b of the magnet roller 45 achieve required characteristics.

In case of an integral magnetizing method, it is only necessary to change the magnetizing pattern with respect to the supply portion 45a and the transport portion 45b of the magnet roller 45.

In addition, the supply portion 45a of the magnet roller 45 actually is a printing section which faces the photosensitive drum 31, while the transport portion 45b is a non-printing section which does not face the photosensitive drum 31.

The length of the transport portion 45b of the magnet roller 45 must be one pitch or more of the lower screw 43.

According to the method as described above, a developing agent can be smoothly transported in the longitudinal direction in a developing apparatus 34 having a longitudinal type screw structure, and therefore, it is possible to realize a developing apparatus which has a small lateral size in its cross-section.

FIGS. 7 to 11 show a second embodiment of the present invention.

Note that those components of the second embodiment which are the same as those used in the first embodiment will be denoted by the same references, and detailed explanation of those components will be omitted herefrom.

FIG. 7 shows a flow of a developing agent in the developing apparatus 34A.

Toner to be charged is supplied to the vicinity of a point a of an upper screw 42, and is brought into contact with and is electrified by a carrier of the developing agent, while the developing agent is transported from a point a to a point b, by rotation of the upper screw 42. The developing agent thus sufficiently electrified falls from a first opening portion 51 provided between points b and c, to between points d and e of a lower screw 43, by its dead weight. Then, the developing agent is transported from the point e to a point f by rotation of the lower screw 43.

A magnet roller 45 is provided such that the portion of the roller 45 which corresponds to an area between points d to f in the lengthwise direction of the developing apparatus 34A faces the screws 42 and 43.

FIG. 8 is a view showing a cross-section of the developing apparatus 34A cut between points a and b in FIG. 7.

A portion of the developing agent to be transported from the point d to the point f by the lower screw 43 is attracted up to the surface of the magnet roller 45 by a magnetic force of a magnet not shown in the roller 45, in the direction of the cross-section of the developing apparatus, as the magnet roller 45 rotates. This portion of the developing agent is transported in the anti-clockwise direction on the surface, and is subjected to restriction of the layer thickness of the developing agent by a doctor blade 46. Thereafter, a portion of toner is taken by the photo-sensitive drum 31. The developing agent including toner the amount of which has thus been reduced is further transported in the anti-clockwise direction, and leaves the magnet roller 45. The developing agent is transported again in the direction toward the point f by the lower screw 43.

FIG. 9 is a view showing a cross-section of the developing apparatus 34A cut between the points a and b.

Magnet sleeves 74 and 75 are respectively connected between points f and g of the lower screw 43 and between points h and a of the upper screw 42. A developing agent transported to a region between the points f and g of the lower screw 43 is transported over the sleeve 74 as the sleeve 74 connected with the lower screw 43 rotates. The developing agent is then received by the sleeve 75 connected to the upper screw 42, and is scratched off onto the point a of the upper screw 42 by a scratch member 92. Thereafter, the developing agent is again transported in the direction toward the point b.

In this embodiment, the developing agent flows as described above. Further, the upper and lower screws 42 and 43 having the magnet sleeves 74 and 75 as main parts of the present invention will be explained more specifically.

FIG. 10 is an outer view showing the lower screw 43.

The difference between the upper and lower screws 42 and 43 is in that the magnet sleeve portion 75 of the upper screw 42 has an outer diameter equal to that of the upper screw 43 while the magnet sleeve portion 74 of the lower screw 43 has an outer diameter smaller than that of the screw 43. By thus reducing the outer diameter of the magnet sleeve portion 74 to be smaller than that of the lower screw 43 by about 1 to 2 mm, the developing agent smoothly enters into the upper screw portion 74 from the lower screw portion 43.

Otherwise, it is possible to ensure a gap between the sleeve 74 and the developing container 41 by setting the outer diameter of the magnet sleeve portion 74 of the lower screw 43 to be equal to that of the screw 43 while enlarging the inner size of the developing container 41 to be larger around the sleeve 74 than that around the screw.

In this embodiment, both the upper and lower screws 42 and 43 have an outer diameter of 18 mm and a pitch of 27 mm. The length of each of the sleeves 74 and 75 is 27 mm corresponding to one pitch of the screws 42 and 43.

The pole arrangement of the magnet sleeves 74 and 75 respectively connected to the upper and lower screws 42 and 43 is shown in FIG. 9.

The lower magnet sleeve portion 74 is internally provided with first to fifth magnets 81a to 81e. The upper magnet sleeve portion 75 is internally provided with first to fifth magnets 91a to 91e.

The lower magnet sleeve portion 74 holds a developing agent on itself by means of a force applied from a magnetic field generated by the first to third magnets 81a to 81e, and transports the developing agent in the direction toward the fourth magnet 81d as the sleeve 74 rotates. The fourth and fifth magnets 81d and 81e of the lower sleeve portion 74 have an equal polarity while the fourth magnet 81d and the first magnet 91a of the upper sleeve 75 have polarities different from each other. Therefore, a force applied by the magnetic filed is generated in the direction from the fourth magnet 81d toward the first magnet 91a, and the developing agent is received by the upper sleeve 75 from the lower sleeve portion 74.

The developing agent transported by the magnetic force from the magnets 91a to 91c by rotation of the upper sleeve portion 75 is scratched off into the upper screw 75 side by a scratch blade 92 fixed to the developing container 41, since the force of holding the developing agent is weakened between the third and fourth magnets 91d and 91e having an equal polarity.

FIG. 11 shows a state of contact between the scratch blade 92 and the upper magnet sleeve portion 75, and the scratch blade 92 is in contact with the upper magnet sleeve portion 75 at an angle to the shaft of the upper sleeve portion 75 such that an end of the blade 92 is positioned so as to correspond to the third magnet 91c of the upper sleeve

portion 75 while the other end of the blade is positioned so as to correspond to the magnet 91d.

The gap between the upper sleeve portion 75 and the scratch blade 92 is 0.2 mm.

