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(54) IMPROVEMENTS IN OR RELATING TO ELECTROSTATIC COPYING

(71) We, MITA INDUSTRIAL COMPANY LIMITED, a Japanese Body Corporate of No. 5, Miyabayashi-cho, Higashi-ku, Osaka, Japan do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:-

This invention relates to an apparatus for electrostatic copying. More specifically, it relates to an electrostatic copying apparatus use of which comprises forming an electrostatic latent image corresponding to an original on a photosensitive member having a photoconductive layer and developing the latent image to render it visible.

Generally, electrostatic copying processes for forming a copied image corresponding to an original include a step of forming an electrostatic latent image corresponding to an original on a photosensitive member having a photoconductive layer, and a developing step for rendering the electrostatic latent image visible. The electrostatic latent image-forming step comprises a step of applying an electrostatic charge to the photosensitive member and a step of projecting the original image on the photosensitive member. The electrostatic latent image formed on the photosensitive member in the latent image-forming step is rendered visible by developing it either directly or after transferring it to a suitable material (latent image transfer). The developing step can be performed by various methods, but generally, it is performed by applying a fine powdery developer (toner) to the electrostatic latent image.

According to the present invention there is provided an electrostatic copying apparatus comprising a housing having at its top surface a transparent plate on which to place the original to be copied, a rotary drum disposed within the housing and having a photosensitive member on its surface, a charging, a developing and a transferring means which are arranged successively around the rotary drum in the moving direction of the surface of the rotary drum, an optical system for projecting the image of the original onto the surface of the rotary drum between the charging means and the developing device, the optical system including a lamp for illuminating the original and a first reflecting mirror which are mounted on a first support frame slidably mounted on a pair of suspending rods extending substantially horizontally within the housing and adapted to be reciprocated at a predetermined speed, a second reflecting mirror mounted on a second supporting frame which is slidably mounted on the suspending rods and adapted to be reciprocated at a speed half of the reciprocating speed of the first support frame, an in-mirror lens fixed within the housing and a third reflecting mirror fixed within the housing; and a receptor sheet conveying system for conveying a receptor sheet through a transfer station defined between the surface of the rotary drum and the transferring means; wherein a semi-transparent member for forming an image is temporarily mounted at a position near the periphery of the housing, the optical length from that position to the third reflecting mirror being the same as the optical length from the surface of the rotary drum to the third reflecting mirror.

The invention will become further apparent from the following description given by way of example with reference to the accompanying drawings, in which:

Figures 1-a to *1-c* are simplified views for illustrating a ghost image which occurs during development in a known rolling contact method;

Figure 2 is a simplified view of an electrostatic latent image-bearing member and a developing apparatus for illustrating the developing step in the electrostatic copying process in accordance with this invention;

Figure 3 is an enlarged view of a part of a brush length adjusting member used in the developing apparatus shown in Figure 2;

Figure 4 is a diagram showing suitable regions of distances d_1 and d_2;

Figure 5 is a simplified view of an electrostatic copying apparatus for illustrating the electrostatic copying process in accordance with this invention;

Figure 6 is a simplified view of an electrostatic eliminator;

Figure 7 is a simplified view of an electrostatic latent image bearing member and a cleaning device for illustrating a cleaning step in the electrostatic copying process in accordance with this invention;

Figure 8 is a perspective view, partly broken away, of the electrostatic copying apparatus in accordance with this invention;

Figure 9 is a sectional view of the electrostatic copying apparatus shown in Figure 8;

Figure 10 is a simplified partially perspective view showing an optical system;

Figure 11 is a perspective view, partly broken away, of an upper part of the electrostatic copying apparatus shown in Figure 8;

Figure 12 is a perspective view showing a support structure;

Figure 13 is a partial perspective view showing the state of a lower part of the electrostatic copying apparatus shown in Figure 8, in which a support has been partly pulled out;

Figure 13A is an exploded view showing a modified example of a support and elements mounted on it;

Figure 14 is a partial perspective view of that part of the electrostatic copying apparatus shown in Figure 8 on which the support is mounted;

Figure 15 is a side elevation of that part of the apparatus on which a rotary drum is mounted;

Figure 16 is a partial perspective view of a paper feed section;

Figure 17A and *Figure 17B* are front elevations of the paper feed section shown in Figure 16;

Figure 18 is a simplified view showing a drive system;

Figure 19 is a simplified partial perspective view for illustrating the drive system;

Figure 20 is a simplified view showing electrical elements of the electrostatic copying apparatus shown in Figure 8;

Figures 21 to *24* are circuit diagrams showing the wire bonding of the electrical elements of the electrostatic copying apparatus shown in Figure 8; and

Figure 25 is a partial perspective view showing a mechanical sensing element which may be provided to register the forward end of an original optically projected on the surface of the rotary drum with the forward end of a receptor sheet.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

The present invention is described in detail with reference to the accompanying drawings.

Electrostatic copying method

Electrostatic copying processes for forming a copied image corresponding to an original image, as is well known, include a xerographic process, an electro-fax process, or a TESI process including an electrostatic latent image transferring step. All of these processes commonly include a step of forming an electrostatic latent image corresponding to an original image on a photosensitive member having a photoconductive layer, and a developing step for rendering the electrostatic latent image visible.

Developing step

The developing step for rendering the electrostatic latent image visible can be performed by various known developing methods. In recent years, a method involving the application of a fine powdery developer (toner) to the electrostatic latent image to be developed has been preferred.

One typical known method within this category comprises magnetically holding a fine powdery developer on the surface of a developer-holding member in the form of a hollow cylindrical sleeve or an endless belt by means of a magnet disposed within the developer-holding member, and then contacting the surface of the developer-holding member with the surface of an image-bearing member having an electrostatic latent image formed thereon (i.e., a photo-sensitive member or a receptor member to the surface of which the electrostatic latent image has been transferred) through the developer, thereby to apply the developer to the electrostatic latent image.

It was first suggested with regard to this known method to move the surface of the developer-holding member and the surface of the latent image bearing member in opposite directions to each other, thereby successively contacting the two surfaces with each other. According to the suggestion, however, the density of the image is low because of a fairly great slippage between the two surfaces (the difference in moving speed), and the image obtained is unsatisfactory with a poor resolving power and a poor reproducibility of halftone.

In an attempt to overcome this disadvantage, a "rolling contact method" was suggested which comprises moving the surface of the developer holding member and the surface of the electrostatic latent image-bearing member in the same direction at the same speed, thereby contacting the two surfaces successively without substantial slippage (for example, British Patent 1,493,280). This rolling contact method can afford an image which has a suitable image density, a high resolving power, and a good reproducibility of halftone. If a mono-component developer (so-called carrierless developer) composed of one kind of magnetic fine powder is used in this rolling contact method, the developer adheres to the surface of the latent image-bearing member too faithfully according to the potential on the surface. This causes the following disadvantages that must be overcome.

(i) The developer adheres thinly to an area which is spaced from the image area by some distance to form a so-called ghost image or fringed image.

(ii) The developer adheres thinly to the background area of the image to cause background fogging.

The ghost image formation and the background fogging are described in detail below with reference to Figures 1-a and 1-c. An electrostatic latent image formed on the surface of electrostatic latent image-bearing member 2 has at its image area I a charge and a potential of a specific polarity (for example, positive), and because of the edge effect of the charge on the image area, a potential of an opposite polarity (for example, negative) in the surrounding of the image area. Accordingly, the potential pattern of the electrostatic image shown in Figure 1-a is known to be as shown in Figure 1-b. If the developer composed of a single magnetic fine powder is caused to approach the electrostatic latent image, the charge of the electrostatic latent image induces a charge of an opposite polarity in the developer, and therefore, the development of the latent image proceeds by the Coulomb's attractive force acting between the two charges. Since the developer is magnetically held on the surface of the developer-holding member, the developer, upon contact with the electrostatic latent image, adheres to that part of the latent image which has a potential above a certain value ($\pm$ y V) that begins to exert a Coulomb's attractive force larger than the magnetic holding force of the developer-holding member on the developer, irrespective of the polarity of the potential on that part. Thus, when the surface of the electrostatic latent image-bearing member is contacted successively with the developer from right to left in Figure 1-a (in the direction shown by arrow A in Figure 1-a), the developer adheres to the portion of image area I, and thinly to part G which is upstream of the image area by distance x. Consequently, as shown in Figure 1-c, a ghost image is formed at part G upstream of image area I. A potential above the certain value ($\pm$ y V) exists on part G′, spaced downstream of the image area I by distance x until the development of image area I ends. When the development proceeds and the potential of the latent image in image area I decreases as a result of the adhesion of the developer to image area I, the potential on part G′ decreases to below $\pm$ y V, and therefore, a ghost image does not substantially form on part G′ downstream of the image area I.

In an ordinary electrostatic copying process in which an electrostatic latent image formed on a photosensitive member is directly developed, the photosensitive member is fatigued as a result of forming an electrostatic latent image in the previous cycle, and it is extremely difficult, if not impossible, to remove the fatigue completely before the beginning of the new cycle. Accordingly, the photosensitive member (i.e., the electrostatic latent image-bearing member) has some residual potential caused by the fatigue in the previous cycle in addition to the potential of the electrostatic latent image to be developed. Generally, the residual potential tends to increase gradually as a result of repeatedly using the photosensitive member with a short recess between cycles. In the case of using an ordinary two-component developer, the developer is biased to a specified potential of the same polarity as the residual potential and thus cancels the residual potential. In contrast, in the rolling contact method, the developer adheres to the surface of the electrostatic latent image-bearing member too faithfully according to the surface potential of the image-bearing member, and in particular, a mono-component developer is attracted by a potential of any of the positive and negative polarities. Hence, if a bias voltage is applied, the adhesion of the developer is increased. Mainly for the above reason, the developer adheres also to an area having the residual potential, and the background fogging of the non-image area gradually increases as the number of copying operations increases.

The present inventors have newly found that if the surface of the developer-holding member and the surface of the electrostatic latent image-bearing member are contacted with each other successively by being moved in the same direction at somewhat different speeds in a developing station where the surface of the developer-holding member is contacted with the image-bearing member through the developer, the developer which adheres weakly to the surface of the image-bearing member and causes ghost image formation and background fogging can be wiped off by exerting the mechanical brushing action on the developer held magnetically to the surface of the developer-holding member without reducing the density and resolving power of the image and the reproducibility of halftone; and that consequently, the desired image free from ghost image formation and background fogging can be obtained.

Specifically, the present inventors have newly found that in an electrostatic latent image developing process which comprises magnetically holding a fine powdery developer on the surface of a developer-holding member by means of a magnet disposed within the developer-holding member, then contacting the surface of the developer-holding member with the surface of an electrostatic latent image-bearing member through the developer, and thus applying the developer to the electrostatic latent image to develop it, an image having a high image density, a high resolving power and a superior reproducibility of halftone and being free from ghost image formation and background fogging can be obtained in a developing zone by moving the surface of the developer-holding member and the surface of the electrostatic latent image-bearing member on contact with each other in the same direction at such speeds that a speed difference of about 20 m/minute $\geq|V_1 - V_2|>0$ m/minute is provided between the moving speed V_1 of the surface of the developer-holding member and the moving speed V_2 of the surface of the electrostatic latent image-bearing member.

The speed difference differs somewhat according, for example, to the potential of the electrostatic latent image to be developed or the characteristics of the developer. It is generally about 20 m/minute $\geq|V_1 - V_2|\geq$ about 1.0 m/minute, preferably about 20 m/minute $\geq|V_1 - V_2|\geq$ about 3.5 m/minute. Especially, the $V_1 - V_2$ is preferably a positive value.

This new finding is described in more detail with reference to Figure 2. Electrostatic latent image-bearing member 2 having an electrostatic latent image formed on its surface, which is, for example, a rotary drum having a photoconductive layer of selenium or cadmium sulfide is rotated in the direction shown by arrow B (clockwise direction in Figure 2). In developing section 4, the electrostatic latent image formed on the surface is developed by a developing device generally shown at 6. The electrostatic latent image to be developed is formed on the surface of the latent image-bearing member 2 upstream of developing station 4 by any method known to those skilled in the art.

Developing device 6 includes developer-holding member 8 to be rotated, magnet 10 disposed within the member 8 and developer supplier 14 for supplying developer 12 to the surface of developer-holding member 8. Developer-holding member 8 may be any desired material which can magnetically hold the developer supplied from supplier 14 to the surface of the developer-holding member by the action of magnet 10 and can be contacted with the surface of electrostatic latent image-bearing member 2 through the developer in developing station 4. For example, it may be made of an endless belt. A suitable developer-holding member is made of a hollow cylindrical sleeve and can be rotated in the direction of arrow C in Figure 2 (in the counterclockwise direction in Figure 20. Furthermore, when the developer used is a mono-component developer composed of a conductive or semiconductive magnetic fine powder (the developer will be described in detail hereinbelow), a developer-holding member composed of a main body of a nonmagnetic metallic material and an insulating coating formed on the surface of the main body is used suitably. Preferred insulating coatings are, for example, organic insulating coatings such as polystyrene or polyethylene terephthalate, inorganic insulating coatings such as aluminum oxide, or composites of these, which have a resistance of at least 10^5 ohms/cm^2, especially at least 10^5 ohms/cm^2.

Magnet 10 to be disposed within developer-holding member 8 may be of any type which has the action of magnetically holding the developer onto the surface of developer-holding member 8. When developer-holding member 8 is a hollow cylindrical sleeve as shown in the drawings, the magnet is preferably a stationary roll-like permanent magnet having a plurality (for example, 8) of magnetic poles which are located on its periphery and alternately have opposite polarities. Preferably, as shown in Figure 2, such a stationary roll-like permanent magnet is generally fixed within the developer-holding member such that one of the magnetic poles is positioned upstream in the rotating direction of the developer-holding member by angle α with respect to position P at which the surface of electrostatic latent image-bearing member 2 approaches the surface of developer-holding member 8 most closely. If, however, developer-holding member 8 is rotated at a fairly high speed, it is sometimes preferred to position one of the magnetic poles of the permanent magnet at position P at which the surface of developer-holding member 8 approaches the surface of the electrostatic latent image-bearing member most closely. When developer-holding member 8 is rotated at a fairly high speed, the developing station (the contact zone between the developer and the surface of image-bearing member 2) must be increased by bringing the surface of image-bearing member 2 closer to the surface of developer-holding member 8 to maintain the developing time (the time during which the surface of the electrostatic latent image-bearing member is in contact with the developer). If one of the magnetic poles is positioned at a point somewhat farther upstream of position P in this case, the surface of electrostatic latent image-bearing member 2 contacts the developer even at an intermediate point between magnetic poles, and development occurs also at this point.

The developing device 6 further includes a brush length adjusting means such as a doctor blade for controlling the thickness of the developer layer which has been supplied to the surface of developer-holding member 8 from developer supplier 14 and held there magnetically. The brush length adjusting means can be made up of, for example, member 16 which is adjustably secured to side wall 14a of supplier 14 that is positioned downstream in the rotating direction of developer-holding member 8. Member 16, as is clearly shown in Figure 3, tapers toward its free end which is positioned near the surface of developer-holding member 8 at a point at which one of the magnetic poles of magnet 10 is situated in its vicinity. Preferably, the thickness of the free end is more than 0 mm and up to 0.5 mm. The angle β defined by both side surfaces of the free end is not more than 15°, preferably not more than 10°.

Preferably, member 16 constituting the brush length adjusting means is disposed near the surface of developer-holding member 8 somewhat upstream of one of the magnetic poles of magnet 10 in the moving direction of the surface of developer-holding member 8. According to this construction, because of the form of the line of magnetic force generated by magnet 10, the developer within developer supplier 14 is not urged against member 16 and does not solidify there. Accordingly, a layer of the developer having a good surface condition is formed on the surface of developer-holding member 8, and the toner image developed increases in quality. It is also preferred that the tip of side wall 14b which forms one edge of the developer outlet of developer supplier 14 and is positioned upstream in the rotating direction of developer-holding member 8 should be disposed somewhat upstream of one of the magnetic poles of magnet 10 in the moving direction of the surface of developer holding member 8. According to this embodiment, the developer is not carried to the outside tip portion of side wall 14b of the developer supplier because of the form of the line of magnetic force generated by magnet 10.

Distance d_1 between the free end of member 16 and the surface of developer-holding member 8, as will be described hereinbelow, is closely related to distance d_2 between the surface of developer-holding member 8 and electrostatic latent image-bearing member 2 at position P at which these surfaces approach each other most closely. Generally, distance d_1 is $0.15\ \text{mm} \leq d_1 \leq 0.5\ \text{mm}$, especially $0.2\ \text{mm} \leq d_1 \leq 0.45\ \text{mm}$. If distance d_1 is too small, a sufficient amount of the developer cannot be supplied to developing station 4. Conversely, if distance d_1 is too large, the layer of the developer held on the surface of developer-holding member 8 becomes thick, and the developer which is situated at the outermost position is held by a weak holding force. Consequently, the scattering of the developer occurs at developing station 4, and the image developed is fogged. On the other hand, distance d_2 between the surface of developer-holding member 8 and the surface of electrostatic latent image-bearing member 2 at position P at which they approach each other most closely is closely related with the distance d_1 described above. Generally, the distance d_2 is $0.6\ \text{mm} \geq d_2 \geq d_1$, preferably $0.55\ \text{mm} \geq d_2 \geq d_1$.

According to the information which the present inventors have obtained through research and experimental work, the distances d_1 and d_2 are preferably within the area defined by a line connecting the four points (0.15, 0.25), (0.5, 0.6), (0.25, 0.6) and (0.15, 0.5) in a graphic representation of Figure 4 in which d_1 (mm) is on the axis of abscissas and d_2 (mm) is on the axis of ordinates, and especially preferably within the area defined by a line connecting the four points (0.2, 0.3), (0.45, 0.55), (0.25, 0.55) and (0.2, 0.5).

Distance d_3 from the forward end of side wall 14b located upstream in the rotating direction of the developer-holding member, which defines one edge of the developer outlet of developer supplier 14, to the surface of developer-holding member 8 is generally $5\ \text{mm} \geq d_3 \geq 1\ \text{mm}$, preferably $3\ \text{mm} \geq d_3 \geq 2\ \text{mm}$.

Developer 12 is suitably a known mono-component developer composed of a single conductive or semiconductive fine powder with a particle diameter of 5 to 30 microns, preferably 8 to 15 microns which is obtained by coating a fine powder of iron, cobalt or nickel, or an oxide of such a metal, or an alloy of such a metal, or a mixture of these with a resin such as an epoxy, styrene or olefin resin, or further adding a suitable coloring agent such as carbon black.

In developing device 6 described above, the surface of the developer-holding member within developing station 4 is contacted with the surface of electrostatic latent image-bearing member 2 through developer 12 retained on its surface. It is important that the two surfaces should be contacted with each other through developer 12 in the manner to be described below.

Electrostatic latent image-bearing member 2 is rotated at a fixed speed in the direction of arrow B (that is, in the clockwise direction in Figure 2), and developer-holding member 8 is rotated at a fixed speed in the direction or arrow C (that is, in the counterclockwise direction in Figure 2). Hence, the surface of image-bearing member 2 and the surface of the developer-holding member are moved in the same direction in developing station 4 where the surface of developer-holding member 8 is contacted through the developer held on it with the surface of image-bearing member 2. These members are moved at such speeds that the moving speed V_1 of the surface of developer-holding member 8 differs from the moving speed V_2 of the surface of image-bearing member 2 as follows:

about 20 m/minute $\geqslant |V_1 - V_2| > 0$ m/minute.

As described in detail with reference to Figures 1-a to 1-c, when a mono-component developer composed of a single type of magnetic fine powder is used in the known rolling contact method which involves moving the surface of developer-holding member 8 and the surface of image-bearing member 2 at substantially the same speeds ($V_1 - V_2 = 0$), a ghost image is formed and the background is fogged, because the developer adheres to the surface of image-bearing member 2 too faithfully according to the potential pattern of the surface. If, however, the surface of developer-holding member 8 and the surface of image-bearing member 2 are moved in the same direction at different speeds as described above, the developer which adheres thinly to the nonimage area with a weak adhering force and is likely to cause ghost image formation and background fogging is scraped off by the mechanical brushing action of the developer held magnetically on the surface of developer-holding member 8. The scraping of the developer is done without substantially reducing the density and resolving power of the image area and the reproducibility of halftone, and the image obtained is free from ghost image formation and background fogging. If the speed difference ($V_1 - V_2$) is larger than about 20 m/minute, the mechanical brushing action of the developer magnetically held to the surface of developer-holding member becomes excessive, and the resulting image has a low density, a poor resolving power, and a poor reproducibility of halftone. Or because the developer applied to the developing station by the rotation of developer-holding member is insufficient, the density of the resulting image decreases.

