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(54) HEATING MEANS, APPARATUS, AND METHOD FOR MANUFACTURING AN ARTICLE OF FOOTWEAR

(57) The present disclosure relates to heating means (130) for providing heat energy without contact to a sole element (101) of an article of footwear (100), in particular of a shoe, such as a sports shoe, preferably a running shoe, wherein the heating means (130) is configured to selectively heat at least partially a contour (110) of the sole element (101). The present disclosure also relates to an apparatus (145) for manufacturing an article of footwear (100), in particular a shoe, such as a sports shoe, preferably a running shoe, the apparatus (145) comprising: heating means (130) as described above. The present disclosure further relates to a method (200) for manufacturing an article of footwear (100), in particular a shoe, such as a sports shoe, preferably a running shoe, the method (200) comprising: providing (210) a sole element (101); providing (220) heating means (130) for providing heat energy without contact to the sole element (101); optionally providing (240) an upper (150); selectively heating (230), using the heating means (130), at least partially a contour (110) of the sole element (101).

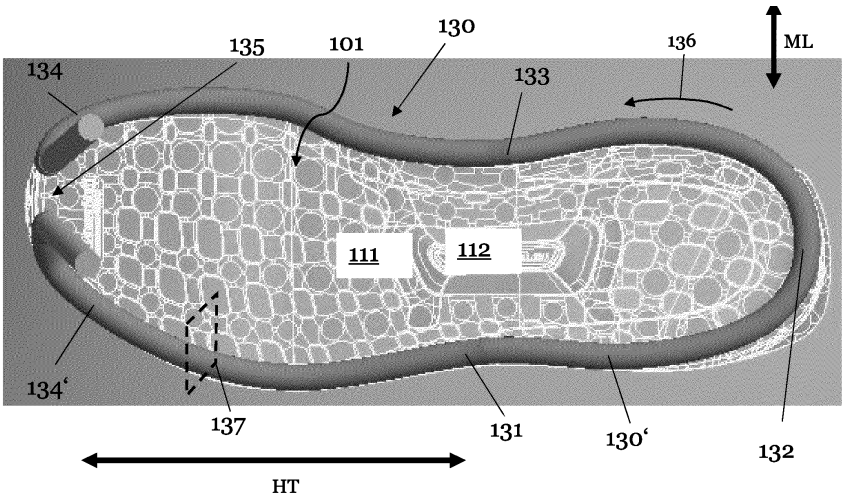

Fig. 2

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Description

1. Technical field

[0001] The present disclosure relates to heating means for providing heat energy without contact to a sole element, and an apparatus for manufacturing an article of footwear, in particular a shoe. The present disclosure also relates to a respective method for manufacturing an article of footwear. Further, the present disclosure relates to a respective article of footwear manufactured by the method and / or the apparatus.

2. Prior art

[0002] Articles of footwear and uppers for such articles are generally known and have various purposes and use cases. For instance, they may be designed to provide benefits for sport applications, for daily work, for leisure time or the like. Particularly in sport applications, uppers for shoes have the potential to provide beneficial performance characteristics such that the overall performance of the wearer during an athletic activity can be increased.

[0003] An article of footwear is commonly described as the combination of an upper and a sole. Typically, the upper covers regions such as the instep, the toe, the medial side, the lateral side, and the heel of a wearer's foot and provides an opening to allow the wearer to step inside the footwear. The sole is connected to the upper such that the sole's top side faces an underfoot portion of the upper, and its bottom side touches the ground during ordinary use of the shoe.

[0004] In manufacturing articles of footwear, for example shoes in particular sports shoes, it is often necessary to permanently connect individual components together. Such components of sporting goods frequently comprise plastic materials. This must be taken into consideration when selecting a suitable method for connecting the components.

[0005] One option is to connect the components mechanically, for example by screwing or riveting the components. However, this may be disadvantageous, for example with respect to the look of the articles of footwear, their weight or the durability or resilience of the connection.

[0006] A further possibility is to glue the components of an article of footwear together. This option may have the disadvantage, for example, that gluing may require complex pretreatment of the components. It may, for example, be necessary, particularly in the case of plastic components, to first roughen and prime the surfaces of the components and to pre-dry the adhesive used for connecting the components in an oven. In addition, adhesives used for the gluing of plastic components of articles of footwear are often harmful or environmentally hazardous.

[0007] In particular for connecting plastic components, various welding options have been used, for example using heat energy.

[0008] Prior art document US 2007 / 0 033 750 A1 describes a system for custom fitting athletic shoes to a wearer. Shoes of a single width for each shoe length have at least a portion of the upper made of a heat malleable material to be custom fitted for the shoe width. The heat malleable material is subjected to infrared radiation until it becomes plastic, and the width of the shoe may be adapted.

[0009] Prior art document US 2014 / 0 000 043 A1 and US 2014/0000044 A1 describe methods for the manufacture of articles of footwear for which electromagnetic induction is used to heat up a last on which two or more shoe components are arranged and thus create a connection between the components.

[0010] Prior art document WO 2012 / 099 784 A2 describes a method for Through-Transmission Infrared Welding (TTIR) of plastic components. The surface areas of two plastic components, which are in contact during the welding, are treated before welding to increase the amount of laser energy absorbed in the connection area and thus to support the welding of the touching plastic components. A main disadvantage of this method is that one of the materials has to be transparent or semi-transparent to the laser light.

[0011] Prior art document EP 3 053 471 A1 relates to a method for the manufacture of sporting goods, in particular a shoe, sporting goods manufactured by such method, for example a shoe, as well as a device for performing such a method. According to one aspect of the invention, a method for the manufacture of sporting goods, in particular a shoe, is provided. The method comprises providing a first component with a first connection surface and a second component with a second connection surface, activating at least one portion of the first connection surface by providing heat energy without contact, and connecting the first component with the second component by joining the first connection surface and the second connection surface.

[0012] Prior art document EP 3 338 580 A1 relates to a method for interconnecting components of a sporting good, in particular a sports shoe, a sports shoe manufactured with such a method as well as an apparatus for performing such method. In one embodiment, the method comprises the steps of (a.) providing a pattern element having at least one removable at least partially non-transparent or non-reflective portion, (b.) irradiating at least one of the first and the second component via the pattern element with heat radiation, and (c.) interconnecting the irradiated first and second component.

[0013] Prior art document EP 3 318 153 A1 relates to a method for joining a sole element with an upper element, comprising the steps of (a) operating a positioning system to position the sole element and the upper element in a defined first position with respect to each other, (b) operating the positioning system to position the sole element and the upper element in a second position for applying a joining agent to the sole element and / or

the upper element and (c) joining the sole element with the upper element by operating the positioning system to position the sole element in contact with the upper element in a third position of the positioning system, wherein the third position is defined with respect to the first position.

[0014] Prior art document CN 110 037 384 B relates to a method for manufacturing a shoe body comprises the following steps: superposing and fixing a tension film and a hot-melt material film, moving a three-dimensional vamp layer to make the surface of the vamp layer press against the hot-melt material film, and making the tension film and the hot-melt material film have a predetermined tension; heating the hot-melt material film in a non-contact manner, so that the hot-melt material film is combined with the surface of the vamp layer, and then removing the tension film from the hot-melt material film. A shoe body manufacturing device for implementing the shoe body manufacturing method comprises: a fixture for fixing the tension film and the hot melt material film, a vamp layer fixing member for the vamp layer to be arranged on, a driving device for driving the vamp layer fixing member or the fixture, and a non-contact heating device for heating the hot melt material film.

[0015] Prior art document US 9 591892 B2 relates to a method of making an article of footwear, wherein the method includes providing a last shaped to resemble a human foot. The method also includes forming at least one footwear component at least in part from a susceptor material that is thermally reactive to an electromagnetic field. The method may further include covering at least a portion of the last with two or more footwear components, wherein the two or more footwear components includes the at least one footwear component formed at least in part from a susceptor material. In addition, the method may include applying an electromagnetic field to the susceptor material, causing induction heating of the susceptor material and joining the two or more footwear components by melding the two or more components with the induction heating.

[0016] Prior art document US 2015 / 0 016 810 A1 relates to an infrared heating apparatus, which irradiates a member to be heated with infrared rays from infrared source to heat the member and sets heated region of the member to be heated with use of shielding member that restricts transmission of infrared rays. The infrared heating apparatus includes: a pair of holding members each having a plate shape that allow the infrared rays to be transmitted therethrough being disposed to intersect with an irradiation direction of the infrared rays between the infrared source and the member to be heated, and the shielding member being interposed and held between the holding members, and being a metal sheet, metal foil or a metal film, which has a prescribed shape that restricts transmission of the infrared rays, and the holding members being placed on each other to be in close contact with each other while the shielding member is interposed between the holding members.

[0017] The above-described methods have several disadvantages. For instance, in some of these methods, the components which are being connected are already in contact when they are heated such that both components are heated up. This can result in a costly, time consuming and inefficient method. It can also be potentially damaging to one or both components due to the potentially different melting points of the materials involved (e.g., one material may already have degraded before the other is sufficiently heated). A further disadvantage of the methods known from the prior art is that heat energy may be dissipated in regions of the components that are not involved in the creation of the connection between the components. Such an unwanted dissipation of heat energy can also be detrimental to the components. Another disadvantage of the methods known from the prior art is that heating of specific regions is usually not performed evenly and may lead to hot sports, in which a component may get burned.

[0018] It is therefore an object underlying the present invention to provide improved heating means, apparatuses, and methods for the manufacture of articles of footwear, in particular sporting goods, for example shoes, which can overcome the deficiencies of the prior art at least partially. In particular, potentially different material properties of components to be connected should be accounted for. Further, the heating means, apparatuses, and methods for the manufacture of articles of footwear should provide for a fast, efficient, and easy manufacturing of said articles of footwear. It should further be possible to dispense with the use of adhesives. It is a general objective to reduce costs in manufacturing such articles of footwear, in particular shoes.

3. Summary of the invention

[0019] The above-mentioned objects are at least partially achieved by the subject-matter of the independent claims. Preferred embodiments are subject of the dependent claims, and other suitable aspects of the present invention are described through the overall disclosure of the present application. It is noted that the headlines in the present disclosure are provided solely for the purpose to assist in keeping an overview during reading. The headlines do not mean that features of the respective embodiments cannot be combined.

Heating means

[0020] In one aspect, the objects are solved at least partially by a heating means for providing heat energy without contact to a sole element of an article of footwear, in particular of a shoe, such as a sports shoe, preferably a running shoe, wherein the heating means is configured to selectively heat at least partially a contour of the sole element.

[0021] In this manner, the heating means provides for an improved heating to the sole element of an article of

footwear. In particular, it is believed that the contour of the sole element may play a key role in connecting the sole element to a further part of an article of footwear, such as an upper. Hence, by providing heating means that can selectively heat at least partially said contour of the sole element, manufacturing thereof can be made more efficient, faster and performed by using less resources, and less labor.

[0022] The heating means has the further advantage that the heat energy, which is provided without contact to the contour of the sole element (or at least a part thereof), may be precisely adjusted to the material properties of the contour of the sole element. For instance, the heat energy may be directly applied to the contour of the sole element. The amount of heat energy provided to contour of the sole element may be individually controllable. Thereby, provision of too much and / or too little heat energy to the contour of the sole element can be avoided. This bears the potential that unwanted dissipation of heat energy in other parts of the sole element, i.e., parts other than the contour, can also be avoided or at least reduced. Moreover, avoidance of too much heat energy has the advantage that overheating of the sole element and / or burning of the sole element can be prevented.

[0023] Further, as described elsewhere herein, the heating means can be shaped in such a manner that different distances of the heating means to the sole element may be provided. This may also help that overheating of the sole element and / or burning of the sole element can be controlled to a greater extent. Moreover, such different distances of the heating means to the sole element may be particularly relevant to compensate for different thicknesses of the sole element. For instance, a greater distance may be provided in areas of the sole element where it is thinner (as such thinner areas may need less heat energy). Additionally or alternatively, a smaller distance may be provided in areas of the sole element where it is thicker (as such thicker areas may need more heat energy).The heating means being configured to "selectively" heat at least partially a contour of the sole element may be understood in such a manner that the heating means should have the capability to provide heat energy without contact only to said contour (or at least part thereof). For instance, heating devices, which heat the overall sole element, i.e., a contour of the sole element and the part within the contour, may not be regarded as heating means that can "selectively" heat a contour (or at least a part thereof) of a sole element. Nevertheless, it is noted that it is not precluded that the heating means according to the present disclosure may still have the capability to heat an inner part of the contour of the sole element, if this is desired. Nevertheless, said heating means must possess the capability to only heat the contour of the sole element.

[0024] The heating means being "configured" to selectively heat at least partially a contour of the sole element may be understood in such a manner that the heating means may be dimensioned to allow for heating of said contour (or at least a part thereof). Thereby, the heating means may, in one example, be structurally designed to allow for this specific way of heating.

[0025] As described elsewhere herein, said selectively heating of the contour (or at least a part thereof) may involve activating said contour (or at least a part thereof). It may be possible that the sole element comprises two main surfaces, i.e., a first main surface and a second main surface, both surfaces being substantially perpendicular to a vertical axis. The vertical axis may correspond to a wearer's main body axis from head to foot when the wearer wearing a shoe comprising said sole elements stands on the ground. The first main surface may face an upper in a manufactured shoe. The second main surface may be substantially opposite to the first main surface and may face the ground. The contour of the sole element referred to herein may be the contour of the first main surface facing the upper in the manufactured shoe.

[0026] It is noted that it is not precluded that an upper may also be heated before being connected to the sole element, as also described elsewhere herein. Said heating of the upper may be performed in a state in which the sole element and the upper are spaced apart. Subsequently joining the sole element and the upper can allow both components to be joined and connected such that the contour of the sole element may be located in the interior of the manufactured article of footwear.

[0027] Since the heating means are configured to selectively heat at least partially a contour of the "sole element", it is understood that this implies that the heating means may provide for structural features to make heating of such a contour of the sole element possible. That is, because the contour of a sole element may not be comparable with a contour of any random object. Rather the contour of a sole element is usually shaped to follow the shape of a foot of a user. Such a shape is generally known to the skilled person in this technical field.

[0028] It is noted that the sole element may be a midsole, an outsole, an outsole element, and a sole plate as described elsewhere herein in greater detail.

[0029] The "contour" of the sole element referred to herein may be understood as the shape or profile of the sole of a shoe, in particular but not limited to when seen from top to bottom (i.e., along a vertical axis). The contour may also comprise the shape or profile of the sole of a shoe as seen from a side (i.e., along a horizontal plane, spanned by a heel to toe axis and a medial to lateral axis). The contour of the sole element referred to herein may be understood as the outline of the sole of a shoe, in particular but not limited to when seen from top to bottom (i.e., along a vertical axis). However, it is to be noted that the contour of the sole element is not limited to the outermost edge of the sole element when seen from the top to bottom. That is, the contour may comprise an extension in the horizontal directions and may encompass an area. In an illustrative example, if the sole element had a circular shape, the contour may be an annular ring covering the outermost edge of said circular shape. It is to note

that the contour of the sole element referred to herein is not limited to the horizontal direction but may additionally or alternatively comprise a vertical extension (i.e., along a vertical axis). That is, the contour may comprise the surfaces on the side of the sole element, such as the medial side, the lateral side, the side to the rear (e.g., at the heel portion), and / or the side to the front (e.g., at the toe portion). The contour may comprise an extension into the thickness of the sole element.

[0030] The heating means for providing heat energy "without contact" may mean that any type of provision of heat energy may be performed without directly touching the contour of the sole element with the heating means. In particular, it may mean that any type of provision of heat energy may be performed without directly touching the sole element with the heating means. Any method and / or heat source known in the art that can accomplish this may be employed for the heating means according to the present disclosure. Merely for the purpose of illustrating this, some examples of heat sources may be the use of radiation (as further described elsewhere herein below), or heat convection in a gas.

[0031] The heating means used for providing the heat energy without contact may be controlled to provide heat energy in a consistent manner across the contour of the sole element or at least across parts of the contour of the sole element. It is noted that the heating means may comprise several heat elements, heat sources, or the like that may be separated from one another or formed as a unitary structure. Said several heat elements, heat sources or the like may be individually controlled. These heat elements, heat sources, or the like may provide differing amounts of heat in different areas or parts of the contour of the sole element. Also, multiple heat sources (each having potentially multiple individual heat elements) may be used to increase the degree of control over the provided amount of heat energy in different areas or parts even further. In general, any heat source known in the art may be used.

[0032] In one example, the objects are solved at least partially by a heating means for providing heat energy without contact to a sole element of an article of footwear, in particular of a shoe, such as a sports shoe, preferably a running shoe, wherein the heating means is dimensioned to heat at least partially a contour of the sole element.

[0033] Reference is also made to the fact that the features and embodiments described in the following represent independent aspects of the invention. While these features will be described in the following in relation to an embodiment in which the heat energy is provided to the contour of the sole element without contact, they may also be combined with or used in embodiments in which the contour of the sole element is activated by providing heat energy via direct contact. For example, the features discussed in the following may be used in combination with an embodiment in which the contour of the sole element is at least partially provided with heat energy via direct contact.

[0034] It is noted that the heating means described herein may be particularly useful in conjunction with and / or when applied to a sole element, such as a sole element of a sports shoe, preferably as a running shoe. However, it should be noted that the heating means could be used with any kind of component that needs to be connected. In this manner, the application of the heating means is not necessarily limited to articles of footwear. Nevertheless, the heating means may be particularly useful when used for sole elements, such as soles used for football shoes, hiking boots, sneakers, basketball shoes, rugby shoes, baseball shoes, golf shoes, tennis shoes, cross-training shoes. Moreover, the heating means may be used in conjunction with sole elements used for shoes for any kind of athletic activity.

[0035] The term "athletic activity" is to be understood such that it includes one or more and / or any combination of at least the following non-exhaustive list: aerobics, athletic exercises, running, hiking, climbing, group fitness classes, walking, cycling, yoga, soccer, tennis, football, basketball, doing a workout, volleyball, gymnastics, weightlifting, cross-training, baseball, softball, rugby, field hockey, wrestling, squash, track and field (such as sprinting, long jump, high jump), cross-country skiing, golfing, lacrosse, triathlon.

[0036] In a preferred embodiment of the heating means as described herein, the heating means is configured to not heat a portion within the contour of the sole element.

[0037] This has the advantage that the heat energy is not provided to portions of the sole element, where such heating may not be necessary. Rather, heating may be provided specifically to portions of the sole where it may be necessary the most. Thus, costs can be reduced, as waste of energy can be mitigated. Further, damage of material of the sole element in said portion within the contour of the sole element can be largely prevented. This may increase longevity of the sole element and of the shoe so manufactured by way of the heating means. In particular, such localized provision of heat energy might increase the lifespan and durability of the sole element, avoiding the degradation of material properties that can occur with excessive heat to the overall sole element. It may also contribute to the safety of the heating means by preventing burns or other heat-related issues to parts of the environment where such a provision of heat energy may not be desired. This could also have a positive effect to personnel.

[0038] It is noted that although the heating means is configured to not heat a portion within the contour of the sole element, this does not exclude that the contour encompasses an extension along the vertical axis, which is provided with heat energy. Thereby, there are still portions of the contour of the sole element along the vertical axis which are heated. For instance, portions of the contour of the sole element along the vertical axis may include a heel counter.

Apparatus for manufacturing an article of footwear

[0039] In a further aspect, the objects are solved at least partially by an apparatus for manufacturing an article of footwear, in particular a shoe, such as a sports shoe, preferably a running shoe, the apparatus comprising the heating means as described herein.

[0040] It goes without saying that the technical properties shown or described for the heating means, the advantages and the improvements over the state of the art are likewise applicable to the apparatus for manufacturing an article of footwear. Same applies vice versa.

[0041] A manufacturing apparatus designed in such a way may take up only a relatively small amount of building space and it may allow the manufacture to be automated to a large extent. It can therefore be particularly suitable for series and mass production. The various manufacturing parameters, as inter alia specified in the method for manufacturing an article of footwear as described elsewhere herein (e.g., a heating time, distance and power of the heat source, pressure, duration of joining and / or pressing) may also be individually adjusted so that individualized articles of footwear, in particular shoes, such as a sports shoes, preferably a running shoes can be manufactured using a single manufacturing apparatus.

