

[54] **ELECTROPHOTOGRAPHIC DUPLICATOR
OF THE TRANSFER TYPE**

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[58] Field of Search..... 355/3, 17, 16

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[57] **ABSTRACT**

In an electrophotographic duplicator of the transfer type an image projected onto a photosensitive surface is transferred onto the surface of a transparent dielectric film superposed with respect to the photosensitive surface. The transfer is accomplished by an AC corona discharge and a uniform irradiation of the superposed dielectric film and photosensitive surface to stabilize the image. Subsequently, a transfer paper and the transparent dielectric film are superposed and the image transferred to the transfer paper by application of a toner and a corona discharge of the opposite polarity of the toner. The image on the transfer paper is then fixed by heating.

4 Claims, 5 Drawing Figures

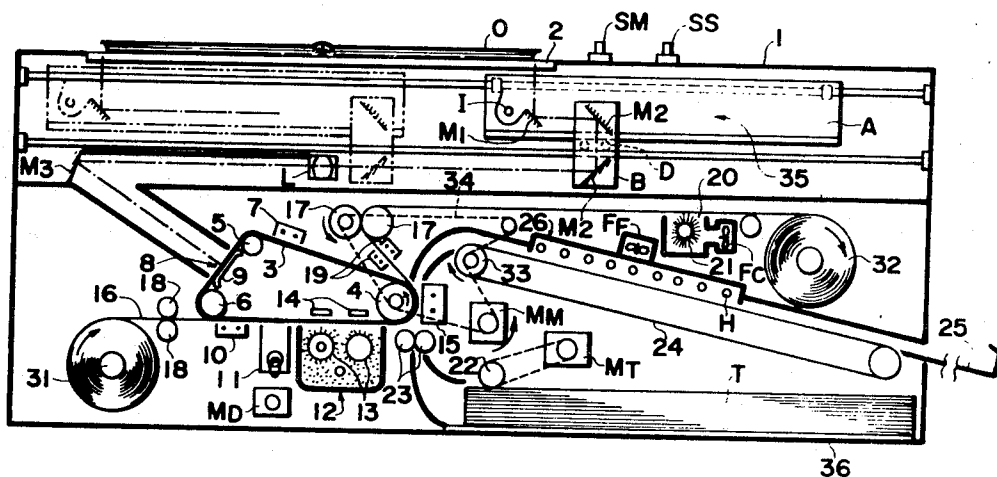


FIG. 1a

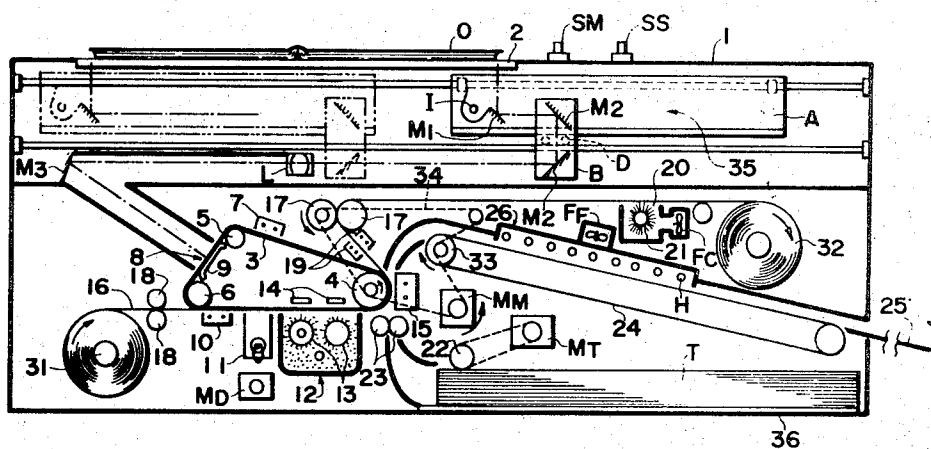


FIG. 1b

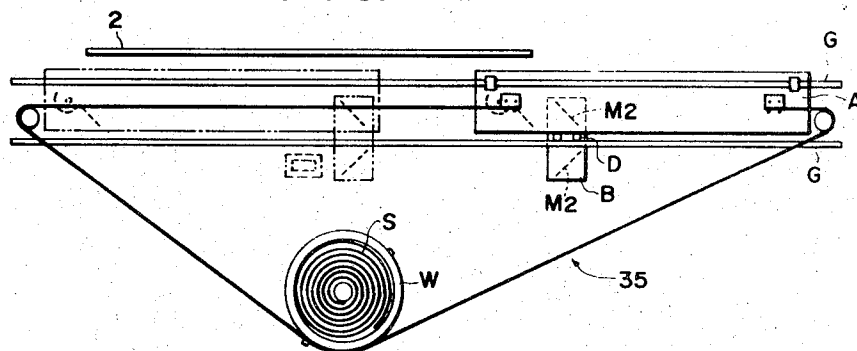


FIG 2

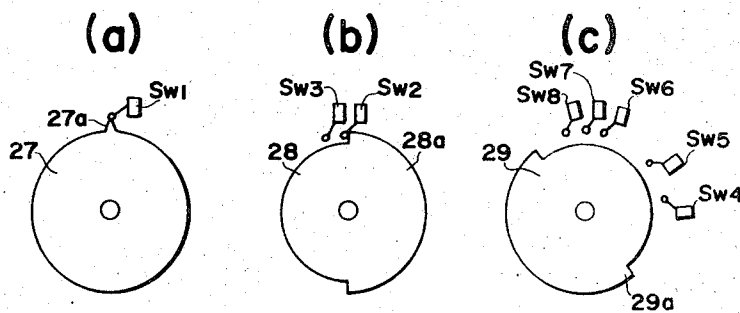


FIG. 3

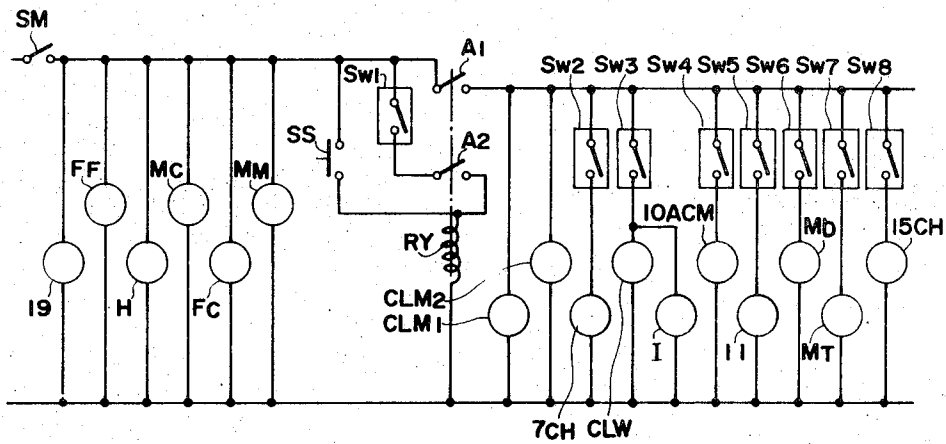
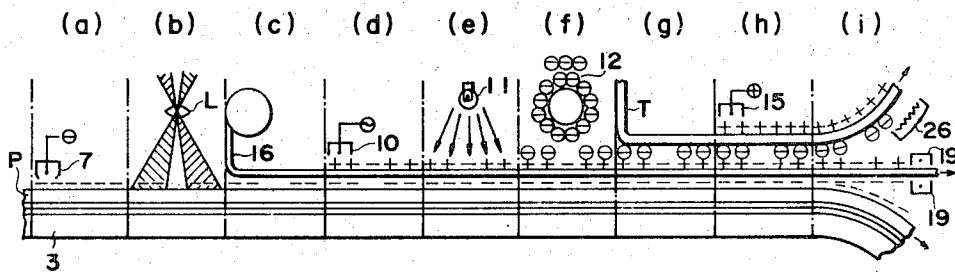


