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XEROGRAPHIC FUSING APPARATUS

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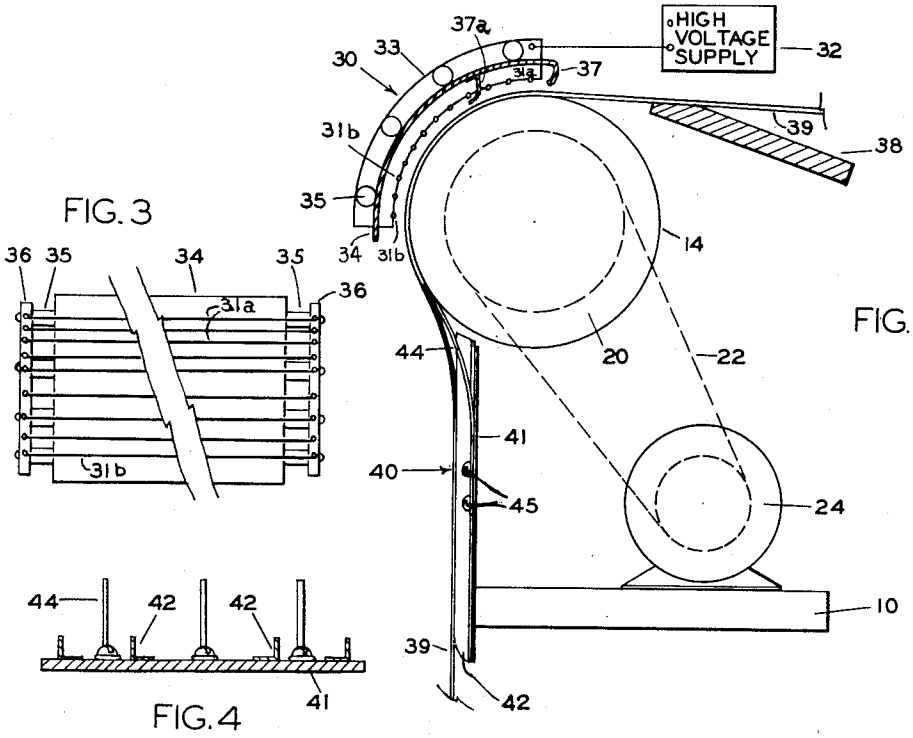

FIG. 1

FIG. 3

FIG. 4

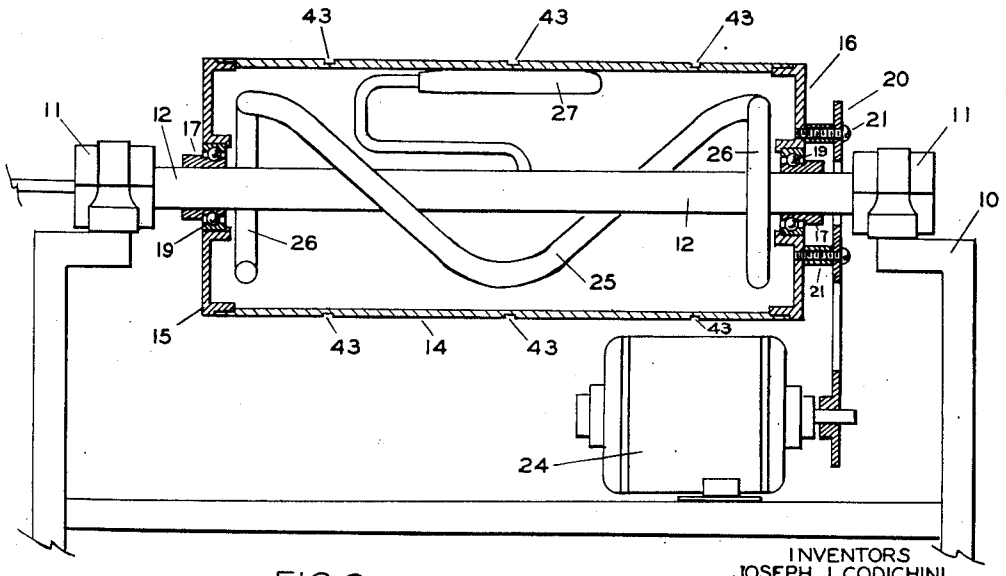

FIG. 2

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XEROGRAPHIC FUSING APPARATUS

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2 Claims. (Cl. 95—1.9)

This invention relates in general to xerography and to fixing apparatus therefor.

