United States Patent [19]

Crandell et al.

[11] **3,898,425**

[45] **Aug. 5, 1975**

[54] **FUSING APPARATUS**

[75] Inventors: **Melvin G. Crandell,** Walworth; **Thomas J. Scudder,** Webster, both of N.Y.

[73] Assignee: **Xerox Corporation,** Stamford, Conn.

[22] Filed: **June 27, 1974**

[21] Appl. No.: **483,749**

[52] **U.S. Cl.** **219/216;** 219/388; 432/227

[51] **Int. Cl.** **H05b 1/00;** G03g 15/20

[58] **Field of Search** 219/216, 388; 432/59, 227; 250/319; 355/9, 17; 118/637; 117/17.5

[56] **References Cited**

UNITED STATES PATENTS

3,076,083	1/1963	Codichini et al.	219/216
3,079,483	2/1963	Codichini et al.	219/216
3,356,831	12/1967	Andrus et al.	219/216 X

Primary Examiner—C. L. Albritton

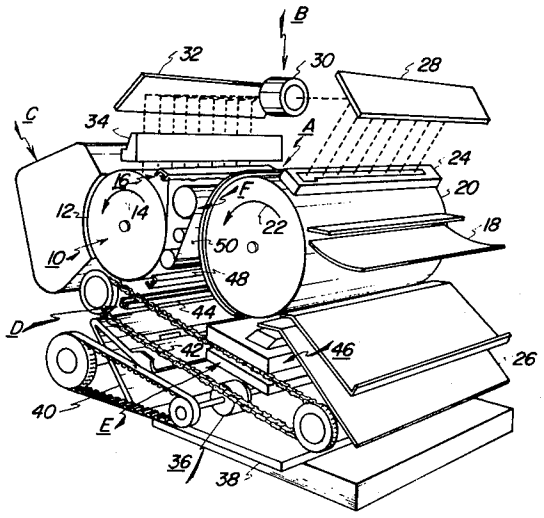
Attorney, Agent, or Firm—H. Fleischer; J. J. Ralabate; C. A. Green

[57] **ABSTRACT**

An apparatus in which a powder pattern deposited on a sheet is affixed permanently thereto. The powder pattern deposited on one surface of the sheet is heated as it moves through a passageway in the apparatus from a receiving station to a delivery station. Fins minimize surface contact of the sheet to prevent scorching thereof.

The foregoing abstract is neither intended to define the invention disclosed in the specification, nor is it intended to be limiting as to the scope of the invention in any way.