Preferably, the speed difference ($V_1 - V_2$) should be a positive value. If the speed difference ($V_1 - V_2$) is a negative value (in other words, if the moving speed V_1 of the surface of developer-holding member 8 is smaller than the moving speed V_2 of the surface of image-bearing member 2), the amount of the developer supplied to developing station 4 by the rotation of developer-holding member 8 tends to be insufficient. Specifically, therefore, it is preferred to render the moving speed V_1 of the surface of developer-holding member 8 somewhat larger than the moving speed V_2 of the surface of the image-bearing member 2. The optimum speed difference $V_1 - V_2$ differs somewhat according to the magnitude of the potential on the electrostatic latent image to be developed, the characteristics of the developer (the sensitivity of the developer to the potential), the magnetic holding power of the magnet for the developer, the moving speed (i.e., the developing speed) of the surface of image-bearing member 2, etc. In the development of an electrostatic latent image in an ordinary electrostatic copying process, the speed difference is about 20 m/minute to about 1.0 m/minute, preferably about 20 m/minute to about 3.5 m/minute.

Example

In an apparatus of the type shown in Figure 2, a rotary drum made by vacuum-depositing selenium on the surface of a cylindrical aluminum support with a diameter of 120 mm was used as an electrostatic latent image-bearing member. The surface of the rotary drum was uniformly charged by positive corona discharge. An original image was projected on the drum surface charged to a fixed positive potential (Vs) to form an electrostatic latent image.

A toner composed of a mono-component magnetic powder was supplied from a developer supplier to the surface of a developer-holding member made of a non-magnetic cylindrical sleeve having a magnet disposed inside, thereby to form a layer of the toner on the surface of the sleeve. The strength of the magnetic force on the surface of the sleeve was about 1,000 Gauss. The particle diameter of the toner was adjusted to 5 to 30 μ to obtain a good quality image and prevent the scattering of the toner particles at the time of transfer. The cylindrical sleeve was rotated at a suitable peripheral speed to convey the toner magnetically attracted to the surface of the sleeve to a developing position.

Thus, the toner was applied to the electrostatic latent image to form a toner image. The toner image formed by development was then transferred to a receptor sheet and fixed on it under pressure.

The residual charge on the rotary drum after the transferring operation was removed by the irradiation of light, and the residual toner was removed by the developing device itself or by a suitable cleaning device equivalent to the developing device.

In the formation of the electrostatic latent image, the surface of the rotary drum was charged so that its surface potential Vs would become about 700 V at the time of development. Then, a light image and a dark image of the reflecting light from an original which had been irradiated with light (adjusted to about 450 W) from a halogen lamp with a rating of 700 W (the length of the light emitting portion was about 280 mm) were projected on the surface of the rotary drum using two reflecting mirrors and an in-mirror lens. The reflecting ratio of the reflecting mirrors was more than about 95%, and the lens had an F value of 5.3 and a focal length of 235 mm.

The cylindrical sleeve used in the development was a hollow cylindrical body of aluminum with a diameter of 32.4 mm, and an aluminum oxide coating obtained by anodization at a low temperature was formed on the surface of the sleeve. The hollow cylindrical body was grounded during use. The shape of the developer supplier, the brush length adjusting member and other parts are as illustrated in Figure 2.

(A) Distance (d_1) between the surface of the cylindrical sleeve and the end of the brush length adjusting member, and distance (d_2) between these surfaces at a point where they come closest to each other:-

Experiment was performed under the aforesaid experimental conditions while varying d_1 and d_2, and the results shown in Table 1 were obtained.

TABLE 1

d_2 mm \ d_1 mm	0.1	0.15	0.2	0.25	0.3	0.35	0.4	0.45	0.5	0.55	0.6	0.65	0.7
0.1													
0.15	X												
0.2	X	X											
0.25	X	F	F										
0.3	F	G	E	F									
0.35	F	G	E	E	F								
0.4	F	G	E	E	E	F							
0.45	F	G	E	E	E	E	F						
0.5	F	G	G	G	G	G	G	F					
0.55	F	F	G	G	G	G	G	G	F				
0.6	X	F	F	F	F	F	F	F	F	F			
0.65	X	X	F	F	F	F	F	F	F	F	F		
0.7	X	X	X	X	X	F	F	F	F	X	X	X	

X - Toner image poor (useless for practical purposes)
F - Toner image fair (limit of practical usefulness)
G - Toner image good
E - Toner image excellent

The results obtained are discussed briefly below.

When d_2 is shorter than $d_1 + 0.05$ mm, the thickness of the toner layer on the surface of the sleeve is larger than d_2. Accordingly, the toner is compressed and solidified in the developing zone, and the development of the electrostatic latent image becomes poor. When d_1 is shorter than 0.1 mm, the toner density of the toner layer on the sleeve surface is low, and the density of the toner image does not increase. Furthermore, when d_1 is less than 0.1 mm, mechancial accuracies, for example in the eccentricity of the cylindrical sleeve or the rotary drum, are rigorously required. When within the range of $d_1 \geqslant 0.1$ mm, d_2 is more than $d_1 + 0.45$ mm, d_2 is far larger than d_1, and the toner layer does not make sufficient contact with the photosensitive surface of the drum, and no useful toner image can be obtained. When the distance d_2 between the surface of the rotary drum and the surface of the cylindrical sleeve exceeds 0.7 mm, good results cannot be obtained. When d_2 is larger than 0.7 mm, the toner layer to be held magnetically onto the surface of the sleeve must necessarily be increased in thickness. When the thickness of the toner layer increases, the magnetic force exerted on the toner particles which will contact the rotary drum is weakened. Accordingly, the electrostatic force between the electrostatic latent image and the toner increases to increase fogging. At the same time, the rotation of the sleeve causes the scattering of the toner particles to soil the copying machine. When the distance d_1 is maintained constant, the density of the toner layer is determined according to the flowability and particle diameter of the toner, the interpole distance of the magnetic roll, the magnetic flux intensity of the magnet, etc. Hence, the distance d_1 should be determined according to these conditions.

(B) Relation between moving speed V_1 of the surface of the cylindrical sleeve and moving speed V_2 of the surface of the rotary drum:-

(a) In consideration of the results obtained in (A), the above experiment was performed while maintaining $d_1 = 0.25$ mm and $d_2 = 0.4$ mm and the peripheral speed V_2 of the rotary drum at 11 m/min. The cylindrical sleeve was moved at varying peripheral speeds V_2 in the same direction as the rotating direction of the rotary drum. The results obtained are shown in Table 2.

TABLE 2

Resistivity of the toner (Ω-cm) \ Difference in peripheral speed between the sleeve and the drum (V_1-V_2 m/sec.)	−11	−9.6	−8.02	−5.04	−2.05	0	0.92	2.41	3.5	6.88	9.86	12.2	15.82	19.8	More than 19.8
10^6	X	G	G	G	F	X	F	G	G	G	G	F	F	F	X
10^9	X	F	F	G	F	X	F	G	G	G	G	G	F	F	X
10^{10}	X	X	F	G	F	X	F	G	E	E	G	G	G	F	X
10^{11}	X	X	F	G	F	X	F	G	E	E	E	G	G	F	X
10^{12}	X	X	F	G	F	X	X	F	E	E	E	G	G	G	F
10^{14}	X	X	X	X	X	X	X	F	G	G	G	G	G	G	G

When the peripheral speed V_2 of the rotary drum is 11 m/min., a toner image of good quality is obtained within the area of $19.8 > V_1 - V_2 > 2.41$, or $-2.05 > V_1 - V_2 > -9.6$. When V_1 is low, non-uniformity in image tends to occur owing to the non-uniformity of the speed. Hence, a special care must be taken to minimize the non-uniformity of the speed. When V_1 is 0, the toner is not supplied to the developing zone, and therefore, an image cannot be obtained. When the peripheral speed V_1 of the cylindrical sleeve is equal to the peripheral speed V_2 of the rotary drum ($V_1 - V_2 = 0$), the rotary drum and the cylindrical sleeve are brought into rolling contact with each other through the toner layer, and toner adhesion occurs very faithfully to the electrostatic latent image. However, the residual potential on the rotary drum coated with photo-sensitive selenium for example is high, too faithful a development is not desirable. The resistivity of the toner shown in Table 2 is a value obtained when a DC voltage of 50 V is applied to the toner layer having a thickness of 1.5 mm. The density of the image decreases with increasing resistivity of the toner. However, the image becomes hard in tone, and increases in sharpness.

(b) The toner image obtained by forming an electrostatic latent image varies according to the maximum potential of the surface of the rotary drum (i.e., the maximum potential Vs of the electrostatic latent image formed) and the resistance (R) of the toner. To make sure of this, the relation of the toner image to the Vs and R values at $V_1 - V_2 = 3.5$ m/min. was examined. The results are shown in Table 3.

TABLE 3

Resistivity R of the toner (Ω-cm) \ Maximum potential Vs (Volts)	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500
10^{6}	G	G	G	F	F	X	X	X	-	-	-	-	-	-
10^{7}	G	E	G	G	F	F	X	X	-	-	-	-	-	-
10^{8}	F	G	E	G	F	F	X	X	X	-	-	-	-	-
10^{9}	F	G	E	E	G	F	F	F	F	X	-	-	-	-
10^{10}	X	F	G	E	E	E	G	F	F	X	-	-	-	-
10^{11}	X	X	F	G	E	E	E	F	F	X	-	-	-	-
10^{12}	X	X	F	G	E	E	E	F	F	X	X	-	-	-
10^{13}	X	X	X	F	F	G	E	F	F	X	X	X	X	-
10^{14}	X	X	X	X	X	X	F	F	F	X	X	X	X	X

When the surface potential Vs reaches 800 V, a ghost image begins to appear. When it exceeds 1000 V, the ghost image increases very much, and the resulting image is useless. When the resistivity of the toner exceeds 10^{14} ohms-cm, a sufficient image density cannot be obtained unless the surface potential is increased extremely. Toner particles having a low resistivity adhere to the electrostatic latent image in an increasing amount, and therefore, the fog density increases. For this reason, a good image cannot be obtained unless the surface potential is reduced. When the surface potential is less than 200 V, the density of the image decreases extremely (the reflective image density is less than 0.5), and the image obtained is not feasible. Even when the surface potential is less than 200 V and the resistivity of the toner is less than 10^{6} ohms-cm, the density of the image can be increased by weakening the magnetic force of the developer-holding member. However, since the surface potential of a bright area of the image (the residual potential) is almost constant, the amount of the toner adhering to the residual potential increases, and the resulting image has an extremely high fog density.

Electrostatic copying process which involves developing an electrostatic latent image formed on a photosensitive member, and transferring the developed image to a receptor sheet (the toner image-transferring step)

As described hereinabove, various forms of electrostatic copying process exist for producing a copied image corresponding to the image of an original. In recent years, there has been an increasing demand for "plain paper copying (PPC)" by which a copied image is formed on a sheet of plain paper (including papers somewhat processed but being substantially equivalent to plain paper).

The electrostatic copying process for producing a copied image on plain paper generally includes a step of forming an electrostatic latent image corresponding to an original image on a photosensitive member, a developing step for applying a fine powder developer (toner) to the resulting electrostatic latent image to render it visible, a step of transferring the toner image on the photosensitive member after the transferring, and a cleaning step for removing the toner remaining on the photosensitive member after the transferring.

Referring to Figure 5, the electrostatic copying process is briefly described below. The photosensitive member (i.e., the electrostatic latent image-bearing member) 2 which is in the form of a photosensitive drum to be driven in the direction of arrow B first undergoes the action of corona discharge device 20, and a static charge is applied to the surface of photosensitive member 2 (the charging step). Then, the image of an original (not shown) is projected onto the surface of the photosensitive member 2 by an optical system 22 in an original image exposing zone located downstream of the corona discharge device in the rotating direction of photosensitive member 2 (the step of exposing an original image). Consequently, an electrostatic latent image corresponding to the original image is formed on the surface of photosensitive member 2 (the electrostatic latent image-forming step. Then, by a developing device 6 desirably of the type shown in Figure 2, a fine powdery developer (toner) is applied to the electrostatic latent image on the surface of photosensitive member 2 to develop the latent image into a toner image (the developing step). Then, the toner image on photosensitive member 2 is transferred in transferring zone 24 to a receptor sheet fed from a receptor sheet supplying section composed, for example, of paper supply cartridge 26. The receptor sheet having the toner image transferred to its surface is set to fixing device 28 constructed, for example, of a pair of press rollers, and the toner image is fixed to the receptor sheet under pressure, after which the sheet is discharged onto receiving tray 30 (the fixing step). In the meantime, the photosensitive member, after the toner image formed on it has been transferred to the receptor sheet, is irradiated with electrostatic eliminating lamp 32, whereby the residual charge on the photosensitive member is removed (the charge eliminating step). The toner remaining on the photosensitive member is removed (the cleaning step).

Toner image transferring step

The toner image transferring step in the electrostatic copying process summarized above is conveniently carried out generally by bringing the surface of photosensitive member 2 into close contact with the surface of the receptor sheet in transferring zone 24, and applying a discharge current to the receptor sheet from its back using corona discharge device 36 for transfer.

The toner image transfer method described, however, has the defect that some distortion occurs in the toner image transferred onto the receptor sheet. The present inventors extensively studied the distortion of the toner image, and obtained the following information. In the conventional method for toner image transfer, the receptor sheet to be fed into the transfer zone first passes between shield side plates of corona discharge device 36, and is then brought into close contact with the surface of photosensitive member 2.

Accordingly, before the surface of photosensitive member 2 comes into close contact with the surface of the receptor sheet, both surfaces are influenced by the discharge current of discharge device 36. As a result, the toner on the surface of photosensitive member 2 or on the surface of the receptor sheet undergoes vibration between the two surfaces and is thus scattered. Scattering of the toner, in turn, causes the distortion of the toner image transferred to the receptor sheet.

On the basis of this information, the present inventors have found that the distortion of the toner image on the receptor sheet can be effectively prevented by bringing the surface of photosensitive member 2 into close contact with the surface of the receptor sheet as soon as, or before, the receptor sheet passes between the shield side plates of corona discharge device 36 (that is to say, before the receptor sheet enters a zone where it is influenced by the discharge current), and thereby physically preventing the vibration and scattering of the toner particles.

The close contact of the surface of photosensitive member 2 with the surface of the receptor sheet before the passing of the receptor sheet between the shield side plates of corona discharge device 36 can be achieved, for example, by positioning the ends of the shield side plates (especially the one which is more upstream in the moving direction of the receptor sheet) of corona discharge device 35 in proximity to the surface of photosensitive member 2, and properly disposing, with respect to corona discharge device 36, that part of the receptor sheet conveying path which is situated upstream of corona discharge device 36 in the moving direction of the receptor sheet (the path is formed by receptor sheet guide plate 38, etc. although this is not shown in detail in the drawings), as shown in Figure 5.

Fixing step

The receptor sheet closely containing the surface of photosensitive member 2 in the transfer step is separated from the surface of photosensitive member 2 by such a means as peeling nail 40 at a point downstream of transfer station 24. It is then conveyed to receiving tray 30 through fixing device 28.

In the step of conveying the receptor sheet from transfer station 24 to receiving tray 30, the receptor sheet collects static charge at the time of transferring or fixing the toner image by fixing device 28. The electrostatic charge may cause the receptor sheet to turn upward from the surface of guide plate 42 in the transfer path from transfer station 24 to fixing device 28, and thus paper jamming occurs. Or the electrostatic charge causes the receptor sheet to turn upward at the time of discharge into receiving tray 30, and the receptor sheet cannot be properly discharged onto receiving tray 30.

The present inventors have found that if electrostatic eliminator 44 is provided above receptor sheet guide plate 42 in the receptor sheet conveying path between transfer station 24 and fixing device 28, the action of eliminator 44 urges the receptor sheet against the surface of guide plate 42. Thus, the receptor sheet is conveyed in good condition without paper jamming and other troubles. If electrostatic eliminator 46 is provided above the end of the receptor sheet conveying path (i.e., above the inside end of receiving tray 30), the action of eliminator 46 urges the receptor sheet downward, and thus prevents it from turning upward at the time of discharging onto receiving tray 30.

Electrostatic eliminators 44 and 46 may conveniently be "sparkless electrostatic eliminators" which are obtained by processing an electrically conductive cloth or resin plate, a cloth having fine electrically conductive fibers or fine metal wires interwoven or a film having a conductive fine powder dispersed in the resin into a saw teeth form so as to permit a corona discharge between the sharp edges of the saw teeth and a charged body.

Cleaning step

After the transferring of the toner image formed on the surface of photosensitive member 2 to the surface of the receptor sheet in transfer station 24, the toner remaining on the surface of photosensitive member 2 can be removed by various methods, for example, by lightly rubbing the surface of photosensitive drum 2 with a rotary fur brush. Preferably, cleaning can be performed by contacting a hollow cylindrical or endless belt-like, developer-holding member having a toner magnetically held to its surface by the action of a stationary permanent magnet disposed in its inside, with the surface of photosensitive member 2 through the developer layer on the developer-holding member while providing the largest possible difference in speed between them (therefore, it is preferred to move the surface of the developer-holding member in a direction opposite to the moving direction of the surface of photosensitive member 2).

Referring to Figure 7, cleaning device 34 which performs the cleaning method described above includes developer-holding member 50 preferably of a hollow cylindrical form, and stationary permanent magnet 52 disposed within it. Preferably, developer-holding member 50 and magnet 52 are equivalent to developer-holding member 8 and magnet 10 used in developing device 6 described hereinabove with reference to Figure 2. The developer-holding member 50 magnetically holding toner 12 (same as the toner used for development) on its surface by the action of magnet 52 is rotated in the direction of arrow D (in the clockwise direction in Figure 7) so that its surface moves in a direction opposite to the moving direction of the surface of photosensitive member 2. Thus, the surface of developer-holding member 50 is continuously contacted with the surface of photosensitive member 2 through developer layer 12. Brush length-adjusting member 56 secured to frame member 54 is provided at a position downstream by a fixed distance from position Q (at which the surface of developer-holding member 50 is closest to the surface of photosensitive member 2) in the rotating direction of member 50. The end of brush length-adjusting member 56 is close to the surface of developer-holding member 50, and serves to remove the excess of the developer from developer-holding member 50 and adjust the length of the developer brush on developer-holding member 50 to the desired value. Frame member 54 has receptacle 58 removably secured to it. Receptacle 58 is positioned beneath brush length-adjusting member 56 and is adapted to receive the developer which has been removed from the surface of developer-holding member 50 by the action of brush length-adjusting member 56 and fallen downward.

In cleaning device 34, the surface of developer-holding member 50 is moved in a direction opposite to the moving direction of the surface of photosensitive member 2. Hence, developer layer 12 magnetically held on the surface of developer-holding member 50 slides over the surface of photosensitive member 2 at a fairly high relative speed. The mechanical brushing action of the developer thus causes the remaining toner on the surface of photosensitive member 2 to be removed from it, and the toner is magnetically attracted to the surface of the developer-holding member. This action is more effective as the magnetic action of magnet 52 is larger and the rotating speed of developer-holding member 50 is higher (i.e., the relative speed of the surface of member 50 and member 2 is larger). The developer layer on developer-holding member 50 which has become excessive as a result of the adhesion of the developer removed from the surface of photosensitive member 2 undergoes the action of brush length-adjusting member 56. As a result, the excess of the developer (the amount of the developer which corresponds to the amount of the developer removed from the surface of photosensitive member 2) is removed from developer-holding member 50, and let fall into receptacle 58.

In the cleaning method using cleaning device 34 described above, it is important to avoid the formation of a deposit of the developer in area 60 which is upstream of position Q at which the surface of photosensitive member 2 is closest to the surface of developer-holding member 50 in the moving direction of the surface of photosensitive member 2. The deposit of the developer is formed by the developer which has been carried to area 60 by developer-holding member 50. If the deposit of the developer is formed in area 60, the surface of photosensitive member 2 which has been mechanically brushed at position Q then makes contact with the deposit of the developer not sufficiently held to the surface of developer-holding member 50. As a result, the developer would again adhere to the surface of photosensitive member 2.

To avoid the formation of the deposit of the developer in area 60, it is important to dispose magnet 52 so that one of the poles of magnet 52 which is closest to position Q is positioned downstream of the rotating direction of the developer-holding member 50 by certain angle γ which is preferably not more than 15° with respect to position Q.

It is also very important to properly adjust distance d_4 between the surface of developer-holding member 50 and the surface of photosensitive member 2 at position Q where the two surfaces are the closest to each other, and distance d_5 between the end of brush length-adjusting member 56 and the surface of developer-holding member 50. Distance d_4 can be set within the range of 1.2 to 0.5 mm, and distance d_5 within the range of 0.6 to 0.25 mm, in such a manner that the deposit of the developer will not form.

Cleaning can be performed fairly well even if the rotating direction of developer-holding member 50 is the same as the moving direction of photosensitive member 2. In this case, the relation between d_4 and d_5 is quite the same as that between d_2 and d_1 described hereinabove.

Decreasing of the amount of the developer to be removed

It is known that in the conventional electrostatic copying apparatus for performing the electrostatic copying process described hereinabove with reference to Figure 5, the amount of the developer to be removed from the surface of photosensitive member 2 by cleaning device 34 and received by receptacle 58 is fairly large. The reason for this has been investigated. It has been consequently found that the amount of toner particles which remain on the surface of photosensitive member 2 after the transfer is relatively small and can be neglected if the toner image transferring step is carried out with a good transfer efficiency; and that the amount of toner particles which are carried to the cleaning device as adhering to the surface of photosensitive member 2 is considerably large, and a considerable portion of the developer particles removed from the surface of photosensitive member 2 into receptacle 58 by cleaning device 34 is the latter-mentioned toner.