In the art of xerography it is usual to prepare a powder image, generally of a pigmented thermoplastic resin, which is formed on a sheet or web. In order to make this powder image permanent, the usual process contemplates a fixing step wherein the powder is fused by means of heat, solvent or the like. It is essential, however, in the fixing or fusing step that the powdered image be made permanent with substantially no dislocation or distortion of its position on the web so that the permanent image will be a true and exact reproduction of the powder image.

It is, therefore, an object of this invention to provide fixing apparatus for liquifying a powder pattern on a sheet or web in substantially its exact distribution over the surface thereof.

It is another object of the invention to provide xerographic fixing apparatus for fusing a xerographic powder image on a paper sheet without detectable distortion of the image.

It is a further object of the invention to provide xerographic fixing apparatus for fusing large surface xerographic powder images in a compact system and to accomplish the fixing according to means and methods free from danger of charring or other damage to the to the base material.

It is an additional object of the invention to provide xerographic fixing apparatus for liquifying a xerographic powder image on a sheet or web, wherein the sheet or web is carried through a fixing zone while electrically secured to a moving member such as, for example, a rotating cylinder.

Additional objectives of the invention will, in part, be obvious and will, in part, become apparent from the following specifications and drawings in which:

Figure 1 is a side elevation in section of the xerographic fixing apparatus according to one embodiment of the invention.

Figure 2 is a front elevation partly in section of a portion of the apparatus of Figure 1.

Figure 3 is an internal plan view of an electrode assembly according to the apparatus of Figure 1.

Figure 4 is an end cross section of a collecting chute according to the apparatus of Figure 1.

In Figures 1 and 2 is shown a supporting frame having pillow blocks 11 thereon to receive and mount a stationary axle 12 across the frame. Mounted thereon is a moving member such as a drum or cylinder 14 having end plates 15 and 16 at either end thereof, the end plates being rotatably carried by sleeves 17 mounted on the axle. Optionally, bearing members such as ball bearings 19 operate between sleeves 17 and the end plates for easy rotation of the drum. At one end of the drum a sprocket 20 is secured to end plate 16 by screws 21, the sprocket being driven by chain 22 which is in turn driven by a drive means such as, for example, an electric motor 24 mounted on the frame. It will be understood, of course, that in most operations it is desirable that the electric motor drive the drum through intermediate means (not shown) whereby suitable speed adjustment may be achieved, thus it is generally desirable to operate the device through reduction gears or the like which are maintained at a desired gear ratio to achieve a relatively slowly rotating or moving support member.

Within the drum 14 are heating members 25 optionally in the form of electric heating units having a full loop 26 of the heating unit adjacent each end of the drum whereby additional heat is supplied within the drum at the areas containing the greatest mass to be heated. A thermostat control 27 is mounted within the drum and preferably substantially against the inner surface thereof. This thermostat control operates to maintain the drum temperature at a predetermined heat range and preferably at a constant temperature within about plus or minus 5°. In the arrangement shown in Figure 2, the thermostat control unit 27 is positioned between the drum cylinder and the heating units whereby its response to changing temperature is somewhat in advance of the drum surface thus assisting in maintaining fine temperature control.

Externally mounted around a segment of the drum is an electrostatic charging station such as a corona discharge electrode 30, this electrode comprising a plurality of fine conductive strands or wires 31 which are conductively connected to a high voltage source 32. This high voltage source may optionally be a relatively uniform D. C. source or may, if desired, be pulsating D. C. or A. C. so biased as to present a potential predominately of one polarity in any of which cases the electrode acts as a corona discharge member. The mounting means for this electrode which comprises a supporting shield or shell 33 mounted adjacent to the drum and preferably following around and conforming with the curve of the drum. A conductive ground plate 34 is mounted on the inner side of shield 33 by insulating supports 35, and the corona wires 31 are mounted thereunder on insulating terminal mounts 36. For convenience and flexibility of operation the terminal mounts are provided with a multiplicity of mounting points, optionally evenly and regularly spaced, the corona wires being threaded there through a desired pattern as described herinafter. As mounted thereon, the corona wires are positioned closely adjacent to the periphery of the drum with the conductive ground plate directly behind or outside the wires. Optionally one or more shields or guides may be mounted adjacent to the corona electrode to insure the maintenance of adequate spacing between the sheet or web material and the corona electrode. For example, a shield or guide 37 is mounted adjacent to the first or front portion of the corona discharge electrode and serves to guide the entering sheet or web toward and into contact with the drum member 14. In addition, one or more guides 37A may be positioned along the path of travel to prevent the sheet or web from pulling away from the drum and contacting the electrode wires.

