Title: BOOT FOR JOINTS, ESPECIALLY FOR CONSTANT VELOCITY JOINTS, WITH A TRANSITION AREA

Abstract: The present invention provides for a boot (10) for joints, especially constant velocity joints, having a first attachment region (12) and a fold region (16) with a plurality of folds (18) with peaks (20) and roots (22) and a transition area (24) adjacent to the last fold (18.1) arranged near said first attachment region (12), said transition area (24) comprising a connecting root (52) between said last fold (18.1) in the transition part (50), wherein at least part of said transition part (50) being inclined towards said first attachment region.
Boot for joints, especially for constant velocity joints, with a transition area

The present invention provides for a boot for joints, especially for constant velocity joints, having a first attachment region and a fold region with a plurality of folds with peaks and roots, as well as a system comprising said boot and the use of such a boot and said system in constant velocity joints.

Space is certainly one of the most dominant characteristics and problems connected with the use and function of boots to be mounted especially on joints, including constant velocity joints. In an articulated or bended state of a joint, especially at angles above 30, most preferred above 35 degree, in an inner area, where the folds of a boot are folded up, a convolute package is formed. Said convolute package is strain-induced, and, thus, tends to turn into an unwanted position. Further, pressure is induced in the fold region of the boot in the convolute package, especially in the roots and peaks thereof.

Thus, it is the object of the present invention to provide for a boot and a system comprising such a boot showing a less strain induced and less pressured fold region when used in articulated states of joints.

In accordance with the present invention, the object is solved by a boot for joints, especially constant velocity joints, as defined in the beginning, comprising further a transition area adjacent to the last fold arranged nearest said first attachment region, said transition area comprising a connecting root between said last fold and said transition part, wherein at least a part of said transition part being inclined towards said first attachment region. In fact, one may say, that the boot in accordance with the present invention shows a half cut smallest fold arranged near said first attachment region. Advantageously, the boot in accordance with the present invention provides for a convolute package in a form of a stack in an articulated state when mounted on joints, especially constant velocity joints, said stack being of homogeneous art when compared to convoluted packagings obtainable with boots known from the state of the art. Especially at angles above 30 degree, further preferred above 35 degree, much more preferred above 40 degree, the convoluted package in form of a stack is orientated mainly in parallel with a main axis of a shaft, and most of flanks of folds of the fold region of the claimed boot are at least in part in contact with each other, that also holds for said transition part of the transition area. Thus, the convolute package is very small, and due to the orientation as a stack, the load lasting on the convolute packaging is advantageously distributed throughout the convolute package.

CONFIRMATION COPY
Finally, the stress is decreased. The claimed boot, thus, shows a higher lifetime compared with boots known from the state of the art.

In a preferred embodiment of the present invention, said transition part of said transition area, in a cross-sectional view in a direction of a main axis of said boot, has a convex or an essentially planer shape. Whereas in accordance with the present invention it is sufficient that only at least a part of said transition part, preferably more than 60 percent of the same referred to its length, will incline towards said first attachment region, it is preferred that over its whole length, said transition part is of essentially planar or convex shape.

Said transition part of said transition area is arranged directly adjacent to said connecting root. Said connecting root is showing an outer curved wall that is at least in part slightly increasing in height with respect to the first attachment region. When said transition part has the preferred convex shape, over the whole length of said transition part, the same is inclining towards said first attachment region. Especially preferred is an embodiment where said transition part is thus mimicking at least in part the geometry of second flanks of folds directed to a second attachment region by which a boot may be mounted on a joint casing.

Preferably, an angle $\phi$ defined between a line for an inner surface of said connecting root and an inside end of said first attachment region adjacent said transition area, and a line defined by an inner surface of said first attachment region, is in a range of about 0 degree to about +60 degree, preferably of about +10 degree to about +40 degree, most preferably in a range of about +15 degree to about +35 degree. If angle $\phi$ was 0 degree, thus, said transition part of said transition area only in part is inclined towards said first attachment region. If angle $\phi$ was clearly above +60 degree, it would not be possible to solve the object to provide for a boot having an optimized and decreased packaging volume of a convolute package in an articulated state.