In the conventional electrostatic copying apparatus, corona discharge device 20 for charging and the original illuminating lamp (not shown) of optical system 22 are adapted to be de-energized as soon as an electrostatic latent image is formed on the surface of photosensitive member 2 by the charging step and image-exposing step. Hence, a part of the surface of photosensitive member 2 which is positioned between the shield side plates of corona discharge device 20 upon the completion of the electrostatic latent image-forming step is already charged, and, without being exposed to the light from the lamp of optical system 22, proceeds to a position where it undergoes the action of developing device 6 by the rotation of photosensitive member 2. Hence, a fairly large amount of the developer adheres to that part of the surface of photosensitive member 2 which has been described above (the developer adheres to cover the entire surface black). The above-mentioned part of the surface of photosensitive member 2 does not form an image corresponding to an original image. Usually, without being contacted closely with the receptor sheet at transfer station 24, this part advances past transferring station 24, the position where it undergoes the action of electrostatic eliminating lamp 32 to a position where it undergoes the action of cleaning device 34. Accordingly, a considerably large amount of the developer adhering to the above-mentioned part of the surface of photosensitive member 2 by the action of developer device 6 is carried directly to a position where it undergoes the action of cleaning device 34. This developer is removed from the surface of photosensitive member 2 by the action of cleaning device 34, and constitutes a major proportion of the developer received in receptacle 58.

The conventional electrostatic copying apparatus, therefore, has the disadvantage that a considerable amount of the developer unwanted by developing device 6 is wasted, and the irradiating light from electrostatic eliminating lamp 32 is shielded by the developer adhering the surface of photosensitive member 2 in the state of solid black and the eliminating effect by electrostatic eliminating lamp 32 is insufficient.

This disadvantage can be overcome to a considerable extent by de-energizing only the corona discharge device 20 upon the completion of the electrostatic latent image-forming step, and de-energizing the original-projecting lamp of optical system 22 with a predetermined time lag (substantially equal to, or longer than, the time required until that part of photosensitive member 2, which is situated between the shield side plates of discharge device 20 when corona discharge device 20 is de-energized, passes the original image projecting zone by the rotation of photosensitive member 2). By so doing, that part of photosensitive member 2, which has been charged when corona discharge device 20 is de-energized, receives light from the original-illuminating lamp which is reflected by the white back surface of an original press member (not shown), the original, etc. in the original image projecting zone, and thereby a considerable amount of the electrostatic charge applied to the above-mentioned part of photosensitive member 2 is removed.

As stated above, the light from the original-illuminating lamp is projected on the surface of photosensitive member 2 after it has been reflected by the back surface of the original press member or by the original. Especially when the light is reflected by an original including an image area, the static charge applied to the above-mentioned part of photosensitive member 2 cannot be completely eliminated. To eliminate the electrostatic charge exactly and completely, an additional static eliminating lamp (now shown) capable of lighting the surface of photosensitive member 2 directly or through a reflecting mirror is provided between corona discharge device 20 and developing device 6, and for a time period which corresponds to the above-mentioned time lag, this additional eliminating lamp is energized upon the completion of the electrostatic latent image-forming step (that is, when corona discharge device 20 and original-illuminating lamp of optical system 22 have been de-energized). The above-mentioned problem can therefore be completely solved by this contrivance. If the toner image transferring step is carried out with a good transferring efficiency (for example, at least 85%, especially at least 90%) in the apparatus of this construction, the amount of the developer which remains on the surface of photosensitive member 2 after transfer of the toner image is very small, and therefore, cleaning device 34 can be omitted.

Electrostatic copying apparatus

The following description concerns a preferred embodiment of the electrostatic copying apparatus in accordance with this invention for carrying out the electrostatic copying process described above with reference to Figure 5 which comprises applying an electrostatic charge to the surface of photosensitive member 2 having a photoconductive layer by corona discharge device 20 (the charging step), then projecting the image of an original on the surface of photosensitive member 2 by an optical system (the original image exposing step), thus forming an electrostatic latent image corresponding to the original image on the surface of photosensitive member 2, then applying a fine powdery developer (toner) to the electrostatic latent image on the surface of photosensitive member 2 by developing device 6 to develop the latent image into a toner image (the electrostatic latent image developing step), transferring the resulting toner image to the surface of a receptor sheet (the toner image transferring step), and fixing the toner image on the receptor sheet (the fixing step).

General construction

The general construction of the electrostatic copying apparatus is described with reference to Figures 8 and 9.

The electrostatic copying apparatus has a substantially rectangular parallelpipedal housing shown generally at 100. On the top surface of housing 100 are provided transparent plate 102 on which to place an original to be copied, flexible, original-holding plate 104 for covering the original placed on transparent plate 102, and control panel 106 having control switches and other components to be described.

Rotary drum 108 having photosensitive member 2 mounted on its surface is disposed at the center of the lower half portion of housing 100. Around drum 108 to be rotated in the direction of arrow B are arranged along the moving direction of the surface of rotary drum 108 a corona discharge device 20 for charging, developing device 6, corona discharge device 36 for transfer, electrostatic eliminating lamp 32, and cleaning device 34 in this order. Optical system 22 for projecting the image of an original placed on transparent plate 102 onto the surface of rotary drum 108 in an exposing station between corona discharge device 20 for charging and developing device 6 is disposed above rotary drum 108 and within the upper half portion of housing 100. Below the rotary drum and within the lower part of housing 100 is provided conveyor system 112 for conveying a receptor sheet from paper-supplying cassette 110a or 110b mounted on one side portion of housing 100 (on the right-hand side in Figures 8 and 9) to receiving tray 30 mounted on the other side portion (on the left-hand side in Figures 8 and 9) of housing 100 through a transfer station having corona discharge device 36 disposed in it. Fixing device 28 composed of a pair of cooperating press rollers 114a and 114b is provided in a space in receptor sheet conveying system 112 which is between the transfer station and receiving tray 30.

The constituent elements of the apparatus are described in more detail below.

Partitioning of the housing, and a cooling system

Within housing 100 are disposed front vertical base plate 101 extending from its one side to the other side and rear vertical base plate 103 (see Figure 11). Between two base plates 101 and 103 is fixed partitioning plate 116 which extends from one side of housing 100 to the other and partitions the space between two base plates 101 and 103 into an upper portion including optical system 22 and a lower portion including rotary drum 108, the various devices provided around rotary drum 108 and receptor sheet conveyor system 112. As will be described hereinbelow, partitioning plate 116 has opening 118 through which to pass the light to be projected on the surface of rotary drum 108 by the optical system 23. At a position on partitioning plate 116 which is apart from opening 118 to the left in Figure 9 by a fixed distance, the lower end of vertical transparent plate 120 through which the above light can pass is connected. Preferably, vertical transparent plate 120 is formed in the same thickness and of the same material as transparent plate 102. If vertical transparent plate 120 does not have the same refractive index as transparent plate 102, the image projected on the surface of rotary drum 108 would be out of focus. The upper end of vertical transparent plate 120 is connected to a partitioning plate extending to the right side portion of housing 100. Partitioning plate 122 has opening 124 at its right-hand side portion extending substantially horizontally. Furthermore, partitioning plate 126 for blocking the communication of opening 118 in partitioning plate 116 with opening 124 in partitioning plate 122 is removably secured between partitioning plates 116 and 122.

It will be appreciated therefore that the space between front vertical base plate 101 and rear vertical base plate 103 is partitioned into an upper half and a lower half by partitioning plate 116, and the upper half and lower half portions are each sealed by the cooperation of partitioning plates 116, 122 and 126 and vertical transparent plate 120 so that they do not communicate with each other.

The upper half portion of the space between front vertical base plate 101 and rear vertical base plate 103 includes optical system 22, and suction blower 130 which constitutes a cooling system for cooling original-illuminating lamp 128 of optical system 22. As will be described hereinbelow, this lamp 128 is adapted to be reciprocated substantially horizontally within housing 100. Suction blower 130 provided near the left end of the upper half portion sucks the air through suction opening 132 formed on the left side wall of housing 100, as shown by arrows. The air flow sucked by suction blower 130 is let out from opening 136 formed in partitioning plate 134, then proceeds toward the right of the upper half portion, passes through opening 124 of partitioning plate 122, further passes through discharge opening 138 formed on the right-hand side wall of housing 100, and is thus discharged from housing 100. This air flow effectively cools original-illuminating lamp 128.

Generally, original-illuminating lamp 128 of optical system 22 attains a considerably high temperature in operation, it is necessary therefore to suck the air from outside the housing 100, direct the air flow to original-illuminating lamp 128 to cool it, and then discharge the air flow out of housing 100. On the other hand, photo-sensitive member 2 having a photoconductive layer mounted on the surface of rotary drum 108 is sensitive to heat. If, therefore, the air flow which has attained a high temperature as a result of cooling original-illuminating lamp 128 contacts the surface of rotary drum 108, photosensitive member 2 is likely to be deteriorated. Furthermore, if the air flow for cooling original-illuminating lamp 128 acts on developing device 6 and cleaning device 34 provided around rotary drum 108, the fine powdery developer will be scattered by the action of the cooling air flow. It is likely therefore that the apparatus will be soiled or the resulting toner image will be distorted.

In the preferred embodiment of the electrostatic copying apparatus of this invention described hereinabove, the upper half portion of housing 100 in which optical system 22 and suction blower 130 are provided is non-communicatively partitioned by the cooperation of partitioning plates 116, 122 and 126 and vertical transparent plate 120 from the lower half portion of housing 100 in which rotary drum 108 and developing device 6 and other components around rotary drum 108 are provided. Accordingly, the air flow which is sucked by suction blower 130 through suction opening 132 and discharged from discharge opening 138 to cool original-illuminating lamp 128 does not flow into the lower half portion. Consequently, there is no likelihood of the deterioration of photosensitive member 2 by the hot air flow, or of the soiling of the apparatus and the distortion of the toner image by the scattering of the toner particles.

In the preferred embodiment of the electrostatic copying apparatus of this invention, partitioning plate 122 is provided which has a portion extending from the upper edge of discharge opening 138 formed on the right-hand side wall of housing 100 substantially horizontally to the inside of housing 100 by a fixed distance. Partitioning plate 122 has opening 124 for the air flow. Accordingly, the air flow for cooling is well discharged through opening 124 and discharge opening 138, but the light from illuminating lamp 128 is mostly shielded by the part of partitioning plate 122 and the right-hand wall of housing 100 which are at right angles to each other. Hence, the light from lamp 128 does not leak from housing 100, and therefore, is not likely to affect the eyes of the operator. To prevent light leakage from lamp 128 completely, a plurality of shielding plates (not shown) inclined at a fixed angle may be provided at intervals at opening 124 and/or discharge opening 138.

Partitioning plates 116, 122, etc. also have an effect of reinforcing housing 100 and increasing its rigidity.

In the embodiment shown in the drawings, vertical transparent plate 120 is provided at a position spaced to the left from opening 118 of partitioning plate 116 by a fixed distance. Alternatively, transparent plate 120 may be provided directly at opening 118 of partitioning plate 116. In this case, the upper half portion of housing 100 including optical system 22 and suction blower 130 is non-communicatively separated from the lower half portion including rotary drum 108 and developing device 6 and other component parts around the drum only by means of partitioning plate 116 and transparent plate 120 provided at opening 118. If desired, therefore, auxiliary partitioning plate 122 can be omitted. If, however, the provision of auxiliary partitioning plate 122 is omitted, a considerable amount of the light from lamp 128 of optical system 22 leaks from housing 100 through discharge opening 138. Furthermore, it is likely that the light from outside housing 100 will fall upon in-mirror lens 144 to cause optical noises to optical system 22. Accordingly, when auxiliary partitioning plate 122 is to be omitted, it is desirable to provide a plurality of light shielding plates inclined at a fixed angle at intervals in discharge opening 138.

Instead of providing transparent plate 120 at opening 118 of partitioning plate 116, one or a plurality of air jet nozzles may be provided near opening 118 so that the upper portion of housing 100 is non-communicatively separated from its lower portion at opening 118 by the action of an air flow which flows somewhat upwardly into opening 118 from the tips of the air jet nozzles (by the so-called air curtain action). The pressure of the air flow from the air nozzle needs to be equal to, or somewhat higher than, the pressure of the cooling air stream which would flow from the upper portion to the lower portion of housing 100 through opening 118 in the absence of such air flow from the air nozzles. When such an air nozzle is provided and transparent plate 120 having the same refractive index as transparent plate 102 on which to place an original is absent in the light path extending from in-mirror lens 144 of optical system 22 (optical system 22 will be described in detail hereinbelow) to the surface of rotary drum 108, this light path must be adjusted to include the light path that would be increased by the refractive index of transparent plate 102. If further desired, instead of providing an air curtain as described above, the flowing of the air stream from the upper portion to the lower portion of the housing can be blocked by providing a suitable sucking means in the lower portion of housing 100 to maintain the air pressure in the lower portion somewhat higher than the air pressure of the upper portion of the housing.

Optical system

Now, referring to Figures 9 to 11, the optical system is described in detail.

Optical system 22 includes original-illuminating lamp 128, first reflecting mirror 140, second reflecting mirror 142, in-mirror lens 144, and third reflecting mirror 146. Illuminating lamp 128 and first reflecting mirror 140 are secured to first support frame 150 slidably mounted on a pair of suspending rods 148a and 148b which extend substantially horizontally in the upper half portion of the space between front vertical base plate 101 and rear vertical base plate 103. Second reflecting mirror 142 is secured to second support frame 152 mounted slidably on suspending rods 148a and 148b. In-mirror lens 144 is secured at a fixed position between partitioning plates 116 and 134. Third reflecting mirror 146 is secured to a predetermined position between partitioning plates 116 and 122.

First support frame 150 to which lamp 128 and first reflecting mirror 140 are secured is reciprocable between the position shown by the solid line in Figure 9 and the position shown by the two-dot chain line in Figure 9, and second support frame 152 to which second reflecting mirror 142 is secured is reciprocable at a speed half of the speed of first support frame 150 between the position shown by the solid line and the position shown by two-dot chain line shown in Figure 9.

By particular reference to Figure 10, a drive mechanism for driving first support frame 150 and second support frame 152 in this manner will be described. In rear vertical base plate 103 (see Figure 11) provided in housing 100, pulley 156 to be driven by a motor via a drive system to be described, and first follow-up pulley 158 and second follow-up pulley 160 are rotatably provided. Third follow-up pulley 162 is rotatably provided in second support frame 152. First wire 164 and second wire 166 are wrapped around these pulleys in the following manner. First wire 164 which is fixed to rear vertical base plate 103 and extends from one end 164a is first wrapped about first follow-up pulley 158, then about pulley 156 and further about second follow-up pulley 160, and other end 164b is fixed to first support frame 150. Second wire 166 fixed to rear vertical base plate 103 and extending from one end 166a is wrapped about third follow-up pulley 162, and other end 166b is fixed to first support frame 150.

Thus, when pulley 156 is rotated in the direction of arrow E at a fixed speed, first support frame 150 is moved in the direction of arrow E at the peripheral speed of pulley 156. Second support frame 152 is moved in the direction of arrow E at a speed one half of the above peripheral speed by the principle of tackle. When pulley 156 is rotated in the direction of arrow F at a fixed speed, first support frame 150 is moved in the direction of arrow A at the same peripheral speed as pulley 156, and second support frame 152 is moved in the direction of arrow F at a speed half of the peripheral speed of pulley 156 in accordance with the principle of tackle.

Optical system 22 successively scans the image of the original placed on transparent plate 102 and projects it onto the surface of drum 108 while first support frame 150 moves from the position shown by the solid line to the position shown by the two-dot chain line at the same moving speed as the moving speed of the periphery of rotary drum 108 and second support frame 152 moves from the position shown by the solid line to the position shown by the two-dot chain line at a speed half of the moving speed of the periphery of rotary drum 108. First support frame 150 and second support frame 152 may be constructed such that in case of need, they can be returned at faster speeds than their moving speeds mentioned above from the position shown by the two-dot chain line to the position shown by the solid line.

The path of the reflecting light of the original illuminated by lamp 128 secured to first support frame 150 is briefly described. The reflecting light from the original first passes through transparent plate 102 and reaches first reflecting mirror 140. It is reflected by first reflecting mirror 140, and reaches second reflecting mirror 142 where it is further reflected. The reflected light is then reflected onto the mirror within in-mirror lens 144, passes through vertical transparent plate 120, and reaches third reflecting mirror 146. It is reflected by third reflecting mirror 146, and reaches the surface of rotary drum 108. When the original is scanned by lamp 128, first reflecting mirror 140 and second reflecting mirror 142 while first support frame 150 and second support frame 152 move, lamp 128 and first reflecting mirror 140 move at the same speed as the peripheral speed of rotary drum 108, whereas second reflecting mirror 142 moves at a speed half of this speed. Accordingly, throughout the entire step of scanning the original, the optical length from the original to in-mirror lens 144, and the optical length from in-mirror lens 144 to the surface of rotary drum 108 are always maintained substantially constant. If vertical transparent plate 120 is made in the same thickness and of the same material as transparent plate 102 on which to place the original, the influence (i.e., the refractive index) of transparent plate 102 on the light path extending from the original to the lens of in-mirror lens 144 becomes equal to the influence (i.e., the refractive index) of vertical transparent plate 120 on the light path extending from the lens of in-mirror lens 144 to the surface of rotary drum 108. Accordingly, the individual elements of optical system 22 can be positioned without consideration of the effects of transparent plate 102 and vertical transparent plate 120 on the light paths.

In optical system 22 in which first reflecting mirror 140 and second reflecting mirror 142 move at different speeds along a pair of suspending rods 148a and 148b, the distance between the reflecting mirrors changes according to the position of first support frame 150 to which first reflecting mirror 140 is fixed and second support frame 152 to which second reflecting mirror 142 is secured. Accordingly, at the time of fixing both ends of each of first wire 164 and second wire 166 at fixed positions or at the time of exchanging the used wires 164 and 166, it is considerably difficult to position first support frame 150 and second support frame 152 in a fixed relation on suspending rods 148a and 148b so that the optical length from the original to in-mirror lens 144 is equal to the optical length from in-mirror lens 144 to the surface of rotary drum 108.

However, according to the optical system 22 in the preferred embodiment of the electrostatic copying apparatus of this invention, first support frame 150 and second support frame 152 mounted slidably on suspending rods 148a and 148b can be positioned in a fixed relation very easily and rapidly, and the two ends of first wire 164 and/or second wire 166 can be fixed at predetermined positions.

In optical system 22 in accordance with the preferred embodiment of the electrostatic copying apparatus of this invention, a part of first support frame 150, for example block portion 150a having a hole through which rod 148b extends, and a part of second support frame 152, for example block portion 152a having a hole through which rod 148b extends, are formed in a predetermined dimension. These block portions 150a and 152a cooperate with a suitable stopping member, for example support bracket 168 (see Figures 8 and 11) secured to the right-hand end portion of rear vertical baseplate 103 and supporting the right-hand end portion of suspending rod 148b, thereby to form a positioning means for first support frame 150 and second support frame 152. Specifically, optical system 22 shown in the drawings is constructed such that first support frame 150 and second support frame 152 can be suitably positioned in a fixed relation by contacting the right-hand end of block portion 152a of second support frame 152 with the left-hand end of support bracket 168 and contacting the right-hand end of block portion 150a of first support frame 150 with the left end of block portion 152a of second support frame 152. Accordingly, in assembling the apparatus, block portion 150a of first support frame 150, block portion 152a of second support frame 152 and support bracket 168 are contacted with each other as described hereinabove, and both ends of first wire 164 and/or second wire 166 are fixed to predetermined positions of rear vertical base plate 103 and first support frame 150. Thus, first support frame 150 and second support frame 152 are held so that they can move in a fixed relation to each other. Then, first support frame 150 and second support frame 152 can be moved to the starting position of scanning shown, for example, by the solid line in Figure 9.

According to the preferred embodiment of the electrostatic copying apparatus in accordance with this invention, optical system 22 is constructed such that the positioning of in-mirror lens 144, namely focus adjustment, can be performed more easily than in conventional optical systems.

According to the prior techniques, the positioning of in-mirror lens 144 is performed by first observing an image projected on the surface of rotary drum 108 to determine whether the image of the original placed on transparent plate 102 has been formed correctly on the surface of rotary drum 108, and then meticulously adjusting the position of in-mirror lens 144 according to the result of observation. It is relatively difficult however to observe the surface of rotary drum 108 while meticulously adjusting the position of in-mirror lens 144, because rotary drum 108 is disposed substantially centrally in housing 100 and the various devices provided around the drum will block vision beyond the surface of rotary drum 108.

In optical system 22 in accordance with the preferred embodiment of the electrostatic copying apparatus of this invention, a semi-transparent image-focusing plate (member 170 shown by the two-dot chain line in Figure 9) made, for example, of ground glass can be temporarily fixed at a position spaced from the surface of third reflecting mirror by a length same as the optical length extending from the surface of third reflecting mirror 146 to rotary drum 108.

