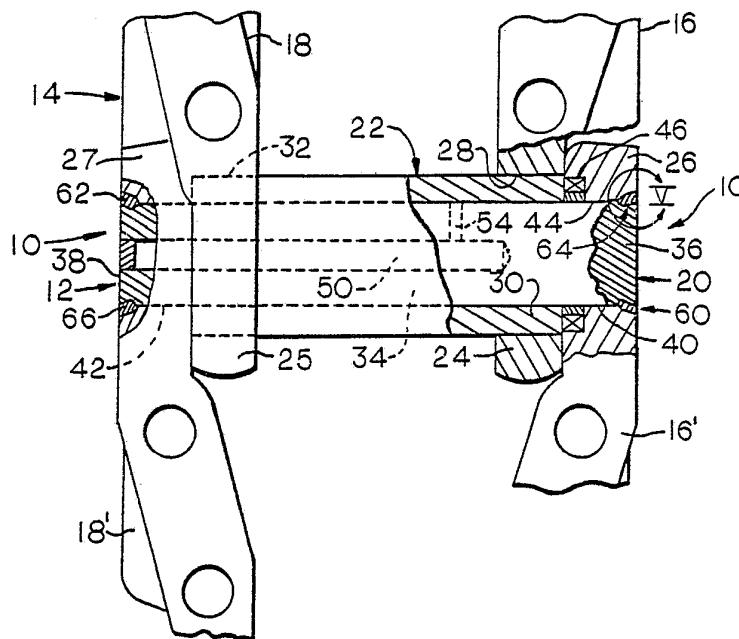




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(54) Title: TRACK JOINT RETAINING APPARATUS



(57) Abstract

Apparatus (10) for retaining a joint (12) of an endless track (14) for a crawler-type vehicle which includes a metal preform (64, 66) which is pressed into a retainer cavity (60, 62) surrounding and located at each of the ends of the joint (12) of the track (14). The cavities (60, 62) are cooperatively formed by a pin groove (70) in the opposite end portions (40, 42) of the pin (20) and a link socket (72) in the respective link outboard end portions (26, 27) and which are disposed in registry with the pin grooves (70). Once intruded into the cavities (60, 62), the formed-in-place retainers (64, 66) thereby provided virtually eliminate any end play in the joint (12) during operation of the crawler vehicle.

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DescriptionTrack Joint Retaining ApparatusTechnical Field

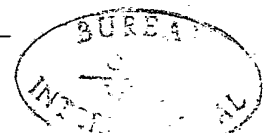
5 This invention relates generally to an endless track for crawler-type vehicles and more particularly to apparatus for retaining a joint of such track.

Background Art

10 A track joint is customarily held together by an interference fit between the ends of the track pins and their respective link bores into which the pin ends are received. While a substantial force, sometimes exceeding 60 tons (54.4 metric tons), is typically used to press the links onto their respective pin ends, the
15 links still have a tendency to move outwardly on the pin as a result of forces exerted on the track during operation of the vehicle.

20 Until recently, the amount of end play which developed in operation was normally within acceptable limits. However, with the introduction of larger crawler vehicles and engines with greater horsepower, even for smaller vehicles, the amount of end play has increased so as to become a concern, especially for
25 sealed and lubricated track. In sealed and lubricated track, excessive end play can lead to a loss of the lubricant and the ingress of abrasive materials which can lead to excessive wear and premature failure of the track.

30 Various methods have been employed to limit the amount of end play in track joints. Keeper assemblies, such as those disclosed in U.S. Patent 4,182,578 issued on January 8, 1980 and U.S. Patent 4,288,172 issued on September 8, 1981, both to Richard E. Livesay et al. and both assigned to the
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assignee hereof, have been successfully employed to reduce such end play movement. In order to accommodate manufacturing tolerances, joints utilizing such keepers must have a certain amount of clearance which produces a limited amount of built-in end play. As a result, these keepers reduce, but do not completely eliminate, end play.

Another method of limiting end play is disclosed in U.S. Patent 3,831,257 issued to Roger L. Boggs et al. on August 27, 1974, which patent is also assigned to the assignee hereof, wherein welding about the ends of the track pins is employed. In this method, retention is quite dependent on the strength of the weld. In practice, weld strength is difficult to control with any degree of consistency. If a weld is so weak that it breaks, all of its retention ability is lost.

In U.S. Patent 1,507,757 issued to Edwin H. Savage on September 9, 1924, a soft metal key is driven through an opening in a rail and shoe of a track unit and into an angled pin groove to provide a locking device for securing the pin with the track unit.