In a most preferred embodiment of the present invention, at least said connecting root, but probably also the further roots of the fold region of the boot claimed, is twisted with an angle $\alpha$, the angle $\alpha$ being defined between a line going through connecting root and said main axis of the claimed boot. Usual boots known from the state of the art show no twisting in an unmounted state with respect to the roots, that is angle $\alpha$ is 90 degree. In contrast thereto, the twisting with an angle $\alpha$ in an unmounted state is advantageously used not only to decrease the space needed for the convolute packaging, if the boot would be articulated, but also to minimize stresses and pressure induced in the boot when articulated. Preferably, angle $\alpha$ referred to said connecting root, is in a range between about 10
degree to about 50 degree, preferably between about 15 degree to about 40 degree. In contrast thereto, angle a of the first root adjacent to said second attachment region is in a range of about 70 degree to about 89 degree, preferably in a range of about 75 degree to about 88 degree. In a further preferred embodiment of the present invention, angle a referring to said connecting root as well as said roots between the folds of the fold region increases from the first attachment region towards the second attachment region of the boot. Thus, angles a of roots between said connecting root and a first root neighbouring said second attachment region are higher than angle a, referred to said connecting root, and lower than angle a referred to said first root.

The embodiments and preferred embodiments of the present invention set forth above, refer to a boot for joints, especially constant velocity joints, in an unarticulated state. However, under articulation of the boot in accordance with the present invention, further singular features are observable. Thus, the present invention also refers to a boot for joints, especially constant velocity joints, having a fold region with a plurality of folds, wherein under articulation at joint angles γ above 35 degree, on an inner area, where the folds are folded up, all folds are packed to a stack. In contrast thereto, under articulation, boots known from the state of the art, at joint angles γ above 35 degree did not show that all folds are packed to a stack, but instead bear at least one fold separated from the other folds forming a convolute packaging. In a preferred embodiment of the present invention, also a transition area of a transition part is part of said stack. Preferably, within said stack flanks of all folds are essentially adjacent with each other, most preferably essentially parallel orientated with each other. The terms "orientated" or "adjacent" do not mean that the flanks of the folds are in direct contact with each other, and especially not in contact over their whole surfaces, but only that they are orientated with each other essentially adjacent, preferably essentially parallel. Of course, they may be in contact at least with a part of the surfaces of said flanks of said folds. The term "essentially" in that respect does not mean that each flank of each fold is orientated towards the neighbouring flank of the neighbouring fold in a more or less co-linear manner, but also encompasses embodiments in which especially the flanks of a first fold neighbouring a second attachment region is twisted by an angle in a region about 50 degree to about 80 degree, referred to a line through the peak of said first fold, and, further, a line defined by an inner surface of a first attachment region. At least, the convolute packaging in form of a stack, thus, is a lop-sided stack.

In a further preferred embodiment of the present invention, the boot claimed under articulation comprises said transition area adjacent to a last fold arranged nearest said first attachment region, said transition area comprising said transition part, wherein at least a
part of an outer surface of said transition part is in contact with at least a part of an outer surface of a first flank of said last fold. Preferably, said outer surface of said transition part is in contact over its whole area with said outer surface of said first flank of said last fold. It is further preferred that said transition part is at least partially essentially parallel with said first flank of said last fold.

In a further preferred embodiment, the claimed boot under articulation is characterized in that at least said first flank of said first fold and said transition part of said transition area are orientated in parallel to a main axis of a shaft on which the boot is arrangable. Further, also a second flank of said first fold as well as the first and second flanks of further folds of the fold region of the claimed boot are more or less essentially orientated in parallel to said main axis of said shaft. The higher the joint angle \( \gamma \), the more orientated in parallel are the first and second flanks of the folds of the fold region of the boot in accordance with the present invention. Again, it must be pointed out that the term "orientated in parallel" is to be understood as explained above with respect to the definition of the stack in that flanks of all folds in the stack are essentially adjacent, preferably essentially parallel, with each other. Thus, in that respect it is referred to the definition of the term "adjacent" or "parallel", as well as term "essentially" given above.

In a most preferred embodiment of the present invention, the boot under articulation comprises an inner surface of said last root of said last fold neighbouring said first attachment region and/or an inner surface of connecting root are in contact with a joint casing to which said boot is arrangable. Preferably, at high joint angles \( \gamma \), that is joint angles \( \gamma \) around about 45 degree and more, the inner surface of said connecting root as well as said inner surface of said last root of said last fold of the fold region are in contact with said joint casing to which said boot is arrangable. At other joint angles \( \gamma \), for example joint angles \( \gamma \) in a region between about 39 degree to about 43 degree, preferably said inner surface of said last root of said last fold is in contact with the joint casing, and, further preferred, also inner surfaces of at least one of the further roots of the further folds are in contact with said joint casing. The main contact surface between the stack of the convolute packaging in the boot under articulation is provided for by the inner surface of the transition part of said transition area, whereas further contact surfaces are only provided for by the inner surfaces of roots of the folds of the fold region, preferably of only one or only two inner surfaces of one or two roots of one or two folds of said fold region at joint angles \( \gamma \) around 40 degree or more. The contact through said contact surfaces of the boot is made with the outer surface of said shaft and/or especially the front edge of said joint casing.
The present invention further refers to a system comprising a boot in an unarticulated state or under articulation as described before, a shaft, and a joint casing, said boot being upset mounted on the shaft on the joint casing. By said upset mounting, it is further possible to reduce the space needed for the boot in the claimed system. Preferably, the system is mounted upset in a range of around 10 percent to around 35 percent, referred to the length of an unmounted boot according to the present invention.

