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(54) Method of increasing the working life of a heating element of a fixing device and associated fixing device.

(57) Heating element (20) for a device for fixing images developed by means of toner (25) on a support (12). The element is characterised by a protective layer (33) of wear-resistant material based on carbon particles deposited on the said heating element by means of growth by the vacuum deposition of carbon ions. The said protective layer also results in a reduced coefficient of friction between the said heating element and the film for conveying the said support across the said fixing unit, thereby increasing the working life of the said heating element.

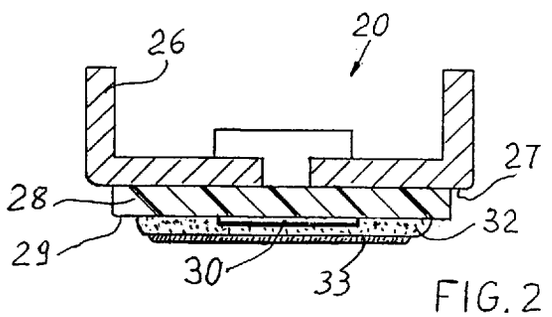


FIG. 2

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FIELD OF THE INVENTION

This invention relates to a fixing device and a method of fixing the image produced, e.g. by an electrophotographic apparatus on a support (usually, but not only, a sheet of paper) using a fixing device which uses a thick-film heating element and a film of heat-resistant material wound in a ring in the form of an endless belt for conveying the support across the fixing device, and more particularly to a method of increasing the working life of the heating element, reducing the friction between the said heating element and the belt and decreasing the value of the torque required to slide the belt over the surface of the heating element.

BACKGROUND OF THE INVENTION

European Patent No. 372 479 discloses a method of the type mentioned hereinabove for fixing the image on a support, in which the apparatus is formed by a heating element having a heating surface, a base plate for supporting the heating element, a stand for housing the said base plate, a film in the form of a belt which is in sliding contact with the heating surface and is fed simultaneously with the support, with a pressing roller which applies pressure between the support, the belt and the heated surface of the heating element. In this manner, the toner deposited on the support is heated to the fusing point and when it cools remains permanently anchored to the said support.

However, the sliding operation generates friction between the heating surface of the heating element and the belt, this friction opposing the movement of the said belt and leading to the gradual deterioration of the heating surface.

In order to solve this problem, in the prior art, a protective layer of anti-friction material such as glass or ceramics of low thickness, e.g. 10 μm, is deposited on the heating surface, but this still does not allow for a sufficient working life for the heating element which has to be used in systems offering high reliability.

SUMMARY OF THE INVENTION

A preferred embodiment of this invention uses a material and an associated process for depositing it on the heating surface of the heating element, which considerably improves the coefficient of friction between the belt and the heating surface and reduces the abrasion of the latter.

This may be achieved by depositing a layer of appropriate thickness formed by a layer of amorphous carbon similar to diamond (referred to by the acronym DLC, which stands for Diamond-Like Carbon) by means of a process for the vacuum deposition of carbon ions.

This and other features of the invention will be clearer from the following description of a new heating element for fixing the image on a support and of a preferred embodiment of the protective layer for the heating element in order to reduce wear and friction between the belt and the surface of the heating element.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 shows a device for fixing the images using the heating element and belt technique;

Fig. 2 is a transverse section of the fusing unit comprising the heating element.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Fig. 1 shows a device 10 for fixing the image developed by toner particles 25 on a support 12, according to a known electrographic process.

In a first embodiment of the invention, shown in Fig. 1, a closed-ring film in the form of an endless belt 14 of flexible, heat- resistant material is wound around two rotating rollers 15 and 16. One of the two rollers, e.g. the roller 15, is a drive roller, while the roller 16 turns freely, driven in rotation by the belt 14.

In a second embodiment of the invention, not shown, the film is in the form of a non-endless belt, and is similarly wound on a supply shaft and on a take-up shaft in the form of a roll.

The device 10 also comprises a fusing unit 20 fixed to the structure of the electrophotographic apparatus and extending transversely to the belt 14 in a direction parallel to the rollers 15 and 16 and thus perpendicularly to the movement of the belt 14. The fusing unit 20 is disposed in the interior of the belt 14 and, together with the rollers 15 and 16, helps to maintain tension in the belt.