The intensity and the angle of each pole of the upper and lower sleeve portions 75 and 74 are shown in Table 2.

Table 2

MAGNET	POLARITY	INTENSITY	ANGLE
FIRST MAGNET 81a	N	400G	235°
SECOND MAGNET 81b	S	800G	170°
THIRD MAGNET 81c	N	900G	85°
FOURTH MAGNET 81d	S	900G	20°
FIFTH MAGNET 81e	S	600G	310°
FIRST MAGNET 91a	N	900G	190°
SECOND MAGNET 91b	S	600G	2700°
THIRD MAGNET 91c	N	400G	355°
FOURTH MAGNET 91d	N	800G	80°
FIFTH MAGNET 91e	S	900G	130°
(The angle is indicated by an angle in the clockwise direction from the direction of 0 o'clock as 0°.)			

In this case, the gap between both of the sleeve portions 75 and 74 is preferably set to 3 to 4 mm.

According to the method as described above, a developing agent can be smoothly transported in the longitudinal direction in a developing apparatus 34 having a longitudinal type screw structure, and therefore, it is possible to realize a developing apparatus which has a small lateral size in its cross-section.

FIGS. 12 to 15 show a third embodiment of the present invention. Note that those components of the third embodiment which are the same as those used in the above embodiments will be denoted by the same references, and detailed explanation of those components will be omitted herefrom.

FIG. 12 is a cross-section showing a flow of a developing agent in the developing apparatus 35B.

Toner to be charged is supplied from a toner hopper (not shown) to the vicinity of a point a of an upper screw 42, and is brought into contact with and electrified by a carrier of the developing agent, while the developing agent is transported from a point a to a point b, by rotation of the upper screw 42. The developing agent thus sufficiently electrified falls from a first opening portion 51 provided between points b and c, to between points d and e of a lower screw 43, by its dead weight. Then, the developing agent is transported from the point e to a point f by rotation of the lower screw 43.

A magnet roller 45 is provided such that the portion of the roller 45 which corresponds to an area between points d to f in the lengthwise direction of the developing apparatus 35B faces the screws 42 and 43.

FIG. 13 is a view showing a cross-section of the developing apparatus 35B cut between points a and b in FIG. 12.

A portion of the developing agent to be transported from the point d to the point e by the lower screw 43 is attracted up to the surface of the magnet roller 45 by a magnetic force of a magnet not shown in the roller 45, in the direction of the cross-section of the developing apparatus, as the magnet roller 45 rotates. This portion of developing agent is transported in the anti-clockwise direction on the surface, and the layer thickness of the developing agent is restricted by a doctor blade 46. Thereafter, a portion of toner is taken by the photosensitive drum 31. The developing agent including toner the amount of which has thus been reduced is further transported in the anti-clockwise direction, and leaves and falls from the magnet roller 45. The developing agent is transported again in the direction toward the point f by the lower screw 43.

FIG. 14 is a view showing a cross-section of the developing apparatus 35B cut between the points a and b.

A magnet sleeve 101 is connected between points f and g of the lower screw 43, and the developing agent transported to a region between the points f and g is transported over the sleeve 101 as the group of magnets in the sleeve 101 connected to the lower screw 43 rotate. The developing agent reaches the vicinity of the upper screw 42. The agent is scratched off by the upper screw 42, and is then transported toward the point b, again.

In this embodiment, the developing agent flows as described above. Further, the lower screw 43 having a magnet sleeve 101 as a main part of the present invention will be explained more specifically.

FIG. 15 shows the lower screw 43 and the magnet sleeve portion 101.

The magnet sleeve portion 101 of the lower screw 43 has an outer diameter equal to that of the lower screw 43. The center of the axis of the lower screw 43 is shifted by approximately 2 to 3 mm from the center of the axis of the magnet sleeve portion 101, as shown in FIG. 14.

The outer shape of the magnet sleeve 101 is indicated by a continuous line, and the outer shape of the lower screw 43 behind the sleeve 101 is indicated by a dotted line. Since the magnet sleeve portion 101 is positioned to be higher by two or three mm than the lower screw 43, a developing agent can smoothly enter into the magnet sleeve portion 101 from the lower screw 43.

In addition, the magnets in the sleeve portion 101 which will be described later are fixed not around the center of the axis of the sleeve portion 101, but around the center of the screw axis. Therefore, the magnets rotate together with the screw in the anti-clockwise direction in FIG. 14, as the screw rotates.

On the other hand, the sleeve portion 101 itself is fixed to the developing container 41. The arrangement of poles in the magnet sleeve 101 is shown in FIG. 14, and the magnet sleeve 101 comprises first to sixth magnets 102a to 102f which are arranged such that magnets of n-polarity and s-polarity are alternatively disposed at equal intervals.

The intensity of each pole and the angle of each of the first to sixth magnets 102a to 102f are shown in Table 3.

Table 3

MAGNET	POLARITY	INTENSITY
FIRST MAGNET 102a	N	600G
SECOND MAGNET 102b	S	600G
THIRD MAGNET 102c	N	600G
FOURTH MAGNET 102d	S	600G
FIFTH MAGNET 102e	N	600G
SIXTH MAGNET 102f	S	600G
(At an equal interval angle of 60°)		

As the lower screw 43 rotates in the anti-clockwise direction, the group of the magnets 102a to 102f rotate in the anti-clockwise direction, together with the axis, in the sleeve portion 101.

By a force applied from a magnetic field generated between the magnets 102a to 102f, a developing agent is held on the surface of the sleeve 101, and moves over the surface of the sleeve portion 101 in the clockwise direction opposite to the rotation direction of the magnets 102a to 102f, as the sleeve 102 rotates. The developing agent is thus transported to the vicinity of the upper screw 42. Since the sleeve portion 101 is shifted to be higher than the lower screw 43, the gap between the sleeve portion 101 and the upper screw 42 is about 1 mm, so that the developing agent is scratched off by the wings of the upper screw 42.