In a further preferred embodiment of the present invention, the claimed system provides for an angle $\beta$, defined between said main axis of said shaft in an unarticulated condition of said system, and a peak line defined by a peak of said last fold nearest said first attachment region, angle $\beta$ being in a range of about 10 degree to about 60 degree, most preferably in a range of about 22 degree to about 45 degree. In a most preferred embodiment of the system claimed, angle $\beta$ of further folds following said last fold of the fold region towards said second attachment region is higher than angle $\beta$ of said last fold. Angle $\beta$ of said first fold adjacent said second attachment region is preferably in a range of about 65 degree to about 92 degree, most preferably in a range of about 70 degree to about 88 degree. Thus, angle $\beta$ referring to the folds between said last fold nearest said first attachment region and said first fold adjacent said second attachment region show angles $\beta$ increasing from the last fold to the first fold.

The present invention further refers to a use of a boot in an articulated or unarticulated state as described above in constant velocity joints, as well as to a use of a system as described above in constant velocity joints.

Other advantages and features of the invention will become apparent to one of skill in the art reading the following detailed description with reference to the drawings illustrating features of the invention by way of example.

**Brief description of the drawings**

For more complete understanding of this invention, reference should now be made to the embodiments illustrated in greater detail in the accompanying drawings and described below by way of examples of the invention.

In the drawings:

Fig. 1 is a side cut view of the system comprising a boot known from the state of the art.
Fig. 2 shows a partial section through the upper part of a boot according to the state of the art in an unmounted state.

Fig. 3 shows a partial section of an upper part of a further boot according to the state of the art in a mounted state.

Fig. 4 shows a partial section of an upper part of a boot in accordance with the present invention in an unmounted state.

Fig. 5 shows a partial section of the upper part of the boot according to Fig. 4 in a mounted state.

Fig. 6 is a cross-sectional view of a system according to the present invention with boot 10 in accordance with Fig. 4 and 5.

Fig. 7a and 7b show a system in accordance with Fig. 6 and Fig. 1 in a bended state at a joint angle \( \gamma \) of 40 degree.

Fig. 8a and 8b show a system in accordance with Fig. 6 and Fig. 1 in a bended state at a joint angle \( \gamma \) of 47 degree.

Fig. 9 shows a partial section of the upper part of a further embodiment of the boot in accordance with the present invention.

Fig. 10 is a side view of the boot in accordance with Fig. 9.

**Detailed description of the drawings**

Although the present invention is described with respect to a boot for joints, especially constant velocity joints, the present invention may be adapted and utilized for other fixable sealing applications, including such applications outside of a constant velocity joint. Especially, the boot in accordance with the present invention may be a convoluted boot. However, also any other machinery form parts may be protected by the boot in accordance with the present invention. The boot in accordance with the present invention usually shows two attachment regions. If the boot is designed to be fixed on a shaft and a joint
casing, the first attachment region is assigned to the shaft, whereas the second attachment region is assigned to the joint casing in the sense of the present invention.

In the following detailed description, especially orienting terms are used such as "left", "right", "inner", "outer", "next to", "nearest", "following", "neighbouring" and the like. It has to be understood that these terms are used for convenience of description of the components or embodiments by reference to the drawings. These terms do not necessarily describe the absolute location in space, such as upward, downward, left, right etc., that any part must assume. Further, in the following description, various operating and numerical parameters and components are described with several constructed embodiments. These specific parameters and components are included as examples and are not meant to be limiting, with the exception of parameters and components being claimed in the enclosed set of claims.

Further, it is to be expressively pointed out that the invention is not restricted to the feature combinations as shown in the figures. Instead, the features which are respectively closed in the description including the description of the figures can be combined with those features specified in the figures. In particular, it is to be noted that the reference signs which are incorporated in the patent claims are not intended in any way to restrict the scope of protection of the present invention, but rather merely refer to the exemplary embodiments shown in the figures. Furthermore, it is to be noted that the embodiments of a boot 10 in accordance with Fig. 1 to 9 merely constitute exemplary embodiments, in particular with regard to the number of annular folds provided there. More or fewer folds can be arranged in a fold region 18. Finally, identical reference signs are used for identical features when discussing the drawings.

