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(54) **Printing unit and printing method**

(57) The invention relates to a printing unit having a photoconductor which is in contact with a transfer belt, the transfer belt being deflected over deflection rolls and being capable of being brought into contact with a substrate to be printed in the region of a transfer zone. For the effective printing of electrically nonconductive substrates, in particular in mass production printing, the in-

vention provides that, in the region of the transfer zone on the side of the transfer belt facing away from the substrate to be printed, there is arranged a transfer apparatus to which an electric voltage is applied in order to generate an electric charge in the region of the transfer zone. In this case, a high-frequency alternating current charge with a superimposed direct current charge is preferably generated.

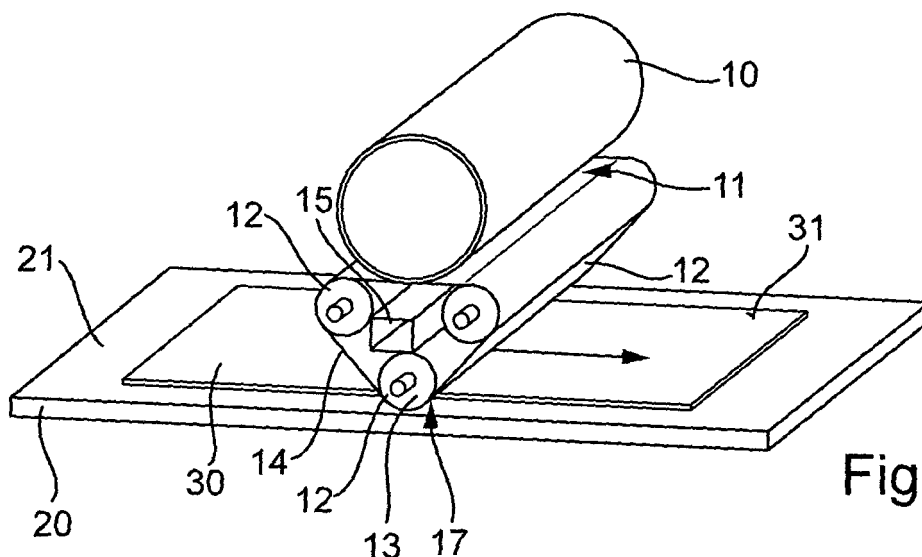


Fig. 1

Description

[0001] The invention relates to a printing unit having a photoconductor which is in contact with a transfer belt, the transfer belt being deflected over deflection rolls and being capable of being brought into contact with a substrate to be printed in the region of a transfer zone.

[0002] The invention further relates to a printing method.

[0003] EP 0 727 778 A1 discloses a method for printing substrates, for example compact discs (CD). In this case, a photoconductor of an electrophotographic printing apparatus is in image-transferring contact with an endlessly circulating transfer belt. The transfer belt picks up the developed toner image from the photoconductor and transfers it to the substrate in a transfer zone. In order to ensure the most complete toner transfer possible, the substrate is heated on its surface to be printed. As soon as the substrate comes into contact with the toner, the plastic components of the toner melt. This hot transfer, as it is known, is used for coating electrically nonconductive and primarily rigid substrates. In order to ensure good toner transfer, there must be a sufficiently high proportion of plastic, in particular a proportion of resin, in the toner. As a result, however, the relative proportion of functional components in the toner that can be transferred is low. Functional components are those components which ultimately perform a chemical or physical function in the applied coating. Examples of these are electrically conductive particles, light-absorbing or light-scattering elements, ceramic pigments (for mechanical resistance, for example), chemical components, etc.

In the case of the known resins, the temperature window within which the melting is intended to take place is relatively narrow. Therefore, high requirements are placed on the uniform heating of the substrate.

[0004] In the event of too low temperatures, as a rule only a thin toner layer is melted and transferred to the substrate. In the event of slightly too high temperatures, "hot offset" takes place. In this case, the toner is baked onto the transfer belt and the latter then has to be replaced or cleaned.

[0005] The hot transfer is limited to those substrates which can be heated appropriately without their being deformed or their material properties being changed.

[0006] A further disadvantage is that, in the event of successive printing steps, first of all the transfer belt and then the photoconductor and the developer unit heat up. This can lead to shortening of the service life or to system failure.