12 Claims, 8 Drawing Figures



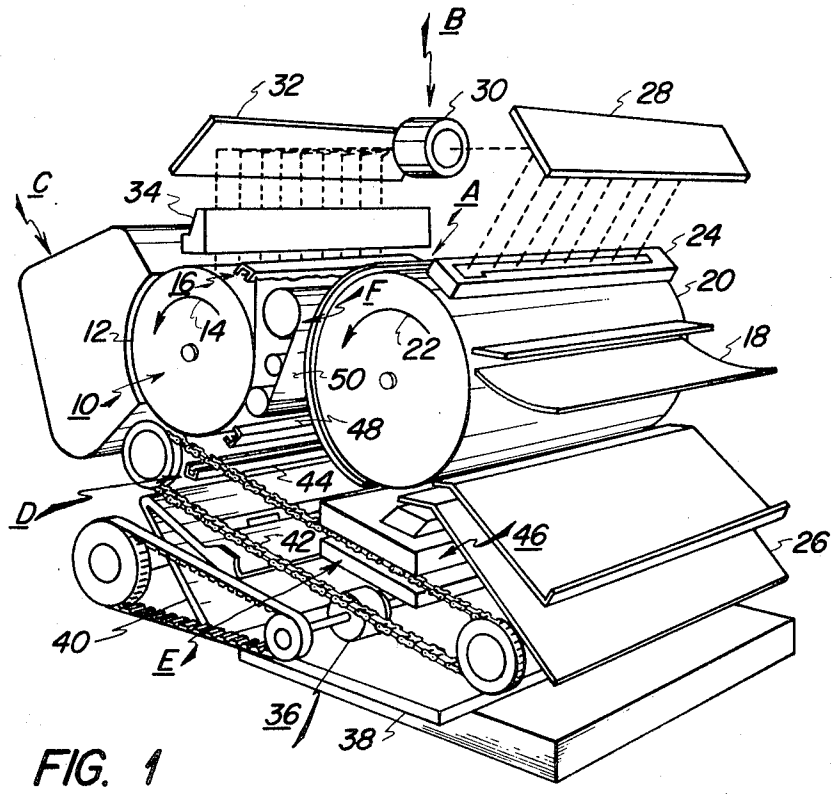


FIG. 1

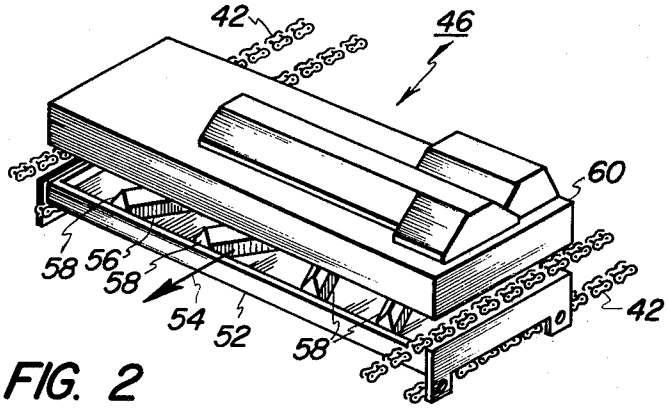


FIG. 2

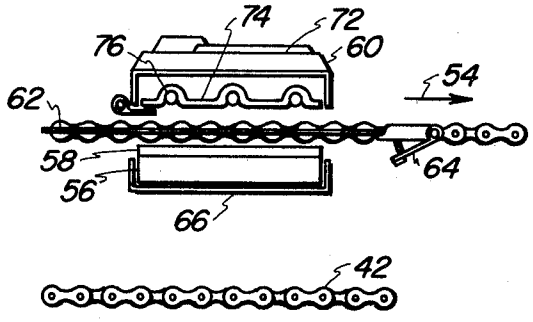


FIG. 3

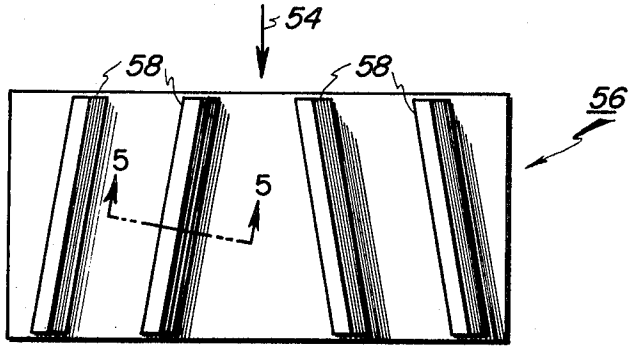


FIG. 4



FIG. 5

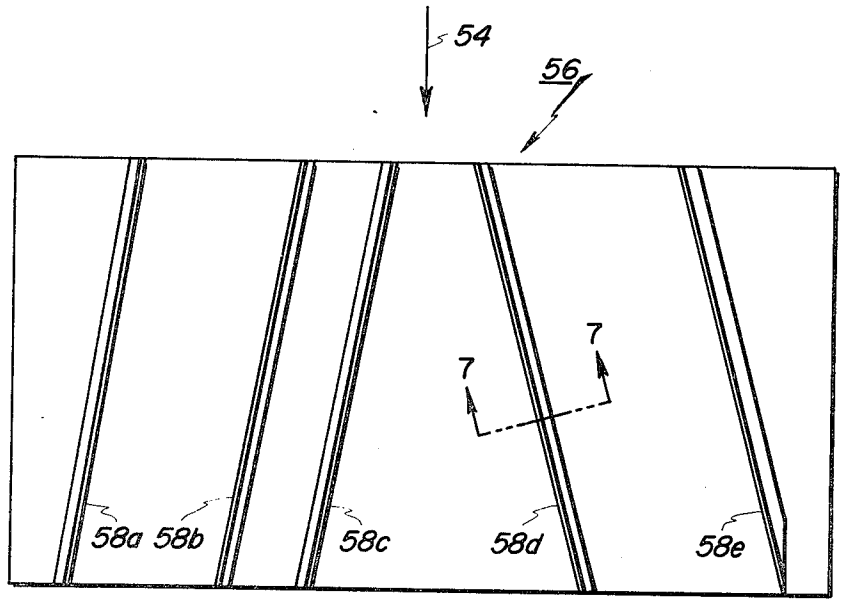


FIG. 6

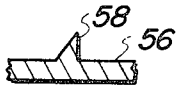


FIG. 7



FIG. 8

FUSING APPARATUS

BACKGROUND OF THE INVENTION

This invention relates generally to an electrostatographic printing machine, and more particularly concerns an apparatus for affixing substantially permanently a powder pattern to a sheet of support material in image configuration without the scorching thereof.

In electrostatographic printing, an image bearing member is charged to a substantially uniform level and, thereafter, selectively discharged to record thereon an electrostatic latent image corresponding to an original document being reproduced. This latent image is developed or rendered viewable by depositing toner particles thereon. The toner powder image may be fused to the image bearing member or, in lieu thereof, transferred to the sheet of final support material and fused thereto. Generally, the toner particles are a heat settable colored thermoplastic powder. These toner particles adhere electrostatically to the image bearing member or final sheet of support material and, are passed through the fuser which generates heat of sufficient intensity to permanently affix the toner particles, in image configuration, thereon.

