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[54] **HEAT FIXING APPARATUS**
5 Claims, 2 Drawing Figs.

[52] **U.S. Cl.** **219/388,**
95/89, 219/216, 219/349, 219/405, 219/521
[51] **Int. Cl.** **F27b 9/06**
[50] **Field of Search** 219/388,
349, 216, 405, 521, 347—9; 263/3; 165/104;
95/89; 34/77, 68

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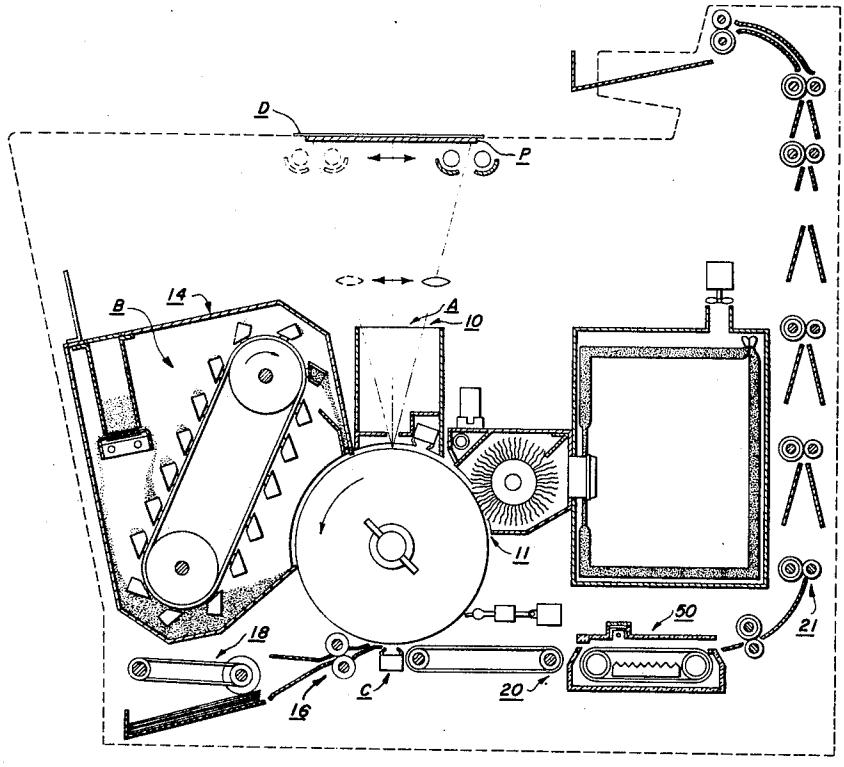
ABSTRACT: Apparatus for fixing fusible material such as electroscopic particles upon support material. The apparatus includes a fuser member in the form of an endless belt in contact with the support material being transported. The fusing belt member comprises a highly thermally conductive material which is coated with an electrically insulating material. The support material is electrostatically tacked to the belt member to enhance uniform thermal contact therebetween.



