

# PATENT SPECIFICATION

(11) 1 242 072

## DRAWINGS ATTACHED

1 242 072

- (2) Application No. 28550/68 (22) Filed 14 June 1968  
 (31) Convention Application No. P 15 72 330.5 (32) Filed 15 June 1967 in  
 (33) Germany (DT)  
 (45) Complete Specification published 11 Aug. 1971  
 (51) International Classification G 03 g 15/14/B 65 h 29/56  
 (52) Index at acceptance  
 G2H 12 6X 6Y 8F1 8FY 8Y  
 B6C A7  
 B8R 6J2 6J5



## (54) ELECTROPHOTOGRAPHIC COPYING APPARATUS

(71) We, AGFA-GEVAERT AKTIEN-GESELLSCHAFT, a body corporate recognised under German Law, of Leverkusen, Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:

This invention relates to an electrophotographic copying apparatus.

The invention provides an electrophotographic copying apparatus, which comprises a copying cylinder mounted so as to be rotatable about its axis and coated with a layer of a photo-conductive material, and, arranged adjacent to the periphery of the copying cylinder, a first corona discharge device for imparting a uniform electrostatic charge to the photo-conductive layer, exposure means for effecting image-wise exposure of the said layer to light in order to produce an electrostatic charge image on the said layer, means for developing the charge image with an electrostatically attractable toner powder, a second corona discharge device of the same polarity as the first corona discharge device for effecting transfer of the toner powder from the copying cylinder to a copy support sheet in contact with the copying cylinder, a third corona discharge device of which the polarity is opposite to that of the second corona discharge device and arranged substantially to neutralise the charge imparted by the second corona discharge device to each part of the copy support sheet in turn, prior to removal of that part of the copy support sheet from the copying cylinder, blower means arranged to direct a flow of air onto the leading edge portion of the copy support sheet when the said leading edge portion is exposed to the action of the third corona discharge device, and means for feeding individual copy support sheets to the copying cylinder in turn.

Experiments have shown that the reliability with which ready removal of the copy support sheets from the copying cylinder is achieved is increased to a surprising degree by the blower means even when, as is preferred, the blower means is arranged to direct only a light current of air onto the leading edge portion of the copy support sheet. Since a very small pressure drop of approximately 2 to 3 millimetres of water across the blower means is sufficient, and this would scarcely be capable of exerting any significant mechanical force tending to remove the copy support sheet, it is believed that the flow of air serves mainly to improve the charge equalisation process by influencing the ion current between the third corona discharge device and the leading edge portion of the copy support sheet.

The apparatus according to the invention has the advantage that it does not require the relatively powerful, and consequently costly, air blower devices or the mechanical gripper devices utilised in known forms of apparatus to remove the copy support from the copying cylinder after transfer of the toner powder to the copy support. Upon neutralisation of the electrostatic charge that has been applied to effect transfer of the toner powder to the copy support, the electrostatic forces attracting the copy support to the copying cylinder are eliminated and the copy support falls away from the cylinder almost of its own accord so that it can, for example, be removed by means of a simple stripper plate.

Advantageously, in order so to control the magnitude of the charge applied by the third corona discharge device to the copy support as to achieve substantially complete neutralisation of the charge on the copy support and to prevent build-up of an opposite charge of comparable magnitude to the original charge, the said corona discharge devices are each provided with means for choking the ion flow between the ion source

[Price 25p]

SPECIFICATION AMENDED - SEE ATTACHED SLIP

and the surface to be charged, the third corona discharge device being choked to a greater extent than the first and second corona discharge devices. The choke means may, for example, be a control grid which in the case of the first two corona discharge devices is connected to a voltage within the range of from 600 to 800 volts of the same polarity as the first and second corona discharge devices, corresponding to the usual charge potential of the photo-conductive layer, and in the case of the third corona discharge device is connected to earth. Preferably, however, each of the choke means comprises a slot aperture in an earthed housing of the corona discharge device, which aperture faces in the direction of the surface to be charged, the width of the aperture in the case of the said third corona discharge device being smaller than the width of the apertures in the case of the first and second corona discharge devices.