In the context of the present invention, the term "angle φ" is to be understood as follows: With respect to a boot in accordance with the present invention, angle φ is defined between a line 58 (see Fig. 4) through an inner surface of a connecting root, and an inside end of said first attachment region adjacent said transition area, and a line 56 defined by an inner surface of said first attachment region. Thus, line 58 is a tangent with respect to connecting root as well as inside end of said first attachment region. Line 56, in contrary, is defined by an inner surface of said first attachment region being co-linear to a main axis 26 of the boot. In contrast to the definition of angle φ with respect to a boot in accordance with the present invention, angle φ for a boot in accordance with the state of the art is defined in another way. The reason is a transition area 24 of the boot in accordance with the present invention may be seen as resembling the second (right) flank 29.1 of last fold 18.1
of a boot in accordance with the present invention (see fig. 2). Thus, in a boot in accordance with the state of the art, whereas line 56 is defined in an identical way, when compared to angle \( \phi \) defined for a boot in accordance with the present invention, line 58 is defined by inner surface 23.1 of last root 22.1 of last fold 18.1 as well as a last peak 20.1 of last fold 18.1. Thus, line 58 may be described as a tangent with respect to last root 22.1, and with respect to peak 20.1 as going through a turning point defined by said last peak 20.1 of the said last fold 18.1. From the definition of angle \( \phi \) with respect to a boot in accordance with the present invention as well as a boot in accordance with the state of the art, it becomes quite clear that the sign of angle \( \phi \) is changing. Thus, in the context of the present invention, angle \( \phi \) is designated with "+" with respect to a boot in accordance with the present invention, whereas with respect to a boot in accordance with the state of the art, negative values are used.

In the context of the present invention, the term "joint angle \( \gamma \)" is to be understood as follows: In an articulated state of a system in accordance with the present invention, joint angle \( \gamma \) is defined by a main axis of 94.1 of said shaft 92 in an unarticulated situation, and a main axis 94.2 of said shaft in the articulated situation. This may also be taken from Fig. 7a or 8b of the present invention.

In the context of the present invention, the term "angle \( \alpha \)" is to be understood as follows: Angle \( \alpha \) is defined between a line 62 going through connecting root or any other root of the folds in the fold region, also through roots of folds in a fold region of a boot in accordance with the prior art, and said main axis 26 of the boot. The definition of angles \( \alpha \) with respect to a boot in accordance with the state of the art as well as a boot in accordance with the present invention may also be derived from Fig. 2 to 4 of the present invention. Line 62 in each case is dividing either connecting root or any other roots in a symmetrical way. Whereas for roots in accordance with the state of the art, angle \( \alpha \) is always 90 degree in an unmounted state, in a mounted state also boots in accordance with the present invention may show an angle \( \alpha \) between around 80 degree to around 89 degree for some of the roots in the fold region. In contrast thereto, angle \( \alpha \) with respect to all roots including connecting root of a boot in accordance with the present invention already in the unmounted state show an angle \( \alpha \) being less than 90 degree.

In the context of the present invention, the term "angle \( \beta \)" is to be understood as follows: Angle \( \beta \) is defined between said main axis 94 of said shaft in an unarticulated condition of the claimed system in accordance with the present invention, and a peak line 64 defined by a peak of said last fold nearest the first attachment region. Thus, angle \( \beta \) in each case
refers to a mounted boot, however, in an unarticulated condition. Line 64 goes through said peak of said last folds, thus, is going through a turning point of said last fold 18.1. Further, similar angles \( \beta \) are obtainable with respect to the further folds of the fold region of the boot in accordance with the present invention.

The boots are usually made of a thermoplastic elastomere material or mixtures of ther-moelastic plastomere materials, for example based on polyurethane (TPU), polyamide (TPA), polyolefines (TPO), polyester (TPEE) or a thermoplastic elastomere vulcanizate (TPV), or a thermoplastic poly-ether-ester-elastomere (TPEE). The material or mixtures of materials of the boots in accordance with the present invention may be made of or may further comprise other materials, especially additives like diffusion-promoting add mixtures or any other additives a person skilled in the art will be aware of in view of the use of the boots in question, especially in view of the demands of automotive industry if the boots are used for automotives. However, the boots in accordance with the present invention may also be made of usual rubber-elastic materials, including mixtures thereof.

