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Method and system for applying a layer of soundabsorbing material to the surface of an inner cavity of a pneumati tire

Abstract

A method and a system for applying a layer of sound-absorbing material to the inner surface of a cavity of a pneumatic tire comprising an applicator device having an applicator roller for implementing the application of the layer of sound-absorbing material to the inner surface after the removal of a lining and arranged, in use, at a position directly facing and in proximity to the inner surface and at a distance from the inner surface that substantially approximates the thickness of the layer of sound-absorbing material; a roller for winding the lining after the separation from the layer of sound-absorbing material; and further configured to make it possible to maintain substantially uniform the speed of the applicator roller and the winding roller.

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Background/Summary

TECHNICAL SECTOR

(1) The present invention relates to a method and a system for applying a layer of sound-absorbing material to the surface of an inner cavity of a pneumatic tire.

PRIOR ART

(2) As is known, a pneumatic tire comprises a toroidal carcass, which has two annular beads and supports an annular tread. Between the casing and the tread, a tread belt is interposed, which comprises a number of tread plies. Within the carcass ply, an innerliner is arranged which is airtight, constitutes an inner lining and has the function of retaining the air within the pneumatic tire in order to maintain the inflation pressure of the pneumatic tire itself over time.

(3) In recent years the development of pneumatic tires has been directed towards pneumatic tires that are provided with an inner lining made of a sound-absorbing material for reducing the noise generated by a pneumatic tire rolling on a road surface.

(4) The sound-absorbing material is applied to an already vulcanized pneumatic tire and preferably to the innerliner, to that area of the pneumatic tire that comes into contact with the asphalt; in particular, the sound-absorbing material is applied to the tread and, at least partially, to the side walls.

(5) Typically, the procedure for applying the sound-absorbing material provides for the positioning of the pre-vulcanized pneumatic tire on a frame, whereupon it is blocked by means of lateral rails in such a way as to prevent any lateral translation of the pneumatic tire itself.

(6) In response to an operator command, the sound-absorbing material application process is initiated in inserting a sound-absorbing material applicator device into the inner cavity of the pneumatic tire, in a position directly facing a surface of the inner cavity itself, the pneumatic tire is then driven into rotation by the frame using motorized rollers.

(7) The sound-absorbing material is provided with an adhesive layer that is applied to the surface that is intended to make the connection with the inner cavity of the pneumatic tire and is protected by a removable lining (liner) that is applied at the adhesive layer.

(8) Said applicator device is conveniently implemented by means of a movable arm which serves to move the device from a position for the application of the sound-absorbing material, wherein it is inserted into the cavity, to a position for the manipulation of the pneumatic tire, wherein it is arranged externally to the cavity, and vice versa. The applicator device comprises an applicator roller that, after the removal of the lining, is intended to implement the application of the sound-absorbing material to the surface and arranged at a position directly facing and in the vicinity of the surface of the pneumatic tire; and a roller for winding the lining, whereupon the same is wound after the separation thereof from the sound-absorbing material.

(9) The winding roller and the applicator roller are provided with actuating means intended to bring them into rotation around the respective axes thereof at appropriate and synchronous speeds, in such a way as to prevent the lining and/or the absorbent material from tearing due to excessive tension or being too loose.

(10) The adhesive layer that is normally used, if exposed to air, polymerizes within seconds,