Disclosure of the Invention

In accordance with one aspect of the present invention, a joint of an endless track for a crawler-type vehicle has a pin and a pair of links. The pin has opposite ends and first and second end portions. The links each having a bore of a size sufficient for receiving a respective one of the first and second pin end portions. Each of the first and second pin end portions have a groove. Each groove is spaced a preselected distance from a respective one of the opposite pin ends. Each of the links is provided with a socket adjacent the link bore. Each socket is in substantial registry along an interface with a



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respective one of the pin grooves in the installed position of the links on the pin end portions. Respective ones of the sockets and grooves each cooperate to form one of a pair of retainer cavities. 5 Each cavity is adapted to receive and deform a formed-in-place retainer of sufficient shear strength along the interface to maintain its respective link in a fixed axial relationship on the pin during operation of the vehicle.

10 In another aspect of the invention, an endless track is assembled by the steps of placing a pair of metal preforms adjacent an opening of each of the retainer cavities and forcing a preform into each cavity and deforming the preform into tight contact 15 with the walls of the cavity to provide a formed-in-place retainer.

In another aspect of the invention, a joint of an endless track is repaired by the steps of pushing the pin out of the link end portion, shearing the 20 formed-in-place retainer, removing the sheared retainer from its retainer cavity, replacing the pin end portion in its link end portion, placing a metal preform adjacent the cavity opening, forcing the preform into the cavity and deforming the preform into a new 25 formed-in-place retainer.

More specifically the formed-in-place retainer has, in its deformed state, a modulus of elasticity preferably in excess of 25 million pounds per square inch (172,000 MPa) and is tightly intruded into the 30 retainer cavity between a surface in the link socket and an opposite surface in the pin groove to provide a rigid lock between the pin and link, thereby limiting end play movement.

35



Brief Description of the Drawings

Fig. 1 is a fragmentary plan view of an endless track with a portion of a joint thereof in section illustrating an embodiment of the retaining apparatus;

Fig. 2 is a frontal view of a preferred embodiment of the preform;

Fig. 3 is a side view of the preform of Fig. 2;

Fig. 4 is an enlarged sectional view of one end of the joint illustrated in Fig. 1;

Fig. 5 is a greatly enlarged fragmentary sectional view of the apparatus shown in Fig. 1;

Fig. 6 is a view similar to Fig. 5, but illustrating a preform as it would appear entering the retainer cavity before deformation;

Fig. 7 is a force/displacement curve of a preferred embodiment of the formed-in-place retainer; and,

Fig. 8 is an enlarged sectional view similar to Fig. 4, but illustrating the formed-in-place retainer as it would appear when being sheared in response to removing the pin.

Best Mode For Carrying Out the Invention

Referring more particularly to Fig. 1 of the drawings, apparatus embodying the principals of the present invention is generally depicted at 10 for rigidly retaining a joint 12 of an endless track 14 of the type used on a crawler-type vehicle, not shown. The endless track 14 is generally of a conventional design, the major components of which include a plurality of right-hand links 16,16' and left-hand links 18,18', pins 20 and hollow bushings 22. Each right-hand link 16,16' and left-hand link 18,18' has an inboard end portion 24,25, and an opposite outboard end portion 26,27, respectively. The inboard end portions



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24,25 each have a bore 28 of a size sufficient to enable the inboard end portions to be press fitted onto the ends 30,32 of the bushing 22. The pins 20 have a mid-portion 34, opposite ends 36 and 38 and opposite end portions 40 and 42. The pin mid-portion 34 is of a size to be received within the hollow bushing 22 and freely pivot relative to the bushing.

The outboard end portions 26,27 of the links 16',18' each have a bore 44. Each bore 44 is of a size sufficient to enable the outboard end links portions 26,27 to be press fitted onto the opposite end portions 40,42 of the pin 20.

The above assemblage is successively repeated with the next adjoining links, pins and bushings to complete the construction of the endless track.

