

Oct. 20, 1970

C. L. HUBER
FUSING APPARATUS

3,535,492

Filed May 31, 1968

2 Sheets-Sheet 1

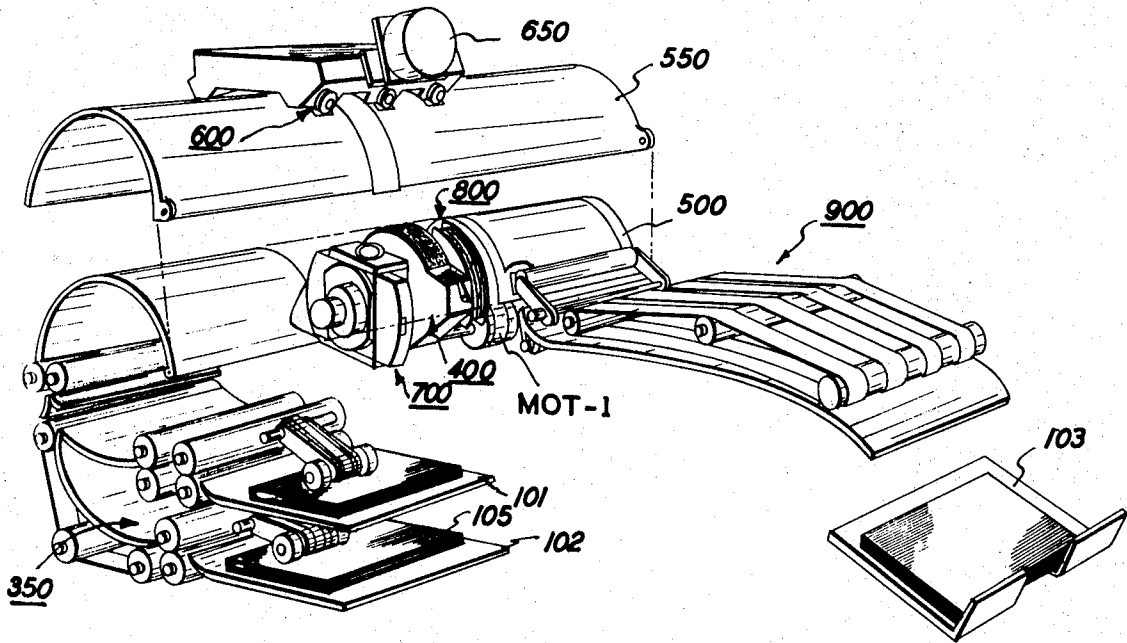


FIG. 2

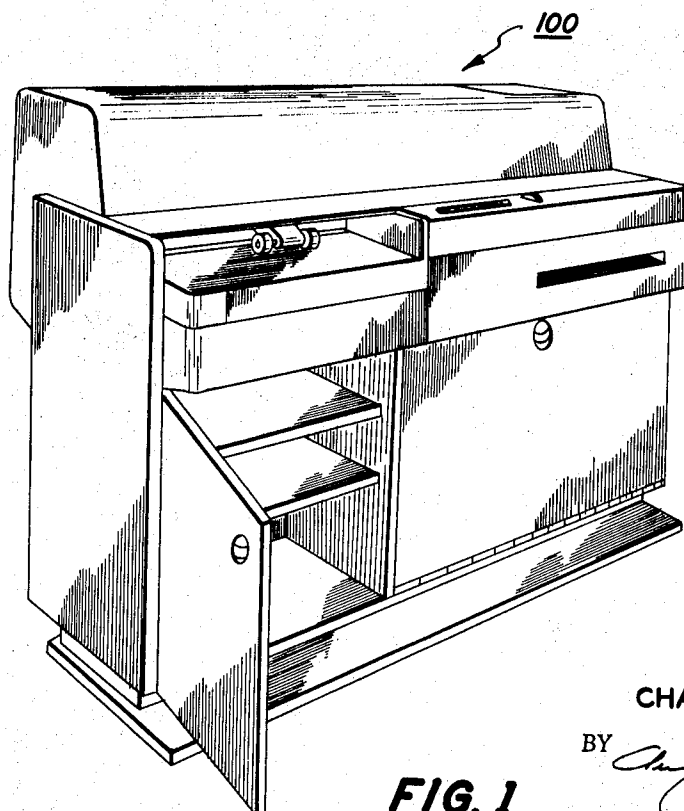


FIG. 1

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2 Sheets-Sheet 2

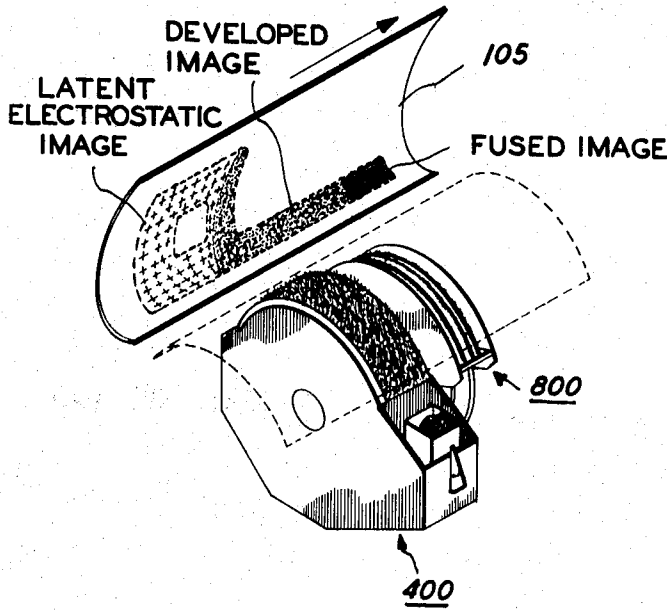


FIG. 5

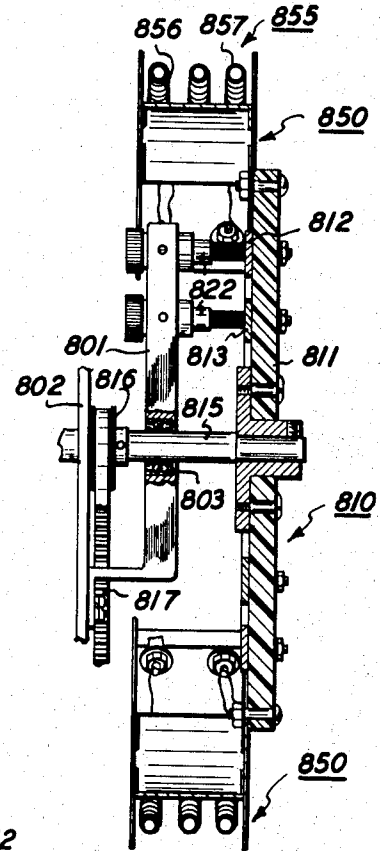


FIG. 4

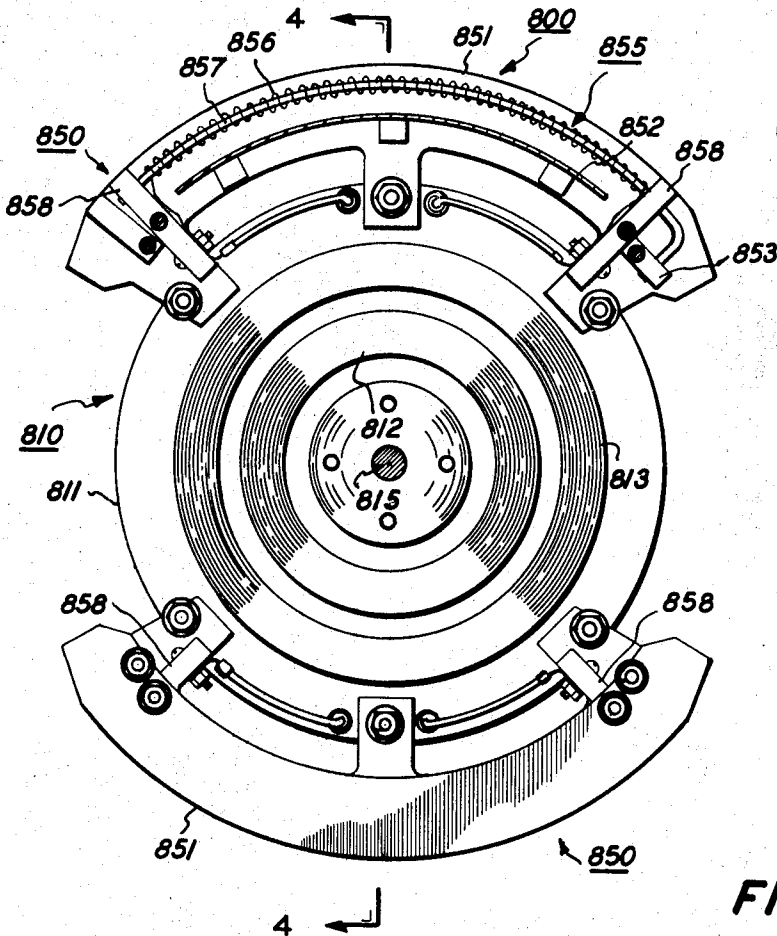


FIG. 3

1

2

3,535,492

FUSING APPARATUS

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3 Claims

ABSTRACT OF THE DISCLOSURE

Apparatus for permanently affixing electroscopic toner particles in image configuration to an electrographic support material upon which the toner powder is electrostatically bonded including a plurality of radiant heating elements supported for movement in a circular path adjacent to and transverse of the path of support material movement such that the toner powder is uniformly fused to the support material by the rotating heating elements passing adjacent thereto.

BACKGROUND OF THE INVENTION

This invention relates to improvements in heat fusing devices and, in particular, to an improved apparatus for fixing electroscopic toner powder images to a support material.

