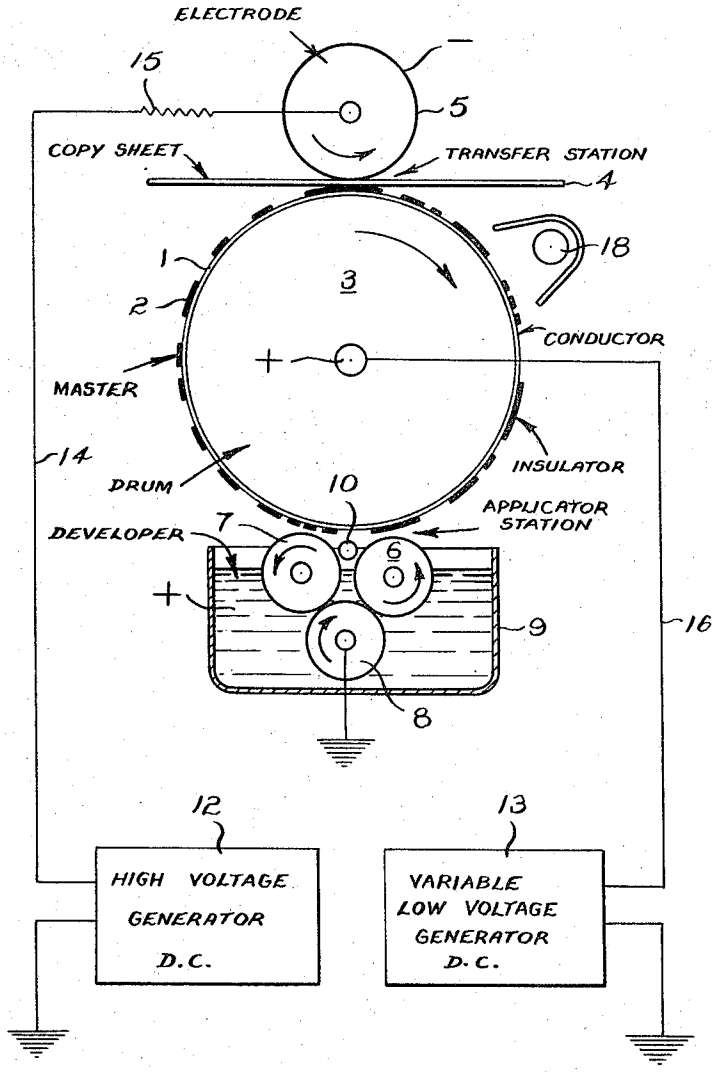
Feb. 13, 1968 J. MATKAN ETAL 3,368,894

MULTIPLE COPY PRINTING METHOD AND APPARATUS

Filed Nov. 3, 1964



United States Patent Office

3,368,894

Patented Feb. 13, 1968

3,368,894

MULTIPLE COPY PRINTING METHOD AND APPARATUS

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Filed Nov. 3, 1964, Ser. No. 408,645
Claims priority, application Australia, Nov. 5, 1963, 37,308/63
4 Claims. (Cl. 96—1)

ABSTRACT OF THE DISCLOSURE

A method and apparatus for printing multiple copies from a master having a printing surface consisting of insulator sections interspersed with relatively conductive sections. The insulator sections of the master are charged to a high D.C. voltage of given polarity at a combination charging and transfer station, by conductive connection to a roller electrode. From the charging and transfer section the master is moved to an applicator station where it is contacted with a liquid developer containing toner particles that are attracted to a charge of the aforesaid given polarity, thus producing a developed image on the printing surface of the master. The master is then returned to the combination charging and transfer station, at which the developed image is transferred to a copy sheet passing between the charging electrode and the master printing surface, the copy sheet constituting a part of the conductive connection between the electrode and the printing surface. Thus, the printing surface insulator sections are recharged simultaneously with the transfer operation as a part of the next printing cycle. Throughout the complete printing cycle, the conductive sections of the master are maintained at a low unidirectional potential of opposite polarity from the potential to which the insulator sections are charged, by means of a conductive connection to an adjustable low voltage D.C. supply. The potential of the conductive portions of the master is adjusted to obtain optimum contrast in the developed image as transferred to the copy sheet. The preferred apparatus utilizes a drum construction for continuous printing operation with the master being maintained on the periphery of the drum and moving continuously between the transfer station and the applicator station and back again. Where the conductive sections of the master comprise a photoconductor, the printing surface is illuminated at a point intermediate the transfer station and the applicator station to prevent maintenance of a developable charge on these portions of the master.

