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G. A. ASER ET AL

3,435,500

PRESSURE ROLL AND METHOD OF MANUFACTURING

Filed Oct. 14, 1964

Sheet 1 of 2

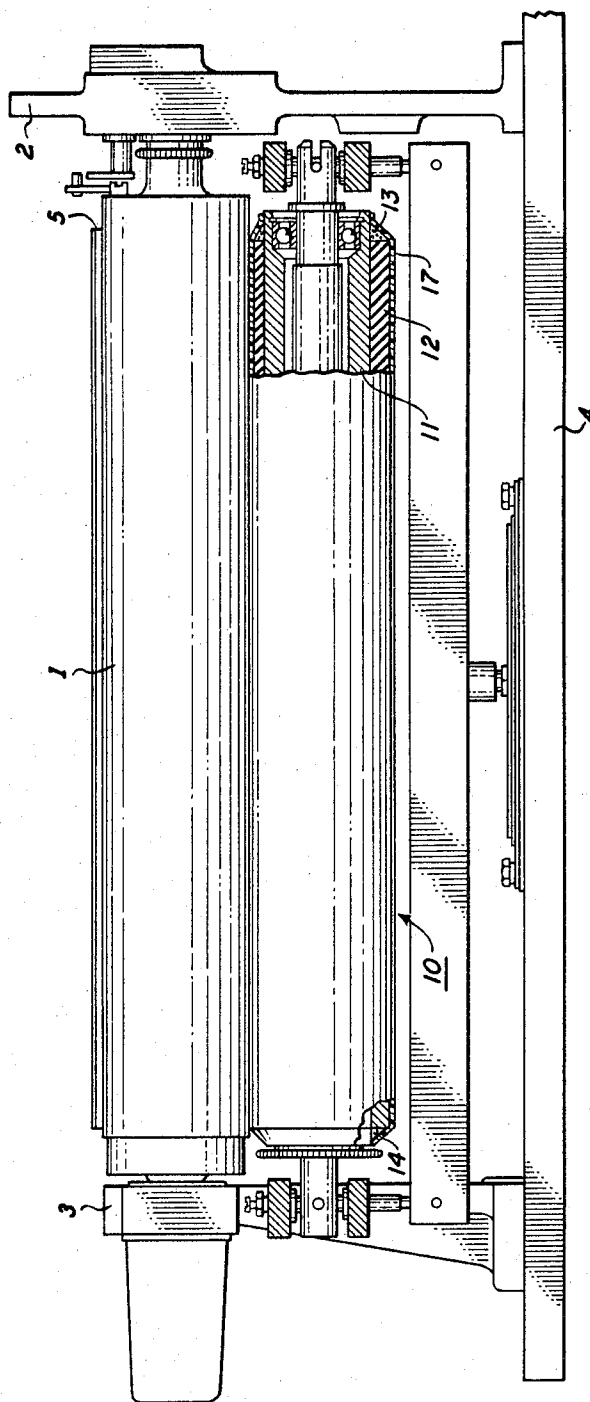


FIG. 1

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Sheet 2 of 2

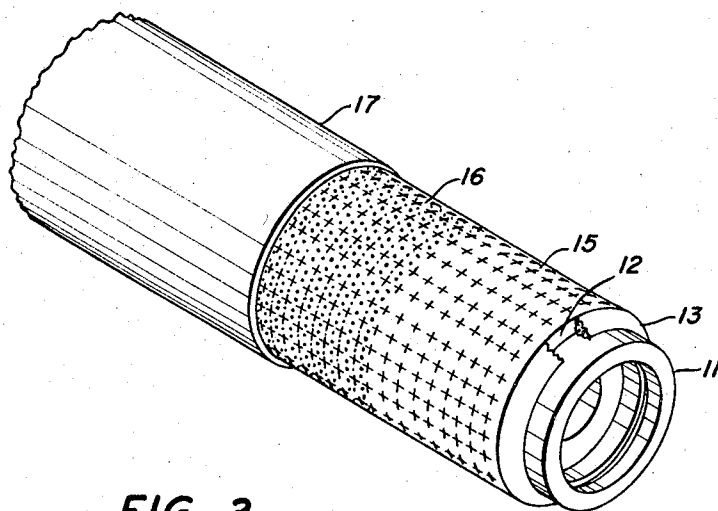


FIG. 3

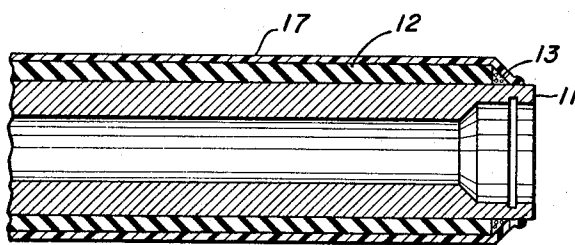


FIG. 2

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PRESSURE ROLL AND METHOD OF MANUFACTURING

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13 Claims

ABSTRACT OF THE DISCLOSURE

A pressure roller for use in the heat pressure fixing of thermoplastic resin material onto the support material. The roller is constructed of a cylindrical metallic core covered with a cylinder of silicone rubber. Ring seals of a fluoro-silicone rubber are positioned on the core in contact with the ends of the cylinder. The ring seals and cylinder are covered with a sleeve of Teflon FEP.

This invention relates to an improved deformable roller and the process by which it is manufactured.

More specifically, the invention relates to an improved roller for use in a xerographic fusing device of the type disclosed in Aser et al. Patent 3,291,466, or a similar device. Although the invention is considered to have general application, it is particularly useful in the field of xerography and has an important application in the heated pressure fusing device used in fusing resinous powder images produced by electrophotography or xerography on to sheets of paper and the like to which the powder images have been transferred after they have been formed by deposition of powder on an electrostatic latent image, as disclosed in said depending application.

One of the methods in common use for developing the electrostatic latent image is described in Walkup Patent 2,618,551, and is known as cascade development, and is in general use for line copy development. In this technique, the powder or toner is mixed with a granular "carrier" material, and this two-component "developer" is poured or cascaded over the plate surface. The function of the carrier material is to improve the flow characteristics of the powder and to produce, on the powder, by triboelectrification, the proper electrical charge so that the powder will be attracted to the image. More exactly, the function of the carrier material is to provide the mechanical control to the powder, or to carry the powder to an image surface and, simultaneously, to provide homogeneity of charge polarity.

