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(54) **Apparatus and method for the continuous decoration of strips by sublimation**

(57) An apparatus for the continuous decoration of strips by means of sublimation includes a first reel (2) onto which is wound a strip (3) to be decorated, a second reel (5) onto which is wound a transfer backing (6) bearing a decoration to be transferred, at least one first pair of rollers (9, 10) to couple the strip (3) to be decorated and the transfer backing (6), heating means (12) to sublimate the decoration and transfer it from the transfer backing (6) to the strip (3) to be decorated. The apparatus includes furthermore an electrostatic charge generator (11) active at least on the transfer backing (6) or on the strip (3) to be decorated, for generating an electrostatic attraction between the strip (3) to be decorated and the transfer backing (6).

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Description

[0001] The present invention has as its subject an apparatus for the continuous decoration of strips by means of colour sublimation. In addition, the present invention has as its subject a method for the continuous decoration of strips with the said apparatus by means of colour sublimation. In particular, the present invention is directed at an apparatus and a method for transferring onto metallic and non-metallic strips a decoration, carried by a transfer backing, by means of sublimation.

[0002] Within the scope of the present invention, transfer backing has the meaning of an element configured as a strip which bears a decoration formed by sublimatable solid pigments.

[0003] Various apparatuses are known for the continuous decoration of strips by sublimation.

[0004] The known apparatuses include a first reel from which the strip to be decorated is unwound. The latter may be a strip of metallic material or of non-metallic plastic material. The known apparatuses furthermore include a second reel from which the transfer backing is unwound.

[0005] The prior art apparatuses include furthermore a first pair of opposed rollers between which both the strip to be decorated and the transfer backing are made to pass. In particular, one side of the transfer backing, and in particular the side bearing the decoration, is coupled with one side of the strip which is to be decorated.

[0006] The two rollers exert pressure on each other to ensure adhesion between strip and backing. The rollers are also heated so as to bring the strip and the backing up to sublimation temperature. The pigments forming the decoration consequently sublimate and the latter is transferred onto the strip.

[0007] The spent transfer backing is then decoupled from the decorated strip which is wound onto a third reel, while the spent transfer backing is wound onto a fourth reel.

[0008] The zone in which the transfer of the decoration by sublimation occurs is formed approximately by the contact zone of the two heated rollers. However, the extension of this zone can be insufficient to ensure the transfer of the decoration in a complete and satisfying manner.

[0009] To obviate this drawback, apparatuses are available in which the contact zone between the strip to be decorated and the transfer backing extends beyond the contact zone between the rollers. This is effected, for example, by having the strip to be decorated and the transfer backing run over a single heated roller and pressing the strip to be decorated and the transfer backing onto the roller with an endless belt which extends along an arc of circumference of the roller. In this way, the contact zone between strip and backing extends along the entire arc of circumference of the roller affected by the endless belt.

[0010] To further increase the above-mentioned contact zone, some apparatuses include two mutually coupled endless belts between which the strip and the backing are made to pass simultaneously. In this case, the belts are supported and moved by two respective pairs of rollers. In this case, the heating of the strip and of the backing is performed by suitable heating means. These heating means are located in proximity to the endless belts, so that the heating occurs in the contact area between strip and backing.

[0011] The Applicant has found that apparatuses of known type for the continuous decoration of strips by sublimation can be improved in respect of various aspects.

[0012] In fact, the available apparatuses do not always ensure optimal adhesion and intimate contact between the strip to be decorated and the transfer backing.

[0013] Indeed, in the apparatuses including the pair of opposed rollers, the zone in which adhesion occurs between the strip to be decorated and the transfer backing is limited to the line of contact between the two rollers. This zone may be insufficient to ensure the adhesion necessary for optimal decoration.

[0014] Furthermore, in the apparatuses equipped with the roller and endless belt, the adhesion zone between the strip to be decorated and the transfer backing is noticeably extended. However, in solutions such as those described, the pressure exerted on the strip and the backing are in fact lower, and adhesion and intimate contact between strip and backing are therefore not in general acceptable.

[0015] Finally, in apparatuses which provide two endless belts coupled together, the contact zone between the strip to be decorated and the transfer backing increases further, but the pressure exerted consequently reduces and does not guarantee sufficient adherence.