Advantages are provided by thermoplastic elastomer materials. These include materials known from the prior art that has two different polymer segments, namely a relatively rigid resin segment and an elastic soft segment. The individual polymer segments are comprised of longer chains of similar monomers. The resin segments hold the soft segments together by physical, network-like bonds. A thermoplastic elastomer material for manufacturing boots in accordance with the present invention is the thermoplastic material marked under the brand name "Hytrel" by the DuPont company.

In another aspect of the invention, said first and/or said second attachment region of the boot is at least partially manufactured of an elastomer material. In contrast to thermoplastic elastomere materials, an elastomer material has the advantage of having a reduced so-called "cold flow" then situated underneath the fastening element. This cold flow is understood to be the phenomenon in which, when subjected to clamping or compression stress, the plastic material in said first, but also in said second attachment region "escapes" literally from the fastener, as a result of which the boot can come loose during operation, particularly when under thermal stress. Other regions of said first and/or said second attachment region can nevertheless be manufactured of a thermoplastic elastomer material. The same advantage can also be achieved if a layer of the thermoplastic elastomer material is placed underneath the elastomer material. Possible elastomer materials include for example polyurethane rubber, polyester-based polyurethane/rubber mixtures or polychloroprenes.
Said first attachment region of the boot is advantageously at least partially comprised of a layer of a thermoplastic elastomer material or a layer of an elastomer material. To a great extent, this avoids the known disadvantages of using thermoplastic elastomer materials in the clamping region of the collar. It is also possible for the layer, which is comprised of an elastomer material, to be integrally joined in a permanent fashion to the fastening mechanism.

As the method with which boots in accordance with the invention can be manufactured a pressblower injection blow moulding process is preferred, however, boots may also be produced with an injection/intrusion process, an injection moulding process, an injection/pressing process and/or an extrusion/blow moulding process. The pressblower injection blow moulding process and the injection/extrusion process are advantageously used, because precisely-dimensioned boots may be produced by said processes.

In the context of the present invention, said first and said second attachment region may be embodied in any possible way with respect to the needs of the system for which the boot shall be attached. For example, said first and/or second attachment region may comprise a binder seat region. In said binder seat region, a binder element may be located in order to fix the boot to any possible machinery parts, especially to a shaft and a joint casing. Such a binder element may be selected from each kind of fasteners known from the prior art, such as clamping elements, especially clamping straps, but also clamp or compression rings. Useful fasteners exhibit clamping and/or compression forces on the binder seats region of the boot. Further, said first and/or second attachment region may provide for slits located within the binder seats region directed towards a possible clamping element. Further, on said inner side surface of the first and/or second attachment region annular beads may be located, especially when slits are present in the binder seat region. The annular beads and the slits may especially be orientated to each other. The slits and/or annular beads may have different depths and/or heights. Further, the embodiment of said first and/or said second attachment region may be different from each other, but also may be identical. In a cross-sectional view, the annular beads located on the inner surface of the first and/or second attachment region, may have a triangular or a half-round shape. But also any other shape is possible. Further, said first and/or second attachment region may comprise orientating means in the form of a ring element or several block elements provided for only outside part of said first and/or second attachment region and at the ends of the boot opposing each other. Said orientating means are useful for defin-
ing the binder seats region, and to hinder the binder element to sideslip from said first
and/or second attachment region when the boot is mounted.

Referring now to the drawings, it must first of all be stated that all drawings used are true
to scale, that is that all angles $\alpha$, $\beta$, $\gamma$ or $\phi$ are directly measurable from the drawings of the
present invention.

Fig. 1 illustrates a system in accordance with the prior art with a boot 10 mounted on a
shaft 92 and a joint casing 90 forming a system 100 by way of binder elements in a first
attachment region 12 and a second attachment region 14, the binder elements being not
shown. The boot 10 has a fold region 16 with five folds 18.1 to 18.5. Folds 18.1 to 18.5
show peaks 20.1 to 20.5 and roots 22.1 to 22.4 between peaks 20.1 to 20.5.

Fig. 2 shows a partial section of a further boot in accordance with the prior art, being simi-
lar to the boot 10 shown in Fig. 1, however, comprising a slit 36 in the second attachment
region 14 and an annular bead 35 being orientated towards the slit 36. Second attach-
ment region 14, thus, provides for a second binder seat region 31 for a binder element not
shown, with one slit 36 and one corresponding annular bead 35. In contrast thereto, the
first attachment region 12 provides for a first binder seat region 30 only providing for an
inner surface 44 one centrally located annular bead 34. Boot 10 in accordance with Fig. 2
is shown in an unmounted and unarticulated state. A line 56 going through the inner sur-
face 44 of said first attachment region 12 together with line 58 going through an inner sur-
face 23.1 of last root 22.1 as well as peak 20.1 of last fold 18.1 of boot 10 defines an an-
gle $\phi$ of -28 degree. Further, one may derive from Fig. 2 that angle $\alpha$ between a main axis
26 of boot 10 and line 62 going through a root between two peaks of neighbouring folds in
the fold region 16 is 90 degree for all roots 22 of said boot 10.

