

[54] **APPARATUS FOR FUSING
XEROGRAPHIC TONERS**

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[51] Int. Cl. **F26b 11/02**

[58] Field of Search. **34/23, 114, 122, 155, 162, 34/160**

[56] **References Cited**

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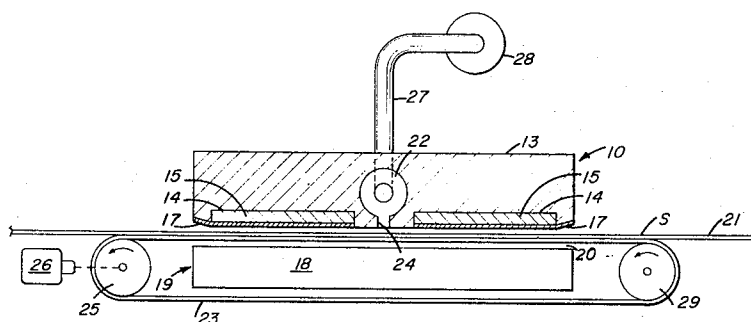
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[57] **ABSTRACT**

A device for thermofusing an electroscopic toner image to the surface of a support by moving the support through a passageway formed by a pair of platens, at least one of which is heated. The heated platen is connected to an air supply, the air being discharged under pressure through a slot in the heated platen and directed toward the image-bearing surface. The air is heated as it is discharged and attains a temperature sufficient to fuse the toner image. The air pressure is sufficient to hold the support in a spaced relation with respect to the heated platen. In another embodiment, a vacuum platen is arranged adjacent the other surface of the support, the applied vacuum or suction drawing the thin layer of air on the image-bearing surface through the support to increase the efficiency of the device by utilizing the heated air more effectively.