Various types of fusing devices are employed in electrostatographic printing, U.S. Pat. No. 3,306,595 issued to Eisner in 1967 discloses a paper guide employing a rotatable, beveled, double conical shaped member having a portion thereof positioned above a fuser base. The conical member advances the sheet through the fuser. An arrangement of this type is adapted to minimize sheet scorching as it passes through the fuser. Other fusing devices utilize radiant heating elements for raising the temperature of the toner material to its set point. A fuser of this type is described in U.S. Pat. No. 3,079,483 issued to Codichini et al. in 1963. The temperature within a fusing device must be controlled to insure that excess heat is not produced thereby. If the temperature exceeds the kindling temperature of the sheet of support material, which is typically plain paper, scorching may occur. This problem is common to most types of fusing devices utilized in electrostatographic printing.

Frequently, scorching of the sheet is caused by the contact between the heater or insulator and sheet. An insulator is provided generally to support the sheet of support material as it passes through the fusing device. The contact surface between the insulator and the sheet of paper, as well as the duration of contact, determines the magnitude of heat transferred thereto. In order to minimize the amount of heat being transferred to the sheet of support material and to prevent scorching thereof, it is necessary to minimize the duration of contact and the contact area.

Accordingly, it is a primary object of the present invention to improve fusing devices employed in electrostatographic printing machines so as to prevent scorching of the sheet of support material passing therethrough.

SUMMARY OF THE INVENTION

Briefly stated, and in accordance with the present invention, there is provided an apparatus having a sheet passageway therethrough for affixing permanently a powder pattern to the sheet.

