Nov. 14, 1944. H. W. ALDEN 2,362,456

STEERING DRIVE AXLE

Filed Feb. 9, 1942 2 Sheets-Sheet 1

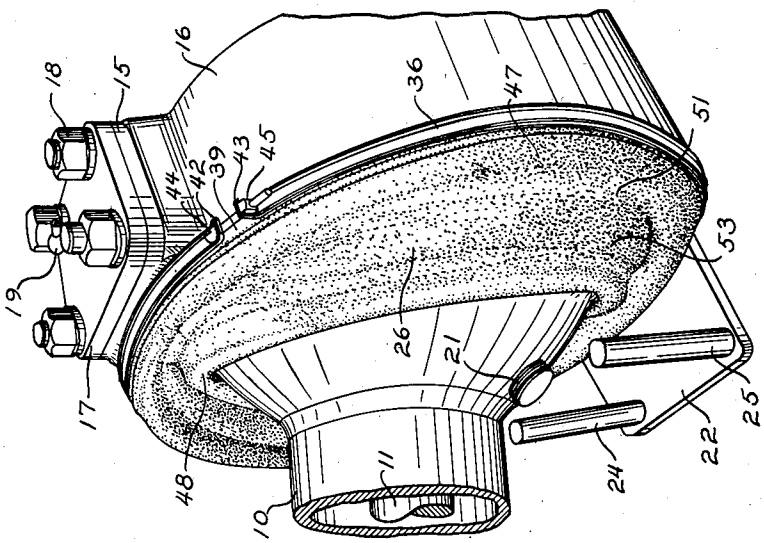


Fig. 2

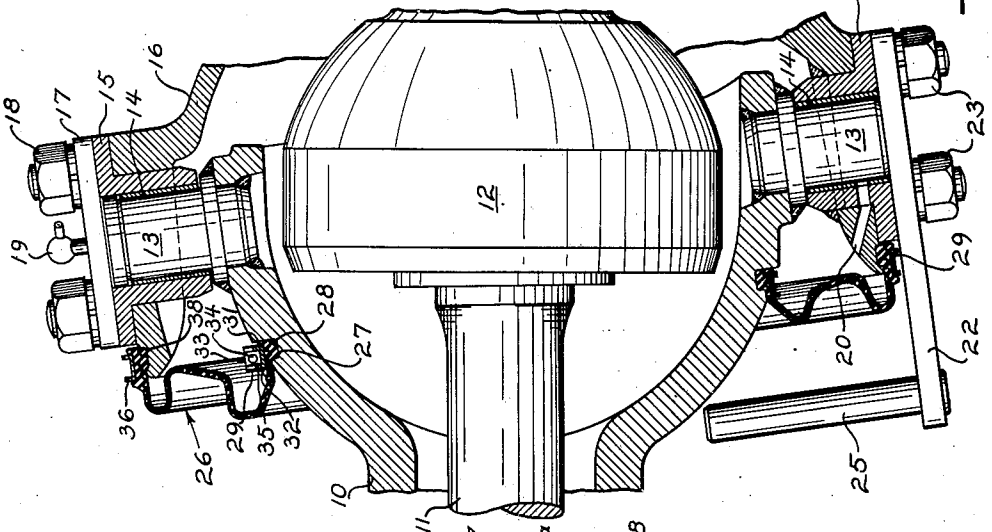


Fig. 1

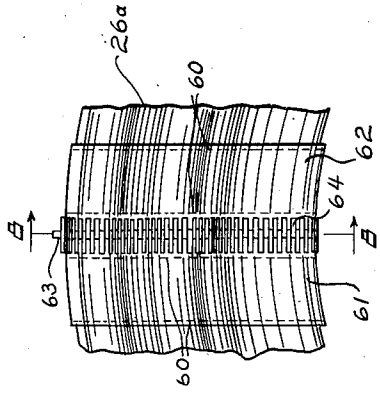


Fig. 7

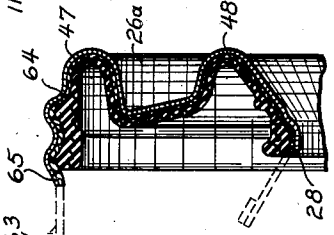


Fig. 8

Inventor

Herbert W. Alden

By Strauch & Hoffman

Attorneys

Nov. 14, 1944. H. W. ALDEN 2,362,456

STEERING DRIVE AXLE

Filed Feb. 9, 1942 2 Sheets-Sheet 2

Fig. 3

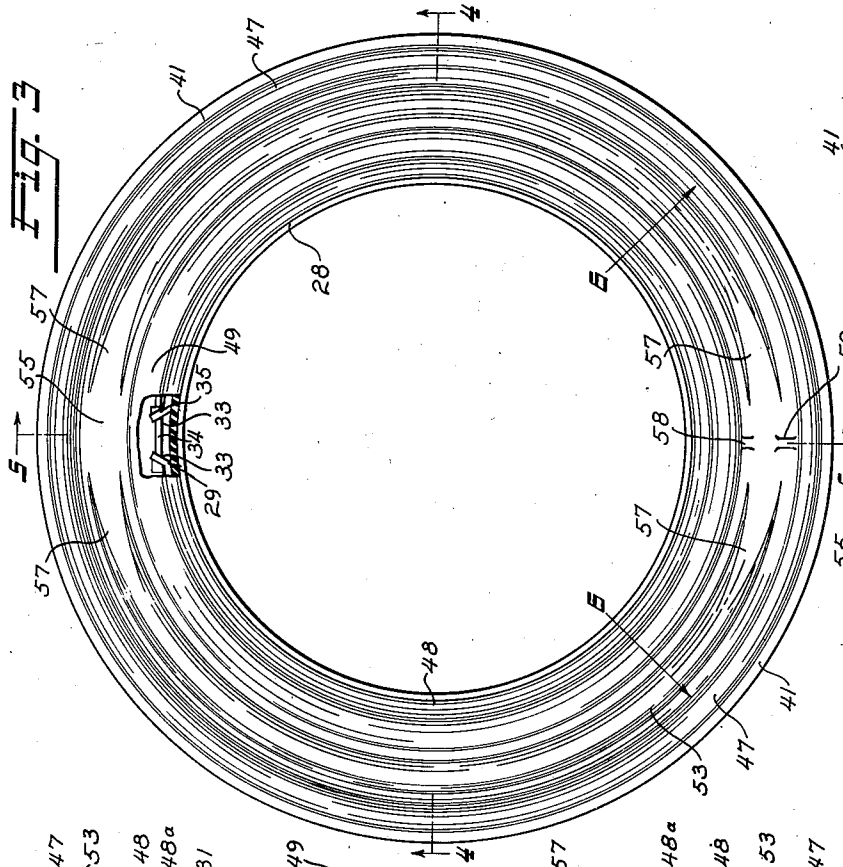



Fig. 6

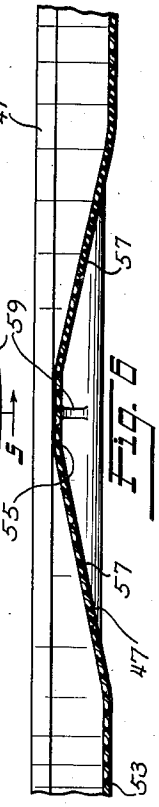



Fig. 4

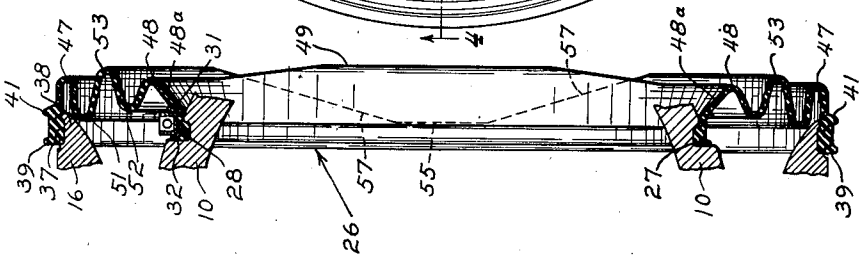
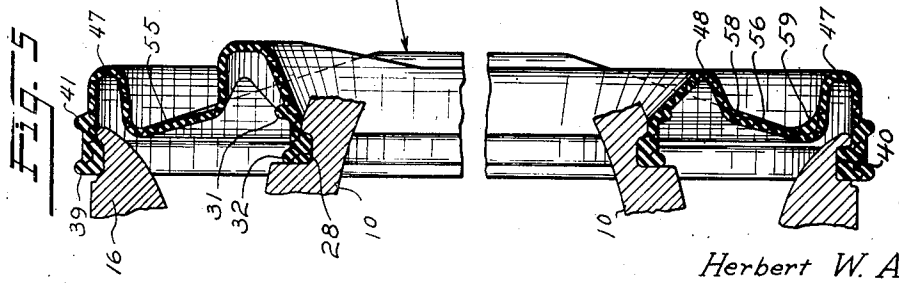



Fig. 5




Inventor

Herbert W. Alden

By Strauch & Hoffman

Attorneys

Patented Nov. 14, 1944

2,362,456

# UNITED STATES PATENT OFFICE

2,362,456

## STEERING DRIVE AXLE

Herbert W. Alden, Detroit, Mich., assignor to The Timken-Detroit Axle Company, Detroit, Mich., a corporation of Ohio

Application February 9, 1942, Serial No. 430,129

15 Claims. (Cl. 280—96.1)

The present invention relates to lubricant sealing means for pivoted joints and more particularly to a boot for sealing the annular opening between the inner and outer relatively movable housing sections of steering drive axles, although it is not limited to such use and may be advantageously employed to seal other type joints.