Advantageously, the distance between the third corona discharge device and the periphery of the copying cylinder is greater than the distance between the periphery of the copying cylinder and the first and second corona discharge devices.

Advantageously, the apparatus includes, for supplying current to the three corona discharge devices, a common transformer and two separate half-wave rectifiers, the first two corona discharge devices being connected to one of the rectifiers, which is arranged to block the negative half of the wave, and the third corona discharge device being connected to the other rectifier, which is arranged to block the positive half of the wave.

One form of electrophotographic copying apparatus constructed in accordance with the invention will now be described by way of example with reference to the accompanying drawing, the single figure of which is a diagrammatic end view, partly in section of the apparatus, with an associated circuit diagram.

Referring to the accompanying drawing, the apparatus comprises an earthed copying cylinder 1 coated in a known manner with a photo-conductive selenium layer and, arranged adjacent to the periphery of the cylinder, a first corona discharge device 2 for charging the layer uniformly to a potential within the range of from +600 to +800 volts. The copying cylinder 1 rotates in the direction shown by the arrow *A* so that, as each part of the layer on the copying cylinder 1 is charged by the corona discharge device 2, it moves under a projection objective 3. The projection objective 3 projects onto the surface of the copying cylinder 1 an image of an original 4 which is illuminated by strip lights 5 and 6 and is supported in a known manner on a carriage 7 which is

driven, by means of a cord 8, at a speed equal to the peripheral speed of the copying cylinder 1, but in the direction indicated by the arrow *B*, which is opposite to the direction indicated by the arrow *A*.

The electrostatic charge image of the original produced on the charged layer by this exposure is then developed by means of a developing device 8 which applies an electrostatically attractable powder to the surface of the cylinder. As the cylinder 1 rotates, it comes into contact with a copy support in the form of a sheet of paper, which is fed to it in the direction indicated by the arrow *C* from a stack of paper 10 by means of a paper pick-up roller 9. The sheet of paper resting against the copying cylinder 1 now passes beneath a second corona discharge device 11 which charges the back of the sheet of paper to a potential within the range of from approximately +600 to +800 volts. As a result of this charge, the electrostatically attractable powder moves from the cylinder 1 onto the surface of the copy support or sheet of paper.

To enable the removal of the paper sheet, which adheres to the copying cylinder 1 with considerable force because of the positive charge applied to the back of the paper, a third corona discharge device 14 is provided from which a negative ion current flows to the sheet of paper to neutralise the charge produced by the first and second corona discharge devices 2 and 11, respectively. Correct matching of the electrostatic charges applied to the sheet is achieved by narrowing the apertures in the earthed housings of the corona discharge devices 2 and 11 that face towards the photo-conductive layer to slits 2*a* and 11*a*, respectively. The ion flow from the corona discharge wires 2*b* and 11*b* to the photo-conductive layer is thus limited. With suitable selection of the width of the slits 2*a* and 11*a*, only the desired charge of approximately +600 to +800 volts is applied to the photoconductive layer. The ion current from the corona discharge wire 14*b* of the third corona discharge device 14 is limited even more than the ion current from the first and second corona discharge devices 2 and 11 by the provision of a correspondingly narrower housing aperture 14*a*. The third corona discharge device 14 is also at a greater distance from the surface being charged than are the first and second corona discharge devices 2 and 11, respectively. Owing to these measures, it is possible to arrange that the third corona discharge device 14 does not re-charge the back of the sheet to a negative voltage comparable in magnitude to the positive voltage to which it had been charged by the second corona discharge device 11, but only neutralises the charge applied by the latter device. The copy support which has been discharged

in this way falls away from the copying cylinder 1 almost of its own accord and can be conveyed without difficulty to a heat fixing device 15. In order to facilitate the removal of the copy support even further, an air blower nozzle 16 extending over the whole width of the copying cylinder is provided, which by means of an outlet slit 16a extending over the whole width of the copying cylinder blows air at a low pressure of approximately 2 to 3 millimetres of water onto the leading edge portion of the sheet as it passes the third discharge corona 14. This improves the reliability of removal of the leading edge portion of the sheet.

