MACHINE FOR COPYING AN ORIGINAL MAKING A MASTER FROM THE ORIGINAL, AND PRINTING FROM THE MASTER

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References Cited

UNITED STATES PATENTS
3,426,678 2/1969 Carper et al. 101/132.5

ABSTRACT

An office copy type of machine is provided which photoelectrically copies an original document, makes an offset printing master therefrom and thereafter is used to print with ink as many copies on ordinary paper as are desired.

5 Claims, 6 Drawing Figures
TO AND GATE 126
(PAPER DRIVE
MOTOR 34)
TO DRIER 54
FROM
POWER
SUPPLY 112

TO
CHARGE
APPLICATION
GATE 124
TO
PROJECTING
OPTICS GATE 130
TO
DEVELOPER
SOL GATE 128
TO
COUNTER 22
TO
INK-OIL
SOLENOID 58
TO
PAPER SUPPLY
MOTOR 62

Fig. 3

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ATTORNEYS
Fig. 2A

Fig. 3A

Fig. 4
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MACHINE FOR COPYING AN ORIGINAL MAKING A MASTER FROM THE ORIGINAL, AND PRINTING FROM THE MASTER

BACKGROUND OF THE INVENTION

1. Field of the Invention
This invention relates to machines for making multiple copies of a document, and more particularly, to an improved copy printing machine.

2. Description of the Prior Art
The presently available copying machines which are used in offices for making multiple copies of an original document, and especially office copy machines employing the principles of electrophotography, make a separate exposure of the original document for each copy to be produced. Those machines which employ paper coated with photoconductive material make each copy on paper coated with photoconductive material.

While the cost of the machine which makes copies on photoconducively coated paper are relatively inexpensive especially when compared with the cost of machines which use the principles of xerography, and which machines are extremely costly and complex, the coated copy paper is expensive. Also, because of the extra weight of the copy and its "feel," it is not generally liked.

OBJECTS AND SUMMARY OF THE INVENTION

An object of this invention is to provide a duplicating machine which has the relative low cost construction of the coated paper duplicating machine while producing as output copy uncoated paper.

Yet another object of this invention is the provision of duplicating apparatus which combines the best features of electrophotographic copying and ink printing.

Still another object of the present invention is the provision of a novel and unique duplicating machine.

The novel features of the invention are set forth with particularity in the appended claims. The invention will best be understood from the following description when read in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a printing master produced by electrophotography which is employed with this invention;
FIG. 2 is a schematic arrangement of a duplicating machine in accordance with this invention;
FIG. 2A illustrates an alternative inking arrangement to that shown in FIG. 2;
FIG. 3 shows an arrangement for controlling the timing and the operation of the various devices used in the embodiment of the invention;
FIG. 3A illustrates an arrangement for actuating the inking arrangement of FIG. 2A;
FIG. 4 shows an arrangement for controlling the number of times the various devices used in the embodiment of the invention are operated.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The machine to be described herein uses electrophotography for producing a printing master, which may be called an inverse lithographic master. As used herein, the term inverse lithography is defined as a printing process in which a water soluble ink is used and an oily substance is applied to keep the background clean of ink.

FIG. 1 represents a printing master of the type used in accordance with this invention. Effectively, the printing master comprises the usual photoconductive paper 10 which has been treated in such a manner so that the photoconductive surface layer 12, is rendered oleophylic and the images 14 which are made of pigment or toner deposited on the surface by the usual electrophotographic process to develop charge images are porous, absorb oil and can be inked. The images 14 are mirror images, which are necessary to make the image which is printed from it come out right side up.

A description of a reverse lithography printing master of a type suitable for use with this invention is described and claimed in an application for patent by this inventor and assigned to a common assignee. It is entitled "Electrophotographic Printing Master for Inverse Lithography," filed Feb. 27, 1970, Ser. No. 14,912. Briefly, a coating of a thin thermoplastic hydrocarbon such as a wax or polystyrene is applied to the photoconductive surface of the sheet which makes it oleophylic. The toner image is applied in the usual manner. The oleophylic background is coated with oil and rejects an aqueous ink. The porous toner image absorbs the oil and provides a surface to which the viscous aqueous ink adheres.