Dimensioning of heating means, areas to be heated

[0042] In a preferred embodiment of the apparatus for manufacturing an article of footwear as described herein or the heating means as described herein, the heating means is dimensioned so as to heat at least 10 % of the contour of the sole element in a circumferential direction, preferably at least 20 %, more preferably at least 30 %, even more preferably at least 40 %, even more preferably at least 50 %, even more preferably at least 60 %, even more preferably at least 70 %, even more preferably at least 80 %, most preferably at least 90 % of the contour of the sole element in a circumferential direction.

[0043] This has the advantage that only a specific amount of the contour can be heated. For instance, some parts of the contour may not be of particular importance. Thereby, also an improved temperature distribution may be achieved, allowing to adjust to a desired comfort level based on the individual requirements of the respective sole element. Providing heat to a larger amount of the contour may aid in providing an improved connection of the sole element to an upper. This may potentially increase a bonding stretch between the sole element and the upper. By configuring the heating to cover more portions, it could possibly reduce the chances of concentrated overheating which would protect the material of the sole element and increase the lifespan of the sole element.

[0044] It is noted that the amount of the contour that is heated in the circumferential direction does not necessarily mean that the heated portion must be connected along the circumferential direction of the contour. Thereby, it may be encompassed that the contour of the sole element comprises one or more portions, which may be separate from one another, but that form in combination the amount of the (overall) contour that is heated.

[0045] The circumferential direction may be generally understood by the skilled person as the direction along the periphery of the sole element, as seen from the top to the bottom (e.g., along the vertical axis).

[0046] In a preferred embodiment of the apparatus for manufacturing an article of footwear as described herein or the heating means as described herein, the heating means is dimensioned to not heat at least 20 % of an innermost area of the sole element, preferably to not heat at least 30 %, more preferably to not heat at least 40 %, even more preferably to not heat at least 50 %, even more preferably to not heat at least 60 %, most preferably to not heat at least 70 % of the innermost area of the sole element.

[0047] This has the advantage that the heat energy is not provided to portions of the sole element, where such heating may not be necessary. In particular, it was found that heating the contour of the sole element alone and no further parts of the sole element may be sufficient in providing an improved bonding. Thereby, not heating an innermost area of the sole element contributes to reduce costs, waste of energy, and damage of material of the sole element. This increases longevity of the sole element and of the shoe so manufactured by way of the heating means.

[0048] The "innermost area" of the sole element may be understood as the area of the first main surface of the sole element as described elsewhere herein. Thereby, the innermost area of the sole element may face the exterior, if the sole element is not connected to an upper. Further, the innermost area may extend within the contour of the sole element. Preferably, the innermost area that is not heated may be connected to form a unitary area. Nevertheless, it is not precluded that the innermost area comprises various sub-areas that are not connected to one another.

[0049] In a preferred embodiment of the apparatus for manufacturing an article of footwear as described herein or the heating means as described herein, the contour of the sole element comprises at most 10 % of an outermost annular area of the sole element, preferably at most 8 %, more preferably at most 6 %, most preferably at most 5 % of an outermost annular area of the sole element.

[0050] As noted elsewhere herein, the contour of the sole element is not limited to the outermost edge of the sole element when seen from the top to bottom. That is, the contour may comprise an extension in the horizontal directions and may encompass an area. Nevertheless, without wishing to be bound by theory, it is believed that the contour should not extend in the horizontal directions too much. Thereby, this preferred embodiment has the advantage that only the portion of the sole element believed to be relevant the most to provide a sufficient bond is heated.

Heating arm

[0051] In a preferred embodiment of the apparatus for manufacturing an article of footwear as described herein or the heating means as described herein, the heating means comprises a heating arm, wherein the heating arm preferably resembles the contour of the sole element, wherein the heating arm is preferably opened in proximity to a toe portion of the sole element when heating the contour of the sole element.

[0052] This has the advantage of improving heating of the sole element. For instance, the design of a heating arm that resembles the contour of the sole element can provide a more accurate and a more uniform heat distribution to the contour of the sole element that matches the shape and anatomical structure of a foot of a wearer. This is particularly useful, as this contour of the sole element serves as a connection surface to an upper.

[0053] Further, the heating arm according to this preferred embodiment might be an efficient way to use a single element to provide heat to multiple portions of the contour of the sole element. This may reduce the need for multiple heating elements. However, multiple heating elements are not precluded as described elsewhere herein.

[0054] The heating arm may be understood as a structural element that substantially forms the heating means. The "arm" may additionally or alternatively be referred to as a leg, or the like.

[0055] In a preferred embodiment of the apparatus for manufacturing an article of footwear as described herein or the heating means as described herein, the heating arm comprises one or more of the following segments: a lateral segment, a heel segment, a medial segment, a toe segment.

[0056] This has the advantage of providing distributed and targeted heating for specific portions of the contour of the sole element. This segmented approach of the heating arm may offer several benefits: for instance, different parts of the contour of the sole element may have different heating needs. For instance, the heel portion and / or the toe portion of the contour of the sole element can be heated differently than the lateral and / or the medial side. A heating arm with a segmented design may allow heating to be tailored more precisely to these needs for better comfort and efficiency. It is noted that the individual segments of this preferred embodiment may form one integral heating means. However, the individual segments of this preferred embodiment may alternatively be separate from one another.

[0057] In a preferred embodiment of the apparatus for manufacturing an article of footwear as described herein or the heating means as described herein, the heating arm comprises a substantially circular profile in a cross-sectional cut perpendicular to a longitudinal axis of the heating arm.

[0058] The circular profile has the advantage of providing an improved heat energy to the contour of the sole element, preferably by radiation (as further described elsewhere herein below). This may be the case, because the circular profile can aid in distributing the heat energy more evenly. This may result in an improved connection formed between the sole element and an upper.

[0059] In addition, the circular profile may provide for a good volume to surface ratio of the heating arm. This may entail that the heating arm encompasses a minimal volume and / or a minimal physical space, whilst a relatively large surface area for the purpose of heating is provided. In addition, the circular profile may be easily manufactured and may be useful. This may be the cause, because a circular profile is adapted to rounded shapes of the sole element better compared to profiles of different shapes.

[0060] The circular profile as referred to herein may be understood as a geometric shape or cross-sectional of the heating arm that exhibits a substantially continuous, and / or rounded shape. The circular profile may substantially resemble a circle. The circular profile may lack sharp edges or corners. The circular profile may be characterized by its substantially uniform curvature. In one example, substantially all points of the circular profile may be arranged equidistant from the center of the circular profile. Nevertheless, the circular profile referred to herein may also encompass shapes that slightly deviate from a circle. For instance, the circular profile may encompass an elliptical shape and / or a shape with rounded corners.

[0061] The longitudinal axis of the heating arm may be readily understood as the axis that substantially follows the extension of the greatest dimension of the heating arm. The longitudinal axis of the heating arm may follow the circumferential direction of the sole element over a large part.

Coating

[0062] In a preferred embodiment of the apparatus for manufacturing an article of footwear as described herein or the heating means as described herein, the heating means comprises a coating configured to reduce provision of heat energy without contact to the sole element.

[0063] The heating means comprising a coating configured to reduce the provision of heat energy without contact to the sole element may have various advantages. For instance, it may serve to increase energy efficiency and to optimize heat transfer. For instance, the heat energy may be guided better in a manner to specifically heat portions of the sole element, while mitigating the provision of heat energy without contact to other portions of the sole element. For instance, heat energy can be provided where it is intended and the apparatus and / or the heating means may prevent unnecessary heating of other parts.

[0064] In addition, the coating may serve as a protection. For instance, the apparatus and / or the heating means may conserve energy to a greater extent, which may prolong the operating time of the apparatus and / or

of the heating means. It may also be possible to reduce energy costs and to minimize the impact on the environment. Further, by preventing unnecessary provision of heat energy, the coating may also help to protect other components in the apparatus from overheating. Thereby, it is believed that the durability and lifespan of the apparatus may be enhanced.

[0065] In a preferred embodiment of the apparatus for manufacturing an article of footwear as described herein or the heating means as described herein, the coating comprises a non-heat irradiation permissive material, such as ceramics, glasses, preferably gold.

[0066] This further contributes to the advantages mentioned in the foregoing preferred embodiment. Further, the non-heat irradiation permissive material may increase safety. For instance, safety of the personnel in proximity to the apparatus may be increased. That is, because the coating may act as a safety feature by preventing unnecessary provision of heat energy that could potentially cause harm or discomfort to personnel or the like.

[0067] The "non-heat irradiation permissive material" may refer to a substance or material that has low thermal conductivity, which is not conducive to heat transfer, and / or that is not conducive to the passage of ionizing radiation. Such a non-heat irradiation permissive material may be particularly suitable for use in situations where it is important to limit the transfer of heat and / or while providing a barrier to ionizing radiation. This material may be understood as a radiation shielding.

[0068] In a preferred embodiment of the apparatus for manufacturing an article of footwear as described herein or the heating means as described herein, the coating is provided at least partially on a perimeter of the heating means thereby defining an open section on a remaining part of the perimeter of the heating means through which heat energy without contact can be provided to the sole element.

[0069] This further contributes to the advantages mentioned in the foregoing preferred embodiment. The open section allows to fine-tune the exact controlling of the heat energy. In particular, the open section may allow for precision-controlled heating, helping to direct it to specific areas of the sole element where it is most needed. This can improve the overall effectiveness and efficiency of the heating means.

[0070] By defining an open section that allows for direct heat transfer to the sole element, heat energy use may be optimized. This may prevent wasteful diffusion of heat energy into surrounding areas, making the apparatus even more energy efficient. Depending on the design, the configuration of the coated and uncoated areas can be tailored to deliver specific heat profiles, allowing for greater customization of the heat energy to be provided to the sole element. Thereby, a modulated provision of heat energy may be enabled.

[0071] The perimeter may be the circumference of the heating means. In a first example, the perimeter may be the circumference of a cross-sectional cut of the heating means. However, the perimeter of this embodiment may additionally or alternatively cover, in a second example, a circumference of the heating means as seen in a horizontal plane, e.g., from the top to the bottom. Nevertheless, the first example may be the preferred perimeter. The open section may be an open area, an open portion, or the like. Preferably the open section is an open surface formed on an outer surface of the heating means.

[0072] In a preferred embodiment of the apparatus for manufacturing an article of footwear as described herein or the heating means as described herein, the open section defines an angle of at least 10 °, preferably at least 20 °, more preferably at least 30 °, even more preferably at least 40 °, most preferably at least 50 °, and / or wherein the open section defines an angle of at most 80 °, preferably at most 70 °, more preferably at most 60 °, most more preferably at most 50 °.

[0073] This further contributes to the advantages mentioned in the foregoing preferred embodiments. The effect of having an open section that defines an angle according to this preferred embodiment of the heating means can impact the operation and efficiency of the heating means in the various ways. For instance, the angle at which this open section is set can allow for regulating how the heat is spread or focused to the contour of the sole element. A larger angle could provide broader coverage of the contour of the sole element. A smaller angle could help focus the heat on a particular direction or area of the contour of the sole element. These angles also allow customization of the heat distribution based on specific needs and preferences for a certain sole element. Some sole elements may require broad, evenly distributed provision of heat energy, while others may require focused provision of heat energy at specific areas, for instance cold-sensitive areas of the contour of the sole element.

[0074] Without wishing to be bound by theory, it is believed that an optimal balance between these requirements can be struck according to the values as specified in this preferred embodiment.

Energy source and arrangement of heating means

[0075] In a preferred embodiment of the apparatus for manufacturing an article of footwear as described herein or the heating means as described herein, the heating means is configured to provide heat radiation, preferably by one or more heat sources, wherein the heating means is preferably configured to provide infrared radiation, IR-radiation, preferably by one or more IR-radiation sources.

[0076] In general, the IR-radiation as referred to in the present disclosure may encompass a broad range of wavelengths, for instance a range of wavelengths beyond the red end of the visible light spectrum. The IR-radiation as referred to in the present disclosure may encompass at least the following three categories of wavelengths: (1) Near-Infrared (NIR): this region may

span approximately 700 nm to about 2,500 nm. Near-infrared radiation may be closest to the visible light spectrum and may also be useful in applications such as optical communication, fiber optics, and some forms of spectroscopy. (2) Mid-Infrared (MIR): the mid-infrared region covers wavelengths from around 2,500 nm to 25,000 nm (or 25 micrometers). It may also be useful in applications like thermal imaging, chemical analysis, and identifying molecular vibrations in infrared spectroscopy. Far-Infrared (FIR): the far-infrared region extends from about 25,000 nm (25 micrometers) to 1 millimeter (1,000 micrometers). It may also be useful in applications such as astronomy for studying cool objects in space and in some medical diagnostics.

[0077] In some particular examples, when providing heat radiation, in particular infrared radiation, IR-radiation, the wavelength emitted by a respective the IR-radiation source could, for example, lie in the range 700 nanometers (nm) to 1,400 nm, or it could lie in the range 1,400 nm to 3,000 nm.

[0078] The heat source of this preferred embodiment can in general be any heat source known in the art. Merely to give some examples without the intention to limit the scope of protection, the heat source could comprise a laser or a hot radiation plate. The heat sources may additionally or alternatively comprise one or more of the following: infrared heaters, radiant floor heating, space heaters, microwave ovens, heat lamps, solar heaters, induction heaters. Preferably, one or more heat lamps are employed.

[0079] An advantage of using infrared radiation is that it is easy to produce and to provide to the contour of the sole element. The amount of heat energy provided to the contour of the sole element by IR-radiation may, for example, be controlled by adjusting the output power of the heat sources. Further, the intensity of the radiation, the size or emitted wavelength of the IR-sources could easily be adjusted. In addition, the distances of the sources to the contour of the sole element, the view factor of the contour of the sole element, i.e., how much of the emitted energy the contour of the sole element intercepts, and / or the emissivity of the material of the contour of the sole element, or the like could be adjusted. Moreover, the use of infrared radiation does not impose any particular requirements, such as electrical conductivity, on the material of the contour of the sole element.

[0080] As described in this preferred embodiment, preferably infrared radiation, IR-radiation is employed. For this, the heat sources may be an IR-lamp, e.g., a type of IR fluorescent tube. The heat sources may comprise just a single IR-lamp. Alternatively, the IR-radiation source may include several IR-lamps that irradiate the contour of the sole element. It also possible that several separate IR-radiation sources are used.

[0081] In a preferred embodiment of the apparatus for manufacturing an article of footwear as described herein or the heating means as described herein, the heating means comprises a plurality of distinct heating arms, wherein each heating arm preferably comprises one more heat source.

[0082] With this preferred embodiment, heating of the contour of the sole element can be beneficially influenced. For instance, the heating means comprising a plurality of distinct heating arms could potentially enhance the heat energy distribution efficiency. By having a plurality of arms, the heat energy may be spread to different portions of the contour of the sole element substantially simultaneously, reducing the time taken to heat a certain portion of the contour of the sole element. However, as understood, the heat energy may additionally or alternatively be spread to different portions at different times instead of substantially simultaneously, in case this is desired. Additionally, or alternatively, heating by way of one of these distinct heating arms may start earlier as compared to other distinct heating arms. This may be for instance beneficial, in case some portions of the contour of the sole element, for instance a toe portion of the sole element, a heel portion of the sole element, a medial side of the sole element, and / or a lateral side of the sole element require additional provision of heat energy. Such additional provision of heat energy may be thinkable in case the contour of the sole element to be heated in one or more of these portions has a greater annular area (i.e., a greater extension in the horizontal directions directed to the center of the sole element) compared to another portion.

[0083] In a preferred embodiment of the apparatus for manufacturing an article of footwear as described herein or the heating means as described herein, the plurality of distinct heating arms comprises: a looped toe heating arm configured to provide heat energy without contact to a toe portion of the sole element; a linear lateral heating arm configured to provide heat energy without contact to a lateral side of the sole element; a linear medial heating arm configured to provide heat energy without contact to a medial side of the sole element; and / or a looped heel heating arm configured to provide heat energy without contact to a heel portion of the sole element.

[0084] With this embodiment, fine-tuning of the provision of heat energy to the contour of the sole element can be performed. In particular, the looped toe heating arm, the looped heel heating arm, the linear medial heating arm, and / or the linear lateral heating arm allow for a more tailored heating of the contour of the sole element, which can improve the connection of the sole element to an upper.

Mounting means and spring-loaded pins

[0085] In a preferred embodiment of the apparatus for manufacturing an article of footwear as described herein, the apparatus is further comprising a first mounting means for receiving a sole element, wherein the first mounting means comprises biasing means for providing a biasing force to a sole element when received in the first mounting.

[0086] The first mounting means allow to hold the sole element substantially in place. Thereby, precision of providing heat energy to the sole element may be increased. The first mounting means may be implemented in various ways. Just for the sake of given an example, a cup shaped structure may be comprised by the first mounting means. Alternatively, a cavity and / or a recess may be provided such that the sole element could be received in said cavity and / or in said recess.

[0087] As a further example, a substantially flat array may be provided, in which the sole element can be received.

[0088] The biasing means may have the advantage that the mounting means can substantially universally be adapted to several sizes of the sole element. This can reduce costs, as the same first mounting means may be provided for a plurality of different sizes of the sole element.

[0089] It is noted that the term "first" of the expression "first mounting means" does not limit the term "mounting means" itself. In particular, this does not mean that a "first mounting means" may necessarily be different than a "second mounting means" and / or that a "first mounting means" is more limiting than a "mounting means" alone. The term "first" is merely used to name the mounting means appropriately. In case the apparatus comprises a second mounting means, the second mounting means may be different than the first mounting means as described elsewhere herein and in particular further below.

[0090] In a preferred embodiment of the apparatus for manufacturing an article of footwear as described herein, the biasing means comprises a plurality of spring-loaded pins, wherein the biasing means preferably comprises a toe group of spring-loaded pins arranged on a toe portion of the first mounting means, when a sole element is received in the first mounting, wherein the biasing means preferably comprises a heel group of spring-loaded pins arranged on a heel portion of the first mounting means, when a sole element is received in the first mounting means.

[0091] This further contributes to the advantages mentioned in the foregoing preferred embodiments.

[0092] The use of spring-loaded pins, arranged in groups at the toe portion and / or at the heel portion of the first mounting means, may add one or more of the following advantageous effects to the apparatus. For instance, the spring-loaded pins may automatically adjust to variations in the size and / or shape of different sole elements. As a result of which, the apparatus may easily adapt itself to size fluctuations of sole elements, which often pertain in the sector of article of footwear.

[0093] The number of the spring-loaded pins can be selected arbitrarily. The number of the spring-loaded pins may depend on the specific sole element that is used. For instance, at least 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, or more spring-loaded pins may be employed in any one of the groups mentioned in here.

[0094] In a preferred embodiment of the apparatus for manufacturing an article of footwear as described herein, the apparatus is further comprising a second mounting means for receiving a component of an article of footwear, preferably an upper, wherein the first mounting means and the second mounting means can be moved apart from one another and moved together under pressure.

[0095] The provision of a second mounting means designed to receive a component of an article of footwear, such as an upper, in addition to the first mounting means (which may receive the sole element), facilitates that the apparatus can handle multiple components of an article of footwear. Such handling may be performed at the same time, or at different times.

[0096] The ability to move the first mounting means and second mounting means apart and together under pressure may provide the advantage that forming a connection between the sole element and the component can be enhanced. In addition, versatility of the apparatus may be increased. That is, because the range of modifications and / or treatments that can be performed on an article of footwear may be increased.

[0097] With such a movement as specified in this preferred embodiment, the contour of the sole element and the component (e.g., the upper) may be pressed together. This pressure may be provided for a pre-determined duration and with a specific pressure to produce a stable and / or durable connection of the contour of the sole element and the component (e.g., the upper). A suitable duration and / or a suitable pressure will in general depend on several factors. Such factors may include, for example, the material used, the manner and duration of activation, the size of the contour of the sole element and the respective connection surfaces of the component (e.g., the upper). A further factor may be in some cases whether an additional binding agent is used, or the like.

