United States Patent [19]

Tanaka et al.

[11] E **Re. 29,632**

[45] Reissued **May 16, 1978**

[54] **ELECTROPHOTOGRAPHIC DEVICE**

[75] Inventors: **Hiroshi Tanaka**, Tokyo; **Shinkichi Takahashi**, Yokohama; **Tetsuo Hasegawa**, Tokyo; **Toshihiko Sato**, Kawaguchi, all of Japan

[73] Assignee: **Canon Kabushiki Kaisha**, Tokyo, Japan

[21] Appl. No.: **133,990**

[22] Filed: **Apr. 14, 1971**

Related U.S. Patent Documents

Reissue of:

[64] Patent No.: **3,438,706**
Issued: **Apr. 15, 1969**
Appl. No.: **585,091**
Filed: **Oct. 7, 1966**

[30] **Foreign Application Priority Data**

Oct. 11, 1965	Japan	40-62246
Oct. 27, 1965	Japan	40-65491
Mar. 23, 1966	Japan	41-17781
Mar. 23, 1966	Japan	41-17782
Jun. 14, 1966	Japan	41-38695
Aug. 23, 1966	Japan	41-79861[U]
Aug. 25, 1966	Japan	41-56010
Aug. 31, 1966	Japan	41-57482
Sep. 14, 1966	Japan	41-60332

[51] **Int. Cl.**[2] **G03G 15/00**; G03G 21/00

[52] **U.S. Cl.** **355/11**; 355/8; 355/15

[58] **Field of Search** 355/3, 15, 8, 11; 15/236, 401, 256.5

[56] **References Cited**

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Primary Examiner—John Gonzales
Attorney, Agent, or Firm—Fitzpatrick, Cella, Harper & Scinto

[57] **ABSTRACT**

Electrophotographic copying device including novel means for forming a high contrast electrostatic image on a photosensitive member, as well as means for developing said high contrast electrostatic image with toner particles, means for transferring the visualized electrostatic image to copying material and novel cleaning means for removing from the photosensitive member, residual toner particles after transfer of the image.

31 Claims, 49 Drawing Figures

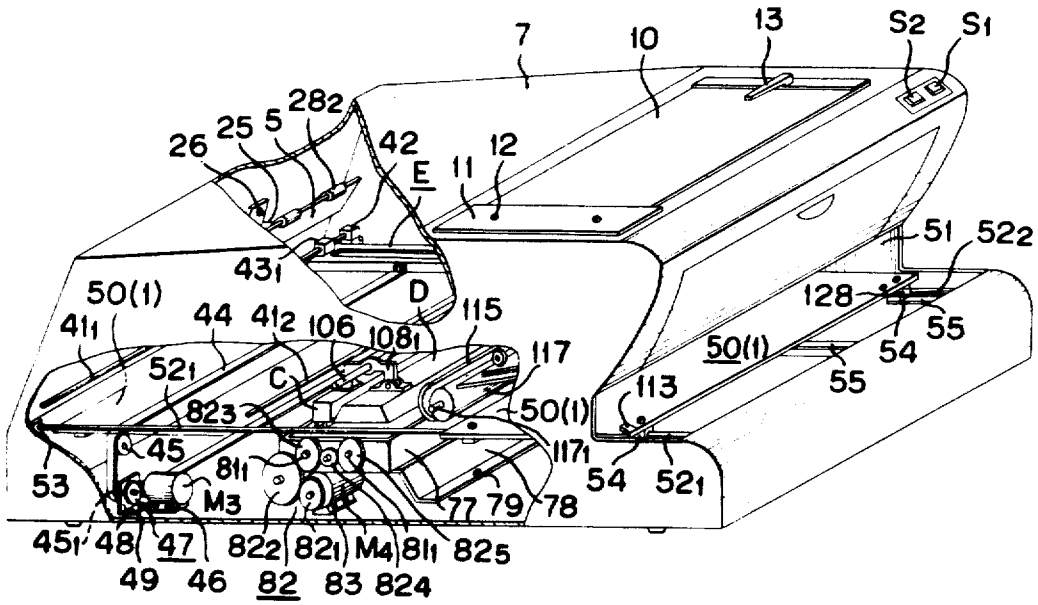


FIG. 1

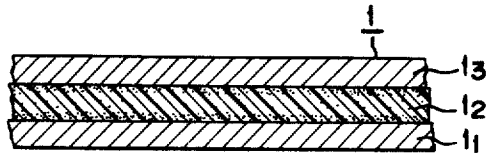


FIG. 2

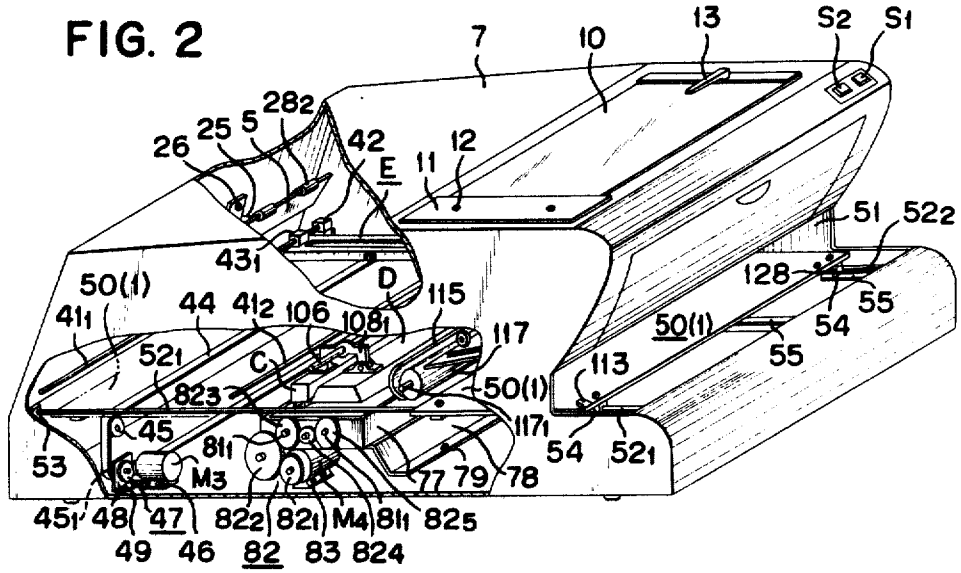


FIG. 8

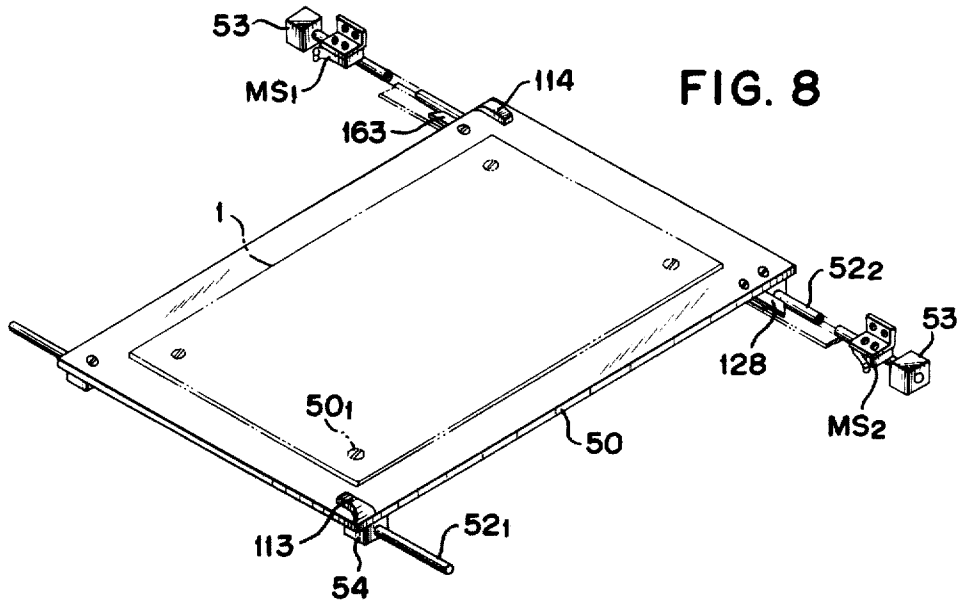


FIG. 3

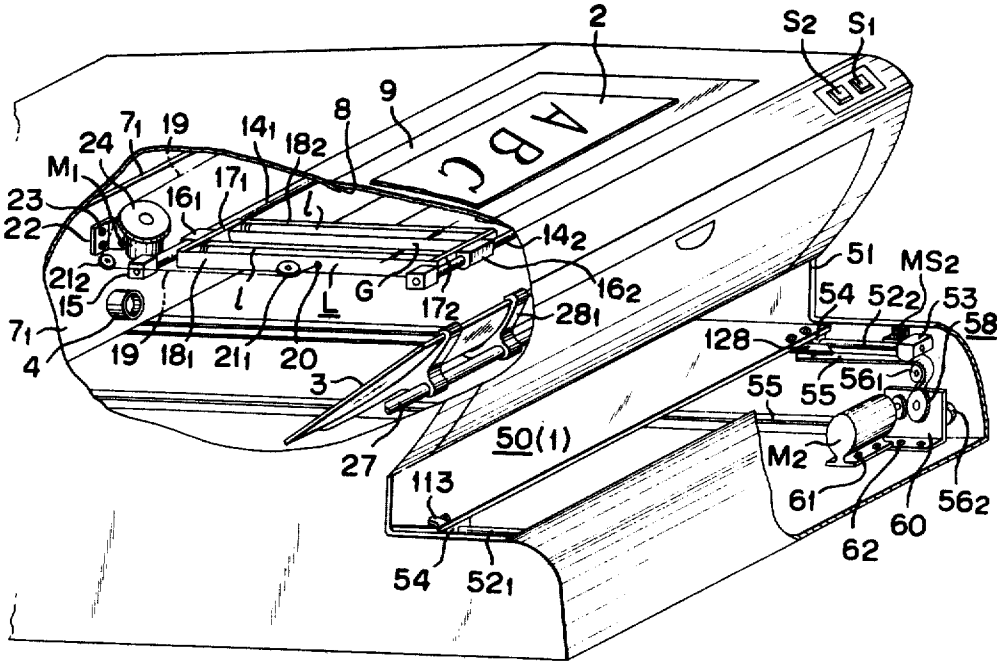


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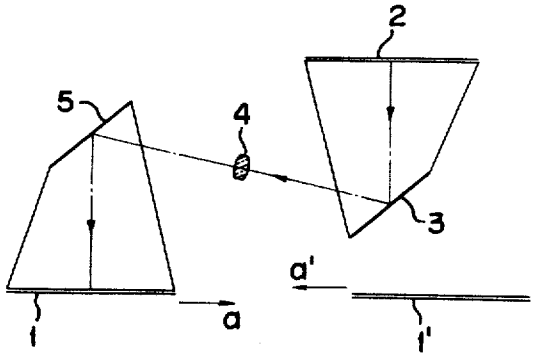


FIG. 5

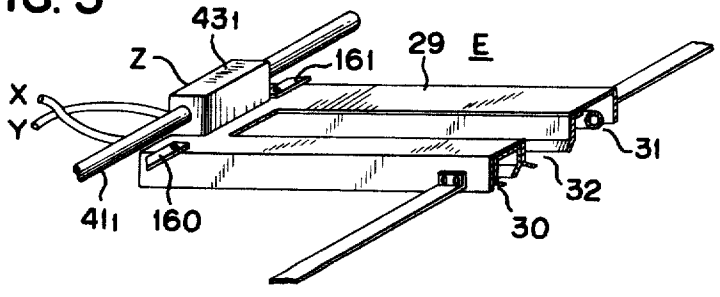


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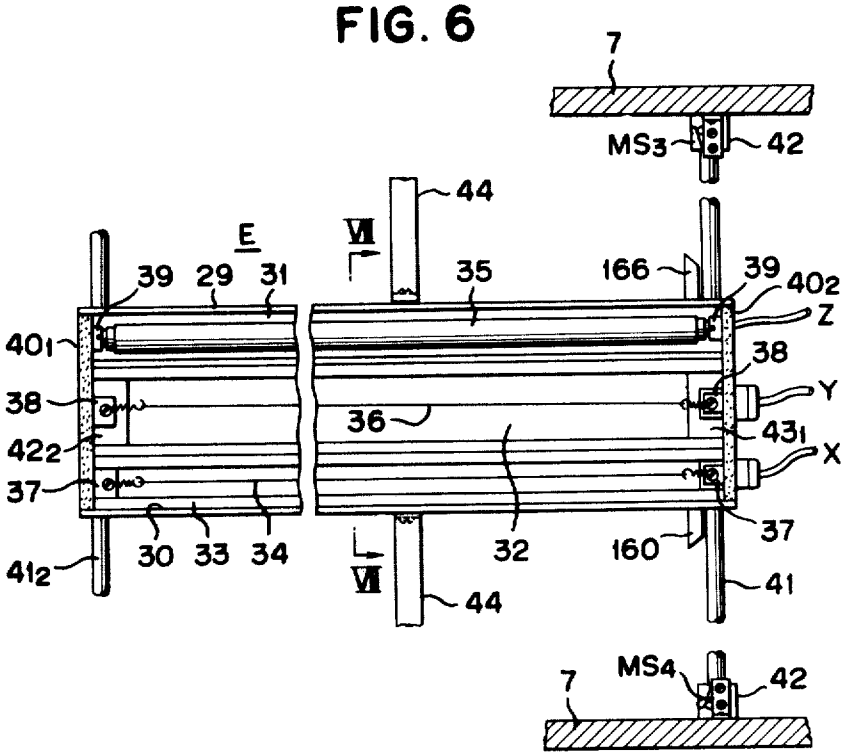
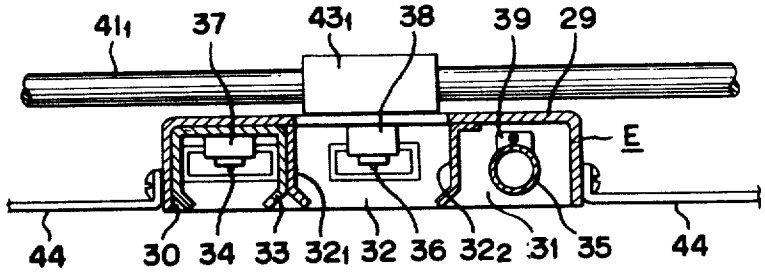

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FIG. 7


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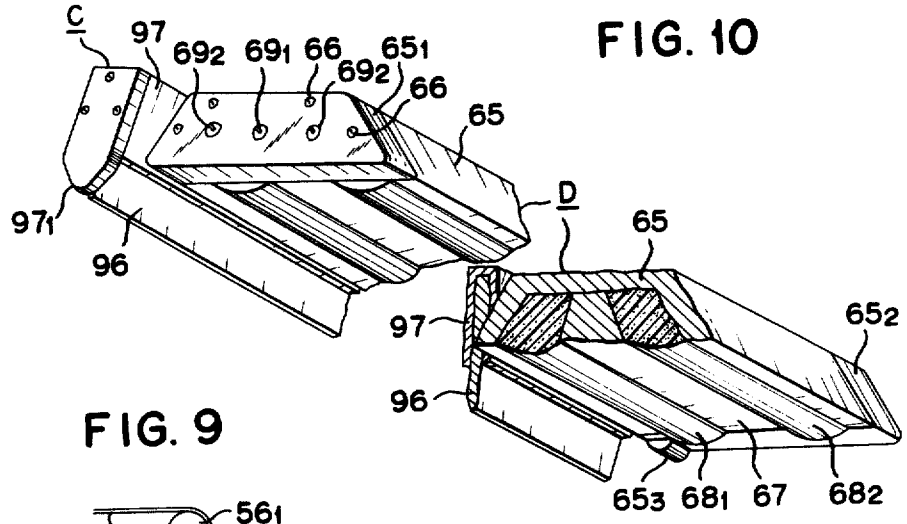


FIG. 10

FIG. 9

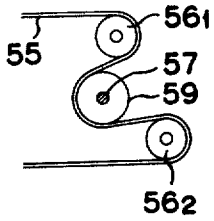


FIG. 11

FIG. 12

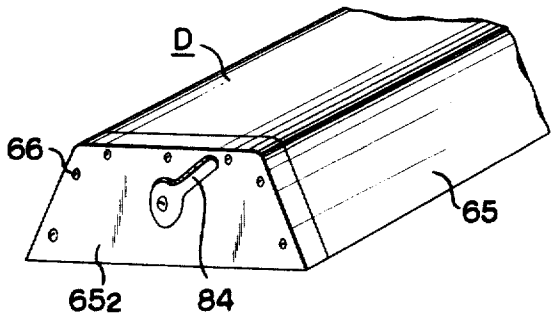


FIG. 13

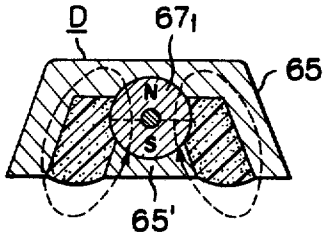


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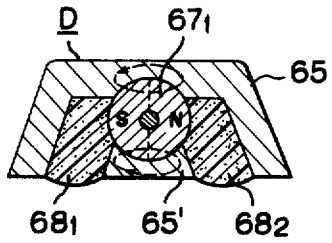


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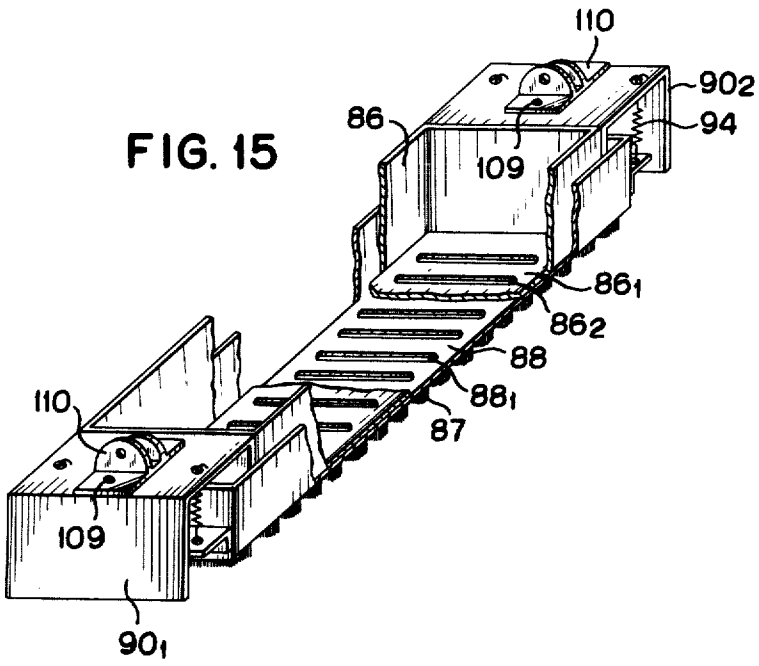


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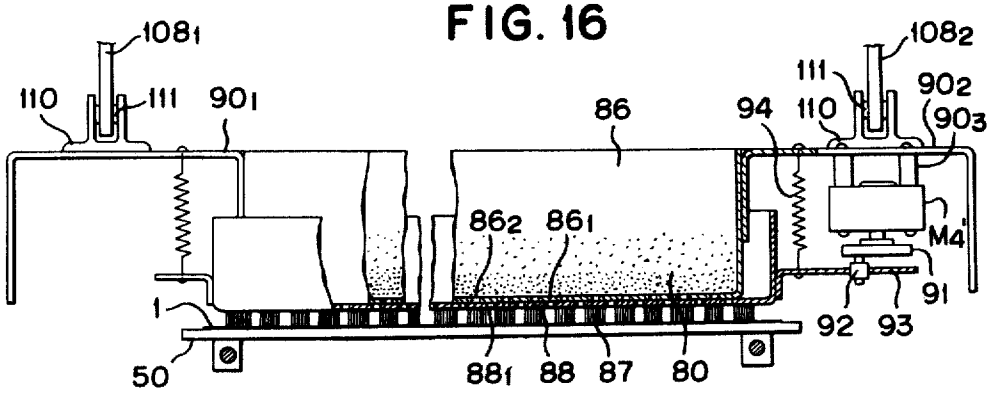