FIG. 4



ELECTROPHOTOGRAPHIC DUPLICATOR OF THE TRANSFER TYPE

BACKGROUND OF THE INVENTION

The present invention relates to an improved electrophotographic duplicator of the transfer type for projecting an original onto a photosensitive material via an optical system, forming the electrostatic latent image on a superposed insulating transparent film by means of AC corona discharge, stabilizing the latent image by a uniform exposure all over the surface of the photosensitive material developing the latent image by means of a dry toner developing device, and producing copies by transferring the developed figure to transfer papers by means of a transferring device.

In general a dry developing type electrostatic duplicator uses a photosensitive material consisting of photoconductive substances such as amorphous selenium and the like mounted on a drum and around which a charging station, an exposure station, a developing station, a transferring station, and a cleaning station are arranged in the order stated above. Thus, at the charging station the photosensitive body is charged by a corona discharge device; at the exposure station the original is exposed to the mirror image and the electrostatic latent image is formed on the surface of the photosensitive material; at the developing station the latent image is developed by means of a cascade developing method or the like; and at the transferring station a dry toner developed image is transferred to transfer papers supplied from the paper supplying station, the transferred image being fused at the heat fixing station for producing copies. However, such a duplicator has the following drawbacks:

1. The framework of the duplicator is large-sized because of the large drum.
2. Its photosensitive material may not be readily exchanged for another photosensitive material.
3. The resolving power of the image is lowered because the image exposure is made on the arc-shaped photosensitive material.
4. Copies produced by such a duplicator have fog because the electrostatic latent image on the photosensitive material is developed directly. So the apparatus is unfit for the reproduction of an original with many stains on its surface.
5. Its photosensitive material has flaws on its surface because a dry toner image is formed directly on the material and the image is transferred to transfer papers.

The present invention is constructed to remove the foregoing drawbacks by forming its photosensitive material into an endless belt shape so that it may be easily exchanged for another belt, making it possible to receive an even image exposure thereby; superposing an insulating transparent film upon the photosensitive material and applying to the superposed material and film an AC corona discharge and uniform exposure all over the surface of the photosensitive material; forming a corrected electrostatic latent image on the insulating transparent film; and, after dry toner developing the latent image, transferring the developed image to transfer papers.

OBJECTS OF THE INVENTION

Accordingly, one object of this invention is to provide an electrophotographic duplicator of the transfer

type for forming a corrected electrostatic latent image on an insulating film superposed upon a photosensitive material thereby producing a high density copy, especially for an original having stains on its surface.

Another object of the invention is to provide electrophotographic duplicator of the non-contact transfer type wherein the surface of the photosensitive body is not damaged.

Still another object of the invention is to provide an electrophotographic duplicator of the transfer type for producing copies which are small-sized and yet which has high resolving power.

The above, as well as other, features and objects of the present invention are readily understood from the following detailed description of the invention taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS:

FIG. 1a is a side-view showing the main components of one embodiment of the present duplicator.

FIG. 1b is a view of the driving mechanism showing the exposure optical system of the slit type for one embodiment of the present duplicator.

FIGS. 2(a), 2(b) and 2(c) illustrate respective relationships between a cam and associated microswitches in one embodiment of the present duplicator.

FIG. 3 is an electric circuit diagram of one embodiment of the present duplicator.

FIG. 4 is a diagram of the image making process in one embodiment of the present duplicator.