[0007] It is therefore an object of the invention to provide a printing unit and, respectively, a printing method, in particular electrically nonconductive substrates being capable of being printed more effectively.

[0008] This object is achieved with a printing unit in which provision is made that, in the region of the transfer zone on the side of the transfer belt facing away from the substrate to be printed, there is arranged a transfer ap-

paratus to which an electric voltage is applied in order to generate an electric charge in the region of the transfer zone.

[0009] The object of the invention relating to the printing method is achieved with a printing unit having a photoconductor which rolls on a transfer belt and, in the process, transfers toner to the transfer belt in a transfer region, it being possible for the transfer belt to be brought into contact with a printing area to be printed of a substrate in a transfer zone in order to transfer the toner and, in a transfer apparatus, an electric charge being generated on the rear of the transfer belt, facing away from the transfer zone, and the charge generated by the transfer apparatus having the same polarity as the charge of the toner.

[0010] Preferably, provision can be made in this case for the charge to be generated in the transfer apparatus in the form of a high-frequency alternating current electric charge with a superimposed direct current charge, the direct current charge having the same polarity as the charge of the toner.

[0011] The toner transfer from the transfer belt to the substrate then takes place under the action of an electric charge which transfers from the transfer belt the toner charged with the same polarity. The high-frequency alternating current acts in such a way that the adhesion of the toner components to the transfer belt is cancelled and the toner components are detached from the transfer belt. Because the transfer apparatus generates the potential on the side facing away from the substrate, an effective transfer of toner with a high efficiency is achieved. The toner rests on the transfer belt without any air cushion and the transfer belt barely interferes with the action of the potential.

[0012] With the printing method according to the invention, the problems of introducing heat into the printing system are circumvented. Even in the event of surface irregularities in the substrate, toner transfer is achieved with high efficiency. It is even possible for printing to be carried out on any desired substrate materials. In particular, solid and flexible substrates can be printed. A particular advantage of the invention is that functional toner having a high proportion of functional components can be transferred, since the proportion of resin can be chosen to be correspondingly low.

[0013] The transfer of different layer thicknesses can be controlled simply by means of a variation in the transfer voltage which is applied to the transfer apparatus.

[0014] According to a preferred refinement of the invention, provision can be made for the transfer apparatus to have a deflection roll. The deflection roll can be kept in direct contact with the transfer belt, so that the distance of the application of toner in the transfer zone from the position of the potential of the transfer apparatus is fixed and minimized. Therefore, reproducible printing operations with constant quality can be configured.

[0015] It is particularly advantageous here if provision is additionally made for the transfer apparatus to have

an electrically conductive core forming the axis of rotation of the deflection roll, which is surrounded by an electrically conductive layer, and for the deflection roll having the electrically conductive layer to roll indirectly or directly on the side of the transfer belt facing away from the transfer zone. Via the electrically conductive core, a uniform distribution of current is effected. The electrically conductive layer keeps the electric potential close to the application of toner. In order to compensate for tolerances during the transfer operation, a variant of the invention proves to be advantageous in which provision is made for the electrically conductive layer of the deflection roll to be resilient and for its elasticity to lie in the range between 20° and 70° Shore A.

[0016] Particularly good toner transfer rates result from the fact that the electrically conductive layer has a conductivity of $10e4$ to $10e7 \Omega/cm$.

[0017] One possible variant of the invention is such that the transfer apparatus has two deflection rolls which are spaced apart from each other, roll on the substrate with the interposition of the transfer belt and between which the transfer apparatus is arranged.

[0018] In the printing method according to the invention, provision can in particular be made for the toner to be present on the transfer belt with a proportion of resin in the range between 25% by weight and 70% by weight.

[0019] A particularly preferred variant of the invention is such that the toner is transferred in the transfer zone in such a way that the thermoplastic or thermosetting constituents of the toner are not melted or cross-linked (dry toner transfer).

[0020] If provision is made for the toner to be transferred with a layer thickness $\geq 20 \mu m$, then higher proportions of functional components can be transferred; the layer thickness should be $\leq 100 \mu m$ after the printing and before the fixing, for adequate mechanical stability of the layer.