In my prior Patent No. 2,075,564, granted March 30, 1937, I have shown a steering drive axle equipped with a sealing boot which effected a considerable saving in cost over the prior seal arrangements in common use between the housing sections of steer drive axles, because it made it unnecessary to provide an accurately machined spherical surface on the inner housing. The seal of said patent after a period of service, however, tended to sag and pull off of the housings.

Accordingly, the major object of this invention is to provide a novel sealing boot assembly for retaining lubricant and excluding dirt, which will retain its shape over long periods of use, will not leak, will not sag or pull off of either housing, and yet will freely allow steering movements of the movable housing.

A further important object is to provide a boot especially constructed to freely undergo a twisting action adjacent the trunnions and a stretching action intermediate the trunnions, and at the same time having the ability to return to normal shape when the movable housing is returned to straight position.

Another object is to provide a sealing boot assembly having means for protecting it against damage from tree limbs and other objects encountered in travelling off of established roads.

A further object is to provide a boot assembly of annular form, embodying a separable joint, which may be opened up to allow the boot to be installed in a steering drive axle or the like joint without disassembling the parts of the joint.

Further objects are to provide an improved clamping means for securing the boot to the housing and to improve and refine other details of the boot disclosed in my aforementioned patent.

Further objects will become apparent as the specification proceeds in conjunction with the annexed drawings, and from the appended claims.

In the drawings:

Figure 1 is a vertical sectional view through a steering drive axle embodying the novel flexible sealing boot of the invention;

Figure 2 is a perspective view of the axle of Figure 1, with a spindle housing turned approximately into full cramp position, illustrating the distortion of the boot;

Figure 3 is an elevational view of the boot as it appears when viewed from the left-hand side of Figure 1 and removed from the axle, part of the boot being broken away to show the inner clamp assembly.

Figure 4 is a sectional view taken substantially on the line 4—4 of Figure 3, with the exception that the clamp is shown 90° out of position, in order to illustrate the clamp coupling, and this view also shows the cooperating portions of the housings;

Figure 5 is a sectional view taken substantially on the line 5—5 of Figure 3, on an enlarged scale with the clamps omitted;

Figure 6 is a sectional view taken substantially on the line 6—6 of Figure 3;

Figure 7 is a fragmental elevational view showing a modified boot also forming part of the invention; and

Figure 8 is a sectional view taken on the line 8—8 of Figure 7.