DETAILED DESCRIPTION OF THE INVENTION

In FIG. 1a, 1 is the framework of the duplicator, 2 is an original exposure station provided on the upper part of the framework, and 3 is an endless supporter, which is shown in the shape of a belt in the drawing, on which photosensitive material P of the same size as the exposure station is attached. Belt 3 and photosensitive material P, for example as shown in FIG. 4, are of the laminated type comprising, an organic semiconductor film of polyvinyl-carbazole including a thin aluminum film as an electrode, a very thin non-crystalline Se evaporated film and a small quantity of silicone fastened on stainless belt 3 which is 50 μ thick length and has a length equal to the length of the original exposure station. Belt 3 is connected with motor driving source M_M and which is rotated constantly by belt 34 via electromagnetic clutch CLM₁ FIG. 3, and is placed on revolving carrier-roller 4 and inverted rollers 5 and 6. Numeral 7 is a charging device consisting of a corona discharger and numeral 8 identifies the exposure aperture of the slit type exposure optical system 35. Exposure optical system 35 is constructed so that revolver D, on the second shifting base B provided with two mirrors M₂, is movable on a pair of guide rails G provided parallel to original 0 at exposure station 2. First shifting base A provided with original illuminating system I and mirror M₁ is mounted on revolver D and is connected by a belt shiftable from one pulley to another on the external boundary of wheel W whose internal boundary and fixed axle are connected by spring S. By the actuation of electromagnetic clutch CLM shown in FIG. 3, wheel W is connected with a driving source (carrier-roller 4) so that W revolves around driving source 4 relative to the revolution of belt 3, by means of a gear transmission and the like which are not illustrated in the drawing. Original 0 is

shifted to the left in the drawing at the peripheral speed of belt 3 while it is being illuminated. Then the second shifting base B is inverted at one half of that speed and the image of original 0 is reflected by means of mirrors M_1 and M_2 . The image is passed through fixed projection lens L, is further reflected by means of fixed mirror M_3 and is then projected on photosensitive material P which is moved along exposure aperture 8. At the end of the scanning of the original electromagnetic clutch CLM is disengaged, wheel W is reversed by means of the accumulated force of spring S and thus shifting bases A and B are returned to their original positions. Further, at the rear part of belt 3 opposite exposure aperture 8 retaining member 9 is provided. 10 is a correction charging device consisting of an AC corona discharger, 11 is a white light source consisting of a tungsten lamp, 12 is a developing device consisting of for example, developing rollers 13 maintained at one polarity and driven by motor M_3 and electrodes 14 at the opposite polarity so that maintained a number of developing brushes may be formed. 15 is a transferring device consisting of a corona discharger, which is mounted opposite to carrier-roller 4 in FIG. 1. 16 is a dielectric transparent film 10–100 μ thick, made from for example a polyester, polyethylene, or vinyl chloride, which is supplied from roll 31 and is wound on roll 32. During passage from charging device 10 to transferring device 15 correcting film is stretched along the belt 3 by means of feed roller 17 and tension roller 18 so that it may be carried at the same speed as the shifting speed of belt 3 by being connected by pressure with photosensitive material P between rollers 4 and 6, and, also, by electromagnetic clutch CLM₂ shown in FIG. 3, motor M_M , feed roller 17, and belt 34. Further, if feed roller 17 is directly connected with carrier-roller 4, electromagnetic clutch CLM₂ may be omitted.

19 denotes an AC corona discharger for removing residual charges on dielectric film 16 and 20 denotes a cleaning device, the residual toner being removed by means of cleaning brush 21 driven by motor M_c , which is not shown in the drawing and is attracted by fan F_c .

22 is a paper supplying roller delivering successive sheets of transfer paper T accumulated on base 36 by the drive of motor M_T . 23 is a pressure connecting roller for placing transfer paper T on dielectric film 16 superposed upon the photosensitive material at transferring device 15. 24 is a conveyer belt carrying transfer paper T to copy receiving tray 25 provided outside the framework of the duplicator. Belt 24 is mounted over roller 33 connected by belt 34 with motor M_M and is thereby driven. 26 is a heat fixing device consisting of heater H and fan F_F .