[0016] Intimate contact between the strip to be decorated and the transfer backing is of fundamental importance for the creation of good-quality decoration on the strips.

[0017] If adherence between the strip to be decorated and the transfer backing is not complete, it can happen that there are areas in which the backing is slightly separated from the strip, creating a gap. In this case, when the pigment sublimates, it can spread into the gap and therefore does not transfer onto the strip to be decorated, still less according to the intended design. At the end of the process of sublimation, the strip ends up decorated in a manner that is at best blurred, indefinite or fuzzy.

[0018] Furthermore, when a gap is created, it can happen that the sublimated pigment does not manage to reach the strip. In this case, areas could appear on the strip in which the decoration is completely absent.

[0019] In this context, the technical task of the present invention is to propose an apparatus for the continuous decoration of strips by sublimation, free from the disadvantages mentioned above.

[0020] In particular, an object of the present invention is to propose an apparatus and a method for the contin-

uous decoration of strips by sublimation which allows high quality and precision in transferring the decoration onto the strip.

[0021] A further object of the present invention is to propose an apparatus for the continuous decoration of strips by sublimation which is simple to use, and a method for the continuous decoration of strips by sublimation which is quick and simple to implement.

[0022] The declared technical task and the specified objects are substantially achieved by an apparatus and a method for the continuous decoration of strips by sublimation according to what is set forth in one or more of the attached claims.

[0023] Further characteristics and advantages of the present invention will become clearer from the indicative, and therefore non-limiting, description of a preferred but not exclusive embodiment of an apparatus and a method for the continuous decoration of strips by sublimation, as illustrated in the attached drawings, in which:

- figure 1 is a schematic lateral view of an apparatus for the continuous decoration of strips by sublimation;
- figure 2 is a perspective view of a detail of the apparatus shown in figure 1; and
- figure 3 is a perspective view of a further detail of the apparatus shown in figure 1.

[0024] Reference no. 1 comprehensively indicates an apparatus for the continuous decoration of strips by sublimation according to the present invention.

[0025] The apparatus 1 includes a first reel 2 onto which a strip 3 to be decorated is wound. The first reel 2 is moved by means of a motor (not illustrated) to allow the unwinding of the strip 3.

[0026] The strip 3 to be decorated is preferably of metallic material and includes a base layer 4 located on a side 3 which is to be decorated of the strip 3 (figure 2). The base layer 4 consists of a coating capable of receiving and retaining sublimated solid pigments.

[0027] Alternatively, the strip 3 to be decorated may also be made in non-metallic material such as, by way of example, plastic material.

[0028] The apparatus 1 includes a second reel 5 onto which a transfer backing 6 is wound. On one side 6a of the latter a decoration is arranged, made with solid sublimatable pigments, which is to be transferred to the strip 3 by sublimation. The second reel 5 is moved by means of a motor (not illustrated) to allow the unwinding of the transfer backing 6.

[0029] Suitable materials for making the transfer backing 6 are polyester, polypropylene, polyethylene, polyurethane, polyamide materials, PVA, polyvinyl butyrate and similar.

[0030] The apparatus 1 includes furthermore preheating means 7 which act exclusively on the strip 3 to be decorated. In the preferred embodiment, the preheating means 7 include at least one infrared ray lamp 8 which heats the strip 3 to a temperature of between 100°C and 230°C, preferably between 130°C and 200°C. Alternatively, the preheating means 7 include a hot air heater or an induction heater.

[0031] The apparatus 1 includes furthermore at least one first pair of rollers 9, 10 to couple the strip 3 with the transfer backing 6. The rollers 9, 10 are coupled and counter-rotating and are arranged with their respective longitudinal axes (not shown) parallel. Each longitudinal axis is perpendicular to a direction "X" of advance of the strip 3 and the backing 6.

[0032] The strip 3 to be decorated and the transfer backing 6 are fed to the rollers 9, 10 with the same linear speed so as to effect their mutual coupling.

[0033] In more detail, the strip 3 and the backing 6 are superimposed in such a way that the side 6a of the backing 6 bearing the decoration is placed in contact with the base layer 4 of the strip 3.

[0034] The rollers 9, 10 exert pressure so as to compress the strip 3 and the backing 6 between them in order to favour their mutual adhesion.