In the preferred embodiment thereof, the apparatus includes transport means, heating means and insulating means. The transport means advances the sheet with a powder pattern deposited on one surface thereof along a path of movement through the passageway from a receiving station to a delivery station. As the sheet is advanced, the heating means heats the powder pattern on the sheet. The heating means is closely adjacent to and spaced from the surface of the sheet having the powder pattern deposited thereon. Insulating means, having a plurality of fins extending transversely to the path of movement of the sheet, are arranged to contact the other surface of the sheet and prevent scorching thereof as the transporting means advances the sheet from the receiving station to the delivery station.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects and advantages of the present invention will become apparent upon reading the following detailed description and upon reference to the drawings, in which:

FIG. 1 is a schematic perspective view of an electrophotographic printing machine having the features of the present invention incorporated therein;

FIG. 2 is a perspective view of the fuser employed in FIG. 1 printing machine;

FIG. 3 is an elevational view of the FIG. 2 printing machine;

FIG. 4 is a plan view of one embodiment of the insulator employed in the FIG. 2 fuser;

FIG. 5 is a sectional elevational view taken along line 5—5 of FIG. 4 in the direction of the arrows;

FIG. 6 is a plan view of another embodiment of the insulator employed in the FIG. 2 fuser;

FIG. 7 is a sectional elevational view of one embodiment of the FIG. 6 insulator fins taken along lines 7—7 of FIG. 6 in the direction of the arrows; and

FIG. 8 is a sectional elevational view of another embodiment of the FIG. 6 insulator fins taken along the line 7—7 of FIG. 6 in the direction of the arrows.

While the present invention will be described in connection with a preferred embodiment thereof, it will be understood that it is not intended to limit the invention to that embodiment. On the contrary, it is intended to cover all alternatives, modifications and equivalents as may be included within the spirit and scope of the invention as defined by the appended claims.

DETAILED DESCRIPTION OF THE INVENTION

A general understanding of an electrophotographic printing machine, in which the present invention may be incorporated, is had by referring to FIG. 1. As shown therein, FIG. 1 depicts schematically the various components of an electrophotographic printing machine adapted to utilize the features of the present invention therein. Hereinafter, continued reference will be made to the drawings wherein like reference numerals have been used throughout to designate like elements. Although the apparatus of the present invention is particularly well adapted for use in an electrophotographic printing machine, it should become evident from the following discussion that it is equally well suited for use in a wide variety of heating devices and is not particularly limited in its application to the particular embodiment herein.

In FIG. 1, the printing machine employs a photoconductive member with a drum 10 having a photoconductive surface 12 secured to and entrained about the circumferential surface thereof. A synchronous speed

motor (not shown) rotates drum **10** in the direction of arrow **14.** In this manner drum **10** rotates photoconductive surface **12** sequentially through a series of processing stations. These processing stations will be described briefly hereinafter.

As drum **10** rotates in the direction of arrow **14,** photoconductive surface **12** initially moves through charging station A. Charging station A includes a corona generating device, indicated generally at **16.** Corona generating device **16** extends in a generally longitudinal direction transversely across photoconductive surface **12.** In operation, corona generating device **16** charges photoconductive surface **12** to a relatively high substantially uniform potential. U.S. Pat. No. 2,836,725 issued to Vyverberg in 1958 describes one type of suitable corona generating device.

Thereafter, drum **10** is rotated to exposure station B. At exposure station B, an original document passes through chute **18** and is grasped by grippers (not shown) mounted on document drum **20.** These grippers hold the original document against document drum **20.** Document drum **20** rotates in the direction of arrow **22** and pulls the original document into the machine under exposure lamps **24.** Exposure lamps **24** are located above document drum **20** and illuminate incremental areas of the original document as drum **20** rotates. After exposure, the grippers release the original document so as to enable it to pass through chute **26** into a catch tray (not shown). The document light image is reflected by object **28** through stationary lens **30** to image mirror **32.** Image mirror **32** reflects the light image through exposure slit **34** onto charged photoconductive surface **12.** This light image irradiates areas of photoconductive surface **12** to discharge selected portions thereof. This records an electrostatic latent image corresponding to the original document on photoconductive surface **12.**