In addition, in this position, the distance between the internal magnets 102a to 102f and the upper screw 42 is large so that the force of holding the developing agent is weakened. Therefore, the developing agent can be easily scratched off from the upper screw 42.

In order to further ensure scratching, it is effective to stick Mylar or the like to the screw used for scratching the developing agent (at a portion between the points h and a of the upper screw 42 in FIG. 12), so that Mylar is brought into contact with the sleeve portion 101 and the developing agent is scratched off by rubbing.

In the present embodiment, both the upper and lower screws 42 and 43 have an outer diameter of 18 mm and a pitch of 27 mm. The length of each of the sleeve portions is 27 mm corresponding to one pitch of the screws.

According to the method as described above, a developing agent can be smoothly transported in the longitudinal direction in a developing apparatus 34 having a longitudinal type screw structure, and therefore, it is possible to realize a developing apparatus which has a small lateral size in its cross-section.

Claims

1. A developing apparatus comprising:

developing agent supply means (45) for supplying a developing agent consisting of toner and a carrier to a portion to be developed;
first stir/transport means (42) opposed to the developing agent supply means (45), for stirring/transporting the developing agent in a first direction; and

second stir/transport means (43) provided below the first stir/transport means (42) in parallel with the first stir/transport means (42), for receiving/transporting the developing agent from/to the first stir/transport means (42), and for sending the developing agent to the developing agent supply means (45), while stirring/transporting the developing agent in a second direction opposite to the first direction, characterized in that:

the developing agent supply means (45) includes

a supply portion (45a) having a plurality of magnetic poles (53a to 53e) arranged in a first magnetic pole arrangement, for supplying the developing agent to the portion (31) to be developed, and

a transport portion (45b) having a plurality of magnetic poles (55a to 55e) arranged in a second magnetic pole arrangement different from the first magnetic pole arrangement, for transporting the developing agent transported by the second stir/transport means (43), to the first stir/transport means (42).

2. A developing apparatus according to claim 1, characterized in that the magnetic poles of the transport portion (45a) of the developing agent supply means (45) consists of at least total three poles of two N-poles and one S-pole or two S-poles and one N-pole.

3. A developing apparatus comprising:

developing agent supply means (45) for supplying a developing agent consisting of toner and a carrier to a portion to be developed;

first stir/transport means (42) opposed to the developing agent supply means (45), for stirring/transporting the developing agent in a first direction; and

second stir/transport means (43) provided below the first stir/transport means (42) in parallel with the first stir/transport means (42), for receiving/transporting the developing agent from/to the first stir/transport means (42), and for sending the developing agent to the developing agent supply means (45), while stirring/transporting the developing agent in a second direction opposite to the first direction, characterized in that:

the second stir/transport means (43) includes a transport portion (74) having a plurality of magnetic poles (81a to 81e) arranged in a first magnetic pole arrangement, for transporting upwardly the developing agent transported by the second stir/transport means (43), and

the first stir/transport means (42) includes a receive portion (75) opposed to the transport portion (74) and having a plurality of magnetic poles (91a to 91e) arranged in a second magnetic pole arrangement different from the first magnetic pole arrangement, for receiving the developing agent transported upwardly by the transport portion (74).

4. A developing apparatus according to claim 3, characterized by further comprising a developing container (41) for containing the second stir/transport means (43), and characterized in that a gap between the transport portion (74) of the second stir/ transport means (43) and an inner wall portion of the developing container (41) is set to be larger than a gap between the second stir/transport means (43) and the inner wall of the developing container (41).

5. A developing apparatus according to claim 3, characterized in that an outer diameter of the transport means (74) of the second stir/transport (43) means is set to be smaller than an outer diameter of the second stir/transport means (43).

6. A developing apparatus according to claim 3, characterized in that magnetic poles arranged at portions opposite to the transport portion of the second (74) stir/transport means (43) and the receive portion (75) of the first stir/transport means (42) are set to have polarities different from each other.

7. A developing apparatus according to claim 3, characterized in that at least a pair of adjacent magnetic poles of the receive portion (75) of the first stir/transport means (42) are set to have an equal polarity, and a scratch member for scratching off the developing agent is provided on the receive portion (75) positioned between the magnetic poles having the equal polarity.

8. A developing apparatus comprising:

developing agent supply means (45) for supplying a developing agent consisting of toner and a carrier to a portion to be developed;

first stir/transport means (42) opposed to the developing agent supply means (45), for stirring/transporting the developing agent in a first direction; and

second stir/transport means (43) provided below the first stir/transport means (42) in parallel with the first

stir/transport means (42), for receiving/transporting the developing agent from/to the first stir/transport means (42), and for sending the developing agent to the developing agent supply means (45), while stirring/transporting the developing agent in a second direction opposite to the first direction, characterized in that:

a magnetic pole is provided at an end portion of the second stir/transport means (43) and a transport portion (101) for sending the developing agent transported by the second stir/transport means (43) by a magnetic force of the magnetic pole (102a to 102f) to the first stir/transport means (42) is provided.

9. A developing apparatus according to claim 8, characterized in that the second stir/transport means (43) is arranged to be rotatable around a first rotation center axis, the transport portion (101) of the second stir/transport means (43) is arranged to be rotatable around a second rotation center axis, and the second rotation center axis is positioned above the first rotation center axis.

10. A developing apparatus according to claim 8, characterized in that a developing container (41) is provided, the second stir/transport means (43) is arranged to be rotatable around a rotation center axis, and the transport portion (101) of the second stir/transport means (43) is constituted by a magnetic pole (102a to 102f) which is fixed around the rotation center axis as a center and which rotates in a same direction as the second stir/transport means (43) rotates, and a cylindrical member which is fixed to the developing container (41) and which covers the magnetic pole (102a to 102f).

11. A developing apparatus according to claim 8, characterized in that the second stir/transport means (43) is arranged to be rotatable around a first rotation center axis, the transport portion (101) of the second stir/transport means (43) is arranged to be rotatable around a second rotation center axis different from the first rotation axis, and adjacent magnetic poles of the transport portion (101) are set to have polarities different from each other.