A pressing roller 22 provided with a thick layer 24 of rubber with high resilience properties (e.g. silicone rubber) is disposed in correspondence with the fusing unit 20 and externally to the belt 14.

The roller 22 is pressed against the fusing unit 20 so as to form a compressed zone of contact of appropriate width "L", as will be seen hereinafter.

The fusing unit 20 (Fig. 2) is formed by a rigid stand 26 of narrow, elongate shape in which a base plate 28 of thermally and electrically insulating material, e.g. alumina, is fixed to a lower surface 27 of the stand 26 by means of flexible fixing elements not shown in the drawings, or by means of gluing. A heating element 30 formed typically of silver- palladium and provided with electric contacts is deposited by a silk-screen printing method on the lower free surface 29 of the base plate 28.

This heating element 30 is covered by a first layer 32 of glass which is in turn covered in an embodiment

of the invention by a second layer 33 of diamond-like carbon.

The heating element 30 has a length slightly greater than the maximum dimensions of the support 12 that can be used, e.g. a width slightly greater than that of an A3 sheet.

When a support 12 (Fig. 1) provided on a surface directed towards the belt 14 with the images developed by the toner 25 is passed between the belt 14 and the pressing roller 22, the heating element 30 is traversed by a predetermined electric current which heats the heating element 30 to a sufficient temperature to fuse the toner particles 25. The fused toner particles 25' also adhere to the support 12 as a result of the pressure applied by the pressing roller 22, thereby producing an indelibly fixed image.

In a typical embodiment, the base plate 28 of alumina has a thickness of 1 mm, a width of 10 mm and a length of 350 mm. The heating element 30 has a thickness of 0.05 mm, a width of 2.25 mm and a length of 310 mm. The layer 32 has a thickness of 10 μm and covers the entire surface 29.

The anti-wear and anti-friction protective layer 33 has a thickness of between 1 and 10 μm and preferably 2-5 μm, a width at least equal to the width of the compressed zone of contact "L" (Fig. 1) and a length equal to that of the heating element 30. The anti-wear and anti-friction protective layer 33 is deposited on the layer 32 of glass once the latter has been thoroughly cleaned by means of washing in appropriate solvents.

The protective layer 33 is deposited in a chamber, in which the pneumatic vacuum is produced, by means of a process for the deposition of carbon particles, which uses a beam of carbon ions produced from a gas containing carbon in an atmosphere of plasma irradiated at high frequency. This process is illustrated, e.g. in European Patent Application No. 509 875.

Experiments carried out by the inventor have shown that with a load of 4-7 kg applied between the belt 14 and the heating element 30 by means of the pressing roller 22 and with a feed rate of the belt 14 of approximately 100 mm/s, the introduction of the anti-wear and anti-friction layer 33 allows for a considerable reduction in the coefficient of friction between the belt 14 and the heating element 30 and for the following improvements under identical test conditions in which the layer 33 is absent:

1) the torque applied to the drive roller 15 required to move the belt 14 at a constant speed with respect to the heating element 30 is reduced to approximately 1 kg/cm, instead of approximately 5 kg/cm as measured in the absence of the layer 33;

2) the torque limit value at which the belt 14 begins to slide with respect to the drive roller 15 as a result of the increase in friction between the belt 14 and the surface 29 of the fusing unit 20 caused by the gradual abrasion of the layer 33 is reached only after approximately 1000 hours of operation, instead of after approximately 300 hours as in the prior art.

It will be clear that additions or modifications can be made to the method and to the fixing device according to this invention without thereby going beyond the scope of the invention.

Claims

1. Method of increasing the working life of a heating element (20) of a device for fixing images on a support (12) in an electrophotographic apparatus, in which the said element is associated with a drive member for the said support in the form of a belt (14), pressed against the said element by a pressing roller (22), characterised by the following steps:
   a) depositing a first protective layer (32) on the said heating element
   b) treating a free surface of the said first layer with solvents for thorough cleaning
   c) depositing a second layer (33) of a wear-resistant material based on carbon particles on the said free surface.

2. Method according to claim 1, characterised in that the drive member in the form of a belt is an endless belt wound in a closed ring.

3. Method according to claim 1, characterised in that the drive member in the form of a belt is a non-endless belt wound on a shaft in the form of a roll.