[0098] In a preferred embodiment of the apparatus for manufacturing an article of footwear as described herein, the first mounting means comprises a cavity having a tapered shape for receiving a sole element.

[0099] The tapered shape the cavity may mean that the cavity has at least one surface that has a tapered shape. A tapered shape allows the cavity to accommodate a wide variety of different sizes and shapes of sole elements. As a result of which, versatility can be increased. This is, because both wider and narrower sole elements can be easily received. This may make the apparatus universally compatible.

[0100] The tapered shape may be a geometric form that gradually narrows or widens along its length. It may be characterized by one end being wider or larger than the other. Although not always the case, the change in width or size may occur smoothly and / or gradually. Sometimes, said change in width or size may occur in a linear or conical fashion.

[0101] The tapered shape and / or the tapered surface of the cavity may additionally or alternatively mean that

the cavity has an inclined surface. In particular, the bottom of said cavity may be smaller than its top through which the sole element may be received. This may allow that a form fit could be established between the sole element and the cavity regardless of the size of the sole element.

[0102] In a preferred embodiment of the apparatus for manufacturing an article of footwear as described herein, the heating means are configured to be moved, preferably rotated, relative to the first mounting means, such that a distance to a sole element can be adjusted, when the sole element is received in the first mounting means.

[0103] With this embodiment, heating means can be adjusted so as to smoothly align with the contour of the sole element. Such rotation may be beneficial, as the height (as seen along a vertical axis) of the sole element may vary as seen along a circumference of the sole element. The movement as specified in this embodiment may facilitate that one or more of the distinct heating arms get inclined relative to the sole element. As a result of which, a distance to the contour of the sole element may be kept substantially equal when as seen along a circumference of the sole element.

[0104] As understood, the heating means referred to in this preferred embodiment may encompass any one or more of the heating arms and the plurality of distinct heating means mentioned elsewhere herein. Thereby, for instance the looped toe heating arm, the looped heel heating arm, the linear medial heating arm and / or the linear lateral heating arm may be moved relative to the first mounting means. Such movement may be performed individually for each heating arm.

[0105] The inclusion of adjustable, preferably rotatable, heating means relative to the first mounting means can have several advantageous effects. For instance, being able to rotate or to move the heating means allows for directing the heat source more precisely, potentially enabling more uniform and efficient heating of different parts of the contour of the sole element. Further, by adjusting the distance between heating means and the sole element, the intensity of the heat applied on the contour of the sole element can be regulated, allowing the apparatus to cater to specific needs and preferences. This feature may also enable the apparatus to adapt to different sizes and shapes of sole elements, so varying distances may be adjusted to work effectively with various types of articles of footwear. In addition, the risk of the heat source coming too close to the sole element (thereby potentially causing damage or burning to the sole element) can be mitigated.

Method for manufacturing an article of footwear

[0106] In a further aspect, the objects are solved at least partially by a method for manufacturing an article of footwear, in particular a shoe, such as a sports shoe, preferably a running shoe, the method comprising: providing a sole element; providing heating means for providing heat energy without contact to the sole element; optionally providing an upper; and selectively heating, using the heating means, at least partially a contour of the sole element.

[0107] It is understood that any one or more of the embodiments, features, advantages, examples or the like as described herein with reference to the remaining aspects and / or embodiments herein may be combined with the method as described in this aspect and vice versa. In particular, it goes without saying that the technical properties shown and / or described for the heating means and / or the apparatus for manufacturing an article of footwear, the advantages, and the improvements over the state of the art are likewise applicable to the method for manufacturing an article of footwear and vice versa.

[0108] In a preferred embodiment of the method for manufacturing an article of footwear as described herein, the heating means is dimensioned to not heat a portion within the contour of the sole element.

[0109] The respective advantages and features described with reference to the heating means and / or the apparatus are also applicable to this preferred embodiment of the method. It is noted that the method may comprise, preferably during heating, not heating a portion within the contour of the sole element.

[0110] In a preferred embodiment of the method for manufacturing an article of footwear as described herein, the method comprises using the heating means as described elsewhere herein and / or using the apparatus as described elsewhere herein.

Bonding, activation, materials

[0111] In a preferred embodiment of the method for manufacturing an article of footwear as described herein, the method comprises forming a bond between the heated contour and the upper.

[0112] In a preferred embodiment of the method for manufacturing an article of footwear as described herein, the bond comprises a chemical bond and / or a mechanical bond.

[0113] It is noted that what kind of bond is formed and / or how stable this bond may be will for example depend on the amount of heat energy provided, the temperature the contour of the sole element is heated to, the degree of activation of the contour of the sole element, the materials involved, the kind of post-processing or curing, and / or the like.

[0114] In a preferred embodiment of the method for manufacturing an article of footwear as described herein, selectively heating, using the heating means, at least partially a contour of the sole element comprises activating at least partially the contour of the sole element, preferably such that an activation temperature of at least one material of the contour of the sole element is reached.

[0115] The contour of the sole element may for example comprise a material that becomes adhesive when

subjected to a certain amount of heat energy. Alternatively, or additionally, the contour of the sole element may comprise a material that enters a chemical reaction with a material of an upper when heated above a certain activation temperature. Such materials can have the advantage that they are easily handled when not activated and only become adhesive / reactive selectively upon activation.

[0116] In a preferred embodiment of the method for manufacturing an article of footwear as described herein, activating at least partially the contour further comprises providing heat energy to the contour such that the contour is at least partially melted.

[0117] The contour of the sole element and the connection surface of the upper may then be joined while the contour of the sole element is still (partially) melted. Further, after solidifying, a connection between the contour of the sole element and the upper may be established. As a result of which, a connection between the contour of the sole element and the connection surface of the upper may be established.

[0118] In a preferred embodiment of the method for manufacturing an article of footwear as described herein, the method comprises connecting the upper to the sole element, preferably without an added adhesive.

[0119] As already mentioned in the background section of the present disclosure, such added adhesives may be harmful to humans and environmentally hazardous. In addition, such added adhesives may be cumbersome to handle, highly inflammable and may generally complicate the manufacturing process of an article of footwear.

[0120] The sole element may comprise a thermoplastic material. Alternatively, or additionally, the contour of the sole element may comprise a thermoplastic material. Thermoplastic materials are well suited to be activated by providing heat energy without contact. After the connection between the contour of the sole element and a connection surface of the upper has been formed, thermoplastic materials may to a large extent regain the properties they had before activation. Thereby, activating thermoplastic materials by providing heat energy may be possible without detrimental effects to the materials.

[0121] In a preferred embodiment of the method for manufacturing an article of footwear as described herein, the sole element and / or the contour of the sole element comprise one or more of the following materials: thermoplastic polyurethane (TPU); a polyamide (PA) such as PA4.10, PA6, PA6.6, PA6.10, PA10.10, PA11 or PA12; a polyetherblockamide (PEBA); a co-polyester; a polyolefin such as a polyethylene (PE) or polypropylene (PP); a polyolefinic elastomer (POE) such as polyisobutylene (PIB), ethylene propylene rubber (EPR) or ethylene propylene diene monomer (M-class) rubber (EPDM); a block copolymer such as an olefin block copolymer (OBC); an expanded material such as expanded thermoplastic polyurethane, an expanded polyamide or an expanded polyetherblockamide; particles of an expanded material such as particles of expanded thermoplastic polyurethane, expanded polyamide and / or expanded polyetherblockamide.

[0122] The particles may be randomly arranged, or they may, at least partially, be aligned or otherwise intentionally arranged. The particles may be connected at their surfaces.

[0123] The benefits of using a foamed or expanded material in the contour of the sole element and / or the sole element may include the increased insulative properties of such materials, allowing the temperature at the contour of the sole element and / or the sole element to be increased while the temperature inside the sole element remains rather low such that unwanted effects on these regions by the heat energy can be avoided or limited.

[0124] It is again mentioned that the materials mentioned above as possible materials for the contour of the sole element are also possible materials for the sole element. The contour of the sole element and the sole element may form one integral component of the same material(s). As an example, the sole element may be made from particles of an expanded material, e.g., particles of eTPU.

[0125] In a preferred embodiment of the method for manufacturing an article of footwear as described herein, the sole element comprises one or more of the following: a midsole, an outsole, an outsole element, and a sole plate. The term sole plate may refer to a flat plate or surface that is used for a specific purpose. The sole plate may provide for stability and support to the foot of the wearer.

[0126] It is noted that the method of manufacturing may additionally or alternatively encompass that a bond can be formed between any two or more of the exemplary sole elements mentioned in the foregoing embodiment. That is, for instance, a midsole may be bonded to an outsole, to an outsole element, and / or to a sole plate. Further, an outsole may be bonded to an outsole element, and / or to a sole element. Further, an outsole element may be bonded to a sole element.

[0127] In a preferred embodiment of the method for manufacturing an article of footwear as described herein, selectively heating is performed by irradiating with heat energy originating from at least one heat source, in particular by irradiating with infrared radiation, IR radiation, originating from at least one IR radiation source. The respective advantages and features described with reference to the heating means and / or the apparatus are also applicable to this preferred embodiment of the method.

[0128] In a preferred embodiment of the method for manufacturing an article of footwear as described herein, the method further comprises activating at least one portion of a connection surface of the upper by providing heat energy without contact and wherein the contour of the sole element and the connection surface of the upper are spaced apart during their heating.

[0129] It is noted that everything that has been described in here with reference to activating the contour

of the sole element (e.g., possible kinds of activation, temperature the contour of the sole element is heated up to, heating time, or the like) may also apply to activating the connection surface of the upper. Merely for the sake of clarity and conciseness, these statements are not repeated here.

[0130] In a preferred embodiment of the method for manufacturing an article of footwear as described herein, the contour and the connection surface of the upper are simultaneously activated by heat energy.

[0131] By simultaneously activating the contour of the sole element and the connection surface of the upper, the number of steps necessary for performing the method can be reduced and the manufacturing expense can be reduced.

[0132] In a preferred embodiment of the method for manufacturing an article of footwear as described herein, the upper and / or the connection surface of the upper comprise a textile material, and wherein the textile material comprises one or more of the following: a knitted construction; a woven construction; a non-woven construction; randomly deposited fibers; a multi-directional layered material; a mesh structure.

[0133] In a preferred embodiment of the method for manufacturing an article of footwear as described herein, the upper and / or the connection surface of the upper and / or the textile material comprise one or more of the following materials: polyethylene terephthalate; polybutylene terephthalate; a polyamide such as PA4.10, PA6, PA10.10, PA12, PA66, PA610, PA612 or a different grade; polyurethane; a polyolefin such as a polyethylene or polypropylene; a polyolefinic elastomer such as polyisobutylene, ethylene propylene rubber or ethylene propylene diene monomer rubber; a block copolymer such as an olefin block copolymer; thermoplastic polyurethane. It is noted that the choice of material used for the upper and / or the connection surface of the upper and / or the textile material may depend on various factors including but not limited to: The kind of upper and / or sole element that is used for manufacturing the shoe and / or the specific way of manufacturing the shoe.

[0134] Alternatively, or additionally, the upper, and / or the connection surface of the upper, and / or the textile material of the upper may comprise one or more of the following materials: thermoplastic polyurethane (TPU), a foamed or expanded material such as expanded thermoplastic polyurethane (eTPU), and expanded polyamide (ePA) or an expanded polyetherblockamide (ePEBA), a non-foamed or compact material, rubber.

[0135] The textile material can be created using different techniques known in the art. A textile material may be beneficially employed in parts of sporting goods that require good ventilation or breathability like a shoe upper or a jacket, to name only two examples.

[0136] Moreover, in combination with the possible materials for the sole element and / or the contour of the sole element mentioned above, the aforementioned possible materials for the upper, and / or the connection surface of the upper, and / or the textile material of the upper can have the advantage of being compatible with one another in the sense that they may form a durable and stable connection.

[0137] In a preferred embodiment of the method for manufacturing an article of footwear as described herein, the method is further comprising solidifying of the connection of the contour of the sole element and the upper.

[0138] Solidifying the connection may be beneficial after joining the two parts, i.e., the contour of the sole element and the upper, as it may increase the durability and strength of the connection produced. Solidifying the connection may, for example, involve allowing the connection to cool for a period. The time necessary for solidifying the connection may vary, for example, due to the ambient temperature, heat capacity of materials, geometry of the components, or the like.

[0139] In a preferred embodiment of the method for manufacturing an article of footwear as described herein, the solidifying is at least partially performed by cooling.

[0140] The cooling may comprise active cooling. Actively cooling the connection of the contour of the sole element and the upper may, on the one hand, accelerate the manufacturing process. On the other hand, it is also possible that actively cooling contributes to establishing a stable and durable connection of the contour of the sole element and the upper.

[0141] In a preferred embodiment of the method for manufacturing an article of footwear as described herein, a bonding strength of the bond between the contour and the upper is at least to N / cm, preferably at least 25 N / cm, more preferably at least 35 N / cm, and most preferably at least 50 N / cm, when measured according to DIN ISO 6133.

[0142] In a measurement according to DIN ISO 6133, a preload of 1 Newton (N) is applied to two components which are peeled apart at a test speed of 50 mm / min. The test range is 100 mm. The result is given as the arithmetic mean peel force between the first peak and the end of the measurement.

Article of footwear manufactured by the method

[0143] In a further aspect of the present disclosure, the objects are solved at least partially by an article of footwear, in particular a shoe, such as a sports shoe, preferably a running shoe, manufactured with a method according to one of the embodiments described in here.

[0144] It goes without saying that the technical properties shown or described for the heating means, the apparatus, and / or the method for manufacturing an article of footwear, the advantages and the improvements over the state of the art are likewise applicable to the article of footwear manufactured by such a method. Same applies vice versa.

[0145] The skilled person will readily recognize if an article of footwear is manufactured by way of the method as described in here or by way of a different method. For

instance, due to the provision of heat energy without contact at least partially to the contour of the sole element, less material of the sole element is heated, which potentially leads to less damage of material of the sole element that does not form part of the connection between the sole element and the upper. This may potentially lead to an improved material composition of the sole element. This may be readily recognizable by way of the specific structure of the sole element and / or of the article of footwear so manufactured. Moreover, the connection between the sole element and the upper is improved in that the connection is only formed at the contour. Also, this may be recognizable to the skilled person. In turn, this may lead to an improved product quality, which distinguishes the article of footwear so manufactured from article of footwears made from other methods.

[0146] In the manufacture of such an article of footwear, the optional features and steps of the inventive method described herein may be combined with each other as desired or individual features or steps may be omitted if deemed unnecessary in order to meet a particular requirement specification for the sporting goods.

[0147] In a preferred embodiment of the article of footwear as described in here, the article of footwear comprises a sole element and an upper connected to the sole element without an added adhesive. Preferably, a bond between the sole element and the upper has a bonding strength of at least to N / cm, preferably at least 25 N / cm, more preferably at least 35 N / cm, and most preferably at least 50 N / cm, when measured according to DIN ISO 6133.

[0148] In a preferred embodiment of the article of footwear as described in here, the article of footwear is a shoe, in particular a sports shoe, such as a running shoe.

[0149] The mentioned advantages of the heating means, apparatus, and method may be particularly pronounced when the article of footwear is used during sports, in particular during running. Nevertheless, any other athletic activities and / or use cases are also encompassed in the present disclosure. Further, it is emphasized that the present invention is not limited to shoes but may also be applied to other kinds of sporting goods like sports apparel or clothing, protection elements, or sports equipment like rackets.

4. Brief description of the figures

[0150] In the following, the invention will be described in more detail with reference to the following figures:

Fig. 1: shows a heating means and a sole element of an article of footwear, in particular of a shoe, such as a sports shoe, according to an embodiment of the present disclosure.

Fig. 2: shows the embodiment of Fig. 1 in a different perspective.

Fig. 3: shows the embodiment of Fig. 1 in yet another different perspective.

Fig. 4: shows a schematic representation of details of a heating means and a sole element of an article of footwear, in particular of a shoe, such as a sports shoe, according to an embodiment of the present disclosure.

Fig. 5: shows a schematic representation of details of an apparatus for manufacturing an article of footwear, in particular a shoe, such as a sports shoe, preferably a running shoe, according to an embodiment of the present disclosure.

Fig. 6: shows an apparatus for manufacturing an article of footwear, in particular a shoe, such as a sports shoe, preferably a running shoe, according to an embodiment of the present disclosure.

Fig. 7: shows details of an apparatus for manufacturing an article of footwear, in particular a shoe, such as a sports shoe, preferably a running shoe, according to an embodiment of the present disclosure.

Fig. 8: shows details of the embodiment of Fig. 7 from a lateral side view.

Fig. 9: shows details of the embodiment of Fig. 7 from a different perspective view.

Fig. 10: shows details of the embodiment of Fig. 7 from yet another perspective view.

Fig. 11: shows a schematic representation of a sole element of an article of footwear, in particular of a shoe, such as a sports shoe, preferably a running shoe, according to an embodiment of the present disclosure.

Fig. 12: shows a flow chart of a method for manufacturing an article of footwear, according to an embodiment of the present disclosure.

Fig. 13: shows a schematic representation of an article of footwear, according to an embodiment of the present disclosure.

5. Detailed description of the preferred embodiments

[0151] In the following only some possible embodiments of the invention are described in detail. However, the present invention is not limited to these, and a multitude of other embodiments are applicable without departing from the scope of the invention. The presented em-

bodiments can be modified in several ways and combined with each other whenever compatible and certain features may be omitted in so far as they appear dispensable. In particular, the disclosed embodiments may be modified by combining certain features of one embodiment with one or more features of another embodiment.

[0152] It is to be understood that not all features of the described aspects / embodiments must be present for realizing the technical advantages provided by the present disclosure, which is defined by the subject-matter of the claims. The disclosed aspects / embodiments may be modified by combining certain features of one aspect / embodiment with one or more features of another aspect / embodiment. Specifically, the skilled person will understand that features, and / or functional elements of one aspect / embodiment can be combined with technically compatible features, and / or functional elements of any other aspect / embodiment of the present disclosure given that the resulting combination falls within the definition of the present disclosure.

[0153] While the embodiments below are described primarily with reference to a sole element for an article of footwear, in particular for a sports shoe, the skilled person will recognize that the disclosure according to the invention can equally be applied in a plurality of different technical fields and / or use cases.

[0154] Throughout the present figures and specification, the same reference numerals refer to the same elements. For the sake of clarity and conciseness, certain aspects of components or steps of certain embodiments are presented without undue detail where such detail would be apparent to those skilled in the art in light of the teachings herein and / or where such detail would obfuscate an understanding of more pertinent aspects of the embodiments.

[0155] As understood by the skilled person and / or to avoid redundancies, reference is also made to the explanations in the preceding sections, which also apply to the following detailed description. Further, not all features, parts, elements, aspects, components and / or steps are expressly indicated by reference signs for the sake of brevity and clarity. This particularly applies, where the skilled person recognizes that such features, parts, elements, aspects, components and / or steps are present in a plurality.

Definitions

[0156] The term "wearer" as referred to herein may be any kind of human capable of wearing an article of footwear. The term "wearer" may be used synonymously to the terms "user", "athlete", "human being", "individual", "person" or the like.

[0157] The term "medial", "medial side", "medial side region", and / or "medial side portion" (e.g., when used in the phrase "medial heating arm", "medial side" of the sole element) as used herein may refer to an inner side and / or inner edge of the sole element or the heating means. This side and / or edge may be closest to a centerline of the body of the wearer, when a shoe comprising the sole element is worn. This side and / or edge may extend from a big toe portion to a heel region. As understood, when this term (e.g., "medial") is used to describe the heating means and / or the apparatus, the skilled person will readily recognize such a side also when no sole element is present.

[0158] The term "lateral", "lateral side", "lateral side region", and / or "lateral side portion" (e.g., when used in the phrase "lateral heating arm", "lateral side" of the sole element) as used herein may refer to an outer side and / or outer edge of the sole element or the heating means. This side and / or edge may be farther way from a centerline of the body of the wearer, when a shoe comprising the sole element is worn. This side and / or edge may extend from a small toe portion to a heel region. As understood, when this term (e.g., "lateral") is used to describe the heating means and / or the apparatus, the skilled person will readily recognize such a side also when no sole element is present.