FIGS. 2A to 2C show a cam mechanism using three discs each of which is of the same radius. First cam 27 has projection 27a by which microswitch SW_1 is turned on (FIG. 2(A)), the second cam 28 has semicircular projection 28a by which microswitches SW_2 and SW_3 are turned on (FIG. 2(B)), the third cam 29 has semicircular projection 29a by which microswitches SW_4 , SW_5 , SW_6 , SW_7 and SW_8 are turned on (FIG. 2(C)). These three cams are fixed on the same axle in the phase relation illustrated in the drawing and are connected via a gear transmission mechanism, which is not shown in the drawing, with carrier-roller 4 serving as a driving source, as they are revolved once, relative to two revolutions of belt 3. Microswitches SW_1 to SW_8

for the working of each device actuated by these cams are connected as indicated in FIG. 3.

That is, relative to a power source and power source switch S_M , motor M_M , heater H in the heat fixing device, fan F_F , AC corona discharger 19 for removing residual charges, motor M_c for operating the brush of the cleaning device and fan F are connected in parallel with each other. Start switch S_S and relay R_Y which are connected in parallel with the aforesaid components, are connected in series with each other. Microswitch SW_1 , which is connected in parallel with start switch S_S , and relay switch A_2 of relay R_Y are connected in series with each other. Electromagnetic clutch CLM₁ of carrier-roller 4 and electromagnetic clutch CLM₂ of feed roller 17 are connected in parallel with each other. Microswitch SW_2 is connected in series with charging device 7, microswitch SW_3 is serially connected with illuminating lamp I of the exposure device and clutch CLW of wheel W, microswitch SW_4 is serially connected with corrections charging device 10, microswitch SW_5 is serially connected with uniform exposure light source 11, microswitch SW_6 is serially connected with driving motor M_D of developing roller 13 in developing device 12, microswitch SW_7 is serially connected with driving motor M_T of paper supplying roller 22 of transfer paper T, and microswitch SW_8 is serially connected with the corona discharger of transferring device 15.

The operation of the present electrophotographic duplicator whose components are as described above will be explained by means of the cam mechanism indicated in FIGS. 2A to 2C, the circuit in FIG. 3 and the diagram in FIG. 4.

Now, when power source switch S_M is closed, motive motor M_M is driven but microswitch SW_1 is in an opened state. That is because microswitch SW_1 is activated by means of projection 27a of the first cam 27 and the contact segment of microswitch SW_1 is mounted on projection 27a of the cam. In this case belt 34 is shifted but clutches CLM₁ and CLM₂ are not actuated, and carrier-roller 4 and feed roller 7 are not turned and belt 3 and insulating film 16 are not shifted. Conveyer belt 24, heat fixing device 26, cleaning device 20 and charge removing device 19 are actuated.

At the start of duplication, when original 0 is placed on exposure station 2 and start switch S_S is pushed, relay R_Y is actuated, contact segments A_1 and A_2 of relay R_Y are closed, clutches CLM₁ and CLM₂ are actuated, carrier-roller 4 is turned by means of clutch CLM₁ and the first cam 27, the second cam 28 and the third cam 29 which are interlocked by gears with carrier-roller 4 are turned, and feed roller 17 is turned by clutch CLM₂. At the instant the first cam 27 is turned, the contact segment of microswitch SW_1 is closed and relay R_Y is self-held. At the instant the second cam 28 is turned, microswitch SW_2 is turned on, charging device 7 starts corona discharge, and photosensitive material P on belt 3, as shown in FIG. 4(a), is carried while being charged. When photosensitive material P is carried just in front of exposure aperture 8, microswitch SW_3 is turned on by projection 28a of the second cam 28. At the instant illuminating lamp I is lighted, clutch CLW of wheel W is actuated, wheel W interlocking with belt 3 is turned, exposure optical system 35 on shifting bases A and B is shifted, the mirror image of original 0 is progressively projected on charged photosensitive material P which is passing