More specifically, this invention relates to an improved radiant heat fuser. Although the invention is considered to have general application, it is particularly useful in the fusing of electroscopic resinous toner powder images onto sheets of support material to which the powder image has been applied by deposition of the electroscopic toner powder onto a latent electrostatic image.

For example, in the electrographic process a sheet of insulating support material usually paper, on a conductive backing, is given an electrostatic charge over its surface in accordance with a desired charge pattern, thereby creating a latent electrostatic image.

Development of the latent image is effected by developers which comprise, in general, a mixture of suitable pigmented or dyed resin-based powder, hereinafter referred to as toner, and a granular carrier material which functions to generate triboelectric charges on, and to carry the toner powder. More specifically, the function of the carrier material is to provide mechanical control of the toner, or to carry the toner to an image surface and simultaneously provide almost complete homogeneity of charge polarity. In the development of the image, the toner powder is brought into surface contact with the support material and is held thereon by the electrostatic forces in a pattern corresponding to the latent electrostatic image. Various development methods well known to those skilled in the art are disclosed in U.S. Pat. No. 2,618,551 issued to L. G. Walkup and U.S. Pat. No. 2,874,063 issued to H. G. Greig. After development the image is normally affixed to the electrographic sheet by any suitable means such as by heat fusing.

A variety of types of finely divided electroscopic toner powders may be employed for developing latent electrostatic images. However, it has been found preferable to develop line copy images with a powder or toner formed of any of a variety of pigmented thermoplastic resins that have been specifically developed for this purpose. A number of such toner powders are available commercially, and these toners are specifically compounded for producing dense images of high resolution and to have characteristics to permit convenient storage and handling. Such toner powders are compounded to permit them to be fixed to the surface of a support material either by heat fluxing or vapor fixing techniques, in accordance with the particular application in which they are employed. The individual

particles of toner (resin) soften and coalesce when heated or plasticized by solvent, such that they become sticky or tackified and readily adhere to the surface of the transfer material.