Referring now to FIG. 2, there may be seen an embodiment of this invention comprising a schematic representation of a machine which can utilize the printing master shown in FIG. 1 to print multiple copies.

By way of illustration, the embodiment of the invention is described as being built around a central drum 20. This is in order to make the overall size of the machine as compact as possible. However, this should not be construed as a limitation upon the invention since it will become apparent to those skilled in the art that it is possible to construct this invention and spread out along a single plane or in two layers as is done with the present duplicating machines.

At the outset, a counter 22 is set by a control knob 24 to the desired number of copies. A start switch (shown in FIG. 4) is then actuated. This causes motor control circuit 26 to apply power to a motor 28. The motor rotates the drum 20 and also rotates an impression cylinder 30, which has a plastic material covering 32, such as Teflon (tetrafluoroethylene). The impression cylinder rolls against the periphery of the drum 20. The drum will make a number of revolutions corresponding to the count selected in the counter 22. As will be seen in FIG. 3, the counter is caused to increase its count by 1 for each revolution of the drum 20.

When the starting switch for the system, as shown in FIG. 4, is actuated, a paper drive motor 34 is caused to operate, thereby rotating a cylinder 36 in a direction to feed a sheet of photosensitive paper from a magazine 38 onto the surface of the drum 20. Such single sheet dispensing arrangements are well known in the art so will not be described in detail here. The single sheet is caused to adhere to the drum in well known fashion, either by having its leading edge forced under catch clips, which are placed at the outside of the sheet, or preferably by having a vacuum applied through openings in the drum periphery which cause the paper to adhere to the drum. These techniques also are well known and will not be described in detail. As the drum rotates, it passes the surface of the photosensitive paper under a charge applicator 40, which is actuated by circuitry, which will be described subsequently herein, to apply a charge to the photoconductive paper surface as it passes thereunder.

The object to be copied is placed upon a transparent glass plate 42 for example, and projecting optics 44, is actuated by circuitry which will be subsequently described herein, to project the image of the material placed on the glass plate 42, onto the photoconductive surface of the sheet as it is passed by the rotating drum past the projecting optics 44. The projecting optics, consisting of a light and lenses which can scan the copy placed on the glass plate 42 so that the scanned image is projected in synchronism with the rotating drum onto the photoconductive sheet. The projecting optics equipment is well known in the art and thus need not be described in detail herein.

As the drum continues to rotate, it passes the paper through a developing station, which, may effectively constitute a magnetic brush. A solenoid 46, is actuated, from circuitry shown in FIG. 4, to cause a tank 48, designated as a developer reservoir, to be pivoted about a pivot 50, whereby a roller 52, which is rollably mounted in the developer reservoir tank, is brought into proximity with the surface of the photoconduc-
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tive sheet. The magnetic roller applies the toner picked up from the developer reservoir 48 to the charge image on the photosensitive surface whereby the charge image which was formed on the surface of the photocouctive sheet by operation of the charge applicator and projecting optics, is developed.

As the drum continues to rotate, it passes the photocoductive sheet with the toner image thereon past the usual dryer arrangement 54, which dries and fixes the toner image on the surface of the photocoductive sheet.

The drum continues to rotate and in doing so passes the imaged photocouctive sheet through a location at which ink is applied. This can be done either by applying an ink and oil mixture to the surface of the photocoductive sheet as shown in FIG. 2, or by first applying oil and then ink as shown in FIG. 2A. As shown in FIG. 2 the arrangement for applying the ink oil mixture comprises an ink and oil reservoir 56, which, at the proper time is caused to pivot by the operation of a solenoid 58 so that a roller 60, is brought in pressing contact with the surface of the photocoductive sheet. The roller 60 rolls an ink and oil mixture and thus, this mixture is applied to the surface of the photocoductive sheet. The ink used in the ink and oil mixture may be parts by weight:

- Carbon Black: 27%
- 40 percent Shellac solution in triethylene glycol: 60%
- Triethylene glycol: 5%
- Ethylene diamine: 98-100 percent pure: 4%
- Castor Oil (U.S.P.): 2%

The ink is mixed with oil, which can be, for example, 0.4 ml. of Magie 400. This is a kerosene fraction distilling between 398°F. and 435°F.