12. An image forming apparatus comprising:

a plurality of latent image forming means (5) for forming an electrostatic latent image on a plurality of image carriers (31) for carrying an image;
a plurality of developing means (34), respectively arranged to be opposed to the image carriers (31), for realizing the electrostatic latent images on the image carriers (31);
supplying means (21) for supplying transferring members to said plurality of image carriers (31), sequentially; and a plurality of transferring means (35) for transferring developed images formed on said plurality of image carriers (31) to the transferring members supplied by said supplying means (21), sequentially, characterized in that:
each of the developing means (3a) includes
developing agent supply means (45) for supplying a developing agent consisting of toner and a carrier to a portion to be developed,
first stir/transport means (42) opposed to the developing agent supply means (45), for stirring/transporting the developing agent in a first direction, and
second stir/transport means (43) provided below the first stir/transport means (42) in parallel with the first stir/transport means (42), for receiving/transporting the developing agent from/to the first stir/transport means (42), and for sending the developing agent to the developing agent supply means (45), while stirring/transporting the developing agent in a second direction opposite to the first direction; and
the developing agent supply means (45) includes
a supply portion (45a) having a plurality of magnetic poles (53a to 53e) arranged in a first magnetic pole arrangement, for supplying the developing agent to the portion (31) to be developed, and
a transport portion (45b) having a plurality of magnetic poles (55a to 55e) arranged in a second magnetic pole arrangement different from the first magnetic pole arrangement, for transporting the developing agent transported by the second stir/transport means (43), to the first stir/transport means (42).

13. An image forming apparatus according to claim 12, characterized in that the magnetic poles of the transport portion (45a) of the developing agent supply means (45) consists of at least total three poles of two N-poles and one S-pole or two S-poles and one N-pole.

14. An image forming apparatus comprising:

a plurality of latent image forming means (5) for forming an electrostatic latent image on a plurality of image carriers (31) for carrying an image;

a plurality of developing means (34) respectively arranged to be opposed to the image carriers (31), for realizing the latent electrostatic images on the image carriers (31);

supplying means (21) for supplying transferring members to said plurality of image carriers (31), sequentially; and a plurality of transferring means (35) for transferring developed images formed on said plurality of image carriers (31) to the transferring members supplied by said supplying means (21), sequentially,

characterized in that:

each of the developing means (34) includes

developing agent supply means (45) for supplying a developing agent consisting of toner and a carrier to a portion to be developed,

first stir/transport means (42) opposed to the developing agent supply means (45), for stirring/transporting the developing agent in a first direction, and

second stir/transport means (43) provided below the first stir/transport means (42) in parallel with the first stir/transport means (42), for receiving/transporting the developing agent from/to the first stir/transport means (42), and for sending the developing agent to the developing agent supply means (45), while stirring/transporting the developing agent in a second direction opposite to the first direction;

the second stir/transport means (43) includes a transport portion (74) having a plurality of magnetic poles (81a to 81e) arranged in a first magnetic pole arrangement, for transporting upwardly the developing agent transported by the second stir/transport means (43), and

the first stir/transport means (42) includes a receive portion (75) opposed to the transport portion (74) and having a plurality of magnetic poles (91a to 91e) arranged in a second magnetic pole arrangement different from the first magnetic pole arrangement, for receiving the developing agent transported upwardly by the transport portion (74).

15. An image forming apparatus according to claim 14, characgterized by further comprising a developing container (4) for containing the second stir/transport means (43), and characterized in that a gap between the transport portion (74) of the second stir/ transport means (43) and an inner wall portion of the developing container (41) is set to be larger than a gap between the second stir/transport means (43) and the inner wall of the developing container (41).

16. An image forming apparatus according to claim 14, characterized in that an outer diameter of the transport means (74) of the second stir/transport means (43) is set to be smaller than an outer diameter of the second stir/transport means (43).

17. An image forming apparatus according to claim 14, characterized in that magnetic poles arranged at portions opposite to the transport portion (74) of the second stir/transport means (43) and the receive portion (75) of the first stir/transport means (42) are set to have polarities different from each other.

18. An image forming apparatus according to claim 14, characterized in that at least a pair of adjacent magnetic poles of the receive portion (75) of the first stir/transport means (42) are set to have an equal polarity, and a scratch member for scratching off the developing agent is provided on the receive portion (75) positioned between the magnetic poles having the equal polarity.

19. An image forming apparatus comprising:

a plurality of latent image forming means (5) for forming an electrostatic latent image on a plurality of image carriers (31) for carrying an image;

a plurality of developing means (34) respectively arranged to be opposed to the image carriers (31), for realizing the electrostatic latent images on the image carriers (31);

supplying means (21) for supplying transferring members to said plurality of image carriers (31), sequentially; and a plurality of transferring means (35) for transferring developed images formed on said plurality of image carriers (31) to the transferring members supplied by said supplying means (21), sequentially;

characterized in that:

each of the developing means (34) includes

developing agent supply means (45) for supplying a developing agent consisting of toner and a carrier to a portion to be developed,

first stir/transport means (42) opposed to the developing agent supply means (45), for stirring/transtransporting the developing agent in a first direction, and

second stir/transport means (43) provided below the first stir/transport means (42) in parallel with the first stir/transport means (42), for receiving/transporting the developing agent from/to the first stir/transport means

(42), and for sending the developing agent to the developing agent supply means (45), while stirring/transporting the developing agent in a second direction opposite to the first direction; and

a magnetic pole (102a to 102f) is provided at an end portion of the second stir/transport means (43) and a transport portion (101) for sending the developing agent transported by the second stir/transport means (43) by a magnetic force of the magnetic pole (102a to 102f) to the first stir/transport means (42) is provided.

20. An image forming apparatus according to claim 19, characterized in that the second stir/transport means (43) is arranged to be rotatable around a first rotation center axis, the transport portion (101) of the second stir/transport means (43) is arranged to be rotatable around a second rotation center axis, and the second rotation center axis is positioned above the first rotation center axis.