Any residual charge pattern on or in the photo-conductive layer is removed by uniform illumination with a lamp 12, and each portion of the layer in turn is cleaned to remove residual powder from it by a cleaning device 13 before it passes under the corona discharge device 2 again for a further copying cycle.

The current supply to the corona discharge devices is provided by a transformer 17 which is connected to a 220 v., 50 cycles network 18 and 19, the secondary winding delivering a voltage of approximately 5,000 to 6,000 volts. A rectifier 21 arranged to block the negative half wave and a rectifier 22 arranged to block the positive half wave are connected to one pole of the secondary winding, the other pole of which is connected to earth. Smoothing capacitors 23 and 24 are connected in parallel with the rectifiers 21 and 22, respectively. The rectifier 21 is connected by way of resistors 25 and 26, respectively, to the discharge wires 2b and 11b, whilst the rectifier 22 is connected to the discharge wire 14b by way of a resistor 27.

#### WHAT WE CLAIM IS:

1. An electrophotographic copying apparatus, which comprises a copying cylinder mounted so as to be rotatable about its axis and coated with a layer of a photo-conductive material and, arranged adjacent to the periphery of the copying cylinder, a first corona discharge device for imparting a uniform electrostatic charge to the photo-conductive layer, exposure means for effecting imagewise exposure of the said layer to light in order to produce an electrostatic charge image on the said layer, means for developing the charge image with an electrostatically attractable toner powder, a second corona discharge device of the same polarity as the first corona discharge device for effecting transfer of the toner powder from the copying cylinder to a copy support sheet in contact with the copying cylinder, a third corona discharge device of which the polarity is opposite to that of the second corona discharge device and arranged substantially to neutralise the charge imparted by the

second corona discharge device to each part of the copy support sheet in turn, prior to removal of that part of the copy support sheet from the copying cylinder, blower means arranged to direct a flow of air onto the leading edge portion of the copy support sheet when the said leading edge portion is exposed to the action of the third corona discharge device, and means for feeding individual copy support sheets to the copying cylinder in turn.

2. Apparatus as claimed in claim 1, wherein the blower means is arranged to produce a pressure drop across itself within the range of from 2 to 3 millimetres of water.

3. Apparatus as claimed in any one of claims 1 to 2, wherein the said corona discharge devices are each provided with means for choking the ion flow between the ion source and the surface to be charged, the third corona discharge device being choked to a greater extent than the first and second corona discharge devices.

4. Apparatus as claimed in claim 3, wherein each of the choke means comprises a slot aperture in an earthed housing of the corona discharge device, which aperture faces in the direction of the surface to be charged, the width of the aperture in the case of the said third corona discharge device being smaller than the width of the apertures in the case of the first and second corona discharge devices.

5. Apparatus as claimed in any one of claims 1 to 4, wherein the distance between the third corona discharge device and the periphery of the copying cylinder is greater than the distance between the periphery of the copying cylinder and the first and second corona discharge devices.

6. Apparatus as claimed in any one of claims 1 to 5, which includes, for supplying current to the three corona discharge devices, a common transformer and two separate half-wave rectifiers, the first and second corona discharge devices being connected to one of the rectifiers, which is arranged to block the negative half of the wave, and the third corona discharge device being connected to the other rectifier, which is arranged to block the positive half of the wave.

7. Electrophotographic copying apparatus substantially as hereinbefore described with reference to, and as shown in, the accompanying drawing.

ABEL & IMRAY,  
Chartered Patent Agents,  
Northumberland House,  
303-306 High Holborn,  
London, W.C.1.