After the electrostatic latent image is recorded on photoconductive surface **12,** drum **10** rotates the latent image to development station C. At development station C, the electrostatic latent image recorded on photoconductive surface **12** is rendered visible by depositing toner particles thereon. In the development system, a developer mix of carrier granules, i.e. ferromagnetic granules, and toner particles, i.e. heat settable thermoplastic particles, is brought into contact with the electrostatic latent image to form a powder image on photoconductive surface **12.** Numerous types of developer systems are suitable for rendering this electrostatic latent image visible. However, in the electrophotographic printing machine depicted in FIG. **1,** a cascade development system is employed. In cascade development, the developer mix is transported from a sump or lower region to an upper region where it is discharged to cascade in a downwardly direction over the latent image recorded on photoconductive surface **12.** This forms a toner powder image on the electrostatic latent image corresponding to the original document. Cascade system includes a conveyor system arranged to advance the developer mix from the sump to the discharge region. The conveyor system employs buckets secured to endless belts entrained about a pair of spaced rollers. The buckets pass through the sump and are filled with the developer mix which is transported in an upwardly direction therefrom to the discharge region. At the discharge region, the buckets discharge the mix cascading it in a downwardly direction over the electrostatic latent image recorded on photoconductive surface **12** forming a toner powder image thereon.

At the proper time during the machine cycle, a pair of feed rollers, indicated generally by the reference number **36,** move from an inoperative position wherein they are spaced from the uppermost sheet of the stack of support material to an operative position in contact therewith. The stack of sheets are located on a tray **38** and engage feed roller **36.** Feed rollers **36** advance the uppermost sheet into chute **40.** The sheet feeding apparatus is more fully described in copending application Ser. No. 460,627 filed in 1974, the disclosure of which is hereby incorporated into the present application. The pair of gripper bars mounted on chain; **42** draw the sheet of support material from chute **40** and interpose it between drum **10** and corona generating device **44.** Corona generating device **44** applies an electrostatic charge to the sheet of support material attracting the toner powder image adhering to photoconductive surface **12** thereto. A gripper bar continually moves the sheet of support material through transfer station D. After the entire toner powder image has been transferred to the sheet of support material, the gripper bars advance the sheet of support material, with the toner powder image adhering thereto, to fixing station E.

Fixing station includes a fuser, indicating generally by the reference numeral **46.** Fuser **46** is the subject matter of the present invention and will be described in greater detail with reference to FIGS. **2** through **8,** inclusive. In general, fuser **46** has suitable radiant heating elements and control circuits for maintaining the temperature thereof substantially constant to permanently affix the toner powder image to the sheet of support material advancing therethrough. After exiting fuser **46,** the support material passes from the electrostatic printing machine to the catch tray. Once in the catch tray, the sheet of support material may be readily removed therefrom by the machine operator.

Continuing now with the printing process, drum **10** passes through cleaning station F. At cleaning station F, pre-clean corona generating device **48** applies a charge potential to photoconductive surface **12** to neutralize the remaining charge thereon and the charge on residual toner particles adhering thereto. Web cleaning system **50,** then removes the residual toner particles from photoconductive surface **12.** Photoconductive surface **12** is now ready for the next machine cycle. The foregoing machine cycle is repeated for each successive copy.

It is believed that the foregoing description is sufficient for purposes of the present application to illustrate the general operation of an electrophotographic printing machine embodying the teachings of the present invention therein.

