

Sole Construction for Shoes, and a Process for its Production.

The present invention refers to a sole construction for shoes comprising pre-shaped wooden parts interconnected at the area of the ball of the foot by flexible intermediate portions of foamed polyurethane.

- 5 Sole-constructions of wood are already known and have many advantages. Such wooden soles are hard or rigid at the heel portion, at the mid-portion of the foot and at the toe area and thus support the foot in an orthopaedically favourable manner. If for orthopaedic reasons wooden soles are provided with a
- 10 shaped foot bed, then they basically comprise a heel vault, a support for the inner region of the foot, a support for the outer region, a support for the middle portion of the foot, a depression for the ball of the foot and, if desired, also a toe barrier. All these portions must have a certain strength
- 15 and stability and this requirement is fulfilled with wooden soles. Furthermore, wood insulates against cold, is temperature-controlling and absorbs humidity, so that shoe soles of wood are hygienic and comfortable to wear.

Known soles consisting wholly of wood have, however, the drawback

20 that they are stiff at the area of the ball of the foot and thus

hinder the rolling motion of the foot on walking. Such stiffness can under certain circumstances be detrimental to health.

For these reasons sole-constructions have been proposed which consist of two wooden parts connected with one another at the
5 area of the ball of the foot by a flexible intermediate portion. Thus, the sole-construction becomes flexible at this area and can follow the rolling motion of the foot on walking.

It has already been proposed to make the flexible intermediate portion from foamed polyurethane. This material gives a
10 reliable and strong connection between the intermediate portion and the wood without the need for additional measures. The polyurethane is formed of two components, a polyol compound (based on polyesters or polyethers) and isocyanates (comprising at least two NCO-groups). These -NCO groups react with the hydroxy
15 groups (OH-groups) of the wood, or with other compounds contained in the wood and comprising active hydrogen atoms, so that a strong chemical bond can be reliably established between wood and polyurethane.

In addition, a mechanical bond is formed since the polyurethane
20 foam penetrates during its formation into the pores of the wood. Such sole-constructions can be rapidly produced in a simple manner by introducing the individual wooden parts into a mould

and filling the remaining space or cavity with the polyurethane-forming agent.

It has now been found that known sole constructions comprising wooden parts interconnected by polyurethane do not meet all requirements. If such constructions are strongly bent at the area of the ball of the foot the marginal parts of the intermediate portion, i.e. those parts located near the sole of the foot and near the walking surface are too greatly elongated or too strongly compressed. If the intermediate portion is too greatly elongated a risk of cracks or fractures arises at the area of transition between the intermediate portion and the wooden parts. If there is too strong a compression, the intermediate portion becomes deformed outwards which makes the wearer of the shoe uncomfortable. Too strong a compression additionally results in the danger of pinching the wearers foot between the wooden parts especially if the dimension of the intermediate part (measured in the longitudinal direction of the sole) is small at the marginal part adjacent the foot and thus allows the edges of the wooden parts to approach each other when the sole is bent.

The present invention sets out to avoid the mentioned drawbacks and to further improve a shoe sole comprising an intermediate portion consisting of foamed polyurethane. For this purpose the invention essentially consists in a sole construction for shoes comprising at least one assembly of two wooden parts interconnected at the area of the ball of a wearers foot by

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a flexible intermediate portion of foamed polyurethane, thereby to define a sole construction upper-surface and a sole construction under-surface : the dimension of this intermediate portion in the longitudinal direction of the sole construction being greater at its upper and lower marginal parts (measured as a continuation of the upper-surface and under-surface respectively) than the minimum such dimension of an inner part intermediate those surfaces; the said marginal parts merging with the said inner part in a rounded fashion; and those upper contact surfaces, between the upper marginal part of the intermediate portion and the wooden parts extending generally obliquely towards the said inner part. By increasing the width at the marginal parts the specific elongation and the specific compression of these parts becomes substantially reduced. In addition, such a construction results in a greater area of connecting surface , as between intermediate portion and wooden parts as (compared to a construction having intermediate portions of equal width throughout) so that a better mechanical and chemical bond is reliably achieved.

According to the invention, both marginal parts of the intermediate portion merge in a smoothly rounded fashion to the inner part. Thus, sharp edges which, on bending could cause destructive tension and compression stresses are avoided.