Reference has been directed in pursuance of Section 9, subsection (1) of the Patents Act, 1949, to patent No. 1,198,466.



in this way falls away from the copying cylinder 1 almost of its own accord and can be conveyed without difficulty to a heat fixing device 15. In order to facilitate the removal of the copy support even further, an air blower nozzle 16 extending over the whole width of the copying cylinder is provided, which by means of an outlet slit 16a extending over the whole width of the copying cylinder blows air at a low pressure of approximately 2 to 3 millimetres of water onto the leading edge portion of the sheet as it passes the third discharge corona 14. This improves the reliability of removal of the leading edge portion of the sheet.

Any residual charge pattern on or in the photo-conductive layer is removed by uniform illumination with a lamp 12, and each portion of the layer in turn is cleaned to remove residual powder from it by a cleaning device 13 before it passes under the corona discharge device 2 again for a further copying cycle.

The current supply to the corona discharge devices is provided by a transformer 17 which is connected to a 220 v., 50 cycles network 18 and 19, the secondary winding delivering a voltage of approximately 5,000 to 6,000 volts. A rectifier 21 arranged to block the negative half wave and a rectifier 22 arranged to block the positive half wave are connected to one pole of the secondary winding, the other pole of which is connected to earth. Smoothing capacitors 23 and 24 are connected in parallel with the rectifiers 21 and 22, respectively. The rectifier 21 is connected by way of resistors 25 and 26, respectively, to the discharge wires 2b and 11b, whilst the rectifier 22 is connected to the discharge wire 14b by way of a resistor 27.

#### WHAT WE CLAIM IS:

1. An electrophotographic copying apparatus, which comprises a copying cylinder mounted so as to be rotatable about its axis and coated with a layer of a photo-conductive material and, arranged adjacent to the periphery of the copying cylinder, a first corona discharge device for imparting a uniform electrostatic charge to the photo-conductive layer, exposure means for effecting imagewise exposure of the said layer to light in order to produce an electrostatic charge image on the said layer, means for developing the charge image with an electrostatically attractable toner powder, a second corona discharge device of the same polarity as the first corona discharge device for effecting transfer of the toner powder from the copying cylinder to a copy support sheet in contact with the copying cylinder, a third corona discharge device of which the polarity is opposite to that of the second corona discharge device and arranged substantially to neutralise the charge imparted by the

second corona discharge device to each part of the copy support sheet in turn, prior to removal of that part of the copy support sheet from the copying cylinder, blower means arranged to direct a flow of air onto the leading edge portion of the copy support sheet when the said leading edge portion is exposed to the action of the third corona discharge device, and means for feeding individual copy support sheets to the copying cylinder in turn.

2. Apparatus as claimed in claim 1, wherein the blower means is arranged to produce a pressure drop across itself within the range of from 2 to 3 millimetres of water.

3. Apparatus as claimed in any one of claims 1 to 2, wherein the said corona discharge devices are each provided with means for choking the ion flow between the ion source and the surface to be charged, the third corona discharge device being choked to a greater extent than the first and second corona discharge devices.

4. Apparatus as claimed in claim 3, wherein each of the choke means comprises a slot aperture in an earthed housing of the corona discharge device, which aperture faces in the direction of the surface to be charged, the width of the aperture in the case of the said third corona discharge device being smaller than the width of the apertures in the case of the first and second corona discharge devices.

5. Apparatus as claimed in any one of claims 1 to 4, wherein the distance between the third corona discharge device and the periphery of the copying cylinder is greater than the distance between the periphery of the copying cylinder and the first and second corona discharge devices.

6. Apparatus as claimed in any one of claims 1 to 5, which includes, for supplying current to the three corona discharge devices, a common transformer and two separate half-wave rectifiers, the first and second corona discharge devices being connected to one of the rectifiers, which is arranged to block the negative half of the wave, and the third corona discharge device being connected to the other rectifier, which is arranged to block the positive half of the wave.

7. Electrophotographic copying apparatus substantially as hereinbefore described with reference to, and as shown in, the accompanying drawing.

ABEL & IMRAY,  
Chartered Patent Agents,  
Northumberland House,  
303-306 High Holborn,  
London, W.C.1.

Reference has been directed in pursuance of Section 9, subsection (1) of the Patents Act, 1949, to patent No. 1,198,466.