In Carlson Patent 2,297,691, it is noted that a variety of types of finely divided electroscope powders may be employed for developing electrostatic latent images. However, as the science of xerography has progressed, 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 the purpose. A number of such developing materials are manufactured and marketed commercially and are specifically compounded for producing dense images of high resolution and to have characteristics to permit convenient storage and handling. Such developing materials are compounded to permit them to be fixed to the surface of a transfer material either by heat fixing or vapor fixing techniques, in accordance with the particular application in which they are employed, that is, the individual particles of resin (toner) soften and coalesce when heated or plasticized by solvent, so that they become sticky or tackified and readily adhere to the surface of the support material.

The term "tackified" and the several variant forms

thereof used throughout this specification are employed to define the condition of the powder particles of the xerographic powder image when heated or plasticized by a solvent in a manner such that the individual particles soften and coalesce and in which state they become stocky 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.

One of the important applications of the process of xerography comprises its use in automatic copying machines for general office use wherein the powder images formed on a xerographic plate are transferred to paper and then fixed thereon by heat fusing. In order to fuse resinous powder images formed of the powdered resins now commonly used, it is necessary to heat the powder and the paper to which it is to be fused to a relatively high temperature, such as approximately 325° F. It is undesirable, however, to raise the temperature of the paper substantially higher than 375° F. for long periods of time because of the tendency of paper to discolor at such elevated temperatures.

It has long been recognized that one of the fastest and most positive 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 flat plate.