through exposure aperture 8 while original O is being illuminated, and an electrostatic latent image is thus formed as shown in FIG. 4(b). After passing through inventing roller 6, photosensitive material P is pressed against dielectric film 16 supplied from roll 31 and is superposed upon film 16 (FIG. 4(c)). When microswitch SW₄ is closed by means of projection 29a of the third cam 29, correction charging device 10 starts AC corona discharge, an electrostatic image, as shown in FIG. 4(d), resulting from the characteristics of the output current of the AC corona discharger is formed on dielectric film 16. Microswitch SW₅ is closed by means of projection 29a of the third cam 29, light source 11 is lighted, photosensitive material P is excited and thus an electrostatic image is stabilized as shown in FIG. 4(e) on dielectric film 16 and its contrast increased. Developing device 12 is actuated at the instant microswitch SW₆ is turned on by means of projection 29a of the third cam 29 and, as shown in FIG. 4(f), dielectric film 16 is developed by the toner. Prior to development dielectric film 16 is carried with photosensitive material P to transferring device 15, microswitch SW₇ is turned on by means of projection 29a of the third cam 29, one sheet of the upper-most transfer paper T, which is the last copy to be made, is delivered by means of paper supplying roller 22 from the transfer paper receiver and subsequently transfer paper T is pressed against dielectric film 16 to be superposed upon one another (FIG. 4(g)). When microswitch SW₈ is turned on by means of projection 29a of the third cam 29, transferring device 15, starts the corona discharge with a polarity opposite to the polarity of the toner image, and transfers the toner image formed on dielectric film 16 to the transfer paper as shown in FIG. 4(h). After the transfer, transfer paper T is separated from dielectric film 16, film 16 is separated from photosensitive material P, material P passes through charging device 7 again for its second shift, the residual charge of film 16 is removed by means of AC corona discharger 19 arranged just behind transferring device 15, and the residual toner is wound on roll 32 while being removed by means of cleaning device 20. Transfer paper T to which the toner image has been transferred is fixed by heat, when it passes under heat fixing device 26 by means of conveyer belt 24, and is carried to receiving tray 25. When photosensitive material P has completed one revolution and is just ahead of charging device 7, projection 28a of the second cam 28 is deactuated and switch SW₂ is turned off, for the reason that the second cam 28 makes one-half of its revolution. Consequently, when photosensitive material P makes its second revolution, it is shifted without being charged, and when it passes through exposure aperture 8, switch SW₃ is turned off because projection 28a of the second cam 28 is deactuated, and, while illuminating lamp 1 of the afore-mentioned exposure optical system 35 is extinguished, photosensitive material P stops moving and is returned to its original position by means of the aforementioned return spring. Thus, photosensitive material P, without being subjected to exposure, is again superposed upon insulating film 16 and passes through connection charging device 10, and is carried past light source 11 and developing device 12, but, because projection 29a of the third cam 29 is deactuated and switches SW₄, SW₅, and SW₆ are turned off in regular sequence, no image is made. Further, because projection 29a of the third cam 29 is de-

actuated and switch SW₇ is turned off, transfer paper T is not supplied. Before photosensitive material P arrives at transferring device 15, that is, makes a revolution after the transferring operation is started, the trailing end of the transfer paper passes through transferring device 15 and the transferring operation is ended. Simultaneously, time switch SW₈ is turned off because projection 29a of the third cam 29 is deactuated, the corona discharge of transferring device 15 being stopped thereby. Further, when the photosensitive material is shifted and arrives at its original position just before charging device 7, that is, when material P has made two revolutions, microswitch SW₁ is turned off by means of projection 27a of cam 27, and thus relay R_Y is self-released, clutches CLM₁ and CLM₂ becomes deactivated, photosensitive material P and dielectric film 16 being stopped at the same time.