Preferably, the said contact surfaces are curved and depart generally tangentially from the sole-construction upper

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surface so that no steps are formed at the area of transition. Such steps would be uncomfortable to the wearer of the shoe particularly if such steps would contact the foot sole of the wearer. It is also envisaged that the lower marginal portions maybe obliquely directed, and optionally curved and tangential as above. Thus, the thickness of the intermediate portion measured in a direction perpendicular to the sole gradually increases up to a value equal to the total thickness of the sole, so that a smooth transition between non-yielding wooden parts and yielding intermediate portion is achieved and no uncomfortable steps occur between wooden parts and intermediate parts.

According to a preferred feature of the invention the or each intermediate portion is symmetrical about a central vertical transverse plane or a central horizontal plane. Thus, all bending stresses exerted are equally distributed over the individual parts and any injury of these intermediate parts on such bending stress is reliably prevented.

It is of advantage if, as according to a further feature of the invention, the or each intermediate portion has an inner parts which possesses forwardly extending and rearwardly extending integral protrusions. Such protrusions still further increase the connecting surface between both wooden parts and the intermediate part and still further improve the chemical

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bond. In such a construction, the mechanical bond can be made more reliable by providing the protrusions at their ends with greater dimensions than the remaining parts thereof for example by giving the protrusions a dove-tail end. For
5 avoiding local peak stresses, it is convenient if the protrusions merge with the inner parts in a smoothly rounded manner.

With the known embodiment one single intermediate portion of polyurethane is provided for inter-connecting two wooden
10 parts. In such an embodiment, the intermediate part must, on bending of the sole take up the total stress. This intermediate portion may therefore become excessively stressed. Also, any flexible upper connected to the sole is on such bending equally strongly loaded at one single area and it may become
15 necessary to provide gussets in the upper which can be uncomfortable even in shoes or sandals having a free toe portion or heel portion. In closed shoes, having neither a free toe portion nor a free heel portion any interruption in the upper, whether a recess, a cut-out gusset, could not be accepted.
20 Therefore and according to the invention more than two wooden parts may be provided correspondingly inter-connected to form more than one such assemblies arranged within the ball area of the foot thereby distributing bending motion of the sole over a plurality of intermediate portions. In this case, the
25 intermediate portion can be narrower than a single intermediate

portion could be. Since the bending stress is distributed over a plurality of intermediate parts and thus over a greater area it is not required to provide gussets in the upper at the corresponding region.

5 The or each intermediate portion can, as seen from above, be substantially straight. However, it is often convenient to provide an intermediate portion which is arcuate as seen from above and which thereby adapts in an orthopaedically more favourable manner to the bending motion of the sole
10 on walking.

The invention also provides the possibility of forming the walking sole integrally with the or each intermediate portion, and extending beneath the said under-surface, thereby not only simplifying the production operation but also providing
15 an additional bonding link between the wooden parts.

It is already known to produce a sole-construction comprising an intermediate portion of foamed polyurethane by introducing the wooden parts into a mould and by introducing into the free space of the mould a polyurethane-forming material which is
20 allowed to foam within the closed mould. A sole produced in such a manner does not however show completely plane surfaces, free from steps, because it is impossible to produce the wooden parts with sufficient accuracy, whereby the polyurethane will overflow or flow out. In practice, such

wooden parts cannot be accurately dimensioned relative to the mould because of the inherent dimensional instabilities of wood and the slight non-uniformity of wood-working operations even when using modern machines. Therefore, and according to 5 the invention, it is envisaged that at the upper surface and the side surfaces of the sole-construction, after removal of the sole from the mould, should be mechanically finished preferably by grinding or milling, so that these surfaces are completely without steps and exhibit no uncomfortable 10 steps.

The polyurethane-forming material may be filled into the mould prior to closing this mould, so that the sole can be produced in a simple manner without expensive equipment.