But, 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, so that as the next sheet is placed on the heated plate, the tackified image partially removed from the first sheet will partly transfer to the next sheet and, at the same time, part of the tackified image from said next sheet would adhere to the heated plate. This process is commonly referred to in the printing art as "set off" or "offset," the latter term being preferred.

The offset of toner onto the heated contacting surface has heretofore led to the rejection of contact fusers in favor of their heat fixing devices, primarily coiled radiant element heaters with reflectors. These radiant element heaters with reflectors have the disadvantage of dissipating a large quantity of heat into the machine enclosure in which they are used, heat transfer by radiation to the powder image is inefficient, and they present a safety hazard because of the exposed radiant element.

Aser et al. Patent 3,291,466, provides a direct contact fusing device which will rapidly fuse toner images without causing the toner particles to smear while in a tackified state or to offset onto the device. A roller manufactured in accordance with the disclosure of this application may be used, for example, in such a fuser and, therefore, for convenience of illustration the invention is described with reference to its use in this type heat fuser. However, it is to be understood that it may be employed with equal facility in other fields.

A roller used in such a fuser must have suitable resiliency to deform when held in pressure contact with another roller, thereby providing an increased arc of contact between the support material and the heated roll of the fuser to assure proper fusing. It has also been found that such a roller must be resistant to offset preventing substances, for example, silicone fluid, used in such a fuser to prevent toner from adhering to the rollers. In prior art rollers, it has been found that offset preventing substances cause the bottom roller of the fuser to swell and deteriorate.

The principal object of this invention is to provide a method for manufacturing pressure rollers suitable for use in a heated contact fusing device.

It is another object of this invention to provide, for use in a heated contact fusing device, a roller having suitable resiliency, heat resistance, resistance to silicone fluid, ozone and toner resistance, and having suitable triboelectric properties.

These and other objects of the invention are attained by means of a roller including a steel core to which silicone rubber is bonded. An outer sleeve of an adhesive material such as Teflon FEP, a Du Pont Corporation product composed of fluorinated ethylene/propylene, is secured to the rubber mandrel by an adhesive substance and the heat shrinking of this sleeve onto the rubber, as permitted by the heat shrinking property of the Teflon FEP.

Abhesive is a relatively new term that was coined by Dow Corning Corporation primarily in connection with their silicones to define a surface that has "release" characteristics such that it is highly repellent to sticky or tacky substances. The word is adopted in this sense herein and is solely used throughout the disclosure.

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

FIG. 1 illustrates a preferred embodiment of a roller manufactured in accordance with this disclosure being used in a heated pressure fusing device;

FIG. 2 illustrates a roller being constructed in accordance with the disclosure;

FIG. 3 is a section view of an end of a roller constructed in accordance with this invention to more clearly illustrate the parts.

Referring now to FIG. 1 there is shown a heat fuser device including an upper roll 1 suitably journaled in vertical frame plates 2 and 3 secured in spaced relation to a base 4. The upper roll is provided internally with a heating element, not shown.

To effect fusing of a toner image on a support material the support material is brought image side up into pressure contact with the upper roll 1 by advancing the support material between the upper roll 1 and a bottom pressure roll; generally referred to by reference character 10, constructed in accordance with the invention.

To prevent toner offset onto the upper roll 1, its peripheral surface is covered with a coating of an abhesive material, such as Teflon. In addition, a thin film of an abhesive liquid, such as a silicone fluid, is applied to the surface of the upper roll by wick 5 continually supplied with additional silicone fluid by a suitable applicator device, not shown, since it forms no part of the subject invention.

However, for further details of the heat fuser shown in FIG. 1, reference is made to the above referenced Aser et al. Patent 3,291,466.

Referring now to the subject matter of the invention, the pressure roll 10 includes a core 11 enclosed by a sleeve 12 of deformable material intermediate its ends. Ring seals 13 and 14 encircle the core at opposite ends of sleeve 12, the sleeve and ring seals, in turn, being enclosed by a sleeve of abhesive material 17.