[0035] The apparatus 1 includes furthermore an electrostatic charge generator 11 for generating an electrostatic attraction force between the strip 3 and the transfer backing 6. More precisely, the generator 11 acts on the transfer backing 6 by electrically charging it. The electrostatic charge produces the high-intensity electrostatic attraction force which ensures a firm and intimate coupling between the transfer backing 6 and the base layer 4.

[0036] To this end, the coating which constitutes the base layer 4 is preferably of a dielectric nature. In other words, the coating is an insulating material so that, once contact has been made between the strip to be decorated and the transfer backing, it does not disperse the electric charges applied to the transfer backing by the generator 11. In this way, the above-mentioned electrostatic attraction force can be generated.

[0037] In detail, in the preferred embodiment, the coating which makes up the base layer 4 consists of semi-transparent thermosetting powders. The powders can have a basis of polyester, polyurethane or acrylic resins or various mixtures.

[0038] In an alternative embodiment, the coating can be a liquid with a basis of polyester, polyurethane or acrylic resins or various mixtures. Furthermore, the base layer 4 can include a further layer of transparent coating.

[0039] Advantageously, the electrostatic charge generator 11 is located in proximity to the first pair of rollers 9, 10. More precisely, the generator 11 is positioned at the exit of the coupled strip 3 and backing 6 from the first pair of rollers 9, 10.

[0040] The apparatus 1 furthermore includes heating means 12 which act on the strip 3 and the backing 6 to enable the decorating pigments to reach sublimation temperature and to be transferred onto the strip 3. A further function of the heating means 12 is to enable the coating which constitutes the base layer 4 to undergo a thermosetting reaction. In this way, the colouring pig-

ments transferred onto the coating are solidly incorporated into the base layer 4.

[0041] The heating means 12 include a main heater 13 which acts on the strip 3 to be decorated and on the backing 6 when they are coupled. The main heater 13 enables the latter to reach a temperature of between 120°C and 230°C, preferably between 150°C and 200°C.

[0042] In any event, the temperature reached by the heater 13 must be such as to heat the pigments to the point of completing their sublimation.

[0043] In the preferred embodiment, the transfer backing 6 has a melting point higher than both the sublimation temperature of the pigments and the temperature necessary for the thermosetting of the base layer 4. In this case, the main heater 13 brings about both the sublimation of the pigments and the thermosetting of the base layer 4.

[0044] In an alternative embodiment, the transfer backing 6 is made of a material which has a melting point lower than the thermosetting temperature. In this case, the main heater 13 brings about only the sublimation of the pigments, and the apparatus provides a further heater (not shown) which acts exclusively on the the decorated strip 3 to bring about the thermosetting of the base layer 4.

[0045] Irrespective of the embodiment being considered, the heater 13 includes advantageously a pair of infrared ray lamps 14, mutually opposed with respect to the strip 3 and the backing 6. In this way, heating is efficient and uniform.

[0046] Advantageously, the heating means 12 include furthermore at least one heating element (not shown in the drawings) located in at least one of rollers 9, 10. Preferably, the heating means 12 include heating elements located in both the rollers 9, 10.

[0047] The apparatus 1 furthermore includes cooling means 15. The latter lower the temperature of the decorated strip 3 and of the spent transfer backing 6 in order to facilitate their separation.

[0048] The cooling means 15 include at least a first fan 16 which generates an airflow directed at the transfer backing 6. Advantageously, the cooling means 15 include a second fan 17, opposed to the first, which generates an airflow directed at the strip 3. In this way, faster and more uniform cooling is obtained.

[0049] Apparatus 1 includes furthermore a second pair of rollers 18, 19 which facilitate decoupling between the decorated strip 3 and the spent transfer backing 6 (figure 3).

[0050] Similarly to the first pair of rollers 9, 10, the rollers 18, 19 are coupled and counter-rotating and are arranged with their respective longitudinal axes (not shown) parallel. Each longitudinal axis of the rollers 18, 19 is perpendicular to the direction "X" of advance. The decorated strip 3 and the spent transfer backing 6 pass through the second pair of rollers 18, 19.

[0051] Advantageously, the second pair of rollers 18, 19 contributes to removing heat from the strip 3 and the backing 6. In fact, the rollers 18, 19 are placed in contact with the strip 3 and the backing 6 and absorb by conduction a fraction of the residual heat.