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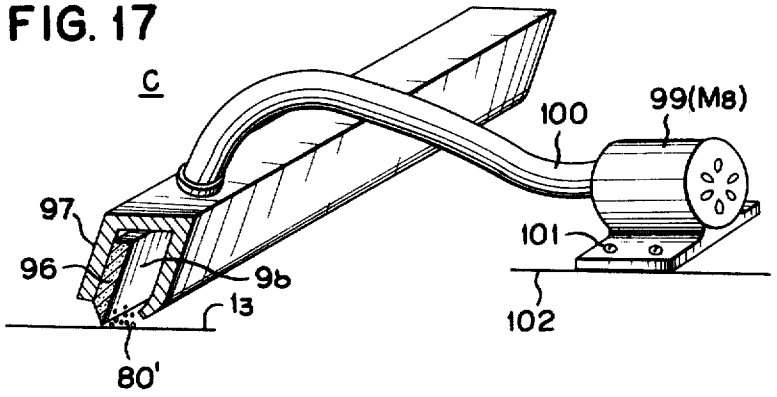


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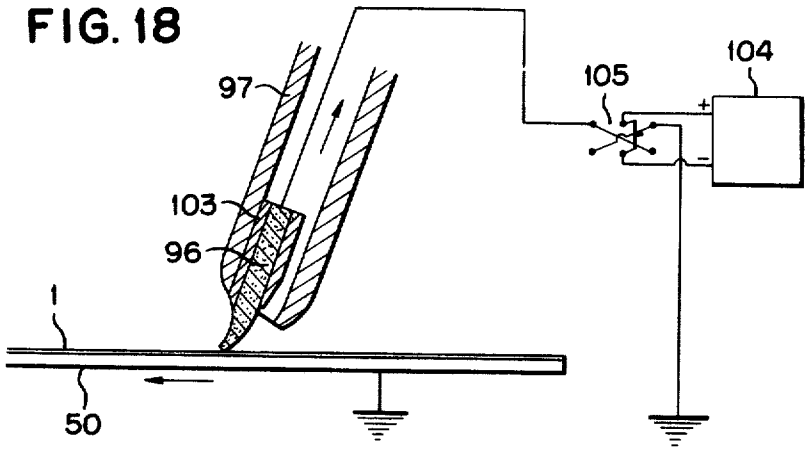


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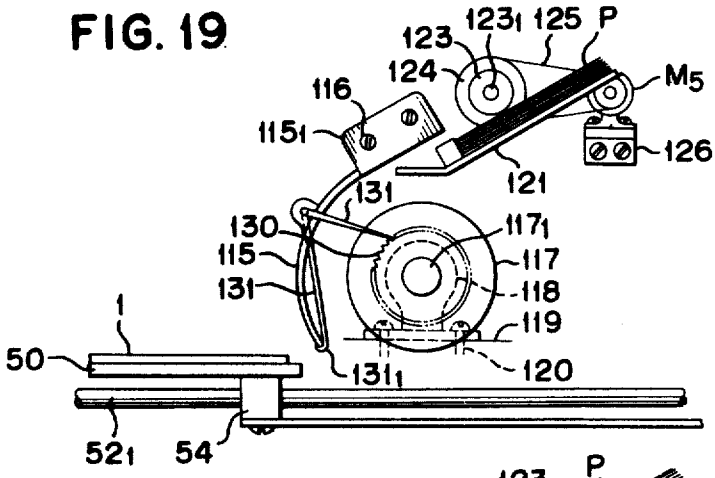


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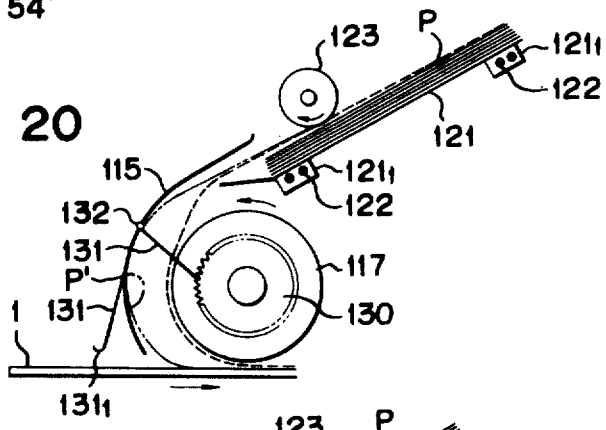


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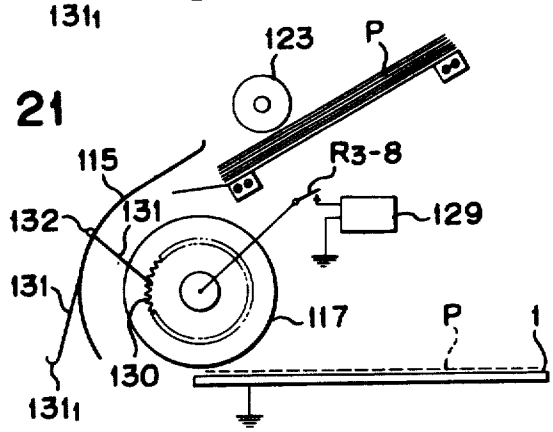


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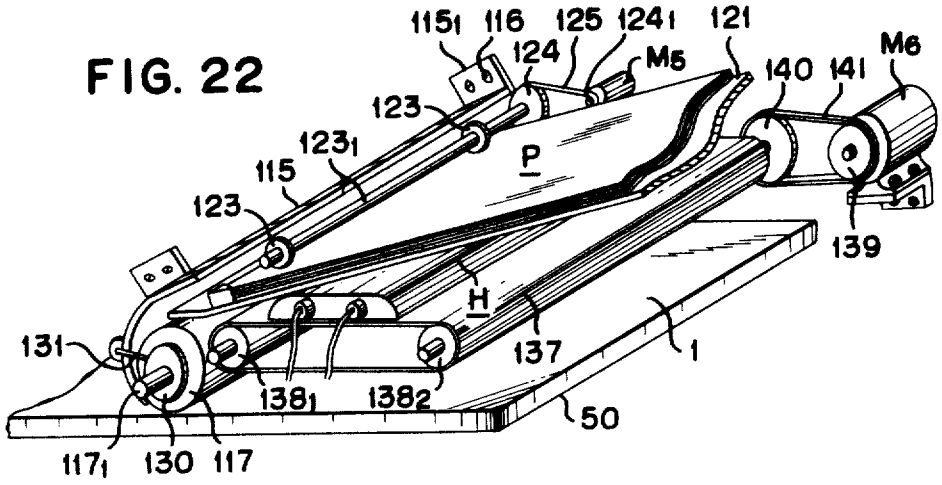


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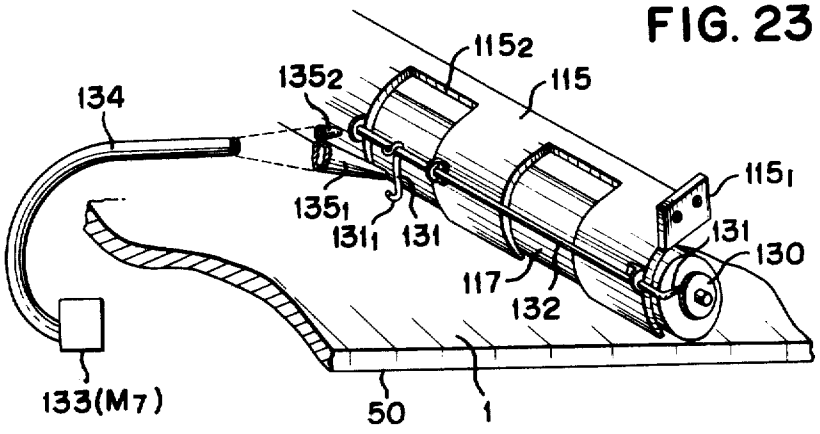


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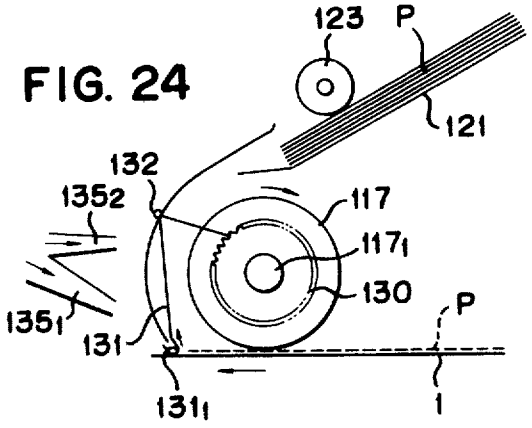


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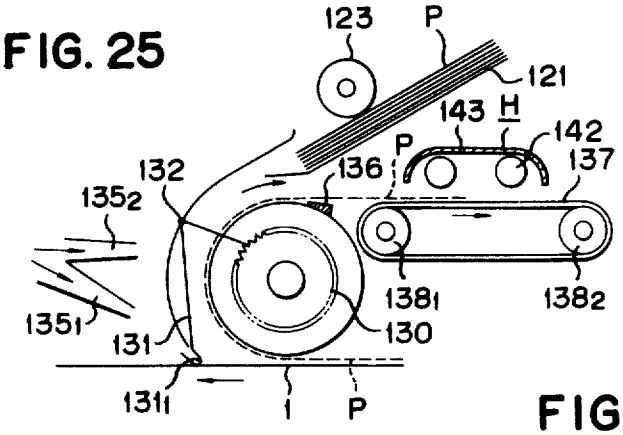

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FIG. 26

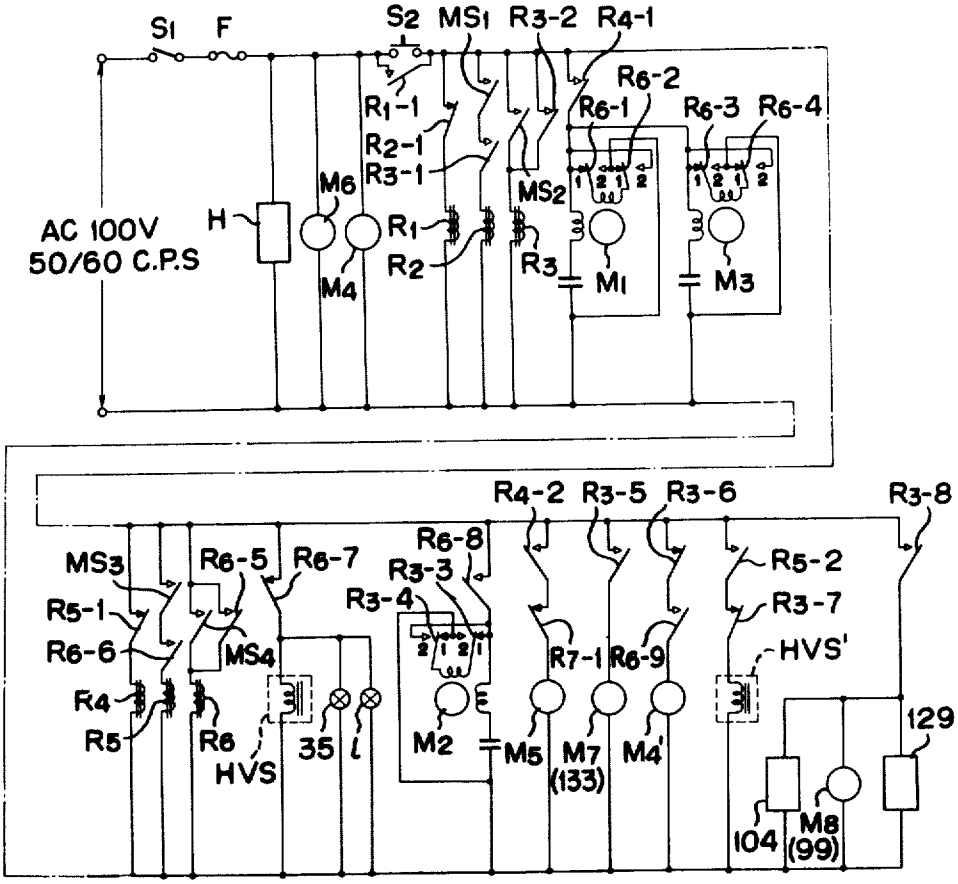

S1
F
S2
MS1
R3-2
R4-1
R6-2
R1-1
R6-1
R6-3
R6-4
R2-1
R3-1
M6
MS2
AC 100V
50/60 C.P.S
H
R1
R2
R3
M1
M3
M4
R4-2
R3-5
R3-6
R3-8
MS3
R6-5
R6-7
R6-8
R3-3
R3-4
R5-2
R5-1
R3-7
R6-6
MS4
R7-1
R6-9
HVS'
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M8
(99)

FIG. 27

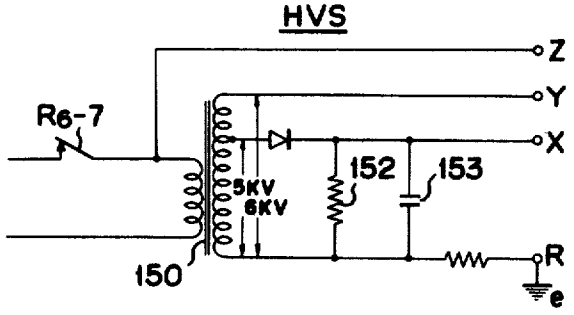


FIG. 28

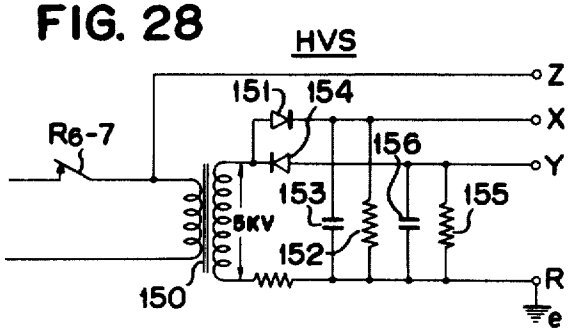


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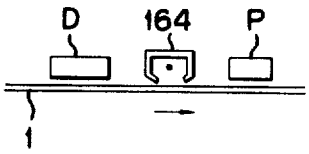


FIG. 30

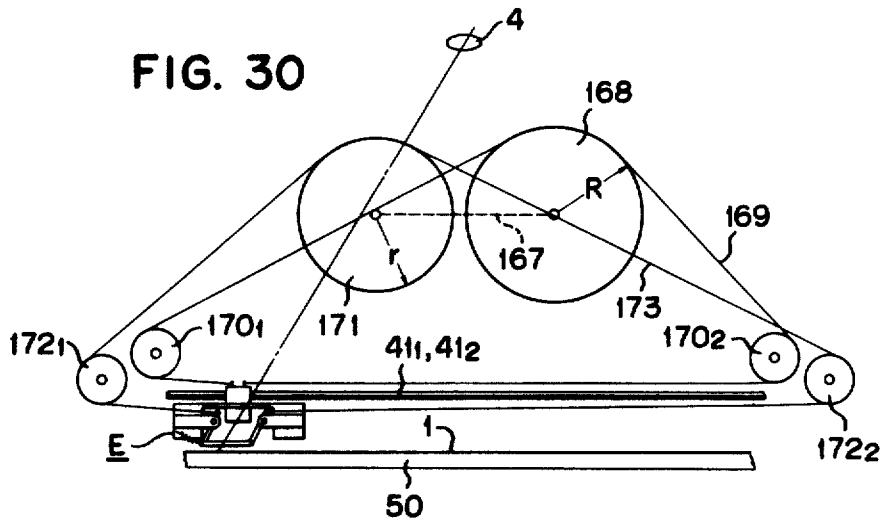


FIG. 31

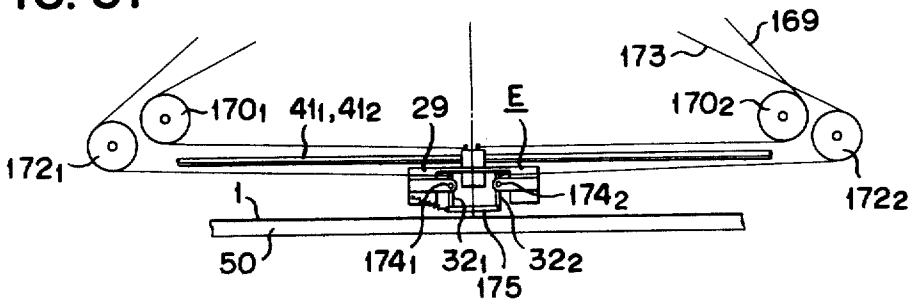


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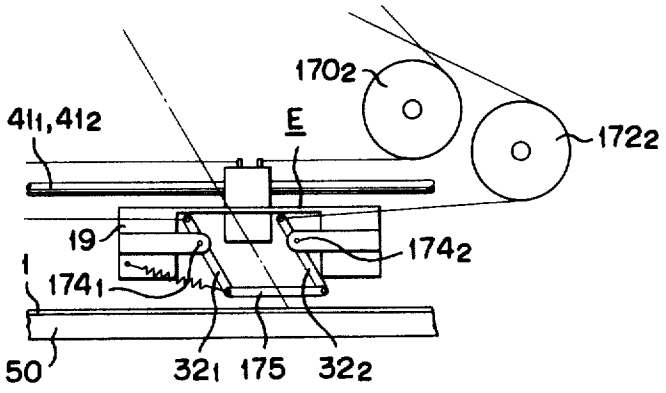


FIG. 33

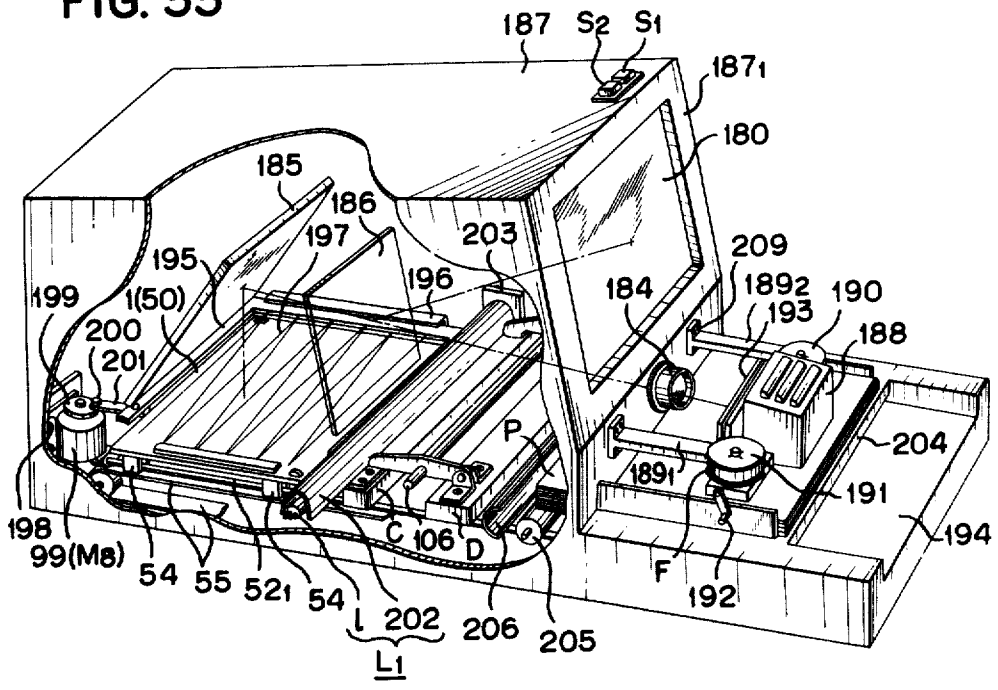


FIG. 34

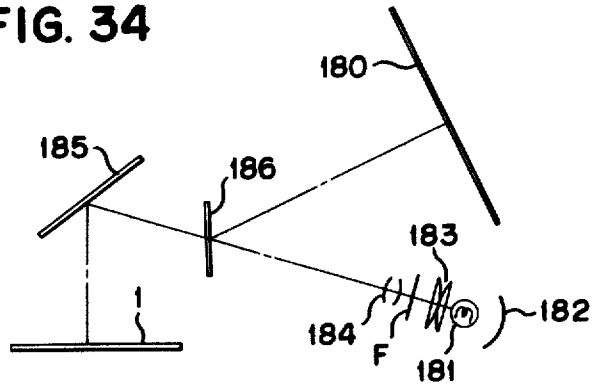


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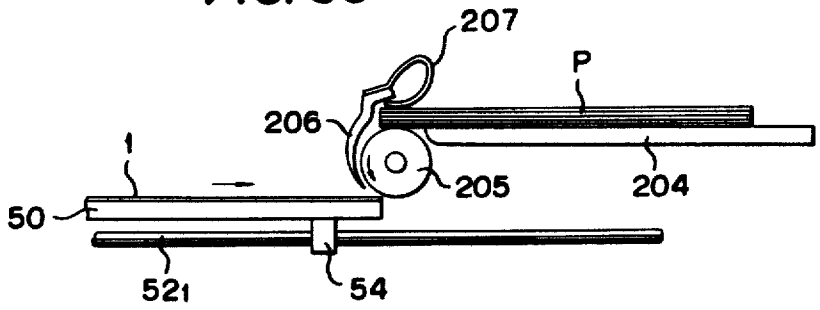