permanently attaching the sound-absorbing material to the inner cavity. During the application of the sound-absorbing material it is therefore necessary, just before application, to separate the lining from the sound-absorbing material (peeling-off) in such a way as to leave the adhesive exposed to air for the shortest possible period of time.
(11) Moreover, it is of paramount importance that, during the application within the cavity, the sound-absorbing material does not undergo elongations or compressions which, after a few thousand kilometers of use of the pneumatic tire, may lead to cracks within the sound-absorbing material itself.
DESCRIPTION OF THE INVENTION
(12) The object of the present invention is therefore to provide a method for applying a layer of sound-absorbing material to the surface of an inner cavity of a pneumatic tire that is free from the disadvantages of the state of the art and that is, in particular, easy and inexpensive to implement.
(13) A further object of the present invention is accordingly to provide a system for applying a layer of sound-absorbing material to the surface of an inner cavity of a pneumatic tire that is free from the disadvantages of the state of the art and that is, in particular, easy and inexpensive to manufacture.
(14) According to the present invention a method and a system are provided for applying a layer of sound-absorbing material to the surface of an inner cavity of a pneumatic tire according to that determined within the attached claims.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
(1) The present invention is now described with reference to the attached drawings, which illustrate several non-limiting exemplary embodiments, wherein:
(2) FIG. **1** is a schematic side view, and with parts removed for clarity, of a system that has been implemented for the application of a layer of sound-absorbing material to the surface of the inner cavity of a pneumatic tire, implemented according to the present invention;
(3) FIG. **2** shows the system of FIG. **1** at the end of the step for the application of the layer of sound-absorbing material to the surface of the inner cavity of the pneumatic tire.
PREFERRED EMBODIMENTS OF THE INVENTION
(4) With reference to FIG. **1**, the numeral **1** denotes, in the entirety thereof, a system **1** for the application of a layer **2** of sound-absorbing material to the surface **3** of an inner cavity **4** of a pneumatic tire **5**. It is to be understood that the phrase “profile of the inner cavity **4** of a pneumatic tire **5**,” refers to a surface profile of the pneumatic tire **5**.
(5) The sound-absorbing material is attached (preferably glued) to the surface **3**.
(6) The layer **2** of sound-absorbing material preferably has a uniform thickness. It has been experimentally shown that one layer **2** of sound-absorbing material, having a thickness of between 20 mm and 40 mm, makes it possible to obtain satisfactory performance in terms of noise reduction; advantageously, the layer **2** of sound-absorbing material has a thickness of between 25 mm and 35 mm, preferably equal to 30 mm.
(7) The layer **2** of sound-absorbing material is advantageously made from any porous material with an open/closed cell finish chosen from amongst: expanded polyurethane, polystyrene, expanded melamine, Ethylene-Propylene Diene Monomer (EPDM). The density of the sound-absorbing material is between 15 kg/m.sup.3 and 120 kg/m.sup.3. Preferably, the density of the sound-absorbing material is between 15 kg/m.sup.3 and 80 kg/m.sup.3; in more detail, the density of the sound-absorbing material is preferably between 15 kg/m.sup.3 and 50 kg/m.sup.3.
(8) The pneumatic tire **5** is arranged on a frame **6** that is suitable for supporting, and bringing into rotation around a central X axis thereof, the pneumatic tire **5** by means of actuating means **7**, in

particular by means of motorized rollers **7**. The frame **6** is designed to bring the pneumatic tire **5** into rotation at a substantially constant speed and preferably between 1 and 15 m/min. Preferably, the pneumatic tire **5** is housed within the frame **6** in such a way as to prevent any lateral translation of the pneumatic tire **5** itself during the rotational movement around the X axis.

(9) The layer **2** of sound-absorbing material is provided with an adhesive layer GL that is evenly applied to the surface that is intended to make the connection with the surface **3**; the layer **2** of sound-absorbing material which is provided with a removable lining **8** (liner) applied to the adhesive layer GL is fed to the system **1** in order to allow for the winding of the layer **2** of sound-absorbing material.

(10) The layer **2** of sound-absorbing material is wound onto a storage reel (not shown) which is arranged externally to the system **1**. The layer **2** of sound-absorbing material wound onto the storage reel has a length that is intended to cover slightly less than the entire surface **3**.

(11) According to what is shown in FIG. **1**, the system **1** comprises a device **9** for applying the layer **2** of sound-absorbing material.