With continued reference to the drawings, in which like reference characters have been employed to designate like parts throughout the several views thereof, the steering drive axle in which the invention is embodied comprises a stationary housing 10 containing a drive axle 11, the latter driving the vehicle wheels through a universal joint 12, and a stub shaft (not shown) in well-known manner.

Housing 10 is provided with an enlarged end portion of substantially spherical shape carrying a pair of aligned trunnions 13. Journalled for steering movements on trunnions 13, by means of bushings 14 and socket members 15, is a spindle-carrying housing 16, upon which the wheel assembly is journalled in well-known manner. The upper socket member is held in place on housing 16 by means of a plate or cap 17 and stud and nut assemblies 18, a grease fitting 19 being carried by the plate for providing lubrication for the top trunnion. Also, during operation a body of lubricant is adapted to be maintained on the lower part of the housing, being introduced through a filler plug 21, and led through passages 20 to the lower trunnion.

The axle construction thus far described is disclosed and claimed in my co-pending application Serial No. 429,829, filed February 6, 1942, now Patent #2,333,911, issued November 9, 1943, for "Steering drive axle," and will not be further described.

A lower socket assembly is held in place on

the movable housing by means of a special plate 22, and stud and nut assemblies 23. As seen in Figures 1 and 2, plate 22 extends inwardly beyond the trunnion axis and is provided with upstanding guard posts 24 and 25. These posts are adapted to clear the stationary housing in all pivoted positions thereof, and to overlie the flexible sealing boot of the invention and protect it from injury from tree limbs, stones, and other objects encountered in normal operation of the vehicle.

The annular space or opening between the two loosely telescoped housings is sealed against lubricant leakage in all pivoted positions of the housings by the novel boot of the invention designated as 26 which, in addition to embodying novel formations which enable it to undergo a maximum twisting action adjacent the trunnions and a maximum stretching action intermediate the trunnions without permanently being pulled out of shape, at the same time also has sufficient rigidity to withstand the lubricant pressure and avoid sagging, even after long periods of use. The boot also embodies improved means for holding it onto the housing. The boot may be made of any suitable flexible material, but I have found that a fairly loosely woven fabric carcass, impregnated with "Neoprene" or its equivalent has proved very successful, the neoprene resisting deterioration by lubricants and the fabric reenforcing the boot against tearing.

As seen in Figures 1 and 5, housing 10 is provided with a circumferential groove 27, into which a circumferential bead 28 on the inner periphery of the boot snugly seats, the boot being held in place by means of a split clamping ring 29 seating between shallow beads 31 and 32 provided on the interior of the boot. Ribs 31 and 32 serve to properly position the clamp during assembly, and also prevent it from sliding out of its proper position during tightening of the clamp and also during subsequent operation. It should be observed that although the band is slightly offset from groove 27, by reason of the fact that the band is flat and engages a large area of the boot, and the body of the boot underlying the clamp is backed up by portions of the stationary housing, there is no tendency for the clamp to slip off the boot when it is being tightened.

The clamping band is preferably held in place as shown in Figure 3. The band is provided with out-turned apertured ends 33, through which a bolt 34 is passed and held in place by a nut 35. During assembly of the axle the boot is preferably applied to groove 27 and clamped in place before the housings are joined, but if desired it may be applied later, since the boot is sufficiently flexible to permit it to be turned back upon itself to render the clamping means fully accessible.