6 Claims, 3 Drawing Figures



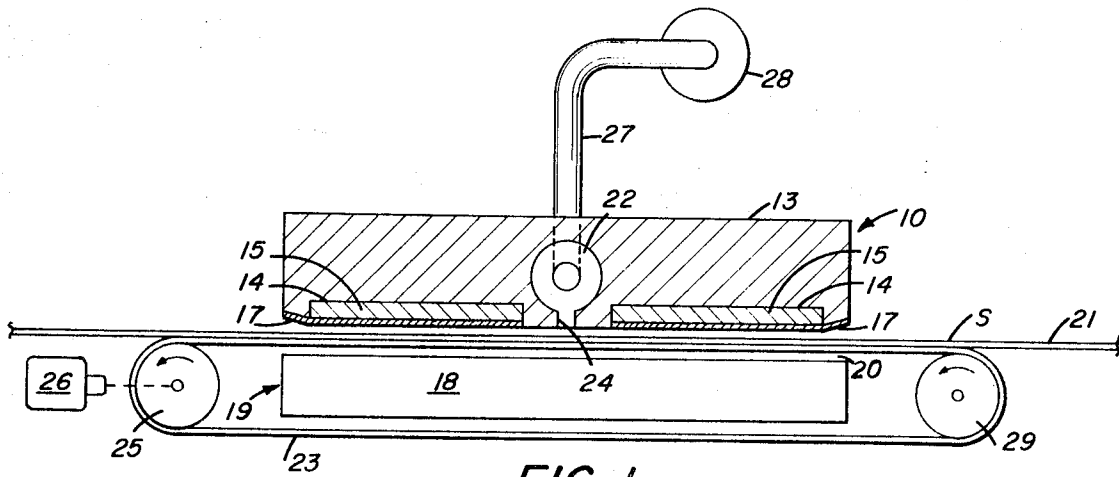


FIG. 1

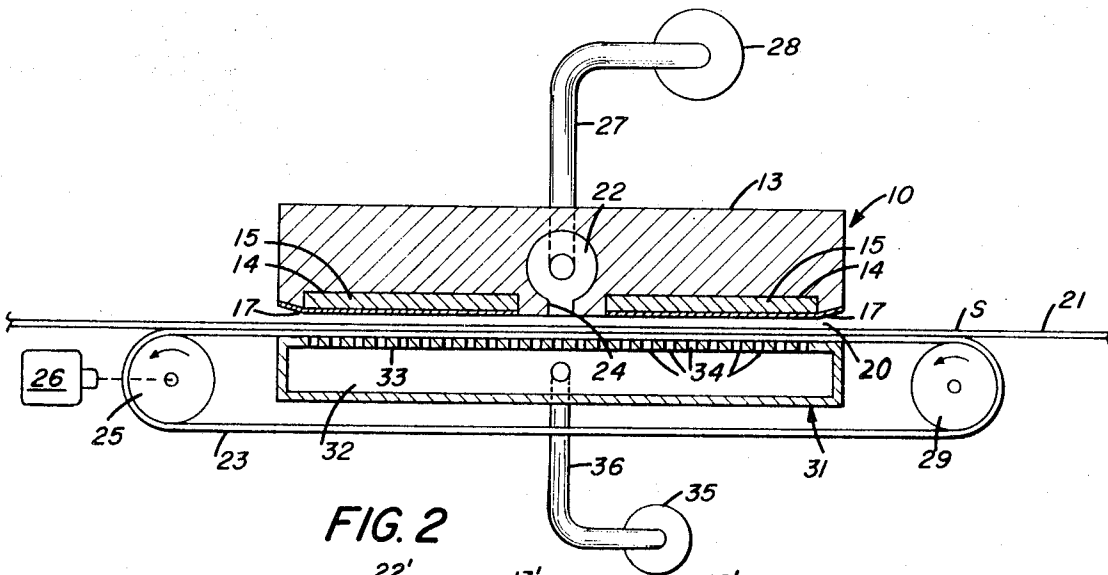


FIG. 2

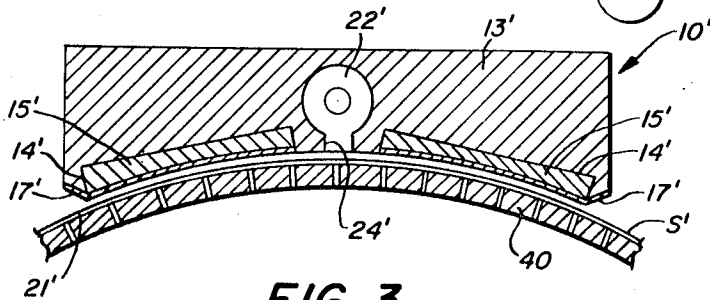


FIG. 3

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APPARATUS FOR FUSING XEROGRAPHIC TONERS

FIELD OF THE INVENTION

The present invention relates to a method and apparatus for fusing an electroscopic toner image to the surface of a support bearing said toner image and, more particularly, to a method and apparatus by which the image-bearing support is moved between a plurality of platens, one or more being heated, and maintained in spaced relation to the platen facing the image-bearing surface of the support by air directed thereagainst and which is heated by said platen and/or by decreasing the pressure in a perforated platen facing the other surface of the support.

DESCRIPTION OF THE PRIOR ART

The prior art teaches that a toner image can be formed on a support bearing a latent electrostatic image by toner particles of either the dry (powder) or wet (liquid carrier) type. Such an image can be fixed to its support or carrier by the process of heat fusing; that is, by the application of heat, in which case, the toner particles forming the image must be of a thermoresponsive material, such as a heat fusible resin which coalesces and adheres to the surface of the support when heated and then cooled to ambient temperature.

In order to fuse such a resinous toner image, it is necessary to heat the toner and the support, which can be paper, to which it is to be fused to a relatively high temperature. For given materials, a temperature range exists in which fusing of the toner image will occur. Below such a temperature range, the resinous toner will not properly adhere to the surface of the support. If the temperature is too high, there is a tendency for the support to discolor or scorch and, in some cases, the toner will explode or vaporize.

Various techniques have been developed for fusing, such as, oven fusing, hot air fusing, radiant fusing, hot and cold pressure roll fixing and fusing, and flash fusing. Any one of these techniques, when considered by itself for a specific fusing application in xerography, has certain limitations and/or deficiencies. In general, it has been difficult to achieve a completely satisfactory design for a toner fuser that will provide a short warm-up time, low electric current requirements, adequate heat insulation and uniform heat distribution. In addition, most fusers in use at the present time also possess the disadvantage that they cannot be readily adapted to randomly fusing images on supports of different thickness. Specifically, a hot air oven system tends to be slow to reach maximum heat output and requires a high power source of potential. Hot and cold pressure systems have presented problems with respect to offsetting of the toner particles, resolution degradation, and poor retention of the toner particles.