In this optical system 22, in-mirror lens 144 can be positioned relatively easily by temporarily fixing image focusing plate 170 before the right-hand side wall of housing 100, partitioning plate 126 and third reflecting mirror 146 are mounted. By so doing, the image of the original placed on transparent plate 102 is projected onto image focusing plate 170. Since image-focusing plate 170 is positioned near the right-hand side wall of housing 100 (the wall is not mounted when positioning in-mirror lens 144) and is made of a semi-transparent material such as ground glass, the image of the original projected on the focal plane of image focusing plate 170 can be observed easily from outside the right-hand side wall of housing 100 (in Figure 9). Accordingly, the position of in-mirror lens 144 can be easily adjusted meticulously while observing the image of the original projected onto the focal plane of image focusing plate 170. Image focusing plate 170 is mounted at such a position that the optical length from the surface of third reflecting mirror 146 to be provided later to the focal plane of image focusing plate 170 is equal to the length from the surface of third reflecting mirror 146 to that portion of rotary drum 108 onto which the image of the original will be projected. Hence, if in-mirror lens 144 is fixed correctly at a position at which the image of the original is correctly formed on the focal plane of image focusing plate 170, and third reflecting mirror 146 will be later mounted, the image of the original can be correctly formed on the surface of rotary drum 108.

After in-mirror lens 144 has been positioned and fixed, image focusing plate 170 is removed, and then third reflecting mirror 146, partitioning plate 126 and the right-hand side wall of housing 100 are mounted. The space between partitioning plates 126 and 116 in which image focusing plate 170 is temporarily fixed is utilized as a space for accommodating electrical means for operating and controlling various component parts of the electrostatic copying apparatus.

Rotary drum and various devices provided around it

Referring to Figures 8, 9 and 12 to 14, rotary drum 108 and corona discharge device 20, developing device 6, corona discharge device 36, static eleminating lamp 32 and cleaning device 34 disposed around rotary drum 108 are described below in detail.

In a preferred embodiment of the electrostatic copying apparatus of this invention, a support generally shown at 172 is secured to front vertical base plate 101 and rear vertical base plate 103 centrally beneath partioning plate 116 in a manner such that it is freely slidable in the forward and rearward directions (the direction perpendicular to the sheet surface of Figure 9). To support 172 are secured rotary drum 108, corona discharge device 20 for charging, developing device 6 and cleaning device 34.

Referring to Figures 12 and 13, support 172 includes vertical front plate 174 and vertical rear plate 176 arranged substantially parallel to each other with a distance therebetween corresponding nearly to the distance between front vertical base plate 101 and rear vertical base plate 103, and a pair of horizontal members 178 and 180 which extend from both side portions of vertical front plate 174 substantially horizontally over vertical rear plate 176. Preferably, support 172 further includes cover 181 which is removably secured and covers the left portion of the top of support 172. Guide rolls 182 and 184 are mounted on the rear ends of horizontal members 178 and 180 respectively which extend beyond vertical rear plate 176. Guide rail 188 having groove 186 at its bottom surface is secured to horizontal member 178. Flat guide rail 190 is secured to horizontal member 180. Furthermore, notch 192 is provided at the upper edge of horizontal member 178 near its forward end.

Front vertical base plate 101 has opening 195 having a shape corresponding to the shape of support 172 so that support 172 can be set at a predetermined operating position through opening 195. A pair of channel-like guide rails 194 and 196 (see Figures 14, 13 and 9) are fixed to front vertical base plate 101 and rear vertical base plate 103. Guide rails 194 and 196 which extend rearward from front vertical base plate 101 over rear vertical base plate 103 receive and guide the guide rolls 182 and 184 mounted on the rear ends of horizontal members 178 and 180 of support 172. Guide roll 198 adapted to be engaged with groove 186 of guide rail 188 and guide roll 200 adapted to be engaged with the bottom surface of guide rail 190 are rotatably mounted respectively on the front vertical base plate 101 near the forward ends of guide rails 194 and 196. At the upper portion of guide rail 194 near its forward end is provided locking means 202 (see Figures 11 and 13) which cooperates with notch 192 of horizontal member 178. Locking means 202 secured to partitioning plate 116 may be of any known type, and includes an engaging member (not shown) which is elastically restrained by an elastic means such as a spring, extends downward through the openings formed in partitioning plate 116 and guide rail 194, and comes into engagement with notch 192, and operating part 204 which by hand operating, can lift the engaging member.

It will be appreciated therefore that support 172 is mounted so that it is slidable in the forward and rearward directions (the direction perpendicular to the sheet surface of Figure 9) through opening 195 formed in front vertical base plate 101. Briefly stated, support 172 is mounted slidably by engaging guide rolls 182 and 184 with guide rails 194 and 196 and guide rails 188 and 190 with guide rolls 198 and 200. When support 172 is inserted rearward and reaches the operating position (i.e., the position at which vertical front plate 174 is situated substantially on the same plane as front vertical base plate 101, and vertical rear plate 176 is situated adjacent rear vertical base plate 103), locking means 202 and notch 192 cooperate to lock support 172 releasably. To pull out the support forward and if desired, remove it from housing 100, operating part 204 of locking means 202 is operated to release the cooperation of locking means 202 and notch 192, and support 172 is caused to slide forward.

Rotary drum 108, corona discharge device 20, developing device 6 and cleaning device 34 are mounted on support 172 described above.

Referring to Figures 12 to 15, the mounting of rotary drum 108 on support 172 will be described. In each of vertical front plate 174 and vertical rear plate 176 of support 172 is formed a slot 208 extending upward from the lower edge of each of plates 174 and 176 to its central part in a somewhat inclined manner. Slot 208 is adapted to receive shaft support member 218 rotatably fitted in each end portion of shaft 206 of rotary drum 108 through a suitable means such as ball bearings. Shaft 210 is rotatably secured to vertical front plate 174 and vertical rear plate 176 of support 172, and rotary drum-holding lever 212 for supporting shaft support member 218 in place is secured to each of the forward end of shaft 210 which projects forward beyond vertical front plate 174 and the rear end of shaft 210 which projects rearward beyond vertical rear plate 176.

Rotary drum 108 can be mounted on, and removed from, support 172 in the following manner. To mount rotary drum 108 on support 172, holding lever 212 is turned clockwise by a suitable angle from the position shown in Figure 13 to position it at a point which does not interfere with slot 208. Then, rotary drum 108 is fitted into support 172 from below, and shaft supporting members 218 fitted in the end portions of shaft 206 are inserted into slots 208. Holding levers 212 are then turned to the positions shown in Figure 13, and fixed in position by such a means as screws 213. As a result, shaft supporting member 218 fitted in both end portions of shaft 206 of rotary drum 108 is supported in a substantially circular hole defined by the hook-like forward end of holding lever 212 and the semi-circular upper end of slot 208. To remove rotary drum 108 from support 172, the fixing of holding levers 212 by means such as screws 213 is released, and holding levers 212 are turned clockwise from the positions shown in Figure 13. The rotary drum 108 is moved downward along slots 208. To the rearmost end of shaft 206 of rotary drum 108 is fixed joint 217 which is adapted to be drivingly connected to joint 216 rotatably mounted on rear vertical base plate 103 (joint 216 is rotated by a motor through a drive system to be described below in detail). Joints 216 and 217 may be of any known type, and are adapted to be connected to each other when their angular positions are in agreement as prescribed. To the forward end portion of shaft 206 is fixed a grip knob 220 which the operator can grip when pulling out or removing support 172 from housing 100 or when mounting or removing rotary drum 108. Grip knob 220 (see Figure 8 also) is connected to shaft 206 via a known one-way clutch placed therein, and can rotate rotary drum 108 and its shaft 206 only when turned in a predetermined rotating direction of the rotary drum 108 (i.e., the direction shown by arrow B --- see Figure 9). Since joints 216 and 217 are connected to each other when their angular positions are in agreement as prescribed, joints 216 and 217 must be brought into agreement by rotating rotary drum 108 and shaft 206 when mounting rotary drum 108.

As will be described in detail below, developing device 6 and developer-holding member 50 of cleaning device 34 are adapted to be rotated when rotary drum 108 is rotated. If, therefore, rotary drum 108 is adapted to be rotated also in a direction opposite to the prescribed rotating direction (the direction shown by arrow B), developing device 6 and developer-holding members 8 and 50 of cleaning device 34 are rotated in a direction opposite to the predetermined rotating direction, and it is likely therefore that the developer contained in developer supplier 14 of developing device 6 will abnormally overflow from it, or build up on the surface of the rotary drum. However, since in rotary drum 108 shown in the drawings, securing of grip knob 220 to the forward end of shaft 206 is through the one-way clutch, even when by inadvertence in mounting rotary drum 108, grip knob 220 is rotated in a direction opposite to the predetermined direction, rotary drum 108 rotates only in the predetermined direction, and developing device 6 and cleaning device 34 are free from such adverse effects as described above.

Corona discharge device 20 for charging is mounted detachably on support 172 by fitting it into opening 222 formed in vertical front plate 174. Mounting and detaching of corona discharge device 20 can be very easily performed by gripping grip knob 224 provided at its front end. Member 225 which constitutes a shield case for corona discharge device 20 is fixed at a position between vertical front plate 174 and vertical rear plate 176 where corona discharge device 20 is to be provided.

Developing device 6 which is preferably of the type described in detail with reference to Figure 2 is also mounted on support 172. Developer supplier 14 in developing device 6 is fixed in place by a suitable means such as positioning pin 226 to be inserted into the front plate and the rear plate of supplier 14 through vertical front plate 174 and vertical rear plate 176 of support 172. Furthermore, as described in detail with reference to Figure 2, developer-holding member 8 in the form of a hollow cylindrical sleeve having a roll-like permanent magnet disposed in it is pivotably supported by bearing member 227 provided at each of the front and rear plates of developer supplier 14. Pin 229 fixed to bearing member 227 is received in adjusting piece 228 adjustably mounted on vertical front plate 174 and vertical rear plate 176 of support 172. Thus, the distance between the surface of rotary drum 108 and the surface of developer-holding member 8 can be meticulously adjusted. The entire developing device 6 consisting of developer-holding member 8 and developer supplier 14 as an integral unit can be detached from support 172 by merely detaching the pin 229 fitted in the bearing member 227 and the positioning pin 226. A developer supply opening positioned at the top of developer supplier 14 is situated at the left end of the top surface of support 172, and therefore, is open without being covered by cover 181 (Figure 12). A brush length-adjusting member preferably of the type described hereinabove with reference to Figure 2 is secured to developer supplier 14.

Support 172 further has cleaning device 34, preferably of the structure described in detail hereinabove with reference to Figure 7, mounted on it. The shaft for developer-holding member 50 of cleaning device 34 is rotatably supported by the adjusting piece 230, and adjusting piece 230 is adjustably mounted on vertical from plate 174 and vertical rear plate 176. Hence, by adjusting the position of adjusting piece 230, the clearance between the surface of rotary drum 108 and the surface of developer-holding member 50 can be meticulously adjusted. Furthermore, developer-holding member 50 can be detached from support 172 be merely detaching adjusting piece 230 from vertical front plate 174 and vertical rear plate 176. Developer receiver 58 of cleaning device 34 is fixed in position between vertical front plate 174 and vertical rear plate 176 of support 172 and its forward end portion is placed on frame member 54 which, together with the lower edge of vertical front plate 174, defines a receiving opening of developer-receiver 58. A brush length-adjusting member of the type described in detail hereinabove with reference to Figure 7 (not shown in Figure 13) is secured to frame member 54. Receptacle 58 which is inserted through the receiving opening defined at its front portion and placed on frame member 54 can be easily mounted or detached by grasping grip knob 232 provided at its front end.

Electrostatic eliminating lamp 32 and corona discharge device 36 for transfer are mounted directly on front vertical base plate 101 and rear vertical base plate 103 at predetermined positions around rotary drum 108. As most clearly shown in Figure 14, electrostatic eliminating lamp 32 is fixed to front vertical base plate 101 and rear vertical base plate 103 by a suitable means such as screws at a predetermined position with respect to the surface of rotary drum 108 to be mounted on support 172. Corona discharge device 36 for transfer is mounted detachably at a predetermined position with respect to the surface of rotary drum 108 to be mounted on support 172 by being fitted into notch 234 of a prescribed shape formed in front vertical base plate 101 and rear vertical base plate 103. Corona discharge device 36 can be very easily mounted and detached by grasping grip knob 236 provided at its front end.

As best shown in Figure 14, nail 40 for peeling a receptor sheet is fixed to rear vertical base plate 103 via fixing bracket 238 at a position which is adjacent corona discharge device 36 downstream of the moving direction of the surface of rotary drum 108 and is near the rear end of corona discharge device 36 for transfer. Nail 40 serves to peel a receptor sheet from the surface of rotary drum 108 having toner image so as to send the receptor sheet having the toner image to fixing device 28 through a passage defined by receptor sheet conveying roller 240 and receptor sheet guide plate 42. The receptor sheet peeled off from rotary drum 108 by the action of peeling nail 40 undergoes the action of peel roller 241 (see Figure 19) which cooperates with conveying roller 240 and fed onto guide plate 42. To peel the firmly adhering receptor sheet from the surface of rotary drum 108 exactly, it is preferred to make peeling nail 40 such that its forward end 40a is engaged with the edge of the receptor sheet projecting from the surface of rotary drum 108. This can be achieved by making the rear end of rotary drum 108 smaller in diameter than the remainder (the surface of the smaller-diameter portion is not utilized for the formation of an electrostatic latent image and a toner image), or by somewhat decreasing the width of rotary drum 108.

In the electrostatic copying apparatus of the type described hereinabove for performing the electrostatic copying process described above by reference to Figure 5, the developer contained in developer supplier 14 is consumed as the copying process is performed. Hence, the developer must be supplied occasionally to supplier 14. Furthermore, as the copying process proceeds, the developer removed from the surface of rotary drum 108 builds up in receptacle 58 of cleaning device 34. Hence, the developer in receptacle 58 must be occasionally recovered. On the other hand, as described in detail hereinabove with reference to Figure 2, in order to perform the developing step in good condition, it is important to maintan distance d_2 between the surface of developer-holding member 8 and the surface of rotary drum 108 and distance d_1 between the developer-holding member 8 and the forward end of brush lenght-adjusting member 16 secured to developer supplier 14 at suitable values. Furthermore, as already described with reference to Figure 7, to perform the cleaning step in good condition, it is important to maintain distance d_4 between the surface of developer-holding member 50 and the surface of rotary drum 108, and distance d_5 between the surface of developer-holding member 50 and the forward end of brush length-adjusting member 56 at suitable values.

In the preferred embodiment of the electrostatic copying apparatus of this invention described above, developing device 6 together with rotary drum 108 is mounted on support 172 which is mounted on front vertical base plate 101 and rear vertical base plate 103 in a manner such that it is slidable in the forward and rearward directions, and the supply opening of developer supplier 14 of developing device 6 is opened upward. Hence, supplying of the developer to developer supplier 14 can be performed by merely pulling support 172 forward and feeding the developer through the supply opening. Thus, it is not necessary to construct the apparatus such that for supplying the developer, the entire developing device 6 is caused to slide forward with respect to rotary drum 108, or developer supplier 14 to slide forward with respect to developer-holding member 8 of developing device 6. If the apparatus is constructed in this way as in conventional electrostatic copying apparatus, it is extremely difficult, if not impossible, to maintain distance d_2 exactly at a predetermined value, and distance d_2 is likely to be changed by the sliding of the entire developing device 6 or developer supplier 14 in the forward and rearward directions.

In the preferred embodiment of the electrostatic copying apparatus in accordance with this invention, cleaning device 34 is also mounted on support 172, and only the receptacle 58 of cleaning 34 is adapted to be moved forward of support 172 and pulled out. Hence, the developer that builds up in receptacle 58 can be rapidly and easily recovered without any adverse effect on distance d_4 by merely pulling out receptacle 58 forward. There is no need to construct the apparatus such that in recovering the developer, the entire cleaning device 34 may slide forward with respect to rotary drum 108, or frame member 54 having brush length-adjusting member 56 fitted thereto may slide forward with respect to developer-holding member 50 of cleaning device 34. Accordingly, distance d_4 can be maintained exactly at a predetermined value.

Furthermore, in the preferred embodiment of the electrostatic copying apparatus of this invention, as can be easily understood from Figures 9 and 14, when support 172 is pulled out by forward sliding, a transfer station having corona discharge device 36 and a receptor sheet passage nearby (the receptor sheet conveying system and the receptor sheet passage in their entirety will be described hereinbelow) are directly exposed. Thus, any receptor sheet which jams up at these portions can be easily removed.

Since corona discharge device 20 is mounted easily detachably on support 172 and corona discharge device 36, on front vertical base plate 101 and rear vertical base plate 103, they can be very easily repaireed, cleaned or replaced in the event they are damaged, cut off or soiled. Support 172 having developing device 6, cleaning device 34 and corona discharge device 20 mounted on it, when pulled out forward to a predetermined position, is blocked by a suitable blocking member to check further forward movement and thus to prevent inadvertent dropping of support 172. It is also possible to construct the apparatus such that support 172 can be completely detached from housing 100 by somewhat lifting it after it has been pulled out forward to a predetermined position. Support 172 completely detached from housing 100 in this way can be placed temporarily on an auxiliary frame (not shown) which can hold support 172 by engagement with bottom surfaces of guide rails 188 and 190.

Figure 13A shows a modified example of a support which is mounted on front vertical base plate 101 and rear vertical base plate 103 so that it is slidable in the forward and rearward directions (i.e., the direction perpendicular to the surface of the sheet surface of Figure 9) and a rotary drum, a developing device and a cleaning device which are mounted on the support.

The support shown generally at 472 in the modified example shown in Figure 13A includes vertical front plate 474 and vertical rear plate 476 which are disposed substantially parallel to each other with an interval therebetween corresponding to the distance between front vertical base plate 101 and rear vertical base plate 103, and a pair of channel-like horizontal members 478 and 480 which extend substantially horizontally from both side portions of vertical front plate 474 beyond vertical rear plate 476. Horizontal members 478 and 480 of support 472 are slidably engaged respectively with a pair of guide rails 494 and 496 which are slidably received in a pair of guide rails 493 (only one of them is shown in the drawing) extending backward from front vertical base plate 101 (not shown in Figure 13A) beyond rear vertical base plate 103. This causes support 472 to be mounted on front vertical base plate 101 and rear vertical base plate 103 so that it is slidable in the forward and rearward directions. Locking means 502 of any known type is provided in the inside upper edge portion of vertical front plate 474 of support 472. Locking means 502 is elastically and releasably engaged with part 195a of opening 195 of front vertical base plate 101 when support member 472 is inserted and reaches an operating position where vertical front plate 474 is situated substantially on the same plane as front vertical base plate 101 and vertical rear plate 476 is adjacent rear vertical base plate 103.

Rotary drum 108, corona discharge device 20 for charging, developing device 706 and cleaning device 734 are mounted on support 472.

Rotary drum 108 shown in Figure 13A is constructed such that cylindrical body 409 having a photosensitive material on its surface can be easily detached as required. Specifically, rotary drum 108 shown in Figure 13A has support shaft 406 and a pair of discs 410 and 412 rotatably mounted on support shaft 406 through bearing means 407. Discs 410 and 412 are connected to each other by a plurality (three in the drawing) of stays 414 arranged in spaced apart relationship in the circumferential direction. To disc 412 is fixed gear 344 which is to mesh with gear 354 of developing device 706 and gear 348 of cleaning device 734, as will be described in detail hereinbelow by reference to Figure 19. Cylindrical body 409 having photosensitive member 2 is fitted with discs 410 and 412 and stays 414, inserted in an annular recess formed in the inside part of the end of cylinder 409, and held in position by disc 416 fixed to disc 410 by a plurality of screws 415.

In the modified example shown in Figure 13A in which support shaft 406 is supported on bearing means 407, it is not necessary to maintain the linearity of the axis of shaft 406a severely over its entire length. In other words, the shaft is easy to make since it is sufficient to finish only that part of shaft 406 at which to locate bearing means 407 within the range of predetermined linearity.

Rotary drum 108 of the above construction is detachably mounted on support 472 by detachably fixing support shaft 406 to vertical front plate 474 and vertical rear plate 476 of support 472. In each of vertical front plate 474 and vertical rear plate 476, slot 408 extending upwardly from the lower edge of each plate to its center in a somewhat inclined manner is formed. Each slot 408 has part 408a having a width smaller than the diameter of support shaft 406 by a predetermined dimension and circular part 408b having its center somewhat deviated with respect to the longitudinal axial line of this part 408a and having substantially the same diameter as the diameter of support shaft 406. Chord-like groove 405 having a width corresponding to each of vertical front plate 474 and vertical rear plate 476 is formed at both end portions of support shaft 406. Notch 404 is formed at the forward end portion of support shaft 406 to indicate the position of groove 405. To mount rotary drum 108 on support 472, support shaft 406 is maintained in the condition shown in Figure 13A in which its grooves 405 receive vertical front plate 474 and vertical rear plate 476 of support 472 respectively, and inserted into slot 408 up to the part 408b via part 408a. Then, support shaft 406 is turned counterclockwise in Figure 13A to direct grooves 405 at both its ends downward. In the next place, stopper 413 having projecting portion 413a to be engaged with groove 405 is fixed only to vertical front plate 474 by means of screws 417 to block the rotation of support shaft 406, thereby to mount support shaft 406 and rotary drum 108 exactly at predetermined positions of support 472. Rotary drum 108 can be detached from support 472 by reversing the above procedure. When rotary drum 108 has been mounted at a predetermined position of support 472 and support 472 is inserted at a predetermined position (i.e., the position at which vertical front plate 474 is situated on substantially the same plane as front vertical base plate 101 and vertical rear plate 476 is adjacent rear vertical base plate 103), gear 344 of rotary drum 108 is drivingly connected to a drive system to be described. The driving connection of gear 344 to the drive system can be achieved, for example, by pivotably supporting a shaft (not shown) to be rotated by the drive system on rear vertical base plate 103, and fixing a gear (not shown) to be in mesh with gear 344 at the forward end portion of this shaft which extends beyond vertical rear plate 476.