FIG. 36

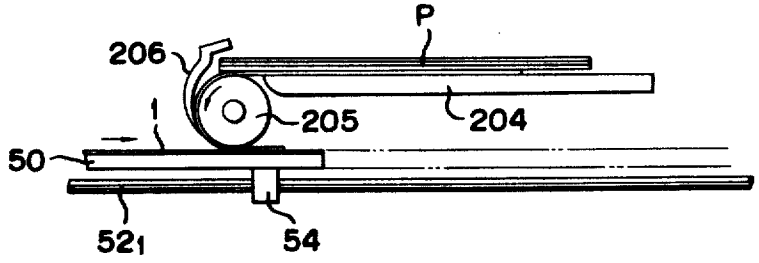


FIG. 37

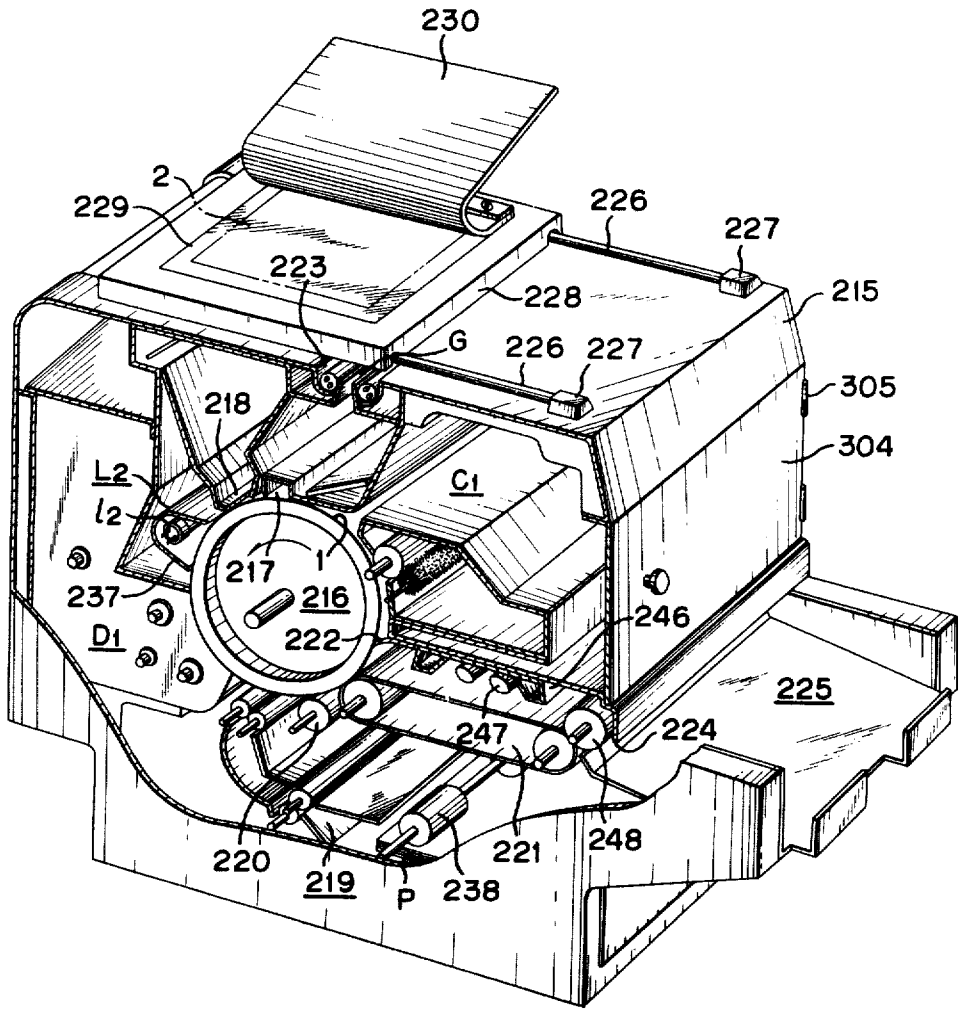

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FIG. 38

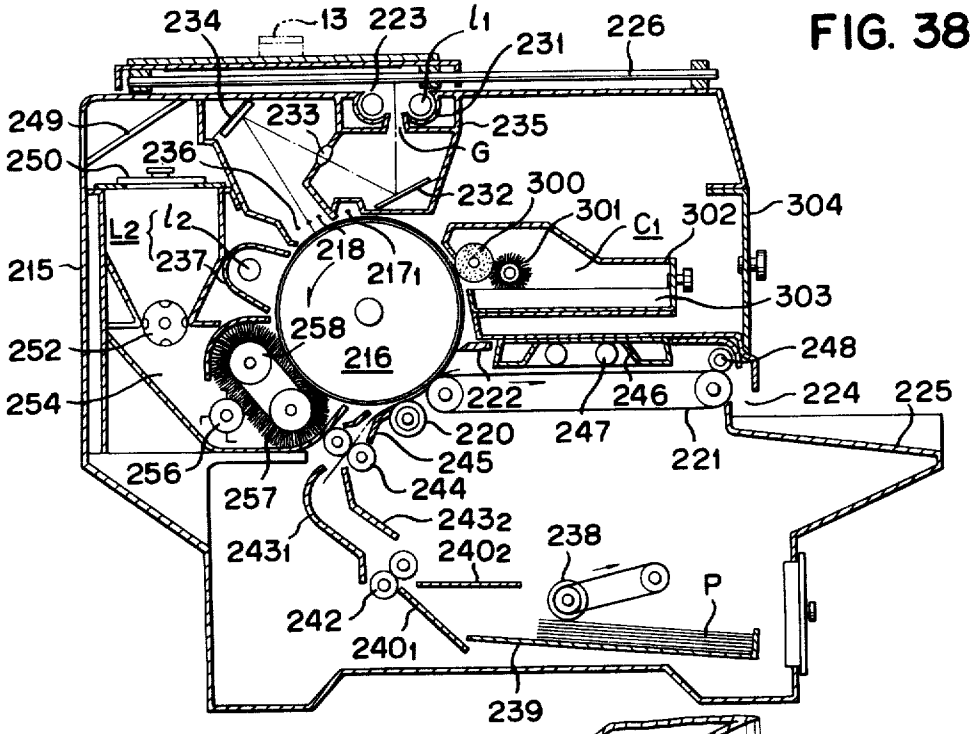

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FIG. 39

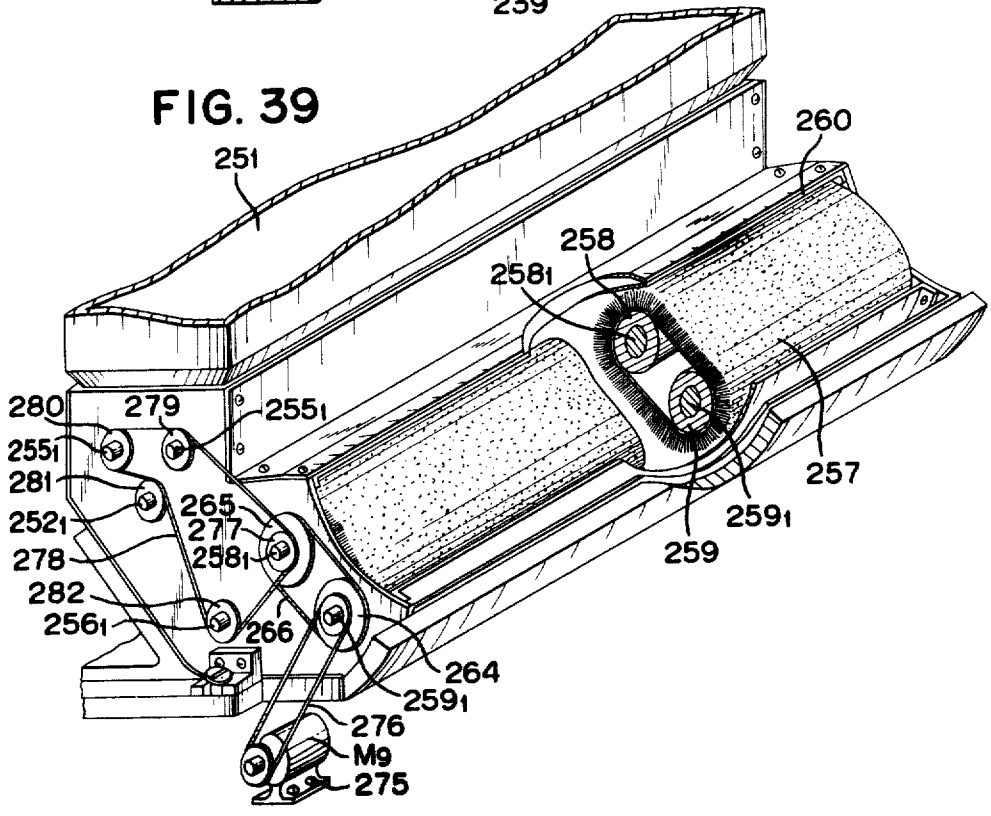

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FIG. 40

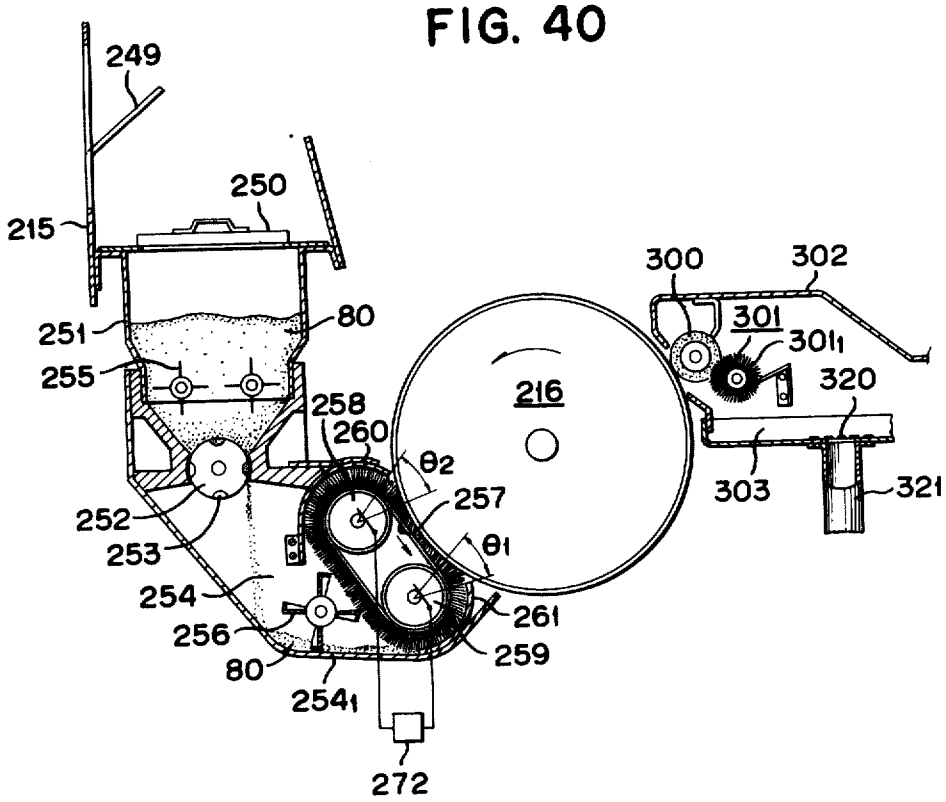

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FIG. 41

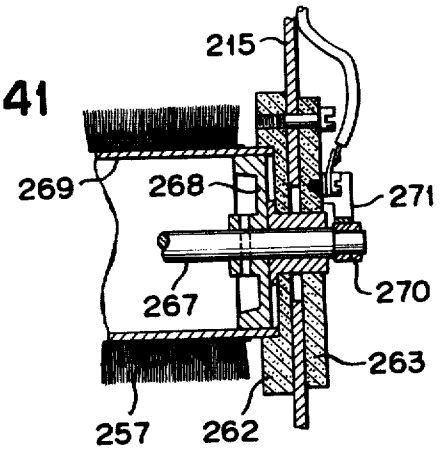

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FIG. 42

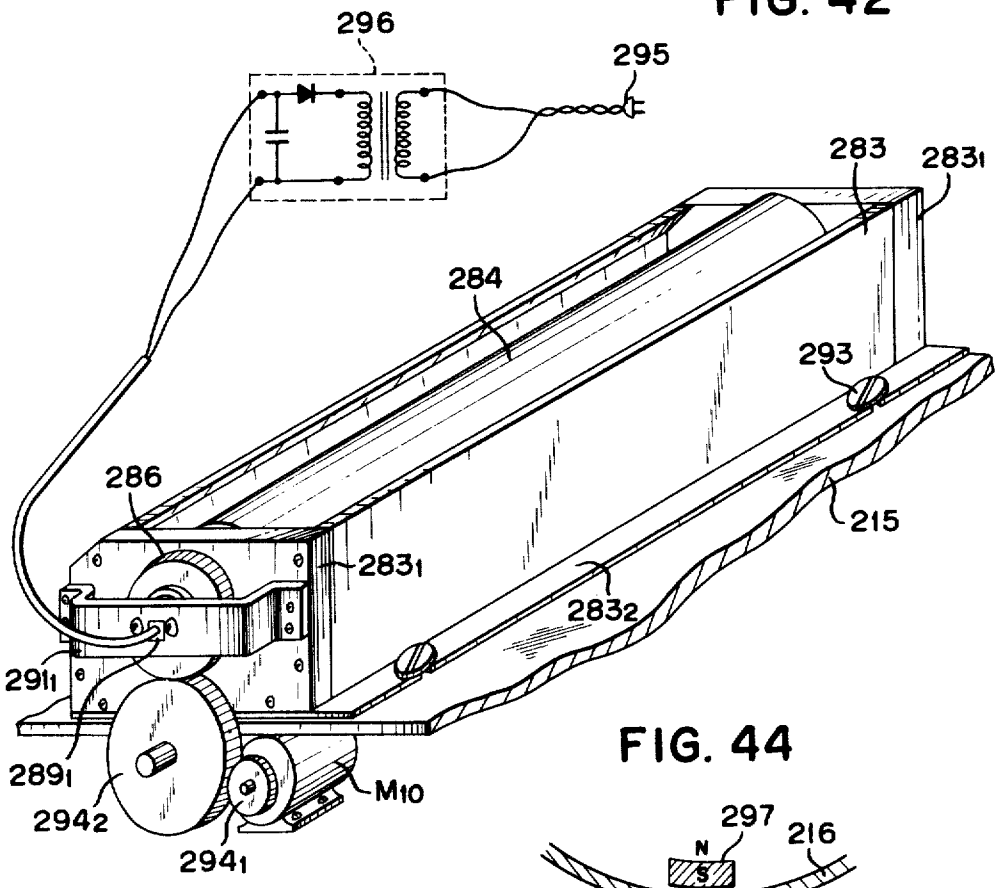


FIG. 44

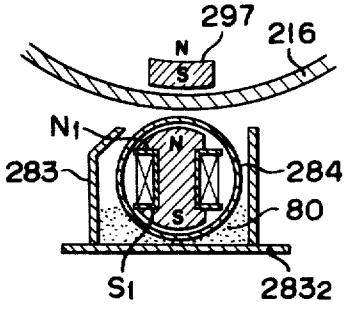


FIG. 43

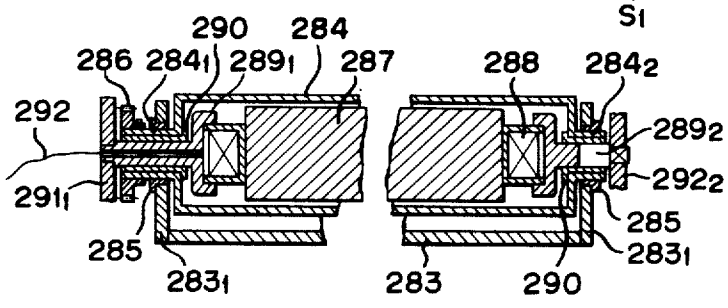


FIG. 45

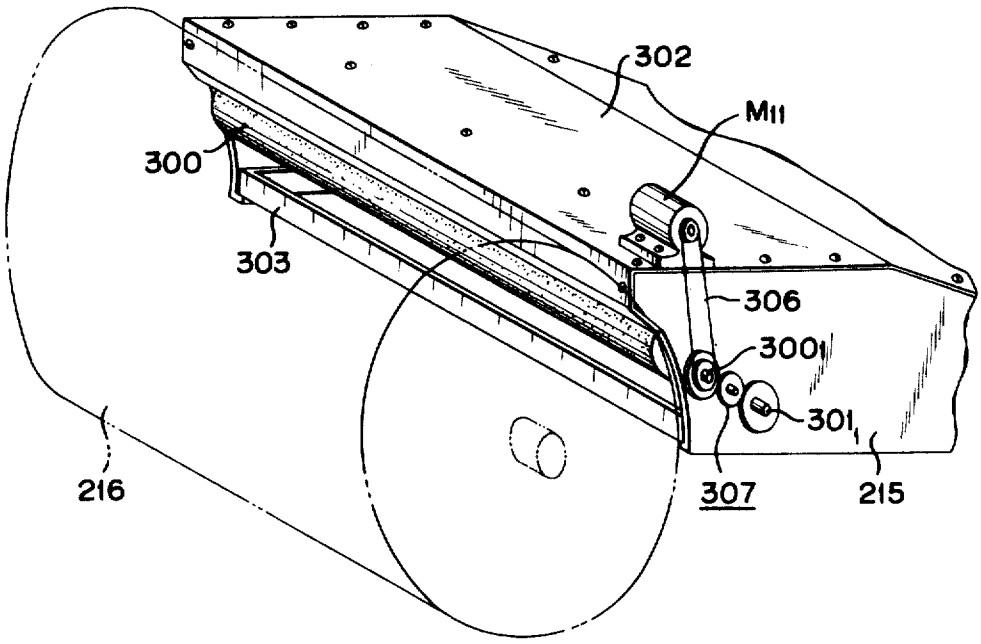


FIG. 46

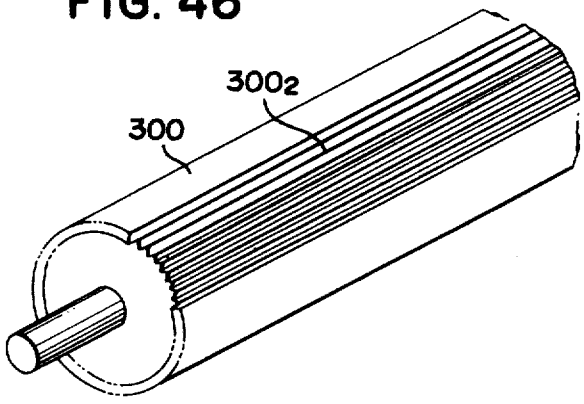


FIG. 47

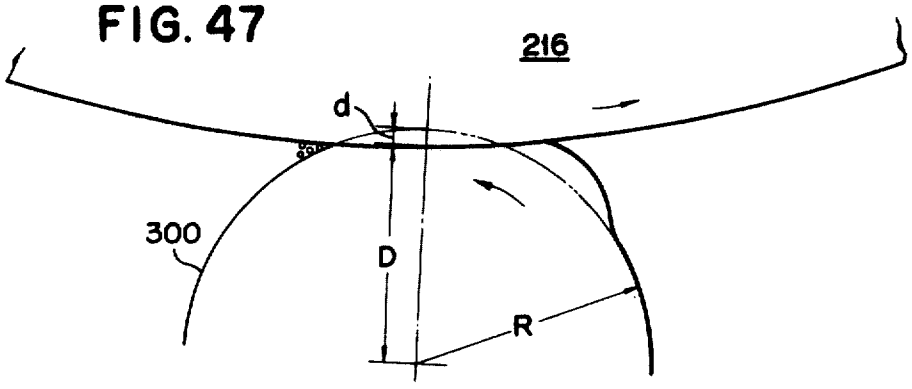


FIG. 48

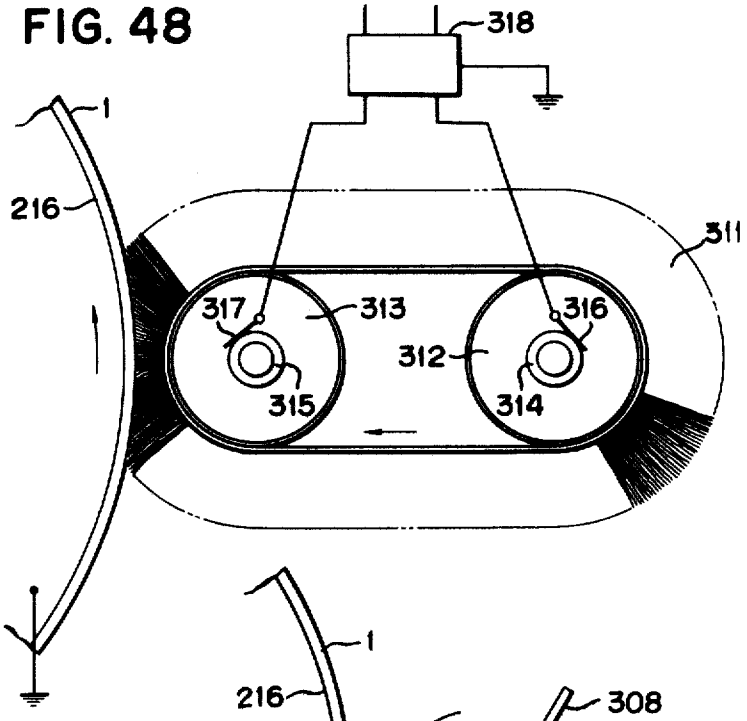
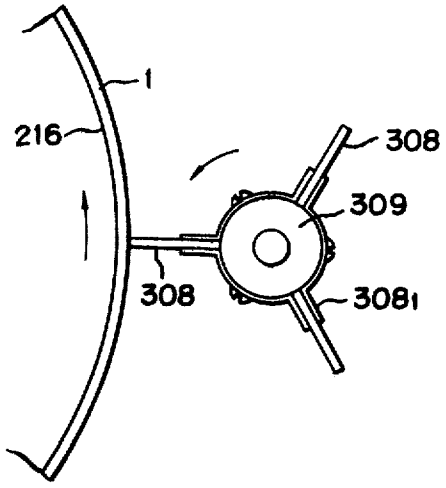


FIG. 49



ELECTROPHOTOGRAPHIC DEVICE

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

The present invention relates generally to electrophotographic copying means and, more particularly, to an electrophotographic copier wherein a static image is formed on the surface of the insulating layer of a photosensitive plate, the image is visualized by a developer, the visible image is thereafter transferred onto copying material, which is then fixed to obtain a permanent electrophotographic copy image. Additionally, the copier comprises means for cleaning the photosensitive plate after the completion of the transfer of the visible image, so that the photosensitive plate can be used over and over again. Further, the invention comprises a microfilm reader-copier.

In accordance with the conventional Xerox (trademark) copying system, a static image is formed by means of the so called Carlson process, as described in U.S. Pat. No. 2,297,691. According to said process, the photocoductive layer of a photosensitive plate is formed of amorphous selenium. The photoconductive layer is uniformly charged by direct current corona discharge, and then the original image is projected thereon to discharge the electric charge on the portion exposed to the light rays. A static image is thus formed on the surface of the photoconductive layer in accordance with light and dark pattern of the original image. The static image is visualized or developed by means of the Cascade method, using electric static powder (which is hereinafter referred to as "toner"). Thereafter, the visible image is transferred onto copying material, and it is then fixed to produce the permanent electrophotographic copy image. The photosensitive plate is then cleaned by a fur brush, and the cleaned photosensitive plate can be used over and over again.

In copying devices based on the Carlson process, it is necessary to bind an electric charge directly on the surface of the photoconductive layer and, therefore, the material used for forming said photoconductive layer must have a high resistivity. The choice of available materials is thus restricted to specific photoconductive materials which can bind a charge, and which have high resistivity, such as amorphous selenium. The sensitivity of such a conventional photosensitive plate is low, at most around ASA 10, and the static contrast of the static image is around 300 to 500 v. at most. Another problem is that, when the photosensitive plate is used over and over again, it is easy to cause damage and deterioration on the surface thereof, and because of fatigue of the photoconductor, the quality of the image deteriorates. The plate must then be replaced.

There has been proposed an alternative method in U.S. Pat. No. 3,124,456 issued to T. H. Moore. According to this patent, the photosensitive plate has a photoconductive layer composed of CdS or CdSe and a binder resin provided on a conductive base, and a transparent insulating layer is applied thereover. Radiation of the original image and the charging of the plate are carried out simultaneously from the side of the transparent insulating layer, and the static image is formed on the surface of the transparent insulating layer by making

use of a difference in building up of this charge. This difference is caused by the difference of the time constant brought about by the difference of the impedance of the photoconductive layer in the light and dark places of the original image. Since the static image is formed by means of the difference of impedances of the photoconductors, the static contrast is still low. In order to obtain an excellent image by means of this device, the capacitance of the transparent insulating layer must be larger than the capacitance of the photoconductive layer, and the thickness of the transparent insulating layer must be controlled within the range of from 2 to 6μ. With such a thin insulating layer, breakdowns can readily occur, and it is difficult to use such a photosensitive plate for a long period of time. When the thickness of the translucent insulating layer is increased, the static contrast deteriorates, and the quality of the image is lowered.

Another alternative system has been proposed in U.S. Pat. No. 3,041,167 issued to R. M. Blakney et al., according to which the photosensitive plate comprises a photoconductive layer on a conductive base, and an over-coating layer protecting the photoconductive layer. In this method, before carrying out the sensitizing charge, a charge of the polarity opposite to that of the sensitizing charge is bound onto the surface of the coating layer, or, after having carried out the charging treatment, light rays are uniformly irradiated on the whole surface. But this charging does nothing at all for the formation of the static image. Rather, after the completion of the copying cycle, a charge is trapped on the surface between the photoconductive layer and the over-coating layer which must be removed. This is done by charging the surface of said over-coating layer with a charge of the opposite polarity. Fatigue of the photosensitive plate is cured by having the trap charge of the opposite polarity against the photoconductive layer, which is not charged. The sensitizing charge is then carried out, there being no trap charge in the photoconductive layer.

In accordance with this process, the fatigue of photosensitive plate is completely cured, but in so far as the static image forming process is concerned, there is little difference between the static contrast of the Carlson process and that of this process. By carrying out the illumination of the original image after the sensitizing charge, the photocoductors become conductive in the light exposed areas, and the carrier is injected from the side of the conductive base to weaken the external field by means of the charge on the over-coating layer, and the static contrast is formed between the same and the unexposed areas. In other words, static contrast is obtained by the difference of the capacitances between the two layers, i.e., the over-coating layer and the photoconductive layer in the light exposed area and the unexposed area, and therefore, the obtained static contrast is around 300 to 500 v. at most. When compared with the photosensitive plate without an over-coating layer, there is not a large difference. On the other hand, the over-coating layer must be very thin, compared to the photoconductive layer, and therefore, it will, in time, wear out or break down, and it is not possible to protect the photoconductor layer really well. It is thus difficult to expect long term use of the photosensitive plate.

The elctrophotographic copying device of the present invention is based on a completely new process which overcomes the drawbacks of the above-noted processes. The electrophotographic copying device of

this invention is based on the process described in copending U.S. patent application Ser. No. 563,899 and Ser. No. 571,538 [of the present applicants].

In the process of this invention, fundamentally speaking, the photosensitive plate comprises a base, a photoconductive layer on said base, and a translucent insulating layer on said photoconductive layer. First of all, the surface of the translucent insulating layer is charged (the primary charge), and by making use of the field thereof, the charge layer is strongly trapped between the photoconductive layer and translucent insulating layer and in the immediate neighborhood thereof. Next, an alternating current corona discharge [(the secondary corona discharge) of the] *or a corona discharge of* polarity opposite to the primary charge, and the illumination of the original image, are carried out simultaneously. Then, light rays are uniformly irradiated on the whole surface of the translucent insulating layer to form the static image of high contrast in accordance with light and dark patterns of the original image on the surface of the translucent insulating layer.

The static contrast obtained in accordance with the present process is remarkably high. The photoconductive layer has a thickness almost the same or a little thicker than the photoconductive layer described in U.S. Pat. No. 3,041,167, and the insulating layer has a thickness the same as that described in U.S. Pat. No. 3,041,167. With these thicknesses, it is possible to obtain the static contrast ranging from 1000 v. to 1500 v.

Thus, in accordance with the present invention it is possible to employ the translucent insulating layer whose thickness is from 10μ to 50μ, and therefore, it is possible to form the layer by means of the adhesion of insulating film without being restricted to the resin coating method, and it is thus possible to properly protect the photoconductive layer. At the same time the photosensitive plate has a greatly extended useful life.

The novel process for forming a static image of high contrast on the insulating layer requires new devices different from the conventional copiers, not only for the means for forming the static image, but also for development, transfer of the image, cleaning, etc.

Firstly, it is necessary to charge the surface of the translucent insulating layer of the photosensitive plate, as mentioned above. In this case, the charge layer of the polarity opposite to that of the charge on the surface of the insulating layer should be formed in the neighborhood of the adjoining surface of the photoconductive layer and the translucent insulating layer. Therefore, the conventionally known corotron, or scorotron, or a like corona discharger, or any suitable device for charging by closely adhering an electrode onto the translucent insulating layer, can be employed. Next, as the means for irradiating corona discharge of the polarity opposite to the primary charge or alternating current corona discharge, a corona discharger whose upper portion is optically open is required, because the original image should be irradiated through said corona discharger simultaneously. Also, this corona discharger should be constructed so that the charge width and the slit exposure width are equal.

Next, as the means for uniformly irradiating light rays throughout the whole surface of the translucent insulating layer, a source of actinic radiation such as an infrared ray lamp, a fluorescent lamp, or the like should be used. As the means for developing the static image, the fur brush developing method, magnetic brush developing method, or Cascade developing method or the like can all be used, but the fur brush developing method is particularly adapted for the device of the present invention.