Referring now to FIG. **2,** fusing apparatus **46** is depicted therein in detail. Fuser **46** includes a bottom housing **52.** A sheet of insulating material **56** is disposed in bottom housing **52.** Insulator **56** includes a plurality of fins extending in an upwardly direction therefrom and transversely to the path of movement of the sheet of support material, as indicated by arrow **54.** Thus, fins **58** extend in a transverse direction to arrow **54.** As shown in FIG. **2,** four fins are employed in fusing apparatus **46.** Fins of one pair extend parallel to each other and transversely to the fins of the other pair. Top housing **58** includes a radiant energy source adapted to heat the sheet of support material moving in the direc-

tion of arrow **54.** As the sheet of support material passes through the passageway defined by top housing **58** and bottom housing **52,** the trailing edge thereof engages fins **58.** Fins **58** minimize the contact area between the sheet and insulating member **56** so as to reduce the potentiality of sheet scorching.

Turning now to FIG. **3,** chain **42** advances support material **62** held thereon by gripper bar **64** in the direction of arrow **54.** Bottom housing **52** includes an outer casing **66** forming an enclosure for insulator **56.** Fins **58** extend in an upwardly direction from insulator **56** to engage the training edge of support material **62** as it is moved in the direction of arrow **54.**

Top housing **60** is similar in construction to bottom housing **52.** Top casing **72** forms an enclosure for radiant heating plate **74.** Top plate **74** is a metal platen with a plurality of circular grooves extending across the length thereof in a substantially parallel relation to one another. Tubular heating elements **76** are secured, as by brazing, in each of the circular grooves. All of the tubular heating elements **70** and **76** include a coil nickel chromium resistance wire compacted in a dielectric material which is enclosed by a metal sheet. The configuration of each tubular heating element is such that the individual coil of the wire is more closely spaced at the ends than at the middle to effect a heating gradient across each unit. By spacing the coils in a predetermined pattern, as described, temperature distribution is achieved across the face of each radiant heating plate. The tubular heating elements in each panel are connected to each other at one end by a conductor fastened to terminal pins extending from the metal sheets, and at the opposite ends thereof, the tubular heating elements are connected in pairs to a terminal thereby forming a unitary resistance element for the top heating element, which is connected to a source of electrical power.

The detailed structural configuration of the fuser as hereinbefore described is more fully described in U.S. Pat. No. 3,079,485 issued to Codichini et al. in 1963, the relevant portions of that disclosure being hereby incorporated into the present application.

Referring now to FIG. **4,** there is shown one embodiment of insulator **56.** As shown in FIG. **4,** a sheet of support material **62** advances in the direction of arrow **54.** Insulator **56** includes a plurality of fins **58** extending in an upwardly direction therefrom adapted to contact the surface of support material opposed from that having the toner powder image thereon. In FIG. **4,** four fins **58** are illustrated. One pair of fins **58** extends in a transverse direction to the other pair of fins **58.** In this manner, the sheet of support material moving in the direction of arrow **54** engages fins **58** rather than the entire surface of insulator **56.** This minimizes the contact between the advancing sheet of support material and the surface of insulator **56.** Minimizing the contact area reduces the heat transferred to the sheet of support material so as to prevent scorching thereof. In addition, the point of contact between fins **58** and the advancing sheet of support material continually changes during the movement of the sheet along its path of travel. It should be noted that the fins will contact the trailing edge of the sheet due to curl therein.

Referring now to FIG. **5,** there is shown a section of fins **58.** As shown therein, fins **58** are formed from a triangular prism.

Turning now to FIG. **6,** there is shown another embodiment of insulator **56.** As shown therein insulator **56** includes five fins **58.** All of the fins **58** extend in a transverse direction to the direction of movement of support material **62** as indicated by arrow **54.** Fins **58***a*, 58*b*, and **58***c* are parallel to one another. Fin **58***d* is more closely spaced to fin **58***c* than fin **58***a*. Fins **58***d* and **58***e* are also parallel to one another. However, fins **58***a*, 58*b*, and **58***c* extend in a transverse direction to fins **58***d* and **58***e*. Thus, fins **58***a*, 58*b* and **58***c* form acute angles with fins **58***d* and **58***e*.

Referring now to FIG. **7,** there is shown one embodiment of fins **58.** As shown therein, fin **58** is one-half of a triangular prism.