[0052] In the preferred embodiment, the apparatus 1 includes furthermore a third reel 20, onto which the decorated strip 3 is wound, and a fourth reel 21 onto which the spent transfer backing is wound. The third reel 20 and the fourth reel 21 are moved by respective motors (not shown).

[0053] Alternatively, the decorated strip 3 and the spent transfer backing 6 are kept coupled and are wound together onto the third wheel 20. In this case, the spent transfer backing 6 protects the decorated surface of the strip 3.

[0054] The invention also creates a method for the continuous decoration of strips by sublimation.

[0055] The method includes a preliminary stage of preparing the strip 3 to be decorated.

[0056] This preliminary stage includes a stage of painting one surface of the strip 3 with at least one layer of base coating to constitute the base layer 4 of the strip 3 to be decorated. The coating used in this stage is of the type already described with reference to apparatus 1.

[0057] The method includes furthermore the stage of preheating solely the strip 3 to be decorated. The preheating is performed in such a way that strip 3 reaches a temperature of between 100°C and 230°C, preferably between 130°C and 200°C. Advantageously, the preheating is performed to prepare the strip 3 for accepting the pigments which subsequently sublimate.

[0058] The method includes furthermore the stage of coupling the strip 3 to be decorated with the transfer backing 6 bearing the decoration created with the above-mentioned sublimatable pigments. In detail, th side 6a of the backing 6 bearing the decoration is placed in contact with the base layer 4.

[0059] Advantageously, the stage of coupling the strip 3 and the backing 6 includes also the stage of preliminarily heating the coupled strip 3 and the backing 6.

[0060] Subsequently, the stage of electrostatically charging the transfer backing 6 is performed, in order to generate the electrostatic attraction force between the backing 6 and the strip 3. In particular, the electrostatic charging stage includes the stage of applying the electrostatic charges to the transfer backing 6 by means of an electrostatic field.

[0061] The method includes furthermore the stage of heating the coupled strip 3 and transfer backing 6 up to the sublimating temperature of the pigments. In detail, during this stage the coupled strip 3 and backing 6 reach a temperature of between 120°C and 230°C, preferably between 150°C and 200°C.

[0062] During this stage, the pigments sublimate and diffuse onto the base layer 4, imprinting themselves on it.

[0063] Advantageously, the heating stage is performed after the stage of electrostatically charging the transfer backing 6, so that the diffusion of the sublimated pigments is extremely localised. In fact, the electrostatic force thus generated enables intimate adhesion between

the backing 6 and the strip 3 which continues at least during the subsequent heating stage.

[0064] After the sublimation process has taken place, the method continues with a stage of cooling the decorated strip 3 and the spent transfer backing 6. This stage is preferably performed by the application of an air flow directed at the strip 3 and the backing 6. This stage enables the consolidation of the pigments in the base layer 4 and, therefore, the stabilisation of the decoration on the strip 3.

[0065] In the preferred embodiment, the method continues with a stage of decoupling the decorated strip 3 and the spent transfer backing 6. The method includes furthermore the stages of receiving the decorated strip 3 and the spent transfer backing 6.

[0066] In an alternative embodiment, the method includes the stage of applying a protective coating after the stage of separating the decorated strip 3 and the spent transfer backing 6. This stage is performed by the application to the decorated strip 3 of a transparent or semi-transparent coating.

[0067] Alternatively, the method can include the stage of keeping the strip 3 and the backing 6 coupled and, subsequently, the stage of receiving the said elements still coupled.

[0068] The invention achieves the objects set forth. In fact, the electrostatic attraction force, which is established thanks to the use of the electrostatic charge generator, enables considerably improved adhesion between the transfer backing 6 and the strip 3.

[0069] The electrostatic force allows the reduction to the point of elimination of the gaps which can be created between the strip 3 and the backing 6 after their mutual coupling. In this way, when the pigments sublimate, they are transferred onto strip 3, reproducing the desired decoration exactly.

[0070] Consequently, the decoration is applied with continuity over the whole of the base layer 4 of the strip 3 and no areas which are discoloured or entirely without decoration appear.