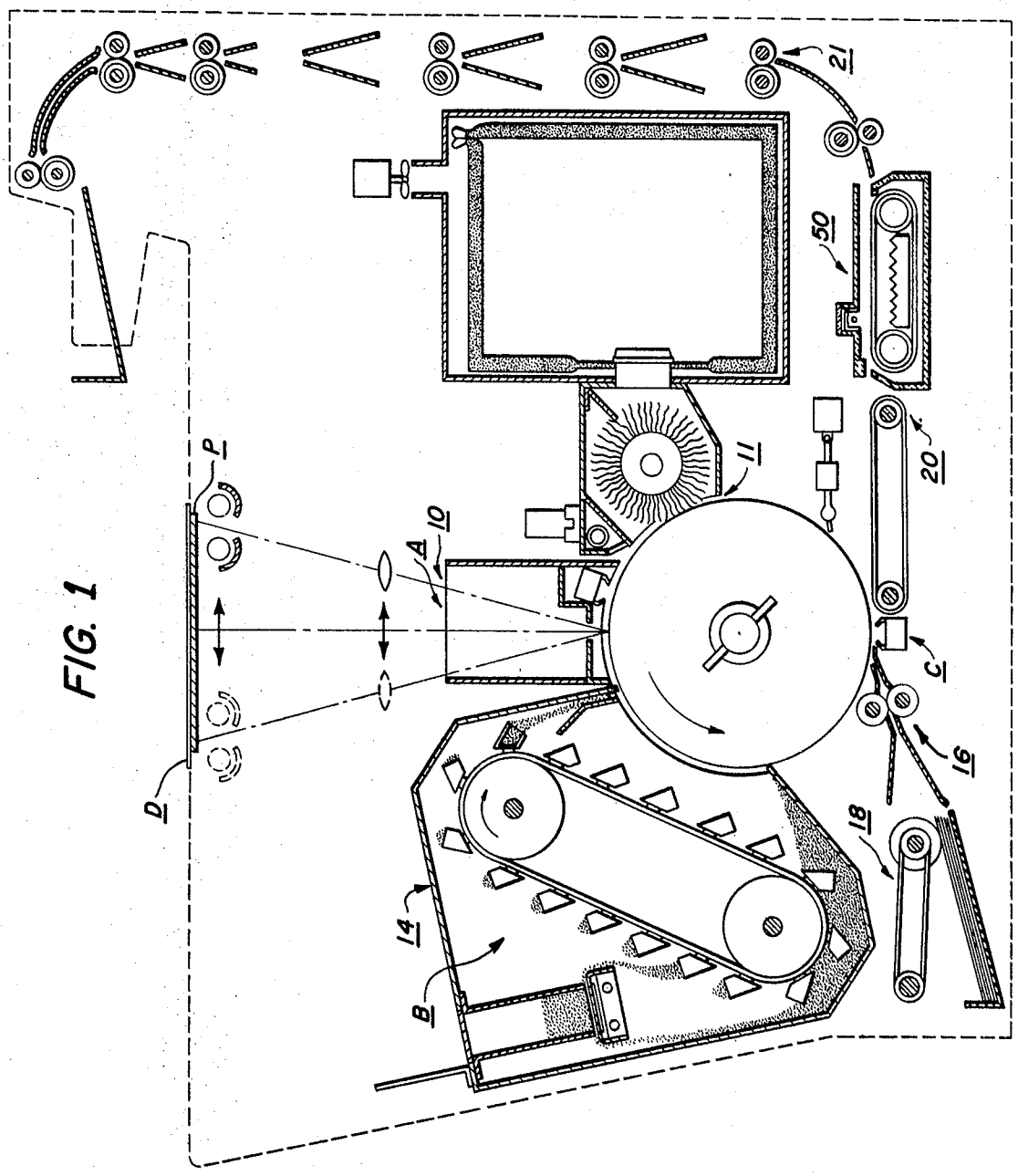


FIG. 1

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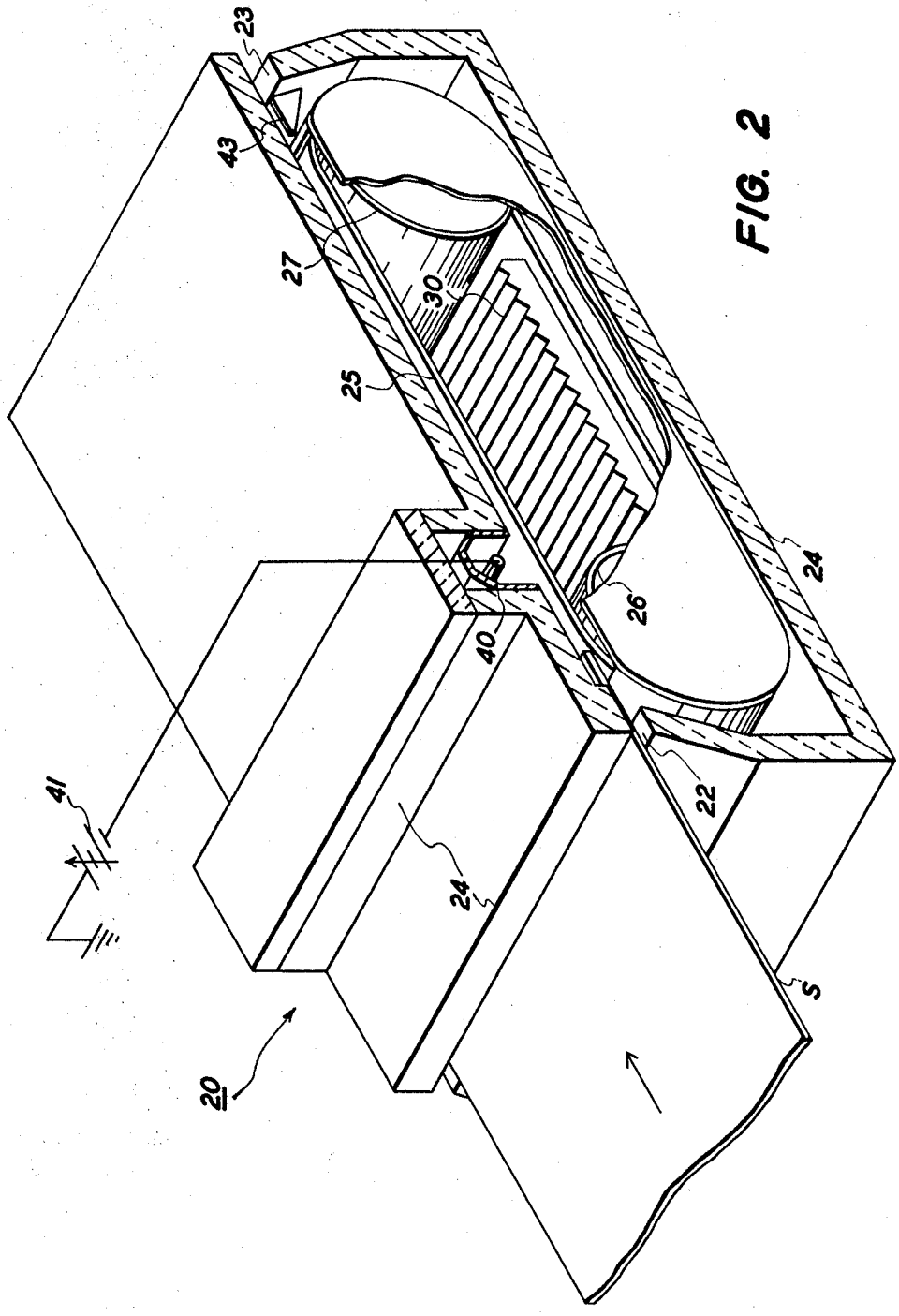

FIG. 2

HEAT FIXING APPARATUS

This invention relates to heat fixing systems, and particularly, to improvements in fuser apparatus for particulate material such as resinous toner particles, that is used in electrostatic automatic copiers/reproducers capable of high speed operation.

It has been recognized that one of the preferred methods of applying heat for fusing the powder image to paper is to bring the powder image into direct contact with a hot surface, such as a heated roller. However, in order to produce fused images effectively and efficiently, it has been necessary to utilize relatively large and structurally dense fuser rollers which consume large amounts of heat in order to overcome heat losses effected by the roller supporting structures. Heater elements for these roller fusers are generally supported interiorly of one of the rollers which have high temperature gradients needing a relatively large power supply to overcome heat losses as well as for fusing purposes. With the requirement for high fuser heater element temperatures comes the need to provide elaborate temperature controls to insure against equipment protection. Moreover, image offset is normally a problem in the absence of special offset materials, such as, oil which must be continuously applied to the roller surfaces. There are other heat fixing devices not particularly suited for high-speed copying/duplicating, such as, coiled radiant element heaters with reflectors. These radiant element heaters with reflectors and other types such as the recirculating heated air type have the disadvantage of dissipating a large quantity of heat into the image enclosure in which they are used, heat transfer to the powder image is inefficient, and for the case of the coiled heater element they present a safety hazard because of the exposed element.

It is therefore the principal object of this invention to improve the construction of a direct contact fusing device for toner images which will require a minimum of heat to accomplish the rapid fusing of toner images.

It is another object of this invention to facilitate the handling of sheet material upon which thermoplastic particles are to be fixed into and out of contact with heat fusing apparatus without image offset.

These and other objects of the invention are attained by means of a direct contact fusing device in which the toner image is fused by forwarding the sheet of support material bearing toner images upon a fuser member in the form of a highly thermally conductive belt which is sufficiently heated to fix the image upon the support material. A corona discharge device is arranged to spray a charge onto the sheet to provide uniform thermal contact between the sheet and belt which is coated with an electrically insulating material to obtain a high quality fix.

For a better understanding of the invention, as well as other objects and further features thereof, reference is had to the following detailed description of the invention to be read in connection with accompanying drawings wherein:

FIG. 1 illustrates schematically a xerographic reproducing apparatus adapted for high-speed automatic operation and incorporating a heat fuser constructed in accordance with the invention;

FIG. 2 is an isometric view of the fuser apparatus of the invention.