With the Carlson process, the contrast of the static image has been 300 v. to 600 v. at most, and therefore, it has been impossible to cover sufficiently the change of friction-generated tribo-charge caused by the environment even by employing such means as the bias method. Also, in order to produce a positive-positive image, it is necessary that the toner have a charge of the polarity opposite to that the charged portion (in the case of Xerox ® it is + and in the case of Electrofax ® it is −) so that it will adhere on the charged portion and not adhere on the non-charged portion. If the fur brush developing method is used, the toner is sprayed on at the time when the photosensitive plate and the brush are rubbed together, and it physically adheres onto the non-charged portion, bringing about the so-called fog, and therefore it cannot be used on the practical basis. Where a negative-positive image is desired, the toner should adhere to the non-charged portion, and therefore, good results can be obtained, but since the voltage of the contrast is low, it is difficult to produce a really good image. On the other hand, a fur brush is generally required to sufficiently clean off the surface of the photosensitive plate, and since the surface of the photosensitive plate is generally rough, (particularly in the case of Electrofax ®) fog is created mechanically when the plate is strongly brushed with a fur brush. The fur brush thus cannot be practically used for negative-positive either. Therefore, the Cascade method or the magnetic brush developing method have been heretofore employed. As is well known, these methods require elaborate apparatus.

However, in accordance with the process which is employed in the device of the present invention, the contrast of the static image is 1000 v. to 1500 v. At the same time, the surface on which the static image is formed is a smooth and highly insulated layer. Therefore, in case the secondary corona discharge is the direct current corona, and a positive-positive image is to be obtained, the toner of the opposite polarity adheres to the non-charged portion, or the portion where the degree of charge is low. A foggy image is thus avoided, even when spraying the toner at the same time, since the surface is smooth. Nor is there any fear that a mechanically fogged image will be created even with hard rubbing, and an excellent visible image can be formed.

The static image which is formed when the applied secondary corona discharge is an alternating current corona is mainly bonded on the dark places of the original image and is formed by the positive charge (in case when the primary charge is positive), but in the light places of the original image, a negative charge is formed, to thus form a positive and negative static image, and for the same reasons as in the case when the secondary corona discharge is direct current, foggy images are avoided. In either case, the static image has a high contrast, and the bias developing method is very effectively employed.

Since the field of the static image is strong, when the relative resistance of the fur brush, which is the carrier, is low, the attenuation of charge is remarkable. This can bring about undesired phenomena such as Lichtenberg image caused by discharge development or the like and, therefore, the resistance of the carrier should be high. It has been determined that, to produce excellent images, the resistance of the carrier must be greater than $10^8\Omega$-

cm. When the so-called magnetic brush developing method is adopted for the device of the present invention, it is necessary to use a novel magnetic brush developing device. Even in this case the carrier must be insulating, and it should be covered by a resin having a resistance greater than $10^8\Omega$-cm.

On the other hand, in the embodiment where AC corona discharge is applied simultaneously with the irradiation of the original image, the static image can be formed by the positive charge and the negative charge, and therefore at the time when development is carried out it is possible to produce a remarkably fogless visible image.

The transfer of the visible image can be carried out by applying a corona discharge from behind the copying material, which is overlaid on the photosensitive surface, as is conventionally done. But, insofar as the present invention is concerned, the static image forming surface of the photosensitive plate is the highly insulating layer, and therefore when the corona discharge is applied from the side of the copying material, after laying the copying material thereon, the charge caused by the corona discharge is trapped on the photosensitive plate, and it is easy to create a large electric field between the copying material and the photosensitive plate. Therefore, transfer of the image is poor.

On the other hand, the press-transfer method, which cannot be done in accordance with the Carlson process, can be effectively adapted as the image transferring means in the present invention. Thus, in the embodiment wherein the direct current secondary corona discharge is applied simultaneously with the irradiation of the original image, and when the formed static image is developed as a positive-positive image, it is possible to obtain excellent transfer of the image by laying the copying material on the visible mage surface of the photosensitive plate, and pressing the copying material against the photosensitive plate with a conductive elastic roller.

The charged toner between the copying material and the photosensitive plate is considered to be divided by the difference of capacities between the two. Of course in this case, most of the charge on the photosensitive plate which controls the toner forms the electric field between the same and the charge induced on the side of the copying material to free the toner. Generally speaking, papers are used as the copying materials, and since the capacitance thereof is larger than the capacitance of the insulating layer and the photoconductive layer of the photosensitive plate, more of the charged toner is moved to the copying material, and excellent transfer of the visible image is obtained.

In this case, it is especially important that the elastic conductive roller and the base of the photosensitive plate have the same potential, and they are preferably grounded.

However, in the embodiment employing an alternating current secondary corona discharge, the static image is mainly formed by the primary charge remaining in the dark portion of the original image and, therefore, in order to obtain the positive-positive image, the visible image is produced by the toner charged in the polarity opposite to the polarity of the charge of the static image. It is thus impossible to effect transfer by simple pressing. In this case, before the visible image is transferred, the surface of the photosensitive plate is charged uniformly by a corona discharge, and then when the copying material is pressed onto the surface of the photosensitive plate, it is possible to obtain excellent transfer of the image.

The reason for this is not apparent yet, but when the primary charge in the static image forming process is positive, and the charge of the corona discharge before transfer of the image negative, it can be considered in the same manner as when a DC secondary corona discharge is carried out simultaneously with the original image irradiation. But when the charge caused by the corona discharge before the transfer of the image is positive, the negative charged toner is charged positive by the positive corona discharge, and it is considered to be expelled against the positive charge on the insulating layer to accelerate transfer of the image.

Of course, when the secondary corona discharge is direct current, the charge before the transfer of the image is not necessary, but it is possible to produce an even better result if it is carried out before the image is transferred.

The copying material laying over the photosensitive plate is tightly adhered on the surface of the insulating layer because the voltage of the static image is high on the insulating layer. Therefore, after completion of image transfer, peeling off the copying material from the photosensitive plate is impossible by only jetting air thereagainst as is done in the conventional Xerox system. However, the surface of the photosensitive plate of the device of the present invention is a hard, durable insulating layer, and therefore the copying material can be peeled off forcibly by a scraping member, and at the same time by jetting air thereagainst.

Cleaning of the surface of the photosensitive plate is complicated by remarkably high voltage of the static image formed on the surface of the insulating layer of the photosensitive plate. This is particularly true because the charge is not reduced when the image is formed. Thus, if removal of remaining developing agent is tried by the friction of a fur brush driven at a high speed as in conventional devices, the insulating layer is charged because its high resistivity, and the developer is adhered thereon even more tightly. Cleaning is thus not possible. However, when cleaning is carried out while imparting an appropriate bias voltage between the photosensitive plate and fur brush, it does become possible.

On the other hand, since the surface of the photosensitive plate, i.e., the insulating layer, has high physical strength, there is no fear that the surface of the photosensitive plate will be damaged, even if rubbing is carried out under comparatively strong pressure.

Therefore, in the device of the present invention, the cleaning member is formed of a highly elastic or resilient material, such as rubber, synthetic resin or the like, and the cleaning is carried out by rubbing the surface of the insulating layer while applying appropriate pressure thereon. Excellent cleaning is attained and, at the same time, it is not necessary to employ high speed rotation. Because of this feature, the device becomes simple and can be produced at low cost, which can be accounted to be an advantage of the invention. Needless to say, this method cannot be applied to the photosensitive plate of the conventional type wherein the static image is formed on the photoconductive layer because the surface of the photoconductive layer will be damaged by the friction of the elastic body.

In carrying out the cleaning process in accordance with the present system, the elastic cleaner can be made conductive, and a voltage of polarity opposite to that of the remaining developer can be applied to the cleaner,

so that the remaining developer is attracted statically onto the cleaner. This produces an even better effect. In accordance with another aspect of the present invention, it is possible to carry out the printing operation while reading the original copy during the copying process. In other words, it is possible to produce a novel reader-printer according to which it is not necessary to change the device in either case of reading or printing. This is because when the corona discharge is applied at the same time as the original image is irradiated, a leaking light of around 10 lux is permissible. The static image is formed on the surface of the highly insulating layer by making use of the charge trapped strongly within the photoconductive layer, and the static contrast is not reduced. It is thus possible to form a static image having static contrast in excess of 500 v.