Turning now to FIG. **8,** there is shown another embodiment of fin **58.** As shown therein, fin **58** is one-half of a truncated triangular prism.

While the foregoing has illustrated various embodiments of fins, it will be obvious to one skilled in the art that the fins may all be parallel to one another as well as transverse to one another.

It should be noted that the essential feature of the present invention resides in having the fins extend in a direction transverse to the path of movement of the sheet of support material. Positioning the fins transversely to the direction of movement of the sheet minimizes the contact area, time and continually changes the point of contact as the sheet moves along its path of movement. Minimization of the contact area and time, as well as changing the points of contact prevents sheet scorching.

Thus, it is apparent that there has been provided in accordance with the present invention, an apparatus that fully satisfies the objects, aims and advantages set forth above. While the present invention has been described with specific embodiments thereof, it is evident that many alternatives, modifications and variations will be apparent to those skilled in the art in light of the foregoing description. Accordingly, it is intended to embrace all such alternatives, modifications and variations as fall within the spirit and broad scope of the appended claims.

What is claimed is:

1. An apparatus having a sheet passageway therethrough for affixing permanently a powder pattern to a sheet including:

means for transporting the sheet with the powder pattern deposited on one surface thereof along a path of movement through the passageway from a sheet receiving station to a sheet delivery station;

means for heating the powder pattern deposited on the sheet, said heating means being closely adjacent to and spaced from the surface of the sheet having the powder pattern deposited thereon; and

insulating means operatively associated with said transporting means, said insulating means having a plurality of spaced fins extending transversely to the path of movement of the sheet and arranged to contact the other surface of the sheet as said transporting means advances the sheet from the receiving station to the delivery station, said heating means being substantially opposed from said insulating means with the sheet passageway interposed therebetween.

2. An apparatus as recited in claim **1,** wherein said heating means includes a radiant energy source arranged to be in thermal communication with the sheet

for supplying the energy output thereof onto the sheet.

3. An apparatus having a sheet passageway therethrough for affixing permanently a powder pattern to a sheet including:

means for transporting the sheet with the powder pattern deposited on one surface thereof along a path of movement through the passageway from a sheet receiving station to a sheet delivery station;

a radiant energy source arranged to be in thermal communication with said sheet for supplying the energy output thereof onto the sheet, said radiant energy source comprising a plate member, a plurality of tubular heating elements secured to said plate member with the longitudinal axis thereof substantially parallel to one another, and means for energizing said heating elements; and

insulating means operatively associated with said transporting means, said insulating means having a plurality of fins extending transversely to the path of movement of the sheet and arranged to contact the other surface of the sheet as said transporting means advances the sheet from the receiving station to the delivery station.

4. An apparatus having a sheet passageway therethrough for affixing permanently a powder pattern to a sheet including:

means for transporting the sheet with the powder pattern deposited on one surface thereof along a path of movement through the passageway from a sheet receiving station to a sheet delivery station, said transporting means comprising an endless conveyor, means for driving said conveyor, and at least one sheet gripper secured to said conveyor for moving the sheet from the sheet receiving station to the sheet delivery station;

means for heating the powder pattern deposited on the sheet, said heating means being closely adjacent to and spaced from the surface of the sheet having the powder pattern deposited thereon; and

insulating means operatively associated with said transporting means, said insulating means having a plurality of fins extending transversely to the path of movement of the sheet and arranged to contact the other surface of the sheet as said transporting means advances the sheet from the receiving station to the delivery station.

5. An apparatus having a sheet passageway therethrough for affixing permanently a powder pattern to a sheet including:

means for transporting the sheet with the powder pattern deposited on one surface thereof along a path of movement through the passageway from a sheet receiving station to a sheet delivery station;

means for heating the powder pattern deposited on the sheet, said heating means being closely adjacent to and spaced from the surface of the sheet having the powder pattern deposited thereon; and

insulating means operatively associated with said transporting means, said insulating means having a plurality of fins extending transversely to the path of movement of the sheet and arranged to contact the other surface of the sheet as said transporting means advances the sheet from the receiving station to the delivery station, said insulating means having at least a pair of fins extending transversely to one another.