For a general understanding of the illustrated copier/reproduction machine, in which the invention may be incorporated, reference is had to FIG. 1 in which the various system components for the machine are schematically illustrated. As in electrostatic systems such as a xerographic machine of the type illustrated, a light image of a document to be reproduced is projected onto the sensitized surface of a xerographic plate to form an electrostatic latent image thereon. Thereafter, the latent image is developed with an oppositely charged developing material to form a xerographic powder image, corresponding to the latent image on the plate surface. The powder image is then electrostatically transferred

to a support surface to which it is fixed by a fusing device whereby the powder image is caused permanently to adhere to the support surface.

In the illustrated machine, an original D to be copied is placed upon a transparent support platen P fixedly arranged in an optical system generally indicated by the reference numeral **10**. The image rays are projected by means of the optical system for exposing the photosensitive surface of a xerographic plate in the form of a drum generally indicated by the reference numeral **11**.

The xerographic drum **11** is mounted upon the frame of the machine and is adapted to rotate in the direction of the arrow at a constant rate. During this movement of the drum, the light image of the original on the platen is projected upon the xerographic surface of the drum at an exposure station A. The exposure of the drum surface to the light image discharges the photosensitive surface in the areas struck by light, whereby there remains on the belt a latent electrostatic image in image configuration corresponding to the light image projected from the original on the supporting platen. As the drum surface continues its movement, the electrostatic image passes through a developing station B in which there is positioned a developer assembly generally indicated by the reference numeral **14**. The developer assembly **14** deposits developing material onto the drum whereat the material is directed to cascade down over the drum surface in order to provide development of the electrostatic image. As the developing material is cascaded over the xerographic surface, toner particles in the development material are deposited on the drum surface to form powder images.

The developed electrostatic image is transported by the drum surface to a transfer station C whereat a sheet of copy paper is moved at a speed in synchronism with the moving drum in order to accomplish transfer of the developed image. There is provided at this station a sheet transport mechanism generally indicated at **16** adapted to transport sheets of paper from a paper handling mechanism generally indicated by the reference numeral **18** to the developed image the drum at the station C.

After the sheet is stripped from the drum, it is conveyed to a fuser apparatus according to the present invention generally indicated by the reference numeral **20** whereat the developed transferred xerographic powder image on the sheet material is permanently affixed thereto as will be described hereinafter. After fusing, the finished copy is discharged from the apparatus by a conveyor **21** to a suitable point for collection externally of the apparatus.

Suitable drive means may be arranged to drive the drum in conjunction with exposure of an original to be copied, to effect conveying and cascade of toner material, to separate and feed sheets of paper and to transport the same across the transfer station C and to convey the sheet of paper through the fuser apparatus in timed sequence to produce copies of the original.

It is believed that the foregoing description is sufficient for the purposes of this application to show the general operation of an electrostatic copier using a fuser apparatus constructed in accordance with the invention.

As shown in FIG. 2, the fuser apparatus **20** is of the heated type through which a sheet of support material, indicated by the reference letter S, is adapted to be conveyed during a fusing operation. The support material S is conveyed through an entrance slot **22** formed on one side of the housing of fuser apparatus and out of an exit slot **23** formed in an opposite wall of the housing. The housing for the apparatus comprises insulated walls **24** made of a highly reflective material coated with a high thermal insulating material. Within the housing the support material is conveyed by an endless belt **25** supported for movement on and by a pair of rollers **26** and **27** arranged with their axes in parallel. Shafts for the rollers **26** and **27** may be suitably journaled and connected by driving devices such as timing belts or chains to a suitable drive system to effect continuous movement of the belt in a direction indicated by the

arrow to thereby effect movement of the support material through the housing of the fuser apparatus. Located between the upper and lower runs of the belt **25** is a heater element **30** which is in the form of a strip or resistance heater element directed to radiate heat to the belt **25**. By being heated in this manner, belt **25** is, in effect, a fusing member adapted to give up heat uniformly to the support material S which carries the toner particles in image configuration.