Fig. 3 again is a partial section of the upper half of a boot in accordance with the state of
the art, however, now in a mounted, but unarticulated state. Boot 10 being part of a sys-
tern 100 not shown in detail (see Fig. 1 in that respect) corresponds to boot 10 of Fig. 1.
Especially, the first attachment region 12 and the second attachment region 14 are em-
bodied differently compared to the boot in accordance with the state of the art in Fig. 2 of
the present invention. First attachment region 12 provides for a side wall 40 of orientating
means 38 and, further, a side wall 42 also providing an orientating means for a binder
element not shown. The second attachment region 14, in turn, provides for a side wall 41
of orientating means 39 as well as a further side wall 43 of a second attachment region
14, thus also presenting an orientating means for a further binder element not shown.
Boot 10 in accordance with Fig. 3 is mounted upset in view of the direction of arrow 66 on a shaft in the joint casing not shown in Fig. 3. By said upset mounting, some roots 22 between peaks 20 are slightly twisted with respect to a main axis 26 of the boot or main axis 94 of a shaft not shown in Fig. 3. As may be derived from Fig. 3, angle $\alpha_1$ referring to root 22.1 between peaks 20.1 and 20.2 defined by line 62.1 is about 85 degree, whereas angle $\alpha_2$ referring to the third root 22.3 and defined by line 62.2 is again 90 degree.

Fig. 4 now shows a partial section of the upper part of the boot 10 in accordance with the present invention. A first attachment region 12 and a second attachment region 14 are embodied similar to the first and the second attachment regions 12, 14 of the boot in accordance with the state of the art according to Fig. 3. In contrast to said boot 10 in accordance with the state of the art in Fig. 3, boot 10 in accordance with the present invention shows a transition area 24 comprising a connecting root 52 between a transition part 50 and a last fold 18.1. Line 58 defined by an inner surface 53 of connecting root 52 and an inside end 46 of the first attachment region 12 as well as line 56 defined by an inner surface 44 of the first attachment region 12 forms an angle $\phi$ being around +24 degree. Further, boot 10 of fig. 4 being unmounted and unarticulated provides for an angle $\alpha_1$ between a main axis 26 of said boot 10 and a line 62.1 going through connecting root 52 of around 48 degree. Further, an angle $\alpha_2$ between said main axis 26 and further line 62.2 going through root 22.4 is around 86 degree. Angles $\alpha_1$, thus, are increasing from angle $\alpha_1$ to angle $\alpha_2$ in the boot 10 in accordance with the present invention.

Fig. 5 now shows a boot 10 of Fig. 4 in a mounted, but unarticulated state. The boot 10 is mounted upset in the direction of an arrow 66 on a shaft and a joint casing not shown here forming a system 100. Transition part 50 has, in a cross-sectional view, a convex-like shape and provides for an outer surface 51. Last fold 18.1 provides for a first flank 28.1 with an outer surface 60. Angle $\beta$ defined by said main axis 26 of boot 10 or main axis 94 of said shaft not shown, and a line 64 going through peak 20.1 of said last fold 18.1, is about 36 degree. An angle $\beta$ not shown in Fig. 5, however being defined by a further line 64 going through root 22.3, is about 68 degree.

Fig. 6 now shows a system 100 in accordance with the present invention, comprising root 10 in accordance with Fig. 4 and 5 being upset mounted on a shaft 92 and a joint casing 94. Shaft 92 defines a main axis 94, and boot 10 defines main axis 26.

Fig. 7a now shows the system in accordance with Fig. 6 at a joint angle $\gamma$ of 40 degree. On an inner area 80 a stack 82 is formed by the folds 18 of the fold region 16 of boot 10.
as well as the transition area 24. Especially, transition part 50 with its outer surface 51 is in direct contact over the whole length with outer surface 60 of the first flank 28.1 of last fold 18.1. The inner surfaces of two of the roots of the boot 10 are in direct contact with the front edge of joint casing 92, whereas the last two roots neighbouring the second attachment region 14 are not in direct contact with joint casing 90, but nearly in contact with the same. One may say that first flanks 28 and second flanks 29, as defined in Fig. 2 and 4, are more or less orientated essentially adjacent, more precisely essentially parallel with each other. Further, folds 18 as well as transition part 50 are orientated more or less in parallel with bended main axis 94.2 of shaft 92.