21. An image forming apparatus according to claim 19, characterized in that a developing container (41) is provided, the second stir/transport-means (43) is arranged to be rotatable around a rotation center axis, and the transport portion of the second stir/transport means (43) is constituted by a magnetic pole (102a to 102f) which is fixed around the rotation center axis as a center and which rotates in a same direction as the second stir/transport means (43) rotates, and a cylindrical member which is fixed to the developing container (41) and which covers the magnetic pole (102a to 102f).

22. An image forming apparatus according to claim 19, characterized in that the second stir/transport means (43) is arranged to be rotatable around a first rotation center axis, the transport portion (101) of the second stir/transport means (43) is arranged to be rotatable around a second rotation center axis different from the first rotation axis, and adjacent magnetic poles of the transport portion (101) are set to have polarities different from each other.

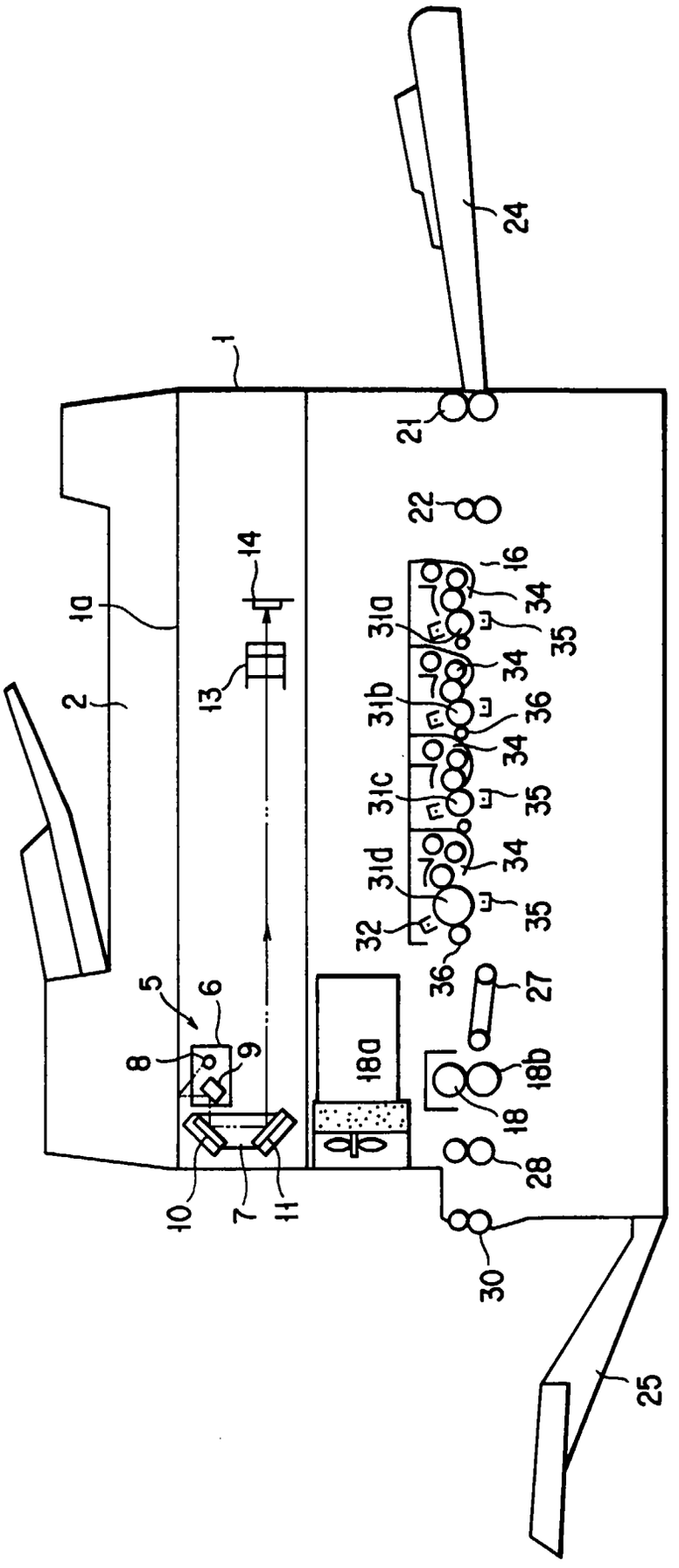

1
2
5
6
7
8
9
10
11
13
14
16
18a
18b
18
21
22
24
25
27
28
30
31a
31b
31c
31d
32
34
35
36