[0021] The method is particularly preferably carried out in such a way that a plurality of toner layers are printed successively over one another, in order to produce a three-dimensional object (rapid prototyping or manufacturing). In this case, provision can be made for fixing of the application of toner to be carried out between the individual printing steps or a sequence of printing steps.

[0022] The invention will be explained in more detail below, using exemplary embodiments illustrated in the drawings, in which:

Fig. 1 shows an isometric illustration of part of a printing apparatus, and

Fig. 2 shows a side view of a further configuration variant of a printing unit in a schematic illustration.

[0023] Fig. 1 shows a printing unit having a photoconductor 10, which is constructed in the usual way (OPC roll). The photoconductor 10 is assigned an exposure unit and a developer unit (not illustrated). By using the

exposure unit, a latent charge image is generated on the photoconductor 10 and is developed with the developer unit, toner being applied to the surface of the photoconductor 10. In a transfer region 11, the photoconductor 10 is in contact with an endlessly circulating transfer belt 14. The transfer belt 14 is deflected over three deflection rolls 12, 13, one of the deflection rolls (deflection roll 13) being part of a transfer apparatus 16.

[0024] In the region enclosed by the transfer belt 14, a corona unit 15 is arranged and assigned to the transfer region 11. The corona unit 15 generates an electric charge, which is polarized oppositely to a charge held on the photoconductor 10. The toner is therefore drawn onto the transfer belt 14. The deflection roll 13 of the transfer apparatus 16 has an electrically conductive core, through which the axis of rotation of the deflection roll 13 leads. For the purpose of uniform current distribution, the core preferably has a round cross section and is formed as a solid material (for example as a graphite rod). The core is surrounded by an electrically conductive layer having a conductivity $< 10^6 \Omega/cm$ (based on the layer thickness). The layer material is resilient. The deflection roll 13 rolls with the cylindrical outer side of the electrically conductive layer on the inner side of the transfer belt 14. In the deflection region of the deflection roll 13 of the transfer apparatus 16, the outer side of the transfer belt 14 is in contact with a substrate 30 to be printed. Here, the transfer belt 14 rolls on the printing area 31 of the substrate 30 that is to be printed. The substrate 30 is held on a supporting surface 21 of a transport apparatus 20.

[0025] To transfer the toner from the transfer belt 14 to the substrate 30, the core of the deflection roll 13 (of the transfer apparatus 16) is connected to a controllable voltage supply. Via the latter, a high-frequency alternating current charge with superimposed direct current charge is generated. On the surface of the electrically conductive layer of the deflection roll 13, the direct current charge then produces a potential which has the same polarity as the toner charge. The transfer apparatus 16 therefore transfers the toner from the transfer belt 14 and transfers it to the printing area 31 in the transfer zone.

[0026] The high-frequency alternating current acts in such a way that the adhesion of the toner particles to the transfer belt is cancelled and these are then detached from the transfer belt 14.

[0027] Fig. 2 shows a further printing unit having a photoconductor 10 which, once again, rolls on a circulating transfer belt 14 for the purpose of the toner transfer. The transfer belt 14 is deflected over four deflection rolls 12, a corona unit 15 being arranged between the two upper deflection rolls 12, as in Fig. 1.

[0028] The two lower deflection rolls 12 are spaced axially parallel apart from each other. Between the deflection rolls 12, a further corona unit is arranged as transfer apparatus 16. In this case, the corona unit is arranged on the rear of the transfer belt 14 in the transfer zone defined between the deflection rolls 12. Between the deflection rolls 12, the transfer belt 14 lies flat on the printing

area 31. The corona unit 15 of the transfer apparatus 16 again generates a high-frequency alternating current with superimposed direct current, a charge having the same polarity as the toner charge being generated via the direct current, so that the toner is repelled by the transfer belt 14.

Claims

1. Printing unit having a photoconductor (10) which is in contact with a transfer belt (14), the transfer belt (14) being deflected over deflection rolls (12, 13) and being capable of being brought into contact with a substrate (30) to be printed in the region of a transfer zone (17),

characterized in that

in the region of the transfer zone (17) on the side of the transfer belt (14) facing away from the substrate (30) to be printed, there is arranged a transfer apparatus (16) to which an electric voltage is applied in order to generate an electric charge in the region of the transfer zone.