A paper feed or slide 38 is mounted adjacent to the drum and positioned to feed a paper sheet or web 39 against the drum, preferably tangentially thereagainst and at a location to meet the surface of the drum at a point directly below electrode 30. Beyond the charging station, thus being at a point where the sheet or web has been secured to the drum and heated for image fusion, is a paper stripping guide chute 40 positioned and adapted to strip a web or sheet material from drum 14 and guide it to a collecting or receiving point. This chute 40, as shown also in Figure 4, comprises a bed plate 41 having a series of small surface area raised tracks 42 mounted thereon and adapted to support and guide the sheet or web 39 and to make contact with the sheet over an insignificant proportion of its area, whereby electrostatic action with the still charged sheet or web is held to a minimum. Stripper feelers such as wires 44 are secured to plate 41 by rivets 45 or the like and are curved therefrom to slide along drum 14 in grooves 43 where they act to peel or strip the sheet from the drum and guide it to chute 40.

In use and operation the heating units 25 and driving means 24 are energized, for example, by connection to a conventional 110 volt A. C. power source and a warm up period is allowed for the drum to come ot the desired operating temperature as controlled by the thermostat. Electrode 30 is then energized by connection to a high voltage power source such as a high voltage direct current source to generate a corona discharge from the electrode toward the surface of the drum. A sheet

or web 39 carrying a thermoplastic image to be fused is then placed on paper feed 38 with the image surface facing upwardly, and is moved into contact with the drum beneath electrode 30. At this point the corona discharge serves to spray a stream of ions onto the sheet, the ions thereby securing the sheet tightly against electrically grounded drum. In this manner the sheet is carried by the drum past the charging station or zone where a continuous ion spray is deposited on the sheet. Since the sheet is held tightly against the drum during its travel through the charging station, the heat from the drum penetrates the paper by thermal conduction, radiation and/or convection, fusing thereon the thermoplastic image. After emerging from the charging station, the sheet is carried by the drum, still effectively being in the fusing zone until it meets stripper feelers 41 which peel it from the drum and guide it to chute 40, thence to a suitable collecting or receiving zone. While on the chute, the sheet or web is virtually suspended in air, since it rides on tracks 44 which have relatively small contact area as compared with the sheet area, thus permitting rapid cooling of the sheet and simultaneously affording free motion of the sheet over the tracks with little friction drag resulting from electrostatic attraction between the sheet or web and the collecting chute.

It will be recognized that a sheet or web being fed through the fusing zone becomes relatively suddenly heated with the result that any residual moisture contained therein may be expelled from the web. In the case of a paper sheet or web this appears to result in conductivity or at least in dissipation of the charge which has been deposited thereon by the initial section of the corona discharge electrode. As described hereinafter, the detrimental effects of the characteristic are overcome by a proper selection of the corona discharge structure and elements. It should be noted here, however, that these characteristics and properties are utilized to advantage in assisting removal of the sheet or web from the drum to which it has been electrostatically secured. In this manner stripper feelers 41 are advantageously positioned at a point along the surface of the drum where the sheet or web is becoming ready for removal therefrom, whereby the step of such removal is facilitated.

The apparatus of the invention is particularly intended for the fusing of xerographic powder images on a sheet material that may be, and usually is, paper. According to the present xerographic process, the powder image consists of pigmented resin particles fusing at a temperature only slightly short of the charring point of paper, thus necessitating operations within a narrow time-temperature range. In addition, the fusing operations are carried out at a temperature at which the humidity effects are translated into altered electrical properties.

In spite of the critical conditions which must be met in the process of fusing such a powder image to a web material which is easily charred, the operation of the device and apparatus disclosed herein can be made relatively free from critical controls. Thus the equal temperature control achieved by the thermostatic control member 27 can be maintained at a temperature such that rapid fusing of the powder image is achieved while the degree of charring of the best material is kept at a negligible level.

The balance of time-temperature conditions can be achieved with the following structure and conditions, although it is obvious that similar results can be had with increased temperatures coupled with decreased time or by decreased temperatures and increased time. In one specific structure, the drum is a cylinder with a radius of 4 inches rotated at 2 R. P. M. or about 4 feet per minute. The distance between the point where the paper contacts the drum and the point where it is stripped therefrom is about 8 inches, so that the paper is secured tightly against the drum for a time of 10 seconds. The thermostatic control is set so that the drum is maintained at an even temperature of about 375° F. With this or an equivalent time-temperature combination, the resin image is thoroughly fused onto the paper and the paper base is not detectably charred or discolored.