While not intended to be so limited, the embodiment of the present invention to be hereinafter described is particularly well suited for use in an endless track which is sealed and lubricated. A track of this configuration normally has each joint provided with a pair of seals, one of which is shown at 46, and a lubricant reservoir, such as a sealed bore 50 in the pin 20. As best shown in Fig. 4, each seal 46 is disposed within a counterbore 52 in each link outboard end portion 26 and 27. Lubricant in the reservoir 50 is communicated to the pivoting interface between the bushing 22 and the mid-portion 34 of the pin 20 by a cross hole 54 in the pin 20, as best shown in Fig. 1. A thrust ring 56 is disposed in each of the counterbores 52 so that all of the joint components can be pushed together into abutment without crushing the seals 46. In other words, the outboard link end portions 26 and 27 are in close abutting contact with adjacent ends of the thrust rings 56. The other ends of the thrust rings abut the adjacent opposite end of the bushing 22. As a consequence, there is essentially no end play in the joint 12 after the assemblage is completed.



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The apparatus 10 is principally directed toward maintaining the above-described abutting relationship during operation of the crawler-type vehicle. The apparatus 10 includes a pair of retainer
5 cavities 60 and 62, each cavity being of a shape and orientation to receive and deform a respective one of a pair of formed-in-place retainers 64 and 66.

As both cavities 60,62 are mirror images of each other, only cavity 60 will be hereinafter
10 described in detail with particular reference to Figs. 4 through 6, it being understood that such description applies to cavity 62.

Cavity 60 is defined by a pin groove 70 and a link socket 72. Groove 70 is formed in its respective
15 pin end portion 40 and extends around at least a portion of the circumference of such end portion. While it should be understood that the groove 70 need be only partially or in segments about the circumference of the pin, it is preferable that it be
20 continuous or annular to avoid the waste of time, labor and equipment in machining the part.

The groove 70 is disposed a preselected distance from the adjacent pin end 36. Such distance is related to the physical properties of the pin and is
25 sufficient to provide the portion of the pin between its end 36 and the groove 70 with strength greater than that of the retainer 64. Maintaining this relative strength relationship functions to prevent damage or breakage of the pin during disassembly of the joint.

Referring to Fig. 5, the groove 70 preferably
30 has a frustoconical surface 76, a bottom extremity 78 and a curvilinear side wall 80. The curvilinear side wall 80 extends from the cylindrical surface of the pin end portion 40 to the bottom extremity 78. The
35 frustoconical surface 76 joins the curvilinear surface 80 adjacent the bottom extremity 78 and extends



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radially outwardly toward its peripheral edge adjacent the pin end 36. The frustoconical surface 76 is at an angle within a range of from between 20 to 30 degrees from its central axis, and preferably at an angle of approximately 25 degrees. The above configuration facilitates the substantially complete filling of the groove 70 by the retainer 64.

The socket 72 is formed in the link outboard end portion 26. The socket 72 is disposed in registry along an imaginary interface 81 with pin groove 70 when link outboard end portion 26 is in its installed position on the pin end portion 40. The socket 72 can be of other configurations depending on various criteria, such as material hardness and configuration of the retainer preform. Preferably, however, the socket 72 has at least a first frustoconical surface 82. This first frustoconical surface 82 is disposed in a spaced concentric relationship to the groove frustoconical surface 76 and extends radially inwardly from an outer side 84 of the link outboard end portion 26 toward the link bore 44. The cavity 60 has an annular opening 85 on the outer side 84. The first frustoconical surface 82 is preferably disposed at a second angle which is less than the angle of the groove frustoconical surface 76. This second angle is preferably within a range of 15 to 35 degrees, with an angle of about 20 degrees being preferable. Providing the first frustoconical surface 82 with an angle less than the angle of the groove frustoconical surface 76 advantageously produces a wedging action on the retainer 64 which facilitates the loading of the retainer in shear on application of an axial force F , as shown in Fig. 5.

The socket 72 preferably includes a second frustoconical surface 86 extending from the first frustoconical surface 82 to an inner peripheral edge 88



adjacent the link bore 44. The second frustoconical surface 86 is preferably at an angle of approximately 45 degrees which facilitates the intrusion of the retainer 64 into the groove 70.

5 Prior to being deformed, the formed-in-place retainers 64,66 are each identified as a preform 90, as shown in Figs. 2, 3, and 6. While the preform 90 is herein disclosed as being a continuous ring, split or segmented rings are intended to be included within the
10 scope of the present invention. It should also be understood that the preform 90 may take other configurations with the following description being exemplary of the preferred configuration.

 As best shown in Figs. 3 and 6, the preform 90
15 has a generally rectangular cross-sectional configuration provided with a lead-in chamfer 92 about the periphery of one end thereof and a beveled face 94 on such end. The lead-in chamfer is preferably at the same angle as the first frustoconical surface 82 of the
20 socket 72. The beveled face 94 is preferably at an angle such that it is parallel to the side wall 80 of the groove upon intrusion of the preform into the cavity 60 to facilitate filling of the groove 70.