Since the surface of the photocouctive sheet has been treated to be oleophilic, it rejects the aqueous ink and assumes a coating of oil. The toner image absorbs the oil and assumes a coating of the aqueous ink.

Referring to FIG. 2A, if it is desired to sequentially apply oil and then an aqueous ink, the oil is contained in a reservoir 57 from which there extends a roller 59. The reservoir is pivoted by a solenoid 61, which brings the roller at the proper time in contact with the surface of the photosensitive sheet, whereby oil is deposited on the oleophilic background but not on the surface of the toner image. Thereafter, as the drum continues to rotate, the solenoid 63 is inactivated and pivots the reservoir 57 and roller 60 out of the way. The solenoid 63 is activated.

This pivots ink reservoir 65 causing roller 67 to be pressed against the sheet surface to roll thereover and leave a coating of ink on, only the toner image. As the drum rotates, when the sheet passes out from under the roller 67, the solenoid 63 is inactivated, pivoting the ink reservoir and roller out of the way.

Referring back to FIG. 2, as the drum continues to rotate, it is moved to the location of the impression cylinder 30. However, at that time, a paper supply motor 62, is actuated by circuitry shown in FIG. 3, whereby it causes a roller 64, to rotate whereby a single sheet of ordinary paper is withdrawn from the paper magazine. This paper is guided so that its leading edge is aligned with the leading edge of the photocouctive sheet in the paper passes between the impression cylinder and the photocoductive sheet.

The reason the impression cylinder is covered with an insulating plastic material surface is, that it has been found that as the plastic material rotates, it rubs against the sheet of paper, it develops a charge which has the effect of attracting toner from the photosensitive sheet. As the drum continues to rotate, it passes by a paper received tray 68, which receives the print which is peeled from the photocoductive sheet, by a finger 70, which not only separates this printed paper from the photocoductive sheet, but also helps to guide it into the paper receiving tray 68.

If a single copy is all that is required, then, the counter 22, at this stage has its count increased to the count of the one copy which had been printed. This solenoid moves a finger, or peeler 74 against the drum surface whereby the photocoductive sheet is separated from the drum surface and is guided into a master receiving tray 76. If more than one copy is required, the solenoid 72 is not actuated.

If more than one copy of the printing master is required, as has been indicated by the counter set to the count of the one copy, then the drum continues to rotate. When more than one copy is desired, on more than one rotation of the drum 20, the paper drive motor 34 is not actuated, neither is the charge applicator, or the projecting optics, or the solenoid 46, or the dryer 54. The drum rotates and carries with it the printing master past all of these locations and brings it to the location at which the roller 60 again is moved into contact with the surface of the printing master to again apply an ink and oil mixture. It should be noted that the solenoids 46 and 58, are rendered inoperative when the paper has passed the respective rollers 52 and 60, and thereby pivot the respective developer reservoir and inkoil mixture reservoir back to positions where the respective rollers 52 and 60 are no longer pressed against the drum.

The drum continues to rotate and makes as many revolutions as are required to cause the counter to count up to the count selected indicative of the number of copies desired. For each revolution of the drum an additional copy is produced. When the counter attains its final count condition, it actuates the solenoid 72, which causes the finger 74 to remove the printing master from the drum surface and deposit it into the master receiving tray 76, and after a short delay, the motor control circuit is turned off thereby stopping the motor 28.

The small delay is the interval required for the drum to rotate to a predetermined starting position and is accomplished by a time delay relay, as shown in FIG. 4.