This invention relates to improvements in and relating to multiple copy printing and in particular it relates to printing of the type using electrical transfer from a master to which developer or ink is applied and from which it is transferred to independent sheets or a web passing through the machine.

It is already well known to effect printing by electrostatic methods in which an electrophotographic surface is charged, exposed, inked, and then transferred to a web or sheets, and it is also known to utilise an electrical field to aid transfer of an image under certain conditions.

Many problems exist, however, in the type of printing referred to above, in particular difficulty exists in controlling the inking of the master with the developer to be transferred and in controlling the transfer of the developer to the paper or other medium being printed, and it is therefore the object of this invention to provide an improved method of and means for effecting such printing in which there will be a highly effective form of control

over the acceptance of the developer or ink by the master and the subsequent transfer of the image to the paper or other sheets.

The method according to this invention comprises the inking or development of a master (hereinafter simply referred to as development) having relatively conductive areas and relatively insulating areas which define the image, the insulating areas being charged preferably at the transfer locality and subsequently inked or supplied with developer in an applicator station where a biasing voltage is used which is such that it gives the correct differential between the charge of the developer and the charge on the insulator in relation to the relatively conductive portions of the master, the developed or inked master then transferring the image at the transfer station. The charging cycle can at the same time effect the electrical transfer of the developer or ink from the insulating section to the paper or the like passing through this station (this paper being hereinafter referred to as the copy sheet), this cycle being repeated continuously until the required number of copies have been printed.

The mechanism can conveniently comprise a roller or other member on which the image to be printed is produced by utilising relatively insulating and relatively conductive sections to define the image, this master so produced being subjected alternately to a charging and transfering action at a transfer station and to a developing or inking action, the latter being achieved by passing the charged surface through a zone in which the developing or inking liquid is applied to the master in a highly agitated and controlled manner, the master being subjected at the transfer station to an electrical field which can be supplied either from a corona discharge device or from a charged roller, the field being applied between the transfer station and the developer, while a biasing voltage is applied between the master and the developer or ink, this latter voltage being variable to allow an exact control of the picking up by the insulated sections of the correct amount of developer or ink and the repelling of the developer or ink from the conductive sections.

It will be realised that the polarities will vary according to the type of developer or ink being applied to the master, and also that the mechanism can be widely varied, but as a typical example of how the invention may be applied, a drum contains on it a master which may comprise a paper or similar backing having a relatively conductive nature on which is formed an image in a resin or similar material which is a relatively good insulator. Such image may be produced by developing a latent electrostatic image on a photoconductor medium with an insulating resin, or the master can be produced by printing an insulating image on to a sheet, the essential feature being that the image is defined by relatively insulated and relatively conducting sections.

At the upper part of the drum is a transfer station at which the image is transferred from the insulator to a copy sheet of paper or other medium by electrostatic transfer, the transfer station thus embodying a roller which presses the copy sheet of paper or the like into contact with the master on the drum at this locality, the electrode and the drum having a high voltage applied between them with a directional effect such that the developer or ink held by the insulator will tend to move to the roller electrode under the applied field, so that if the developer has a positive characteristic, the electrode will have a negative potential applied thereto from any suitable means.

At the lower part of the roller is an applicator station which comprises a bath of developer or ink into which dips at least one roller of a series of rollers which lift the developer or ink into a trough which causes the developer or ink to be applied to the master on the drum by

causing the trough to be over-filled so that the liquid washes the master and causes the ink or developer medium to adhere to the insulated portions of the master due to the difference in polarity of the charge of the insulator and the charge on the particles of the developer or ink.