2. Printing unit according to Claim 1, **characterized in that** the transfer apparatus generates a high-frequency alternating current charge with a superimposed direct current charge, the direct current charge having the same polarity as the toner charge.

3. Printing unit according to Claim 1 or 2, **characterized in that** the transfer apparatus (16) has a deflection roll (13).

4. Printing unit according to Claim 3, **characterized in that** the transfer apparatus (16) has an electrically conductive core forming the axis of rotation of the deflection roll (13), which is surrounded by an electrically conductive layer, and **in that** the deflection roll (13) having the electrically conductive layer rolls indirectly or directly on the side of the transfer belt (14) facing away from the transfer zone (17).

5. Printing unit according to Claim 4, **characterized in that** the electrically conductive layer of the deflection roll (13) is resilient and its elasticity lies in the range between 20° and 70° Shore A.

6. Printing unit according to Claim 4 or 5, **characterized in that** the electrically conductive layer has a conductivity of $10e4$ to $10e7$ Ω/cm .

7. Printing unit according to one of Claims 1 to 3,

characterized in that

the transfer apparatus (16) has a corona unit which is arranged in the region of the side of the transfer belt (14) facing away from the transfer zone (17).

8. Printing unit according to one of Claims 1 to 7, **characterized in that** the transfer apparatus (16) has two deflection rolls (12) which are spaced apart from each other, roll on the substrate (30) with the interposition of the transfer belt (14) and between which the transfer apparatus (16) is arranged.

9. Printing method using a printing unit having a photoconductor (10) which rolls on a transfer belt (14) and, in the process, transfers toner to the transfer belt (14) in a transfer region (11), it being possible for the transfer belt (14) to be brought into contact with a printing area (31) to be printed of a substrate (30) in a transfer zone (17) in order to transfer the toner and, in a transfer apparatus (16), an electric charge being generated on the rear of the transfer belt (14), facing away from the transfer zone (17), and the charge generated by the transfer apparatus (16) having the same polarity as the charge of the toner.

10. Printing method according to Claim 9, **characterized in that** the transfer apparatus (16) generates a high-frequency alternating current charge with a superimposed direct current charge, the direct current charge having the same polarity as the charge of the toner.

11. Printing method according to Claim 9 or 10, **characterized in that** the transfer apparatus (16) is formed by at least one deflection roll (13) arranged in the transfer zone (17).

12. Printing method according to Claim 11, **characterized in that** the charge of the transfer apparatus (16) is generated on the outer side of the deflection roll (13), the inner side of which rolls on the transfer belt (14).

13. Printing method according to either of Claims 9 and 10, **characterized in that** the transfer apparatus (16) is formed by a corona unit which acts on the rear of the transfer belt (14), facing away from the transfer zone (17).

14. Printing method according to one of Claims 9 to 13, **characterized in that** the toner is present on the transfer belt (14) with a proportion of resin in the range between 10% by weight and 90% by weight, preferable 25% by weight

and 70% by weight.

15. Printing method according to one of Claims 9 to 14,
characterized in that
the toner is transferred in the transfer zone (17) in
such a way that the thermoplastic or thermosetting
constituents of the toner are not melted or cross-
linked (dry toner transfer) 5
16. Printing method according to one of Claims 9 to 15, 10
characterized in that
the toner is transferred with a layer thickness ≥ 20
 μm .
17. Printing method according to Claim 16, 15
characterized in that
a layer thickness of $\leq 100 \mu\text{m}$ is printed.
18. Printing method according to one of Claims 9 to 17, 20
characterized in that
a plurality of toner layers are printed successively
over one another, in order to produce a three-dimen-
sional object (rapid prototyping or manufacturing).
19. Printing method according to Claim 18, 25
characterized in that
fixing of the application of toner is carried out be-
tween the individual printing steps or a sequence of
printing steps.