In conventional reader-printers, whether the photosensitive plate is of the silver salt system or the Carlson process type, when leaking light projected from the reader portion is present during the exposure process, a foggy image or extreme deterioration of density may result. It is thus impossible to read and print at the same time.

Therefore, reading is done in a conventional reader-printer by inserting the film with a movable reflecting mirror set at a predetermined reading position. Thereafter, by rotation or transfer of the mirror the light image of the film is projected onto the photosensitive plate for printing. It is necessary to completely cut off the leaking light from the reader portion during printing. Since the reflecting mirror is large, it is necessary to prevent vibration or bending during and after movement, so a large protective frame is necessary. This involves a large, high precision driving mechanism. This inevitably increases cost of production, and the operation thereof is complicated. Furthermore, the speed for copying operation is reduced because of the time required for the movement of the reflecting mirror.

However, in accordance with the device of the present invention, even if there is more or less leaking light present, the printed image is still good. It is thus possible to use a fixed half mirror (i.e., semi-silvered) in place of the movable, fully reflecting mirror of the conventional devices. The reader-printer of the present invention thus has none of the drawbacks of the conventional devices.

A general object of the present invention is to provide an electrophotographic copying device effective to carry out the novel processes for forming the static image as described in the above-noted copending applications.

Another object of the present invention is to provide an improved electrophotographic copying device which is capable of forming a static image, developing the same, transferring the image into copying material and cleaning the transfer surface.

A further object of the present invention is to provide an effective charger capable of charging a photosensitive plate at the same time as the irradiation of the original image.

A still further object of the present invention is to provide novel fur brush and magnetic brush developing means effective for the device of the present invention.

Another object of the present invention is to provide press-transferring means which does not require the application of an electric field from outside and the precharge image means which impart corona discharge before the transfer of the image is carried out.

Yet another object of the present invention is to provide novel cleaning means for cleaning the surface of the photosensitive plate.

Still another object of the present invention is to provide novel means for automatically peeling off the copying material from a photosensitive plate.

A still further object of the present invention is to provide a novel electrophotographic copier wherein reading and copying can be carried out simultaneously.

A further object of the present invention is to provide a novel electrophotographic copier wherein the photosensitive plate may be shaped in a drum form or in a plane form.

The above and other objects and advantages of the present invention will become clear from the following description of several embodiments thereof, which will be described with reference to the attached drawings, in which:

FIG. **1** is an enlarged, cross-sectional view of the photosensitive plate used in the device of the present invention;

FIG. **2** is a perspective view, partially cut away, of an embodiment of the device of this invention, wherein the photosensitive plate is made in the form of a plane board, and is moved reciprocatingly in the horizontal direction;

FIG. **3** is a perspective view, partially cut away, showing a portion of the internal mechanism of the embodiment of FIG. **2**;

FIG. **4** is a diagram showing the optical system of the same embodiment;

FIG. **5** is a perspective view of the left half portion of the device for forming the static latent image;

FIG. **6** is a plan view showing the lower portion of FIG. **5**;

FIG. **7** is a diagram showing the transverse cross-section along the line VII—VII of FIG. **6**;

FIG. **8** is a perspective view of the photosensitive plate receiver base;

FIG. **9** is a diagram showing the reciprocatingly moving portion of the receiver base;

FIG. **10** is a perspective view, partially cut away, showing the underside of the developer and the cleaner;

FIG. **11** is a perspective view of the device of FIG. **10**, mounted in the copier;

FIG. **12** is a perspective view showing a portion of the developer;

FIG. **13** is a horizontal cross sectional view of FIG. **12**;

FIG. **14** is a horizontal cross sectional view of the developer of FIG. **13** in the cleaning position;

FIG. **15** is a perspective view, partially cut away, of a modified embodiment of the developer;

FIG. **16** is a vertical cross sectional view of FIG. **15**;

FIG. **17** is a perspective view showing an embodiment of toner recovering means provided for recovering the toner which is scraped off the photosensitive plate;

FIG. **18** is a diagram showing the application of a voltage of the opposite polarity to the charge of the toner applied to the cleaning plate;

FIGS. **19–21** are cross sectional views showing operation of the transfer means;

FIGS. **22** and **23** are perspective views of the fixing mechanism and the mechanism for peeling off of the transfer paper;

FIGS. **24** and **25** are diagrams showing operation of the devices of FIGS. **22** and **23**;

FIG. 26 is a circuit diagram for the embodiment of the invention shown in FIG. 2;

FIGS. 27 and 28 show high voltage electric source circuits of the static image forming portion of the invention, FIG. 27 showing the case wherein the alternating corona discharge is used for the secondary charge and FIG. 28 showing the circuit when direct current is used for the secondary discharge;

FIG. 29 is a diagram of an embodiment wherein the photosensitive plate containing the powder image is charged before the image transfer operation is carried out;

FIG. 30 is a diagram showing the front view of the device for preventing the shield plates of the discharger on both sides of the light path of the light source from coming into a part of the light path;

FIG. 31 is a diagram showing the side view of FIG. 30, with the latent image forming means located at the center portion;

FIG. 32 is a diagram showing the front view of the device of FIG. 30, wherein the latent image forming means is on the opposite position;

FIG. 33 is a perspective view, partially cut away, showing a micro-film reader-printer embodiment of the invention;

FIG. 34 is a diagram showing the optical system of the embodiment of FIG. 33;

FIGS. 35 and 36 are diagrams showing the enlarged side view of the paper feeding mechanism and the transfer mechanism;

FIG. 37 is a perspective view, partially cut away, of an embodiment of the present invention employing a drum form of photosensitive plate;

FIG. 38 is a vertical cross sectional side view of the embodiment of FIG. 37;

FIG. 39 is a perspective view of the fur brush belt for development and the toner supplying portion used for the embodiment of FIG. 37;

FIG. 40 is a vertical cross sectional view of FIG. 39;

FIG. 41 is a cross sectional view of the end portion of the fur brush belt driving roller;

FIG. 42 is a perspective view showing a magnetic brush roll embodiment of the developer;

FIG. 43 is a cross sectional view of FIG. 42;

FIG. 44 is a horizontal cross sectional view of FIG. 42;

FIG. 45 is a perspective view of the cleaning means;

FIG. 46 is a perspective view of the cleaning roller;

FIG. 47 is a diagram showing operation of the cleaning roller;

FIG. 48 is a diagram showing an embodiment wherein an endless belt of fur brush is employed as a cleaning roller; and

FIG. 49 is a diagram showing a side view of the cleaning roller.

The photosensitive plate used in the device of the present invention comprises, as shown in FIG. 1, three layers prepared by forming the photoconductive layer 1_2 on the conductive base 1_1, and by forming the translucent, highly insulating layer 1_3 on the photoconductive layer 1_2. Layer 1_3 is a material of high wear resistance having a smooth surface.

It is noted that, as used herein, "translucent" means transparent, semi-transparent, or translucent to activating (i.e. actinic) radiation.

As the base 1_1 of the photosensitive plate, paper with metal plate or metal foils such as Al adhered thereon may be used. Humidity absorbing paper is preferred. The base can be formed of other insulating materials or may be similar to the translucent insulating layer 1_3 in place of said conductive base. In such a case, the photosensitive plate is used by placing the same on the conductive supporter.

As the translucent, insulating layer 1_3, fluorin resin, polyester resin, polyethylene resin, polypropylene resin, polycarbonate resin, acryl resin, vinyl resin, epoxy resin or the like can be used, and Mylar, Teflon, Vinylon (trademarks) or the like are most appropriate for the purpose, and they are used in the thickness ranging from 10 to 50μ.

As the photoconductive layer 1_2, [amorphous selenium,] CdS, CdSe, CdTe, Zno, [ZnS,] InSb, Te, Se, and organic semi-conductors or the like can be used. It is not necessary to bind charge directly on the photoconductive layer, and therefore, it is possible to use high sensitivity photoconductors. The sensitivity of the photosensitive plate is therefore remarkably high. Thus, when the photoconductor is an n-type semi-conductor, it is preferable that the polarity of the primary charge for forming the static image should be positive, and in the case of p-type semi-conductors, it is preferable that it should be negative.

FIG. 2 and FIG. 3 show the electrophotographic copier of the present invention wherein the photosensitive plate is in a plane, and is reciprocatingly moved in the horizontal direction. The optical system thereof is shown in FIG. 4. The image of the original copy 2 (FIG. 4) is formed or projected on the photosensitive plate 1 in the static latent image forming portion through reflecting mirror 3, image forming lens 4, and reflecting mirror 5 to form the static latent image in accordance with the light rays of the original copy 2. Then the photosensitive plate is moved horizontally in the direction as is shown by an arrow a to the position 1', and the development and the transferring of the image are carried out. After the completion of these operations, the photosensitive plate is moved in the opposite direction as shown by arrow a', during which time the copying paper is peeled off to transport the copying paper to the fixing portion. Thereafter the photosensitive plate is cleaned and returned to the static latent image forming portion.

A large rectangular opening 8 is provided on the upper surface of the front portion of the main body 7 of the device (on the right side in FIG. 2 and FIG. 3) and a transparent original copy receiver base 9, made of glass or synthetic resin, is inserted therein. The original copy is pressed thereon by the pressing plate 10 as shown in FIG. 2. The pressing plate 10 is fixed onto the main body 7 by means of a retainer 11 and screws 12. The pressing plate 10 is made of rubber cloth or the like, and by covering the whole surface of the original copy receiver base 9, light rays are prevented from leaking outside. A handle 13 is provided for opening and closing the pressing plate.

Two guide rails 14_1 and 14_2 are fixed onto the body 7 by bearings 15 across the body 7 with the space therebetween being a little larger than the width of the above mentioned original copy receiver base 9, and being right below the same. The illuminating means L composed of two shades 18_1, and 18_2, and the lamp l such as a fluorescent lamp or the like are provided with a space G between the frame plates 17_1, and 17_2, which are united to the moving guide pieces 16_1 and 16_2 fitted to the respective rails 14_1 and 14_2, and the original copy 2

is illuminated from below through the transparent original copy receiver base **9**.

Flexible member **19**, which is a rope, belt, chain or the like, has its respective end portions fixed on the central portion of the side surface of shades 18_1, 18_2 by means of the lock member **20**. The flexible member **19** is suspended on the four guide rollers 21_1 and 21_2 (only two shown) fitted to body **7**, and is also hung on drive pulley **24** which is interlocked to the motor M_1 fixed on the body **7** or the frame 7_1 inside the body **7** by means of the lock washer **22**, and screws **23**. By means of the rotation of motor M_1 the lamp is moved from the left side of the body **7** (on the front side in FIG. **3**) to the right side of the body **7** (the rear side in FIG. **3**), and the original copy **2** is scanned with light rays, and the backward movement thereof is attained by the reverse rotation of the motor M_1.

In order to lead the image of the original copy **2** illuminated by the illuminator L to the static latent image forming portion at the rear part of the device through the space G, the front reflecting mirror **3** and the rear reflecting mirror **5** are provided across the body **7** with an angle of about 45° to the copy supporter **9**. Arms **25** are fixed onto the front and rear portions of the body **7** (the front portion being not shown in the diagram) by screws **26**, and the shaft **27** is provided on the arm **25** (FIG. **3**). The rear shaft rod is not shown in FIG. **3**. The front mirror **3** is supported on the holder 28_1 and the rear mirror **5** is supported by the holder 28_2, and the respective holders are provided on the front shaft rod **27** and the rear shaft rod (not shown) in such a manner that the inclination angle thereof can be freely adjusted.

The lens **4** for forming the image is mounted on the center line of the front and rear portions of the body **7**, for example, on frame 7_1 in FIG. **3**.

The static latent image forming portion is provided below the reflecting mirror **5**, and in FIGS. **5–7** the static latent image forming means E is illustrated. This comprises discharger chamber **30** for the primary charge, and light source lamp chamber **31** for all out illumination with the lower surface opened. These elements are provided at the lower surface of the frame plate **29**, and the secondary discharge chamber and slit **32** for all out exposure is formed between the two chambers **30** and **31**. The primary discharger is provided with a discharging wire **34** within the sealed case **33** inside chamber **30**. A bulb **35** is contained in chamber **31**, and a secondary discharge source **36** is provided in secondary chamber **32**. The discharge source supports **37**, **38**, and bulb socket **39**, are insulatingly mounted on insulating frames 40_1, 40_2 on both side of frame **29**, and are respectively provided with lead wires X, Y, and Z.

The static latent image forming means E is moved towards the left side from the right side of the body **7** above the photosensitive plate **1** in the direction opposite to the direction of the movement of illuminating means L, when the photosensitive plate **1** stops at the position of the dotted line of FIG. **2**. As soon as the static latent image formation is completed, it is moved back in the opposite direction. A pair of guide rails 41_1 and 42_2 are mounted on body **7** by the bearing **42** and moving pieces 43_1 and 43_2, fixed on frame **29**, are supported on rails 41_1, 41_2. Each end of the flexible member **44** is connected to the central portion of frame **29**, and flexible member **44** is supported on the three guide rollers **45** (two of which are not shown) fixed onto body **7** and two driving rollers 45_1. The motor M_3 fixed onto body **7** by the screw **46** is interlocked to driving rollers 45_1 through a train of speed reducing gears **47**, and by the normal as well as reverse rotations of the motor M_3, the latent image forming means E is reciprocatingly moved. Bearing **48** (FIG. **2**) supports the train of speed reducing gears **47** and drive roller 45_1, and stop screws **49** are also provided.

The photosensitive plate base **50** is shown in FIG. **8**, and has photosensitive plate **1** thereon. It is reciprocatingly moved back and forth between the static latent image forming portion and the opening **51** (FIG. **2**), where the image-bearing paper is discharged. This reciprocating mechanism is of the same type as that used for the static latent image forming means E and the illuminating means L. Namely, parallel rails 52_1 and 52_2 are provided in the front and rear directions on both right and left sides of body **7**, and are fitted onto body **7** by means of the bearing **53**. Sliding piece **54** is provided on the lower surface of receiving base **50**, and a flexible member **55** is fitted onto receiving base **50**; 56_1 and 56_2 are the guide rollers thereof. Drive motor M_2 drives the photosensitive plate receiver base, and shaft **57** is connected to the shaft of the motor M_2 through the train of speed reducing gears **58**, and has the drive pulley **59** and drives the flexible member **55**. Bearing **60** and stop screws **61**, **62** are also provided.

As described in the foregoing, when the motor M_2 is rotated in the normal direction, receiving base **50** and the photo-sensitive plate **1** (fixed thereon by screws 50_1) are moved forward from the position shown by the dotted line to the position shown by the solid line, and on the reciprocating path thereof, the developer D (shown in FIGS. **10–16**) is provided right above the photosensitive plate **1** so as to have the same faced against the photosensitive plate **1**.

With reference to FIGS. **10** and **11**, yoke **65** of the developer D, has the lower surface thereof opened, and at the opening portions on both right and left sides thereof are the end surface covers 65_1 and 65_2 made of non-magnetic materials and fixed by means of screws **66**. In the internal hollow portion of yoke **65** the non-magnetic materials 68_1 and 68_2 are provided for controlling the magnetic path of the stick form permanent magnet **67**. Magnet **67** and non-magnetic materials 68_1 and 68_2 are fixed onto the end surface covers 65_1 and 65_2 by means of screws 69_1 and 69_2. Yoke **65** is removably hung on body **7** by the hanger **73** fixed on the upper surface thereof by means of screws **72** and clip **76** fixed to frame **74** by means of the screws **75**. As is shown in FIGS. **2** and **11**, the developing agent box **77** is fixed onto body **7** by screws **79** and the supporting board **78** right below the lower moving surface of the photosensitive plate receiver base **50**, so as to have the said developing agent box faced against the opening of the lower surface of yoke **65**. Developer **80** is prepared by mixing the visualizing particles (toner) and a carrier having a specific resistance of over $10^8\Omega$-cm. so as to coat the surface thereof with an insulating film. The particles are placed in the developing agent box **77**, and a stirrer **81** is rotated by the motor M_4 (see FIG. **2**). A train of gears **82** consisting of gears 82_1, 82_2, 82_3, 82_4 and 82_5 imparts rotations from the motor M_4 to the shaft 81_1 of the stirrer, and screws **83** fix the motor M_4 onto body **7**.

In operation, when the photosensitive plate **1** and the photosensitive plate receiving base **50** are not positioned for developing, a magnetic path is formed through both ends of the yokes 65_1, 65_2, and developer **80** within the developing agent box **77** is attracted by magnet **67** and

a magnetic brush is formed thereby. The moving photosensitive plate **1** is subjected to friction against toner which is frictionally charged and the static image is developed thereby.

Developing agent box **77** is removable through an opening (not shown) provided on the right side wall of the body **7** so that developer can be added as required. It is also necesssary to remove developer adhered to the developer D. For this purpose, as shown in the diagrams of FIGS. **13** and **14**, the magnet **67** is formed as a round rod and north and south poles are set on the symmetrical positions on the diameter. To clean the developer, poles are rotated by an angle of 90° with the handle **84** (FIG. **12**) from the outside of the end surface cover 65_2, and the north pole and the south pole are turned cross-wise so that the magnetic path will go within the yokes **65** and **65'**, and no magnetic field will be produced outside thereof. Developer will then fall off.

FIGS. **15** and **16** show a modification of the developing means. The developing box **86** is hung down above the photosensitive plate **1** in the same manner as in the case of the above-mentioned yoke **65**, perpendicularly to the direction of the reciprocating movement of the photosensitive plate **1**. A fur brush plate **88** with fur brush **87** pointed downwardly is hung on the lower surface of the bottom 86_1. If rabbit or badger fur is used, they must be refined before they are employed. It is also possible to paste the fur on the plate **88**. Small holes or grooves 86_2 and 88_1 are provided on bottom 86_1 and plate **88**, respectively spaced from brush **87**. The plate **88** of fur brush **87** is placed so that when developing is not being carried out, the holes 86_2 and 88_1 are not in registration. When developing is carried out, the motor M_4' (fixed on the lower surface of the supporting frame 90_2 of the developing box **86** with the bracket 90_3) is rotated to drive eccentric plate **91**, and the rotation is transmitted to rod **93** having the eccentric pin **92** provided on plate **88**, and fur brush **87** is reciprocatingly moved against the direction of the photosensitive plate **1**, and the developer which falls at the time when the holes 86_2 and 88_1 are in register is brushed on the photosensitive plate by means of brush **87**, to carry out the developing.

In operation, fur brush **87** works as the carrier, so toner alone can be used as the developer. As mentioned above, furs of a rabbit or a badger can be used or human hair, synthetic fibers or the like can be used, provided that whatever is used has a specific resistance over 10^8 Ω-cm. The length of the fiber should be adjusted so that when the fur touches the photosensitive plate, they should be bent, as toner falling from hole 88_1 should not fall on the photosensitive plate directly. The advantage of this embodiment is that toner adhered on the white portion of the image on the photosensitive plate, which could cause fogging, is removed by the fur brush by means of triboelectricity (i.e. static charge) between the fur brush and the photosensitive plate. A coil spring **94** is used for hanging the fur brush plate **88**.

The photosensitive plate **1** on base **50** is continuously advanced while receiving the above mentioned developing treatment, until it arrives at the image transferring position D. When the transferring of the image is complete, it is cleaned and brought back to the static latent image forming position, where it stops.

In FIG. **2**, C stands for the cleaning means, and the detailed explanations thereof are given in FIGS. **10**, **11**, **17** and **18**. A plate form cleaning plate **96** is fixed onto the holder **97**, the plate form cleaning plate **96** being obtained by wrapping the elastic body, or hard core such as rubber or synthetic resin or the like with a cloth with cushion material in between the rubber or synthetic resin and the cloth. The fixed plate form cleaning plate **96** slidingly rubs the surface of the insulating layer 1_3 on the upper surface of the photosensitive plate **1** to remove the toner which remains after the transferring of the image, because of the durability of the photosensitive plate to effect perfect cleaning by imparting a much stronger frictional resistance than can be used in the Xerox ® system.