Preferably the developer or ink is kept at earth potential, with the high voltage then applied between the electrode at the transfer station and the earth, the biasing voltage being applied between earth and the roller on which the master is positioned.

In the case with the positive developer, the roller will of course be positively biased so that the positive developer particles are then driven away from the conductive sections of the master which are in contact with the conductive drum, but the insulated sections will retain the charge given to them by the electrode as they pass the transfer station.

The means for supplying the charging and transfer voltage and the biasing voltage can conveniently comprise a high tension supply for the charging and transfer voltage embodying a transformer with suitable rectifiers fed therefrom and with smoothing condensers across the supply to give the necessary direct current, the voltage preferably being made variable by utilising any of the well known regulating devices.

The low voltage supply, which should be infinitely variable for best results, can again comprise a transformer feeding rectifier which include a grid circuit and on which the voltage supplied to the grids is variable, thereby regulating the output voltage accordingly, a smoothing choke and condenser being again used to give the necessary current supply.

The high voltage supply should preferably be in the vicinity of 2.2 kv. while the low voltage supply is preferably variable between 0 and 300 volts, this allowing ample adjustment under operating conditions to select the exact bias which will give the maximum deposition of developer or ink on the insulated sections of the master yet will prevent the developer or ink from adhering to the conductive sections of the master.

If desired a discharge lamp may be used adjacent to the drum at a point between the transfer station and the applicator station for the purpose of discharging any voltage which may otherwise be held on the master if it is of the type which utilises photoconductive zinc oxide or the like on the relatively conductive section. The light will of course not discharge the insulator.

From the foregoing it will be realised that according to this invention a master, which conveniently may be carried on a drum but which could also be equally carried on a flat bed or other mechanism which could be subjected to the various stations as required, has an image formed on it which consists of relatively insulated sections and relatively conductive sections, this image being charged by means of a suitable electrode with a polarity which is opposite to the polarity of the particles of the developer or ink which is to be applied to the master, this charge being held on the insulated sections but not on the conductive sections so that an electrostatic image is then present which when it passes through the applicator station can have a controlled amount of developer or ink applied to it by means of correct regulation of a biasing voltage on the master, this biasing voltage allowing the conductive sections to have the voltage applied thereto whereas the insulated sections will retain their original voltage as obtained from the charging electrode, the differential between the two voltages being variable by varying the bias so that it is possible to control the repulsion factor of the conductive sections in relation to the developer or ink and thus control the amount of developer or ink which can deposit on the conductive sections, this method of control also giving some control of the developer or ink which will be deposited on the insulated sections because if the conductive background is raised to a higher voltage it will have the effect of tending to move the similarly charged developer or ink particles away from the master and in this way by varying the voltage very accurate control can be obtained.

The drawing shows schematically how the invention can be placed into effect, the master M in this case consisting of relatively conductive sections 1 with relatively insulating sections 2 forming the image which is to be printed, this master M being carried on the periphery of a drum 3 which is driven by any suitable means.

4 represents the copy sheet to which the image is to be applied, and this sheet is held down on the master M on the drum 3 by means of a roller electrode 5.

The applicator station is formed between the drum 3 and a pair of rollers 6 and 7 which are driven to revolve in the same direction by means of a suitably driven roller 8 with which they are in contact, the roller 6 carrying ink or developer over into the space between the rollers 6 and 7 and any surplus developer or ink passing between the roller 7 and the drum 3 and flowing back into the container 9 for the ink or developer.

A control rod 10 may be used in the developer space for the purpose of regulating the flow of the developer at the applicator station, this control rod serving to confine the developer to close proximity to the master M on the drum 3 at the applicator station.

The developer and the rollers 6, 7 and 8 are earthed and a pair of earthed generators are supplied, the generator for the high voltage being designated 12 and the generator for the low voltage being designated 13, this latter generator being variable so that the low voltage, which is a biasing voltage, can be closely controlled, but of course the high voltage generator can also be variable if that is required.