[0071] In addition, the decoration applied to the strip 3 is much sharper and does not display any blurring or fuzzing, because the absence of gaps prevents an excessive and undesirable diffusion of the pigment.

[0072] There is, therefore, an overall improvement in the quality of the decoration by sublimation.

Claims

1. An apparatus for the continuous decoration of strips by sublimation, including:

- a first reel (2) onto which a strip (3) to be decorated is wound ;
- a second reel (5) onto which a transfer backing (6) bearing a decoration to be transferred is wound ;
- at least one first pair of rollers (9, 10) for coupling the strip (3) to be decorated with the transfer support (6);
- heating means (12) for sublimating the decoration and transferring it from the transfer backing (6) to the strip (3) to be decorated;

characterised by including furthermore an electrostatic charge generator (11) active at least on the transfer backing (6) or on the strip (3) to be decorated, in order to generate an electrostatic attraction force between the strip (3) to be decorated and the transfer support (6).

2. An apparatus according to claim 1, **characterised in that** the electrostatic charge generator (11) is located in proximity to the first pair of rollers (9, 10).

3. An apparatus according to claims 1 or 2, **characterised in that** the electrostatic charge generator (11) acts on the transfer backing (6).

4. An apparatus according to one of the preceding claims, **characterised in that** the electrostatic charge generator (11) acts on the transfer backing (6) downstream from the first pair of rollers (9, 10).

5. An apparatus according to one of the preceding claims, **characterised in that** the heating means (12) include at least one main heater (13) which acts on the transfer backing (6) and on the strip (3) to be decorated, coupled together.

6. An apparatus according to one of the preceding claims, **characterised in that** the heating means (12) include furthermore at least one heating element located in the first pair of rollers (9, 10).

7. An apparatus according to one of the preceding claims, **characterised by** including furthermore preheating means (7) acting on the strip (3) to be decorated.

8. An apparatus according to claim 7, **characterised in that** the preheating means (7) include an infrared ray lamp (8).

9. An apparatus according to claim 7, **characterised in that** said preheating means (7) include a hot air heater.

10. An apparatus according to one of the preceding claims, **characterised by** including furthermore cooling means (15) for lowering the temperature of the decorated strip (3) coupled with the transfer backing (6).

11. An apparatus according to claim 10, **characterised**

in that the cooling means (15) include at least one first fan (16) for directing an air flow at the decorated strip (3) coupled with the transfer backing (6).

12. An apparatus according to one of the preceding claims, **characterised by** including furthermore a third reel (20) for winding on at least the decorated strip (3).

13. An apparatus according to claim 12, **characterised by** including furthermore a fourth reel (21) for winding on the spent transfer backing (6).

14. An apparatus according to one of the preceding claims, **characterised by** including furthermore a second pair of rollers (18, 19) for facilitating the decoupling of the decorated strip (3) from the transfer backing (6).

15. A method for the continuous decoration of strips by sublimation, including the stages of:

- preparing a strip (3) to be decorated;
- coupling the strip (3) to be decorated with a transfer backing (6) bearing a decoration to be transferred;
- heating the strip (3) to be decorated coupled with the transfer backing (6) up to sublimation temperature;

characterised by including furthermore the stage of electrically charging at least the transfer backing (6) or the strip (3) to be decorated in order to generate an electrostatic attraction force between the transfer backing (6) and the strip (3) to be decorated.

16. A method according to claim 15, **characterised in that** the stage of electrically charging the transfer backing (6) includes the stage of applying electrical charges to the transfer backing (6) by means of an electrostatic field.

17. A method according to claims 15 or 16, **characterised in that** the stage of preparing the strip (3) to be decorated includes the stage of painting the strip (3) with a base coating of dielectric nature to create a base layer (4).

18. A method according to one of claims 15-17, **characterised in that** the stage of electrically charging the transfer backing (6) precedes the stage of heating the strip (3) to be decorated coupled with the transfer backing (6).

19. A method according to one of claims 15-18, **characterised in that** the stage of electrically charging the transfer backing (6) follows the stage of coupling the strip (3) to be decorated with the transfer backing (6).

20. A method according to one of claims 15-19, **characterised in that** the stage of coupling the strip (3) to be decorated with the transfer backing (6) includes furthermore the stage of preliminarily heating the strip (3) and the transfer backing (6).