In contrast thereto, Fig. 7b shows the situation at a joint angle of 40 degree in a system 100 with a boot 10 in accordance with the prior art as shown in Fig. 1. On an inner area 80 no stack is formed by all folds, especially last fold 18.1 is not part of a stack. Further, the folds are orientated essentially perpendicular to a main axis 94.2 of shaft 92. Further, not the roots of the folds in fold region 16 are in contact with the joint casing 90, but instead joint casing 90 is contacted with the part of an inner surface of a flank of the first fold adjacent the second attachment region 14.

Fig. 8a and 8b are similar to Fig. 7a and 7b, however, the joint angle γ is now 47 degree. One may see that with respect to a system 100 in accordance with the present invention as shown in Fig. 8a, now all folds are packed to a stack 82 on said inner area 80, and that all flanks of the roots are at least in part in contact with each other. Further, also inner surface 53 of connecting root 52 is in contact with the front edge of joint casing 90. The same also holds with respect to root 22.1 of last fold 18.1. The further roots, especially root 22.4, is not in contact with its inner surface with said joint casing 90. In contrast thereto, Fig. 8b shows the situation in the system 100 with boot 10 in accordance with the state of the art, being more or less similar to the situation shown in Fig. 7b.

Fig. 9 provides for a further embodiment of a boot in accordance with the present invention. Fig. 9 is a partial section through an upper part of an unmounted and unarticulated boot 10 with a first attachment region 12 and a second attachment region 14 bearing two slits and correspondingly arranged annular beads on an inner surface of said second attachment region 14. A transition area 24 of said boot 10 is similar to transition area 24 as shown in Fig. 4, however, transition part 50 now has a planer shape and no convex shape. Transition part 50 inclines from a connecting root 52 to the first attachment region 12 between connecting root 52 and a side wall 42 of said first attachment region 12.
Fig. 10 is a side view of boot 10 in accordance with Fig. 9, whereas especially inclining transition part 50 of transition area 24 can be derived from.

The present invention consequently provides for a boot and a system that through the provision of a transition area near the first attachment region of a boot, especially for the attachment on a shaft, permits a minimization of space provided for especially on the inner area of a boot mounted on constant velocity joints in an articulated state at high joint angles $\gamma$.

While the inventive boot has been described in connection with one or more embodiments, the disclosure is not meant to be limiting. Rather, the invention covers all alternatives, modifications, and equivalents within the spiritual scope of the appended claims taking into account the description.
Patent Claims

1. Boot (10) for joints, especially for constant velocity joints, having a first attachment region (12) and a fold region (16) with a plurality of folds (18) with peaks (20) and roots (22) and a transition area (24) adjacent to the last fold (18.1) arranged nearest said first attachment region (12), said transition area (24) comprising a connecting root (52) between said last fold (18.1) and a transition part (50), wherein at least a part of said transition part (50) being inclined towards said first attachment region (12).

2. Boot according to claim 1, characterized in that said transition part (50), in a cross-sectional view in a direction of a main axis (26) of said boot (10), has a convex or an essentially planar shape.

3. Boot according to anyone of the preceding claims, characterized in that an angle φ defined between a line (58) for an inner surface (53) of said connecting root (52) and an inside end (46) of said first attachment region (12) adjacent said transition area (50), and a line (56) defined by an inner surface (44) of said first attachment region (12), is in a range of about 0 degree to about 60 degree.

4. Boot according to anyone of the preceding claims, characterized in that at least said connecting root (52) is twisted with an angle α, the angle α being defined between a line (62) going through connecting root (24), and said main axis (26) of boot (10).

5. Boot according to claim 4, characterized in that the angle α referring to said connecting root (52) as well as said roots (22) increases from the first attachment region (12) towards a second attachment region (14) of the boot (10).

6. Boot (10) for joints, especially constant velocity joints, having a fold region (16) with a plurality of folds (18) wherein under articulation at joint angles γ above 35 degree, on an inner area (80), where the folds (18) are folded up, all folds (18) are packed to a stack (82).

7. Boot according to claim 6, characterized in that flanks (28, 29) of all folds (18) in the stack (82) are essentially adjacent with each other.

8. Boot according to anyone of claims 6 or 7, characterized in that it comprises a transition area (24) adjacent to a last fold (18.1) arranged nearest a first attachment region
(12), said transition area (24) comprising a transition part (50), wherein at least a part of an outer surface (51) of said transition part (50) is in contact with at least a part of an outer surface (60) of a first flank (28.1) of said last fold (18.1).