In rotary drum 108 shown in Figure 13A, the cylindrical body 409 has at its both ends parts 409a and 409b having no photosensitive member 2, and small-diameter part 409c adjacent part 409a. The small-diameter part 409c is positioned corresponding to peeling nail 440 fixed to the inside surface of vertical front plate 474. Peeling nail 440 has the same function as peeling nail 440 already described hereinabove, and acts to peel off a firmly adhering transfer sheet from the surface of rotary drum 108. In the embodiment shown in

Figure 13A, peeling nail 440 is fixed to the inside surface of vertical front plate 474. Accordingly, a peeling roller (not shown in Figure 13A) which acts cooperatively with peeling nail 440 is mounted not on rear vertical base plate 103 but on front vertical base plate 101.

Corona discharge device 20 for charging, same as in the embodiment described hereinabove with reference to Figures 12 and 13, is detachably mounted on support 472 by inserting it into the opening formed in vertical front plate 474.

Developing device 706 shown in Figure 13A includes developer supplier 714, developer-holding member 708 in the form of a hollow cylindrical sleeve fixed to the front and rear plates of developer supplier 714, and a roll-like permanent magnet (not shown) rotatably mounted by a suitable bearing within developer-holding member 708. In developing device 706 shown in Figure 13A, unlike developing device 6 shown in Figure 2, developer-holding member 708 remains stationary, and the permanent magnet inside it rotates. The developer fed from developer supplier 714 onto the surface of developer-holding member 708 is moved over the surface of developer-holding member 708 by the rotation of the roll-like permanent magnet. The roll-like permanent magnet is rotated by the driving force transmitted by gear 354 fixed to a shaft (not shown) for the roll-like permanent magnet which extends through support shaft 707 integrated with developer-holding member 708.

Developing device 706 of the above construction is detachably mounted on support 472 by inserting auxiliary holding pins 715 fixed to the front and rear plates of developer supplier 714 into slots 444 formed in vertical front plate 474 and vertical rear plate 476 of support 472, inserting both end portions of support shaft 707 for developer-holding member 708 into slots 446 formed in vertical front plate 474 and vertical rear plate 476, turning the stopper 448 (made preferably of an elastic material) from the position shown by the solid line to the position shown by the one-dot chain line, putting it on a pin and fixing it there to hold support shaft 707 in slots 446. Accordingly, both developer supplier 714 and developer-holding member 708 can be removably mounted on support 472 very easily. The distance between the surface of rotary drum 108 and the surface of developer-holding member 708 is prescribed as desired by contacting a pair of rings 711 rotatably mounted on both end portions of support shaft 707 via bearing 709 and having a diameter larger than the diameter of developer-holding member 708 by a predetermined dimension, with parts 409a and 409b at both ends of rotary drum 108.

Cleaning device 734 illustrated in Figure 13A includes support frame 754, developer-holding member 750 in the form of a hollow cylindrical sleeve fixed to support frame 750, roll-like permanent magnet 749 rotatably mounted within developer-holding member 750 by a suitable bearing means (not shown), and developer receiver 758. In cleaning device 734 of this structure, substantially same as in developing device 706, developer-holding member 750 remains stationary, and magnet 749 is rotated by the driving force transmitted by gear 348 fixed to a shaft (not shown) for magnet 749 which extends through the inside of support shaft 751 integrated with developer-holding member 750.

Cleaning device 734 of the construction described above is detachably mounted on support 472 in the following manner. Auxiliary holding pins 755 fixed to the two ends of support frame 754 are inserted into slots 482 formed in vertical front plate 474 and vertical rear plate 476. A portion of support shaft 751 which is near its each end is inserted into slot 484 formed in each of vertical front plate 474 and vertical rear plate 476, and each of stoppers 486 preferably made of an elastic material is turned from the position shown by the solid line to the position shown by the one-dot chain line, put on a pin and fixed there to hold support shaft 751 within slots 484. As a result, both support frame 754 and developer-holding member 750 fixed to it are detachably mounted on support 472 very easily. The distance between the surface of rotary drum 108 and the surface of developer-holding member 750 is set as prescribed by contacting a pair of rings 752 rotatably mounted through bearings 753 on the end portions of support shaft 751 and having a diameter larger than the diameter of developer-holding member 750 by a predetermined dimension, with parts 409a and 409b at both end portions of rotary drum 108 at which no photosensitive material 2 is present. Receptacle 758 is detachably mounted on support frame 754 by bringing L-shaped flange 759 formed at its one edge portion into engagement with stay 761 fixed to support frame 754, and placing the bottom surface of receptacle 758 on a suitable support member (not shown) which projects from the inside surface of support frame 754. Hence, as required, the entire cleaning device 734 can be removed from support 472 with receptacle 758 remaining attached to support frame 754. Or receptacle 758 alone can be very easily detached from support 472 independently of support frame 754 and developer-holding member 750 fixed to it (i.e., without removing the entire cleaning device 734). This permits very rapid and easy inspection and maintenance.

Obviously, developing device and the cleaning device in the preferred embodiment of the electrostatic copying apparatus of this invention described above can be fixed to, and detached from, the support very easily.

Receptor sheet conveying system

The receptor sheet conveying system 112 is described with reference to Figures 9, 16, 17A and 17B.

Receptor sheet conveying system 112 for conveying a receptor sheet consists of a cassette receiving section for receiving a part of paper cassettes 110a or 110b, and a receptor sheet conveying system for conveying a receptor sheet stacked in cassette 110a or 110b to receiving tray 30 through a transfer station having corona discharge device 36 for transfer disposed in it and a fixing station having fixing device 28 disposed in it.

First, the cassette receiving section is described with reference to Figures 16, 17A and 17B. Paper supplying cassettes 110a and 110b differ from each other in their own sizes and in the sizes of receptor sheets stacked therein (for example, cassette 110a contains receptor sheets with a size of JIS-B5, and cassette 110b contains receptor sheets with a size of JIS-A4). Otherwise, their constructions are substantially the same, and the cassette receiving section for receiving a part of cassette 110a is substantially the same as the receiving section for receiving a part of cassette 110b. The following description, therefore, is directed mainly to paper supplying cassette 110a and the cassette receiving section for receiving it.

The paper supplying cassette 110a is composed of substantially rectangular parallelpiped-al case 242a with an open top, and case 242a includes auxiliary bottom plate 244a made of a relatively rigid material such as cardboard, metal or synthetic resin and layer 246a of receptor sheets of a predetermined size (for example B5). In Figure 16, bottom plate 244a and receptor sheet layer 246a are omitted. Fitting lever-receiving recess 248a is formed on both sides of case 242a, and opening 250a for receiving receptor sheet-lifting lever 286a is formed centrally near the forward end of the bottom plate of case 242a. Nails 252a for blocking the forward end of receptor sheet are fixed to the top end of each corner of case 242a at its forward end. Wedge-shaped notch 253a is formed in the upper edge of the forward portion of each side plate of case 242a. The operations of fitting lever-receiving recesses 248a, lifting lever-receiving opening 250a, blocking nails 252a and notches 253a will be described in detail hereinbelow.

Openings 254a and 254b are formed on the right-hand wall of housing 100 of the electrostatic copying apparatus to receive paper supplying cassettes 110a and 110b (see Figure 9). Inwardly of openings 254a and 254b are provided receiving member 256a and 256b (omitted in Figure 16) which act on the front parts of the paper supplying cassettes 110a and 110b to be inserted through these openings 254a and 254b. For convenience, one of the receiving members, 256a, is described. Receiving member 256a has a cassette bottom guiding portion 258a which extends downwardly and inclinedly from a position immediately inwardly of opening 254a toward the inside of housing 100 and guides the bottom surface of paper supplying cassette 110a inserted through opening 254a, cassette end abutting portion 260a which the forward end of paper supplying cassette 110a to be inserted through opening 254a abuts, and receptor sheet guiding portion 262a which further extends toward the inside of housing 100 from the top end of abutting portion 260a and guides the receptor sheet fed from cassette 110a to the receptor sheet conveying system, as will be described hereinbelow.

At a position above cassette bottom guiding portion 258a by a predetermined distance from it, shaft 266a to be rotated selectively in the direction of arrow E (in the clockwise direction in Figures 16, 17A and 17B) by the action of clutch MC3 which may be an electromagnetic clutch or a combination of a rotary spring clutch and an electromagnetic solenoid is mounted rotatably on front vertical base plate 101 and rear vertical base plate 103. A pair of paper feed rollers 268, for example, are secured to shaft 266a. A pair of stop plates 270a with which wedge-shaped notches 253a formed in the paper supplying cassette 110a come into engagement are fixed to front vertical base plate 101 and rear vertical base plate 103 at a position above cassette bottom guiding portion 258a.

Immediately inwardly of receiving member 256a, shaft 272a is rotatably mounted on front vertical base plate 101 and rear vertical base plate 103. A nearly fan-shaped positioning member 274a is fixed to one end (the forward end in Figure 16) of shaft 272a. Near shaft 272a is disposed a stop pin 276a fixed to front vertical base plate 101. A pull spring 278a is set between stop pin 276a and that end of positioning member 274a which is farther away from stop pin 276a. A pair of projecting sections 280a and 282a to be engaged with stop pin 276a are formed at that end of positioning member 274a which is nearer stop pin 276a, and that portion of positioning member 274a which is between two projecting sections 280a and 282a forms an arc having a predetermined radius of curvature. The stop pin 276a, positioning member 274a and pull spring 278a are constructed such that they operate as follows:

In the state shown in Figures 16 and 17A in which one projecting section 280a of positioning member 274a come into engagement with stop pin 276a, shaft 272a is urged in the clockwise direction by the elastic action of pull spring 278a, and therefore, shaft 272a is set in position by the engagement of projecting section 280a with stop pin 276a. If, as described hereinbelow, shaft 272a is turned counter-clockwise in Figures 16 and 17A in resistance to the elastic action of pull spring 278a as a result of operating the paper supplying cassette 110a, the pull spring 278a retracts from its most stretched state and urges shaft 272a counterclockwise. Accordingly, shaft 272a is turned by the elastic action of pull spring 278a to the state illustrated in Figure 17B in which other projecting section 282a of positioning member 274a comes into engagement with stop pin 276a, and set in position. In other words, stop pin 276a, positioning member 274a and pull spring 278a are constructed so as to urge shaft 272a elastically to a first angular position at which the projecting section 280a comes into engagement with stop pin 276a (the angular position shown in Figure 16 and 17A), or to a second angular position at which the projecting section 282a comes into engagement with pin 276a (the angular position shown in Figure 17B).

To shaft 272a described above are fixed a pair of cassette linking levers 284a with a distance therebetween corresponding substantially to the width of paper cassette 110a. When cassette 110a is inserted by contacting its bottom surface with cassette bottom guiding portion 258a of receiving member 256 with shaft 272a being at the first angular position described above, cassette linking levers 284a are fitted into recesses 248a of cassette 110a. Intermediate between cassette linking levers 284a, receptor sheet-lifting lever 286a is rotatably mounted on shaft 272a. Receptor sheet-lifting lever 286a can extend through opening 250a formed centrally near the forward end portion of the bottom plate of cassette 110a and a notch (not shown) formed in receiving member 256a at a position corresponding to opening 250a, and can directly act on auxiliary bottom plate 244a and receptor sheet layer 246a placed in cassette 110a. When shaft 272a is at the first angular position, lever 286a is held in the position shown in Figures 16 and 17A at which the forward end of lever 286a is retracted from opening 250a. When shaft 272a is turned to the second angular position described above, lever 286a is elastically urged counterclockwise in Figures 16, 17A and 17B (in a direction to lift auxiliary bottom plate 244a and receptor sheet layer 246a in cassette 110a) by an elastic means such as spring 288a with one end fitted to shaft 272a and the other end to lifting lever 286a.

It is believed to be already clear from the above description how the paper supplying cassette 110a is inserted into the cassette receiving section and how a receptor sheet is fed from the receptor sheet layer in cassette 110a. The mechanism is summarized below, however.

To insert cassette 110a into the receiving section through opening 254a formed on the right-hand wall of housing 100, it is first necessary to contact the bottom surface of cassette 110a with bottom guiding portion 258a of receiving member 256a and insert cassette 110a until its forward end abuts abutting portion 260a of receiving member 256a, thus attaining the state shown in Figures 16 and 17A. At this time, shaft 272a is located at the first angular position at which one of projecting sections 280a of positioning member 274a is in engagement with stop pin 276a. Thus, upon the insertion of cassette 110a as described above, cassette linking levers 284a fixed to shaft 272a are fitted into recesses 248a formed on both sides of the forward end portion of cassette 110a. The transfer sheet lifting lever 286a mounted on shaft 272a is locked at a retracted position at which its forward end is substantially on the same plane as cassette bottom guiding portion 258a of receiving member 256a.

Then, paper supplying cassette 110a is turned in a direction in which its forward end inserted in the receiving section moves upwardly. As a result, as shown in Figure 17B, notches 253a of cassette 110a come into engagement with stop plates 270a to stop the turning of paper supplying cassette 110a by pull spring 278a and to prevent its rearward movement. At the same time, with the turning of the paper supplying cassette 110a, cassette linking levers 284a are turned counter-clockwise, and shaft 272a is brought to the second position at which other projecting portion sections 282a of positioning member 274a is engaged with stop pin 276a. Thus, lifting lever 286a is unlocked, and by the action of spring 288a, is elastically urged counterclockwise, whereby is forward end projects from opening 250a of cassette 110a and elastically lifts auxiliary bottom plate 244a and receptor sheet layer 246a in the cassette 110a to urge the topmost receptor sheet elastically against paper feed roller 268a. Two corners of the forward end of the topmost receptor sheet lifted by lever 286a from layer 246a come into engagement with blocking nails 252a to check its upward movement. When in such a condition, paper feed rollers 268a are rotated in the direction of arrow E, the topmost receptor sheet urged elastically against it is delivered toward the transfer station, moved along guide portion 262a of receiving member 256a, and fed into a receptor sheet conveying system to be described.

When it is desired to take out paper supplying cassette 110a from the receiving section after all the receptor sheets in cassette 110a have been consumed, cassette 110a in the state shown in Figure 17B is turned in a direction in which its forward portion moves downward to attain the state shown in Figure 17A. Consequently, notches 253a of paper supplying cassette 110a depart from stop plates 270a, and paper supplying cassette 110a is in condition for rearward movement. At the same time, with the turning of the paper supplying cassette 110a, cassette linking levers 284a and shaft 272a are turned clockwise, and shaft 272a, is returned to the first position at which one of the projecting sections 280a of positioning member 271a comes into engagement with stop pin 276a. The foremost end of paper supplying cassette 110a moving downward causes receptor sheet-lifting lever 286a to rotate clockwise and return to its retracted position where it is locked in position. Thereafter, paper supplying cassette 110a is moved rearward, and taken out of the receiving section.

In paper supplying cassette 110a shown in the drawings, auxiliary bottom plate 244a is substantially of the same size as the receptor sheet placed on it, and only the forward end portions of auxiliary bottom plate 244a and receptor sheet layer 246a are lifted by the action of receptor sheet lifting lever 286a. Accordingly, the receptor sheet layer 246a is inclined at a certain angle. In this case, the angle of the topmost receptor sheet with respect to blocking nails 252a changes somewhat according to a change in the thickness of receptor sheet layer 246a. Hence, the action of blocking nails 252a on the receptor sheet are somewhat changed, and this may sometimes hamper the action of delivering only the topmost receptor sheet exactly. To cope with this situation, it is possible to utilize auxiliary bottom plate 244a which is located only beneath the front half of receptor sheet layer 246a and to provide a suitable guide means on the inner surface of each of the two side walls of case 242a whereby auxiliary bottom plate 244a is lifted substantially in parallel to the bottom plate of cassette 110a or 110b by the action of lifting lever 286a. According to this construction, the front half of the receptor sheet layer can be lifted substantially in parallel to the bottom plate of cassette 110a or 110b, and the angle of the topmost receptor sheet with respect to blocking nail 252a can be maintained substantially constant, and therefore, the action of blocking nail 252a on the receptor sheet can be maintained in the most suitable condition.

Now, receptor sheet conveying system 112 is will be described in detail below with reference mainly to Figure 9. Receptor sheet conveying system 112 for conveying a receptor sheet from cassette 110a or 110b to receiving tray 30 through the transfer station and fixing device 28 consists, for example, of roller pairs 290, 292, 294 and 296 each consisting of a driven roller and an idle roller, a receptor sheet guide plate between the rolls in each pair, and receptor sheet conveying roller 240 and guide plate 42 already described above with reference to Figure 14. It is of course possible, as described in detail with reference to Figure 5, to provide electrostatic eliminators 44 and 46 above guide plate 42 and/or above the inside end portion of receiving tray 30 so as to facilitate the conveying of receptor sheet. It is important to construct the receptor sheet conveying system 112 such that paper jamming which occurs at any part of receptor sheet conveying system 112 can be rapidly and easily corrected. For this purpose, upstream of conveying system 112 for example, the rollers and guide plate defining the underside of the conveying system are mounted on supporting frame 300 pivotably fixed to pin 298 so that should paper jamming occur at this part, support frame 300 will be turned clockwise with pin end 298 as a center to cope with the paper jamming rapidly and easily. Paper jamming which occurs in or near the transfer station can be adjusted easily and rapidly by sliding in the forward direction (the direction perpendicular to the sheet surface in Figure 9) support 172 having rotary drum 108, developing device 6 and cleaning device 34 mounted on it, as already described. At the most upstream part and the most downstream part of conveying system 112, paper jamming can be adjusted rapidly and easily by first removing the paper supplying cassette 110a or 110b or receiving tray 30 through the opening which has been set free by the removing of cassette 110a or 110b or receiving tray 30.

Driving system

The driving system is now described mainly with reference to Figures 18 and 19.

Referring to Figure 18, in the preferred embodiment of the electrostatic copying apparatus of this invention, optical system 22, rotary drum 108, developing device 6, cleaning device 34, fixing device 28, and receptor sheet conveying system 112 are driven by main motor DM (see Figure 9). Main driving twin sprocket 304 is fixed to the output shaft of main motor DM. Around one member of sprocket 304 are wrapped first endless chain 306 and second endless chain 308. First endless chain 306 starts at one member of sprocket 304, extends through driving sprocket 312 for driving optical system 22 for scanning [which sprocket is connected selectively to driven pulley 156 (see Figure 10) of optical system 22 by a scanning electromagnetic clutch MC1 (see Figure 20)], sprocket 316 for returning optical system 22 [which sprocket is connected selectively to driven pulley 156 of optical system 22 by return electromagnetic clutch MC2 (see Figure 20)], linking sprocket 318 equipped with a linking gear, sprocket 320 for driving rotary drum 108 (which sprocket is drivingly connected to shaft 206 of rotary drum 108 as already described with reference to Figure 15, or drivingly connected to gear 344 of rotary drum 108 via a driven shaft and a gear fixed to it as described above with reference to Figure 13A) and idle sprocket 322, and returns to the one member of sprocket 304. Second endless chain 308 starts at the other member of sprocket 304, extends through sprocket 324 fixed to one of the shafts of a pair of press rollers for driving fixing device 28, sprocket 326 fixed to one shaft of roller pair 294 for conveying a receptor sheet, idle sprocket 328 and sprocket 330 fixed to one shaft of roller pair 296 for driving receptor sheet conveying rollers, and returns to the other member of sprocket 304. Sprocket 332 equipped with a linking gear is drivingly connected to linking sprocket 318 over which first endless chain 306 is stretched, and third endless chain 334 is wrapped around sprocket 332. Third endless chain 334 starts from sprocket 332, extends through sprocket 336a selectively connected to shaft 266a of paper feed roller 268a by electromagnetic clutch CM3 (see Figure 20), sprocket 336b connected selectively to shaft 266b of paper feed roller 268b by electromagnetic clutch MC4 (see Figure 20), idle sprocket 338, sprocket 340 fixed to one shaft of roller pair 290 for driving the receptor sheet conveying rollers and sprocket 342 fixed to one shaft of roller pair 292 for driving the receptor sheet conveying roller, and returns to sprocket 332.