21. A method according to one of claims 15-20, **characterised by** including furthermore the stage of preheating the strip (3) to be decorated before the stage of coupling the strip (3) with the transfer backing (6).

22. A method according to one of claims 15-21, **characterised by** including furthermore the stage of cooling the strip (3) coupled with the transfer backing (6) after the heating stage.

23. A method according to one of claims 15-22, **characterised by** including furthermore the stage of storing the decorated strip (3) still coupled with the spent transfer backing (6).

24. A method according to one of claims 15-23, **characterised by** including furthermore the stage of decoupling the strip (3) from the spent transfer backing (6).

25. The use of an electrostatic charge generator (11) in an apparatus for the continuous decoration of strips by sublimation in order to generate an electrostatic attraction force between a strip (3) to be decorated and a transfer support (6) bearing a decoration to be transferred.

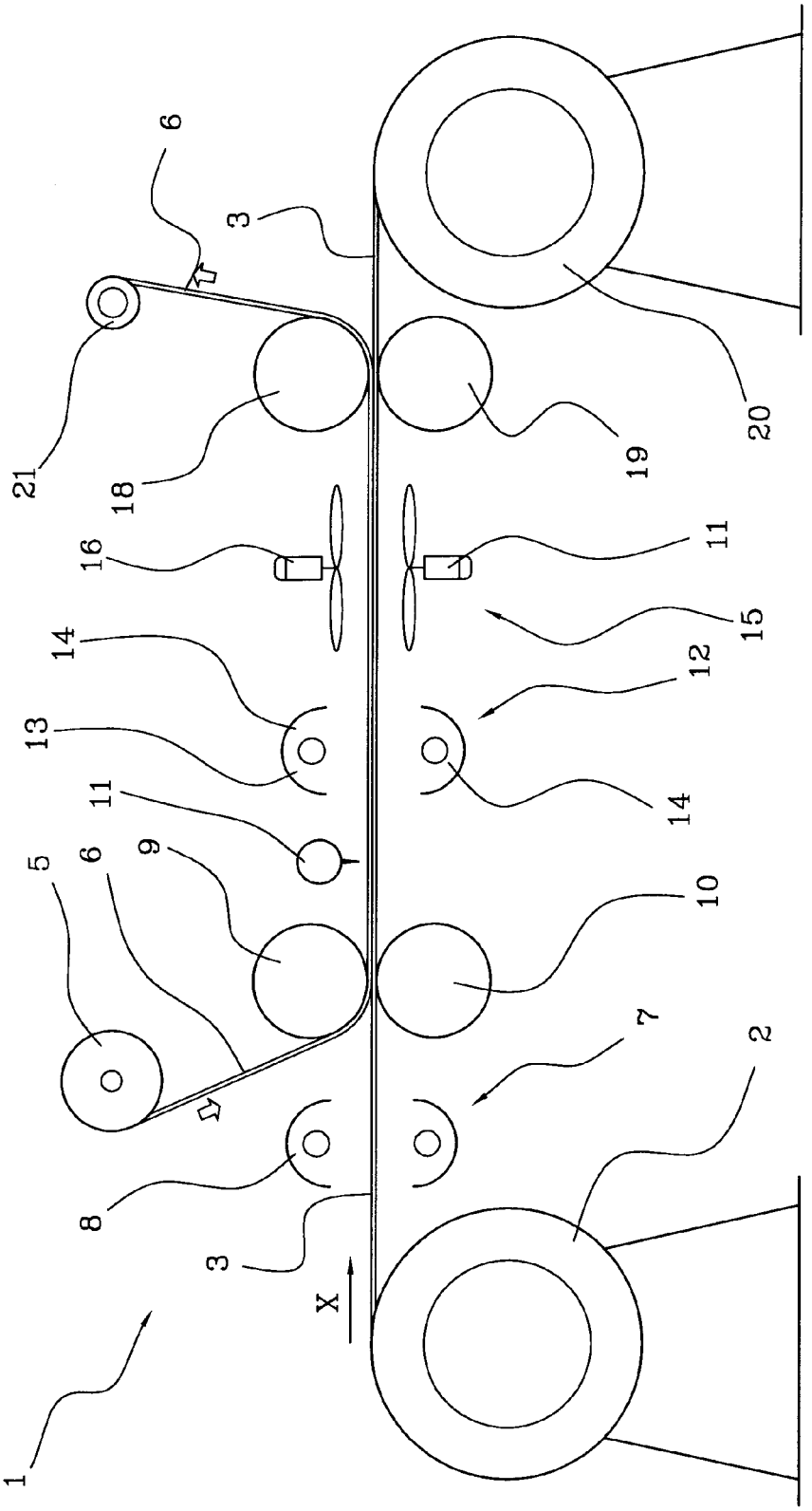
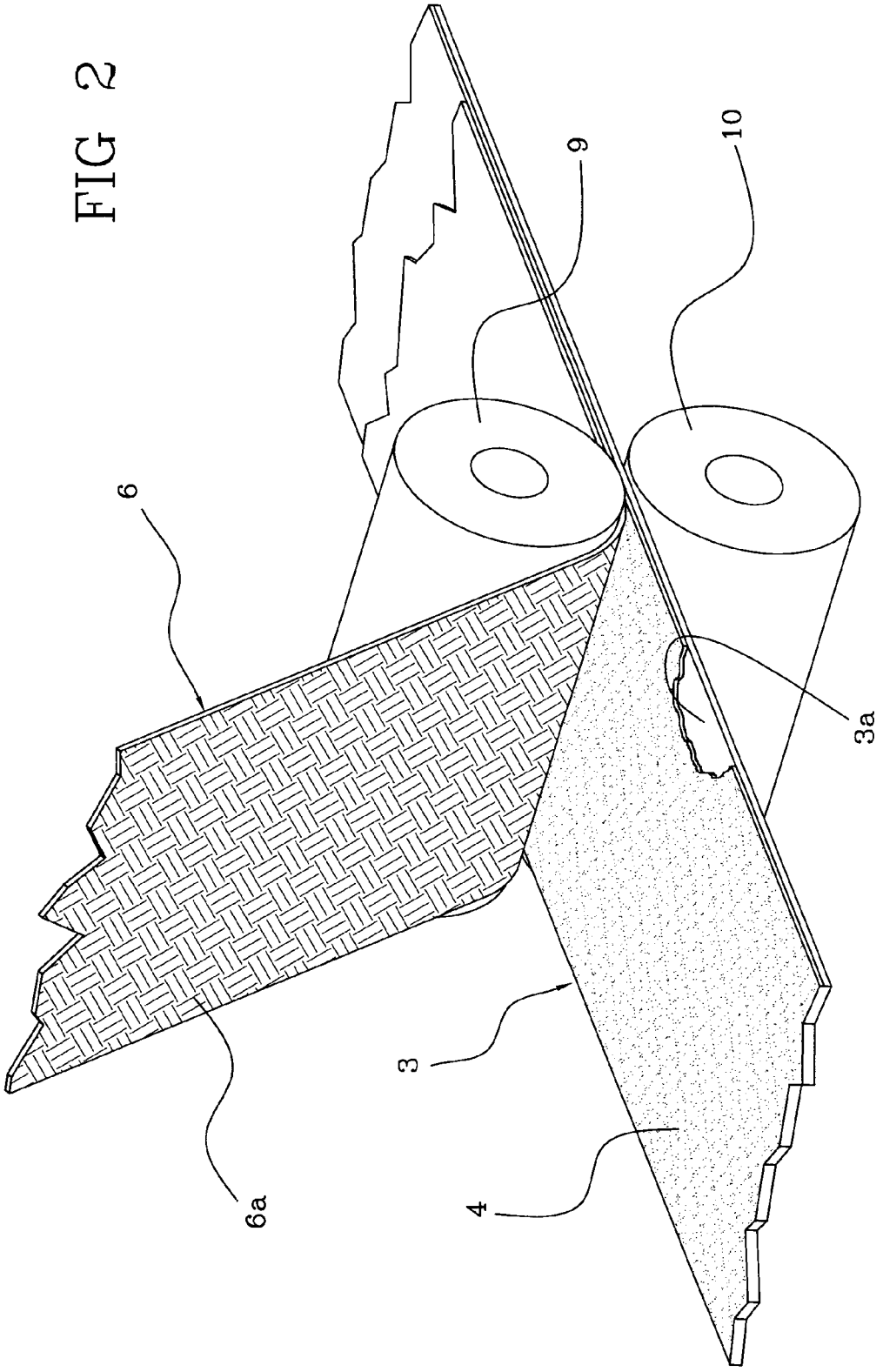