The outer edge of the boot is held in place in somewhat similar manner on housing 16 by means of a clamp ring 36. In this instance however the boot is provided with a wider bead 37 fitting in a circumferential groove 38 in housing 16, the band being accurately positioned on the boot by means of beads 39 and 41. Band 36 is provided with out-turned apertured ends 42 and 43, pulled into clamping position by means of a bolt 44 and nut 45. During the assembly operation the inner edge of the boot is always secured in place first, and the outer edge of the boot is then pulled up over housing 16, with bead 37 fitting in groove 38, to complete the boot assembly operation. To facilitate the assembly operation the bottom portion of bead 37 is enlarged to form a tongue 40 fitting in a recess in housing 16. By inserting the tongue at the bottom of the housing first, the boot may be gradually worked over the open end of the housing, in a manner similar to placing a tire on a rim, without having the bottom of the boot slip off before assembly of the upper part of the boot is completed. The clamping ends of outer clamp ring 36 may be disposed in any desired angular position whichever proves to be the most convenient for tightening the clamp, but the fastening ends of the inner clamp ring are preferably located vertically above the axis of the axle housing, for a reason to be hereinafter pointed out.

The two regions or zones of maximum circumferential displacement of the housings relatively to each other, when housing 16 is rocked about the axis of the trunnions, occurs in two places located intermediate and 90° from the trunnions. Therefore, the sealing boot must undergo a maximum stretching or elongation in these regions.

Figure 4 is a section taken through the two zones of maximum stretch, but with the housing positioned for straight ahead driving, and illustrates the novel form given the boot to successfully meet the condition of stretch required. Boot 26 is provided with an outer, continuous circumferential corrugation or re-entrant curved formation 47, which smoothly merges into beads 37 and 41. Adjacent its inner edge, the boot is provided with a slant-sided continuous corrugation 48, having an enlarged portion 49 adjacent the top trunnion, as seen in Figure 5, for a purpose that will presently appear. By providing a slant-sided wall on corrugation 48, chafing engagement with the enlarged portion of housing 10 during operation is avoided, the slant-sided wall also facilitating proper stretching of the boot during steering.

Portions 51 and 52 of corrugations 47 and 48, respectively, merge into the base of a third corrugation 53, which is interrupted adjacent the trunnions as will be hereinafter pointed out.

It is apparent from the foregoing disclosure that by providing three corrugations, namely, 47, 48 and 53 in the two regions of greatest stretch or deformation, the spindle housing may be rocked into either extreme positions without appreciable resistance, and since the stretch is divided among three corrugations, no part of the boot is distorted to the extent that it will not return to the position shown in Figure 4 when the housings are again brought into alignment. In Figure 2, with the parts as shown in full cramped position, the deformation is seen to be shared by corrugations 47, 48 and 53, with none of the parts being so distorted as to impair their ability to return to original position. Also, it is apparent that by reason of the shape of corrugation 48, engagement of its sloping wall 48a with housing 10 is avoided.

Adjacent the two trunnions, the action is limited substantially solely to twisting, and in order to facilitate proper flexing of the boot adjacent the top and bottom trunnions, corrugation 53 is interrupted as shown in Figure 5 (taken along the trunnion axis or through the zones of maximum twist) to provide flat portions 55 and 56 adjacent the top and bottom trunnions respectively. I have found that by providing flat portions extending approximately a half inch either side of the trunnion axis, and merging them into corrugation 53 two or three inches from the trunnion axis, the boot is excellently suited to twisting adjacent the trunnions without undergoing harmful deformation. As seen in Figure 4 corrugation 53 smoothly merges at each end into the

flat portions along tapering flat surfaces 57. The flat portion 56 adjacent the lower trunnion is preferably provided with narrow fillets 58 and 59 which merge into walls of corrugations 47 and 48, respectively. As seen in Figure 3, fillets 58 and 59 are relatively narrow and are substantially parallel to the trunnion axis, with the result that they materially reinforce flat portion 56 against sagging outwardly in response to lubricant pressure in the boot adjacent the lower trunnion, and yet do not interfere with the desired twisting of the flat portions when the axle undergoes steering movements.

Referring to Figures 3 and 4, corrugation 48 is provided with an enlarged portion 49 adjacent the upper trunnion, merging back into corrugation 48 as seen in Figure 4 along slanting surfaces 58, so that when during assembly, the fastening assembly for inner clamp ring 29 is located opposite the enlarged portion, sufficient clearance is provided so that during subsequent steering movements of housing 16 in either direction there will be no possibility of the boot contacting, and possibly being injured, by the out-turned ends of the clamp.