[0159] The term "toe portion" and / or "toe region" of a sole element as used herein may refer to the front part of the sole element, e.g., the forefoot part of the sole element, in which toes of the foot of the wearer can be received, when worn. The toes of the foot of the wearer may include the big toe, and / or of the big toe knuckle. It may include an anterior end of the foot, when worn. Further, the toe portion and / or the toe region may include distal phalanges, intermedial phalanges and proximal phalanges of a foot of a wearer, when worn. The toe portion and / or the toe region may additionally include a frontal part of the metatarsal bones of a foot of a wearer, when worn.

[0160] The term "midfoot portion" and / or "midfoot region" of a sole element may refer to the central portion of the sole element. The midfoot portion / midfoot region of the sole element may cover an area of the foot corresponding to the arch of the foot when a shoe comprising the sole element is worn. In one example, the midfoot portion / midfoot region may cover less than about half of the underfoot portion, the central point of it being located approximately at half of the length along a heel to toe axis. In one example, the midfoot portion / midfoot region may cover less than about one third of the underfoot portion, the central point of it being located approximately at half of the length along a heel to toe axis.

[0161] The term "heel portion" and / or "heel region" of a sole element as used herein may refer to the back part of the sole element, e.g., the rear part of the sole element, which usually provides support and cushioning to the heel of the foot of the wearer, when a shoe comprising the sole element is worn. In said heel portion and / or heel region of the sole element, an anterior end of a foot of the wearer may be received. In particular, the "calcaneal region" of a foot of a wearer may be received. The calcaneus is a large bone that makes up the heel of the foot.

[0162] The term "upward direction" as used herein may be the direction from an underfoot portion of the upper to an upper portion of the upper. For instance, the upward direction may be the direction from the sole element of a shoe to an instep portion of the upper. The upward direction may be substantially parallel to a vertical axis.

[0163] The term "downward direction" as used herein may be directed substantially opposite to the upward direction.

[0164] The term "vertical axis" as used herein may substantially correspond to the wearer's main body axis from head to foot when the wearer stands on the ground.

[0165] Unless otherwise stated, the term "substantial" or "substantially" as used in the present context may be understood to a great or significant extent or for the most part or essentially. In particular, manufacturing tolerances are included by this term. Hence, any values, shapes, and / or arrangements or the like described using the term "substantial" or "substantially" may slightly deviate from the described values, shapes, and / or arrangements, or the like.

[0166] The term "and / or" is only an association relationship describing associated objects and represents that three relationships may exist. For example, A and / or B may represent three conditions: i.e., independent existence of A, existence of both A and B and independent existence of B. In addition, the character "/" in the disclosure usually represents that previous and next associated objects form an "or" relationship.

[0167] The terms "bottom", "top", "one end", "the other end", "outer side", "upper", "above", "inner side", "under", "below", "horizontal", "coaxial", "central", "end" "part", "length", "outer end" etc., which indicate the orientation or positional relationship, are based on the orientation or positional relationship shown in the drawings.

[0168] The terms "upper", "above", "below", "under" and the like as used in the present invention to indicate a relative position in space are used for the purpose of facilitating explanation to describe a sole for a shoe, an element, a part, an object and / or a feature shown in the drawings relative to the relationship of another sole for a shoe, element, part, object and / or feature.

Description of figures

[0169] **Fig.** 1, Fig. 2, **and Fig.** 3 show a heating means 130 and a sole element 101 of an article of footwear 100 (not shown in its entirety in Fig. 1, as understood by the skilled person, but schematically shown in Fig. 13), in particular of a shoe, such as a sports shoe, according to an embodiment of the present disclosure. Fig. 2 shows the embodiment of Fig. 1 in a different perspective. Fig. 3 shows the embodiments of Fig. 1 in yet another perspective.

[0170] The heating means 130 are configured for providing heat energy without contact to the sole element 101 of an article of footwear 100, preferably a running shoe. The heating means 130 is configured to selectively heat at least partially a contour 110 (as best seen in Fig. 11) of the sole element 101.

[0171] As can be best seen from Fig. 2, since the heating means 130 are configured to selectively heat at least partially a contour 110 of the sole element 101, the heating means 130 may have structural features to make heating of such a contour 110 possible. In Fig. 2, the heating means 130 is therefore dimensioned such that it adopts an outline of the sole element 101. As generally known, the contour of any random object could (significantly) differ from the contour 110 of the sole element 101.

[0172] It is noted that the sole element 101 may be a midsole, an outsole, an outsole element, and a sole plate.

[0173] The heating means 130 may be configured to not heat a portion 111 (as best seen in Fig. 11) within the contour 110 of the sole element 101. The portion 111 within the contour 110 of the sole element 101 is to be understood in such a manner that it is enclosed by the contour 110 of the sole element 101. That is, the portion 111 may be in proximity to the contour 110 and / or may abut the contour 110. The portion 111 within the contour 110 of the sole element 101 may not form part of the contour 110. The contour 110 and the portion 111 may be separate parts of the sole element 101. Nevertheless, they can comprise the same material as described elsewhere herein in greater detail.

[0174] Further, the heating means 130 may be dimensioned so as to heat at least 10 % of the contour 110 of the sole element 101 in a circumferential direction CD (said circumferential direction CD being exemplarily indicated in Fig. 11), preferably at least 20 %, more preferably at least 30 %, even more preferably at least 40 %, even more preferably at least 50 %, even more preferably at least 60 %, even more preferably at least 70 %, even more preferably at least 80 %, most preferably at least 90 % of the contour 110 of the sole element 101 in the circumferential direction CD.

[0175] As can be best seen from Fig. 11, the circumferential direction CD may be the direction along the periphery of the sole element 101, as seen from the top to the bottom (e.g., along the vertical axis and / or along the downward direction DD).

[0176] As best seen from Fig. 2, the heating means 130 is dimensioned to not heat at least 20 % of an innermost area 112 (as indicated in Fig. 11) of the sole element 101, preferably to not heat at least 30 %, more preferably to not heat at least 40 %, even more preferably to not heat at least 50 %, even more preferably to not heat at least 60 %, most preferably to not heat at least 70 % of the innermost area 112 of the sole element 101.

[0177] The heating means 130 may comprise a heating arm 130'. As described elsewhere herein, the heating means 130 can additionally or alternatively comprises a plurality of heating arms (130a, 130b, 130c, 130d). The heating arm 130' may resemble the contour 110 of the sole element 101. As shown in particular on the lefthand side of Fig. 2, the heating arm 130' may be opened in

proximity to a toe portion 105 (as indicated in Fig. 1) of the sole element 101, when the contour 110 of the sole element 101 is being heated. In this manner, the heating arm 130' may form an opening 135.

[0178] Thee opening 135 of the heating arm 130' may be small to ensure that a large part of the contour 110 is heated. This opening 135 may nevertheless have the advantage that the toe portion 105 of the sole element 101 may be less heated and / or not heated. Not heating in the area near the toe portion 105 might provide additional comfort to the user, as this part of the shoe may, as a result of which, be less rigidly fixed. Thereby, this may allow for some movement and / or for a slightly more relaxed fit in the toe portion 105. In particular, the toe portion of the foot of a wearer is usually more sensitive to pressure or the like compared to another portion of the foot. Moreover, the exclusion of the toe portion 105 of the sole element 101 from heating could prevent potential overheating of the contour 110 of the sole element 101.

[0179] The heating arm 130' may comprise one or more of the following segments 131, 132, 133, 134, 134': a lateral segment 131, a heel segment 132, a medial segment 133, and a toe segment 134, 134'.

[0180] In one example, the lateral segment 131 may be a substantially linear lateral segment. In one example, the heel segment 132 may be a curved heel segment. In one example, the medial segment 133 may be a substantially linear medial segment. In one example, the toe segment 134, 134' may be a curved toe segment. As can be seen, the toe segment 134, 134' may be composed of two toe segments 134 and 134'. Between the two toe segments 134 and 134' the opening 135 may be arranged.

[0181] Fig. 4 shows a schematic representation of details of a heating means 130 and a sole element 101 of an article of footwear 100, in particular of a shoe, such as a sports shoe, according to an embodiment of the present disclosure.

[0182] The heating arm 130' may comprise a substantially circular profile 138 in a cross-sectional cut 137 (the cross-sectional cut 137 is exemplarily indicated in Fig. 2 by way of the dashed box 137) perpendicular to a longitudinal axis 136 (as exemplarily indicated in Fig. 2 by way of the arrow 136) of the heating arm 130'.

[0183] In one example, the heating arm 130' may comprise a circular profile 138 substantially all along the longitudinal axis 137 of the heating arm 130'. However, this must not necessarily be the case. In one example, the heating arm 130' may comprise sections along the longitudinal axis 137 of the heating arm 130', wherein some of these sections may have a circular profile 138. Other sections along the longitudinal axis 137 of the heating arm 130' may have a different shape in a cross-sectional cut 137 perpendicular to the longitudinal axis 138 of the heating arm 130'.

[0184] The heating means 130 may comprise a coating 140 configured to reduce provision of heat energy without contact to the sole element 101.

[0185] The coating 140 may be a thin layer of material applied to the heating means 130. The coating 140 may be applied on a surface, for instance an internal surface of the heating means 130 and / or on an external surface of the heating means 130. The external surface of the heating means 130 may be exposed to the exterior. Merely to give some examples, the coating 140 may comprise one or more of the following non-exhaustive list: a protective coating, a functional coating, a barrier coating, a thermal coating, an anti-corrosion coating, an optical coating, a decorative coating.

[0186] In particular, the coating 140 may comprise a non-heat irradiation permissive material, such as ceramics, glasses. Preferably, the coating 140 may comprise gold.

[0187] The coating 140 may be provided at least partially on a perimeter of the heating means 130. Thereby, the coating 140 may define an open section 141 on a remaining part of the perimeter of the heating means 130 through which heat energy without contact can be provided to the contour 110 of the sole element 101. As can be seen from the schematic representation of Fig. 4, the perimeter can be the circumference of the heating means 130 in a cross-sectional cut 137 of the heating means 130.

[0188] As shown in the exemplarily representation of Fig. 4, the open section 141 may be defined by an angle a. The angle α may be at least 10°, and / or at most 80° as described elsewhere herein. However, depending on the desired extension 115 (as seen in Fig. 11 and in Fig. 4) of the contour 110 of the sole element 101 that is to be provided with heat energy, the angle α may be different. The angle α of the open section 141 can help to optimize the balance between delivering adequate heat energy to the sole element 101 and preventing overheating of the sole element 101.

[0189] In any one of the embodiments described in here, the heating means 130 may be configured to provide heat radiation, preferably by one or more heat sources, wherein the heating means is preferably configured to provide infrared radiation, IR-radiation, preferably by one or more IR-radiation sources.

[0190] Activating (as described elsewhere herein) the contour 110 of the sole element 101 may for example be performed by irradiating the contour 110 of the sole element 101 with heat energy originating from at least one heat source. The heat source may comprise individually controlled heat sources. These individually controlled heat sources may, e.g., provide differing amounts of heat energy to different areas of the contour 110 of the sole element 101. It is also possible that multiple heat sources are used instead of just the one heat source. In general, any heat source known in the art can be used.

[0191] Moreover, as has already been mentioned elsewhere herein, it is in general also conceivable that the heat energy is provided via direct contact with the heat source, e.g., via direct contact of the contour 110 of the sole element 101 with an IR-heat source.

[0192] Employing infrared IR radiation may have various advantages. For instance, IR radiation heats objects directly without the need to heat the intervening medium (air), making it more energy-efficient than traditional convection heating systems. This translates into reduced energy costs and longer battery life for battery-powered heating mechanisms. Infrared heating can additionally provide gentle, comfortable warmth akin to sunlight. This can result in a very comfortable warming effect, which could have advantages to the sole element 101. Further, unlike traditional heating methods, infrared heat may be felt immediately as soon as the heating means 130 employing an IR heat source is switched on. Therefore, waiting times can possibly be reduced, which may make the manufacturing process using such heating means 130 more efficient. In essence, the time for the heating means 130 and / or an apparatus 145 comprising such heating means 130 to warm up can be reduced. IR radiation usually does not lead to quite high temperatures as traditional heaters. This may have the benefit to reduce risks of burns or the like. Furthermore, IR radiation does not reduce oxygen or humidity levels in the air, making them safer for indoor environments. The use of one or more IR-radiation sources may offer the flexibility to control heat levels or target specific sections of the sole element 101 more intensely if required.

[0193] **Fig. 6, Fig.** 7, **Fig. 8, Fig. 9, and Fig.** 10 show an apparatus 145 for manufacturing an article of footwear 100, in particular a shoe, such as a sports shoe, preferably a running shoe, according to an embodiment of the present disclosure. **Fig.** 7 shows further details of said apparatus 145 for manufacturing an article of footwear 100 of Fig. 6. **Fig.** 8 also shows further details of the embodiment of Fig. 6 from a lateral side view. **Fig. 9 and Fig.** 10 show details of the embodiments of Fig. 7 from different perspective views.

[0194] As can be gathered from the figures, the apparatus 145 comprises the heating means 130 described elsewhere herein.

[0195] The heating means 130 may comprise a plurality of distinct heating arms 130a, 130b, 130c, 130d. Each of this plurality of distinct heating arms 130a, 130b, 130c, 130d may comprise one more heat source.

[0196] One or more of the plurality of distinct heating arms 130a, 130b, 130c, 130d may be controlled individually. This may offer a high degree of customization. This is, because different portions of the contour 110 of the sole element 101 can be heated to different temperatures. Moreover, the plurality of distinct heating arms 130a, 130b, 130c, 130d may provide redundancy. In particular, in the unlikely event that one of the plurality of distinct heating arms 130a, 130b, 130c, 130d may fail, one or more other of the plurality of distinct heating arms 130a, 130b, 130c, 130d may be able to continue their function. As a result of which, the provision of heat energy to the contour 110 of the sole element 101 may not be interrupted. In addition, reliability of the provision of heat energy may be increased. Furthermore, by providing the option of operating only necessary heating arms 130a, 130b, 130c, 130d rather than the plurality of distinct heating arms 130a, 130b, 130c, 130d, this bears the potential to save energy. The plurality of distinct heating arms 130a, 130b, 130c, 130d may also provide better control over the temperature distribution. Furthermore, with each heating arm 130a, 130b, 130c, 130d having one or more heat sources, it allows for finer adjustments in heat compared to a single heat source.

[0197] As seen in Fig. 6, Fig. 7, Fig. 8, Fig. 9, and Fig. 10, the plurality of distinct heating arms 130a, 130b, 130c, 130d comprises four heating arms. Nevertheless, this is merely an example and depending on the desired needs, more or less distinct heating arms 130a, 130b, 130c, 130d may be provided.

[0198] The plurality of distinct heating arms 130a, 130b, 130c, 130d may comprise: a looped toe heating arm 130a configured to provide heat energy without contact to a toe portion 105 of the sole element 101; a linear lateral heating arm 130c configured to provide heat energy without contact to a lateral side of the sole element 101; a linear medial heating arm 130b configured to provide heat energy without contact to a medial side of the sole element 101; and / or a looped heel heating arm 130d configured to provide heat energy without contact to a heel portion 107 of the sole element 101.

[0199] One or more of the plurality of distinct heating arms 130a, 130b, 130c, 130d may be movable relative to other another independently. Movement of the one or more of the plurality of distinct heating arms 130a, 130b, 130c, 130d may comprise one or more or any combination of the following: translation in one, two and / or three spatial axes, rotation about one, two and / or three spatial axes. With this, a distance of one or more of the plurality of distinct heating arms 130a, 130b, 130c, 130d to the sole element 101 may be increased and / or decreased. This allows to provide more and / or less heat energy without contact to the contour 110 of the sole element 101. This can be performed without varying the heat source, e.g., without adjusting a power setting of the heat source. Accordingly, this movements provides more control flexibility and increases the operational capabilities.

[0200] Further, as described elsewhere herein, one or more of the plurality of distinct heating arms 130a, 130b, 130c, 130d are configured to be inclined, for instance relative to the sole element 101. With this, the provision of heat from the heating means 130 to the sole element can be fine-tuned. In particular, this has the advantage that, for instance, one and the same of the one or more of the plurality of distinct heating arms 130a, 130b, 130c, 130d can have different distances to the sole element 101. Thereby, without varying the power setting of the heat source, e.g., the power provided to the heating means 130, a different amount of heating may be achieved.

[0201] Thereby, the heating means 130 can be adjusted so as to smoothly align with the contour 110 of the sole element 101. In particular, the angle of inclination of the one or more of the plurality of distinct heating arms

130a, 130b, 130c, 130d with respect to the sole element 101 may be at least 5°, preferably at least 10°, more preferably at least 20°, more preferably at least 30°, even more preferably at least 40°, even more preferably at least 50°, even more preferably at least 60°, even more preferably at least 70°, even more preferably at least 90°. Additionally or alternatively, the angle of inclination of the one or more of the plurality of distinct heating arms 130a, 130b, 130c, 130d with respect to the sole element 101 may be at most 80°, preferably at most 70°, more preferably at most 60°, even more preferably at most 50°, even more preferably at most 40°, even more preferably at most 30°, even more preferably at most 20°, even more preferably at most 10°.

[0202] This inclination has the further advantage that the risk of the heat source coming too close to the sole element 101 (thereby potentially causing damage or burning to the sole element 101) can be mitigated.

[0203] The linear lateral heating arm 130c and / or the linear medial heating arm 130b may be elongated as shown in particular in Fig. 9. The term elongated means that there may be a dimension along one axis of the lateral heating arm 130c and / or the medial heating arm 130b, which may be larger than one and preferably than both dimensions along the remaining axes, the remaining axes being substantially perpendicular to said one axis. It is understood that when dimensions are described herein, manufacturing tolerances usually must be taken into consideration. Thus, the dimensions described herein may vary slightly.

[0204] This particular heating system design leveraging a plurality of distinct heating arms 130a, 130b, 130c, 130d could have several potentially beneficial impacts on the performance of the apparatus 145 and / or on the heating means 130. For instance, each of these distinct heating arms 130a, 130b, 130c, 130d may allow for heating specific portions of the contour 110 of the sole element 101 substantially independently from one another. These portions may be the toe portion 105, the heel portion 107, the medial side and / or the lateral side (being encompassed by the midfoot portion 106). This could result in a more precise and more effective heat distribution within these portions of the contour 110 of the sole element 101. Furthermore, each of the different heating arms 130a, 130b, 130c, 130d may potentially be adjusted and controlled individually. Moreover, this design of the plurality of distinct heating arms 130a, 130b, 130c, 130d may result in better heat distribution throughout the contour 110 of the sole element 101. In this manner, cold spots may potentially be reduced. Furthermore, having separate heating arms 130a, 130b, 130c, 130d for different portions of the sole element 101 can enhance the heating mechanism's efficiency in principle.

[0205] Further, as each heating arm 130a, 130b, 130c, 130d of the plurality of distinct heating arms 130a, 130b, 130c, 130d may provide heat energy without contact, this may reduce the risk of damaging the material of the contour 110 of the sole element 101. In general, due to the provision of heat energy without contact, the plurality of distinct heating arms 130a, 130b, 130c, 130d may lead to less wear and tear to the sole element 101 as compared to heating systems that require direct contact. However, as noted elsewhere herein, provision of heat energy by way of direct contact is not precluded.

[0206] The apparatus 145 may further comprise first mounting means 120 for receiving any sole element 101. The first mounting means 120 may comprise biasing means 121, 122 (as shown in Fig. 5) for providing a biasing force to a sole element 101 when received in the first mounting 120.

[0207] The apparatus 145 may further comprise second mounting means 160 for receiving a component 150 of an article of footwear 100, preferably an upper 150. The first mounting means 120 and the second mounting means 160 may be moved apart from one another and moved together under pressure.