 As best shown in Figs. 2 and 3, the preform 90
25 is preferably provided with a plurality of radially oriented slots 96. The slots 96 extend a preselected axial distance into the preform 90 from the beveled end face 94. This arrangement is advantageous during any required disassembly of the joint 12, as hereinafter
30 described, and facilitates the intrusion of the preform 90 into the groove 70.

 In order to provide sufficient strength and rigidity for use in the track joint 12, the preform 90 is a ferrous material having a modulus of elasticity in
35 the range of 19 to 30 million psi (131,000 to 207,000 MPa). A preform 90 constructed from a wrought steel



with a hardness in a range of from Rockwell B60 to C35 has been found to be preferred. It should be understood, however, that the hardness of the preform 90 must be less than the corresponding hardness of the materials of the link and pin forming the cavity 60.

A ferrous powdered metal material can be satisfactorily used for the preform 90. Such powdered metal preform 90 preferably has a minimum initial density of 6.8 grams per cubic centimeter. After installation, the powdered metal material preferably has a minimum density of 7.5 grams per centimeter. The hardness of the powdered metal preform 90 is preferably in a range of from Rockwell B40 to B100, with a preferred hardness of Rockwell B90.

Industrial Applicability

To construct an endless track 14, the links 16,16' and 18,18', pins 20 and bushings 22 are assembled in the manner described above. A preform 90 is thereafter placed adjacent the annular opening 85 of the cavity 60. A sufficient force, as by means of a press 97, is then applied to the preform 90 to ram the preform 90 into the cavity 60 resulting in the preform 90 being plastically deformed and intruded into its formed-in-place retainer shape substantially conforming to the shape of the cavity 60. A force in the range of 100,000 to 200,000 pounds (445 to 890 kN) is normally required, with a force of approximately 150,000 pounds (667 kN) being typical. Forces in this range ensures the substantially complete filling of the cavity 60 and the tight wedging of the retainer material against all of the surfaces of the cavity 60. More importantly, the retainer material is tightly compacted between reacting surfaces defined principally by the frustoconical surface 76 of the groove 70 and the second frustoconical surface 86 of the socket 72 which



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are disposed on opposite sides of the interface 81 between the groove 70 and socket 72 portions of the cavity 60. As a consequence, an axial force F , as shown in Fig. 5, acting on the link outboard end portion 26 is resisted through the shear properties of the formed-in-place retainer 64. Because of its high modulus of elasticity, the retainer 64 is substantially rigid, thus preventing any significant outward axial movement of the outboard end portion 26 on the pin end portion 40. A second preform 90 is similarly pressed into its cavity 62 at the other end of the joint 12.

In an example assembly, an experimental test was run on a laboratory press of a retainer of the above-described configuration made from a ferrous powdered metal material and having a Rockwell B60 hardness. The shear area of about 1.5 square inches (9.68 CM^2) along the interface 98 was capable of withstanding a shear force in excess of 50,000 pounds (22,680 Kg) without plastic deformation occurring in the retainer. The powdered metal retainer had a modulus of elasticity of about 19 million psi (131,000 MPa) before deformation, and about 25 million psi (172,000 MPa) after deformation. This increase in modulus of elasticity was in response to the increase in density resulting from the large deformation force applied during intrusion of the preform 90 into the cavity.

It should be noted that by varying the shear area, the shear force carrying capability of the retainer 64 can be varied. Hence, the retainer 64 can be designed in accordance with the actual forces which will be experienced during operation of the various sizes of crawler vehicles. Shear force capability can thereby be maintained at a value greater than the operational forces. As a consequence, an endless track 14 constructed in accordance with the present invention will have joints 12 which have virtually no end play during operation of the crawler-type vehicle.



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As noted above, the material of the retainer 64 has a high modulus of elasticity. This produces a force/displacement curve 98, as depicted in Fig. 7, having a steep sloped straight line portion 100 which is in the elastic range of this material and an abrupt curved portion 102 in its plastic range. By providing the retainer 64 with the preferred mechanical properties described above, the elastic limit 104 can be elevated. As a consequence, the retainer 64 is able to withstand a higher force without suffering plastic deformation and with very little deflection. Also, the difference in the force between the elastic limit 104 and the ultimate strength 106 of the material is reduced. It is desirable that the ultimate strength 106 be no more than 25% greater than the elastic limit 104. This is advantageous in that the retainer 64 can be designed to withstand operational forces approaching its elastic limit 104 without too great of an additional force being required to shear the retainer 64 for disassembly purposes. Thus, the force necessary to remove the pin 20 and simultaneously shear the retainer 64 is kept within the capacities of currently employed track presses. This eliminates waste and expenses in acquiring higher capacity track presses.