In Figures 7 and 8 I have shown a modification of the invention in which boot 26a is split radially to permit it to be installed without disassembling the axle. This boot is used primarily for servicing existing axles in the field.

Secured to the free ends of the boot are a pair of slide fastener assemblies 61 and 62 of the "zipper" type having fastener elements 64 and an associated closure operator 63 of well-known form. Assemblies 61 and 62 are preferably stitched or otherwise secured to the boot so as to bring the neighboring ends 60 of the boot into close proximity as seen in Figure 7. As seen in Figure 8, the fastener and key extend inwardly beyond bead 28, so that after the ends are joined the fastener can be clamped in place in the groove 27 along with bead 28, and the key and excess fastener cut off. At its upper end the slide fastener extends outwardly sufficiently to allow it to be brought under the outer clamp ring. Preferably the boot is zippered closed, the zipper parts permanently wired together at 65, and the excess material, indicated by the broken lines in Figure 8 cut off, along with the closure operator 63. The boot is now in annular form and is supplied to the housings in the manner of the one previously described, the slide fastener being secured under the clamp ring.

Since the ends of the boot terminate slightly short of fastener elements 64, the latter do not hold the clamp rings away from the clamping portions of the boot.

While the fastener assembly is capable of excluding dirt from the interior it is not fluid tight and the boot is accordingly installed on the housing with the zipper joint well above the lubricant level. Also, the zipper joint is preferably located in the region of minimum stretch and minimum twist, so as to subject it to minimum distortion and wear in service. I have found that when the joint is located approximately 35 degrees above the horizontal centerline of the axle, or approximately 55 degrees from the upper trunnion, very satisfactory results are secured.

From the foregoing disclosure it is apparent that I have provided a novel flexible sealing boot assembly which is designed to efficiently withstand both the twisting and stretching actions to which it is subjected in service, without setting up resistance to turning; the boot is reenforced against sagging in response to fluid pressures; it is provided with novel means for clamping it to the housing sections so that it will not tend to pull away from the housings, even after long periods of service; and that the invention also provides a split boot of modified form which may be readily applied to existing axles or the like without disassembly of any parts thereof, and yet the boot, when assembled, has all of the advantages of the one-piece boot.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed and desired to be secured by United States Letters Patent is:

1. In a lubricated joint, an inner member and an outer member having nested portions pivotally interconnected by spaced trunnions and providing an annular opening therebetween; means for sealing said opening in all pivoted positions of said members, comprising an annular flexible element having its marginal edges secured to said members along annular zones of engagement, the latter being so disposed when said members are in neutral position as to intersect a common plane located substantially parallel to the pivotal axis of said members, said flexible element having means adjacent said trunnions to facilitate twisting, and having additional means intermediate said trunnions to facilitate stretching in response to relative pivotal movement of said members.

2. In a lubricated joint, a pair of members having nested portions pivotally interconnected by spaced trunnions and providing an annular opening therebetween; means for sealing said opening in all pivoted positions of said members, comprising an annular flexible element having its marginal edges secured to said members, and being provided with circumferential corrugations intermediate said trunnions, and flattened portions adjacent said trunnions, for permitting stretching of said element intermediate said trunnions, and twisting of said member adjacent said trunnions.

3. The joint construction defined in claim 2, wherein said corrugations smoothly taper down and merge into said flattened portions.

4. The joint construction defined in claim 2, wherein said element is of endless annular form.

5. In an axle, a pair of housings having nested portions pivotally interconnected by top and bottom trunnions and providing an annular opening therebetween; a flexible annular boot for sealing said opening having a circumferentially directed corrugation interrupted adjacent each trunnion by a flat portion; and means for reenforcing the lower flat portion against sagging in response to lubricant pressure in the boot.

6. The axle construction defined in claim 5, wherein said means comprises at least one radially directed member secured to said lower flat portion and to a portion of the boot contiguous with said lower flat portion.