4. Method of increasing the working life of a heating element (20) of a device for fixing images on a support (12) in an electrophotographic apparatus, in which the said element is associated with a drive member for the said support in the form of a belt (14), pressed against the said element by a pressing roller (22), characterised by the step of depositing a layer (33) of a wear-resistant material based on carbon particles on the surface of the heating element against which the belt is pressed.

5. Method according to claim 4, characterised in that the drive member in the form of a belt is is an endless belt wound in a closed ring.

6. Method according to claim 4, characterised in that the drive member in the form of a belt is a non-endless belt wound on a shaft in the form of a roll.

7. Device for fixing images developed by means of a toner (25) on a support (12), comprising a heating element (20) for the said toner, characterised by a protective layer (33) of wear- resistant material based on carbon particles deposited on the said heating element.

8. Device according to claim 7, characterised in that the layer of wear-resistant material has a thickness of between 1 and 10 μm.

9. Device according to claim 7 or claim 8, characterised in that the said wear-resistant material comprises a layer of carbon grown by the vacuum deposition of carbon ions.

10. Device according to one of claims 7 to 9, characterised by a drive member for the said support in the form of a belt (14) which can slide over the said heating element in contact with the said protective layer (33).

11. Device as in claim 10, characterised by a pressing roller (22) which applies pressure to the said support and to the said drive member (14) against the said heating element.

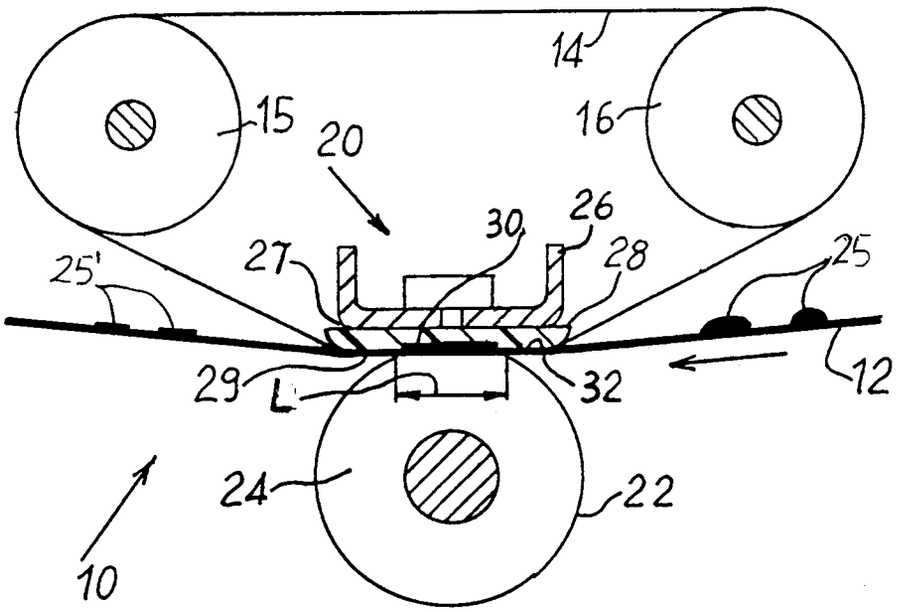


FIG. 1

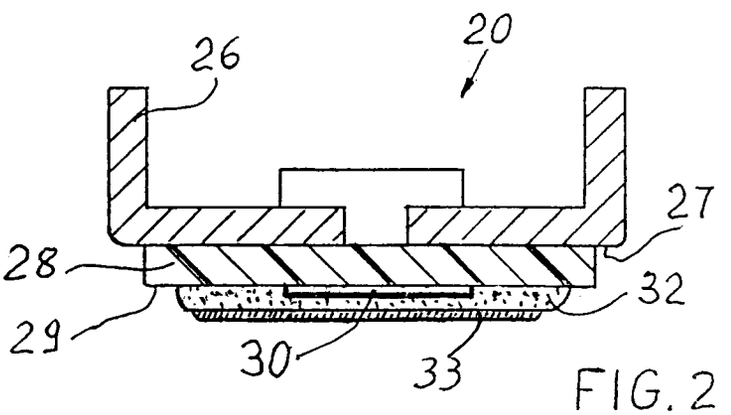


FIG. 2