FIG. 1

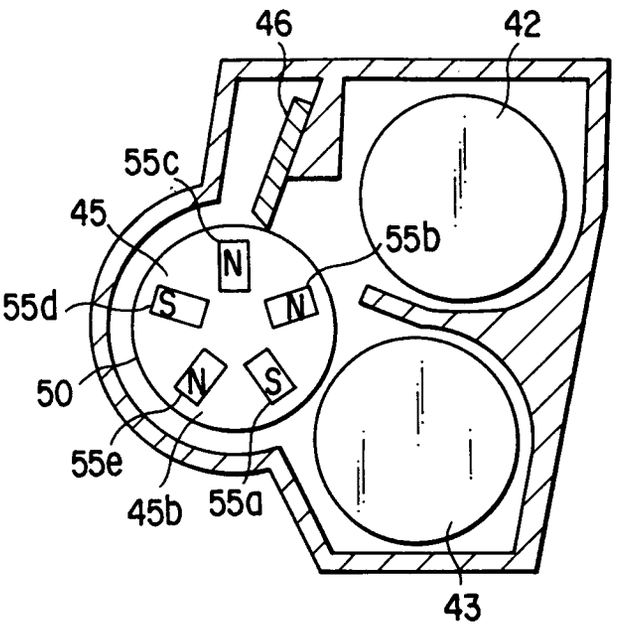
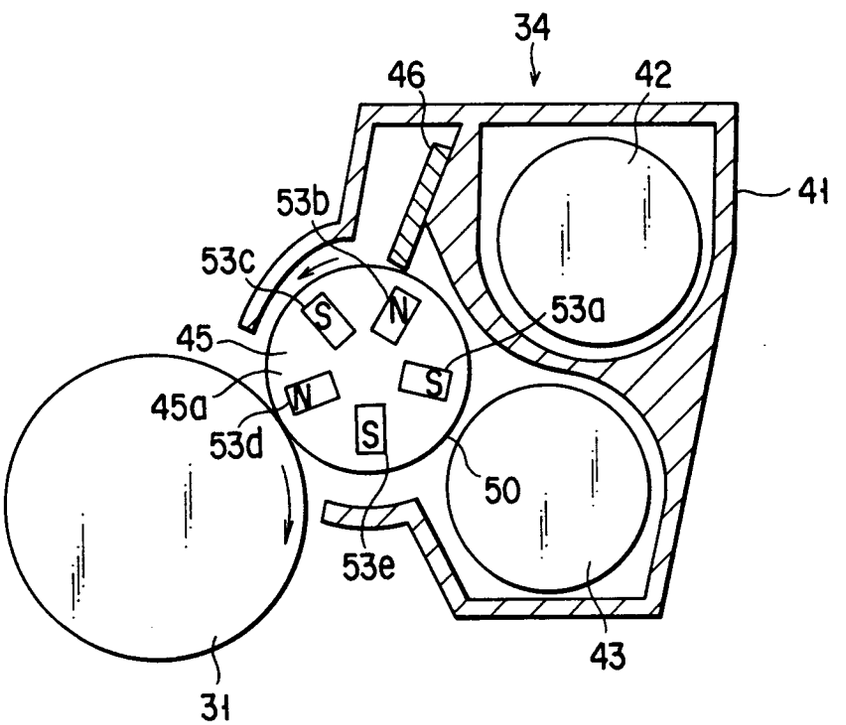

46
42
55c
45
55b
N
55d
S
N
50
N
S
55e
45b
55a
43

FIG. 2


34
46
42
41
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53c
S
N
53a
45
45a
N
S
53d
S
50
53e
43
31