7. The axle construction defined in claim 5, wherein said means comprises a pair of web-like members secured to said lower flat portion and

merging into contiguous portions of the boot, said members extending substantially parallel to the axis of said trunnions, to minimize resistance to steering movements.

8. In a joint, a pair of members having nested portions pivotally interconnected by trunnions and having an annular opening therebetween; a flexible boot for sealing said opening in all pivoted positions of said members, and operable to be applied to and removed from said members without disconnecting said trunnions, said boot comprising an elongated element formed into annular shape and having its marginal edges secured to said members, and with its opposite ends disposed in substantially abutting relationship; means for securing the ends of the boot together to form a continuous annular closure, said boot being adapted to undergo a twisting action adjacent the trunnions and a stretching action intermediate the trunnions, and said means for fastening the ends of said boot together being located in a region of minimum twisting and stretching.

9. In an axle, a pair of housings having nested portions pivotally interconnected by upper and lower trunnions and providing an annular opening; said nested portions being adapted to undergo a maximum relative angular twist adjacent said trunnions and to undergo a maximum relative translational displacement at regions substantially midway between said trunnions; a flexible annular boot secured at its edges to said housings and closing said opening so as to provide a closed lubricant chamber, said boot having circumferentially directed curved portions intermediate said trunnions, to provide for stretch, and flat portions adjacent the trunnions to provide for twist when the housings are rocked; and a separable joint in said boot located above the lubricant level and substantially bisecting adjacent zones of maximum stretch and maximum twist.

10. For use in an axle having a pair of housings providing nested portions pivotally interconnected by trunnions; a flexible sealing boot for closing the space between said members and adapted to have its marginal edges clamped to said housings, said boot comprising an elongated element formed into annular shape and having substantially abutting ends, each of which is provided with a slide fastener, said fasteners adapted to be secured together by a slider to bring the boot into continuous annular form, said fasteners also extending inwardly and outwardly sufficiently to underlie the clamping means for securing the boot to the housings, and means for locking said fasteners independently of said slider, whereby said slider may be removed after assembly of the boot on the axle.

11. In an axle, a pair of housings having loosely telescoped portions pivotally interconnected by trunnions and presenting an annular opening; an annular groove in each housing adjacent said opening; an annular flexible sealing boot fitting over said opening and having beads at its margins seating in the grooves of said housings; clamp means for maintaining said beads in said grooves, the inner of said housings being provided with a generally spherical face adjacent its boot retaining groove, and said boot being provided with an inner circumferentially extending corrugation, having a conical inner wall, for clearing said spherical face in all pivoted positions of said housings.

12. In an axle, a pair of housings having loosely telescoped portions pivotally interconnected by trunnions and presenting an annular opening; an annular groove in each housing adjacent said opening; a flexible annular boot fitting over said opening and having marginal beads fitting into said grooves, one of said beads having a tongue-like portion seating in a deep portion provided in its groove; and clamp means for maintaining said boot assembled on said housings.

13. In an axle, a pair of housings having loosely telescoped portions pivotally interconnected by trunnions and presenting an annular opening, said housings each having a clamping face adjacent said opening; a flexible annular boot fitting over said opening and having its margins engaging said clamping faces; a corrugation in said boot adjacent its inner edge; and a clamping ring holding the inner edge of said boot in engagement with its clamping face on the inner housing, and having an enlarged coupling device adjacent one of said trunnions; and an enlarged portion formed in said corrugation adjacent said one trunnion providing a pocket sufficiently large to clear said coupling device in all pivoted positions of said housings.

14. In an axle, inner and outer housings having loosely telescoped portions pivotally interconnected by trunnions and presenting an axially directed annular opening; a flexible annular boot fitting over said opening and having its edges secured to said inner and outer housings; and guard means carried by one of said housings and overlying said boot, for protecting it against driving hazards.

15. The axle construction defined in claim 14, wherein said guard means is carried by said outer housing and comprises at least one member extending inwardly across the face of said boot.

HERBERT W. ALDEN.