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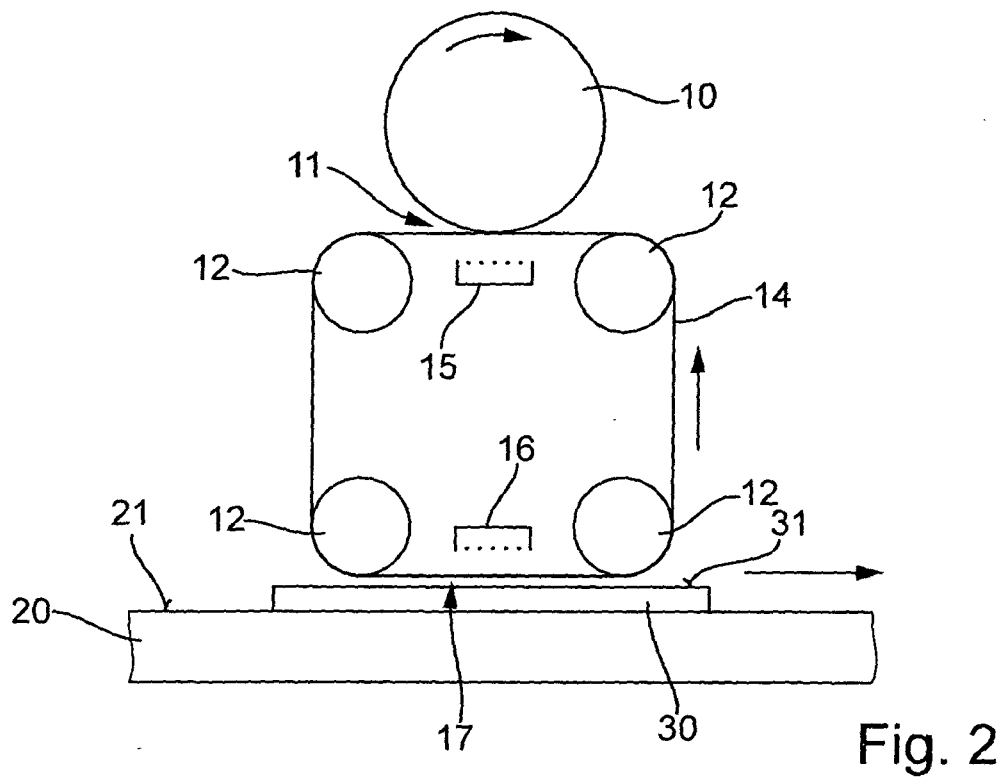
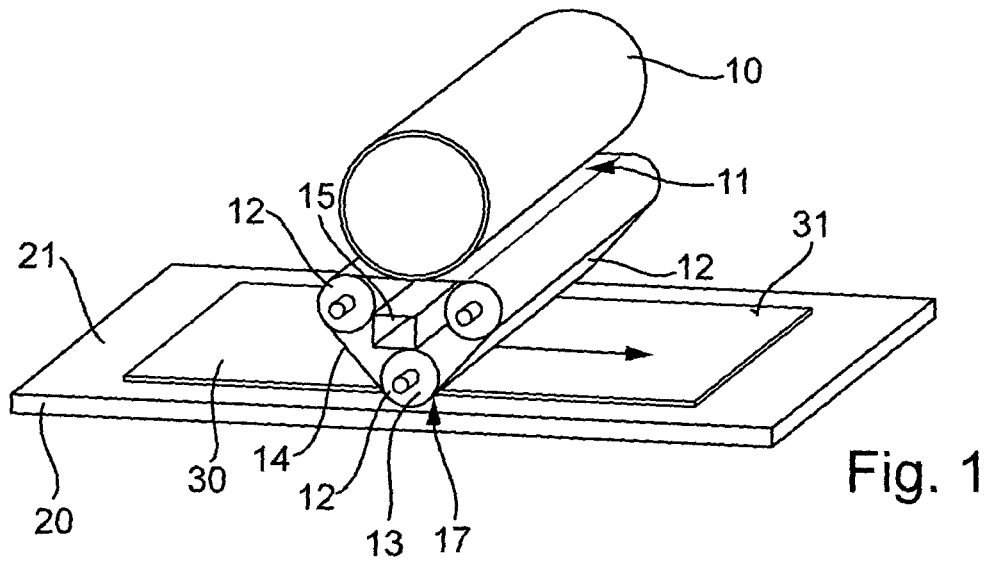
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Application Number
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Place of search Munich		Date of completion of the search 14 October 2009	Examiner Pavón Mayo, Manuel
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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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