6. An apparatus as recited in claim 1, wherein said insulating means includes at least a pair of fins extending parallel to one another.

7. An electrostatographic printing machine of the type having a toner powder image of an original document being reproduced formed on a sheet of support material, including:

a housing member having a passageway therethrough;

means for transporting the sheet with the toner powder image deposited on one surface thereof along a path of movement through the passageway in said housing member from a sheet receiving station to a sheet delivery station;

means for heating the powder pattern deposited on the sheet, said heating means being closely adjacent to and spaced from the surface of the sheet having the powder pattern deposited thereon; and

insulating means operatively associated with said transporting means, said insulating means having a plurality of spaced fins extending transversely to the path of movement of the sheet and arranged to contact the other surface of the sheet as said transporting means advances the sheet from the receiving station to the delivery station, said heating means being substantially opposed from said insulating means with the passageway of said housing interposed therebetween.

8. A printing machine as recited in claim 7, wherein said heating means includes a radiant energy source arrnaged to be in thermal communication with the sheet for supplying the energy output thereof onto the sheet.

9. An electrostatographic printing machine of the type having a toner powder image of an original document being reproduced formed on a sheet of support material, including:

a housing member having a passageway therethrough;

means for transporting the sheet with the toner powder image deposited on one surface thereof along a path of movement through the passageway in said housing member from a sheet receiving station to a sheet delivery station;

a radiant energy source arranged to be in thermal communication with the sheet for supplying the energy output thereof onto the sheet, said radiant energy source comprising a plate member, a plurality of tubular heating elements secured to said plate member with the longitudinal axis thereof substantially parallel to one another, and means for energizing said heating elements; and

insulating means operatively associated with said transporting means, said insulating means having a plurality of fins extending transversely to the path of movement of the sheet and arranged to contact the other surface of the sheet as said transporting means advances the sheet from the receiving station to the delivery station.

10. An electrostatographic printing machine of the type having a toner powder image of an original document being reproduced formed on a sheet of support material, including:

a housing member having a passageway therethrough;

means for transporting the sheet with the toner powder image deposited on one surface thereof along

a path of movement through the passageway in said housing member from a sheet receiving station to a sheet delivery station, said transporting means comprising an endless conveyor, means for driving said conveyor, and at least one sheet gripper secured to said conveyor for moving the sheet from the sheet receiving station to the sheet delivery station;

means for heating the powder pattern deposited on the sheet, said heating means being closely adjacent to and spaced from the surface of the sheet having the powder pattern deposited thereon; and

insulating means operatively associated with said transporting means, said insulating means having a plurality of fins extending transversely to the path of movement of the sheet and arranged to contact the other surface of the sheet as said transporting means advances the sheet from the receiving station to the delivery station.

11. An electrostatographic printing machine of the type having a toner powder image of an original document being reproduced formed on a sheet of support material, including:

a housing member having a passageway therethrough;

means for transporting the sheet with the toner powder image deposited on one surface thereof along a path of movement through the passageway in said housing member from a sheet receiving station to a sheet delivery station;

means for heating the powder pattern deposited on the sheet, said heating means being closely adjacent to and spaced from the surface of the sheet having the powder pattern deposited thereon; and

insulating means operatively associated with said transporting means, said insulating means having a plurality of fins extending transversely to the path of movement of the sheet and arranged to contact the other surface of the sheet as said transporting means advances the sheet from the receiving station to the delivery station, said insulating means having at least a pair of fins extending parallel to one another.

12. A printing machine as recited in claim **7**, wherein said insulating means includes at least a pair of fins extending parallel to one another.

* * * * *