(12) Said applicator device **9** is conveniently implemented by means of a robot/manipulator (not shown) that is provided with a movable arm which serves to move the device from a position for the application of the layer **2** of sound-absorbing material, wherein it is inserted into the cavity **4** of the pneumatic tire, to a position for the manipulation of the pneumatic tyre **5**, wherein it is arranged externally to the cavity **4**.

(13) The applicator device **9** comprises an applicator roller **10** which is intended to implement the application of the layer **2** of sound-absorbing material to the surface **3** after the separation thereof from the lining **8**. The applicator roller **10** is arranged at a position directly facing and in proximity to the surface **3**.

(14) In more detail, the applicator roller **10** is arranged at a distance from the surface **3** that is variable as a function of the compression applied to the layer **2** of sound-absorbing material and necessary in order to produce the strength of adhesion between the adhesive layer GL and the surface **3**. Furthermore, the applicator roller **10** is arranged at a distance from the surface **3** in such a way as to make it possible to recover the lining **8** and to apply the layer **2** of sound-absorbing material without stretching or compressing the layer **2** of sound-absorbing material itself.

(15) The applicator device **9** then comprises a roller **11** for winding the lining **8**, whereupon the lining **8** is wound after the separation thereof from the layer **2** of sound-absorbing material; and a roller **12** for releasing the lining **8**. The releasing roller **12** is substantially interposed between the winding roller **11** and the applicator roller **10** and is intended to separate the layer **2** of sound-absorbing material from the lining **8**, which is subsequently rolled onto the winding roller **11**. The releasing roller **12** is substantially placed alongside the layer **2** of sound-absorbing material at the area wherein the separation of the layer **2** of sound-absorbing material from the lining **8** occurs. The releasing roller **12**, the winding roller **11** and the applicator roller **10** are provided with respective axes of rotation X.sub.10, X.sub.11, X.sub.12, that are parallel therebetween. The applicator roller **10** and the winding roller **11** are made to rotate, when in use, in opposite directions therebetween; clearly, the releasing roller **12** and the winding roller **11** are made to rotate, when in use, in the same direction.

(16) The winding roller **11** is preferably provided with a slit (not shown) formed on the surface and in a radial direction, and is intended to accommodate one end of the lining **8** in such a way as to prevent, when the system **1** is started, the lining **8** from slipping and thereby compromising the winding of the lining **8** itself.

(17) The winding roller **11** and the applicator roller **10** have dimensions (diameter) that are substantially uniform therebetween.

(18) The releasing roller **12** has dimensions (diameter) that are smaller than the dimensions of the winding roller **11** and/or the applicator roller **10**; in particular, the ratio between the diameter of the releasing roller **12** and the diameter of the winding roller **11** and/or the applicator roller **10** is