The retaining apparatus 10 of the present invention enables the track 14 to be disassembled for repair or replacement of worn components, such as the links 16,18 or bushings 22, and then be reassembled. As depicted in Fig. 8, this is accomplished by means of a press 108 which pushes the pin 20 out of the link outboard end portions 26 and 27, while simultaneously shearing the formed-in-place retainers 64 and 66 along their respective interfaces 81. The sheared off portions of the retainers 64 and 66 are thereafter removed from their corresponding grooves 70 and sockets 72. Removal from the grooves 70 is facilitated by the



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slots 96, shown in Figs. 2 & 3, which are preferably of a depth so as to extend past the interface 81. As a consequence, the portion of the preform 90 which had been intruded into the groove 70 becomes a plurality of pieces upon being sheared. Ordinarily, these pieces will simply fall out of the groove upon removal of the pin 20 from the joint 12. To rebuild the track 14, the track components are reassembled as they were initially and a new preform 90 is placed adjacent each of the openings 85 of the cavities 60 and 62. A force is applied to each of the preforms 90 to cause their intrusion into their respective cavities 60,62 and deformation into new formed-in-place retainers 64 and 66.

After an extended period of operation of the track 14, a certain amount of end play can develop in the joint 12 due to internal wear between the axially abutting components of the joint 12. If this happens, the retainers 64 and 66 can advantageously be repressed to again eliminate this end play.

Other aspects, objects, and advantages of the present invention will become apparent from a study of the specification, drawings and the following appended claims.



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Claims

1. In a joint (12) of an endless track (14) for a crawler type vehicle, said joint (12) having a pin (20) and links (16,16' and 18,18'), said pin (20) having opposite ends (36,38) and first and second end portions (40,42) adjacent respective ones of said ends, and said links (16, & 18) each having a bore (44) of a size sufficient for receiving a respective one of said first and second pin end portions (40,42), the improvement comprising:

each of said first and second pin end portions (40,42) having a groove (70), each groove (70) extending around at least a portion of the circumference of its respective pin end portion (40,42) and spaced a preselected distance from a respective one of said opposite pin ends (36,38); and,

each of said links (16,16' & 18,18') having a socket (72) adjacent its bore (44), each socket (72) being in registry along an interface (81) with a respective one of said pin grooves (70) in the installed position of said links (16,16' & 18,18') on said pin end portions (40,42), respective ones of said sockets (72) and grooves (70) each cooperating to form one of a pair of retainer cavities (60,62), each cavity (60,62) being of a size and orientation sufficient to receive and deform a formed-in-place retainer (64,66) having sufficient shear strength along said interface (81) to maintain its respective link (16' & 18) in a fixed axial relationship on the pin (20) during operation of the vehicle.

2. The joint (12) of claim 1 wherein said pin grooves (70) are continuous about their respective pin end portions (40,42) and each includes a bottom extremity (78) and a groove frustoconical surface (76),



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said groove frustoconical surface (76) angling outwardly from said bottom extremity (78) towards its respective pin end (36,38).

5 3. The joint (12) of claim 2 wherein said links (16,16' & 18,18') each have an outer side (84) and said link sockets (72) are each defined by a first frustoconical surface (82) disposed in a spaced concentric relationship to its respective groove
10 frustoconical surface (76), said first frustoconical surface (82) extending from its respective outer side (84) and defining an opening (80) to each of said cavities (60,62) through said outer sides (84) of the links (16,18).

15 4. The joint (12) of claim 3 wherein said groove frustoconical surface (76) is at a first selected angle and said first frustoconical surface (82) of the sockets (72) is at a second selected angle,
20 said second angle being less than said first angle.

 5. The joint (12) of claim 4 wherein said first angle is in a range of between 20 to 30° and said second angle is in a range of between 15 to 35°.

25 6. The joint (12) of claim 3 wherein said link sockets (72) each include a second frustoconical surface (86) extending between said first frustoconical surface (82) and the link bore (44), said second
30 frustoconical surface (86) being at an angle substantially greater than the angle of said first frustoconical surface (82).