FIG. 3

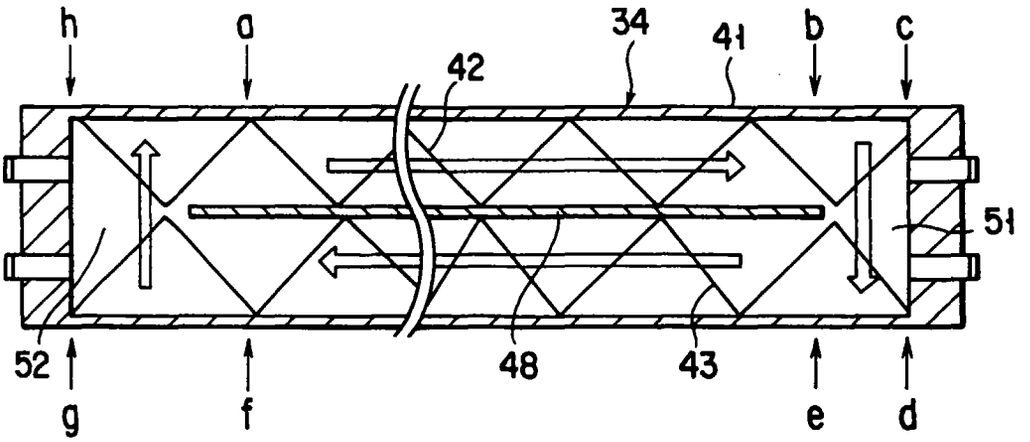

FIG. 4

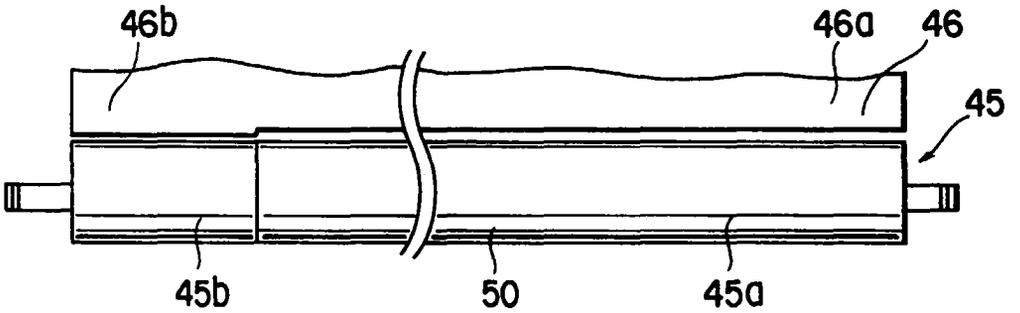

FIG. 5

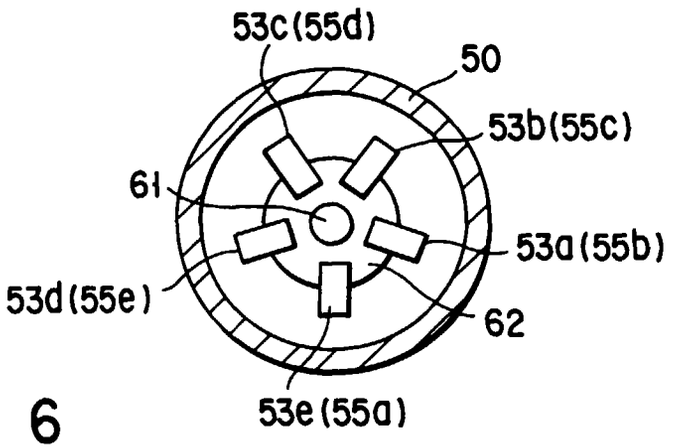

FIG. 6

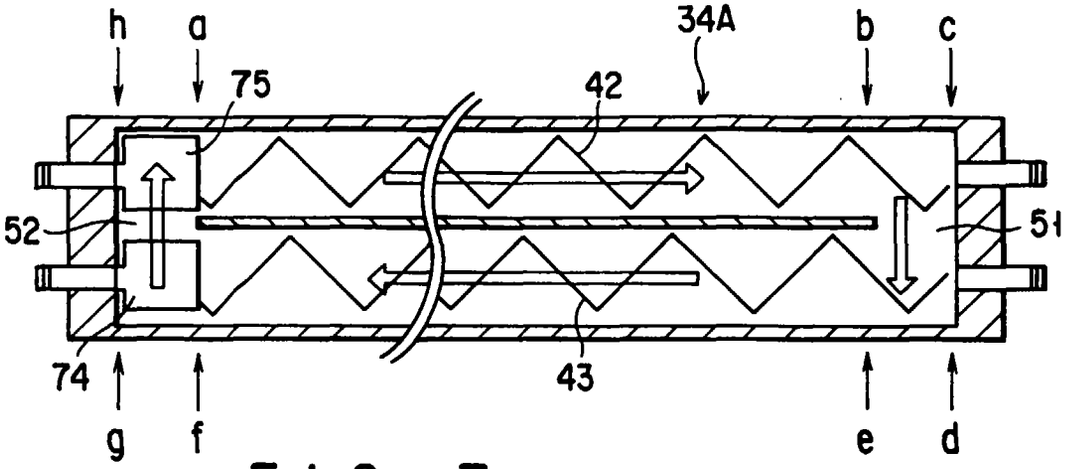

FIG. 7

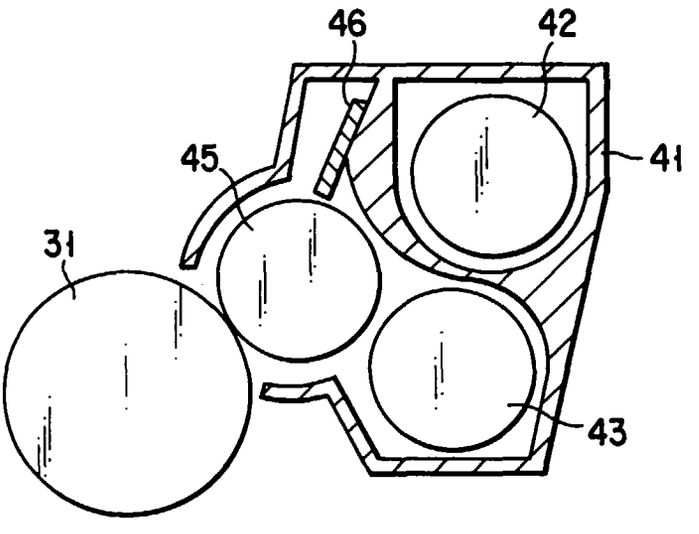

FIG. 8

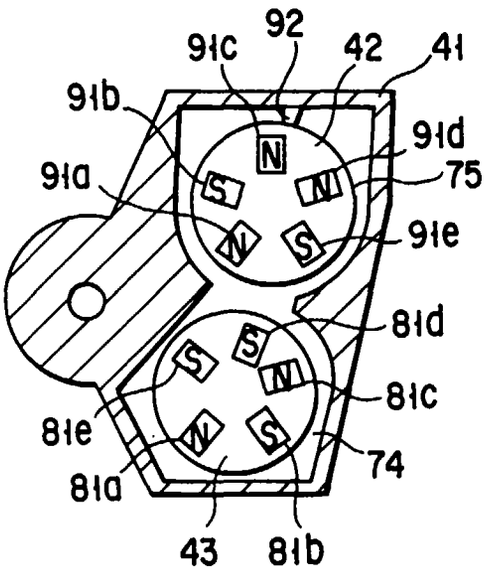

FIG. 9

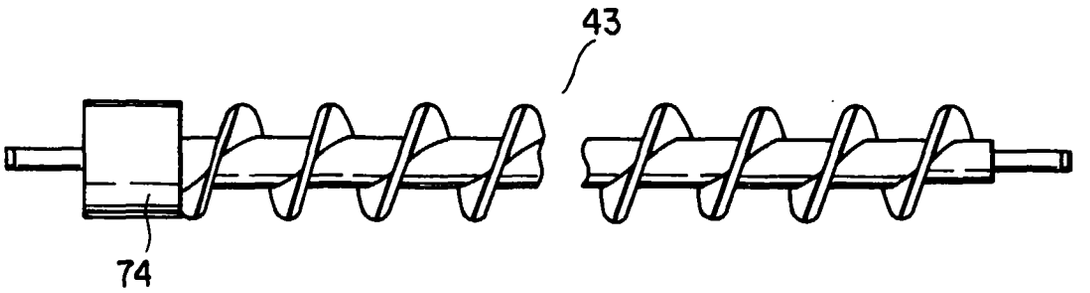

FIG. 10

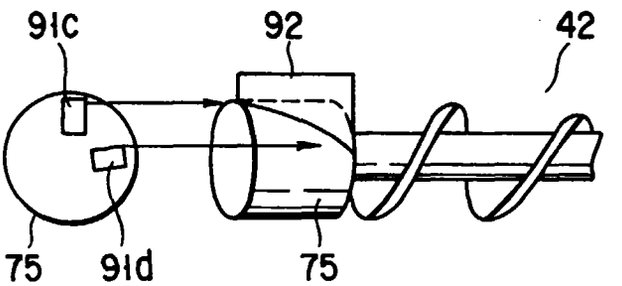

FIG. 11

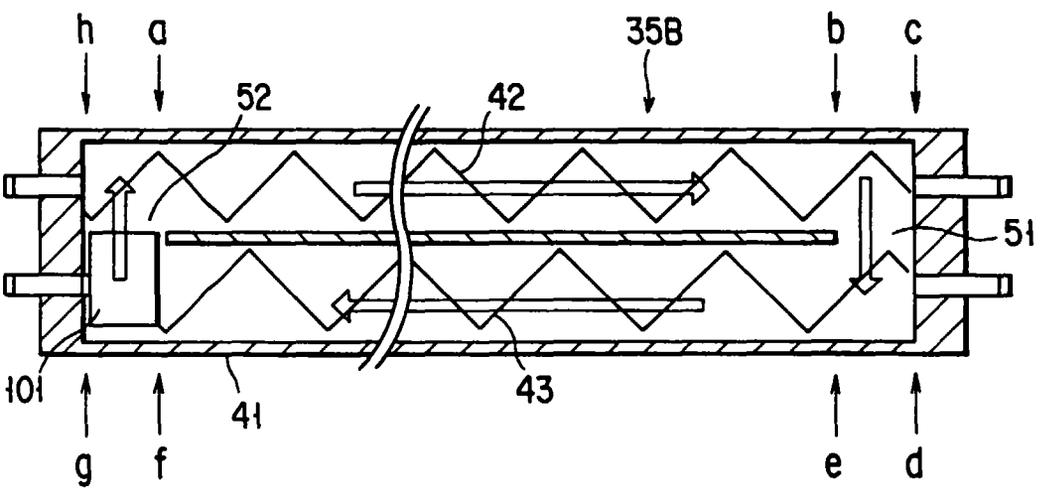

FIG. 12

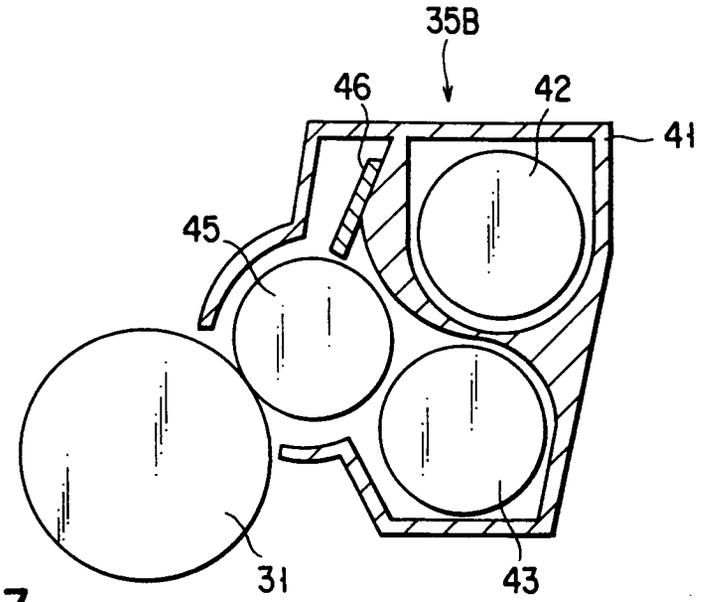

FIG. 13

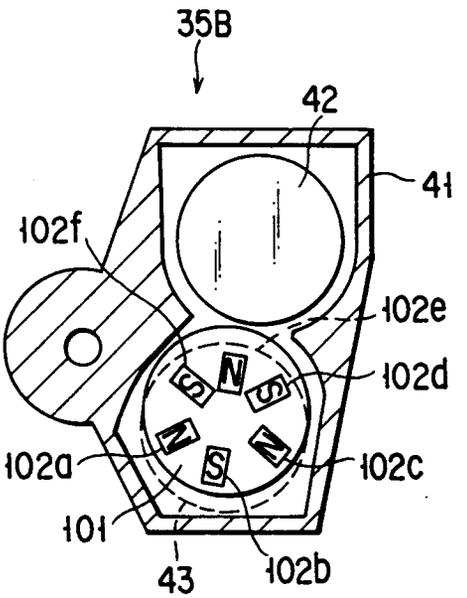

FIG. 14

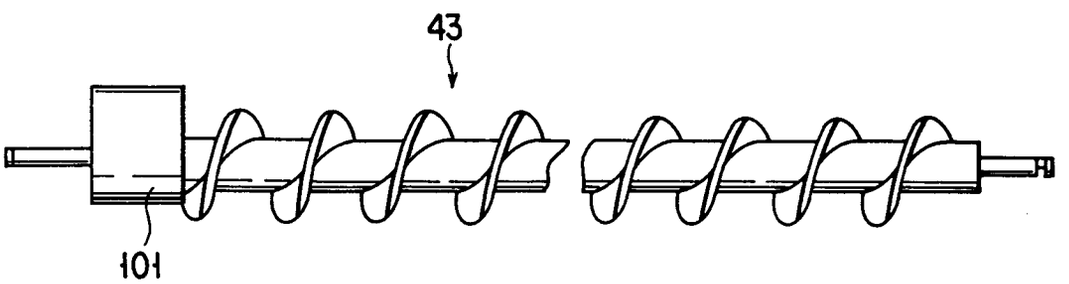

FIG. 15

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 97 11 1965

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 Y A	US 4 940 014 A (SAIJO HIROMITSU ET AL) 10 July 1990 * the whole document * ---	1 12 3,8,14, 19	G03G15/08 G03G15/09 G03G15/01
Y A	EP 0 699 973 A (FUJITSU LTD) 6 March 1996 * figures 1,3,6,54 * ---	12 1,3,8, 14,19	
A	US 5 525 752 A (IZUMIZAKI MASAMI ET AL) 11 June 1996 * figures * ---	1,12,14, 19	
A	PATENT ABSTRACTS OF JAPAN vol. 011, no. 274 (P-612), 5 September 1987 & JP 62 073284 A (FUJI XEROX CO LTD), 3 April 1987, * abstract * ---	1,3,8	
A	PATENT ABSTRACTS OF JAPAN vol. 012, no. 178 (P-708), 26 May 1988 & JP 62 288871 A (CANON INC), 15 December 1987, * abstract * ---	1,3,8	TECHNICAL FIELDS SEARCHED (Int.Cl.6) G03G
A	US 5 129 357 A (YAMAJI MASAAKI) 14 July 1992 * figure 1 * ---	1	
A	US 4 777 512 A (TAKAHASHI MASAYOSHI ET AL) 11 October 1988 * figure 2 * -----	1	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	13 October 1997	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

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