

[54] **ELECTROPHOTOGRAPHIC COPYING MACHINE**

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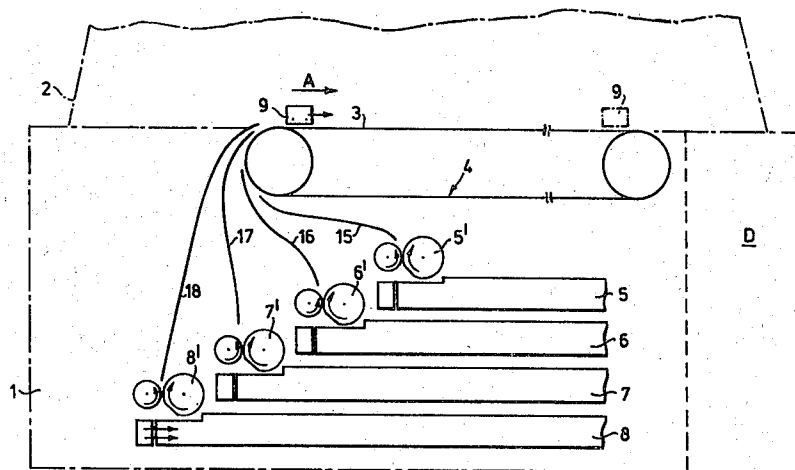
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