The process for manufacturing the pressure roller 10 includes molding and bonding a resiliently deformable material, such as rubber, to a nondeformable core. The mandrel thus formed is then finished, if necessary, to a suitable diameter, leaving the outer peripheral surface in a roughened condition, or the surface is roughened with an abrasive material. The inner surface of the sleeve of abhesive material to be bonded to the rubber is suitably prepared as necessary, for example, by etching, to create a roughened carbonaceous surface assuring a proper bonding with the rubber mandrel. To assure proper sealing of the ends of the rubber mandrel, O-ring seals are bonded to the non-deformable core adjacent the rubber.

The abhesive sleeve is secured to the rubber mandrel by coating the mandrel and seals with an adhesive and inserting the mandrel into the sleeve. If the Teflon FEP is used as the abhesive material, the assemblage is heated, shrinking the sleeve upon the mandrel, further assuring a proper bond. To ensure proper outer surface uniformity of the sleeve after heat shrinking, this assembly is stabilized by heating at a predetermined temperature and time.

A specific method well adapted for making rollers in accordance with the invention will now be described.

The roller, subject of this invention, is manufactured by molding and bonding silicone rubber 12, such as silicone rubber compound L2532-3 manufactured by Raybestos-Manhattan, Incorporated, North Charleston, S.C., to a steel core 11. The molded roll is then cured for fifteen minutes at three hundred twenty degrees Fahrenheit and subsequently post cured for about four hours at four hundred degrees Fahrenheit. After cooling, the rubber mandrel is ground to a specific diameter, for example, 2.327 inches, the surface finish of the roll remaining in an as ground condition 15.

The sleeve of abhesive material 17, for example, Teflon FEP, is cut to proper length, depending on the length of the roll, and etched inside with a treating solution to render the surface receptive to adhesive. The etching solution is an activated form of sodium in an aromatic hydrocarbon solution such that when brought into contact with the fluorocarbon polymer, the solution extracts fluorine atoms from the surface exposing a carbonaceous surface to which adhesives will adhere. A solution of this type, for example, is Chemgrip a product of Chemplast, Incorporated, of East Newark, N.J. The inner surface of the Teflon FEP sleeve is cleaned thoroughly to remove grease and other foreign matter. A standard industrial solvent such as acetone or naphtha is used. However, it is important not to use chlorinated solvents. The inner surface is then treated by dipping, spotting, brushing, or pouring the etchant over the surface. The etchant should be in contact with the inner surface until the surface is a uniform dark brown to black color. After the etch is complete, usually fifteen to sixty seconds, the inside surface of the sleeve is primed with a proper primer, such as Dow Corning A4094 primer, in preparation for the adhesive bond. Right and left hand ring seals 13 and 14, respectively, are bonded on the steel core 11 to facilitate sealing of the silicone rubber, bonded to said core, from the offset preventing material. The ring seals are composed of a deformable material such as Dow Corning Silastic LS-63 fluoro silicone rubber purchased from the Dow Corning Corporation, Midland, Mich. The outside surface of the rings 13 and 14, and the rubber mandrel 12 are coated with a suitable silicone rubber 11 adhesive to secure the sleeve 17 to the mandrel without distorting the outer peripheral surface of said sleeve. A proper silicone rubber adhesive has been found to be a .010 inch thick coating of RTV-108 a silicone rubber adhesive/sealant, manufactured by General Electric Silicone Products Department, Watertown, N.Y.

After coating the rubber mandrel 12, and rings 13 and 14, with adhesive material said members are inserted into the sleeve 17. Using a heat gun of any well-known commercial type or other heating device, the sleeve is heat shrunk over the rubber mandrel and rings forming a sealed enclosure over the rubber core. A minimum temperature of two hundred twenty degrees Fahrenheit is required for shrinking. Since the melting temperature is greater than five hundred twenty-five degrees Fahrenheit, there is little chance of damage from overheating during installation. The roller is then stabilized at three hundred sixty degrees Fahrenheit for one hour to smooth out all wrinkles on the sleeve and to detect the presence of any residual peroxides in the elastomer which could cause further reversion of the rubber.