As clearly shown in Figure 19, gear 344 (see Figure 15 also) is fixed to rotary drum 108. This gear 344 is drivingly connected to gear 348 fixed to the shaft of developer-holding member 50 of cleaning device 34 via speed increase gear device 346, and also to gear 354 fixed to the shaft of developer-holding member 8 of developing device 6 via speed increase gear device 350 and idle gear 352. A gear (not shown) is fixed to the shaft of receptor sheet conveying roller 240 disposed immediately downstream of the transfer station, and is drivingly connected to idle sprocket 322 via an idle gear.

It will be appreciated therefore that optical system 22, rotary drum 108, developing device 6, cleaning device 34 and receptor paper sheet conveying system 112 are properly driven by main motor DM.

Control system

The control system is described with reference to Figures 8, 20 and 24.

Referring to Figure 8, control panel 106 disposed on the top surface of housing 100 has main switch SW, knob EC for adjusting the amount of exposure, alarm lamp L_1 for signalling paper jamming, lamp L_4 for paper supply, print button PB, preset counter PC for presetting the number of copies required, and receptor sheet selecting switch S_8.

Within housing 100 are disposed at the positions shown in Figure 20 switch S_1 for detecting the return of first support frame 150 having first reflecting mirror 140 mounted thereon to a predetermined position, switch S_2 for detecting the movement of first support frame 150 beyond a predetermind position, switches S_3 and S_4 which cooperatively detect paper jamming, switch S_2 for successively starting the supply of receptor sheet when many copies are made, and switches S_6 and S_7 for detecting the presence or absence of a receptor sheet in cassettes 110a and 110b.

Housing 100 also includes various electrical elements such as electromagnetic clutch MC1 for connecting sprocket 312 to pulley 156 of optical system 22, electromagnetic clutch MC2 for connecting sprocket 316 to pulley 156 of optical system 22, electromagnetic clutch MC2 for connecting sprocket 316 to pulley 156 of optical system 22, electromagnetic clutch MC3 for connecting the sprocket 336a to the shaft of paper feed roller 268a, electromagnetic clutch MC4 for connecting sprocket 336a to the shaft of paper feed roller 268a, electromagnetic clutch MC4 for connecting sprocket 336a to the shaft of paper feed roller 268a, high voltage transformer HV-1 for corona discharge device 20, high voltage transformer HV-2 for corona discharge device 36, fan motor RM for driving suction blower 130, main motor DM, original illuminating lamp 128 for illuminating an original, and electrostatic eliminator lamp 32.

The electrical elements described hereinabove with reference to Figures 8 and 20 are incorporated into the electric circuit shown in Figures 21 to 24. The details of the electric circuit itself are believed to be readily understandable from Figures 21 to 24, and a description of them is omitted.

The operation of the preferred embodiments of the electrostatic copying apparatus of this invention is described below by main reference to Figure 8 and Figures 20 to 24.

When it is desired to copy an original placed on transparent plate 102, main switch SW is turned on. Then, as required, exposure adjusting knob EC is operated to adjust variable resistance VR (Figure 21) to set the amount of light from lamp 128 at a suitable value. Furthermore, as required, receptor sheet select switch S_8 is actuated to select a suitable size (for example, B5 or A4) of receptor sheet to be conveyed through conveying system 112.

Referring to Figures 22 and 23, the selection of receptor sheet and the detection of receptor sheet are described. When for example, select switch S_8 (Figure 23) is actuated so as to select a receptor sheet (for example, of B-5 size) in cassette 110a, the pressing of print button PB will bring electromagnetic clutch MC3 for connecting the sprocket 336a to the shaft of paper feed roller 268a into the operative state, as can be understood from Figure 22. Furthermore, switch S_{8-1} shown in Figure 22 interlocks with switch S_8 whereby indicating lamp L_2 provided within the switch S_8 change-over operating member on control panel 106 is lighted to indicate the selection of receptor sheet in cassette 110a. Switch S_6 for detecting the presence or absence of receptor sheet within cassette 110a lights paper supply lamp L_4 when no receptor sheet is present, and subsequent pressing of print button PB does not actuate relay R_1 and thus does not start the copying process. The same can be said when select switch S_8 is actuated to select a receptor sheet (for example, with a size A-4) in cassette 110b.

Assuming that preset counter PC is set at 1 (in which case the terminal of preset counter PC if off), the control of the operation of each component part of the electrostatic copying apparatus is summarized as follows:

(i) When first support frame 150 does not return to a predetermined position before the start of the copying process by pressing the print button PB, switch S_1 is not pressed but is normally open. Hence, electromagnetic clutch MC2 is energized to return first support frame 150 to the predetermined position.

(ii) When print button PB is pressed, relay R_1 is operated and its contacts R_{1-1} and R_{1-2} are closed. Thus, a voltage is applied to the base of transistor Tr_2 to actuate relay SSR_2 and close its contact SSR_{2-1}. Thus, main motor DM and fan motor FM rotate and electrostatic eliminator lamp 32 is lighted. Contact R_{1-1} self-maintains relay R_1. Contact R_{1-2} actuates relay R_2 and relay RR_1 to light the original illuminating lamp 128 and to energize electromagnetic clutch MC3 (or MC4), thus starting paper supply.

(iii) When the forward end of a receptor sheet fed from paper cassette 110a (or 110b) presses switch S_3 disposed on receptor sheet conveying system 112, relay R_{3a} is actuated and its contacts R_{3a-2} and R_{3a-3} are closed. When contact R_{3a-1} is open, relay R_2 is also open and electromagnetic clutch MC3 (or MC4) is deenergized. When contact R_{3a-2} is closed, condenser C_1 is charged, and upon completion of charging, a voltage is applied to transistor Tr_1 to close relay R_{3b} and timer T_1. The time during which transistor Tr_1 is kept in operation by the charge generated in condenser C_1 is determined by the time constant of a CR circuit of condenser C_1 and variable resistance VR_2. Contact R_{3a-3} actuates high voltage transformer HV-1 for corona discharge device 20. When relay R_{3b} operates, its contact R_{3b-1} is opened, and R_{3b-1} releases the self-maintaining of R_1. Furthermore, when R_{3b-2} is closed, SSR_1 is closed to actuate high voltage transformer HV-2 for corona discharge device 36. R_{3b-3} serves to perform changeover between electromagnetic clutch MC1 and electromagnetic clutch MC2, and is connected to electromagnetic clutch MC1 when it is closed.

(iv) Timer T_1 is an on-delay timer, and after a lapse of a certain period of time that can be suitably prescribed from the time of actuation of R_{3a}, its contact T_{1-1} is closed. When T_{1-1} is closed, magnetic clutch MC1 is energized to move first support frame 150 and second support frame 152 forward (scanning movement).

Specifically, after a certain period of time preset by timer T_1 from the time when the forward end of a receptor sheet fed from cassette 110a or 110b pressed switch S_2 disposed on receptor sheet conveying system 112, first support frame 150 and second support frame 152 begin to move forward, and therefore, optical system 22 begins to scan the original placed on transparent plate 102 and to project the image of the original onto the surface of rotary drum 108. Accordingly, by properly adjusting the time to be set by timer T_1, the forward end of the image of the original projected onto the surface of rotary drum 108 can be accurately registered with the forward end of a receptor sheet fed from paper supplying cassette 110a (or 110b).

This registration can also be performed by a mechanical element provided adjustably on receptor sheet conveying system 112 and adapted to be operated by the forward end of receptor sheet. One example of such a mechanical element is shown in Figure 25. In this embodiment, instead of timer T_1 and switch S_3, detecting member 606 is provided which serves to sense the forward end of receptor sheet passing between upper guide plate 602 and lower guide plate 604 defining receptor sheet conveying system 112 between roller pair 290 and roller pair 292. This detecting member 606 at a part near its one end is rotatably supported by rear vertical base plate 103, and at a part near its other end, rotatably supported by bracket 608. Bracket 608 is mounted on upper guide plate 602 adjustably in the receptor sheet conveying direction 610 by a screw which extends through elongated slot 612 extending in the receptor sheet conveying direction 610 and is screwed to upper guide plate 602. One end 606a of detecting member 606 projects beyond rear vertical base plate 103 and contacts an actuator for microswitch 614. Other end 606b of detecting member 606 passes through opening 616 formed in upper guide plate 602, extends to receptor sheet conveying system 112 between upper guide plate 602 and lower guide plate 604, and further projects past opening 618 formed in lower guide plate 604. Detecting member 606 is rotated clockwise in Figure 25 when the forward end of receptor sheet that is conveyed through conveying system 112 comes into engagement with other end 606b, and its one end 606a actuates microswitch 614. When microswitch 614 is operated, electromagnetic clutch MC1 is energized to start the forward movement of first support frame 150 and second support frame 152. Hence, optical system 22 begins to scan the original placed on transparent plate 102 and to project the image of the original onto the surface of rotary drum 108. The forward end of the image projected onto the surface of rotary drum 108 and the forward end of the receptor sheet can be properly registered by changing the fixing position of bracket 608 to move detecting member 606 in the direction of arrow 620 with a part of detecting member 606 which is near the rear vertical base plate 103 being used as a fulcrum, and thus properly adjusting the sensing position of other end 606b of detecting member 606. Preferably, a plurality of protruding portions 622 are provided in the widthwise direction at spaced intervals on the top surface of bottom guide plate 604 so as to bring the forward end of receptor sheet into exact engagement with other end 606b of detecting member 606 and to facilitate smooth conveying of the receptor sheet.

(v) When the rear end of the receptor sheet moving on the receptor sheet conveying system 112 passes S_3, the pressing of S_3 is released to set R_{3a} off, and its contact R_{3a-1} is closed and contacts R_{3a-2} and R_{3a-3} are opened. When R_{3a-3} is off, the operation of high voltage transformer HV-1 for corona discharge device 20 is stopped. On the other hand condenser C_1 is still charged after R_{3a-2} is opened. Thus, until the charge in condenser C_1 dissipates, transistor T_{r1} operates to keep R_{3b} in operation.

(vi) When the charge is condenser C_1 is discharged to a predetermined voltage level, R_{3b} is opened, and its contact T_{3b-2} is opened. When R_{3b-2} is off, SSR_1 and RR_1 are opened to stop the operation of high voltage transformer HV-2 for corona discharge device 36 and light the lamp 128. Furthermore, the connection of R_{3b-3} is switched from the MC1 side to the MC2 side to move first support frame 150 and second support frame 152 backward (return movement).

(vii) When first support frame 150 moves backward and presses switch S_1 provided at its stopping position, switch S_1 is turned off. Accordingly, electromagnetic clutch MC2 is reset to stop first support frame 150 and second support frame 152.

(viii) When the rear end of the receptor sheet moving on conveying system 112 departs switch S_4 (Figure 24), switch S_4 is turned off and KR2-R of keep relay KR2 actuates to close KR2-1 and ground the collector of transistor Tr_3. Thus, the application of a voltage from line X is stopped and transistor Tr_3 becomes inoperative. Tr_2, however, is still in the operative state because of the charge on condenser C_2. When the charge is eliminated from condenser C_2 to a predetermined voltage level, Tr_2 becomes inoperative. As a result, relay SSR2 maintained in the closed state by contacts R_{1-1} and R_{3b-2} and transistor Tr_3 is opened to stop main motor DM and fan motor FM and turn off eliminator lamp 32. The time during which Tr_2 is maintained operative by the charge on condenser C_2 is determined by the time constant of a CR circuit of condenser C_2 and variable resistance VR_3. VR_3 is adjusted so that Tr_2 becomes inoperative when the receptor sheet after the leaving of its rear end from switch S_4 has been completely discharged onto the receiving tray.

When first support frame 150 and second support frame 152 keep moving forward even after R_{3b} is off, switch S_2 for sensing the overrunning of first support frame 150 is pressed by first support frame 150 and actuates KR_3-L of keep relay KR_3 thereby to stop the copying process.

When preset counter PC is set at more than one number of copies, its terminal is turned on and so maintained until the remaining number becomes one. When the remaining number is one, the terminal is turned off. When preset couner PC is on, the first support frame 150 presses switch S_5 during its backward movement (return movement) to turn on switch S_5 and thereby actuate relay R_2. Consequently, its contact R_{2-1} is closed to energize electromagnetic clutch MC3 (or MC4) and to start paper supply. When the forward end of receptor sheet supplied from cassette 110a or 110b presses switch S_3, relay R_{3a} is actuated and its contact R_{3a-1} is opened. Furthermore, relay R_2 is opened to deenergize the electromagnetic clutch MC3 (or MC4). Also, R_{3a-2} and R_{3a-3} are closed. When R_{3a-2} is on, charge is generated on condenser C_1 and transistor Tr_1 is actuated. R_{3b} is also closed and its contact R_{3b-2} is closed. Thus, relay RR1 is actuated to light original-illuminating lamp 128.

Sensing of paper jamming at receptor sheet conveying system 112 is described with particular reference to Figure 24.

The basic theory of sensing paper jamming is that the time tc from the sensing of the rear end of receptor sheet by switch S_3 to the sensing of the rear end of the same receptor sheet by switch S_4 and the time tt preset by on-delay timer T_2 are set in a relation tc<tt, and the operation of the apparatus is stopped and alarm lamp L_1 is lighted when paper jamming causes the relation tc>tt. When the forward end of the receptor sheet presses switch S_3, relay 3a actuates to close its contact R_{3a-4}. As a result, transistor Tr_5 becomes operative, and condenser C_3 is charged. However, KR2-L does not operate since the high voltage side of KR2-L is simultaneously off. When the rear end of the receptor sheet has passed switch S_3, the pressing of S_3 is released to open R_{3a-4} and set the high voltage side in operation. Since transistor Tr_5 is operative for a certain period of time because of the charge on condenser C_3, KR2-L operates and its contact KR2-1 is closed thereby to actuate timer T_2 (when there is an input into timer T_2, its contact T_{2-1} is closed after a preset time, and when the input is cut off before the preset time elapses, timer T_2 returns to the original state). When receptor sheet is conveyed in normal condition, switch S_4 senses the rear end of the receptor sheet before the expiration of the time preset by timer T_2 to actuate KR2-R. Accordingly, contact KR_{2-1} is opened to stop the operation of timer T_2. When KR2-R does not actuate, contact T_{2-1} of timer T_2 is closed after the preset time to actuate KR2-L and open its contact KR_{3-1}. Accordingly, the actuation of relay SSR2 stops and the operation of the apparatus stops. At the same time, alarm lamp L_1 is lighted. The keep relays KR2 and KR3 operate by one pulse and self-maintain mechanically, and even when the power supply is cut off, the self-maintaining condition remains. The self-maintaining condition may be released by applying a signal to another input terminal (reset coil). In resuming the operation of the apparatus after proper correction of paper jamming, it is necessary to operate reset switch RS which is provided for releasing the self-maintaining condition of the relays.

Attention is drawn to the claims of copending patent application No. 14655/78 (Serial No. 1589057) from which the present application has been divided and to the claims of copending patent application Nos. 7912580 (Serial No. 1589054), 7912581 (Serial No. 1589051), 7912583 (Serial No. 1589055) and 7912584 (Serial No. 1589056) also divided therefrom, these copending applications being directed to various different aspects of the disclosure of the present invention.

WHAT WE CLAIM IS:

1. An electrostatic copying apparatus comprising a housing having at its top surface a transparent plate on which to place the original to be copied, a rotary drum disposed within the housing and having a photosensitive member on its surface, a charging, a developing and a transferring means which are arranged successively around the rotary drum in the moving direction of the surface of the rotary drum, an optical system for projecting the image of the original onto the surface of the rotary drum between the charging means and the developing device, the optical system including a lamp for illuminating the original and a first reflecting mirror which are mounted on a first support frame slidably mounted on a pair of suspending rods extending substantially horizontally within the housing and adapted to be reciprocated at a predetermined speed, a second reflecting mirror mounted on a second supporting frame which is slidably mounted on the suspending rods and adapted to be reciprocated at a speed half of the reciprocating speed of the first support frame, an in-mirror lens fixed within the housing and a third reflecting mirror fixed within the housing; and a receptor sheet conveying system for conveying a receptor sheet through a transfer station defined between the surface of the rotary drum and the transferring means; wherein a semi-transparent member for forming an image is temporarily mounted at a position near the periphery of the housing, the optical length from that position to the third reflecting mirror being the same as the optical length from the surface of the rotary drum to the third reflecting mirror.

2. Apparatus according to claim 1, wherein the housing is separated substantially non-communicatively into an upper section and a lower section, and the upper section includes the optical system and a cooling system for sucking air from the outside of the housing for cooling an original illuminating lamp of the optical system and discharging the air out of the housing, and the lower section includes the rotary drum, the charging means, the developing device, the transferring means and the receptor sheet conveying system.

3. Apparatus according to claim 2, wherein the housing is separated into the upper and lower sections by a partitioning means including a transparent plate through which the reflecting light of the image of the original to be projected onto the surface of the rotary drum by the optical system passes.

4. Apparatus according to claim 3, wherein the partitioning means consists of a partitioning plate separating the housing into the upper and lower sections and having an opening through which to pass the reflecting light of the original image, a vertical transparent plate which stands erect on the partitioning plate and through which the reflecting light passes before it passes through the opening of the partitioning plate, and an

auxiliary partitioning plate which co-operates with the transparent plate and prevents the communication of the upper section of the housing with its lower section through the opening of the partitioning plate.

5. Apparatus according to claim 3, wherein the partitioning means consists of a partitioning plate which separates the housing into the upper and lower sections and has an opening through which the reflecting light passes, and a transparent plate disposed at the opening to prevent the communication of the upper section of housing with its lower section through the opening.

6. Apparatus according to any one of claims 3 to 5, wherein the transparent plate in the partitioning means is made of the same material, and in the same thickness, as the transparent plate on which to place the original.

7. Apparatus according to any one of claims 2 to 6, wherein the cooling system comprises at least one air jet nozzle for forming an air curtain which prevents the communication of the upper section of the housing with its lower section through opening of the partitioning plate.

8. Apparatus according to any preceding claim, wherein the receptor sheet conveying system includes at least one paper supplying cassette, and at least one cassette-receiving section for receiving the forward end of the cassette through an opening on the side wall of the housing, the cassette consisting of a substantially rectangular parallelepiped case with an open top for including a relatively rigid auxiliary bottom plate and a layer of receptor sheets of a predetermined size placed on the auxiliary bottom plate, a pair of recesses for receiving linking levers being formed on both sides of the forward end of the case, an opening for receiving a receptor sheet lifting lever being formed centrally near the forward end of the bottom plate of the case, and the cassette-receiving section including a receiving member comprising a cassette bottom guiding portion and a cassette forward end abutting portion, a paper feed roller disposed rotatably above the cassette bottom guiding portion and adapted to be selectively rotated, a shaft disposed rotatably adjacent and inside the cassette forward end abutting portion and biased to a first angular position or a second angular position by an elastic means, a pair of cassette linking levers fixed to the shaft at an interval therebetween and adapted to be fitted into the pair of recesses of the cassette when with the shaft at the first angular position, the cassette is contacted at its bottom with the cassette bottom guiding portion and inserted so that its forward end is brought to a position at which it contacts the cassette forward end abutting portion, and a receptor sheet lifting lever mounted on the shaft at a position between the pair of cassette linking levers, the forward end of the lifting lever being locked at a position rectracted from the opening for receiving the receptor sheet lifting lever when the shaft is at the first angular position, and being urged by an elastic means so that when the shaft is turned from the first position to the second position by rotating the inserted paper supplying cassette in a direction in which its forward end moves upward, the forward end of the lifting lever is unlocked and projects upward from the lifting lever receiving opening of the cassette, lifts the auxiliary bottom plate and the receptor sheet layer, and urges the topmost receptor sheet of the receptor sheet layer against the paper feed roller.

9. Apparatus according to claim 8, which further includes wedge-shaped notches formed at the upper edges near the forward end portions of both side plates of the case, and stop plates which are formed in the cassette-receiving section and adapted to be engaged with the wedge-shaped notches when the cassette is turned in a direction in which its forward end moves upward.