The toner **80'** which has been removed from the plate falls into the toner box **77** after the photosensitive plate **1** and the base **50** have passed, but when a large amount of toner is retained at the end portion of the cleaning plate **96**, there is a tendency for part of the same to be pinched between the cleaning plate **96** and the photosensitive plate **1**. It is therefore preferable that the toner be recovered as quickly as possible. As shown in FIG. **17**, a space **98** can be provided between the cleaning plate **96** and the holder **97**, and air in the space taken out by means of pump **99** through the pipe **100**. Recovered toner is collected in a recovery box (not shown) provided between the pump **99** and the pipe **100**. and is moved appropriately into the developer container. Screws **101** fix the pump **99** onto the frame **102**.

The charge voltage of the static latent image of the device of the present invention is high, as mentioned above, and therefore the remaining toner is difficult to remove. Therefore, if necessary, conductive rubber can be used for the cleaning plate **96**, as shown in FIG. **18**, or a conductive film can be provided thereon. Holder **97** is insulated from the cleaning plate **96** by means of the insulating material **103**, and a DC voltage of around 300 to 500 v., of the polarity opposite to that of the toner charge, is imparted from the electric source **104**. The toner is thus removed by electric attraction. A switch **105** is for changing polarity.

The cleaning means C functions when photosensitive plate **1** is returned, and the developing means D functions when plate **1** is advanced. The conversion of function between cleaning and developing is carried out mechanically in interlocking relation to the reciprocating movement of the photosensitive plate receiver base **50**. In particular, the supporting shaft **106** is fixed onto frame **7** by the bearing **107** across the body **7**, as shown in FIG. **2** and FIG. **11**. Hangers 108_1 and 108_2 are provided on the right and left sides of the supporting shaft **106**. The receiving member **110** is fixed onto the upper surface of developing means D by means of screws **109** and is hung on the front portion of the hanger by the shaft **111**. The rear portions of the hangers 108_1 and 108_2 are fixed onto cleaning means C by the screw **112**, and the developing means D and the cleaning means C are thus connected in a seesaw manner, so that in case one of them is elevated, with the shaft **106** as the fulcrum, the other is lowered. As shown in FIG. **11**, in case the developing means D is elevated (no developing operation is carried out away from the photosensitive plate **1**), the hanging means **73**, the top portion of which is enlarged, is held by the clip **76** thus retaining developing means D at this position. On the contrary, in case the cleaning means C is removed from the photosensitive plate **1**, the clip **76** and the hanger 73_1 keep the cleaning means C at the raised position. Hangers **76**, **73**, 76_1, 73_1 are provided at three places, i.e., on the right,

left and in the center, but in the diagram of FIG. **11**, only one (on the right) is shown.

On the upper surface of the photosensitive plate base **50**, as is shown in FIG. **8**, the projections **113** and **114** are provided. When the photosensitive plate is moved, projection **113** pushes up the lower surface 97_1 of the side plate of the cleaning means C (FIG. **10**) and the cleaning means C is retained by the hangers 73_1 and 76_1. At the same time, the developing means D is lowered to the developing position by releasing hangers **73** and **76**. When receiver base **50** is returned after the image transferring operation is finished, the projection **114** pushes the projecting portion 65_3 (FIG. **10**) of the end portion cover 65_1, and the developing means D is lifted to the non-operational position, and cleaning means C is lowered to the operational position. Operations are carried out in the same manner with developing means of FIGS. **15** and **16**.

The image transferring process, as carried out immediately after the developing process at the time when the photosensitive plate **1** is moving is hereinafter explained with reference to FIGS. **19–22**. An arc-shaped guide plate **115** is attached to body **7** by the ear piece 115_1 fixed with the screw **116** on the right and left sides. Adjacent plate **115**, the shaft 117_1 of the press-roller **117** is fixed onto the frame **119** by the screw **120**. The copy paper receiver base **121** is tilted towards guide plate **115** aslantly above press-roller **117**, and is fixed onto the body **7** by means of the screw **122** and the ear piece 121_1. A paper feed-roller **123** is placed on the copying paper P laid on the receiver base **121**, and rotation of the motor M_5 is transmitted to the pulley **124** on the shaft 123_1 by means of the belt **125**. The motor M_5 is mounted on the base **126** on body **7**.

A sheet of copy paper P is first forced against plate **115** by roller **123**, and the end portion thereof arrives at the path of the photosensitive plate **1** as is shown by P' of FIG. **20**. When the photosensitive plate **1** moves under roller **117**, paper P is forced under the press-roller **117**, and both the photosensitive plate **1** and the copying paper P are closely adhered to each other. The roller **117** is roated by means of friction against plate **1**. As receiver base **50** and photosensitive plate **1** continue to move, the assembly is removed from press-roller **117**, as shown in FIG. **21**, and the projection **128** (FIG. **8**) provided on the receiver base **50** operates microswitch MS_2 fixed on the body **7**, causing rotation of the motor M_2 for driving the photosensitive plate to reverse. The powder image is transferred to the copy paper by press-adhesion with the photosensitive plate **1** as shown in FIG. **24**. On the return movement of receiver base **50**, the photosensitive plate **1**, and copy paper P, copy paper P is peeled off and sent to the fixing process. The mechanism therefor is explained with reference to FIGS. **22–25**.

During the return movement of base **50**, the press-roller **117** is rotated in the direction shown by the arrow in FIG. **24**, and the saw-toothed gear **130** fixed on the shaft thereof, 117_1 is also rotated in the same direction. The V-shaped lever **131** fitted thereto, which was in the tilted or escaped state as is shown in FIG. **20** during paper feeding so as not to disturb the powder image on the photosensitive plate **1**, is raised by rotation of gear **130**, with the shaft **132** on guide plate **115** as the fulcrum. The lower end 131_1 of lever **131** touches photosensitive plate **1** and peels the copy paper P off. Paper P is guided towards the guide plate **115**, and at this time blower **133**, shown in FIG. **23**, is turned on, and air is jetted against the back of the copying paper P from the nozzles 135_1, 135_2 at the ends of the conduit **134** connected to blower **133**, through the openings 115_2 in guide plate **115**. Copy paper P is thus pressed against the press-roller **117**, and in accordance with the rotation thereof, is guided as shown in FIG. **25**. At the upper portion of said roller, it is transferred onto the conveyor **137** of the fixing means H along the guide plate **136** fixed on body **7**.

Fixing means H, as shown in FIGS. **22** and **25**, is located below the copy paper receiver base **121**, and comprises conveyor **137** and the heater H. Horizontal conveyor **137** is suspended between the rollers 138_1 and 138_2, mounted in parallel with body **7** in the front and rear directions, by means of bearings (not shown). Motor M_6 drives conveyor **137** through the pulleys **139**, **140**, belt **141** and roller 138_2. Copy paper P is heated by the heater H, comprising an infrared ray lamp **142** and a cover **143**, and the resin toner is melted on the copy paper P and the image is fixed.

The paper P bearing the image is discharged from the device at the outlet opening **51** (FIG. **3**) on the front surface of the body, by means of the conveyor **137**.

Electrical circuitry for operating the device is illustrated in FIGS. **26–28**.

FIGS. **27** and **28** show the high voltage source (HVS) circuit for carrying out the charging process of the static latent image forming portion, and correspond to the boxes labelled HVS and HVS' in FIG. **26**. The electric source (50–60 c.p.s., 100 v.) is supplied to the primary coil of a transformer **150** to generate a voltage of about 5 kv. on the secondary coil. By means of the rectifier **151** and the parallel R-C network **152**, **153**, it is converted into direct current, and the output terminal X is connected to the terminal X of the primary charger of the static latent image forming portion (FIGS. **5** and **6**). In the embodiment shown in FIGS. **26** and **27**, the photosensitive plate **1** is presumed to be a P-type semiconductor, and the polarity of the input terminal is set up to be positive. In this case, the other pole R of the electrical source is grounded. In the case where the alternating corona discharge is carried out for the secondary charge, the secondary voltage of about 6 kv. is generated as shown in FIG. **27**, and is supplied to the secondary discharge source **36** through the terminal Y. In case the secondary charge of direct current of opposite polarity is carried out, as shown in FIG. **28**, the direct current, of the opposite polarity obtained by the rectifier **154** and the parallel R-C network **155**, **156**, is supplied to the secondary discharge source **36** through the terminal Y.

When the electric source switch S_1 (FIGS. **2** and **26**) is closed, electricity is supplied through the fuse F to the heater H for fixing the powder image (FIGS. **22** and **25**), the conveyor motor M_6 and the motor M_4 for stirring the developer (FIG. **2**), and they start their respective operations. These are always operating even when the start switch S_2 is "on". The start switch S_2 (FIGS. **2** and **26**) is then closed, and the relay R_1 is operated by the constant closing contact $(R_2\text{-}1)-R_1$, and the contact R_1-1 is closed, short-circuiting start switch S_2 so that the circuit is maintained when the button is released. At the same time, the relay R_4 is magnetized through the constant closing contact R_{-1} to close the contacts thereof R_4—1, 2, and therefore the electric current is passed to the following: $(R_4\text{-}1)$—constant closing contact of $(R_6\text{-}1-1)$—Motor M_1—(R-

$_6$-2−1)(R_4-1)—(R_6-3−1)—Motor M_3 (or M_6)—(R_6-4−1)(R_4-2)—(R_7-1)—M_5.

In particular, the illuminator L drive motor M_1 (FIG. 3), the motor M_3 for driving the static latent image forming means E (FIG. 2), the motor M_5 for feeding paper (FIGS. 19 and 22) start rotating. At the same time, electricity is passed to the high voltage electric source HVS (FIGS. 27 and 28) through the constant closing contact R_6-7, and electricity is supplied to the primary discharge source 34 through the terminals X and Y, the secondary discharge source 36, to the all-out-exposure lamp 35 through the terminal Z, and to the illuminating lamp l.

Therefore, the original copy illuminating lamp L starts to proceed towards the right side of the body from the position of FIG. 3, and the latent image forming means E starts to proceed towards the left side of the body from the position of FIG. 2. The image of the original copy is formed on the photosensitive layer 1_2 of the photosensitive plate 1 on the receiver base 50, in accordance with the optical system of FIG. 4, through the slit G of the illuminating means L, the mirror 3, lens 4, and through the exposure slit 32 of the latent image forming means E.

In other words, the static latent image forming means E is moved from the right to the left against the surface of the photosensitive plate 1 which is stopped at the rear portion of body 7, and then the primary charge is uniformly carried out on the photosensitive plate 1 by means of the corona discharge of 5 kv. D.C. by using the primary discharge source 34. Then the secondary charge by means of the discharge source 36, or the alternating corona discharge, and the illumination of the light rays are carried out simultaneously. Further, the all-out-exposure is carried out directly thereafter by means of the lamp 35. Said all-out-exposure is carried out in order to improve the contrast and the stability of the latent image.

By carrying out the above mentioned static latent image process against the photosensitive plate made of three layers (FIG. 1), the charge of the primary chage polarity remains at the dark place where no light is irradiated, on the surface of the insulating layer 1_3, or the said charge is reduced and the charge of the same polarity as that of the secondary charge remains (depending on which arrangement is employed), and the surface potential difference between the light and dark places is 1,000 v. to 2,000 v. This value is remarkably large when compared with the several tens of volts to several hundred volts achieved with the Carlson process.

When the static latent image formation is completed as set forth above, the push piece 160 provided on the frame 29 (FIGS. 5 and 6) closes microswitch MS_4 fixed on the left side of the body 7, and the electric circuit is closed to operate the relay R_6, and the contacts thereof R_6-1−9 are moved in the opposite direction to that shown in FIG. 26. The drive motor M_3 of the above mentioned static latent image forming means E, and the motor M_1 for driving the original copy illuminating lamp are respectively converted to the reverse rotation circuit by means of the respective contacts

(R_6-3−2)—(R_6-4−2)

(R_6-1−2)—(R_6-2−2), and the above mentioned static latent image forming means E and the original copy illuminating means L are driven back. The electric source circuit of the static latent image forming portion is cut off by the contact (R_6-7), as are the electric sources of the discharger for carrying out the primary charge, the secondary charge and the illumination of the all-out-exposure of the original copy. When push piece 160 releases the microswitch MS_4, the relay R_6 is retained in the closed position by means of the contact R_6—5, so the returning operation continues.

When the static latent image forming means and the original copy illuminating means (which are moved at the same speed the same distance) are returned to the original positions (FIGS. 2 and 3) the push piece 161 provided on the static latent image forming means on the opposite side of the pushing piece 160 (FIG. 6) closes microswitch MS_3 provided on body 7, and by means of MS_3—(R_6-6)—R_5 the relay R_5 is operated, and by means of the contact R_5-1 thereof, the circuit of the relay R_4 is opened, and the contacts R_4-1, 2 are opened, and the respective motors M_1, M_3, and M_5 for driving the original copy illuminating lamp L, the static latent image forming means E, and the paper feeding means are stopped until the start switch S_2 is closed. The diameters of the pulley 124, 124' and the diameter of the roller 123 are so planned that the copying paper P is sent to the position P' in FIG. 20 in the paper feeding means during the rotation of motor M_5.

Further, by means of the operation of the relay R_6, the contact R_6-8 is closed, and the motor M_2 (FIG. 3) is turned on by means of (R_6-8)—(R_3-3−1)—Motor M_2—(R_3-4−)—electric source, and moves the photosensitive plate receiver base 50 and photosensitive plate 1 placed thereon towards the front portion of the body 7 as soon as the above mentioned static latent image formation is completed.

During the time when the photosensitive plate is moving, development and the image transferring are carried out as mentioned above, and as soon as the photosensitive plate receiver base 50 arrives at the end point of movement, the push piece 128 (FIG. 8) provided at the front portion of the receiver base 50 closes microswitch MS_2 provided on body 7 (FIGS. 3 and 8) and the relay R_3 is operated by the circuit of MS_2-R_3—electric source. The contacts R_3-1−8 are switched in the opposite direction to that shown in FIG. 26, and through (R_3-2)—R_3, the circuit is maintained after MS_2 reopens. Photosensitive plate 1 is returned by means of the reverse rotation of the motor M_2, and the receiver base 50 is returned by (R_3-5)—M_7, and at the same time, the motor M_7 of the fan 133 for peeling off the paper is turned on. Copy paper P is peeled off by means of the movement of base 50, and is transferred to the fixing means as described hereinabove. Base 50 pushes up the developing means D by projection 114 during return movement, and in place thereof, the cleaning means C is lowered to its operational position. Remaining toner on the surface of the photosensitive plate is cleaned off, as described above. When base 50 returns to its original position at the static latent image forming portion, the push piece 163 (FIG. 8) on the rear portion of base 50 closes the microswitch MS_1, and by the circuit of MS_1—(R_3-1)—R_2—electric source, relay R_2 is operated, and the circuit-maintaining relay R_1 of the start switch S_2 is cut off by the opening of contact R_2—1, releasing the circuit-maintaining feature of switch S_2. The copying process is thus completed, and all of the above mentioned operations are stopped until the start switch S_2 is again closed.

In the above-noted embodiment of the present invention wherein the A.C. corona discharge and the exposure are carried out simultaneously, development is carried out with the toner charged with a polarity opposite to the charge of the static lateng image, to obtain a positive-positive image, and in this case the attraction between the powder image and the photosensitive static image is great, but the image transferring efficiency is low. In this case, it is possible to increase the image transferring efficiency remarkably by carrying the charge by means of a direct current corona discharger **164** to the photosensitive plate and the powder image between the image developing portion D and the image transferring portion P, as shown in FIG. **29**.

In regard to the charge polarity of discharger **164**, either can be used. If it is charged in the opposite polarity (+) against the charge of the powder image (−), the insulating layer 1_3 is charged positively and the powder image is also converted to positive polarity, there is generated a repelling force between the two, and the image is easily transferred. If the charge before the transfer of the image is in the same polarity (−) as the charge (−) of the powder image, the powder image is charged negatively and the white portion (other than the powder image) on the insulating layer 1_3 is also charged in the same polarity, and a repelling force is also generated.

In this embodiment, discharger **164** is placed between the developing means D and the copy paper feeding means, and is fixed onto body **7** facing the photosensitive plate **1**. The electrical control supplying discharge **164** comprises the high voltage electric source HVS' (FIG. **26**) of a single polarity which is similar to source HVS (FIGS. **27** and **28**). The circuit thereof is closed by the contacts R_3–7 and R_5–2 of the relays R_3 and R_5, to supply electricity to discharger **164** simultaneously with the start of movement of the plate.

Generally, in carrying out the image transferring operation, the back surface of the image transferring paper P is kept at the same polarity as that of the electric charge formed on the border layer between the insulating layer 1_3 and the photosensitive layer 1_2 of photosensitive plate **1**. This makes it possible to carry out the image transferring operation effectively and easily, and as the means therefor, as shown in FIG. **21**, a direct current voltage should preferably be imparted to the press-roller **117** from the electric source **129**. The electrical control is supplied by means of contact R_3–8 on the relay R_3 and, if necessary, this also controls the direct current source **104** (FIG. **18**) and the motor M_8 for driving suction fan **99** used when the cleaning operation is carried out in this manner. In FIG. **26**, the electric sources **104** and **129** are D.C. sources having a rectifier and a smoothing device (i.e. a partial R-C network).

In case a fur brush developing step is employed, stirring motor M_4' (FIG. **16**) is driven until the microswitch MS_2 is opened, i.e., at the time when the receiver base **50** starts its movement by means of the operation of the contacts R_3–6, and R_6–9 of the relays R_3 and R_6.

FIGS. **30** through **32** illustrate another embodiment of the transmission mechanism for the static latent image forming means E. In accordance with this embodiment, a drive pulley **168** is provided on the horizontal shaft **167** which is rotated by drive motor M_3 (FIG. **2**), and an endless belt **169** connected to the static latent image forming means E is placed over pulley **168** and guide rollers 170_1 and 170_2. The static latent image forming means E is moved thereby along rails 41_1 and 41_2. The starting, reversal, and stop operations are controlled in the same manner as described above in connection with FIGS. **2** and **6**.

While the static latent image forming means E makes an exposure from the right to left extremities of plate **1**, lens **4** is fixed and therefore, except at the moment when lens **4** is directly above means E (FIG. **31**), shield plates 32_1 and 32_2 (FIG. **7**) will shade some of the light rays as they are projected aslantly, and the degree thereof will be increased the more means E departs from the central position perpendicular to the vertical light axis. FIGS. **30** and **32** illustrate this.

In order to prevent this trouble, shield plates 32_1, and 32_2 are rotatably mounted on frame **29** by means of the shafts 174_1 and 174_2, and they are connected to each other by means of one or two rods **175** to form a parallel-link mechanism. By means of a pulley **171**, on the same shaft **167** on which the pulley **168** is mounted, an endless belt **173**, and guide rollers 172_1 and 172_2 a movement slightly different from that of the static latent image forming means is imparted to said rods. In other words, pulleys **168** and **171** are designed to have the relation of the radius $R > r$ (FIG. **30**), and the amount of the movement of the parallel link mechanism is thereby more reduced than the amount of the movement of the static latent image forming means, so the exposure slit between the shield plates 32_1, and 32_2 is maintained parallel to the light axis. The position at each extremity is shown in FIGS. **30** and **32**.

As noted above, the invention also includes a combined microfilm reader-printer embodiment, and this will now be described.

FIG. **33** shows this embodiment, according to which the image on the microfilm F is projected on a screen **180**, such as frosted glass, and while watching the projected image it is copied. The optical system thereof is shown in FIG. **34**. The film F is projected onto the photosensitive plate **1** by using a lamp **181**, reflector **182**, condenser lens **183**, projecting lens **184**, and reflecting mirror **185**. A translucent reflecting mirror **186** is located between lens **184** and mirror **185**, and a portion of the projected light is guided to a screen **180** to form the image, from which it can be read.