Flash fusing has been desirable for some time because it is not only very efficient at slow or intermittent reproduction speeds but also suitable for high speed copying. A major problem with flash fusing is that it is not selective. Since the term "selective" is used in various ways in connection with fusing processes, it should be clearly understood that it is herein referred to as the preferential fusing of dense image areas leaving low density or background areas unfused.

It is well known to fuse toner particles to a support by means of electrically energized coils which are exposed to the toner image, although arranged in a fusing chamber, thereby providing a heating effect that is a combination of heat radiation and convection. When the support passes through the fuser at a rapid rate, the heat necessary to effect good fusing requires extremely high coil temperatures, as well as extensive coil surface area. Thus, because of the rate of movement of the support, the coils are generally maintained at a temperature that exceeds the support combustion temperature in order that fusing can be achieved within the period of time each portion of the support is subjected to the heat. Consequently, if movement of the support should be interrupted or halted, for any reason, there exists the inherent problem of fire and/or charring of the support.

In the case of fusing with vapor or an atomized form of solvent, special provisions must be made to dispose of the solvent and to safeguard against the inherent fire hazard.

SUMMARY OF THE INVENTION

One object of the present invention is to provide a device for fusing a toner image to a support which permits the support to be moved at a relatively high speed and which insures fusing of the toner image to the support.

Another object of the invention is to provide a device for fusing a toner image to a support which can be available for use with a relatively short period of warm-up time and which is compatible with supports of different thicknesses.

And yet another object of the invention is to provide a device for fusing a toner image to a support in which a very efficient transfer of heat is obtained from a heated platen to the toner image and the upper surface of the support.

Another object of this invention is to provide a device for fusing a toner image to a support in which an even fusing of the toner image is obtained across the entire surface of the support.

Still another object of this invention is to provide a device for fusing a toner image to a support in which the image-bearing surface of the support is not in contact with any part of the fuser during the fusing operation.

Other objects and advantages of the invention will be readily apparent to those skilled in the art when the more detailed description set forth hereinbelow is read in conjunction with the attached drawing.

The aforementioned objects of the invention are attained by a device for thermofusing an electroscopic toner image to the surface of a support by moving the support between two spaced platens, at least one of which is heated. The image-bearing surface of the support faces the heated platen which is provided with a transverse chamber to which an air supply is connected by suitable ducts. The air under pressure passes through an elongated slit in said chamber, becomes heated by the platen, and maintains the image-bearing surface of the support in a spaced relation to the facing surface of the heated platen. The successive portions of the toner image on the support are fused to the support by the heat transferred to the air by the heated platen.

In one of the modifications of the aforementioned device, the platen adjacent to the other surface of the support is provided with a perforated plate with respect to which the support is moved. A suction is applied to this platen, thereby insuring that the image-bearing surface of the support is maintained in the required spaced relation with respect to the heated platen. In this modification, the suction also draws the thin layer of air on the image-bearing surface of the support through the support, thereby rendering the heated air more effective.

By means of such a hot air fuser satisfactorily fused toner images can be obtained with no smearing of the toner particles, as evidenced by wiping tests, even when the linear movement of the support between the platens is as high as about 25 in. per second. Although air under pressure is used, the air does not disturb the toner particles on the surface of the support or cause image smearing by displacement of toner particles.