It has been found that this operation at raised temperature causes dissipation of the charge and extreme difficulty is encountered in holding the paper on the heated drum by electrostatic forces. Therefore, a specific and preferred embodiment of the invention contemplates the following arrangement of parts, with reference to Figure 1. The corona discharge electrode 31 can be considered as being divided into two sections, a preliminary charging section formed by front wires 31*a* and the charge holding section formed by rear wires 31*b*. In ideal operation, a paper or other sheet or web enters the charging zone and is charged by means of the first few wires to an electrostatic charge potential which causes it to cling to the drum until stripped therefrom. In actual operation, however, wherein a paper sheet is passed through the apparatus and becomes slightly electrically conductive, additional charging is carried out in the charge holding section by means of one or more wires 31*b*, which wires are spaced somewhat further apart than are charging wires 31*a* and preferably no more than half as many wires per unit distance as compared with wires 31*a*. The preferred structure is, therefore, one in which about three or four charging wires 31*a* are mounted in adjacent mounting spaces and charge holding wires 31*b* are in alternate or more widely spaced mountings on the rear section. It is, in fact, within the scope of the invention to employ this heat-humidity charge dissipation to remove the sheet material from the drum after it passes through the fusing station, or preferably to utilize this form of charge dissipation to cooperate with the mechanical stripping means. Thus, when operating under constant conditions, it is feasible to position the last corona wire 31*b* at such a point that the sheet is rapidly losing its charge as it approaches strippers 44 and, if desired, is actually free from the drum at this point.

It will be recognized that various modifications may be made in the mechanism and equipment within the scope of the invention so long as the basic and fundamental functional purposes are served. The process steps served by the apparatus contemplates that an image bearing sheet or web will be caused to adhere by electrostatic attraction to a moving member which may, for example, be a rotating drum, and is transported thereon through a fusing stage wherein the image material is liquefied and fused onto or into the sheet or web. The term "fusing" as used in the specification and claims to be interpreted broadly to include heat fusing or melting as caused by the apparatus shown in Figures 1 to 4 or as caused by external heating elements, radiation heaters or the like, and to include also solvent fusing or liquefication as described in Carlson application S. N. 157,883, filed April 25, 1950, as well as other means and methods of liquefying the image wherein the image, originally in the form of a powder, is caused to fuse on the sheet or web.

What is claimed is:

1. Xerographic fusing apparatus for fusing a xerographic powder image fusible at a temperature below the charring temperature of paper on a paper sheet comprising a supporting frame and support members mounted thereon, a rotatable drum on the support members and means for rotating the drum, a plurality of corona discharge wires arranged in stationary position along one segment around the drum and spaced from the surface of the drum, means to feed a paper sheet between the corona discharge wires and the drum the paper being positioned to receive a deposit of ion discharge on its outer surface while in contact with the drum thereby electrostatically securing the paper against the drum and in close contact therewith, and heating members contained within the drum to heat the drum surface, whereby the hot rotating drum fills the dual role of drive member for the sheet material and of fusing zone member and heats the fusible powder to its fusing point by conduction through the sheet material, the corona wires being arranged in two groups, the first group being closely spaced in position adjacent to the point of first contact between the paper sheet and the drum, and the second group being spaced substantially more widely apart.

2. Xerographic fusing apparatus for fusing a xerographic powder image fusible at a temperature below the charring temperature of paper on a paper sheet comprising a supporting frame and support members mounted thereon, a rotatable drum on the support members and means for rotating the drum, a plurality of corona discharge wires arranged in stationary position along one segment around the drum and spaced from the surface of the drum, the corona wires being arranged in two groups, the first group being closely spaced in position adjacent to the point of first contact between the paper sheet and

the drum, and the second group being spaced substantially more widely apart, means to feed a paper sheet between the corona discharge wires and the drum, heating members contained within the drum to heat the drum surface, whereby the hot rotating drum fills the dual role of drive member for the sheet material and of fusing zone member, a collecting chute positioned to receive paper leaving the drum and to guide it to a position for collecting from the apparatus, and stripping guides contacting the rotating drum at a point subsequent to the last corona discharge wire and prior to the collecting chute adapted to strip sheet material from the rotating drum and channel it to the collecting chute, the dual grouping of corona discharge wires being adapted to deposit a high concentration of ion discharge on the outer surface of the paper while in contact with the drum.

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