As already mentioned, a chemical reaction between the NCO-groups 15 present in the isocyanate and the OH-groups of the wood(or the other compounds comprising active hydrogen atoms) takes place when producing a sole-construction according to the invention so that a particularly strong and permanent chemical bond is obtained between the wooden parts and the intermediate portions. 20 It has now been found that for this reaction the water content of the wooden parts, to which the intermediate portion is to be applied, is of importance. If the humidity content is too great, the chemical reaction proceeds too rapidly and the polyurethane foam has during its period of formation no time

to penetrate the pores of the wood so that the strength of the mechanical bond between the wooden parts and the intermediate parts becomes reduced. Furthermore, a high volume of carbon dioxide is produced during the reaction, so that the intermediate portions have a very coarse foam structure especially nearer the wood; this again leads to an increase in the danger of fracture within this zone. According to a preferred further feature of the inventive process, the humidity content of the wooden parts is less than 12 percent, and more preferably less than 6 percent, prior to introducing the wood into the mould. A bond of particularly high strength can be obtained if the humidity content of the wooden parts is between 0.0.1 and 5 percent. In this case, the reaction between the hydroxy groups present in the wood (or the other compounds containing active hydrogen atoms and also present in wood) and the NCO-groups contained in the isocyanate takes place in a particularly advantageous manner, so that not only to a reliable mechanical bond achieved between the wooden parts and the intermediate portions by the polyurethane penetrating the pores of the wood but also a particularly strong chemical bond is formed.

A sole-construction according to the invention can constitute an insole over which the upper of the shoe is lasted and on to which subsequently an intermediate sole and a walking sole (or possibly a walking shoe alone) is fixed. Alternatively,

it can constitute a member which simultaneously forms an in-
sole and/or the foot bed and to which the upper is laterally
fixed. Such a wooden sole-construction is, as a rule, provided
with a walking sole. If the walking sole is integral with the
5 or each intermediate portion it can be applied in a rapid
and simple manner simultaneously with the production of
the intermediate portion. In such a case, the walking shoe is
reliably bonded to the wooden parts and any loosening of the
walking sole (which is a particular danger within the area
10 of the ball of the foot where the intermediate portions occur
and where the bending motion takes place) can be reliably prevented.
Moreover, the walking sole then has no steps whatsoever even
within the area of the or each intermediate portion. No final
machining is required when simultaneously producing the whole
15 walking sole together with the or each intermediate portion.
Simultaneous production of good quality walking sole and
intermediate portions, for which purpose polyurethane of
walking sole quality must naturally be used, can, however, be
effected only if the wooden parts have a humidity content of
20 less than 12 percent, preferably less than 6 percent, because
polyurethane of walking sole quality has a higher specific
weight and gives the mentioned chemical reaction in a satis-
fying manner only if the wood has a humidity content within
the mentioned range.

25 The invention will be further described with reference to the

accompanying drawings in which:

Figure 1 shows a sole-construction according to the invention, to be used as an in-sole over which the upper is lasted, in a section extending in the longitudinal direction of the sole-construction and

Figure 2 shows a sole-construction according to the invention simultaneously forming an in-sole and/or the foot bed.

The sole-construction shown in the drawings, consists of two wooden parts 1, 2 interconnected by an intermediate portion 3 consisting of foamed polyurethane located in the area of the ball of the foot. The upper surface 4 of the sole-construction is to be contacted by the foot sole of the wearer and the undersurface 5 of the sole-construction faces towards the walking surface. In Figure 1 the surface 5 may be subsequently connected with an intermediate sole (not shown) and, if desired, with a walking sole. In Figure 2, the surface 5 immediately carries the walking sole 6, which, in the case shown by way of example is integral with the intermediate portion 3.

The intermediate portion 3 is symmetrically shaped relative to a transverse plane 7 extending essentially perpendicular to the walking surface as well as relative to a horizontal plane 8 extending essentially at right angles relative to this plane 7. The width B at the marginal parts of the intermediate portion

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(measured as a continuation of the upper-surface 4 or under-surface 5) is greater than the minimum width b of the inner-part located therebetween. As is shown in the drawing, both marginal parts merge with the inner part in a rounded fashion. They are also generally tangential to the upper-surface 4 and under-surface 5.

In the embodiment shown in Figure 2, integral protrusions 9 extend forwardly and rearwardly from the inner part of the intermediate portion 3. The protrusions 9 are shown as having a ball-like enlargement at their ends but can alternatively have a dove-tail or other enlarged shape.

