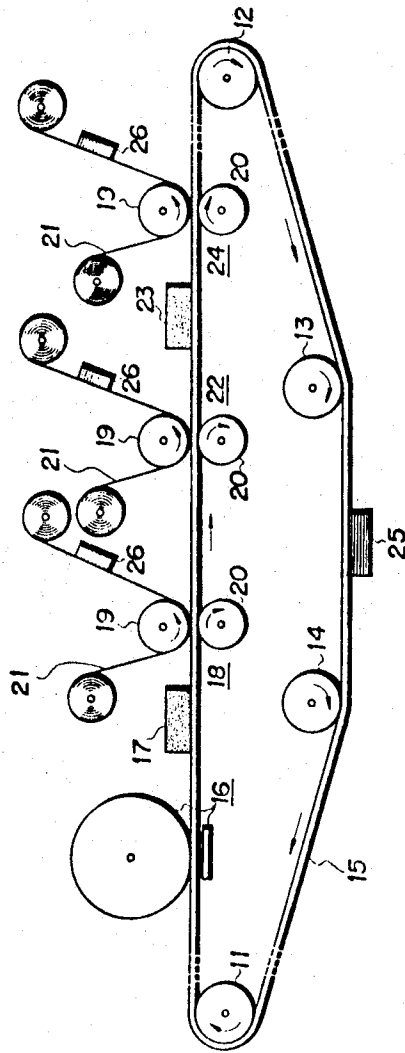


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TSUTOMU HONMA ETAL
POWDER IMAGE TRANSFER SYSTEM

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POWDER IMAGE TRANSFER SYSTEM

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5 Claims. (Cl. 101—1)

This invention relates to electrostatic printing apparatus for use in electronic computers, phototelegraphic apparatus and the like, and relates more particularly to an improved system for transferring powder images formed on a recording medium to a transfer material.

In the conventional process in electrophotography, an exposure plate comprising a thin layer of photoconductive material coated on a conductive backing is given in the dark a uniform electrostatic charge over its photoconductive surface by means of corona charging, and then exposed to the radiation of radial rays, such as X-rays, through an original image to be reproduced so as to form on the photoconductive surface an electrostatic latent image corresponding to the pattern or shadings of said original image to be reproduced. Thereafter, a developing powder formed of pigmented, finely divided resinous particles and having an electric charge of polarity opposite to that of the electrostatic latent image is applied on to the electrostatic latent image and electrostatically deposited thereon thereby forming a visible powder image. Transfer of the powder image is carried out by placing a transfer material on said powder image to attract the powder image carried on the exposure plate to the transfer material, said powder image being given an electric charge of polarity opposite to that of the powder image.

According to another process that has been proposed heretofore, in transferring by placing a transfer sheet or sheets on the powder image formed on the plate, the charge polarity of such transfer sheet is varied alternately in every step of replacing transfer sheets so that a larger number of transfers will be effected.

However, since the above mentioned processes have been developed to be practical or available in electrophotography, it is difficult to directly apply those techniques, for example, to electrostatic high-speed printing apparatus used in electronic computers because of the differences in plates for forming electrostatic latent images, the amount of developing powders and the like factors. Also in the printing apparatus for electronic computers, it is required to produce, in general, a plurality of reproduction prints.

The principal object of this invention is to provide an improved powder image transfer system to promote the grade of transferred images while preventing corona charging in transfer steps.

Another object of this invention is to provide an improved powder image transfer system in which a plurality of reproduction prints can be obtained from a powder image developed on the recording medium by employing a plurality of transfer apparatus in one cycle of transfer steps.

A further object of this invention is to provide an improved powder image transfer system wherein a plurality of simultaneous image reproductions can be successively obtained by supplying developing powder to the recording medium from which said developing powder may be gradually decreased and by repeating developing and transfer steps.

For a better understanding of this invention as well as other objects and advantages thereof, reference is had to the following detailed description of the invention to be read in connection with the accompanying drawing, in which a single figure represents a diagrammatic view

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of an embodiment of an electrostatic printing apparatus embodying the powder image transfer system of this invention.

As shown in the figure, the electrostatic printing apparatus comprises an insulating recording medium, such for example as, resinous sheet 15 of an endless belt type, which is constantly driven by rollers 11, 12, 13 and 14. Upon said resinous sheet 15 is formed an electrostatic latent image by a pulsating voltage from a known printing apparatus 16. The latent image thus formed is developed by a known developing apparatus 17 as by magnetic brushing or the like, and then developing powder is deposited thereon. Such developing powder is transported together with a transfer sheet supplied by a payoff station 21 to a first transfer device 18 through which said developing powder and transfer sheet pass and where transfer is effected. In the transfer device 18, the press roller 19 positioned at a side close to the transfer sheet is formed of conductive material and charged with opposite polarity to powder image, while the press roller 20 located at a side close to the resinous sheet is formed of insulating material, such as hard rubber. Therefore, the powder image can be made to adhere to the transfer sheet by the charging voltage of the conductive roller 19 while the transfer sheet is passed through the rollers 19 and 20. It is to be noted that since the roller 20 close to the resinous sheet is made of insulating material, corona discharging from the roller 19 of the transfer sheet side can be prevented with the result that the latent image-bearing surface is free from contamination, hence the quality of the transferred image will not be damaged. Since a single transfer process will leave a residual powder image on the sheet, a second transfer device 22 is employed which will repeat the transferring functions mentioned above. The functional details of this second transfer device 22 is the same as those described in connection with the first transfer device 18 with the exception that charging voltage as well as pressure imposed on the recording medium by the rollers are higher than those in the first transfer device. As a result, the powder image is further decreased to such an extent that it will not be applicable in the next succeeding transfer operation. However, the powder image carries residual charge which has been previously energized at the printing apparatus 16. Therefore, the residual latent image is further developed by a developing apparatus 23 and developing powder is attractively held thereon. A powder image thus deposited is again transported to a third transfer device 24 where transfer is effected. In this case all the functional details and formation of said third transfer device are the same as those of the first transfer device. Repetition of the above first and second transfer processes will successively produce a number of accurate reproductions.