FIG. 3 shows an arrangement for controlling the timing of the operation of the various devices used in the invention, and shown in FIG. 2, such as the charge applicator, the solenoid which actuates the developer reservoir, etc. Here, the embodiment for controlling the timing simply comprises the shaft 82 which is coupled to be rotatable with the drum, and which has cam surfaces respectively 84, 86, 88 and 90, by way of illustration, which are disposed around the periphery of the shaft. The location and length of these cam surfaces is determined in accordance with the timing which is to be actuated when the cam surface is sensed and the length of the cam surface is determined by the interval over which such actuation is to occur. For example, the counter 22 is to be actuated once per revolution of the drum. Therefore, cam surface 90 will contact the actuating rod 92 of a mechanically actuated switch 94 over a short interval once per revolution, to permit a pulse to be applied to the counter 22. The pulse may be developed by charging a capacitor 96 through a resistor 98 from a voltage source such as a battery 100.

The charge applicator 40 is actuated at the proper time and over the proper interval in response to cam operation of switch 102, which applies power from a power supply 112 when it is operated. The projecting optics is operated in response to operation of cam operated switch 104 whereby power from the power supply 112 is applied to the projection optics. The cam surfaces which cause switches 102 and 104 to operate are not seen in the drawing, but are substantially identical except for placement and length, of the cam surfaces 84 through 90 which are depicted.

A switch 103 is actuated by a cam surface (not shown) to enable power to be applied from the power source 112 to the paper drive motor 34 of the resulting patent. A switch 106 is actuated by the cam surface 86 whereby power may be applied from the power supply 112 to the developer solenoid 46.
A switch 108 is actuated from cam surface 86 and thereby is enabled to apply power from the power supply 112 to the solenoid 58.

Paper supply motor 62 is actuated when cam operated switch 110 is actuated in response to cam surface 88 being sensed. It then can apply power from the power supply motor.

The drier 54 is actuated when switch 111 is actuated by a cam surface (not shown), in the manner to be further described in FIG. 4.

The foregoing arrangement for establishing the timing should be considered as exemplary and not by way of a limitation.

FIG. 3A shows the structure required to cause timely operation of the solenoids 61 and 63 if a successive application of oil and ink is desired as shown in FIG. 2A. Essentially the same structure is used. The shaft 82 carries two cam surfaces 83, 85 for the respective oil and ink application operations. The sensing finger of switch 87 is closed when cam surface 83 is sensed which operates switch 87 allowing it to apply power to the solenoid 61. The sensing finger of switch 89 operates switch 89 when cam surface 85 is sensed thus applying power to solenoid 63 over an interval determined by the length of the cam surface.

FIG. 4 is a schematic circuit arrangement of the logic which may be employed for insuring that certain pieces of the equipment surrounding the drum operate once for developing the photoconductive image and thereafter will not interfere with the printing of duplicates. The power supply for the entire apparatus is represented by the rectangle 112. The starting switch 114 is a momentary switch, which when operated applies current to a relay winding 116. Current flow through relay winding 116 causes its normally open contacts 118 to be closed. Thereby current is maintained applied to the winding 116 through the normally closed contacts 120 which are associated with relay winding 122. Power is then applied to the motor control circuit 26 and to all of the switches through the contact 118.

AND gates 124, 126, 128, 130 and 132 are used to apply power received from cam actuated switches to the equipment which is to be actuated only once. AND gates may be well known electronic arrangements or switch arrangements which are used wherein an output is desired to be provided only when all of the inputs to the AND gate are simultaneously present. The output of AND gate 124 is applied to the charge applicator 40 and energizes it only when an input is received from first count of counter 22 and an output from switch 102, shown in FIG. 3. Since the counter remains in its zero count condition only until the drum has completed a single revolution, the charge applicator will be energized only during the first revolution and then only over the interval during which the switch 102 is actuated.

The paper drive motor 34 is operated in response to the output of AND gate 126 is operated in response to the timed output from switch 103 and when the counter 22 is in its zero count state. The projecting optics 44 is operated by the output of AND gate 130 while the counter 22 is in its zero count state and over the interval when switch 104 is actuated. The solenoid 46 is operated by the output of gate 128, which occurs while counter 22 is in its zero count state and over the interval during which switch 104 is operative. The dryer 54 is operated in response to an output from AND gate 132, which occurs when the counter 22 is in its zero state and while switch 111 provides an output.