9. Boot according to claim 8, characterized in that said transition part (50) is at least partially essentially parallel with said first flank (28.1) of said last fold (18.1).

10. Boot according to claims 8 or 9, characterized in that said transition area (24) is part of said stack (82).

11. Boot according to anyone of claims 6 to 10, characterized in that at least said first flank (28.1) of said first fold (18.1) and said transition part (50) of said transition area (24) are essentially orientated in parallel to a main axis (94) of a shaft (92) on which said boot (10) is arrangeable.

12. Boot according to anyone of the claims 6 to 11, characterized in that an inner surface (61) of last root (22.1) of said last fold (18.1) and/or an inner surface (53) of connecting root (52) are in contact with a joint casing (90) to which said boot (10) is arrangeable.

13. System (100) comprising a boot (10) according to anyone of the claims 1 to 12, a shaft (92), and a joint casing (90), said boot (10) being upset mounted on the shaft (92) and the joint casing (90).

14. System according to claim 13, characterized in that an angle \(\beta\), defined between said main axis (94) of said shaft (92) in an unarticulated condition of said system (100), and a peak line (64) defined by a peak (20) of said last fold (18.1) nearest the first attachment region (12), is in a range of about 10 degree to about 60 degree.

15. System according to claim 14, characterized in that angle \(\beta\) of further folds (18) of the fold region (16) is higher than angle \(\beta\) of said last fold (18.1).

16. Use of a boot in accordance with anyone of claims 1 to 12 in constant with velocity joints.

17. Use of a system in accordance with anyone of claims 13 to 15 in constant velocity joints.
A. CLASSIFICATION OF SUBJECT MATTER
INV. F16D3/84 F16J3/04

ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F16D F16J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>EP 0 464 984 AI (DRAFTEX IND LTD [GB]) 8 January 1992 (1992-01-08) figure 15</td>
<td>1, 2, 4, 8, 10, 12, 13, 16, 17</td>
</tr>
<tr>
<td>X</td>
<td>WO 2010/028816 AI (GKN DRIVELINE INT GMBH [DE]; DEISINGER MARKUS [DE]; WENNING LUDGER [DE]) 18 March 2010 (2010-03-18) figures 9, 10</td>
<td>1, 2, 4, 6-8, 10, 12, 13, 16, 17</td>
</tr>
<tr>
<td>X</td>
<td>WO 2004/104438 AI (GKN DRIVELINE INT GMBH [DE]; DEISINGER MARKUS [DE]) 2 December 2004 (2004-12-02) figure 6</td>
<td>1, 2, 4, 6-8, 10, 12, 13, 16, 17</td>
</tr>
</tbody>
</table>

X Further documents are listed in the continuation of Box C.

See patent family annex.

* Special categories of cited documents:

**A** document defining the general state of the art which is not considered to be of particular relevance

**E** earlier document but published on or after the international filing date

**L** document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another document or other special reason (as specified)

**O** document referring to an oral disclosure, use, exhibition or other means

**P** document published prior to the international filing date but later than the priority date claimed

**T** later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

**X** document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

**Y** document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

**A** document member of the same patent family

Date of the actual completion of the international search

5 May 2011

Date of mailing of the international search report

17/05/2011

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax. (+31-70) 340-3016

Authorized officer

Hassi oti s, Vasi l i s
C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>EP 1 975 475 A2 (TOYODA GOSEI KK [JP]; JTEKT CORP [JP]) 1 October 2008 (2008-10-01) figure 3</td>
<td>1-4, 6-8, 12, 13, 16, 17</td>
</tr>
<tr>
<td>A</td>
<td>EP 2 068 026 AI (JTEKT CORP [JP]; TOYODA GOSEI KK [JP]) 10 June 2009 (2009-06-10) the whole document</td>
<td>1-17</td>
</tr>
<tr>
<td>Patent document cited in search report</td>
<td>Publication date</td>
<td>Patent family member(s)</td>
</tr>
<tr>
<td>---------------------------------------</td>
<td>-----------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE 69109549 T2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ES 2071915 T3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>GB 2245665 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 3202764 B2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 5087254 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 5176390 A</td>
</tr>
<tr>
<td>WO 2010028816 A1</td>
<td>18-03-2010</td>
<td>NONE</td>
</tr>
<tr>
<td>WO 2004104438 A1</td>
<td>02-12-2004</td>
<td>DE 10322902 AI</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 2007502956 T</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 2007042827 AI</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 2008258409 AI</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 2010120546 AI</td>
</tr>
</tbody>
</table>