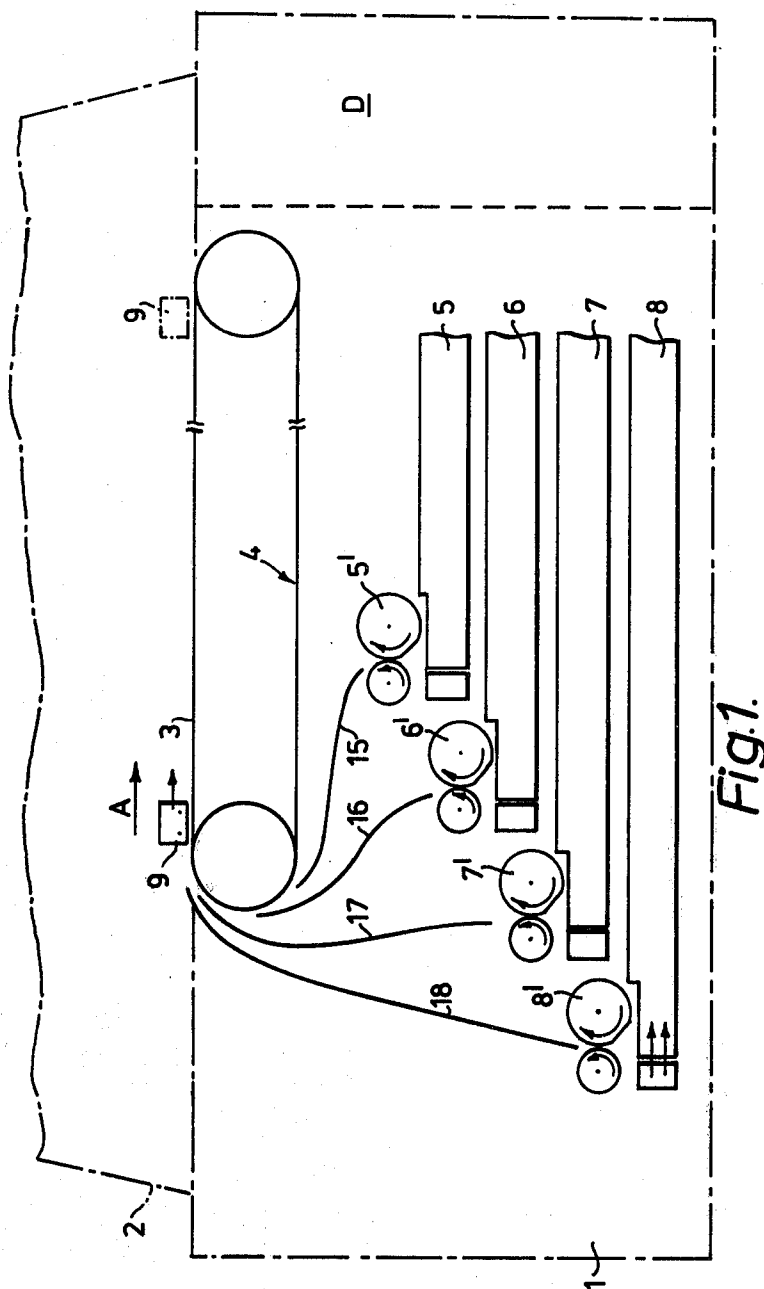
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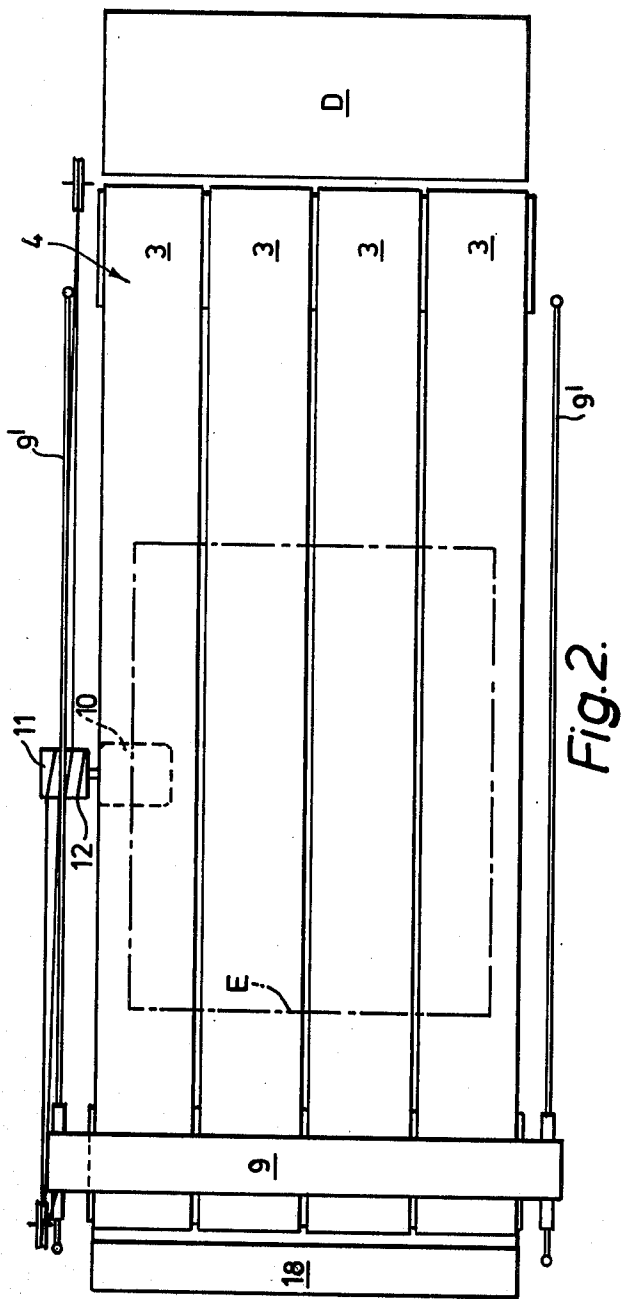
ABSTRACT