between 1:5 and 1:2, preferably equal to 1:4 or 1:3.
(19) It should be emphasized that, according to a preferred embodiment, the winding roller **11** and the applicator roller **10** are not provided with actuating means and that the rotation of the pneumatic tire **5** imparted by the frame **6** also drives into rotation the winding roller **11** and the applicator roller **10**, with a synchronous speed.
(20) According to a further variant, the winding roller **11** and the applicator roller **10** are provided with respective actuating means (not shown) that are intended to bring them into rotation around the respective axes X.sub.10 and X.sub.11 thereof. The actuating means are implemented in such a way as to regulate the speed of rotation of the rollers **10** and **11**, in order to prevent the lining **8** and/or the layer **2** of sound-absorbing material being torn due to an excessive tension or too loose.
(21) Finally, the applicator device **9** comprises means **13** for synchronizing the speed of the winding roller **11** and the applicator roller **10**. The synchronization means **13** are implemented in order to make it possible to maintain substantially uniform the peripheral speed of the applicator roller **10** and the winding roller **11**.
(22) The synchronization means **13** are implemented by means of a transmission **14**, in particular by means of a belt **14**, that connects the shafts **11*** and **10*** respectively of the winding roller **11** and of the applicator roller **10**. During the rotation of the pneumatic tire **5**, the synchronization means **13** drive into rotation the winding roller **11** in the opposite direction with respect to the direction of rotation of the pneumatic tire **5** (and of the applicator roller **10**), thereby allowing for the winding of the lining **8**.
(23) The applicator device **9** also comprises an element **15** for locking the layer **2** of sound-absorbing material.
(24) Hereinafter there will be described the method of operation of the system **1**, which includes, in succession, the following steps: an operator or, alternatively, an automatic manipulator arranges the pneumatic tire **5** on the frame **6** and blocks it by means of side rails in such a way as to prevent any lateral translation of the pneumatic tire **5** itself; at an initial portion, the lining **8** is manually separated (by an operator) from the layer **2** of sound-absorbing material; the initial end of the layer **2** of sound-absorbing material is attached to the locking element **15**, whilst the initial end of the lining **8** is inserted into the slot of the roller winding **11**; the robot/manipulator is arranged at the application position within the cavity **4**; the applicator roller **10** is arranged at a distance from the surface **3** that is variable as a function of the layer **2** of sound-absorbing material and determined in such a way that the layer **2** of sound-absorbing material is compressed to a thickness of between 5 and 15 mm, preferably of between 8 and 13 mm; the pneumatic tire **5** is driven into rotation around the axis X by the frame **6**, whilst the application begins of the layer **2** of sound-absorbing material on the surface **3**; during the rotation of the pneumatic tire **5** around the axis X, the synchronization means **13** make it possible for the winding roller **11** to rotate in the opposite direction to the direction of rotation of the pneumatic tire **5** and to wrap the lining **8** onto said winding roller **11**; during the rotation of the pneumatic tire **5** around the axis X, the pressure exerted by the applicator roller **10** on the pneumatic tire **5** makes it possible for the applicator roller **10** itself to rotate in same direction of rotation as the pneumatic tire **5**; the layer **2** of sound-absorbing material is fed between the applicator roller **10** and the surface **3** (in particular, according to a preferred embodiment, it is fed below the applicator roller **10**) and, finally, connected to the surface **3**; once the layer **2** of sound-absorbing material has been applied over the entire surface **3** (as shown in FIG. **2**) the frame **6** is stopped such that the robot/manipulator can be arranged at the manipulation position, externally to the cavity **4**, and the pneumatic tire **5** can be removed from the frame **6**.
(25) It is important to highlight that the applicator device **9** is implemented in such a way as to leave only a few centimeters of the adhesive layer GL exposed prior to being applied to the surface **3**; in other words, the separation between the lining **8** and the layer **2** of sound-absorbing material takes place substantially in the vicinity of the area wherein the connection takes place of the layer **2** of sound-absorbing material to the surface **3**.

(26) Moreover, the presence of the synchronization means **13** makes it possible to maintain substantially uniform the speed of the applicator roller **10**, and the winding roller **11**, and to prevent the winding of the lining **8** onto said winding roller **11** from stretching or compressing the layer **2** of sound-absorbing material being applied to the surface **3**.
(27) The advantages of the system **1** described in the preceding discussion are therefore clearly evident.
(28) The lack of dedicated actuating means for the applicator roller **10** and the winding roller **11** (which are driven into rotation as a result of the motorized rollers **7**) renders the system **1** advantageously economical to produce. Moreover, the presence of the synchronization means **13**, implemented by means of a transmission member **14**, in particular by means of a belt **14**, prevents, by rotating the applicator roller **10** and the winding roller **11** at the same speed, the strip **2** of sound-absorbing material from undergoing elongations or compressions which may lead to cracks within the sound-absorbing material itself. Finally, the strip **2** of sound-absorbing material is separated from the lining **8** just before being applied to the surface **3**, in such a way as to leave the adhesive layer GL exposed to air for the shortest possible period of time.