In order to achieve good thermal contact uniformly along the entire length of the contacted belt and support material, the support material is electrostatically tacked to the belt surface by a corona discharge device **40** connected to a variable power source **41**. Power source **41** is variable to enable optimum operation during changes in ambient conditions such as humidity, temperature, etc. To ensure good electrostatic contact, the belt surface is coated with a very thin layer of electrically insulating material such as Teflon which also serves to prevent the sheet material from sticking to the belt. The Teflon coating should be thin enough so that it does not interfere with the heat conduction through the belt and may range from about 0.002 to about 0.004 inch. At the end of the belt run, the support material will separate from the belt due to its natural stiffness. Also, separating fingers **43** made of suitable material are used to facilitate separation of the sheet material from belt **25**.

Belt **25** comprises a highly thermally conductive sheet made of material, such as, copper which possesses some resiliency while exhibiting tensile strength of a sufficient magnitude to permit its use as a conveying member. For insuring that heat will be conducted to the toner particles to be fused, the belt should be relatively thin, for example, approximately from about 0.010 inch to about 0.030 inch so that heat can be conducted through the belt with the heater element on the opposite side from the support material. Each of the rollers **26, 27** are preferably made of heat resistant, heat insulating material and are secured to their respective supporting shafts by way of insulating caps or supports.

The distance between the supporting rollers **26, 27** and the length of the belt **25** may be chosen in accordance with necessary or desirable fusing results. For instance, the distance between the rollers **26** and **27** may be shortened in the event that the rate of movement of the support material S through the electrostatic copying/duplicating machine utilizing the fuser apparatus **20** is relatively slow. On the other hand, for electrostatic duplicating machine arrangements capable of high speed reproduction wherein the speed of movement for the support material is relatively fast, it may be desirable to extend the distance between the rollers **26, 27** to compensate for the speed of the support material through the fuser apparatus.

In operation sheet of support material such as paper is directed onto the belt **25** image side up and is tacked to the belt surface by corona discharge device **40** for transfer through the fuser apparatus. Heat circulating within the fuser apparatus and that which is radiated directly from the heater element **30** is applied to the surface of the belt **25** which has very good thermal contact with the support material along the entire length thereof. Since the thickness of the belt **25** is in the order of 0.010 to 0.030 of an inch, it is small enough so that heat can be conducted through the belt with the heater element located on one side of the belt run and a toner image located on the other side. It has been found that excellent fixes of the toner images including both solid area and line copy to moving support material are obtained with temperatures as low as 380° F. at dwell times of about 0.80 to 1.0 second.

With the arrangement of the invention, the response time for the heating element is relatively fast and, the heat that can be applied to a belt will be adequate for any copying/duplicating speed. Also the fusing temperature is independent of the spectral absorption of the toner as in the case of radiant heaters. In addition, the warm up period to bring the belt surface to a fusing temperature is relatively short and no standby periods are required for maintaining the heating elements energized before or during production runs of an electrostatic machine. Since there is a minimum loss of heat by way of conduction and radiation, the amount of energy necessary to energize the heating elements may be substantially reduced. As there is no pressure applied to the image, there is no undesirable "offset" of toner particles. In other words, the amount of heat that the heating element **30** must supply is that which is given up to the toner particles and the support material plus the very small amount of heat that is lost in being transferred from its point of application to the support material.

While the invention has been described with reference to the structure disclosed herein it is not confined to the details set forth and this application is intended to cover such modifications or changes as may come within the purpose of improvements or the scope of the following claims.

What I claim is:

1. A heat fusing apparatus for fixing thermoplastic particles carried on a support material in image configuration, said apparatus including

a thermally insulating housing, means to feed support material bearing heat fusible particles in image configuration into the housing along a predetermined path,

an endless belt member disposed in said housing made of a highly thermally conductive material mounted for carrying and moving said support material along the path and out of the housing,

said belt member being formed therearound with an electrically insulating material in laminar form,

electrical discharge means arranged in the sheet path for electrically tacking said support material to said belt surface uniformly along the entire length thereof, and

electrical heating means for applying heat to the side of said belt member opposite that side upon which the image particles to be fused and said electrically insulating laminar form are positioned during movement of said member, the heat being of sufficient temperature for tackifying and fixing the image upon the support material.

2. The apparatus of claim 1 wherein said belt member comprises a layer of copper material of a thickness ranging from about 0.010 to about 0.030 inch.

3. The apparatus of claim 2 wherein the copper material is covered with an electrically insulating material of a thickness ranging from about 0.002 to about 0.004 inch.

4. The apparatus of claim 3 wherein said electrical discharge means is variable to enable optimum operation during varying ambient conditions.

5. The apparatus of claim 4 including means for removing the support material from said belt member without causing offset of the heat fusible particles.