DESCRIPTION OF THE DRAWING

Reference is now made to the accompanying drawing wherein like reference numerals designate like parts and wherein:

FIG. 1 is a simplified schematic representation of a fusing device embodying the invention and showing the principal elements thereof;

FIG. 2 is a simplified schematic representation of another embodiment of the invention similar to that disclosed in FIG. 1; and

FIG. 3 is a simplified schematic representation of another embodiment of the invention in which the platens are provided with curved surfaces.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

With reference to FIG. 1, a heated platen generally designated by the numeral 10, comprises an insulating block 13 having rectangular recesses 14 in each of which a heater 15 is arranged. Each of heaters 15 is retained in its respective recess by a metal plate or strip 17 which is in thermal contact therewith. A block 18 of insulating material forms a second platen generally designated by the numeral 19 which is arranged in spaced relation to platen 10 and aligned therewith. Heater 15 can be a wire coil type or a solid type, such as a Calrod unit. In either case, the heater 15 is suitably connected to a source of potential (not shown). Platens 10 and 19 are sufficiently wide to accommodate the maximum width of support 21 that will be used in the fuser. The spaced relation of heated platen 10 relative to platen 19 is such that a passageway 20 is formed therebetween through which the support 21 can be moved at a necessary rate to insure good fusing.

Support 21 can be moved in a preselected or defined path which includes in part the passageway 20 between heated platen 10 and platen 19. In this portion of the path, support 21 is moved by a porous mesh belt 23 which encircles pulleys 25 and 29, one of which serves to drive belt 23 from a suitable drive means such as a motor 26 which is shown diagrammatically in FIG. 1 as being connected to pulley 25. Support 21 is carried by the belt 23 with the surface S, that is, the image-bearing surface, being orientated toward heated platen 10. Support 21 is meant to include those materials used in the field of electrophotography which are capable of retaining a toner image on a surface thereof by means of an electrostatic charge corresponding to the image. Such materials can include paper, dielectric materials, materials coated with a photoconductive material, etc. Also, such materials can be in the form of discrete sheets or a continuous web. In any case, the fusing operation is usually the last step in a series of well known steps for attaining a usable toner image.

A flow of air under pressure is introduced into a chamber 22 in platen 10 and directed to surface S of carrier 21 by a slot 24 that extends transversely of platen 10 and support 21 with respect to its direction of movement. Chamber 22 is connected by line 27 to a blower 28. The air introduced into chamber 22 by blower 28 through line 27 can only exit through slot 24 which is sufficiently long so as to extend across the width of the support 21. Slot 24 is closed at its ends so that the air must exit through slot 24 and be directed at surface S. The air pressure is sufficient to maintain surface S in spaced relation to plates 17 on heated platen 19 without disturbing the toner image. As discussed hereinafter, an air space between the facing surfaces of plates 17 and surface S of support 21 is of such size that substantially no air turbulence exists in this space. Hence, the toner image is not molested or disarranged in any way.

Since the toner image on surface S of support 21 must be heated to a temperature to fuse the toner particles to the support without overheating the support itself, the support is introduced into the passageway 20 between platens 10 and 19 so that surface S faces platen 10. In the form that support 21 with its toner image is introduced, the toner particles are adhered to surface S only by the electrical field existing between the charged particles and the charge in the image areas. As a result, the image-bearing surface is preferably not in contact with any other surface prior to fusing of the image.

The thermal conductivity of the air space between the facing surfaces of plates 17 and support 21 increases as the thickness of the air space decreases. The thermal conductivity will also increase as the amount of shear in this space decreases, shear being defined (approximately) as the average air velocity in the space divided by the thickness (distance as measured from facing surface of plate 17 to surface S or to

facing surface of belt 23) of the space. These two effects combine to produce a very noticeable increase in thermal conductivity with a decreasing thickness in air space. In addition, less air is required with the smaller spacings to maintain the shear. As a result, with a 0.005 inch spacing between the facing surfaces of plates 17 and support 21, it has been found that more heat is transferred to the support 21 than is transferred to the exhausting air. Such very high thermal conductivity permits operation without risk of charring support 21 because the heat presented by plates 17 is used so efficiently that an excessive temperature does not have to be generated by heaters 15, thereby negating any charring risk. The dimension of 0.005 inch spacing can be increased to about 0.020 inch before any great difference in thermal conductivity can be noted. Beyond this point, the heat transfer falls off considerably. As a result, support 21 can be moved through passageway 20 at a relatively high rate of speed with completely satisfactory fusing of the toner image to support 21.

Metal plates or strips 17 can be made of a metal having a high thermal conductivity and low heat capacity. This allows the temperature of plates 17 to rapidly reach a required temperature when heaters 15 are energized.