[0208] The ability to adjust the pressure and distance between the two mounting means 120, 160 may enable precise accommodation of different sized and shaped components 101, 150 of an article of footwear 100. As a result of which, use of the apparatus 145 on a variety of articles of footwear 100 styles and sizes is facilitated.

[0209] When treating both the sole element 101 and the component 150 of the article of footwear 100 (e.g., the upper 150), using heat for instance, the ability to adjust pressure and distance between the mounting means 120, 160 can ensure more even and effective treatment across both parts, i.e., the sole element 101 and the component 150 of the article of footwear 100. By allowing movement and alterable pressure, the risk of damage to the article of footwear 100 due to excessive force or incompatible size may be reduced, ensuring safety of the article of footwear 100 during manufacturing thereof. The ability of the first mounting means 120 and second mounting means 160 to move apart also simplifies assembly and disassembly of the respective parts, e.g., the sole element 101 and the component 150 of the article of footwear 100.

[0210] In some examples, the first mounting means 120 and second mounting means 160 may be able to operate simultaneously. This may speed up the manufacturing process, thereby potentially increasing overall efficiency.

[0211] The first mounting means 120 comprises a cavity 123 having a tapered shape 124 (as indicated exemplarily in Fig. 7) for receiving a sole element 101. The tapered shape 124 may comprise an inclined surface 125 (as indicated exemplarily in Fig. 7) as described elsewhere herein.

[0212] The tapered shape 124 / the inclined surface 125 will ensure a secure fit for the sole element 101 within the cavity 123 of the apparatus 145. The tapered shape 124 / the inclined surface 125 may help to secure a sole element 101 more firmly, reducing the risk of the sole element 101 moving or slipping during any process, e.g., during manufacturing of an article of footwear 100. The

tapered shape 124 / the inclined surface 125 may make more efficient use of space. This can be particularly beneficial in smaller workplaces or storage situations. While an incorporation of a such a cavity 123 can secure the sole element 101 effectively when it's inside the cavity 123, it could also potentially make the insertion and removal process of the sole element 101 smoother and less cumbersome.

[0213] The heating means 130 may be configured to be moved, preferably rotated, relative to the first mounting means 120, such that a distance to a sole element 101 can be adjusted, when the sole element 101 is received in the first mounting means 120.

[0214] **Fig. 5** shows a schematic representation of details of an apparatus 145 for manufacturing an article of footwear 100, in particular a shoe, such as a sports shoe, preferably a running shoe, according to an embodiment of the present disclosure.

[0215] As described with reference to Fig. 6, Fig. 7, Fig. 8, Fig. 9, and Fig. 10, the first mounting means 120 of the apparatus 145 may comprise biasing means 121, 122 for providing a biasing force to a sole element 101 when received in the first mounting 120. In one example, the sole element 101 may be pushed into the first mounting means 120, for instance from the top in the downward direction DD. This may cause the biasing means 121, 122 to be pushed downwards so as to adapt to the shape of the sole element 101. In addition, when an upper 150 (as indicated for instance in Fig. 6) is pushed to the sole element 101 (which may be done in a subsequent method step), this may also cause the sole element 101 to push the biasing means 121, 122 (further) in the downward direction DD.

[0216] The inclusion of a first mounting means 120 with a biasing means 121, 122 for providing a biasing force can have several advantageous effects. The biasing force may provide a secure fit for the sole element 101 within the first mounting means 120. It may ensure that the sole element 101 substantially stays in place, for instance during the provision of heat energy without contact. Alternatively, the sole element 101 may substantially stay in place during any other method step of the method as described in here. The biasing means 121, 122 may provide a substantially constant biasing force. This may assure uniform contact of the sole element 101 with the first mounting means 120 and, thereby, with the apparatus 145. This could lead to uniform heat distribution to the contour 110 of the sole element 101 when the apparatus 145 is in operation. Moreover, the biasing means 121, 122 can adapt to different sizes and shapes of any sole element 101 received. This may ensure that a variety of sole elements 101 can be secured effectively. As a result of which, the functionality and / or flexibility of the apparatus 145 may be increased, thereby leveraging operational capabilities.

[0217] The biasing means 121, 122 may additionally or alternatively act as a protective mechanism, providing a safeguard against potential damage caused by moving or slipping of the sole element 101 when it is received in the first mounting means 120.

[0218] The biasing force provided by the biasing means 121, 122 may make it easier to mount and / or to dismount the sole element 101. This may make manufacturing of an article of footwear 100 using such an apparatus 145 easier, which is appreciated by personnel.

[0219] The biasing means 121, 122 may comprise a plurality of spring-loaded pins. The biasing means 121, 122 may comprise a toe group 121 of spring-loaded pins arranged on a toe portion of the first mounting means 120, when a sole element 101 is received in the first mounting 120. Further, the biasing means 121, 122 may comprise a heel group 122 of spring-loaded pins arranged on a heel portion of the first mounting means 120, when a sole element 101 is received in the first mounting means 120.

[0220] Furthermore, the arrangement of spring-loaded pins in a toe group 121 of spring-loaded pins and in a heel group 122 of spring-loaded pins may ensure secure and customized fitting of the sole element 101 in the first mounting means 120. The targeted biasing force at different portions of the sole element 101 so provided may facilitate a more secure grip. As a result of which, the risk of the sole element 101 slipping and / or moving may be reduced.

[0221] Moreover, the spring-loaded pins 121, 122 may distribute a pressure evenly across the toe portion 105 and / or the heel portion 107 of the sole element 101, when received in the first mounting means 120. This may help to maintain substantially consistent contact between the first mounting means 120 and the sole element 101. This may be beneficial for the provision of a uniform heat energy; in case this is aimed at. The spring-loaded pins 121, 122 may generally result in less wear and / or tear on the sole element 101, as compared to non-flexible and / or substantially hard-fixturing mounting elements.

[0222] **Fig. 11** shows a schematic representation of a sole element 101 of an article of footwear 100, in particular of a shoe, such as a sports shoe, preferably a running shoe, according to an embodiment of the present disclosure.

[0223] The contour 110 of the sole element 101 may comprise at most 10 % of an outermost annular area of the sole element, preferably at most 8 %, more preferably at most 6 %, most preferably at most 5 % of an outermost annular area of the sole element 101. This may be best understood in that the contour 110 may comprise an extension 115 in the horizontal directions (i.e., along the plane spanned by the heel to toe axis HT and the medial to lateral axis ML) and may encompass an area. The outermost annular area of the sole element 101 is exemplarily indicated in Fig. 11 by a dotted pattern. It is noted that this annular area merely serves to illustrate the contour 110 of the sole element 101 by way of an example. Various different sizes of the annular area are encompassed in the present disclosure.

[0224] The contour 110 that is heated without contact

should not extend in the horizontal directions too much to ensure that only the portions of the sole element 101 believed to be relevant the most are heated.

[0225] As can be seen from Fig. 11, the "annular area" may not be limited to a ring. More appropriately, the annular area referred to herein may be understood as the area spanned by the outermost edge of the sole element 101 as seen from top to bottom (along the downward direction DD) and the width substantially perpendicular to the outermost edge, i.e., perpendicular to the circumferential direction CD of the sole element 101. The width may be parallel to the extension 115 as indicated in Fig. 11 (and in Fig. 4).

[0226] **Fig. 12** shows a schematic flow chart of a method 200 for manufacturing an article of footwear 100, in particular a shoe, such as a sports shoe, preferably a running shoe, according to an embodiment of the present disclosure.

[0227] The method 200 comprising the following steps: providing 210 a sole element 101; providing 220 heating means 130 for providing heat energy without contact to the sole element 101; selectively heating 230, using the heating means 130, at least partially a contour 110 of the sole element 101.

[0228] Further, as an optional step (as indicated by the dashed box in Fig. 12), the method 200 comprises providing 240 an upper 150.

[0229] The heating means 130 as used in the method 200 may be dimensioned to not heat a portion 111 within (in the meaning of enclosed by) the contour 110 of the sole element 101.

[0230] The method 200 may comprise using the heating means 130 as described elsewhere herein and / or using the apparatus 145 as described elsewhere herein. Further, the method 200 may comprise forming a bond between the heated contour 110 and the upper 150. The bond may be a chemical bond and / or a mechanical bond.

[0231] The usage of chemical and / or mechanical bonds in conjunction or in isolation can have several effects. For instance, a mechanical and / or a chemical bond can result in a more durable connection. It can potentially improve the overall integrity and strength of the connection between the sole element 101 and the upper 150, making the bond last longer. The bonded article of footwear 100 may have an increased resistance to physical stress (due to the mechanical bond) and an increased resistance to chemical deterioration and / or corrosion (due to the chemical bond). This can enhance the life span and reliability of the article of footwear 100 so manufactured. Some materials may resist purely mechanical or chemical bond methods. By having the option to utilize both types of bonds, the connection becomes versatile and capable of working with a broader range of materials. Depending on the specific materials and the type of bonds used, implementing a combination of chemical and mechanical bonds could potentially be more time and cost-efficient than using one type of bond alone.

[0232] In one example, selectively heating 230, using the heating means 130, at least partially the contour 110 of the sole element 101 comprises activating at least partially the contour 110 of the sole element 101, preferably such that an activation temperature of at least one material of the contour 110 of the sole element 101 is reached.

[0233] In one example, activating at least partially the contour 110 of the sole element 101 may further comprise providing heat energy to the at least a part of the contour 110 of the sole element 101 such that a viscous layer of at least one material of the contour 110 of the sole element 101 is formed. By forming a viscous layer, the adhesion of at least a part of the contour 101 of the sole element 101 may be increased such that a connection and / or bond to an upper 150 may form upon joining the sole element 101 and the upper 150 together. The thickness of the viscous layer that is formed by the activation should be sufficient to allow creating the desired connection with the upper 150 but at the same time not degrade the contour 110 of the sole element 101 and / or the sole element 101. What a suitable thickness is to achieve this can depend to a large degree on the material(s) and geometry of the contour 110 of the sole element 101 and / or of the sole element 101.

[0234] In case heat energy is provided to the contour 110 of the sole element 101 and the upper 150 (e.g., to a connection surface 151 of the upper 150 as described elsewhere herein, the connection surface 151 of the upper 150 being exemplarily shown in Fig. 13), it is possible that only the contour 110 of the sole element 101 (or the connection surface 151 of the upper 150, if the roles are reversed) is provided with enough heat energy for a viscous layer to form. In such a scenario, it may be sufficient that the connection surface 151 of the upper 150 is only heated to a temperature below the activation temperature of its material. Alternatively, or additionally, it may be sufficient in such a scenario that the connection surface 151 of the upper 150 is only heated to a temperature below the temperature at which a viscous layer forms on the connection surface 151 of the upper 150. In other words, the upper 150 and the connection surface 151 of the upper 150 may only be preheated. Alternatively, enough heat energy is provided to the connection surface 151 of the upper 150 for a viscous layer also to form there, which can increase the likelihood of a chemical bond to form between the contour 110 of the sole element 101 and the connection surface 151 of the upper 150.

[0235] In one example, the bond may be a chemical bond if the contour 110 of the sole element 101 is heated to the activation temperature of a material and / or to a temperature where a viscous layer forms. In one example, the bond may be a mechanical bond if the connection surface 151 of the upper 150 is at least partially melted.

[0236] It may be possible that activating at least partially the contour 110 further comprises providing heat energy to the contour 110 such that the contour 110 is at

least partially melted.

[0237] The temperature the contour of the sole element is heated up to, which will in turn have an influence on the kind of activation that is affected, will depend on various variables. Some of these variables may be the power emitted by the heating means, the heating time, the distance between the heating means and the contour of the sole element, and the material being heated.

[0238] The temperature the contour 110 of the sole element 101 is heated up to can, for example, be chosen to be the temperature at which a viscous layer is formed (as described elsewhere herein). In this case the temperature the contour 110 of the sole element 101 is heated up to can be chosen to be below the degradation temperature (this may be measured by employing thermogravimetric analysis, TGA), to be below the melting peak (measured by employing differential scanning calorimetry, DSC), and / or to be below the onset of melting. Additionally, or alternatively, said temperature may be chosen to coincide with the onset of melting.

[0239] A suitable heating time will in general also depend on several variables that may further be correlated to each other. For example, the power emitted by the heating means 130, the distance of the heating means 130 and the intended temperature the contour 110 of the sole element 101 is heated up to can all influence the proper heating time. In addition, all these variables may be correlated to each other (e.g., moving the heating means 130 closer and / or increasing its output power will increase the achieved temperature given the same heating time). The proper heating can also depend on factors like the material and geometry of the sole element 101 and the connection surface 151 of the upper 150. The heating time may also be adjusted for process optimization.

[0240] Due to the complicated interdependencies of this plurality of variables, only some exemplary values are listed in the following. The skilled person will adjust these values to the given conditions in a suitable manner. The heating time can for example be in the region of at least 5 s, preferably at least 10 s, more preferably at least 20 s, even more preferably at least 30 s, even more preferably at least 40 s, even more preferably at least 50 s, even more preferably at least 1 min, even more preferably at least 2 min, even more preferably at least 3 min, even more preferably at least 4 min, even more preferably at least 5 min. Alternatively or additionally, the heating time can be for example in the region of at most 5 min, preferably at most 4 min, more preferably at most 3 min, even more preferably at most 2 min, even more preferably at most 1 min, even more preferably at most 50 s, even more preferably at most 40 s, even more preferably at most 30 s, even more preferably at most 20 s, even more preferably at most 10 s, even more preferably at most 5 s. In particular examples, the heating time may be in the range of between 55 s and 65 s. The heating time can also be shorter, e.g., 5 s or 10 s or 20 s. The heating time may also lie in between, e.g., in the region of half a minute.

[0241] As a result of the method 200 so performed, connecting the upper 150 to the sole element 110 can be performed without an added adhesive, although such an additional adhesive is not precluded.

[0242] It is possible that the contour 110 of the sole element 101 and / or the connection surface 151 of the upper may first be coated with an adhesive that only becomes adhesive once activated and which is then activated by providing heat energy without contact. Other possibilities are obvious to the person skilled in the art.

[0243] As noted elsewhere herein, the sole element 101 used for the method 200 may comprise one or more of the following: a midsole, an outsole, an outsole element, and a sole plate.

[0244] Selectively heating 230 may be performed by irradiating with heat energy originating from at least one heat source, in particular by irradiating with infrared radiation, IR radiation, originating from at least one IR radiation source. The method 200 may further comprise activating at least one portion of a connection surface 151 of the upper 150 by providing heat energy without contact. Further, the contour 110 of the sole element 101 and the connection surface 151 of the upper 150 may be spaced apart during their heating. The contour 110 and the connection surface 151 of the upper 150 may be simultaneously activated by heat energy.

[0245] In the simplest case, the contour 110 of the sole element 101 and the connection surface 151 of the upper 150 may be melted to the same extent. However, it is also conceivable that the contour 110 of the sole element 101 and the connection surface 151 of the upper 150 are melted to a different extent. This may be achieved, for example, by the amount of heat energy, which is provided to the contour 110 of the sole element 101 and the connection surface 151 of the upper 150 being different. Alternatively, or additionally, the contour 110 of the sole element 101 and the connection surface 151 of the upper 150 may comprise different materials, for example materials with different melting temperatures or ranges, such that the contour 110 of the sole element 101 and the connection surface 151 of the upper 150 melt to a different extent when providing the same amount of heat energy to them.

[0246] The method 200 may further comprise solidifying of the connection of the sole element 101 and the upper 150. The solidifying may be at least partially performed by cooling. Actively cooling may help to produce and to solidify the connection or to accelerate forming such a connection. As a result of the solidifying a mechanical bond may be formed between the sole element 101 and the upper 150.

[0247] Further, a bonding strength of the bond between the contour 110 and the upper 150 may be at least 10 N / cm, when measured according to DIN ISO 6133, as described elsewhere herein.

[0248] The upper 150 and / or the connection surface 151 of the upper 150 may comprise a textile material.

Said textile material may comprise one or more of the following: a knitted construction; a woven construction; a non-woven construction; randomly deposited fibers; a multi-directional layered material; a mesh structure.

[0249] The article of footwear 100 and in particular the shoe, such as the sports shoe so produced using the apparatus 145 and / or the heating means 130 and / or the method 200 described in here provides various advantages and can be used for various purposes. In particular, the shoe 100 serves several different functions, which makes it quite to be even more attractive to individuals. For example, the shoe 100 serves protective purposes, for example, to protect a wearer's foot from interferences or disturbances from foreign objects, such as sharp or pointed objects on which the wearer may tread. Further, the shoe 100 may facilitate cushioning of the impact forces occurring upon foot strike. The shoe 100 also provides for traction to avoid slipping of the wearer's foot. In addition, the shoe 100 may provide a degree of stability to the wearer's foot, so that the danger of twisting one's ankle or other kinds of injuries, for example injury to the plantar fascia or muscle overloading, etc., can be reduced. Yet a further function of the shoe 100, particularly for performance footwear like running shoes, may be to facilitate a good transmission of forces from the athlete's legs through their feet to the ground. This may also contribute to an efficient running style, to improve the athlete's performance.

[0250] Furthermore, in particular for sports shoes, the foot of the athlete can be cushioned in order to reduce impacts and loads on joints of the athlete. In addition, the shoe 100 can be made rather light due to the manufacturing method. This may further contribute to reduce energy consumption for the athlete, which is for instance relevant at longer distances. Further, the shoe 100 may be provided such that a high degree of cushioning and stabilization can be reached. This may reduce the risk of injuries and may make an athletic activity more comfortable. Moreover, the shoe 100 may be provided such that a high energy return can be ensured to reduce the amount of energy that is necessary for the athlete.

[0251] **Fig. 13** shows a schematic representation of an article of footwear 100, according to an embodiment of the present disclosure. The article of footwear 100 may be manufactured with a method 200 according to one of the embodiments described in here.

[0252] The article of footwear 100 comprises a sole element 101 and an upper 150 connected to the sole element 101, preferably without an added adhesive. A bond between the sole element 101 and the upper 150 may be formed, having a bonding strength of at least 10 N / cm, preferably at least 25 N / cm, more preferably at least 35 N / cm, and most preferably at least 50 N / cm, when measured according to DIN ISO 6133. The article of footwear 100 may be a shoe, in particular a sports shoe, such as a running shoe.

[0253] The bond between the sole element 101 and the connection surface 151 of the upper 150 is exemplarily indicated by way of the dopped box in Fig. 13. However, it is noted that the thickness of the bond may be exaggerated for illustrative purposes only.

[0254] In any of the embodiments of the method 200, the apparatus 145, the heating means 130, and the article of footwear 100 described in here, the sole element 101 and / or the contour 110 of the sole element 101 may comprise one or more of the following materials: thermoplastic polyurethane (TPU); a polyamide (PA) such as PA4.10, PA6, PA6.6, PA6.10, PA10.10, PA11 or PA12; a polyetherblockamide (PEBA); a co-polyester; a polyolefin such as a polyethylene (PE) or polypropylene (PP); a polyolefinic elastomer (POE) such as polyisobutylene (PIB), ethylene propylene rubber (EPR) or ethylene propylene diene monomer (M-class) rubber (EPDM); a block copolymer such as an olefin block copolymer (OBC); an expanded material such as expanded thermoplastic polyurethane, an expanded polyamide or an expanded polyetherblockamide; particles of an expanded material such as particles of expanded thermoplastic polyurethane, expanded polyamide and / or expanded polyetherblockamide.

[0255] A sole element 101 comprising or made of particles of an expanded material may be well suitable for, for example, a midsole due to the particularly good elastic properties and the low weight of the particles. However, such sole elements 101 may also be used for other types of sporting goods, for example, for components that provide for a dampening function, such as knee or elbow protectors.

[0256] The contour 110 of the sole element 101 may also have a material composition different from the rest of the sole element 101 or parts of the sole element 101 to better meet the specific requirements for forming a durable connection with the connection surface 151 of the upper 150. The sole element 101 may, for example, comprise multiple layers with the contour 110 of the sole element 101 being formed by one of these layers at a surface of the sole element 101. The contour 110 of the sole element 101 may furthermore comprise a mixture of different materials and may itself comprise multiple layers to allow a very precise control of the activation process. Similar statements apply to the upper 150 and / or the connection surface 151 of said upper 150.