The term "tackified" is used to describe the condition of the toner powder particles when heated or plasticized by solvent in a manner such that the individual particles soften and coalesce and in which state they become sticky and readily adhere to other surfaces. Although this condition necessarily requires a flowing together of the particles to effect a thorough fusion thereof, it is to be understood that the extent of such flowing is not sufficient to extend beyond the boundary of the pattern in which the particles are formed.

In order to fuse resinous images formed of the powdered toner resins now commercially available, it is necessary to heat the toner powder and the support material (paper) to which it is to be fused to a relatively high temperature, such as approximately 325° F. It is undesirable, however, to heat the temperature of the paper support material substantially higher than 375° F. because of the tendency of paper to discolor at elevated temperatures.

It has long been recognized that one of the fastest and most positive methods of applying heat for fusing the toner powder image to paper support material is to bring the powder image into direct contact with a hot surface, such as a heated flat plate. However, as the powder image is tackified by heat, part of the image carried by the support material will stick to the surface of the heated plate, such that when the next sheet is placed on the heated surface the tackified image partially removed from the first sheet will transfer to the next sheet resulting in an off-set of the former image onto the latter support material. The off-set of toner powder onto the heated contacting surface has led to the development of improved heat-pressure fixing devices such as disclosed in U.S. Pat. No. 3,268,351 issued to W. G. VanDorn. While the method and apparatus disclosed in the aforementioned patent has solved this problem of "off-set" satisfactorily, such apparatus is expensive and requires a substantial space within an automatic operating machine. Another apparatus utilized for fixing toner powder images to support material is radiant heaters with reflectors. These radiant heaters of the type disclosed in U.S. Pat. No. 2,965,868 issued to R. W. Eichler, with reflectors, have the disadvantage of non-uniform fusing of the toner powder to the support material due to the nonuniformity of the radiant heating elements within the reflector, which cause localized hot spots and areas of insufficient fixing of the toner powder to the support surface.

SUMMARY OF THE INVENTION

It is, therefore, an object of this invention to improve electroscopic toner powder fixing apparatus.

Another object of this invention is to improve radiant fusing apparatus by eliminating non-uniform fixing of electroscopic toner powder to a support material.

A further object of this invention is to improve uniform fixing of electroscopic toner powder to a support material by moving the radiant heating element relative to the support surface.

Still another object of this invention is to improve fixing apparatus by uniformly fusing electroscopic toner powder to a support material constrained in a curved or semi-cylindrical configuration.

These and other objects are attained in accordance with the present invention wherein there is provided a plurality of radiant heating elements formed in a curved configuration and supported on a rotatable support plate for movement in a circular path whereby the plurality of heating elements are continuously passed adjacent a moving sheet of support material bearing an unfused electroscopic toner-powder image.

DESCRIPTION OF THE DRAWINGS

Further objects of this invention, together with additional features contributing thereto and advantages accruing therefrom, will be apparent from the following description of one embodiment of the invention when read in conjunction with the accompanying drawings, wherein:

FIG. 1 is a perspective view of an automatic electrographic facsimile transceiver apparatus utilizing the invention of this application;

FIG. 2 is a mechanical schematic view of the apparatus shown in FIG. 1 with the covers removed to better illustrate the components thereof;

FIG. 3 is an enlarged frontal elevation of the fuser apparatus utilized in the facsimile transceiver taken in the direction of paper movement;

FIG. 4 is a vertical elevation view of the apparatus shown in FIG. 3 taken along lines 4—4;

FIG. 5 is a perspective view of the developer apparatus and fuser apparatus of this invention with a sheet of support material passing therethrough.