The resultant roller manufactured in accordance with this disclosure has been described as carried out in a speci-

fic embodiment. However, it will be obvious to one skilled in the art that various minor modifications might be made in the invention disclosed without departing from the scope of the subject invention. Therefore, this application is intended to cover such modifications or changes as may come within the purposes of the improvements or the scope of the following claims.

What is claimed is:

1. The method of manufacturing a deformable oil resistant roller which method includes the steps of:

molding and bonding a cylinder of deformable material to a non-deformable cylindrical core forming a deformable mandrel;

roughening the outer surface of said deformable material;

bonding deformable seals to said non-deformable core adjacent the ends of said deformable materials;

coating said deformable mandrel and seals with an adhesive;

placing a sleeve of an abhesive material having an inside diameter slightly greater than the outside diameter of said deformable mandrel as coated with said adhesive; and,

bonding said sleeve to said deformable mandrel and said seals by heat shrinking the abhesive sleeve over the deformable mandrel.

2. The method of claim 1 wherein said deformable material is rubber.

3. The method of claim 1 wherein said roughening of the outer surface of the deformable material is created by machining the mandrel to a proper size.

4. The method of claim 1 wherein said roughening of the outer surface of the deformable material is done by abrading.

5. The method of claim 1 wherein said adhesive material is a coating of a thixotropic silicone rubber adhesive.

6. The method of claim 1 wherein said abhesive material is a fluorinated ethylene/propylene Teflon.

7. The method of manufacturing a deformable oil resistant roller including the steps of:

molding and bonding silicone rubber to a steel core forming a deformable mandrel;

curing said mandrel for 15 minutes at 320° F.; subsequently post curing the mandrel for about 4 hours at 400° F.;

cooling the rubber mandrel;

grinding the rubber mandrel to a predetermined diameter leaving the outer surface of said mandrel in a roughened condition;

bonding deformable ring seals to said steel core adjacent said rubber material;

coating said rubber mandrel and said ring seals with a predetermined thickness of a silicone rubber adhesive;

etching the inner surface of a sleeve of abhesive material with a treating solution to render the surface receptive to adhesive;

placing said sleeve of abhesive having an inside diameter slightly greater than the outside diameter of said deformable mandrel and said seals as coated with said adhesive about said rubber mandrel and said seals;

applying heat of at least 220° F. and no greater than the melting temperature of the abhesive material causing the sleeve to be heat shrunk over said rubber mandrel and seals forming a sealed enclosure; and stabilizing the thus formed roller at 360° F. for one hour.

8. The method of claim 7 wherein said etching solution is an activated form of sodium in an aromatic hydrocarbon solution.

9. A pressure roller for use in cooperation with the heated roller in a heat fusing device for affixing thermoplastic resin material carried on a support material in image configuration, said pressure roller including:

a cylindrical core;

a cylinder of elastomeric material secured to said core intermediate its ends;

elastomeric ring seals bonded to said core in contact with the ends of said cylinder; and,

an outer sleeve of an abhesive material secured to said cylinder and said ring seals forming a protective seal over said cylinder and said ring seals.

10. The pressure roller as set forth in claim 9 wherein said ring seals have an inside diameter substantially equal to the outside diameter of said core and an outside diameter substantially equal to the outside diameter of said cylinder, each of said ring seals also having a tapered surface sloping downwardly away from its interface with said cylinder.

11. The pressure roller as set forth in claim 10 wherein said sleeve of abhesive material has a length greater than the length of said cylinder and assumes the sloping shape of the tapered surface of said ring seals.

12. The pressure roller as set forth in claim 11 wherein said core is metal, said cylinder is silicone rubber, said ring seals are fluoro silicone rubber and said sleeve is Teflon FEP.

13. The pressure roller as set forth in claim 11 wherein said sleeve has a length greater than the combined lengths of said ring seals and said cylinder so that the ends thereof are in contact with said cylindrical core.

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29—132; 156—86; 263—6