The invention relates to an electrophotographic copying machine comprising an exposure station and a development station, in which the charging unit used for charging the electrophotographic substrate material can be operated either stationary over input material as it moves into the exposure station (in an automatic operating mode) or moving over input material stationary in the exposure station (in a manual operating mode).

3 Claims, 2 Drawing Figures







ELECTROPHOTOGRAPHIC COPYING MACHINE

This invention relates to an electrophotographic copying machine of the kind comprising an exposure station (at which a latent electrostatic image is produced by illuminating a charged electrophotographic substrate) and a development station at which the latent electrostatic image is converted into a permanent image by the attraction of toner particles. Throughout this specification such a copying machine will be described as being a "copying machine of the kind specified."

A known copying machine of the kind specified is capable of producing enlarged permanent copies from transparent originals and utilises a flat bed including a conveyor serving as the input to the development station. The electrophotographic substrate is manually placed on the conveyor while the latter is stationary, the optics of the known machine, and the position of the substrate on the conveyor, being adjusted to optimise the quality of the final copy obtained. When the operator is satisfied that the substrate position, relative to the image, and the focus of the image is correct, the substrate is charged while resting on the conveyor, by being overpassed with a charging unit incorporating one or more conductors at elevated potential. In the known machine being described, the charging unit moves in the direction opposite to the normal transport direction of the conveyor and charges the substrate in a single sweep. The charged substrate is then exposed for the required time to the image of the original to be copied, and the substrate is then conveyed away from the exposure station into the development station as the conveyor moves. During the movement of the conveyor, the charging unit returns to its original position, ready for a similar operation on the next substrate manually placed on the conveyor.

Excellent though the known enlarging copying machine of the kind specified is, it suffers from the disadvantage that it cannot automatically produce multiple copies. Each copy produced on the known machine has to be manually placed on the conveyor in the exposure station.

Automatic machines are, of course, known, but they do not afford the facility for producing a first copy from a substrate which has been subject to a careful manual adjustment of substrate position and/or an adjustment of the optical system of the machine.

The present invention seeks to provide an improved electrophotographic copying machine of the kind specified which utilises the best features of known automatic and manual machines.

According to the present invention an electrophotographic copying machine of the kind specified comprises a reservoir for electrophotographic substrate material, means for drawing the material from the reservoir and means for feeding it to the exposure station of the machine, means for charging the material drawn from the reservoir while the latter is stationary in the exposure station and means for charging the material as it moves from the reservoir to the exposure station.

Conveniently the charging of the material is effected by a corona charging unit, mounted above a conveyor which acts to move the material through the exposure station. The charging unit preferably has one rest position adjacent an upstream end of the conveyor (and when in this rest position can act to charge material as

the latter moves below it to the exposure station from the reservoir) but can also move over the stationary conveyor to charge material resting in the exposure station. Any convenient means can be employed for controlling the position of the charging unit and one suitable arrangement involves connecting the charging unit, at one end, in an endless band, a part of that band being looped around a capstan forming the drive shaft of a reversible electric motor.

Two different charging units can be provided, one permanently fixed adjacent the upstream end of the conveyor and the other movable over the conveyor, but we prefer to use just one charging unit which is operated either stationary relative to the moving sheet or moving relative to a stationary sheet.

Suitably a plurality of reservoirs for sheets of different sizes are provided and we prefer to arrange these so that the sheets from any reservoir are fed to the upstream end of the conveyor at substantially the same point. Suitably, any sheet in passing from a position within the reservoir to the exposure station, is turned through 180°.

Where a conveyor is employed to define the exposure station, we construct this of a material of good electrical conductivity.

Suitably the conveyor is fabricated from a plurality of adjacent endless bands of rubber-like material loaded with conducting material.

Suitably the or each sheet reservoir is mounted in the machine for movement in a plane parallel to the planes of sheets located in the reservoir, and normal to the feed direction of sheets leaving the reservoir.

One embodiment of electrophotographic copying machine in accordance with the invention will now be described, by way of example, with reference to the accompanying drawings, in which:

FIG. 1 is a schematic sectional view of the lower part of the machine showing the sheet reservoirs and the feed means for conveying sheets from those reservoirs to an exposure station of the machine, and,

FIG. 2 is a plan, from above, showing the exposure station of the part of the machine shown in FIG. 1.

The machine comprises a base 1 and an upper part 2 and generally resembles a known enlarging electrophotographic copying machine of the kind specified. The upper part 2 includes an optical projection system by means of which an enlarged image is projected downwardly on to the upper surface 3 of an endless conveyor 4. The conveyor 4 is formed from a number of adjacent wide strips of conducting rubber and serves to convey sheets of electrophotographic material (e.g. zinc oxide coated paper) from an array of four sheet reservoirs 5, 6, 7 and 8 housed within the base 1, through an exposure station (shown generally by the letter "E" in FIG. 2) to the inlet end of a development station (schematically indicated by the letter "D" in FIG. 1).