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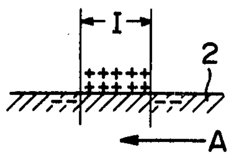

Fig. 1-a

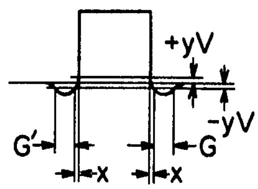

Fig. 1-b

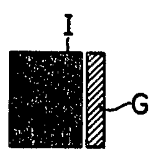

Fig. 1-c

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Sheet 2

Fig. 2

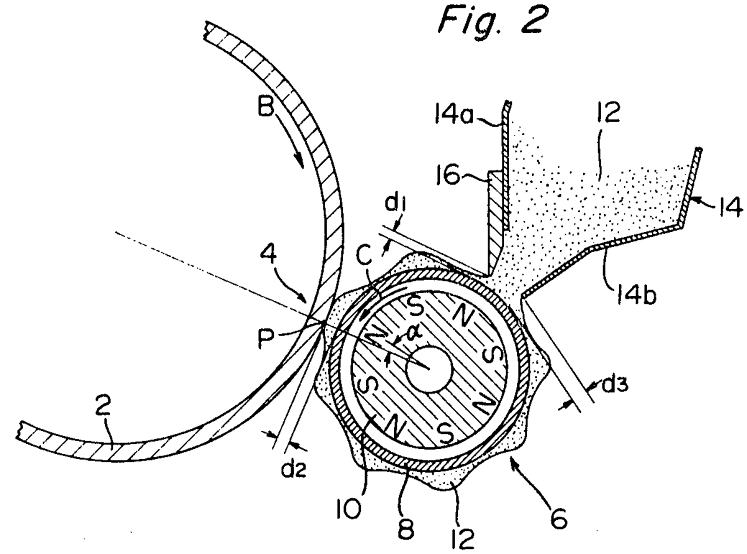


Fig. 3

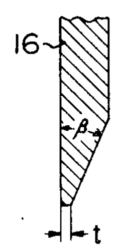


Fig. 4

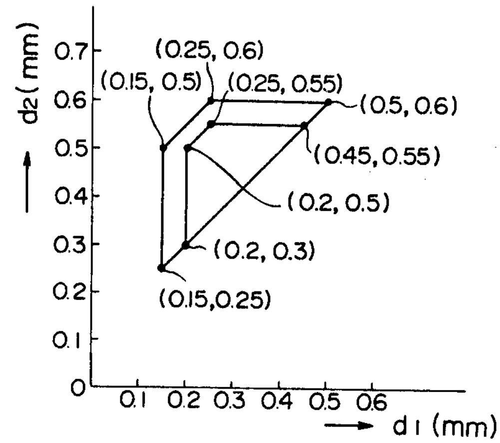


Fig. 6

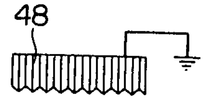


Fig. 5

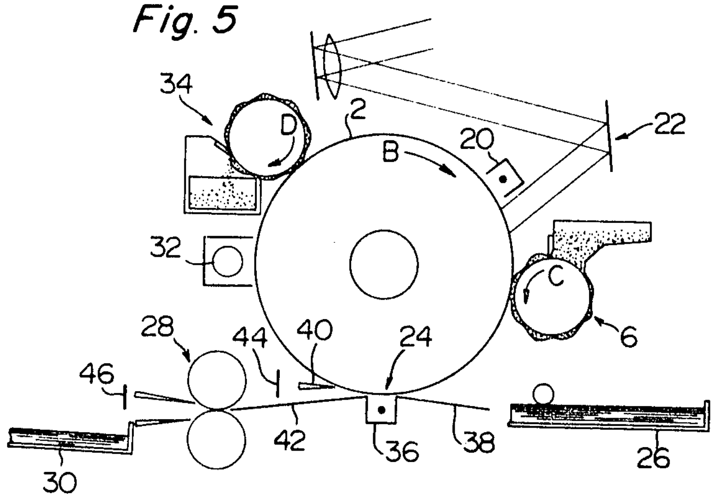
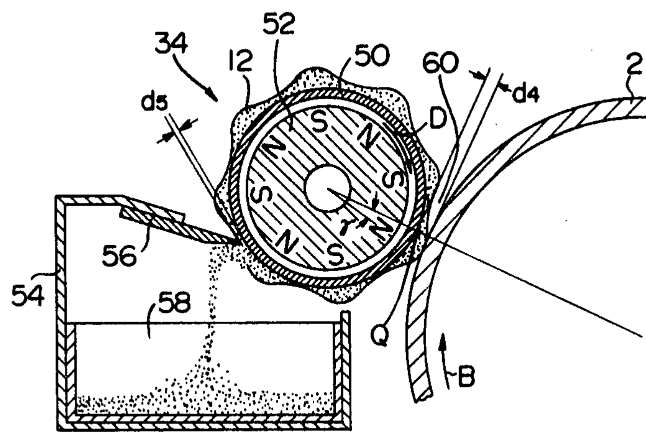


Fig. 7



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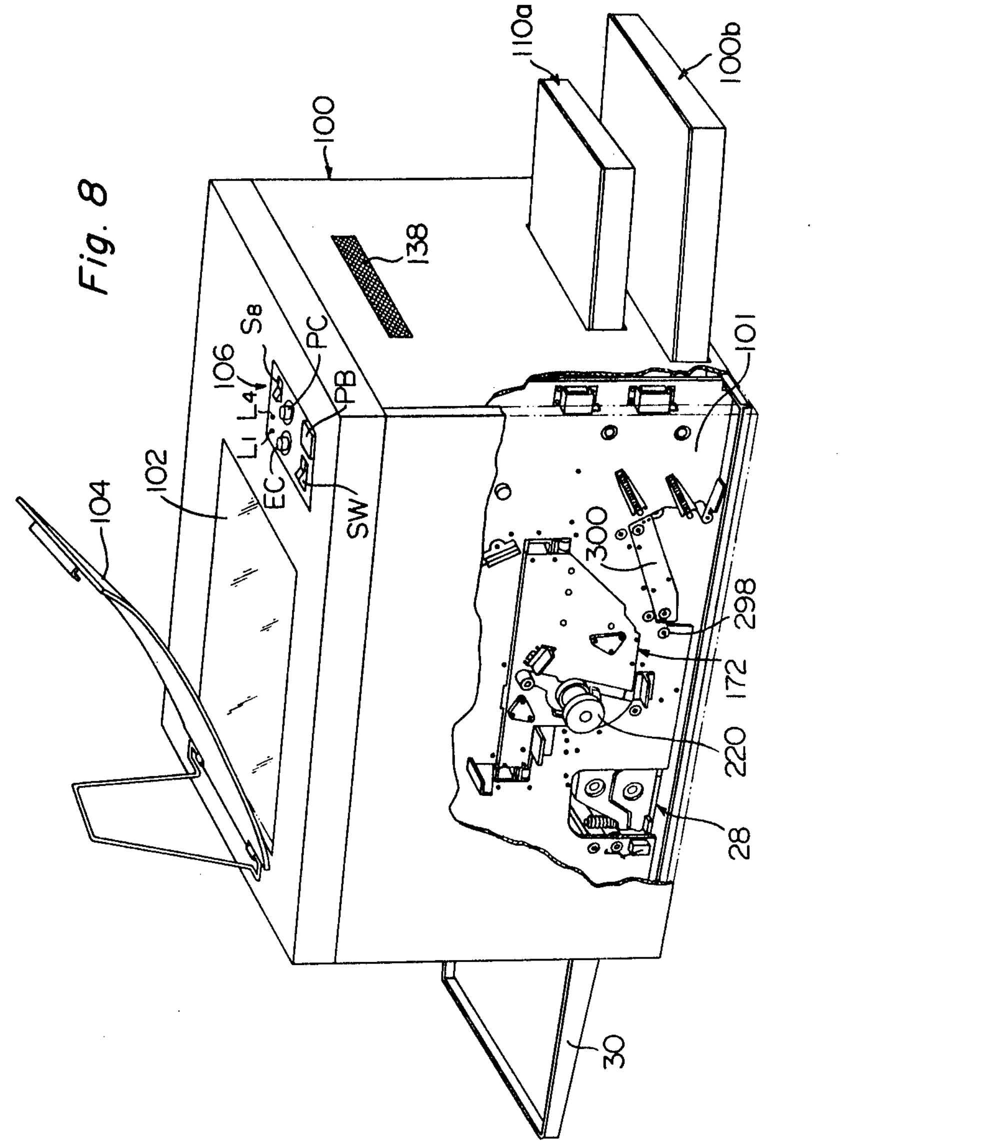
Sheet 5

Fig. 8



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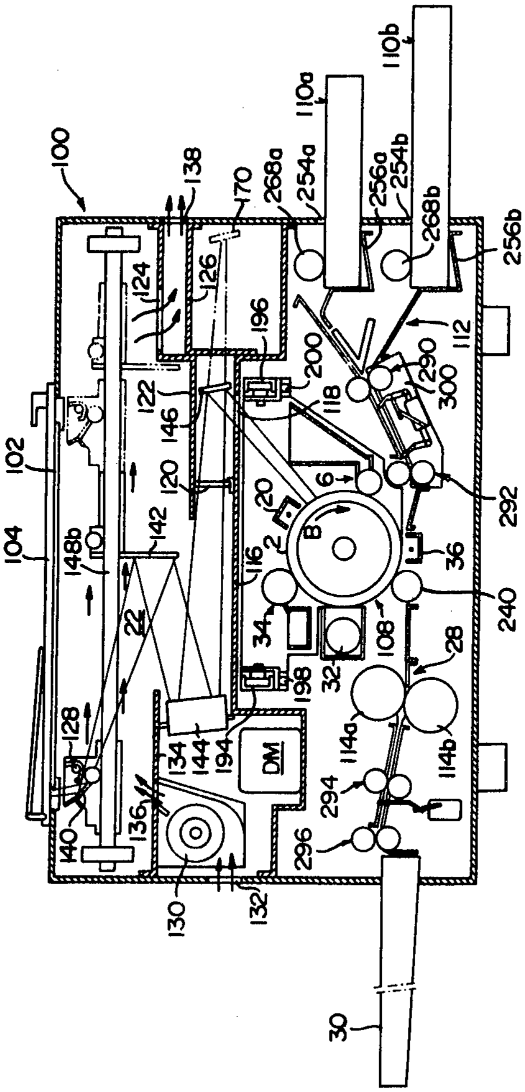
Sheet 6

Fig. 9



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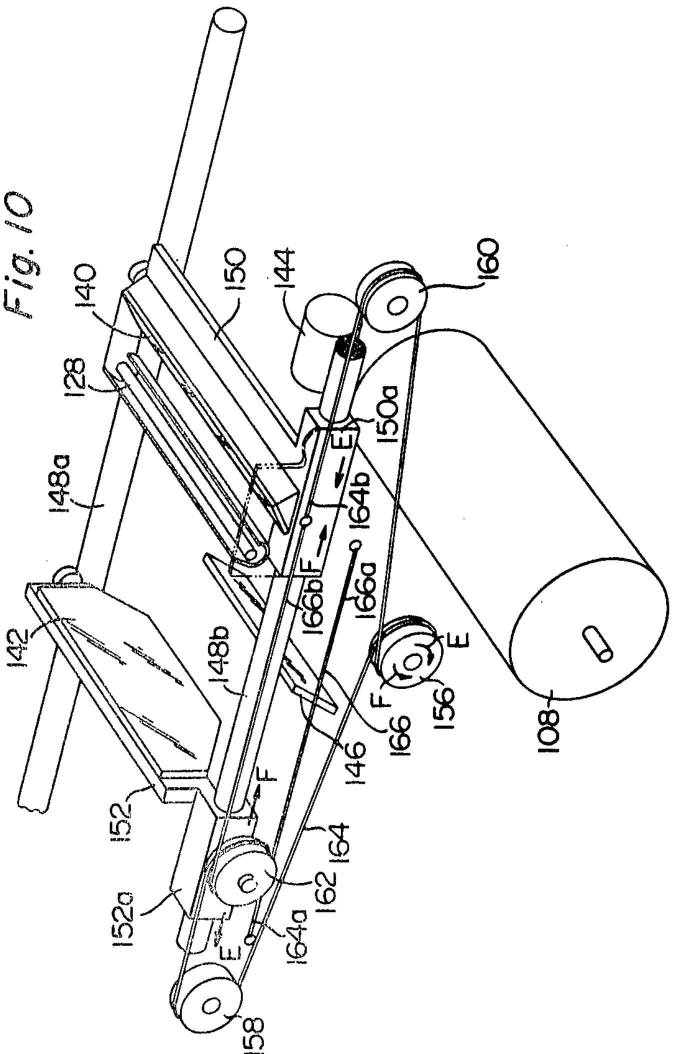
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Sheet 8

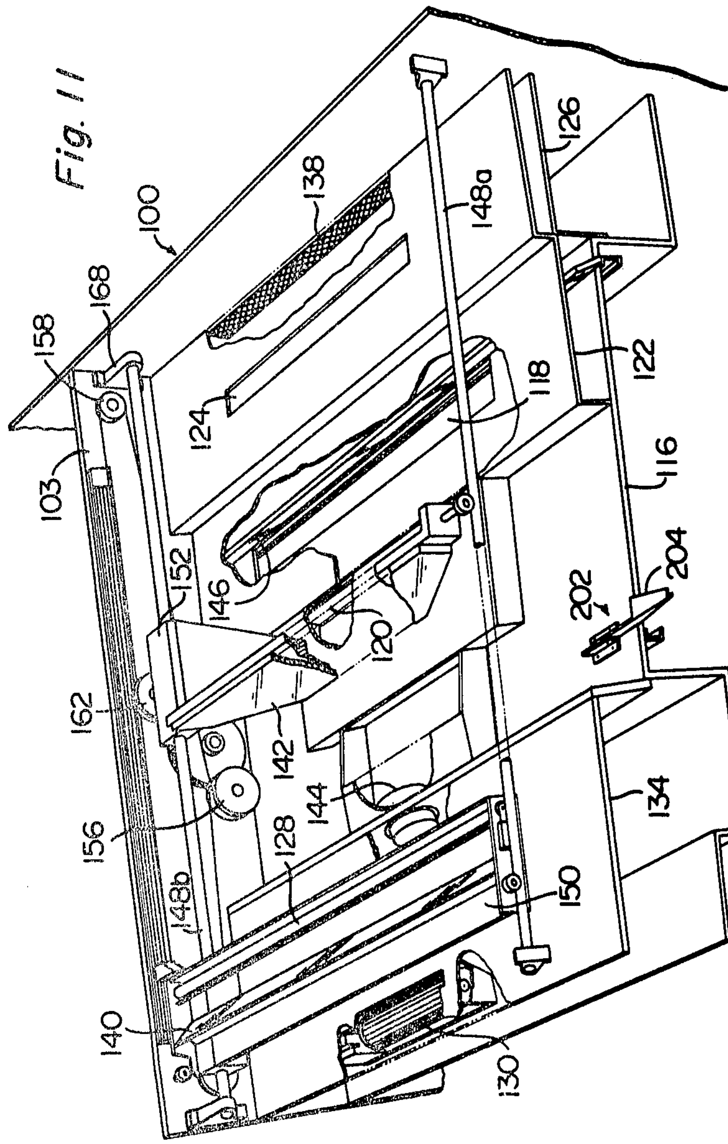
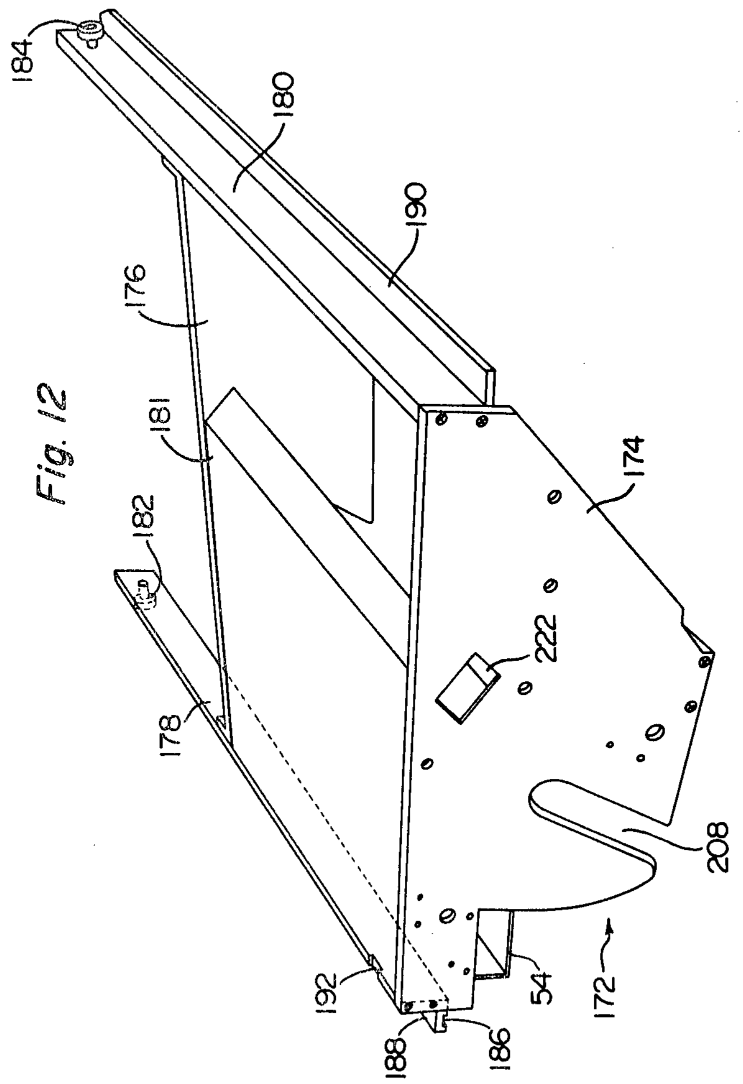


Fig. 11



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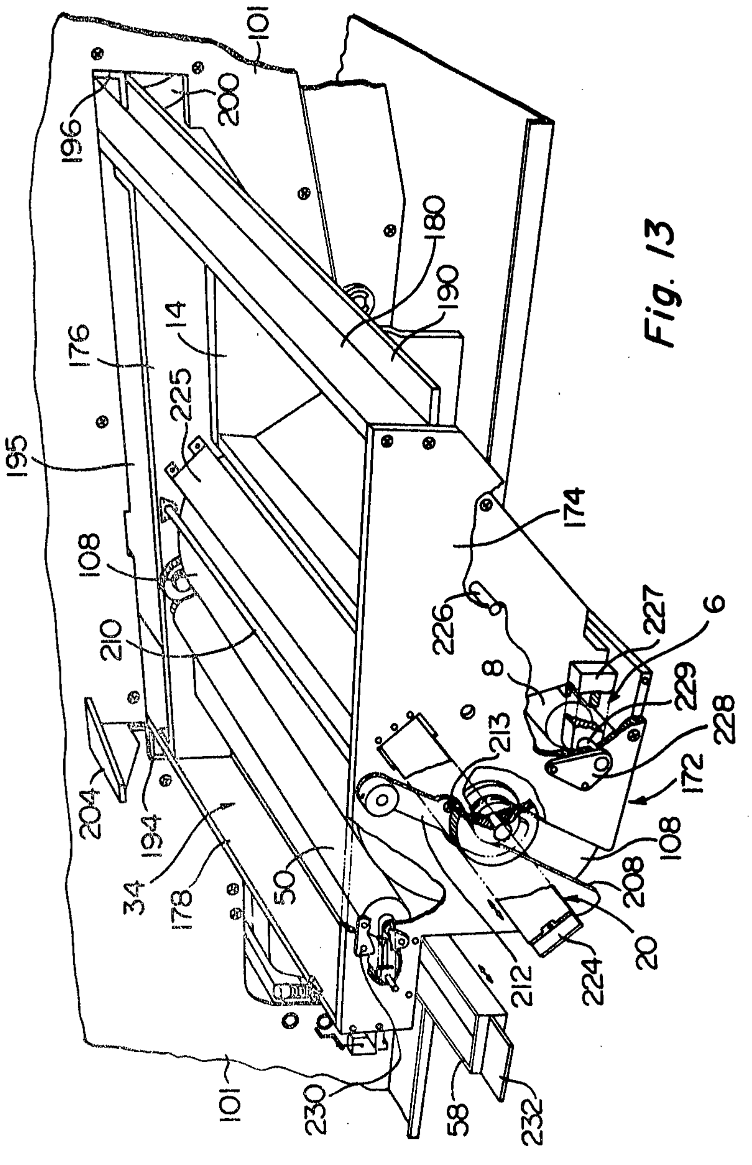
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Fig. 13