When the counter 22 obtains the count selected by the counter selector 24, its output is applied to relay winding 122 to energize it. Relay 122 is a time delay relay. It will not operate the normally closed contacts 120 until an interval sufficient for the drum to complete its revolution has transpired. At that time normally closed contacts 120 will be opened whereby winding 116 is deenergized and normally closed contacts 118 are opened removing power from the motor control system 126 and terminating the operation of the system.

The count attained by the counter is also applied to solenoid 72, causing it to operate, whereby the printing master is removed from the drum surface. Counter output is also used to reset counter 22 to its zero state. The system is thereby established in a condition to start printing on a fresh original.

There has accordingly been described and shown herein a novel and useful arrangement for directly producing a printing master from a photoconductive sheet, employing electrophotography, and thereafter inking the printing master and printing with it in the manner of reverse lithography, on plain paper.

1. Apparatus for making a copy of an original document on plain paper comprising a sheet having a hydrophobic, electrophotographically sensitized, surface, a drum, means for attaching said sheet to said drum, means for rotating said drum for moving said sheet around a predetermined path, means at a first location along said predetermined path for applying a charge to the electrophotographically sensitized surface of said sheet, means at a second location adjacent said predetermined path for applying a light image of said original document to said electrophotographically sensitized surface of said sheet for leaving a charge image corresponding to said light image on said surface, means at a third location along said path for applying a hydrophilic toner to the electrophotographically sensitized surface of said sheet for developing said electrostatic charge image, means at a fourth location adjacent said path for fixing said hydrophilic toner to the surface of said sheet, means at a fifth location along said path for applying oil and aqueous ink to said sheet surface whereby said ink adheres only to the toner image on said electrophotographically sensitized surface of said sheet, means at a sixth location along said path for bringing said paper in printing contact with the electrophotographic surface of said sheet, means at a seventh location along said path for separating said paper from the electrophotographically sensitized surface of said sheet, and timing means actuated responsive to the rotation of said drum for successively actuating all of the means positioned adjacent the path of said drum over the interval during which said electrophotographically sensitized sheet is moved through the successive locations of said means.

2. Apparatus as recited in claim 1 wherein said means at a fifth location along said path for applying oil and aqueous ink to said sheet surface whereby the ink adheres only to the toner image on said electrophotographically sensitized surface includes:

a reservoir of a mixture of an aqueous ink and oil, and means for applying said mixture of aqueous ink and oil to said toner image and said surface of said electrophotographic sheet.

3. Apparatus as recited in claim 1 wherein said means at a fifth location along said path for applying oil and aqueous ink to said sheet surface ink adheres only to the toner image on said electrophotographically sensitized surface includes:

a reservoir of oil, means for applying oil from said reservoir to said toner image, and said surface of said electrophotographic sheet, a reservoir of ink, and means for applying ink from said reservoir to said toner image and said surface of said electrophotographic sheet.

4. Apparatus as recited in claim 1 wherein there is included counter means for counting the revolutions of said cylinder, means for selecting a count from said counter corresponding to the number of copies of said original document desired,
means responsive to said counter being in an initial count condition for enabling to be operative only during a first rotation of said drum, said means for attaching said electrophotographically sensitized paper to the surface of said drum, said charge applicator, said projecting optics, said means for applying toner from said source to said electrophotographically sensitized surface of said sheet, and said fixer means, means for separating said sheet having said electrophotographically sensitized surface from the surface of said drum, and

means responsive to said counter attaining the selected count output for activating said means for separating said electrophotographically sensitized sheet from the surface of said drum, and for thereafter inactivating said means for rotating said drum.

5. Apparatus as recited in claim 1 wherein said means for bringing said sheet of paper in printing contact with said electrophotographically sensitized surface comprises impression cylinder means having its surface covered with plastic material.