Claims

1. A system for applying a layer of sound-absorbing material to an inner surface of a cavity of a pneumatic tire, the system comprising: an applicator device configured to apply the layer of sound-absorbing material to the inner surface and which is movable internally and externally with respect to the cavity; wherein the layer of sound-absorbing material is fed to the applicator device, which is provided with an adhesive layer that is applied to a surface configured to connect with the inner surface and a removable lining applied to the adhesive layer; the applicator device further comprising: a single applicator roller configured to apply and continuously attach the layer of sound-absorbing material to the inner surface after removal of the lining while simultaneously compressing the layer of sound-absorbing material against the inner surface of the cavity to cause adhesion between the adhesive layer and the inner surface of the cavity, wherein the applicator roller is arranged, in use, at a position directly facing and in proximity to the inner surface; a winding roller configured to wind the lining after separation from the layer of sound absorbing material; and synchronization means for maintaining substantially uniform a speed of the applicator roller and of the winding roller.
2. The system of claim 1, wherein the winding roller and the applicator roller are each provided with respective shafts and the synchronization means comprises a belt that connects said shafts.
3. The system of claim 1, further comprising actuating means for rotating the pneumatic tire around a central axis thereof, wherein the rotation of the pneumatic tire imparted by the actuating means drives into rotation, in opposite directions, both the winding roller and the applicator roller.
4. The system of claim 1, comprising a releasing roller configured to release the lining that is substantially placed alongside the layer of sound-absorbing material at an area wherein the separation of the layer of sound-absorbing material from the lining occurs.
5. The system of claim 4, wherein the releasing roller, the winding roller, and the applicator roller are provided with respective axes of rotation that are parallel therebetween.
6. The system of claim 1, wherein the winding roller and the applicator roller have respective diameters that are uniform therebetween.
7. The system of claim 6, comprising a releasing roller configured to release the lining and having a diameter that is smaller than the respective diameter of the winding roller, wherein a ratio between the diameter of the releasing roller and the diameter of the winding roller is between 1:5 and 1:2.
8. The system of claim 7, wherein the ratio between the diameter of the releasing roller and the diameter of the winding roller is equal to 1:4 or 1:3.
9. The system of claim 1, wherein the winding roller is provided with a slit formed on the surface

and in a radial direction and is configured to accommodate one end of the lining.

10. A method for applying a layer of sound-absorbing material to an inner surface of a cavity of a pneumatic tire using the applicator device of claim 1, the method comprising: arranging the applicator device within the cavity; arranging the applicator roller at a distance from the inner surface that is variable as a function of one or more characteristics of the layer of sound absorbing material; driving into rotation the pneumatic tire around an axis thereof; bringing into rotation, at uniform speed and in opposite directions, the winding roller and the applicator roller during the rotation of the pneumatic tire, wherein the applicator roller is driven into rotation in the same direction of rotation as the pneumatic tire and the layer of sound-absorbing material is fed between the applicator roller and the inner surface and is connected to the inner surface; continuously attaching and simultaneously compressing the layer of sound-absorbing material to adhere the sound-absorbing material to the inner surface of the cavity of the tire; and extracting the applicator device from the cavity.

11. The method of claim 10, wherein the winding roller is driven into rotation in the opposite direction to that of the pneumatic tire so as to wind the lining onto the winding roller after separation thereof from the layer of sound-absorbing material.

12. The method of claim 10, wherein the applicator roller is arranged at a distance from the inner surface that is variable as a function of a compression applied to the layer of sound-absorbing material and necessary to produce a strength of adhesion between the adhesive layer and the inner surface.

13. The method of claim 10, wherein the applicator roller is arranged at a distance from the inner surface determined such that the layer of sound-absorbing material is compressed to a thickness of between 5 and 15 mm.

14. The method of claim 13, wherein the layer of sound-absorbing material is compressed to a thickness of between 8 and 13 mm.

15. The method of claim 10, further comprising manually separating an initial section of the lining from the layer of sound-absorbing material and inserting it into a surface slit formed on the winding roller.