FIG 1

FIG 2



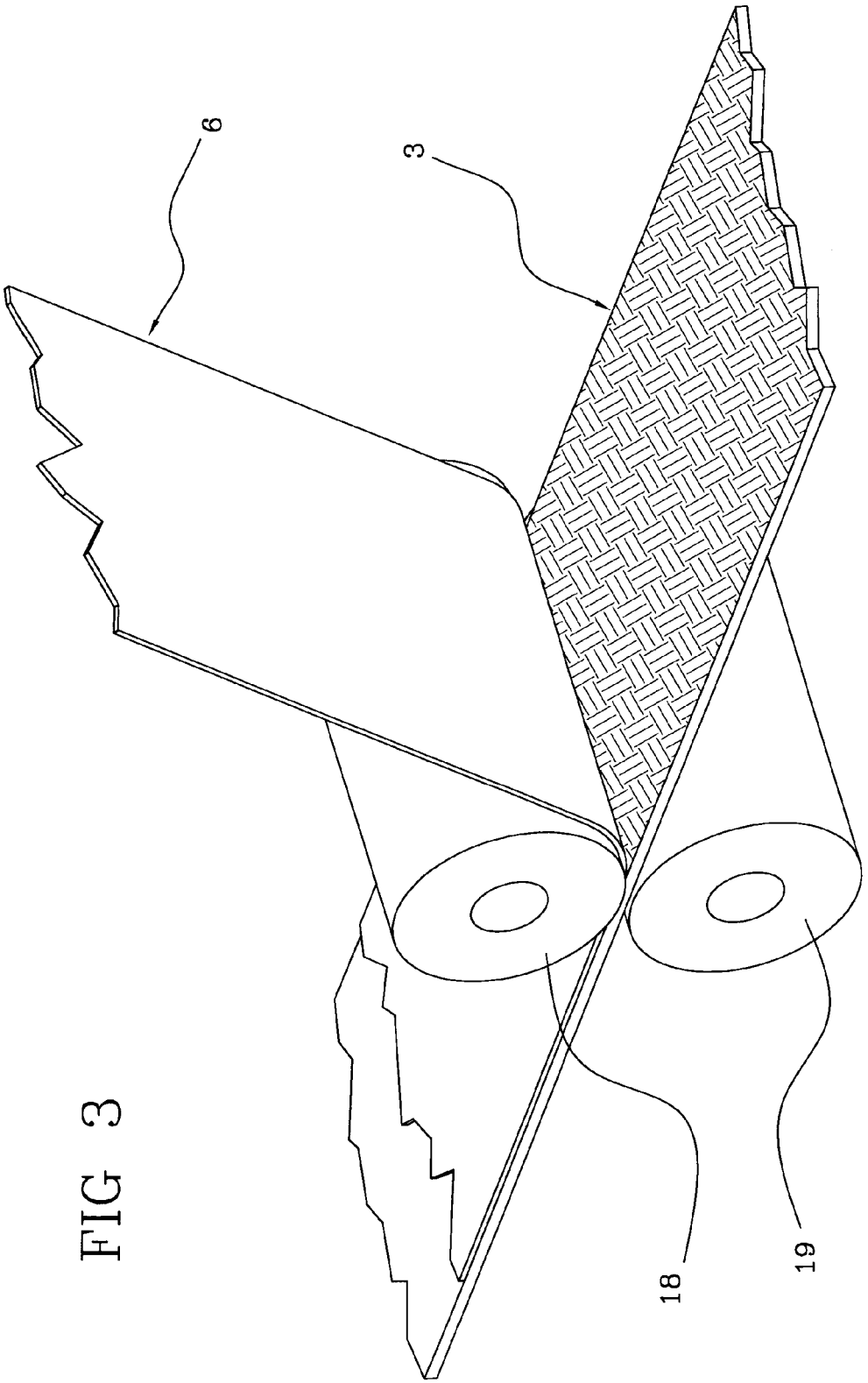


FIG 3