[0257] In any of the embodiments of the method 200, the apparatus 145, the heating means 130, and the article of footwear 100 described in here, the upper 150 and / or the connection surface 151 of the upper 150 and / or the textile material of the upper 150 may comprise one or more of the following materials: polyethylene terephthalate; polybutylene terephthalate; a polyamide such as PA4.10, PA6, PA10.10, PA12, PA66, PA610, PA612 or a different grade; polyurethane; a polyolefin such as a polyethylene or polypropylene; a polyolefinic elastomer such as polyisobutylene, ethylene propylene rubber or ethylene propylene diene monomer rubber; a block copolymer such as an olefin block copolymer; thermoplastic polyurethane. It is noted that the choice of material used

for the upper 150 and / or the connection surface 151 of the upper 150 and / or the textile material may depend on various factors including but not limited to: The combination of the kind of upper 150 and / or the connection surface 151 of the upper 150 and / or the textile material of the upper 150 that is used for manufacturing the shoe and / or the specific way of manufacturing the shoe.

[0258] It is noted that any one or more of the embodiments described herein and / or examples may be combined with further aspects as described herein and details of the embodiments and / or examples may also be omitted, as will be understood by the skilled person. The scope of protection is determined by the claims and is not limited by the embodiments and / or examples disclosed in the above figures.

6. **Further embodiments**

[0259] The invention is further described by the following embodiments:

1. Heating means (130) for providing heat energy without contact to a sole element (101) of an article of footwear (100), in particular of a shoe, such as a sports shoe, preferably a running shoe,
wherein the heating means (130) is configured to selectively heat at least partially a contour (110) of the sole element (101).

2. The heating means (130) according to any one of the preceding embodiments, wherein the heating means (130) is configured to not heat a portion (111) within the contour (110) of the sole element (101).

3. An apparatus (145) for manufacturing an article of footwear (100), in particular a shoe, such as a sports shoe, preferably a running shoe, the apparatus (145) comprising:
heating means (130) according to any one of the preceding embodiments.

4. The apparatus (145) or the heating means (130) according to the preceding embodiment 3, wherein the heating means (130) is dimensioned so as to heat at least 10% of the contour (110) of the sole element (101) in a circumferential direction (CD), preferably at least 20%, more preferably at least 30 %, even more preferably at least 40 %, even more preferably at least 50 %, even more preferably at least 60 %, even more preferably at least 70 %, even more preferably at least 80 %, most preferably at least 90 % of the contour (110) of the sole element (101) in a circumferential direction (CD).

5. The apparatus (145) or the heating means (130) according to embodiment 3 or 4, wherein the heating means (130) is dimensioned to not heat at least 20 % of an innermost area (112) of the sole element (101), preferably to not heat at least 30 %, more preferably to not heat at least 40 %, even more preferably to not heat at least 50 %, even more preferably to not heat at least 60 %, most preferably to not heat at least 70 % of the innermost area (112) of the sole element (101).

6. The apparatus (145) or the heating means (130) according to any one of the preceding embodiments 3 to 5, wherein the contour (110) of the sole element (101) comprises at most 10% of an outermost annular area of the sole element (101), preferably at most 8%, more preferably at most 6%, most preferably at most 5% of an outermost annular area of the sole element (101).

7. The apparatus (145) or the heating means (130) according to any one of the preceding embodiments 3 to 6, wherein the heating means (130) comprises a heating arm (130', 130a, 130b, 130c, 130d), wherein the heating arm (130', 130a, 130b, 130c, 130d) preferably resembles the contour (110) of the sole element (101),
wherein the heating arm (130') is preferably opened in proximity to a toe portion (105) of the sole element (101) when heating the contour (110) of the sole element (101).

8. The apparatus (145) or the heating means (130) according to the preceding embodiment 7, wherein the heating arm (130') comprises one or more of the following segments: a lateral segment (131), a heel segment (132), a medial segment (133), a toe segment (134, 134').

9. The apparatus (145) or the heating means (130) according to the preceding embodiment 7 or 8, wherein the heating arm (130', 130a, 130b, 130c, 130d) comprises a substantially circular profile (138) in a cross-sectional cut (137) perpendicular to a longitudinal axis (136) of the heating arm (130', 130a, 130b, 130c, 130d).

10. The apparatus (145) or the heating means (130) according to any one of the preceding embodiments 3 to 9, wherein the heating means (130) comprises a coating (140) configured to reduce provision of heat energy without contact to the sole element (101).

11. The apparatus (145) or the heating means (130) according to the preceding embodiment 10, wherein the coating (140) comprises a non-heat irradiation permissive material, such as ceramics, glasses, preferably gold.

12. The apparatus (145) or the heating means (130) according to the preceding embodiment 10 or 11,

wherein the coating (140) is provided at least partially on a perimeter of the heating means (130) thereby defining an open section (141) on a remaining part of the perimeter of the heating means (130) through which heat energy without contact can be provided to the sole element (101).

13. The apparatus (145) or the heating means (130) according to the preceding embodiment 12, if dependent on embodiment 9, wherein the open section (141) defines an angle (α) of at least 10°, preferably at least 20°, more preferably at least 30°, even more preferably at least 40°, most preferably at least 50°, and / or wherein the open section (141) defines an angle (α) of at most 80°, preferably at most 70°, more preferably at most 60°, most more preferably at most 50°.

14. The apparatus (145) or the heating means (130) according to any one of the preceding embodiments 3 to 13, wherein the heating means (130) is configured to provide heat radiation, preferably by one or more heat sources (250),
wherein the heating means (130) is preferably configured to provide infrared radiation, IR radiation, preferably by one or more IR radiation sources.

15. The apparatus (145) or the heating means (130) according to any one of the preceding embodiments 3 to 14, wherein the heating means (130) comprises a plurality of distinct heating arms (130a, 130b, 130c, 130d), wherein each heating arm (130a, 130b, 130c, 130d) preferably comprises one more heat source.

16. The apparatus (145) or the heating means (130) according to the preceding embodiment 15, wherein the plurality of distinct heating arms (130a, 130b, 130c, 130d) comprises:

a looped toe heating arm (130a) configured to provide heat energy without contact to a toe portion (105) of the sole element (101);
a linear lateral heating arm (130c) configured to provide heat energy without contact to a lateral side of the sole element (101);
a linear medial heating arm (130b) configured to provide heat energy without contact to a medial side of the sole element (101); and / or
a looped heel heating arm (130d) configured to provide heat energy without contact to a heel portion (107) of the sole element (101).

17. The apparatus (145) according to any one of the preceding embodiments 3 to 16, wherein the apparatus (145) is further comprising a first mounting means (120) for receiving a sole element (101),
wherein the first mounting means (120) comprises biasing means (121) for providing a biasing force to a sole element (101) when received in the first mounting.

18. The apparatus (145) according to the preceding embodiment 17, wherein the biasing means (121) comprises a plurality of spring-loaded pins,

wherein the biasing means (121) preferably comprises a toe group of spring-loaded pins arranged on a toe portion (105) of the first mounting means (120), when a sole element (101) is received in the first mounting,
wherein the biasing means (121) preferably comprises a heel group of spring-loaded pins arranged on a heel portion (107) of the first mounting means (120), when a sole element (101) is received in the first mounting means (120).

19. The apparatus (145) according to embodiment 17 or 18, wherein the apparatus (145) is further comprising a second mounting means (160) for receiving a component of an article (100) of footwear, preferably an upper (150),
wherein the first mounting means (120) and the second mounting means (160) can be moved apart from one another and moved together under pressure.

20. The apparatus (145) according to any one of embodiments 17 to 19, wherein the first mounting means (120) comprises a cavity having a tapered shape for receiving a sole element (101).

21. The apparatus (145) according to any one of embodiments 17 to 20, wherein the heating means (130) are configured to be moved, preferably rotated, relative to the first mounting means (120), such that a distance to a sole element (101) can be adjusted, when the sole element (101) is received in the first mounting means (120).

22. A method (200) for manufacturing an article of footwear (100), in particular a shoe, such as a sports shoe, preferably a running shoe, the method (200) comprising:

providing (210) a sole element (101);
providing (220) heating means (130) for providing heat energy without contact to the sole element (101);
optionally providing (240) an upper (150);
selectively heating (230), using the heating means (130), at least partially a contour (110) of the sole element (101).

23. The method (200) for manufacturing an article of footwear (100) according to the preceding embodi-

ment 22, wherein the heating means (130) is dimensioned to not heat a portion (111) within the contour (110) of the sole element (101).

24. The method (200) for manufacturing an article of footwear (100) according to embodiment 22 or 23, wherein the method (200) comprises using the heating means (130) according to embodiment 1 or 2 and / or the apparatus (145) according to any one of embodiments 3 to 21.

25. The method (200) for manufacturing an article of footwear (100) according to any one of the preceding embodiments 22 to 24, wherein the method (200) comprises forming a bond between the heated contour (110) and the upper (150).

26. The method (200) for manufacturing an article of footwear (100) according to the preceding embodiment 25, wherein the bond comprises a chemical bond and / or a mechanical bond.

27. The method (200) for manufacturing an article of footwear (100) according to any one of the preceding embodiments 22 to 26, wherein selectively heating (230), using the heating means (130), at least partially a contour (110) of the sole element (101) comprises:
activating at least partially the contour (110), preferably such that an activation temperature of at least one material of the contour (110) of the sole element (101) is reached.

28. The method (200) for manufacturing an article of footwear (100) according to the preceding embodiment 27, wherein activating at least partially the contour (110) further comprises providing heat energy to the contour (110) such that the contour (110) is at least partially melted.

29. The method (200) for manufacturing an article of footwear (100) according to any one of the preceding embodiments 22 to 28, wherein the method (200) comprises connecting the upper (150) to the sole element (101), preferably without an added adhesive.

30. The method (200) for manufacturing an article of footwear (100) according to any one of the preceding embodiments 22 to 29, wherein the sole element (101) and / or the contour (110) comprise one or more of the following materials: thermoplastic polyurethane; a polyamide such as PA4.10, PA6, PA6.6, PA6.10, PA10.10, PA11 or PA12; a polyetherblockamide; a co-polyester; a polyolefin such as a polyethylene or polypropylene; a polyolefinic elastomer such as polyisobutylene, ethylene propylene rubber or ethylene propylene diene monomer rubber; a block copolymer such as an olefin block copolymer; an expanded material such as expanded thermoplastic polyurethane, an expanded polyamide or an expanded polyetherblockamide; particles of an expanded material such as particles of expanded thermoplastic polyurethane, expanded polyamide and / or expanded polyetherblockamide.

31. The method (200) for manufacturing an article of footwear (100) according to any one of the preceding embodiments 22 to 30, wherein the sole element (101) comprises one or more of the following: a midsole, an outsole, an outsole element, and a sole plate.

32. The method (200) for manufacturing an article of footwear (100) according to any one of the preceding embodiments 22 to 31, wherein selectively heating (230) is performed by irradiating with heat energy originating from at least one heat source (250), in particular by irradiating with infrared radiation, IR radiation, originating from at least one IR radiation source.

33. The method (200) for manufacturing an article of footwear (100) according to any one of the preceding embodiments 22 to 32, wherein the method (200) further comprises activating at least one portion of a connection surface of the upper (150) by providing heat energy without contact and wherein the contour (110) of the sole element (101) and the connection surface of the upper are spaced apart during their heating.

34. The method (200) for manufacturing an article of footwear (100) according to the preceding embodiment 33, wherein the contour (110) and the connection surface of the upper are simultaneously activated by heat energy.

35. The method (200) for manufacturing an article of footwear (100) according to any one of the preceding embodiments 22 to 34, wherein the upper (150) and / or the connection surface of the upper (150) comprise a textile material, and wherein the textile material comprises one or more of the following: a knitted construction; a woven construction; a nonwoven construction; randomly deposited fibers; a multi-directional layered material; a mesh structure.

36. The method (200) for manufacturing an article of footwear (100) according to any one of the preceding embodiments 22 to 35, wherein the upper (150) and / or the connection surface and / or the textile material comprise one or more of the following materials: polyethylene terephthalate; polybutylene terephthalate; a polyamide such as PA4.10, PA6, PA10.10, PA12, PA66, PA610, PA612 or a different grade;

polyurethane; a polyolefin such as a polyethylene or polypropylene; a polyolefinic elastomer such as polyisobutylene, ethylene propylene rubber or ethylene propylene diene monomer rubber; a block copolymer such as an olefin block copolymer; thermoplastic polyurethane; a foamed or expanded material such as expanded thermoplastic polyurethane, an expanded polyamide or an expanded polyether-blockamide; a non-foamed or compact material; rubber.

37. The method (200) for manufacturing an article of footwear (100) according to any one of the preceding embodiments 22 to 36, further comprising solidifying of the connection of the sole element (101) and the upper (150).

38. The method (200) for manufacturing an article of footwear (100) according to the preceding embodiment 37, wherein the solidifying is at least partially performed by cooling.

39. The method (200) for manufacturing an article of footwear (100) according to any one of the preceding embodiments 22 to 38 if dependent on embodiment 25, wherein a bonding strength of the bond between the contour (110) and the upper (150) is at least 10 N/cm, preferably at least 25 N/cm, more preferably at least 35 N/cm, and most preferably at least 50 N/cm, when measured according to DIN ISO 6133.

40. An article of footwear (100) manufactured with a method (200) according to one of the preceding embodiments 22 to 39.

41. The article of footwear (100) according to the preceding embodiment 40, wherein the article of footwear (100) comprises a sole element (101) and an upper (150) connected to the sole element (101) without an added adhesive,
wherein a bond between the sole element (101) and the upper (150) has a bonding strength of at least 10 N/cm, preferably at least 25 N/cm, more preferably at least 35 N/cm, and most preferably at least 50 N/cm, when measured according to DIN ISO 6133.

42. The article of footwear (100) according to embodiment 40 or 41, wherein the article of footwear (100) is a shoe, in particular a sports shoe.

7. List of reference signs used

[0260]

100	article of footwear
101	sole element for an article of footwear, in particular for a shoe
105	toe portion of the sole element
106	midfoot portion of the sole element
107	heel portion of the sole element
110	contour of the sole element
111	portion within the contour of the sole element
112	innermost area of the sole element
115	extension of the contour of the sole element in the horizontal direction, preferably directed to the center of the sole element
120	first mounting means
121	biasing means of the first mounting means / toe group of spring-loaded pins
122	heel group of spring-loaded pins
123	cavity of the first mounting means
124	tapered shape of the first mounting means
125	inclined surface of the first mounting means
130	heating means
130a	looped toe heating arm
130b	linear medial heating arm
130c	linear material heating arm
130d	looped heel heating arm
130’	heating arm of the heating means
131	lateral segment of the heating arm
132	heel segment of the heating arm
133	medial segment of the heating arm
134	toe segment of the heating arm
134’	toe segment of the heating arm
135	opening of the heating arm
136	longitudinal axis of the heating arm
137	cross-sectional cut of the heating arm
138	circular profile

140	coating of the heating means
141	open section of the coating of the heating means
α	angle of the open section of the coating of the heating means
145	apparatus for manufacturing an article of footwear
150	component of an article of footwear / upper of an article of footwear
151	connection surface of the upper
160	second mounting means
200	method for manufacturing an article of footwear
210	providing a sole element
220	providing heating means
230	selectively heating at least partially a contour of the sole element
240	providing an upper
HT	heel to toe axis (longitudinal direction) of the sole element
ML	medial to lateral axis of the sole element
UD	upward direction
DD	upward direction
CD	circumferential direction of the sole element

Claims

1. Heating means (130) for providing heat energy without contact to a sole element (101) of an article of footwear (100), in particular of a shoe, such as a sports shoe, preferably a running shoe,
wherein the heating means (130) is configured to selectively heat at least partially a contour (110) of the sole element (101).

2. The heating means (130) according to the preceding claim, wherein the heating means (130) is configured to not heat a portion (111) within the contour (110) of the sole element (101).

3. An apparatus (145) for manufacturing an article of footwear (100), in particular a shoe, such as a sports shoe, preferably a running shoe, the apparatus (145) comprising:
heating means (130) according to any one of the preceding claims.

4. The apparatus (145) or the heating means (130) according to the preceding claim 3, wherein the heating means (130) is dimensioned so as to heat at least 10% of the contour (110) of the sole element (101) in a circumferential direction (CD), preferably at least 20%, more preferably at least 30 %, even more preferably at least 40 %, even more preferably at least 50 %, even more preferably at least 60 %, even more preferably at least 70 %, even more preferably at least 80 %, most preferably at least 90 % of the contour (110) of the sole element (101) in a circumferential direction (CD).

5. The apparatus (145) or the heating means (130) according to claim 3 or 4, wherein the heating means (130) is dimensioned to not heat at least 20 % of an innermost area (112) of the sole element (101), preferably to not heat at least 30 %, more preferably to not heat at least 40 %, even more preferably to not heat at least 50 %, even more preferably to not heat at least 60 %, most preferably to not heat at least 70 % of the innermost area (112) of the sole element (101).

6. The apparatus (145) or the heating means (130) according to any one of the preceding claims 3 to 5, wherein the contour (110) of the sole element (101) comprises at most 10% of an outermost annular area of the sole element (101), preferably at most 8%, more preferably at most 6%, most preferably at most 5% of an outermost annular area of the sole element (101).

7. The apparatus (145) or the heating means (130) according to any one of the preceding claims 3 to 6, wherein the heating means (130) comprises a coating (140) configured to reduce provision of heat energy without contact to the sole element (101),
optionally, wherein the coating (140) comprises a non-heat irradiation permissive material, such as ceramics, glasses, preferably gold.

8. The apparatus (145) or the heating means (130) according to the preceding claim 7, wherein the coating (140) is provided at least partially on a perimeter of the heating means (130) thereby defining an open section (141) on a remaining part of the perimeter of the heating means (130) through which heat energy without contact can be provided to the sole element (101).

9. The apparatus (145) or the heating means (130) according to any one of the preceding claims 3 to 8, wherein the heating means (130) is configured to

provide heat radiation, preferably by one or more heat sources (250),
wherein the heating means (130) is preferably configured to provide infrared radiation, IR radiation, preferably by one or more IR radiation sources.

10. The apparatus (145) or the heating means (130) according to any one of the preceding claims 3 to 9, wherein the heating means (130) comprises a plurality of distinct heating arms (130a, 130b, 130c, 130d), wherein each heating arm (130a, 130b, 130c, 130d) preferably comprises one more heat source.

11. A method (200) for manufacturing an article of footwear (100), in particular a shoe, such as a sports shoe, preferably a running shoe, the method (200) comprising:

providing (210) a sole element (101);
providing (220) heating means (130) for providing heat energy without contact to the sole element (101);
optionally providing (240) an upper (150);
selectively heating (230), using the heating means (130), at least partially a contour (110) of the sole element (101).

12. The method (200) for manufacturing an article of footwear (100) according to claim 11, wherein the method (200) comprises using the heating means (130) according to claim 1 or 2 and / or the apparatus (145) according to any one of claims 3 to 10.

13. The method (200) for manufacturing an article of footwear (100) according to claim 11 or 12, wherein selectively heating (230) is performed by irradiating with heat energy originating from at least one heat source (250), in particular by irradiating with infrared radiation, IR radiation, originating from at least one IR radiation source,

optionally, wherein the method (200) further comprises activating at least one portion of a connection surface of the upper (150) by providing heat energy without contact and wherein the contour (110) of the sole element (101) and the connection surface of the upper are spaced apart during their heating,
optionally, wherein the contour (110) and the connection surface of the upper are simultaneously activated by heat energy.

14. The method (200) for manufacturing an article of footwear (100) according to any one of the preceding claims 11 to 13, further comprising solidifying of the connection of the sole element (101) and the upper (150),
optionally, wherein the solidifying is at least partially performed by cooling.