The drawing shows a sole-construction consisting of two wooden parts interconnected by a single intermediate portion. More than two wooden parts can, however, be provided at the area of the ball of the foot adjacent parts connected in each case by a intermediate portion. Wooden parts located between adjacent intermediate portions can thus be made very narrow. All such intermediate portions must be provided within the area of the ball of the foot.

A sole according to the invention may be produced by introducing the wooden parts into a mould and filling the remaining free space of the mould with a foamable polyurethane-forming material. The polyurethane-forming material can be poured into the mould

- prior to closing the mould or after closing the mould. It is also possible to inject the polyurethane-forming material after closing the mould. In each case, the intermediate portions of polyurethane are given their shape by, and become inseparably bonded to, the wooden parts. In the embodiment shown in Figure 2 the walking sole 6 is also simultaneously applied given its final shape. The sole-construction removed from the mould is subsequently ground on the upper surface so that this surface has no uncomfortable steps or depressions.
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- 10 Embodiments of the shoe sole other than those shown in the drawings fall within the scope of the present invention defined in the appended claims.



CLAIMS

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A sole construction for shoes comprising at least one assembly of two wooden parts interconnected at the area of the ball of a wearers foot by a flexible intermediate portion of foamed polyurethane, thereby
5 to define a sole construction upper-surface and a sole construction under-surface: the dimension of this intermediate portion in the longitudinal direction of the sole construction being greater at its upper and lower marginal parts, (measured
10 as a continuation of the upper-surface and under-surface respectively) than the minimum such dimension of an inner part intermediate those surfaces; the said marginal parts merging with the said inner part in a rounded fashion; and those upper contact
15 surfaces, between the upper marginal part of the intermediate portion and the wooden parts extending generally obliquely towards the said inner part.

2. A sole construction as claimed in claim 1 in which the said upper contact surfaces are curved
20 and depart generally tangentially, without forming a step, from the sole-construction upper-surface.

3. A sole construction as claimed in claim 1 or 2 in which those lower contact surfaces, between the lower marginal part of the intermediate portion
25 and the wooden parts, extend generally obliquely



towards the said inner part.

4. A sole construction as claimed in claim 3 in which the said lower contact surfaces are rounded and depart generally tangentially, without forming a step, from the sole-construction under-surface.
5. A sole construction as claimed in any one preceding claim in which the or each foamed polyurethane portion does not extend beyond the interconnection, whereby the wooden upper surfaces are left uncovered.
- 10 6. A sole construction as claimed in any one preceding claim in which the or each intermediate portion is generally symmetrical about a central vertical transverse plane.
- 15 7. A sole construction as claimed in any one preceding claim in which the or each intermediate portion is generally symmetrical about a central horizontal plane.
- 20 8. A sole construction as claimed in any one preceding claim in which the or each intermediate portion has an inner part which possess forwardly extending and rearwardly extending integral protrusions.
9. A sole construction as claimed in claim 8,



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in which the ends of the protrusions are of greater dimensions than the remaining parts thereof e.g. in a dovetail shape.

10. A sole construction as claimed in claim 8 or 9, in which the protrusions merge with the inner parts in a smoothly rounded manner.

11. A sole construction as claimed in any one preceding claim, in which more than two wooden parts, and correspondingly more than one such assemblies, are present.

12. A sole construction as claimed in any one preceding claim in which the or each intermediate portion is arcuate, viewed from above.

13. A sole construction as claimed in any one preceding claim comprising a walking sole extending beneath the sole constructions under-surface and integral with the or each intermediate portion at its lower marginal part.

14. A process for producing a sole construction as claimed in any one preceding claim in which the wooden parts are placed in a mould and foamable polyurethane-forming material thereafter introduced into the remaining space and caused or allowed to



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foam within the closed mould: characterised in that after removal of the sole construction from the mould at least the upper-surface and side surfaces are mechanically finished e.g. by grinding or milling.

5 15. A process as claimed in claim 14 in which the foamable polyurethane-forming material is filled into the mould before the mould is closed.

16. A process as claimed in claim 14 or 15, in which the humidity content of the wooden parts,
10 prior to placement in the mould, is less than 12%.

17. A process as claimed in claim 16 in which the humidity content is less than 6%.

18. A process as claimed in claim 16, in which the humidity content is from 0.01% to 5%.

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