DESCRIPTION OF THE PREFERRED EMBODIMENT

As shown in FIG. 1, the automatic electrographic facsimile transceiver apparatus 100 includes an inner platen support member 500 having a convex semi-cylindrical surface extending axially therealong and an outer platen support member 550 having a concave semi-cylindrical surface extending axially therealong which form a curvilinear passageway through which a record medium or sheet of electrographic recording material is advanced. A rotatable optical scanner and electrographic recorder turret apparatus 700 is positioned adjacent the passageway to functionally form a scanning-recording station axially positioned along the two semi-cylindrical surfaces over which the electrographic recording material passes.

When it is desired to transmit the graphic information on the record medium the sheet is advanced to the scanning station 700 whereat electrical signals representative of the graphic information carried thereon are generated as the optical scanner transverses the graphic information on the sheet. When it is desired to receive information from a remote location, the recorder portion of the turret selectively produces electrostatic charge patterns on the electrographic paper record medium, as it is forwarded within the passageway at the recording or scanning station, in response to electrical signals received by the recorder and representative of the graphic information which is desired to be displayed on the record medium.

After a latent electrostatic image has been formed on the record medium by the selective deposition of electrostatic charge patterns thereon, the charge patterns representative of the graphic information are rendered visible by means of an electroscopic toner powder developing apparatus 400 which uniformly deposits a quantity of toner powder onto the charged surface of the latent electrostatic image bearing record medium. After the latent image is rendered visible, the toner powder image on the surface of the record medium is permanently affixed thereto to provide a facsimile copy of the graphic information thereon.

For the purposes of the present disclosure, reference will be had primarily to use of the facsimile transceiver apparatus in the receive mode of operation, although it is to be understood that the transceiver unit is designed to function both as a transmitter and a receiver. When the automatic electrographic facsimile transceiver apparatus 100 is operated in the receive mode, sheets of electrographic recording material 105 upon which the graphic information is to be recorded, are placed into the machine on a record material tray 102 located at the front of the machine and directly beneath a second copy support tray 101 utilized when the transceiver apparatus is operated in the transmit mode. The record sheets 105 are advanced from the tray 102 by means of an automatic sheet feeder

and are transported into the passageway defined between inner platen assembly 500 and outer platen assembly 550 by means of a sheet transport generally designated 350. The electrographic recording sheets are forwarded into position within the passageway defined between the inner and outer platen assemblies 500 and 550, respectively, and then advanced to the scanner-receiver area by a paper drive mechanism generally designated 600. At the scan-receive turret 700, and upon receipt of suitable electrical control pulses, the paper drive 600 is removed from engagement with the electrographic recording sheet and a stepping drive mechanism 650 engaged therewith to advance the copy sheet at a controlled speed past the scanner-receiver 700.

Information is recorded upon the electrographic record sheet 105 by means of an electrographic recording stylus supported on the rotating turret assembly 700 for rotation therewith to selectively charge an increment of the electrographic recording material, in response to electrical control signals, as the recording material is advanced thereover. The information desired to be recorded on the copy sheet 105, is received by the transceiver apparatus, decoded through appropriate electrical circuitry, and utilized to energize the electrographic recording stylus in the turret assembly 700. In response to these electrical control pulses, the record or copy sheet 105 is electrographically charged in image patterns corresponding to the information coupled into the transceiver apparatus. Upon completion of the recording process, the copy sheet 105 is advanced by the stepping drive assembly 650 over a magnetic brush developer unit 400 whereat the latent electrostatic charge pattern on the sheet is rendered visible by application of the electroscopic toner powder particles which adhere to the record sheet in the charged areas. After the latent electrostatic image on the record sheet has been rendered visible by the electroscopic toner powder, the copy sheet is further advanced along the curvilinear path to a fusing apparatus designated 800 at which point the electroscopic toner powder particles are fused to the copy sheet to create a permanent facsimile copy of the graphic information displayed on the support material. After the toner powder image has been permanently affixed to the record sheet, the sheet 105 is advanced to a sheet transport 900 whereat the completed facsimile copy is forwarded out of the machine and into the copy receive tray 103 located at the front portion of the transceiver.