Each sheet reservoir incorporates a pneumatic sheet-separating system and a pneumatic pick-up roller as described in the specification of U.S. Pat. application Ser. No. 371,391.

The controls of the machine include selection buttons which enable only one of the sheet feed systems to be energised at one time so that on operating the machine, a sheet is drawn from just one of the four reservoirs 5-8. Irrespective of which reservoir the sheet comes from, it passes up and finally appears at the up-

stream end of the conveyor 4, resting on the upper surface 3. Since the conveyor 4 is moving so that its upper surface travels in the direction of the arrow A (in FIG. 1) as the sheet appears at the upstream end, the sheet is moved from left to right into the exposure station E.

Located above the upper surface 3 at the upstream end of the conveyor 4 is a movable corona charging unit 9. This unit can be of any conventional design and is mounted (e.g. on support bars 9' on opposite sides of the conveyor 4) for translation backwards and forwards above the upper surface 3. The movement of the unit 9 is accomplished by means of a reversible electric motor 10 whose output drive shaft is keyed to a capstan 11 having a helical groove 12 formed therein. An endless loop of flexible material links opposite sides of one end of the unit 9, the endless loop being wrapped at least once around the capstan 11. In this way when the motor 10 is energised to rotate in one direction, the unit 9 moves over the upper surface 3 in the direction of the arrow A, and when the motor is energised in the opposite direction, the unit 9 moves in the opposite direction over the upper surface 3. When the motor is not energised, the unit 9 is stationary. The rest positions of the unit 9 are shown in FIG. 1.

From what has been said it will be appreciated that the machine illustrated can be operated in two separate modes.

MANUAL MODE

In the manual mode, the machine is set to withdraw a sheet from a chosen one of the reservoirs 5-8 and to feed it up into the exposure station E. The unit 9 is not supplied with high voltage during the sheet-feeding operation so that the sheet arrives in the exposure station uncharged. The conveyor then stops. The optical system of the upper part 2 of the machine can then be adjusted to optimise the image formed on the sheet. When this has been correctly adjusted, a further button is pressed to supply high voltage to the unit 9 and at the same time to energise the motor 10 to cause the unit to make a single stroke over the sheet in the direction of the Arrow A. The unit 9 then comes to rest on the right-hand side of the exposure station E (shown dotted in FIG. 1). At the completion of the charging operation, the charged sheet is illuminated for a determined period and at the end of the illumination, a latent electrostatic image has been formed on the sheet. This is immediately developed by the conveyor 4 advancing the sheet through the development station D to deliver a permanent copy at the outlet end of the station D. During the movement of the conveyor 4, to feed the sheet through the development station D, the unit 9 returns to its starting position (with the high voltage no longer applied) by a reversal of the direction of rotation of the motor 10.

The machine is now reset in its original condition and could repeat a further manual operation, should that be required, or could perform an "Automatic" operation as will now be described.

AUTOMATIC MODE

In the automatic mode of operation, a sheet is again withdrawn from a chosen one of the reservoirs 5-8 but this time, the high voltage is applied to the charging unit 9, so that as the sheet moves on to the conveyor 4, it is charged. It is thus in a charged state when the conveyor stops to leave the sheet in the exposure sta-

tion. The illumination of the charged sheet then takes place automatically, following which the upper surface 3 of the conveyor 4 continues its advance in the direction of the arrow A, passing the sheet through the development station. Throughout this automatic mode of operation, the unit 9 does not move.

The upper part 2 of the machine with which the base 1 is designed to be used, employs an optical system which varies the median line of the image (as measured with respect to the front of the base 1) depending on the degree of magnification used. In order to enable any sheet to automatically be fed to any chosen part of the exposure station E, each reservoir 5-8 is mounted in the base 1 for movement into or out of the plane of the paper as shown in FIG. 1. Since the optimum position for the reservoir will be a function (in normal circumstances) of the degree of magnification being employed with the upper part 2, it may be desirable to calibrate the reservoir moving systems in terms of degrees of magnification.