15. An article of footwear (100) manufactured with a method (200) according to one of the preceding claims 11 to 14.

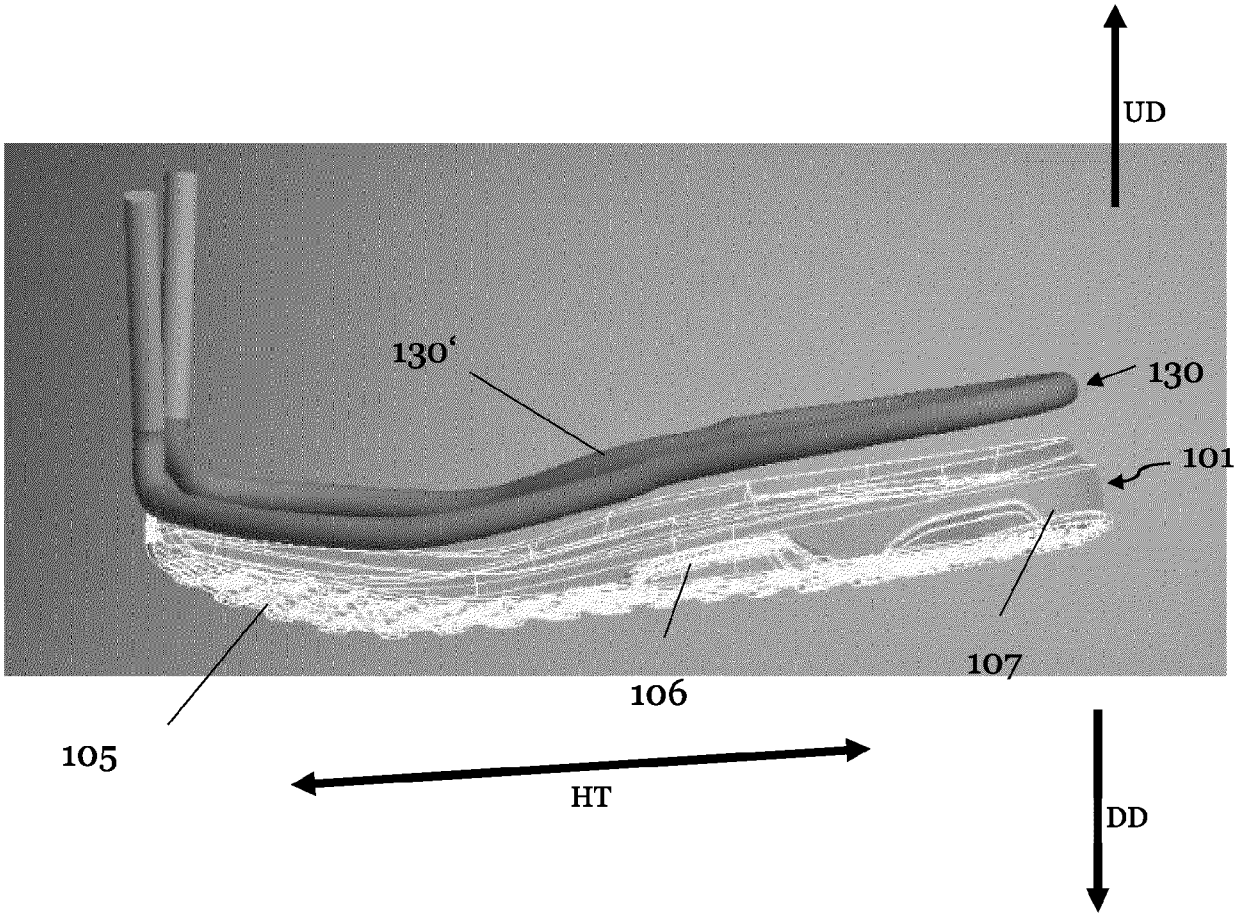
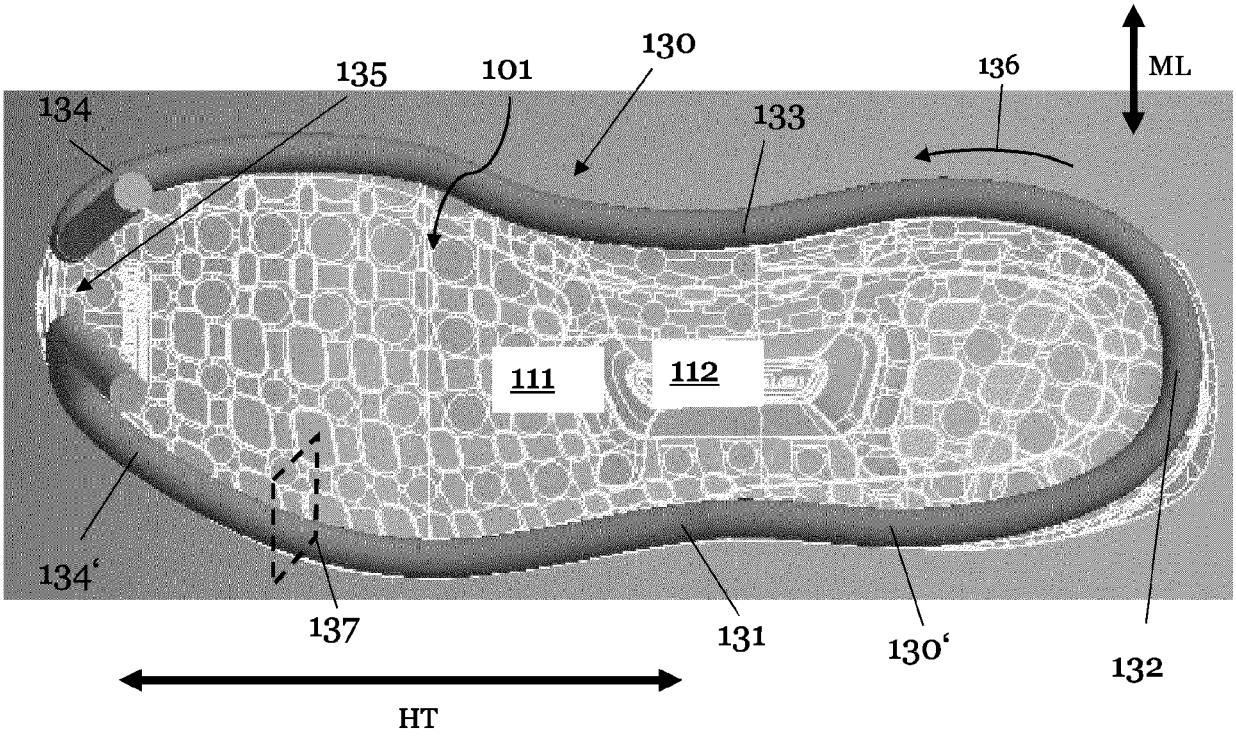


Fig. 1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101
130
136
ML
134
133
111
112
134‘
137
131
130‘
132
HT

Fig. 2

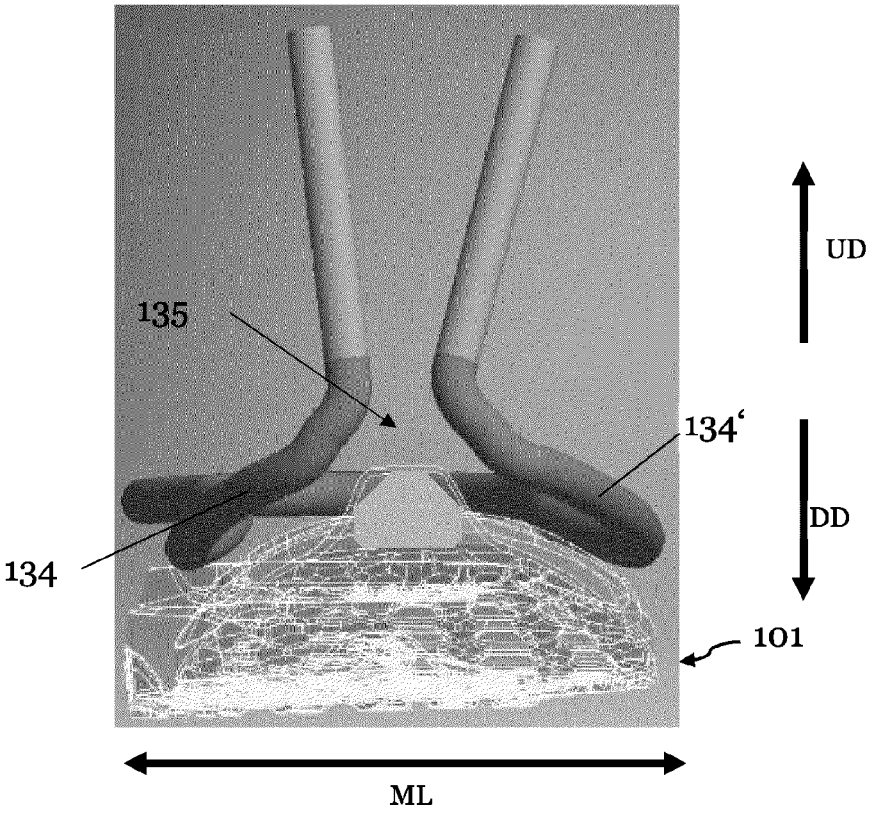

UD
135
134‘
DD
134
101
ML

Fig. 3

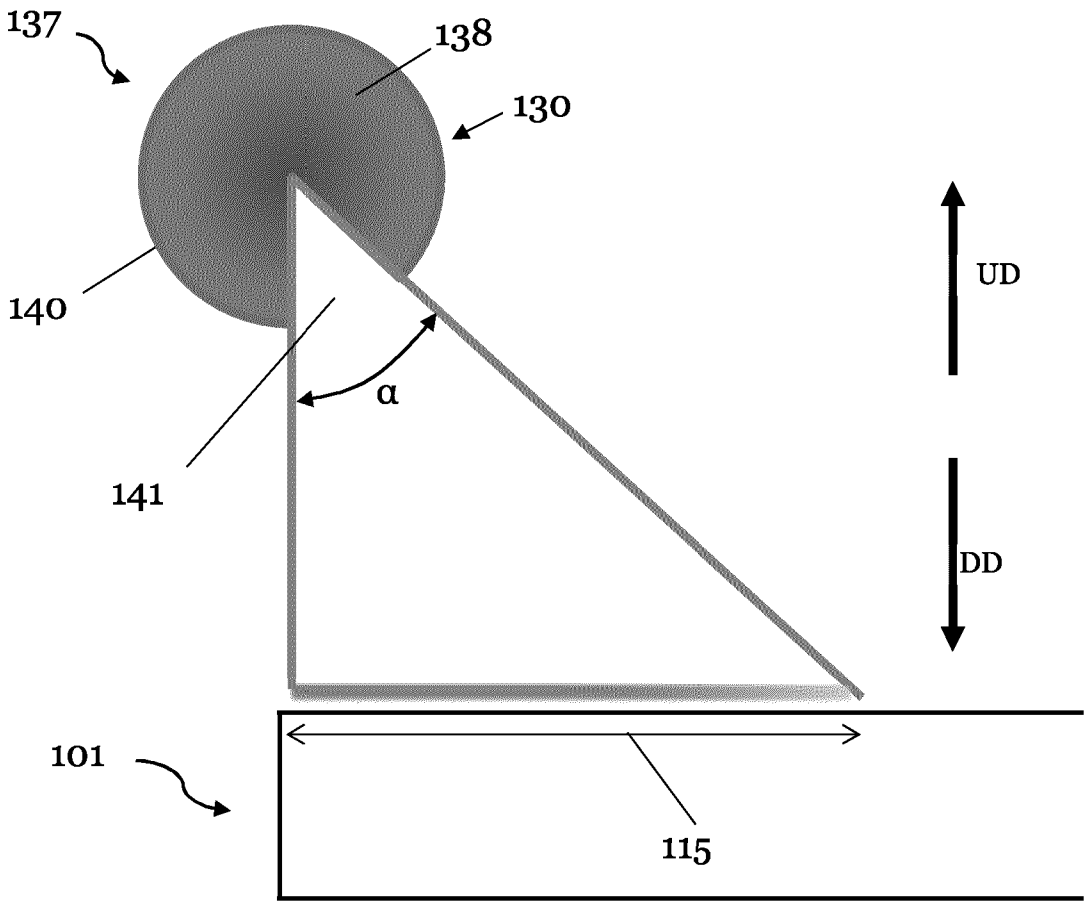


Fig. 4

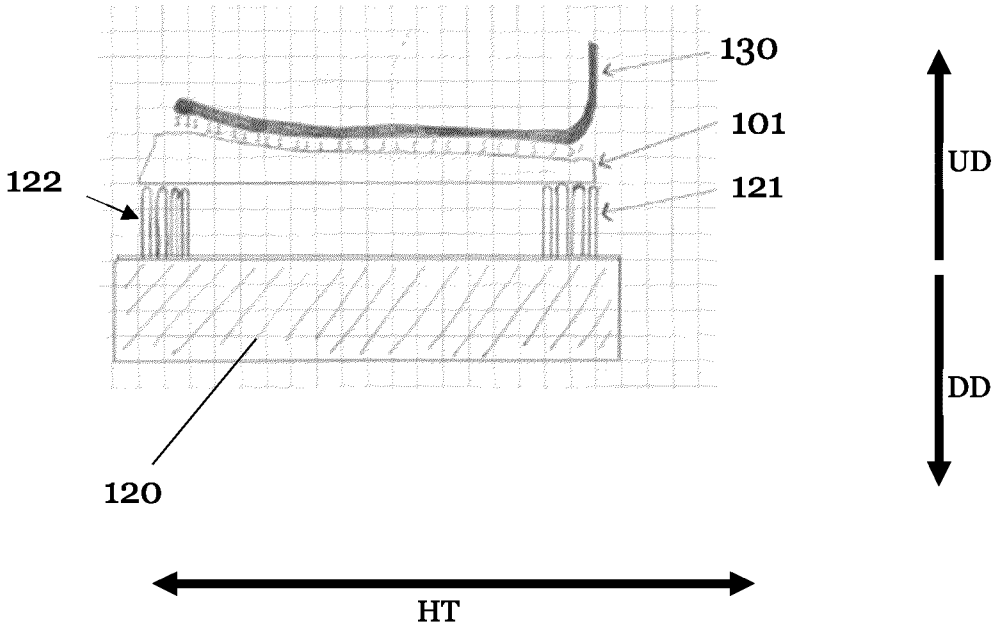
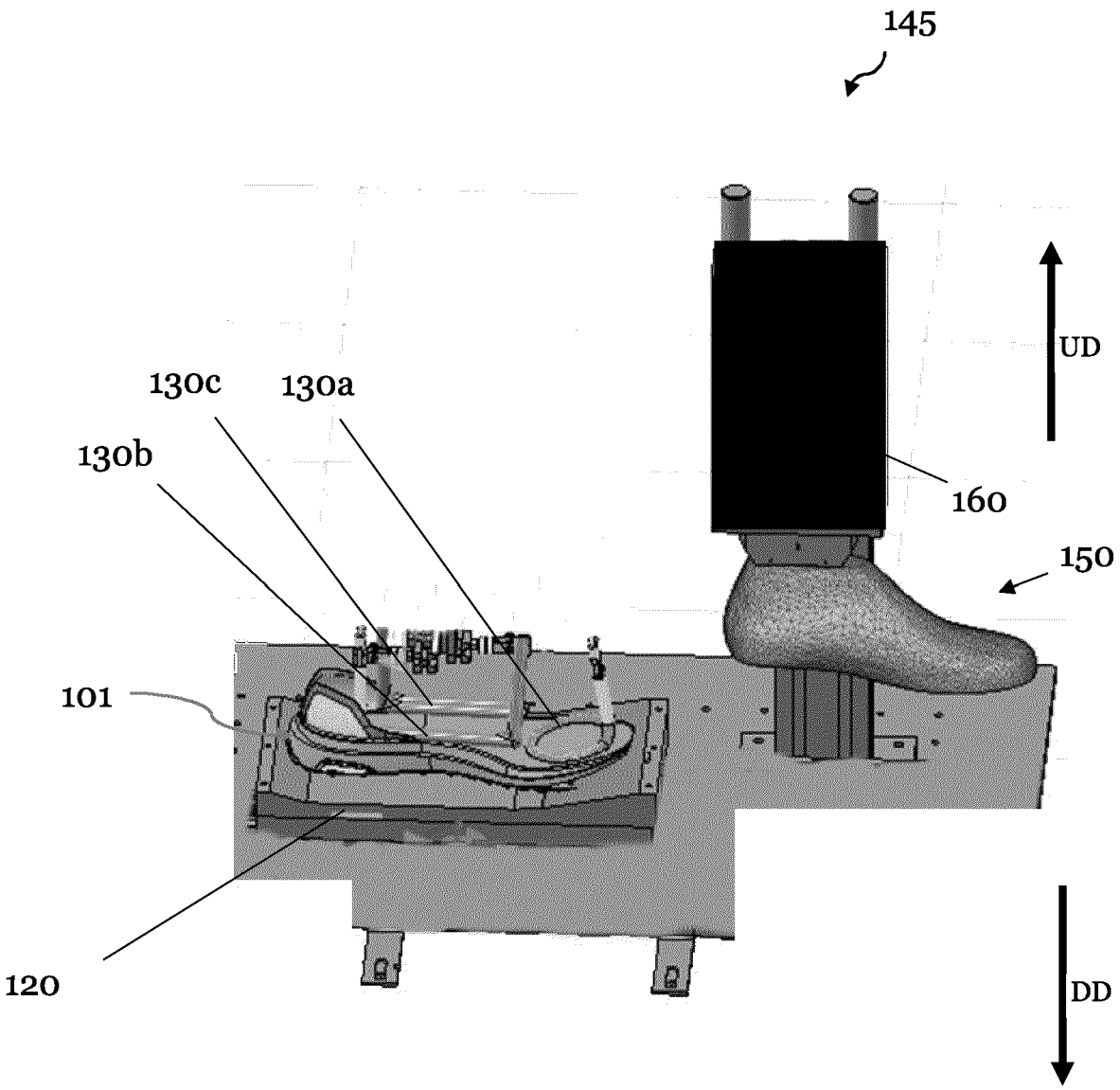


Fig. 5



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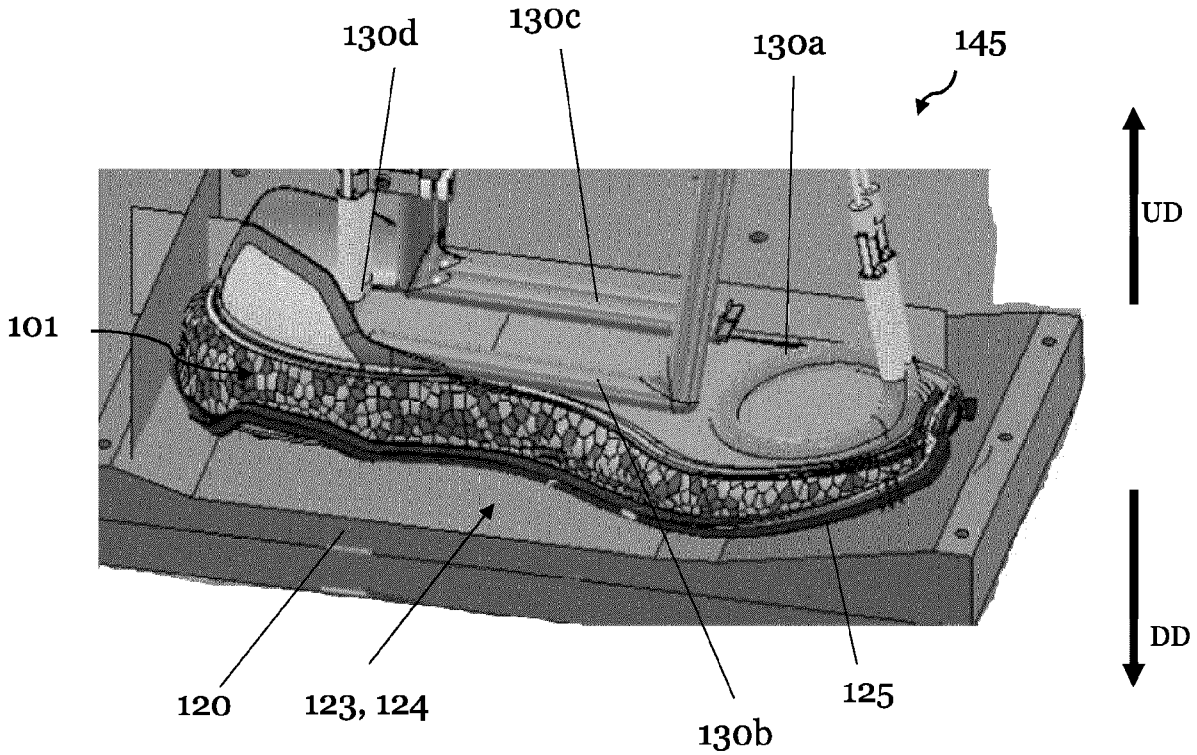
130d
130c
130a
145
UD
101
DD
120
123, 124
130b
125