Referring again to FIG. **33**, a lamp house **188** is supported at a position in front of the body **187** but below screen **180** by means of brackets 189_1 and 189_2, and condenser lens **183** are located therein. A microfilm sending reel **190**, a film pressing plate **193** are all provided on brackets 189_1 and 189_2, which is fixed on the body **187** by screws **209**. Screen **180** is fixed on the surface of the front wall 187_1 of body **187**, and projecting lens **184** is fixed at the lower portion thereof. Photosensitive plate **1** is supported on receiver plate **50** is reciprocatingly moved between the static latent image forming portion, and copy paper is removed from opening **194** in the same manner as in the case of the embodiment of FIGS. **2** and **3**. Flexible body **55** pulls it along guide rails 52_1, and 52_2 (52_2 not shown), together with moving piece **54**. The whole image of the film F is enlarged and projected at once onto the photosensitive plate **1**. Discharger frame **195**, made of insulating material, is large enough to cover the whole surface of the photosensitive plate **1**, and is attached to body **187** by supporter and guide rails **196** directly above plate **1** in the static latent image forming position. Discharger frame **195** is mounted so that it can be moved back and forth a little to prevent the non-uniform charging. Dis-

charge wires **197** are provided within the frame **195**, and the direct current voltage for the primary charge is applied to wire **197** to act on the photosensitive plate. During this time a crank plate **199** is rotated by motor M_8 (fixed on body **187** by the screws **198**), and the frame **195** is vibrated horizontally by means of a pin **200** and rod **201**.

After applying the primary charge, the image is projected, and at the same time the high voltage direct current secondary charge, or alternating current corona discharge of polarity opposite to the primary charge, is applied to the discharge wires **197**, and the static latent image is formed on the photosensitive plate **1**. When this is completed, the photosensitive plate **1** starts to move, and the image is irradiated by total exposure means L_1 (comprising reflector **202** and the bulb l mounted on frame **203**) to stabilize the static latent image and to improve the contrast. The latent image is made visible by the developing means D. The developing means shown in FIGS. **10** and **16** can be used, and operation thereof is the same as previously described. After passing through the developing portion D directly below the lamp housing, the copy paper P nearest feed base **204** (FIGS. **35** and **36**) is fed out by the rotation of feed-roller **205** (preferably grounded), which is in contact with the front lower surface of the copy paper on the copy paper feeding base **204**. Guide **206** guides paper P forward and half around roller **205** to the point where it is laid onto photosensitive plate **1**. It then proceeds along with the photosensitive plate **1**, and the powder image is transferred. The paper proceeds to take out opening **194**, and then stops. There, the copying paper is peeled off, and separate fixing means are employed to thermally fix the powder image. A press-spring **207** having one end fixed on the guide **206** is provided to hold paper P against roller **205**. The ceiling plate forming opening **195** is feed base **204**, and is unitary with body **187**.

When the process is complete, photosensitive plate **1** and base **50** are moved back and developing means D and cleaning means C change their positions in the same manner as in the embodiment of FIG. **11**. Plate **1** is cleaned, and the assembly returns to the static image forming portion, completing one cycle of operation. The cleaning means shown in FIGS. **11**, **17** and **18** can all be used in this embodiment.

The operation of this embodiment is remarkably simple. Motor M_4 for stirring the toner is turned on and is used as described with reference to FIG. **11** by pushing start switch S_2, the high voltage source circuit, lamp house **188**, and the lamp of illuminator L_1 are turned on. Also motor M_8 horizontally vibrates the frame for the discharger **195** (in place of the motor M_3 for reciprocating the latent image forming means as is shown in FIG. 2). Forward movement of the receiver base **50** and photosensitive plate **1**, movement of the copy paper supply roller **205**, and stopping and reverse motion of the receiver base **50** can all be carried out with only slight changes in the relay control circuit of FIG. **26**. For timing the primary charge, the exposure (simultaneously with discharge) and the forward movement of the photosensitive plate after the completion of the exposure and discharge, it is preferred that a time-delay relay be employed.

It is also possible, in this embodiment of the invention, to employ the charging process aimed at the improvement of the copying efficiency described with reference to FIG. **29**.

The embodiment of the invention employing a drum form of photosensitive plate is shown in FIGS. **37** and **38**. The drum **216** is rotated at a peripheral speed of about 5 to 10 cm. per sec. in the direction shown by the arrow, by means of a motor (not shown), and is horizontally mounted. The photosensitive plate **1** comprising three layers is mounted on the periphery thereof, with the translucent insulating layer 1_3 the outermost layer.

The other operative elements are clustered around the periphery of the drum. As shown in the drawings, these include discharger **217** for the primary charge, the discharger and exposure slit **218** for the secondary charge, total exposure means L_2, the developing means D_1, copy paper feeding means **219**, copy roller **220**, conveyor **221**, copy paper peeling means **222**, and cleaning means C_1.

On body or case **215** there is provided light slit G, which is of narrow width, and the window **223**. On the lower portion of the front side of body **215**, there is copy send-out opening **224** and the receiver **225** therefor. A pair of parallel rails **226** is fixed on the right and left sides of the top of the body by means of the bearings **227**, and the original copy base **228** is mounted thereon in such a manner that it can be freely moved back and forth. Window **229**, of transparent glass, or synthetic resin or such like, is mounted in copy base **228**, and the original copy **2** is placed thereon. The copy is pressed flat from above by means of press-board **230**. Copy base **228** is moved from the position shown in FIG. **27** in the manner described in U.S. Pat. No. 2,959,095.

Lamp house **231** borders light ray slit G on both sides, and the internal surface thereof is a reflecting mirror or the like. Bulbs 1_1, fluorescent lamps, are mounted therein. The original copy **2**, placed on copy base **228**, is irradiated through window **223**. The illuminated surface of the original copy is projected onto the photosensitive plate **1** on the periphery of the drum through exposure slit **218** by the optical system. This is comprised of reflecting mirror **232**, lens **233**, and reflecting mirror **234**, which pas the light coming from window **223** and the slit G. The optical system is surrounded by light box **235**, which prevents light from passing into other parts of the device.

Copying is carried out in the same manner as in the case of the plane form embodiment. Direct current high voltage is applied to the discharge wire of discharger **217** to apply the primary charge to the surface of the rotating photosensitive plate **1**. The static latent image in correspondence with the light image is formed on the photosensitive plate **1** as it is subjected to the secondary charge by means of the discharge source **236**, at the same time when the light image of the original copy is projected from the exposure slit **218** by rotation of drum **216**. Depending on the copy to be obtained, the secondary charge is an alternating corona discharge or direct current corona discharge of the polarity opposite to the primary charge, as previously described. The moving speed of the original copy **2** and that of the photosensitive plate **1** are required to have a specific relation, and, the drum driving mechanism and the original copy moving mechanism are interlocked in the manner described in U.S. Pat. No. 2,959,095.

Next, the static latent image on photosensitive plate **1** is irradiated by the total exposure means L_2 comprising reflecting mirror **237** and the bulb 1_2, to increase the contrast and, thereafter, the image is developed by the developer of colored powder in developing means D_1. The copy paper feed roller **238** of the feeding means **219**

pushes copy paper P, sheet by sheet, from the copy paper base **239** between the drum **216** and the roller **220** via feed-guides 240_1, 240_2, 243_1, 243_2, **245**, and rollers **242**, and **244**. The paper is pressed onto the surface of the image-carrying plate by means of copy roller **220**, and the powder image is transferred onto the copy paper P. With further rotation of the drum **216**, the copy paper P is peeled off from photosensitive plate **1** by peeling means **222**, and is transferred onto conveyor **221**. This passes the paper toward the send-out opening and it is heated and thermally fixed thereon by infrared lamp **247**, located within housing **246**. Fixing occurs by melting of the resin in the developing powder. The paper is then sent onto the receiver **225** from the outlet **224**, through the guide roller **248**.

Developing powder remaining on the photosensitive plate is removed by means of the cleaning means C_1, and it is then turned back to the primary charge portion **217**. One cycle of the copying process is thus completed.

The operation of the respective steps is essentially the same as in the case of the preceding plane-plate embodiment, and the structure of the respective processing portions is also almost the same to that previously described. Detailed explanations about these are therefore omitted. Differences in this device mainly reside in the portion where the developing powder is supplied, developed, and in the cleaning portion, and these will be described in detal.

FIG. **40** shows the toner supplying portion, which comprises tank **251** having the lid **250** at the lower portion of opening **249** on the rear wall surface of the body **215**. A rotary valve **252** is provided on the funnel-shaped opening at the lower portion of tak **251**, and toner filling recess **253** therein is gradually supplied to the developing chamber **254**. The toner in tank **251** and at the bottom 254_1 of the developing chamber is intermittently or continuously stirred by means of the mixing blades **255** and **256**, respectively, in order to prevent the toner from aggregating. Alternatively, the toner can be supplied from the horizontal direction by means of a screw conveyor.

Belt **257** has a fur brush mounted thereon, which press-contacts photosensitive plate **1** on drum **216**. Belt **257** is spanned over front and rear rollers **258**, **259**, and driving force is imparted to one of said rollers. They are rotated at about 1.5 times the speed of the drum in the same direction in which the drum is rotated. It is possible to rotate the rollers in the opposite direction to the rotation of the drum, but a more or less foggy image may be obtained.

The fur brush functions as the carrier in the same manner as in the case of the embodiment shown in FIG. **16**, and the same conditions apply to the fur brush of this embodiment, including the material from which it is made, the electric resistance thereof, and the like.

At the point where belt **257** goes around rollers **258**, **259**, the fur brush is surrounded by and contacts semi-circular covers **260**, **261**. The distance between belt **257** and covers **260**, **261** should be from 40 to 95% of the length of the hairs in the brush, so the hairs will contact the covers. The spacing controls the amount of toner which will adhere to the brush. Frictional (i.e., static) electricity is also generated between the hair and the covers and it is therefore desirable to select toner material of the same polarity as that of the frictional electricity charge on the toner. In case a positive-positive image is obtained, for example, the material is selected in such a manner that the toner is charged in the polarity opposite to that of the primary charge of the photosensitive plate. For example, when the primary charge is positive, and rabbit hair is used for the brush, a picolastic resin, or phenol resin colored by carbon or the like can be used. In case the secondary charge is negative, the static image is formed by the negative charge adhered on the light portion of the light image. It is noted that the reverse development in the Carlson process becomes the normal development in accordance with the instant process. Of course, when a negative-positive image is produced, it is the reverse.

The fur brush is rotated while the toner is agitated, and the toner has a charge of the opposite polarity (−) to that of the brush. It is adhered onto the brush, and is contacted against the photosensitive plate at the adjacent surface of the fur brush between the rollers **258** and **259**. The latent image is developed by the attraction of the static electricity caused by the charge of the static image and the charge of the developer. In a preferred embodiment, rollers **258** and **259** are mounted on the body **215** through the insulating support plates **262**, **263** to insulate the body. Shift **267**, end plate **268**, and the cylindrical body **269** are made of conductive materials. Slip ring **270** is provided on the shaft, and a direct current voltage, such as a bias voltage of around 300 to 1000 v. is imparted thereto from electric source **272**. The polarity of the applied bias voltage imparts the voltage of the opposite polarity to the charged polarity of the toner to the brush at the point θ_1 (FIG. **40**) where the fur brush leaves the photosensitive plate. Because of this, the brush attracts toner adhered on the non-image portion in this area and image fogginess is reduced.

In the area θ_2 where the brush is beginning development, when the voltage of the same polarity as that of the charged polarity of the toner is imparted to the brush, adherence of the toner on the surface of the photosensitive plate **1** is accelerated. Thus, when the photosensitive plate is subjected to friction for a substantial distance by means of the fur brush belt, the accumulative effect is to accelerate toner deposition in the primary stage, there is an adjustment effect in the intermediate stage, and in the final stage there is a fog-removing effect. This device is remarkably effective for the present invention, wherein a static latent image of high contrast voltage is employed.

FIG. **39** shows an embodiment of the driving mechanism of the fur brush belt and the toner supplying means. Rotation of motor M_9, fixed on the body **215** by means of screws **275**, is transmitted to the shaft 259_1 of fur brush roller **259** through belt **276** or a gear, and it is further transmitted to rotate shaft 258_1 of fur brush roller **258** through pulleys **264**, **265** and belt **266**. Other rotating elements, mounted on shafts 252_1, 255_1, and 256_1 (rotary valve **252** and stirrer blades **255** and **256**) are powered by belt **278** and the pulleys **279** through **282**. The present invention is, of course, not restricted to the particular belt and fur brush arrangement described, and any fur brush roller having said carrier conditions can be employed. Further, other developing means can be employed, as described with reference to FIGS. **42–44**.

In this case, a magnetic brush is employed, and therefore it is necessary to mix the toner and carrier particles. In the box **283**, hollow shafts 284_1 and 284_2, made of non-magnetic material such as glass, synthetic resin, brass or the like, are provided on both ends of developing cylinder **284**. Said hollow shafts are mounted hori-

zontally on the side wall 283_1 of the box **283** through bearings **285** and the transmission gear **286** is mounted on shafts 284_1, 284_2 to rotate same. The core **287** is contained in the cylinder **284**. Magnetic coil **288** is wound on core **287**, forming a unitary structure. Coil **288** is preferably formed of 3,000 to 3,500 turns of 0.4 mm. enameled wire. Fixed shafts 289_1 and 289_2 are provided on both ends of the coil, and are supported within the hollow shafts 284_1 and 284_2 by bearing **290**. Shafts 289_1 and 289_2 are fitted to supports 291_1 and 292_2 fixed on box **283**, and core **287** and coil **288** are thus fixed so as not to rotate. Lead wire **292** is connected through shaft 289_1 to coil **288**, and direct current is passed therethrough to form the electromagnet. Ordinary electric current source **295** (100 v. 50–60 c.p.s.) is rectified by the rectifier-smoothing device **296** to supply electricity to the coil, or electricity can be supplied from a battery of the same voltage. The pole facing the developer **80** is charged to be, for example, S polarity, and the pole facing the drum **216** is charged in N polarity. The base 283_2 of box **283** is fixed onto the body **215** by bolts **293**, and rotary cylinder **284** is mounted parallel to the drum **216** with a space between the same and the photosensitive plate of about 5 mm. Cylinder **284** is rotated by motor M_{10} through gears 294_1, 294_2 and **286** in the same direction in which the drum **216** is rotated, at a speed about 2 to 4 times faster than the peripheral speed of the drum **216**. The developing powder attracted by the S polarity at the lower portion of the electromagnetic is carried by the rotating non-magnetic cylinder **284**, and on the surface of the periphery thereof, a magnetic brush is formed to visualize the latent image on the photosensitive plate on the surface of the drum. The carrier in this case must also be rendered insulating, as in the case of the embodiment of FIG. **16** to impart to same a resistivity over $10^8\Omega$-cm.

When magnet **297** is placed in the hollow portion of the drum **216** with the S pole thereof faced against the N pole of core **287**, the magnetic powder is attracted by drum **216**, the development is accelerated. It is preferred that the poles N_1 and S_1 of core **287** be placed as close as possible to the adjoining side of cylinder **284** to increase the leaking magnetic flux therein, and on the opposite side the other two poles are placed further away, to weaken the magnetic power in the terminal stage of development. By doing this, developer removed from the surface of the drum will fall below. When the short fiber planting processing or roller processing or the like is carried out on the surface of the non-magnetic cylinder **284** (i.e., surface roughening processes), the friction against the developing powder is increased and transportation of the developing powder is improved.

Following is an explanation of the mechanism cleaning the photosensitive plate on the periphery of the rotary drum. It is noted that insulating layer 1_3 on the surface of the photosensitive plate **1** is mechanically strong, and it is therefore resistive to strong frictional forces. Accordingly, the present invention is an improvement in several respects over conventional xerography systems.

As is shown in FIG. **38**, elastic cleaning roller **300** is press-contacted against the photosensitive plate **1** on the surface of the drum at a point right after the copy paper has been peeled off. A cleaning brush **301** contacts cleaning roller **300** and brushes toner therefrom. Cleaning brush **301** and the cleaning roller **300** are mounted inside cover **302** fixed on the body **215**, so that the toner removed from the photosensitive plate is not sprayed. At the lower portion thereof, drawer box **303** is provided as a toner receiver. Door **304** on the front surface of body **215** is mounted on hinge **305** (FIG. **37**), and the drawer box can be emptied through this door.

Motor M_{11} is mounted on cover **302** as shown in FIG. **45**, and by means of a belt **306** or gears, rotation is imparted to shaft 300_1 of the cleaning roller **300**, to rotate the same in the direction opposite to the rotation of the photosensitive plate **1**. Rotation is also transmitted to the shaft 301_1 of the roller brush **301** by means of gear **307** or a belt, to rotate the roller brush **301** in the direction opposite to the rotation of the roller **300**.

Cleaning roller **300** has at least the outer periphery thereof made of a resilient or elastic material such as natural or synthetic rubber or the like. Sponge form natural or synthetic rubber is one of the most preferable materials. Materials having a hardness of around 15 to 50 are generally preferable. In case the hardness is over 50, it is difficult to obtain proper surface contact against the photosensitive plate, and in case the hardness is below 15, it is too strong mechanically and processing thereof is difficult.

As is shown in FIG. **47**, the outer diameter R of the cleaing roller **300** is slightly larger than the shortest distance D between the axial center and the photosensitive plate **1**, the difference being d. Roller **300** is compressed as much as the difference d, and when the roller is contacted over a considerable portion of its width (for example, around 1/10 of the periphery), and it is slowly rotated at the peripheral speed of 0.5 to 10 cm. per sec. in the direction opposite to the direction of the rotation of the photosensitive plate **1**, a large contact resistance is developed and the frictional power is much larger than the static attraction of the remaining toner. The toner is thus rubbed off. The roller **300** is slowly rotated as is shown by the arrow in FIG. **47**, and therefore the toner is not pinched between the two, so no deterioration of the toner is brought about. It is very effective to form slight concave and convex groove 300_2 (FIG. **46**) on the rubber cleaner roller **300** for increasing the cleaning effect. Cleaning roller **300** is preferably cleaned by the brush roller **301**, because by always keeping cleaning roller **300** clean, it will not leave powder on the photosensitive plate **1**. The rotation of brush **301** is generally faster than the rotation of roller **300**, and powder on the roller **300** is removed mechanically by the strong frictional contact of the resilient hairs on the brush **301**. So, when brush **301** is separated from roller **300**, the toner powder is released into cover **302** by means of the strong movement caused by the resiliency thereof. Separated toner is in the form of a cake or fine powder, and while the toner in the form of a cake can easily fall down, the toner in fine particle form is apt to float in the air after it is separated. A part of receiver **303** is therefore made of air-permeating cloth **320** (FIG. **40**), and cover **302** and receiving source **303** are made air tight. A ventilation window (not shown) a little larger than said cloth portion is provided on the base box, and the air within the cover **302** is sucked through the suction portion (not shown) from a suction pipe **321**. As a result, the floating toner falls down at the bottom of receiver **303**, and it is possible to prevent contamination caused by the toner floating out of the cover **302**.

The above-described cleaning mechanism can also be applied to the devices shown in FIGS. **2** and **33**.

Conventional fur brush cleaning processes cannot be used effectively with the invention, because the attrac-

tion of the photosensitive plate and the toner is very strong. But when the below-mentioned method is adopted, it becomes possible to carry out cleaning by this method. As shown in FIG. **48**, belt **311** has a fur brush, and both rollers **312** and **313** are conductive. A voltage is supplied from direct current source **318** by means of the slip rings **314**, **315**, and brushes **316**, **317**. When roller **313**, nearest the photosensitive plate, is charged with the polarity opposite the polarity of the toner to be removed, and the other roller **312** is charged in the same polarity, toner on the surface of the photosensitive plate is attracted onto the fur brush statically, and when it is contacted against the other roller **312**, it is expelled.