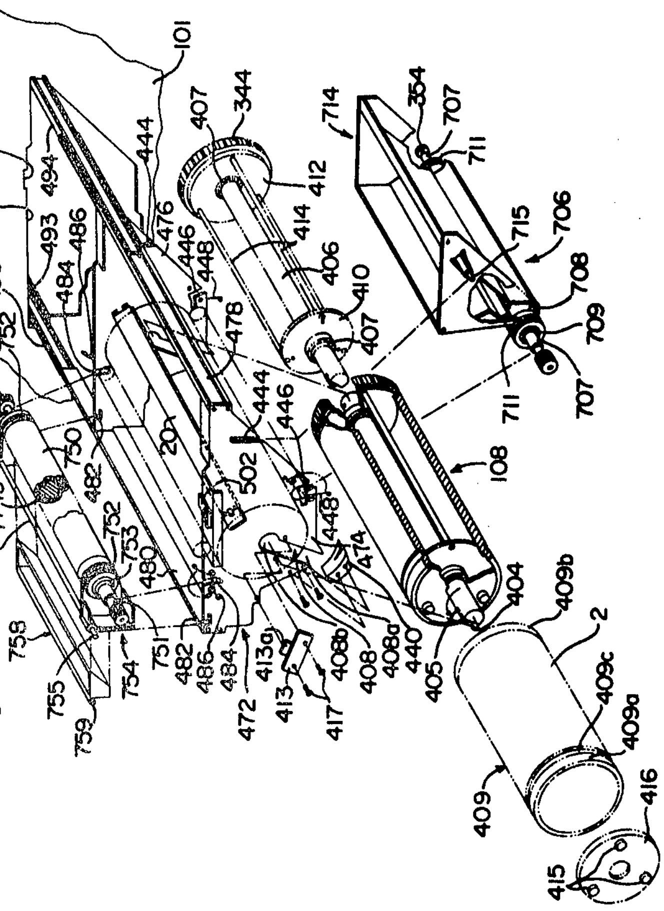
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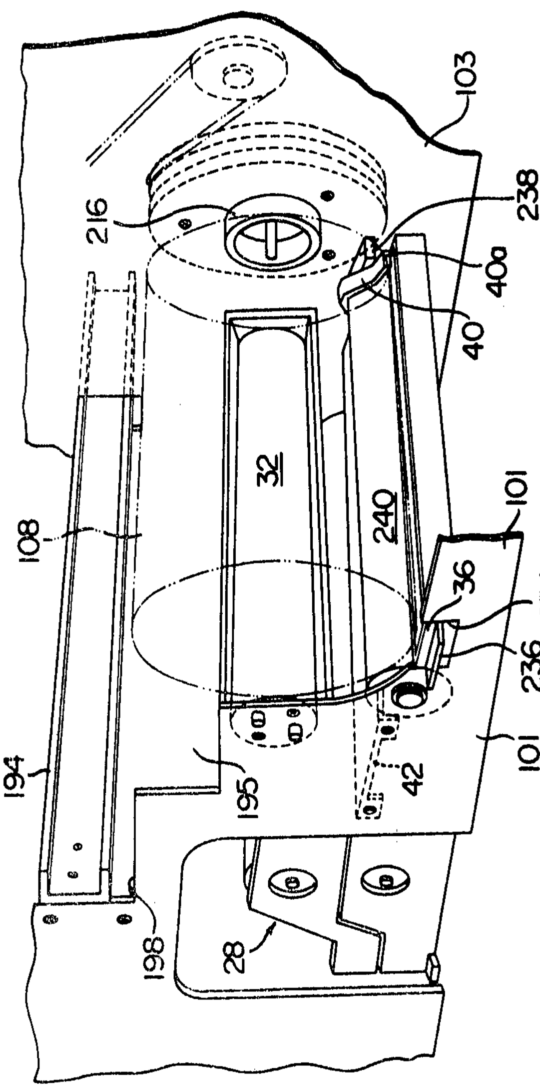
Fig. 13-A

Fig. 14



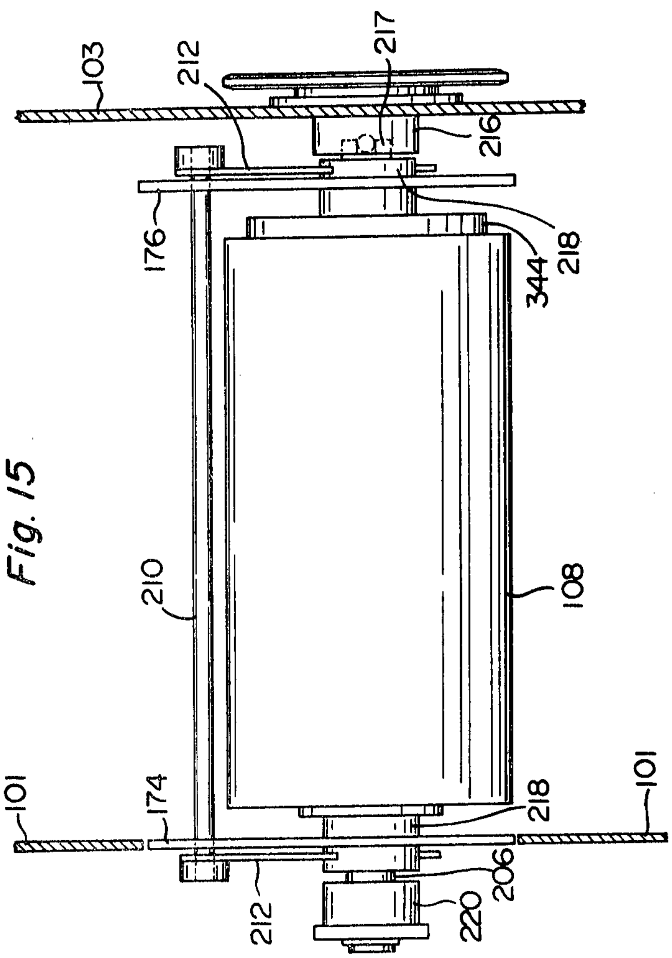


Fig. 15

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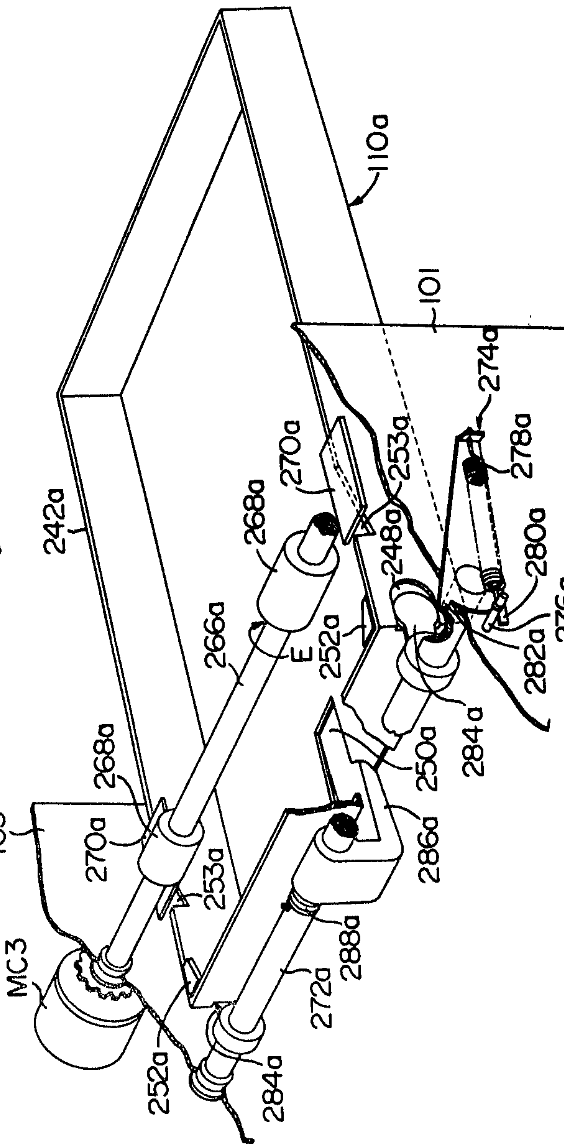
Fig. 16



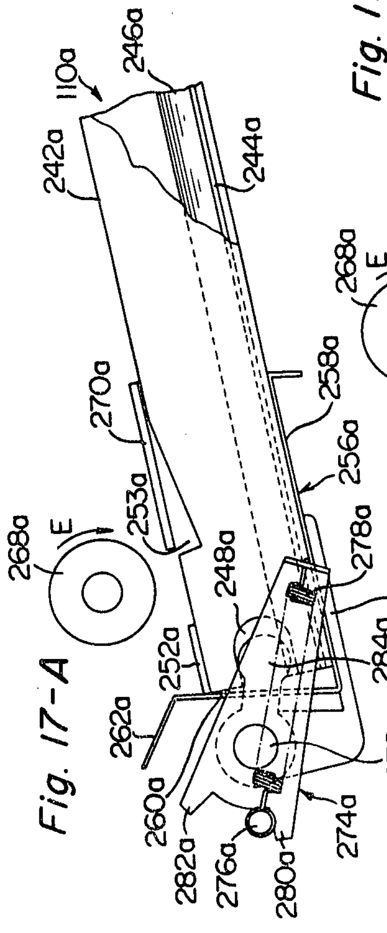


Fig. 17-A

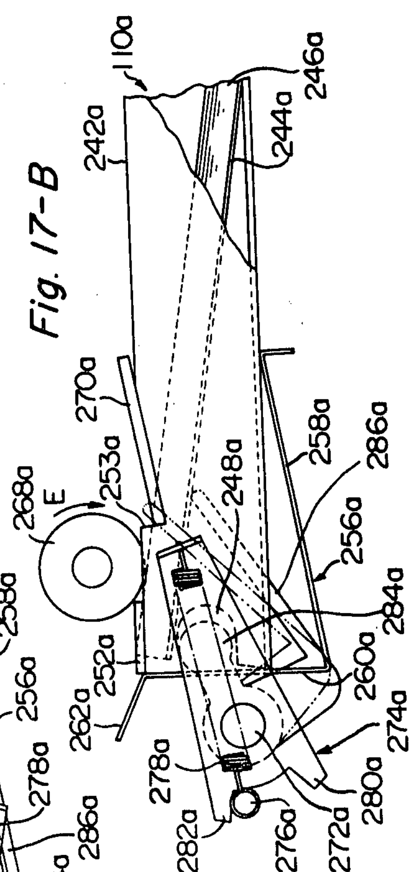


Fig. 17-B

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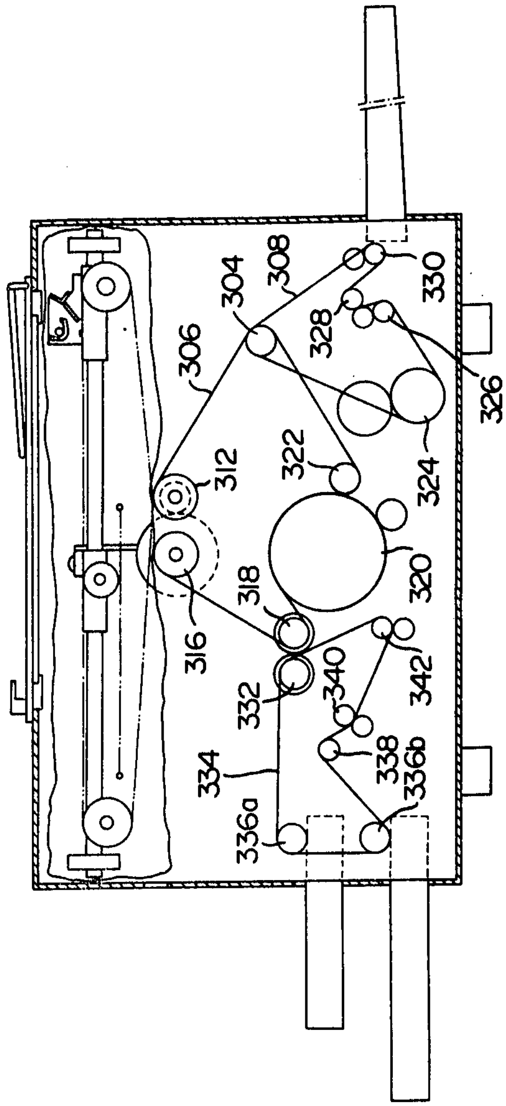
Fig. 18



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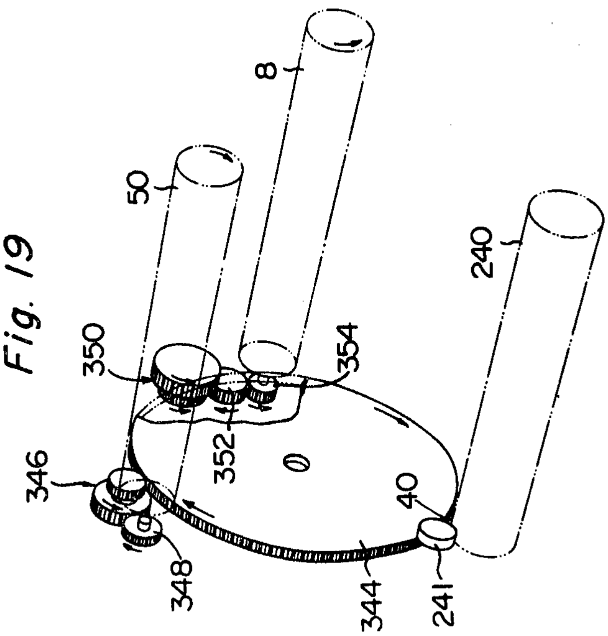

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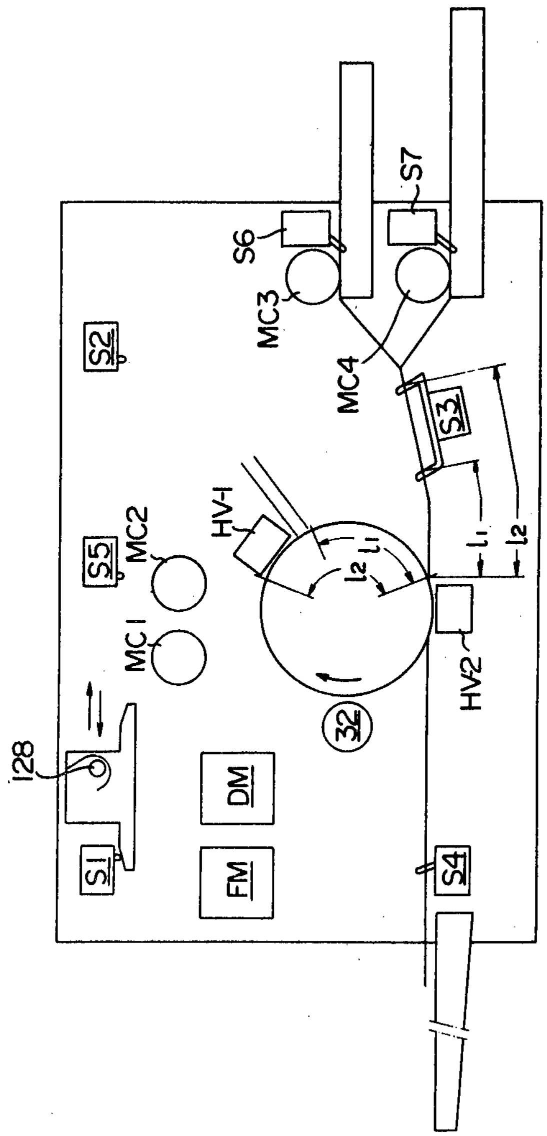

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Fig. 21

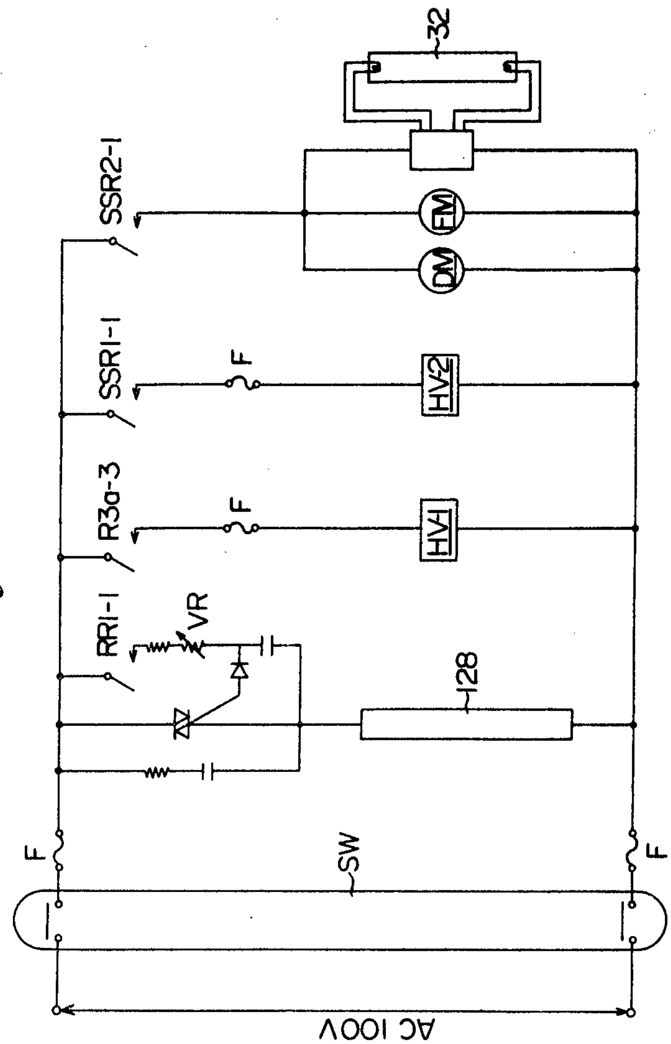

Fig. 22

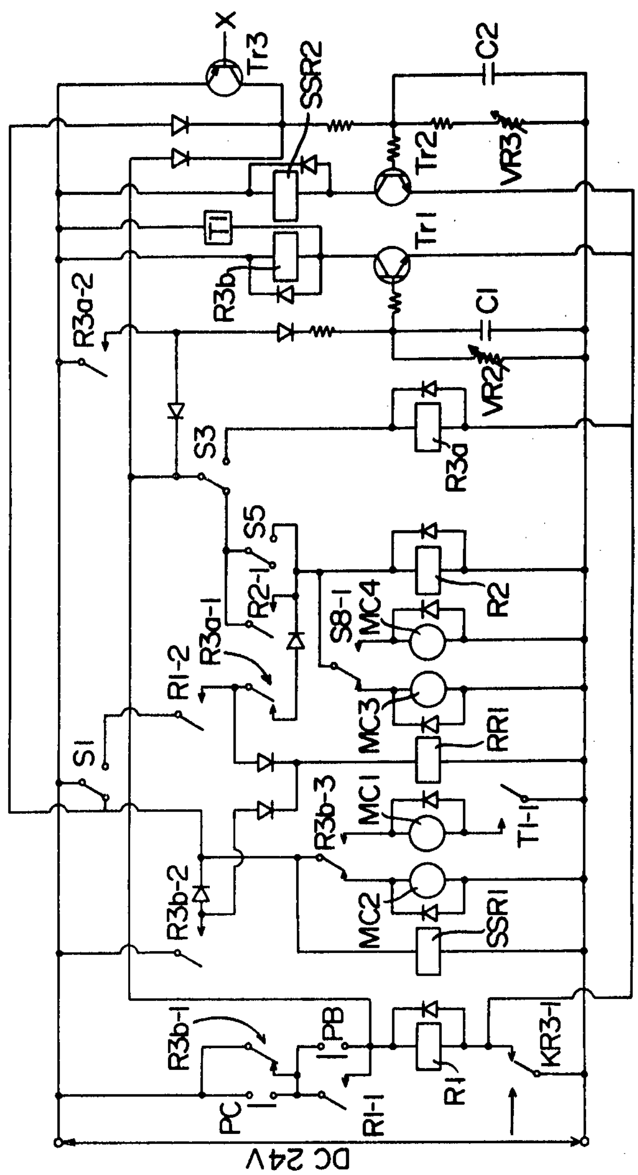
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Fig. 23

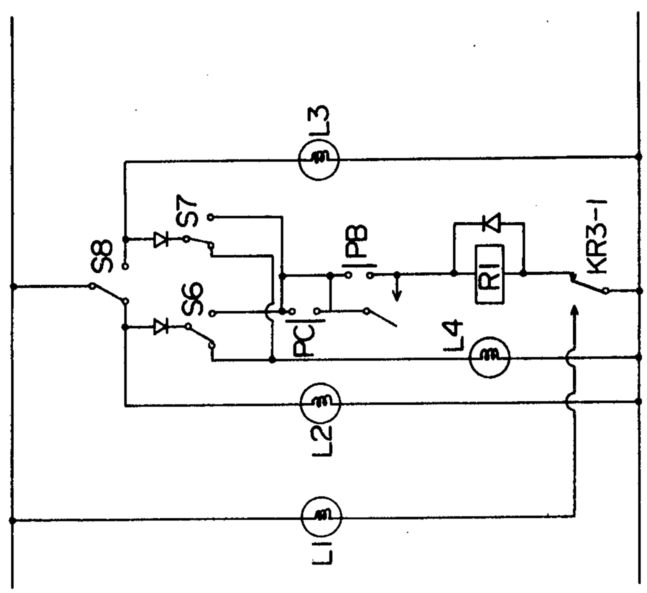

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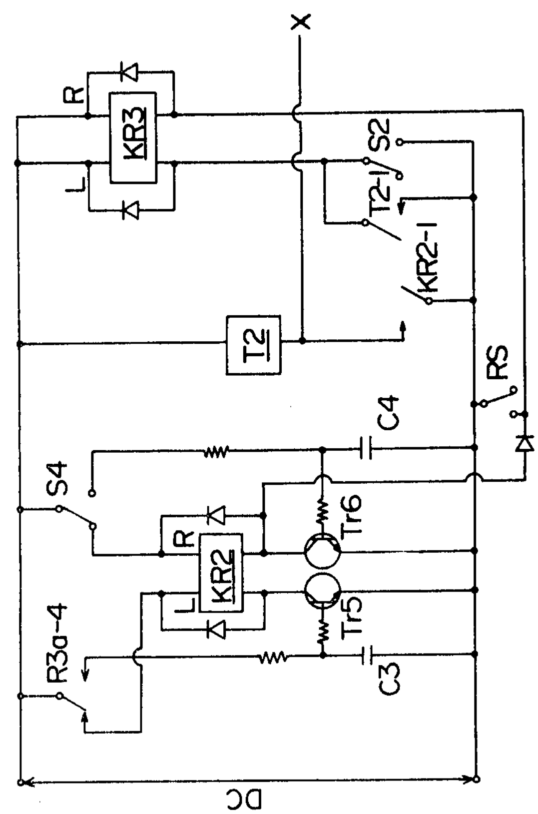
Fig. 24



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Sheet 23

Fig. 25