Fig. 7

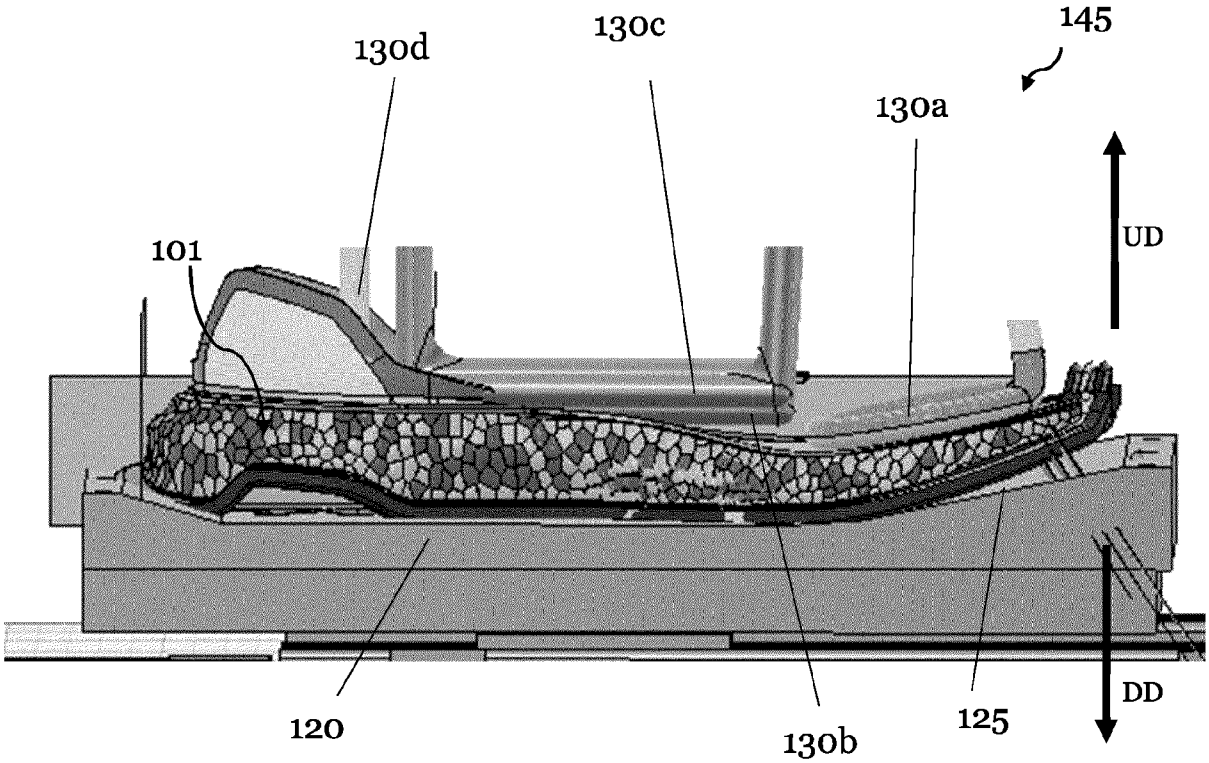
130d
130c
145
130a
UD
101
DD
120
130b
125

Fig. 8

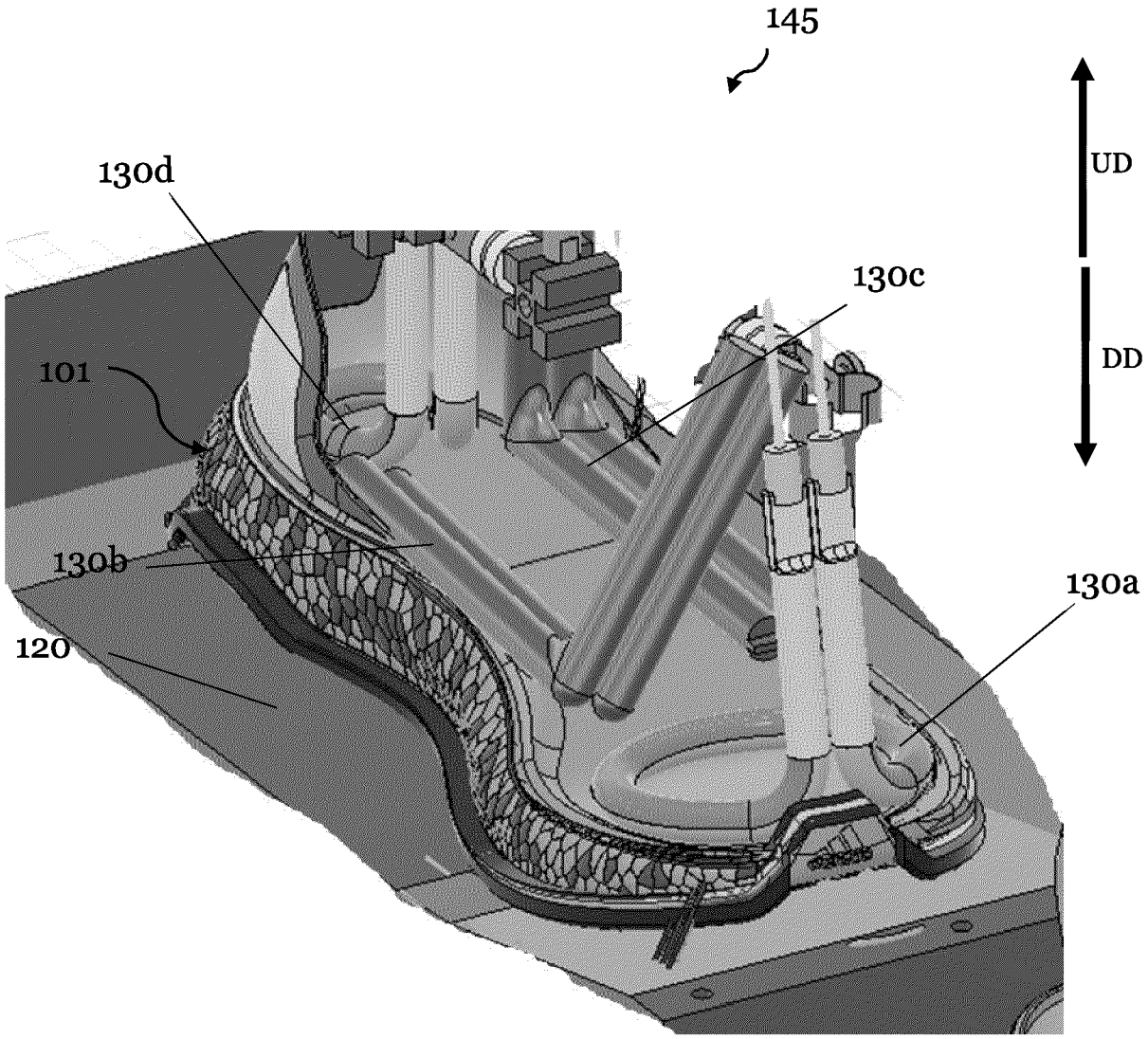

Fig. 9

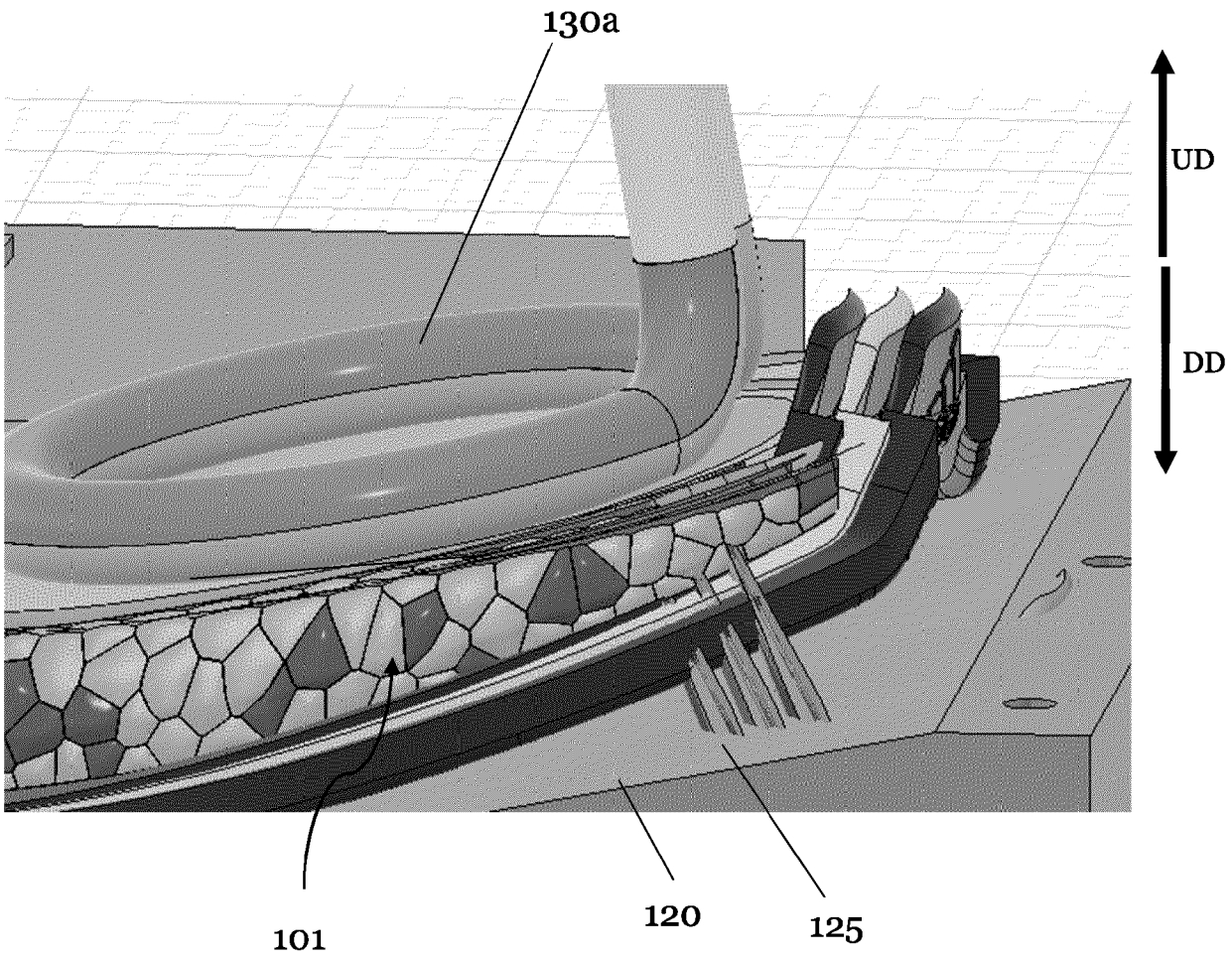

Fig. 10

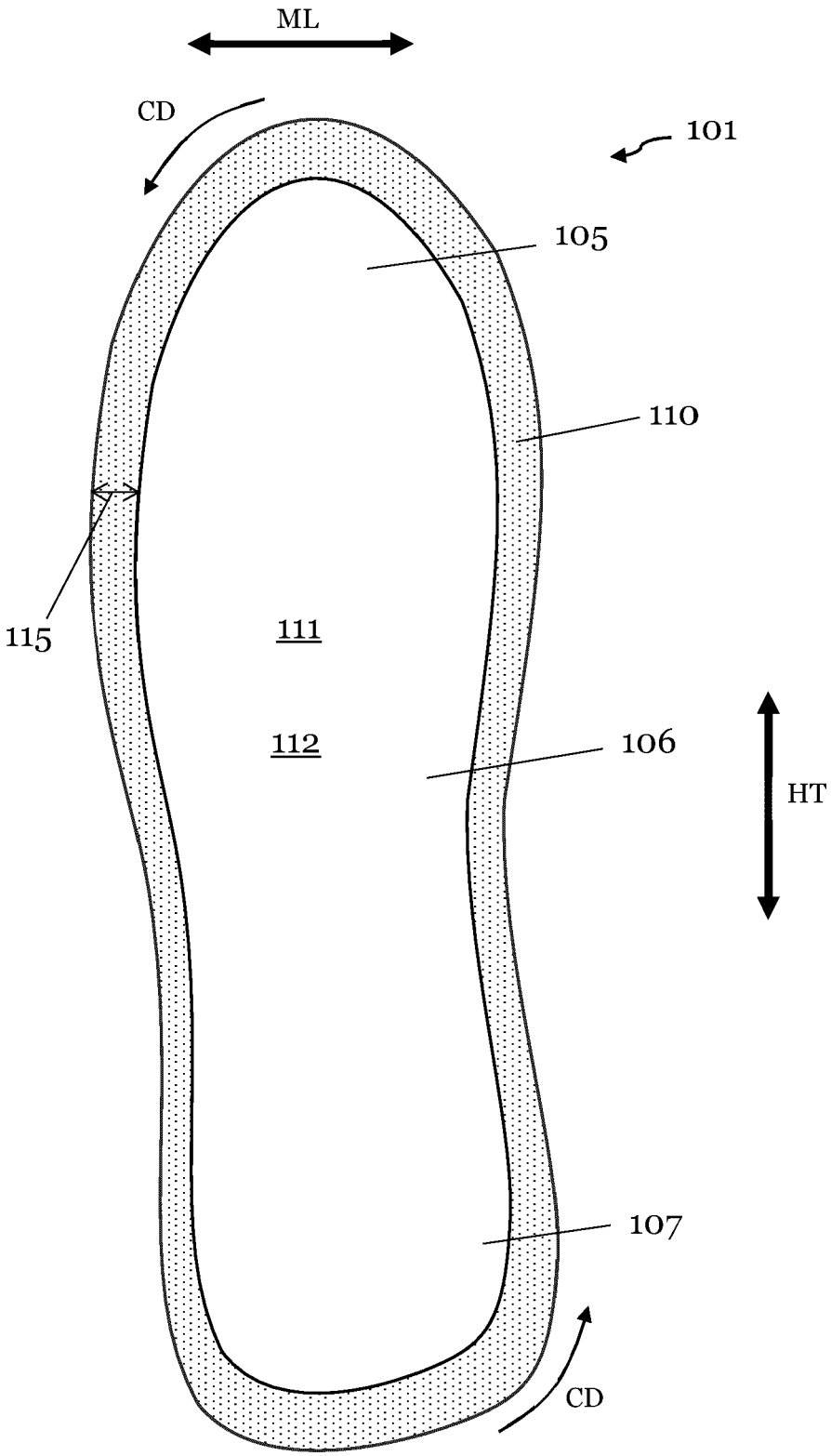

Fig. 11

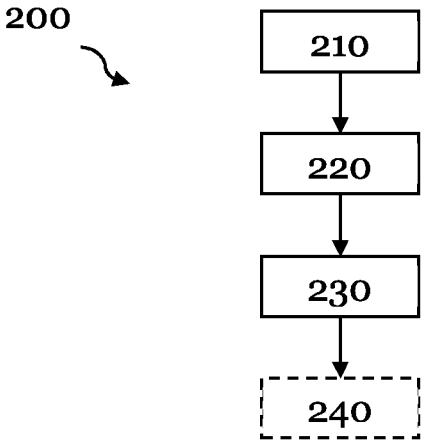

Fig. 12

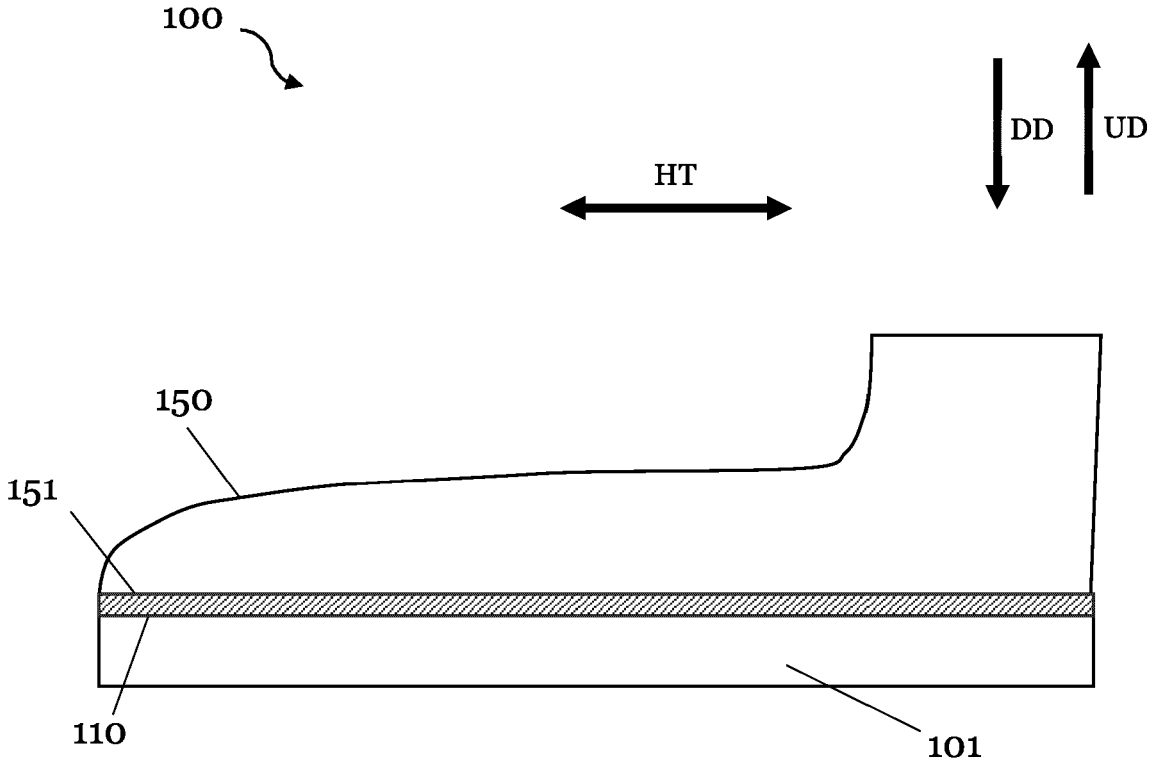

Fig. 13

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European Patent Office
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EUROPEAN SEARCH REPORT

Application Number
EP 24 20 7824

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	DE 19 42 047 A1 (EUGEN G HENKEL MASCHINENFABRIK) 18 March 1971 (1971-03-18) * the whole document *	1-8, 10-12, 14,15 9,13	INV. A43D25/20
X Y	US 2 450 956 A (HART GEORGE T) 12 October 1948 (1948-10-12) * the whole document *	1-8,11, 12,14,15 9,13	
X Y	US 2 186 941 A (TEPPEMA CAMBRIDGE MORRIS MASS) 16 January 1940 (1940-01-16) * claims; figures *	1-6,11, 12,14,15 9,13	
Y A	DE 18 82 393 U (EUGEN G HENKEL MASCHINENFABRIK [DE]) 7 November 1963 (1963-11-07) * the whole document *	9,13 1,3,11, 15	
			TECHNICAL FIELDS SEARCHED (IPC) A43D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	12 March 2025	Cianci, Sabino

CATEGORY OF CITED DOCUMENTS

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EPO FORM 1503 03.82 (P04C01)

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12-03-2025

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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