Accordingly, an image of an original is formed during the first revolution of belt 3, the image is transferred to transfer paper T during its second revolution and at the same time those which have been transferred are delivered to tray 25.

Because the present electrophotographic transfer type has the structure as described above, copies produced by its image correcting means, consisting of an insulating transparent film, a charging device for correction of AC corona discharge and a uniform exposure light source, have no fog, are fair, and have high density, as compared with those produced by duplicators heretofore known. The reason is that an image is formed by positive charge in the dark parts thereof and by negative charge in the light parts thereof on a film, as shown in FIG. 4(e). The present duplicator has the following advantages: 1) It is suitable for the duplication of an original such as a drawing, a document, and the like. 2) It is constructed so that there is no positive charge corresponding to the light parts of the image on the dielectric film because of the AC corona discharge as may be seen clearly from FIG. 4(d), relative to an original having stains on its surface, that is, an original having a small quantity of negative charge in the light parts thereof as in FIG. 4(b) and as a result fair copies with no fog may be produced. 3) Because the photosensitive material is covered with a dielectric film, and is not directly developed, there is no damage to the photosensitive material resulting therefrom 4) The photosensitive material withstands long and repeated use. Finally the apparatus may utilize a photosensitive material with an elastic surface.

I claim:

1. An electrophotographic duplicator of the transfer type comprising:

- means for projecting an image of an original document at an exposure station and including a projection lens;
- a slit-shaped exposure aperture provided on the image plane of said projection lens;
- a photosensitive surface of a photosensitive material formed as a flexible endless belt;
- a number of rollers extending said endless belt along said exposure aperture thereby forming a carrier path for said endless belt and a driving device for driving said endless belt in one direction along said carrier path;
- a first DC corona discharge device adjacent said carrier path for uniformly charging the photosensitive surface and means for supplying a transparent di-

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electric film in superposing relationship with said photosensitive surface;
 a second AC corona discharge device adjacent said transparent dielectric film superposed upon said photosensitive surface for forming an electrostatic latent image thereon corresponding to the electrostatic latent image on said photosensitive surface and formed selectively by positive charge or negative charge on the transparent dielectric film;
 an illuminating device irradiating the whole of the photosensitive surface through the transparent dielectric film upon which said photosensitive surface is superposed thereby stabilizing the electrostatic latent image on said transparent dielectric film;
 a developing device for developing the electrostatic latent image formed on said transparent dielectric film;
 a device for supplying transfer paper to the surface of said developed transparent dielectric film;
 a transferring device for superposing said transfer paper upon said transparent dielectric film a third corona discharge device for charging said transfer paper with a charge of opposite polarity as the polarity of said toner and transferring an image corresponding to the original image;
 a transfer paper carrier path separating the transfer paper passed through said transferring device from the transparent dielectric film path and a transparent dielectric film carrier path separating the trans-

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parent dielectric film from the photosensitive surface; and
 a heat fixing device mounted adjacent said transfer paper carrier path.
 2. An electrophotographic duplicator as in claim 1 further comprising:
 an AC corona discharge device mounted adjacent the carrier path of the transparent dielectric film separated from the endless belt on which the photosensitive surface is formed for removing residual charges therefrom; and
 a cleaning device for cleaning said transparent dielectric film.
 3. An electrophotographic duplicator as in claim 1 wherein said number of rollers comprise a first roller and a second roller mounted parallel to said exposure station, said second roller is a carrier roller corresponding to said transferring device and said transparent dielectric film is superposed upon the photosensitive surface and carried together between said first and second rollers; and
 said second AC corona discharge device facing said carrier path.
 4. An electrophotographic duplicator as in claim 3 wherein said number of rollers comprises a third roller, the carrier path between said first roller and said third roller faces said exposure station, and said first DC corona discharge device is mounted facing the carrier path between said second roller and said third roller.
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