It is to be noted that the high voltage generator is coupled through the lead 14, and a resistance 15 to the electrode 5 while the generator is earthed so that a high potential is applied between the electrode 5, through the roller 3 and through the rollers 6, 7 and 8 to earth, this providing the necessary transfer voltage at the transfer station and also serving to supply the high voltage to the insulated sections 2 of the master M.

The roller or drum 3 is connected by means of the lead 16 to the variable low voltage generator 13 which is earthed so that there is a flow across the applicator station and back to earth through the rollers 6, 7 and 8, the polarity applied to the drum 3 by the low voltage generator 13 being the same as the polarity of the charge of the developer, so that if a positive developer is used the biasing voltage on the drum 3 will be positive whereas the charging voltage will have a negative polarity.

As explained earlier, by adjusting the voltage applied to the drum 3 by the low voltage generator it is possible to have a differential effect between the conductive sections of the master M and the insulating portions 2 of the master M, this differential effect allowing accurate control of the amount of developer or ink which will be picked up by the insulated sections 2 of the image on the master M and transferred to the copy sheet 4.

When the master M includes a photoconductor surface, a light source 18 is preferably included for the purpose of discharging the photoconductor medium, the light source of course not affecting the charge on the insulator which must be sufficiently effective to prevent any bleeding away of the charge through same to the photoconductor beneath. It is preferred to have the insulated sections of the master in a colour which will stop photoconductor action beneath same, and in the case of a zinc photoconductor for instance the insulated image could advantageously be give a yellow colour.

What we claim is:

1. A method of producing multiple copies by printing, using a master having a printing surface consisting of relatively insulating sections and relatively conductive sections comprising:

charging the insulator sections of said master to a

high unidirectional potential of given polarity, at a charge-transfer station, by conductive connection to a charging electrode;

contacting the printing surface of said master with a liquid developer containing toner particles attractable to a charge of said polarity, at an applicator station remote from said charging station, to produce a developed image on said printing surface;

transferring said developed image to a copy sheet passed between said charging electrode and said master printing surface and constituting a part of the conductive connection therebetween, at said charge-transfer station, thereby simultaneously recharging said insulator sections, as before, for a further printing operation;

and continuously maintaining said conductive sections of said master at a low unidirectional potential, of opposite polarity, by conductive connection to a low voltage supply.

2. The method according to claim 1 in which the relatively conductive portions of said master comprise a photoconductor, and in which said master is exposed to light at a point intermediate said charge-transfer station and said applicator station.

3. The method according to claim 1 in which said master is mounted upon the peripheral surface of a drum that is rotated to continuously move the sections of said master printing surface from said charge-transfer station to said applicator station and back again, and including the additional step of adjusting said low voltage supply to obtain optimum contrast in the image produced on said copy sheet.

4. Apparatus for producing multiple copies by printing, using a master having a printing surface consisting of relatively insulating sections and relatively conductive sections, comprising:

a frame;

a conductive drum rotatably supported in said frame and having a master mounted on the periphery thereof with its printing surface facing outwardly;

means for rotating said drum;

a charge-transfer station located adjacent said drum

and including a roller electrode extending transversely of said printing surface and a high-voltage D.C. supply of given polarity electrically connected to said roller electrode;

an applicator station mounted on said frame adjacent said drum, and displaced through a substantial angle from said charge-transfer station, for applying liquid developer containing toner particles attractable to a charge of said given polarity to said printing surface to develop an image thereon as said master passes said applicator station;

means for passing a copy sheet intermediate said roller electrode and said printing surface to complete a conductive connection therebetween and charge said insulator sections of said master printing surface at said given polarity simultaneously with transfer of a developed image from said surface to said copy sheet;

an adjustable low-voltage supply;

and means conductively connecting said low-voltage supply to said drum to continuously maintain said conductive sections of said master at a low D.C. potential of opposite polarity from said given polarity.

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