The cleaning mechanism shown in FIG. **49** is a modification of the mechanism shown in FIGS. **10**, **17** and **18**, wherein a plural number of cleaning plates **308** having more or less elasticity (such as hard rubber or the like) are radially mounted on the core shaft **309**, and one of the cleaning plates is pushed strongly against the photosensitive plate to scrape off the toner. In operation, it functions the same as the previously described devices. However, shaft **309** is interlocked with the rotation of drum **216**, and is intermittently rotated, a new cleaning plate being used for every copying cycle.

Electrical control for the drum type device is remarkably simple, and it is possible to utilize the method described in U.S. Pat. No. 2,959,095, with minor obvious modifications.

It will be understood that various changes in the details, steps, materials and arrangements of parts, which have been herein described and illustrated in order to explain the nature of the invention, may be made by those skilled in the art within the principle and scope of the invention as defined in the appended claims. For example, it is possible to make the drum photosensitive plate into the conventional belt-form photosensitive plate employed in the conventional xerography systems. In this case, it is also possible to adopt the exposure system on the fixed photosensitive plate as has been explained in the embodiment wherein a plane form photosensitive plate is used, as shown in FIGS. **2**, **3** and **33**, without being restricted to the slit exposure system wherein the original image is projected on the moving photosensitive plate. Further, it is more effective to use the charge-exposure system as is shown in FIGS. **30** through **32**.

What is claimed is:

[1. An electrophotographic copying device which comprises:

charging means for applying a primary charge on the surface of a photosensitive plate, which plate comprises a base, a photoconductive layer and a translucent insulating layer overlaid thereon;

means for simultaneously exposing an original image and for applying a corona discharge onto the surface of said charged insulating layer;

means for forming a high contrast static image of the original image on the surface of said insulating layer by uniformly irradiating the whole surface of said insulating layer, thereby activating the photoconductive layer;

developing means for visualizing said static latent image;

means for transferring said visualized image onto copying material; and

cleaning means for removing residual developer from the surface of said insulating layer remaining after the transfer of the image, whereby the photosensitive plate is prepared for repeated use.]

[2. An electrophotographic copying device as claimed in claim **1**, wherein said means for simultaneously exposing the original image and for applying the corona discharge on the surface of the primary charged insulating layer of the photosensitive plate comprises an alternating current corona discharger.]

[3. An electrophotographic copying device as claimed in claim **1**, wherein the developing means for visualizing the static latent image formed on the surface of the insulating layer of the photosensitive plate comprises a fur brush developer.]

[4. An electrophotographic copying device as claimed in claim **1**, wherein the means for transferring the visible image formed on the surface of the insulating layer of the photosensitive plate onto the copying material comprises means for physically pressing said copying material against said insulating layer in the absence of an external electric field.]

[5. An electrophotographic copying device as claimed in claim **1**, wherein the cleaning means for removing residual developer from the surface of said insulating layer remaining after the visible image formed on the insulating layer of the photosensitive plate is transferred onto the copying material comprises an elastic brush.]

[6. An electrophotographic copying device as claimed in claim **1**, wherein the developing means for visualizing the static image formed on the surface of the insulating layer of the photosensitive plate comprises a magnetic brush and which utilizes a developer which comprises a carrier having an insulating resistivity of greater than $10^8\Omega$-cm. and a toner.]

7. An electrophotographic copying device as claimed in claim [3] *24*, wherein said fur brush developing means comprising an endless belt in contact with the surface of said insulating layer, means to rotate said belt, and means for supplying toner to said belt.

8. An electrophotographic copying device as claimed in claim 7, wherein said fur brush developing means additionally comprises means for applying a bias voltage to said belt at a point adjacent to the final point of contact with said layer, said voltage providing a charge of the same polarity as the polarity generated by the frictional charge against the toner.

9. An electrophotographic copying device as claimed in claim **8**, wherein the endless belt additionally comprises means for applying a second bias voltage for charging the belt at a point adjacent the initial point of contact with said layer, with a charge of the polarity opposite to the polarity of the charge generated by said first bias voltage.

10. An electrophotographic copying device as claimed in claim [6] *25*, and additionally comprising means for mixing air with said toner, said toner being attracted to said brush by a frictional charge.

11. An electrophotographic copying device as claimed in claim 7, wherein said endless belt includes adjusting means to vary the contact-pressure of said belt against the static image surface.

12. An electrophotographic copying device as claimed in claim [3] *24*, wherein said fur brush developer comprises:

a container for toner, said container having a plurality of small holes in the lower portion thereof;

a control member adjacent the lower portion of said container, said control member also having a plu-

rality of holes therein and being mounted for movement of said holes into and out of registration with the holes in said container, whereby said toner is stirred and the amount thereof falling through said holes is controlled; and

a fur brush mounted below said container and said control member and having a plurality of holes for passage of said toner.

13. An electrophotographic copying device as claimed in claim [5] *26*, wherein said elastic brush cleaner includes means for charging said brush in the polarity opposite to the polarity of the residual developer remaining on the surface of the insulating layer of the photosensitive plate.

14. An electrophotographic copying device as claimed in claim 13, wherein the elastic brush cleaner additionally comprises a second charging means for charging said brush in the polarity opposite to the polarity of the first charging means, to remove developer adhered on said brush statically.

15. An electrophotographic copying device as claimed in claim [5] *26*, wherein said cleaning means comprises an elastic cleaning roller mounted to pree-contact the surface of said insulating layer with sufficient pressure to be slightly flattened thereagainst, and means for rotating said roller slowly in the direction opposite to the motion of the photosensitive plate.

16. An electrophotograhic copying device as claimed in claim 15, wherein said elastic cleaning roller has a plurality of small transverse grooves on the surface thereof wherein toner is collected.

17. An electrophotographic copying device as claimed in claim [6] *25*, wherein said magnetic brush developing means comprises:

a hollow, rotating, non-magnetic cylinder;

a non-rotating electromagnet mounted within said cylinder and having one pole thereof adjacent said photosensitive plate;

a developer container having an opening for feeding developer adjacent the other pole of said electromagnet; *and*

[the polarity of said first pole being opposite to the charge on said photosensitive plate, whereby developer is magnetically attracted to said cylinder and, on rotation thereof, is repelled by said cylinder and attracted by the charge on said plate, thus visualizing the image.] *another magnetic pole provided opposite to said first pole sandwiching the photosensitive plate therebetween and having a polarity opposite to said first pole, whereby developer is magnetically attracted to said cylinder and, on rotation thereof, is repelled by said cylinder and attracted by the charge on said plate, thus visualizing the image.*

18. An electrophotographic copying device as claimed in claim [6] *25*, wherein said magnetic brush developing means comprises:

a yoke having two, longitudinal, non-magnetic path-controlling sections defining a central open cavity;

a rotatably mounted permanent magnet within said cavity;

a container for developer mounted below said yoke;

developer in said container being attracted to said non-magnetic sections when said magnet is in a first position and repelled from said sections when said magnet is rotated ninety degrees.

19. An electrophotographic copying device which comprises:

a photosensitive plate, which plate comprises a base having a photoconductive layer and a translucent insulating layer overlaid thereon;

means for moving said photosensitive plate;

charging means for applying a primary charge on the surface of said photosensitive plate;

means for simultaneously exposing an original image and for applying a corona discharge onto the surface of said charged insulating layer;

means for forming a high contrast static image of the original image on the surface of the insulating layer comprising a light source irradiating the whole surface of said insulating layer, thereby activating the photoconductive layer;

deveoping means for visualizing the static image with a developer;

means for laying copying material on said visible image in synchronous relation with the movement of said photosensitive plate;

means pressing the copying material onto the visible image for transferring the visible image onto the copying material;

means for peeling off the copying material from the photosensitive plate after transfer of the visible image which comprises a source of compressed air directed against the said material and a peeling-lever operated against the copying material; and cleaning means for removing residual developer remaining on the surface of said insulating layer to prepare the photosensitive plate for repeated use after the copying material is peeled off.

20. An electrophotographic copying device [as claimed in claim 1 and additionally] comprising:

charging means for applying a primary charge on the surface of a photosensitive plate, which plate comprises a base, a photoconductive layer and a translucent insulating layer overlaid thereon;

means for simultaneously exposing an original image and for applying a corona discharge onto the surface of said charged insulating layer;

means for forming a high contrast static image of the original image on the surface of said insulating layer by uniformly irradiating the whole surface of said insulating layer, thereby activating the photoconductive layer;

developing means for visualizing said static latent image;

means for transferring said visualized image onto copying material;

cleaning means for removing residual developer from the surface of said insulating layer remaining after the transfer of the image, whereby the photosensitive plate is prepared for repeated use;

means for moving said corona [discharger] *discharge* over said photosensitive plate;

a pair of tiltable shield boards defining a central slit over said corona [discharger] *discharge*; and

means for tilting said shield boards as said corona [discharger] *discharge* moves over said photosensitive plate, said tilting being adapted to maintain said shield boards substantially parallel with the rays of said original image.

21. A reading and electrophotographic copying device which comprises:

a photosensitive plate comprising a base and a photoconductive layer and a translucent insulating layer overlaid thereon;

charging means capable of applying a primary charge to said insulating layer;

an optical system capable of projecting an original image onto said photosensitive plate;

means for applying a corona discharge to the charged surface of said insulating layer simultaneously with the projection of said original image;

reading means capable of projecting said image, said reading means comprising a semitransparent mirror located in the light path of said optical system and a screen for visualizing the image reflected by said mirror;

means comprising a light source for uniformly irradiating the whole surface of said insulating layer after projection of said original image thereon, whereby said photoconductive layer is activated and a high contrast static image is formed on said insulating layer;

developing means for visualizing the static image with a developer;

means for transferring the developed image onto copying material; and

cleaning means for removing residual developer on the surface of said insulating layer after transfer of the image to said copying material, to prepare the photosensitive plate for repeated use.

22. An electrophotographic copying device [as claimed in claim 1,] *comprising:*

charging means for applying a primary charge on the surface of a photosensitive plate, which plate comprises a base, a photoconductive layer and a translucent insulating layer overlaid thereon;

means for simultaneously exposing an original image and for applying a corona discharge onto the surface of said charged insulating layer;

means for forming a high contrast static image of the original image on the surface of said insulating layer by uniformly irradiating the whole surface of said insulating layer, thereby activating the photoconductive layer;

developing means for visualizing said static latent image;

means for transferring said visualized image onto copying material;

cleaning means for removing residual developer from the surface of said insulating layer remaining after the transfer of the image, whereby the photosensitive plate is prepared for repeated use; and

wherein the means for transferring powder image onto the copying material comprises means for forming an electrostatic image on the insulating layer of the photosensitive plate, laying the said translucent insulating layer onto the photoconductive layer, means for visualizing said image with a colored toner charged in a polarity opposite to the polarity of said image, means for charging said insulating layer inclusive of said powder image to an optional polarity and transferring the image onto the copying material overlaid thereon.

23. An electrophotographic copying device [as claimed in claim 1,] *comprising:*

charging means for applying a primary charge on the surface of a photosensitive plate, which plate comprises a base, a photoconductive layer and a translucent insulating layer overlaid thereon;

means for simultaneously exposing an original image and for applying a corona discharge onto the surface of said charged insulating layer;

means for forming a high contrast static image on the original image on the surface of said insulating layer by uniformly irradiating the whole surface of said insulating layer, thereby activating the photoconductive layer;

developing means for visualizing said static latent image;

means for transferring said visualized image onto copying material;

cleaning means for removing residual developer from the surface of said insulating layer remaining after the transfer of the image, whereby the photosensitive plate is prepared for repeated use; and

wherein means for irradiating corona discharge has the optically opened upper portion and is so arranged that the charge width and the slit exposure width are equal.

24. In an electrophotographic copying device which includes charging means for applying a primary charge on the surface of a photosensitive plate, which plate comprises a base, a photoconductive layer and a translucent insulating layer overlaid thereon, means for simultaneously exposing an original image and for applying a corona discharge onto the surface of said charged insulating layer, means for forming a high contrast static latent image of the original image on the surface of said insulating layer by uniformly irradiating the whole surface of said insulating layer, thereby activating the photoconductive layer, developing means for visualizing said static latent image, means for transferring said visualized image onto copying material, and cleaning means for removing residual developer from the surface of said insulating layer remaining after the transfer of the visualized image, whereby the photosensitive plate is prepared for repeated use, the improvement wherein said developing means for visualizing said static latent image comprises a fur brush developer.

25. In an electrophotographic copying device which includes charging means for applying a primary charge on the surface of a photosensitive plate, which plate comprises a base, a photoconductive layer and a translucent insulating layer overlaid thereon, means for simultaneously exposing an original image and for applying a corona discharge onto the surface of said charged insulating layer, means for forming a high contrast static latent image of the original image on the surface of said insulating layer by uniformly irradiating the whole surface of said insulating layer, thereby activating the photoconductive layer, developing means for visualizing said static latent image, means for transferring said visualized image onto copying material, and cleaning means for removing residual developer from the surface of said insulating layer remaining after the transfer of the visualized image, whereby the photosensitive plate is prepared for repeated use, the improvement wherein said developing means for visualizing said static latent image comprises a magnetic brush developer and utilizes a developer comprising a carrier having an insulating resistivity of greater than $10^8\Omega$-cm. and a toner.

26. In an electrophotographic copying device which includes charging means for applying a primary charge on the surface of a photosensitive plate, which plate comprises a base, a photoconductive layer and a translucent insulating layer overlaid thereon, means for simultaneously exposing an original image and for applying a corona discharge onto the surface of said charged insulating layer, means for forming a high contrast static latent image of the original image on the surface of said insulating layer by uniformly irradiating the whole surface of said insulating layer, thereby activating the photoconductive layer, developing means for visualizing said static latent image, means for transferring said visualized image onto said copying material, and cleaning means for removing residual developer

from the surface of said insulating layer remaining after the transfer of the visualized image, whereby the photosensitive plate is prepared for repeated use, the improvement wherein said cleaning means for removing residual developer comprises an elastic brush.

27. In an electrophotographic copying device wherein an electrostatic latent image formed on the surface of a photosensitive member is moved past a series of processing stations including a development station at which the latent image is developed with toner particles to form a toner image and a transfer station at which the toner image is transferred to copying material, an improvement comprising a resilient scraping blade having a substantially angular engaging edge and being elongated along the width of said photosensitive member, holder means for holding said resilient scraping blade and maintaining its engaging edge in contact with the surface of said photosensitive member for scraping off residual toner particles and means for recovering said scraped off residual toner particles.

28. In an electrophotographic copying device wherein an electrostatic latent image formed on the surface of a photosensitive member is moved past a series of processing stations including a development station at which the latent image is developed with toner particles to form a toner image and a transfer station at which the toner image is transferred to copying material, an improvement comprising a scraping blade positioned in contact with the surface of said photosensitive member for scraping off residual toner particles, means for recovering said scraped off residual toner particles, means for applying to said scraping blade a charge of the same polarity as the polarity of said residual toner particles for repulsing the collected residual toner particles and means for suctioning said collected residual toner particles for recovering the same.

29. In an electrophotographic copying device wherein an electrostatic latent image formed on the surface of a photosensitive member is moved past a series of processing stations including a development station at which the latent image is developed with toner particles to form a toner image and a transfer station at which the toner image is transferred to copying material, an improvement comprising a scraping blade positioned in contact with the surface of said photosensitive member for scraping off residual toner particles, means for recovering said scraped off residual toner particles, means for applying to said scraping blade a first charge of a polarity opposite to the residual toner particles for attracting said residual toner particles to said blade, and means for thereafter applying a charge of opposite polarity to said first charge for repulsing the collected residual toner particles for recovering the same.

30. A cleaning apparatus for removing electrostatically adhering toner particles from an electrostatic recording surface comprising a scraping blade arranged for engaging along an edge thereof said electrostatic recording surface, said edge being axially coextensive with said electrostatic recording surface and adapted to scrape toner particles contacted during relative movement between said scraping blade and said electrostatic recording surface, means for applying to said scraping blade a charge of the opposite polarity as the polarity of the electrostatic adhering toner particles to attract the toner particles being scraped from said photosensitive plate.

31. In an electrophotographic copying device wherein an electrostatic latent image formed on the surface of a photosensitive member is moved past a series of processing stations including a development station at which the latent image is developed with toner particles to form a toner image and a transfer station at which the toner image is transferred to copying material, an improvement for removing residual toner particles from said photosensitive member after the transfer of said toner image comprising a scraping blade having a substantially angular edge positioned to contact the surface of said photosensitive member to remove residual toner particles therefrom by scraping said surface and further comprising means mounting said scraping blade for movement out of contact with the surface of said photosensitive member.

32. An electrophotographic copying device as in claim 31, further comprising a second scraping blade fixed to said mounting means for selective movement into contact with and away from said surface of said photosensitive member.

33. In an electrophotographic copying device wherein an electrostatic latent image formed on the surface of a photosensitive member is moved past a series of processing stations including a development station at which the latent image is developed with toner particles to form a toner image and a transfer station at which the toner image is transferred to copying material, an improvement for removing residual toner particles from said photosensitive member after the transfer of said toner image comprising a resilient scraping blade having a substantially angular engaging edge and being elongated along the width of said photosensitive member and holder means for holding said resilient scraping blade and maintaining its engaging edge in contact with the surface of said photosensitive member to remove residual toner particles therefrom by scraping said surface, said resilient scraping blade being made of hard rubber elastic material.

34. In an electrophotographic copying device wherein an electrostatic latent image formed on the surface of a photosensitive member is moved past a series of processing stations including a development station at which the latent image is developed with toner particles to form a toner image and a transfer station at which the toner image is transferred to copying material, an improvement for removing residual toner particles from said photosensitive member after the transfer of said toner image comprising a resilient scraping blade having a substantially angular engaging edge and being elongated along the width of said photosensitive member and holder means for holding said resilient scraping blade and maintaining its engaging edge in contact with the surface of said photosensitive member to remove residual toner particles therefrom by scraping said surface, said resilient scraping blade being made of a conductive elastic material.

35. A cleaning apparatus for removing electrostatically adhering toner particles remaining on an electrostatic recording surface after transfer of a toner particle image to copy material comprising a resilient scraping blade arranged for engaging along an edge thereof said electrostatic recording surface, said edge extending along the width of said electrostatic recording surface, holder means for holding said resilient scraping blade and maintaining its engaging edge in contact with the surface of said electrostatic recording member to scrape toner particles, means for establishing relative movement between said electrostatic recording surface and said resilient scraping blade, and means for removing toner particles scraped up by said scraping blade to a collection source whereby said toner particles can be reused.

36. In an electrophotographic copying device wherein an electrostatic latent image formed on the surface of a photosensitive member is moved past a series of processing stations including a development station at which the latent image is developed with toner particles to form a toner

image and a transfer station at which the toner image is transferred to copying material, an improvement for removing residual toner particles from said photosensitive member after the transfer of said toner image comprising a resilient scraping blade having a substantially angular engaging edge and being elongated along the width of said photosensitive member, holder means for holding said resilient scraping blade and maintaining its engaging edge in contact with the surface of said photosensitive member to remove residual toner particles therefrom by scraping said surface, and collecting means for receiving said residual toner particles scraped from said surface.

37. An electrophotographic copying device as in claim 36, further comprising means for transporting said residual toner particles from said collecting means to said development station for reuse.

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UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : REISSUE 29,632
DATED : MAY 16, 1978
INVENTOR(S) : HIROSHI TANAKA, ET AL.

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 5, line 36, change "mage" to --image--
Column 11, line 50, change "supports" to --supporters--
Column 11, line 52, change "side" to --sides--
Column 14, line 26, change "." to --,--
Column 16, line 65, change "R-1" to --R_5-1--
Column 21, line 37, change "195" to --194--
Column 22, line 40, change "pas" to --pass--
Column 23, line 29, change "detal" to --detail--
Column 23, line 34, change "tak" to --tank--
Column 25, line 29, change "electromagnetic" to --electromagnet--
Column 29, line 23, change "pree-" to -- press- --
Column 30, line 15, change "deveoping" to --developing--

Signed and Sealed this

Tenth Day of *October 1978*

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

DONALD W. BANNER
Commissioner of Patents and Trademarks