FIG. 2 shows an embodiment of the invention in which a vacuum platen 31 comprising a chamber 32 covered with a plate 33 having a configuration of holes 34, as is well known in the art, is arranged in spaced relation to platen 10. Chamber 32 is connected to a vacuum pump 35 by a duct 36. Support 21 is positioned on and moved by belt 23 with surface S, the toner image-bearing surface facing heated platen 10, as described above with respect to FIG. 1. Also, the spacing between platens 10 and 31 is such as to provide passageway 20 for belt 23 and support 21 with the distance between the facing surfaces of plates 17 and support 21 being generally the same as set forth above. Support 21 is maintained in position on belt 23 by the combined action of the air under pressure being discharged through slot 24 in heated platen 10 and the vacuum being applied through holes 34 in platen 31.

Another advantage obtained by using vacuum platen 31 is that when using normal paper for the making of copies, there is a thin layer of air which is maintained at surface S of support 21 which decreases the capability of the unit to properly fuse. The slight reduced pressure applied to the back of support 21 by vacuum platen 31 draws this layer of air through the paper, thus increasing the thermal conductivity as well as the efficiency of the fusing device.

The device shown in FIG. 2 produces satisfactory fusing with a vacuum in platen 31 in the range between 0.0 and 1.2 inches of mercury. The gap between plates 17 and the surface S of the support 21 can be in the range between approximately 0.002 inches to about 0.022 inches for a satisfactory operation. The fusing temperature, or hot air temperature must be maintained below 400° C to insure that the support does not char or otherwise deteriorate. Satisfactory fusing has been obtained with the support 21 being moved at the rate of approximately 10 to 25 inches per second, the rate being dependent on the type of support and its thickness.

It should be understood that the specific embodiments of the present invention described hereinabove have been described to facilitate a disclosure of the invention rather than to limit the particular form which the invention might assume. For example, support 21 can be moved through passageway 20 between platens 10 and 21 by any suitable means well known in the art for moving a sheet or a web at a generally constant speed. In addition, a perforated metal drum 40 can be used in place of vacuum platen 31 and/or porous mesh belt 23 as shown in FIG. 3, the parts corresponding to those in FIGS. 1 and 2 being indicated by the same numeral with a prime symbol. Also, after the air being discharged from slot 24 in heated platen 10 passes over surface S of support 21, it can be recycled to increase the efficiency of the fusing device. Furthermore, vacuum platen 31 can also be heated to increase the efficiency of the device.

The invention has been described in detail with particular reference to preferred embodiments thereof, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention.

I claim:

1. A device for fusing an electroscopic toner image to the surface of a support bearing said toner image, comprising:
two platens having spaced, opposed surfaces, at least one of said platens having a central chamber and being heated and provided with an elongated slot interconnecting said chamber to the heated surface thereof facing the image-bearing surface;
means for moving said support between said opposed surfaces in a direction transverse of said slot with said image-bearing surface facing the heated surface of said one platen;
means operatively associated with said heated platen for directing a flow of air under pressure into said chamber for discharge through said slot into the space between said opposed surfaces and at said image-bearing surface to maintain the latter in spaced relation to the heated surface of said one platen;
said flow of air between said opposed surfaces transferring sufficient heat from the heated surface of said one platen to said image-bearing surface to fuse said toner image to

said support.

2. The fusing device in accordance with claim 1 wherein said heated platen is provided with one or more heating elements on each side of said chamber and adjacent the facing surface of said heated platen.

3. The fusing device in accordance with claim 1 wherein the other of said platens comprises a hollow, rotatable drum having a perforated peripheral surface for engaging the other surface of said support at least along a line generally opposite and aligned with said elongated slot.

4. The fusing device in accordance with claim 3 including vacuum means connected to said drum for maintaining the other surface of said support against the peripheral surface of said drum.

5. The fusing device in accordance with claim 1 wherein the space between the image-bearing surface of said support and the facing surface of said heated platen is from 0.005 to about 0.020 inches.

6. The fusing device in accordance with claim 4 wherein said vacuum means draws the thin layer of air on said image-bearing surface through said support, thereby rendering more effective the heat transfer from said heated platen to said image-bearing surface by said flow of air.

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