The machine illustrated schematically in the drawings utilises four reservoirs for sheet material (say for paper of continental sizes A2, A3, A4 and A5) each having a pneumatic pick-up roller (5', 6', 7' and 8'). All four rollers can rotate when the machine operates but only one is evacuated so that only one can be effective to remove a sheet from a reservoir and feed it via the appropriate input path (15, 16, 17 and 18, respectively to the upstream end of the conveyor 4.

In place of sheet reservoirs, substrate material in roll form could be used, and supports and feed means for rolls of differing width can be incorporated in the base 1.

The charging unit 9 may be a channel-shaped member (open only on the side facing towards the surface 3) containing one or more fine wires to which a voltage of between 5 and 10 kilovolts is applied when charging is to be effected.

The control panel of the machine comprises a "print" button, a selector button for each of the four sheet reservoirs (preferably marked in terms of paper size), a manual/automatic mode selector switch, an exposure timer control (graduated from "light" to "dark") and a "number of copies" selector dial.

If the "manual" mode is selected, the logic circuitry brought into operation is such that first contact on the "print" button acts to:

- energise a blower in the machine,
- actuate a distributor air valve (on the basis of the selection of sheet reservoir 5 to 8) so that air is drawn through only the appropriate roller 5'-8' to the blower and is fed from the blower only to the appropriate paper stack (to expand the paper stack in the manner described in the aforementioned specification), and
- when the necessary pressure change is sensed in the blower circuit (indicating that the leading edge of a sheet has become attached to the appropriate roller 5' to 8') actuate the drive motors for the conveyor 4 and the rollers 5'-8' and to continue drive of the conveyor 4 until the sheet in question is positioned correctly in the exposure station.

The machine then stops until the print button is pressed a second time. The second actuation of the print button, in the manual mode effects the following sequential operations:

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- d. turn off the light projecting the image down onto the exposure station E,
- e. cause the unit 9 to be supplied with HT voltage,
- f. energise the motor 10 to cause a sweep of the unit 9 over the sheet in the exposure station,
- g. turn on the light again for the selected exposure period,
- h. move the conveyor 4 on again to deposit the charged and exposed sheet in the developer station,
- i. re-energise the motor 10 in reverse direction to return the unit 9 to the upstream end of the conveyor 4, and
- j. when the trailing end of the paper has left the exposure station, to turn on the light again.

The position at which the conveyor stops following the first depression of the print button is cam-controlled on the basis of the particular sheet reservoir selected. One cam is provided for each sheet reservoir and the appropriate cam employed for any given selection of paper size. Different rest positions are needed to ensure that, irrespective of paper size, the sheet is centrally disposed in the exposure station.

When the automatic mode is selected, the logic circuitry brought into operation effects the sequence a) to c) of the first stage of the manual mode with the important addition that d) and e) of the second stage are also carried out during feed of the paper to the exposure station. In the automatic mode f) and i) do not occur at all and the paper feeding, exposure and development phases follow automatically.

The above analysis is simplified and does not mention the provision of a separate motor for the developer sta-

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tion which may be provided.

What is claimed is:

1. An electrophotographic copying machine comprising

- a. an exposure station,
- b. a development station,
- c. at least one reservoir for electrophotographic substrate material,
- d. conveying means for supporting the substrate material at the exposure station and for moving the material to the development station,
- e. a charging unit movable across the exposure station and disposed above the conveying means,
- f. automatic feed means for drawing material from a reservoir and feeding it to the upstream end of the conveying means, and
- g. logic circuit means for energising the charging unit either when stationary at said upstream end during passage of material below it or when moving across stationary material in the exposure station.

2. A machine as claimed in claim 1, in which said automatic feed means is adjustably positioned in the machine relative to a centre line of said conveying means, the position in said exposure station to which the substrate material is automatically fed being adjustable in a direction transverse to said centre line.

3. A machine as claimed in claim 1 in which there are a plurality of different reservoirs for sheets of substrate material of different lengths, the duration of movement of the conveying means during feeding of substrate material being controlled on the basis of the selection of reservoir from which the substrate material is drawn.

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