The fuser apparatus 800 includes a plurality of heating units 850 mounted on a support plate 810 secured to a shaft 815 for rotation therewith. The support plate 810 comprises a circular member 811 of an electrical insulating material upon which is carried a pair of concentric electrically conductive rings 812 and 813 for electrically coupling the heating units 850 to an appropriate power source by means of a pair of brushes 822 supported by arm 801, each brush in contact with one of the rings 812 or 813. The shaft 815, upon which the heating units 850 are carried, is rotatably supported in arm 801 and a frame plate 802 by means of suitable bearings 803 and has the developer apparatus 400 secured to the opposite end such that the fuser apparatus 800 and developer apparatus 400 are rotated at the same speed and form a substantially continuous feed path whereby the latent electrostatic image is first developed by the application of toner powder and the toner powder permanently affixed to the electrographic support material by the fuser apparatus. Rotational movement of the fuser and developer apparatus is provided by means of a motor MOT-1 driving a timing belt 817 about a gear 816 appropriately secured to shaft 815.

As shaft 815 is driven, the fuser apparatus 800, and developer apparatus 400, are rotated adjacent to the path of paper movement in a manner such that the heating units 850 pass adjacent the developed toner powder image on the electrographic sheet material as it is advanced in a semi-cylindrical configuration past the rotating heating

units. The heating units **850** includes a plurality of radiant heating elements **855** comprising Nichrome wires **856** coiled about curved quartz rods **857** and suitably connected to the concentric contact rings **811** and **812** to be energized by the electrical power source connected thereto. The quartz rods **857** are secured at one end in braces **853** and supported by a pair of graphite insulating blocks **858** with the opposite end free to move within one of the graphite blocks **858** to allow for thermal expansion and contraction. A pair of frame plates **851** are positioned on each side of the radiant heating elements **855** for the protection thereof against breakage of these elements. A back plate **852** is supported from frame plates **851** and provides a reflective surface to increase the efficiency of the radiant energy directed from the heating elements **855** to the developed image bearing support material.

In operation, as a sheet of electrographic recording material is advanced by the stepping feed rolls **650** for permanently affixing a toner image thereto, the heating units **850** are rotated adjacent to the support material in a direction transverse to the path of movement of the toner powder image such that the image is exposed to the moving elements to compensate for non-uniform heating due to any irregularities in the wires **856** or windings about the quartz rods **857**. In addition, by moving the heating units, a uniform flow of hot air is circulated about the image bearing support material eliminating localized heat build up and the problems associated therewith as found in prior art radiant fusing apparatus.

While the invention has been described with reference to a preferred embodiment, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the true spirit and scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teaching of the invention without departing from its essential teachings.

What is claimed is:

1. The method of permanently affixing electroscopic toner powder images onto a support surface to which the toner powder is electrostatically bonded including the steps of:

5 forwarding a support material bearing an electroscopic toner powder image electrostatically bonded thereto along a predetermined path of movement, constraining said support material in a semi-cylindrical configuration during the forwarding thereof, 10 passing a heater in a path transverse of said predetermined path of support material movement and in thermal contact therewith to permanently affix the toner powder image onto the support material.

2. The method of claim 1 wherein the step of passing the heater in a path transverse of said predetermined support material movement including passing the heater in an endless path by rotating the heater about an axis parallel to the path of support material movement to cyclically thermally contact the support material and to generate a flow of heated air thereabout.

3. The method of claim 2 wherein the rotational movement of a heater element about an axis parallel to the path of support material movement cyclically thermally contacts the support material with radiant energy.

References Cited

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