After image transfer, any residual latent image remaining on the sheet may be discharged by a discharge device 25 for the transfer steps to follow in the next sequence of operation. The powder image carried on the transfer sheet is fixed thereon by means of heat fixing of any known fixing apparatus 26.

According to the experiments conducted by the inventors, 10-odd accurate reproduction prints having excellent image reproducibility could be obtained by charging a negative electrostatic latent image on the recording medium, under the conditions of the transfer speed of 1 m./sec., applied voltage of -1000 v. to the press roller at the transfer sheet side of the first transfer device, -1200 v. to the press roller at the transfer sheet side of the second transfer device, the second transfer device imposing upon the recording medium a pressure higher than that imposed by the first transfer device, and similar voltages applied to rollers at the transfer sheet side of the consecutive transfer devices.

10-odd accurate reproduction prints having excellent image reproducibility could also be obtained in a similar manner in which the transfer speed was selected to be 10 cm./sec., applied voltage of the press roller at the transfer sheet side of the first transfer device to be —500 v., that of the press roller at the transfer sheet side of the second transfer device to be —600 v., the second transfer device imposing upon the recording medium a pressure higher than that imposed by the first transfer device, and rollers at the transfer sheet side of the consecutive transfer devices were supplied with a similar voltage.

It should be understood that instead of the press rollers of the transfer devices other press means of different configuration such as flat plate may be used, and that voltage applied to the rollers facing the transfer sheets and pressure imposed on the recording medium by these rollers may be varied with respect to each roller. It should also be understood that the recording medium for electrostatic latent image formation need not be endless, and that as transfer sheet, sheets commercially available on the market can be suitably used and are economical. In case the recording medium is of sheet type, the recording medium may be rolled on a suitable spool after discharging and the medium thus rolled may be repeatedly used in the next succeeding sequence of transfer steps by removing and positioning the spool means to the position from which the next sequence for latent image formation starts.

As has been described above, in accordance with this invention, any desired number of reproduction prints can be consecutively obtained by employing a desired number of printing apparatus and by supplying developing powder to cover the shortage in the transfer steps while further developing a residual electrical charge of the latent image, that is, repeatedly effecting developing and transfer steps to accomplish continuous transfers. Since the pressing means of the transfer devices of this invention is formed of conductive material at its side close to the transfer sheet and formed of insulating material at its side close to the recording medium, corona discharge is substantially prevented, with the result that transfers with excellent image reproducibility are achieved. Thus this invention is applicable, for instance, to an electrostatic high-speed printing apparatus in electronic computer output circuits.

While the present invention has been described in a preferred embodiment, it will be obvious to those skilled in the art that various modifications can be made therein within the scope of the invention. It is intended that the appended claims cover all such modifications.

What is claimed is:

1. A powder image transfer system comprising, means for moving a recording medium along a path of travel, printing means for forming electrostatic latent images on said recording medium, a developing apparatus in said travel path for developing the latent image formed on said recording medium to form visible powder images, a trans-

fer material payoff station for supplying transfer material for receiving said powder images on the recording medium, a plurality of transfer devices including press means sequentially disposed along said travel path adapted to press said transfer material and recording medium together, said press means having two sections, one section being formed of conductive material positioned closest to the transfer material and another section formed of insulating material disposed closest to the recording medium, said sections serving to press said transfer material therebetween, and means for applying an electric charge to said conductive material.

2. The powder image transfer system as claimed in claim 1 wherein said recording medium is an endless belt and said press means of each transfer device is made of cylindrical rollers.

3. A powder image transfer system comprising, means for moving a recording medium along a path of travel, printing means for forming electrostatic latent images on said recording medium along said travel path, a developing apparatus for developing the latent image formed on said recording medium along said travel path to form visible powder images, a plurality of transfer devices spaced from each other along the travel path of the recording medium, each being adapted to effect powder image transfer on separate transfer material sheets, each transfer device including press means through which said sheets and recording medium pass, for applying pressure to said sheets and recording medium therebetween, material on one section thereof disposed for pressing on the sheet and formed of insulating material on another section disposed for pressing on the recording medium, and means for applying electric charges and pressure depending upon the transfer speed to the one section of each transfer device in such a manner that the electric charge progressively increases along the path of travel.

4. A device as claimed in claim 3 said pressure applied by said press means increasing progressively along said travel path.

5. A device as claimed in claim 3, wherein said transfer devices constitute first, second, and successive transfer stages, there being additional developing apparatus along said path of travel past said second stage to further develop the residual latent image on the recording medium.

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