 7. The joint (12) of claim 6 wherein said
35 second frustoconical surface (86) is at an angle of approximately 45°.



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8. Apparatus (10) for retaining a joint (12) of an endless track (14) for a crawler-type vehicle, said joint (12) including a pair of inboard end link portions (24,25), a hollow bushing (22), a pin (20) and a pair of outboard end link portions (26,27), said pin having a mid portion (34), opposite ends (36,38) and first and second end portions (40,42) adjacent said opposite ends, said mid portion (34) being of a size sufficient to be pivotally received within said hollow bushing (22), and said outboard end link portions (26,27) being adapted to abut the opposite sides of said inboard end link portions (24,25) and each having an outer side (84) and a bore (44) of a size sufficient to fixedly receive a respective one of said first and second pin end portions (40,42), said apparatus (10) comprising:

each of said first and second pin end portions (40,42) having a groove (70), each groove (70) extending around at least a portion of the circumference of its respective pin end portion (40,42) at a location spaced a preselected distance from its respective pin end (36,38);

each of said link outboard end portions (26,27) having a socket (72) adjacent its respective pin bore (44), each of said sockets (72) being in registry along an interface (81) with a respective one of said pin grooves (70) in the installed position of the link end portions (26,27) on said pin end portions (40,42), said respective sockets (72) and grooves (70) each defining a retainer cavity (60,62) opening on the outer side (84) of its respective link outboard end portion (26,27); and,

a pair of metal formed-in-place retainers (64,66) each positioned in and filling a respective cavity (60,62) and having a sufficient shear strength along said socket-groove interface (81) to maintain its



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respective link end portion (26,27) in abutting relationship against its respective link inboard end portion (24,25).

5 9. The apparatus (10) of claim 8 wherein each of said retainers (64,66) is a ferrous material.

10 10. The apparatus (10) of claim 9 wherein said ferrous material has a modulus of elasticity in the range of 131,000 to 207,000 MPa.

15 11. The apparatus (10) of claim 10 wherein said retainers (64,66) are wrought steel having a hardness in the range of Rockwell B60 to C35.

20 12. The apparatus (10) of claim 10 wherein said retainers (64,66) have a hardness of approximately Rockwell B90.

25 13. The apparatus (10) of claim 10 wherein each of said retainers (64,66) is initially a preform (90) of a ring-shaped configuration and having a generally rectangular cross-sectional configuration.

30 14. The apparatus (10) of claim 13 wherein said preform (90) has a lead-in chamfer (92) about the periphery of one end thereof, said chamfer (92) having an angle which is substantially equal to the angle of said first frustoconical surface (82) of said sockets (72).

35 15. The apparatus (10) of claim 14 wherein said one end of said preform (90) also includes a beveled face (94).



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16. The apparatus of claim 9 wherein said preform (90) includes a plurality of generally radially oriented slots (96), said slots (96) extending axially from said one end inwardly a preselected axial distance.

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17. The apparatus (10) of claim 9 wherein said preform (90) is a powdered metal having an initial minimum density of 6.8 grams per cubic centimeter.

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18. The apparatus (10) of claim 17 wherein said powdered metal (90) has a minimum density of 7.5 grams per cubic centimeter after intrusion into said cavities (60,62).

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19. The apparatus (10) of claim 18 wherein said preform (90) has a hardness in the range of Rockwell B40 to B100.

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20. The apparatus (10) of claim 19 wherein said preform (90) has a hardness of approximately Rockwell B90.

25

21. The apparatus (10) of claim 8 wherein said pin grooves (70) are continuous about their respective pin end portions (40,42) and each groove (70) includes a bottom extremity (78) and a frustoconical surface (76) angling outwardly from said bottom extremity (78) towards its respective pin end (36,38).

30

22. The apparatus (10) of claim 21 wherein said link sockets (72) each include at least a first frustoconical surface (82), each of said first frustoconical surfaces (82) being disposed in spaced concentric relationship to its respective frustoconical surface (76) of the pin grooves (70) and extending from its respective outer link side (84).

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23. The apparatus (10) of claim 22 wherein said groove frustoconical surface (76) is at a first selected angle and said first socket frustoconical surface (82) is at a second selected angle, said second angle being less than said first angle.

24. The apparatus (10) of claim 23 wherein said first angle is within a range of 20 to 35° and said second angle is in a range of 25 to 30°.

25. The apparatus (10) of claim 22 wherein said link sockets (72) each include a second frustoconical surface (86) extending between said first frustoconical surface (82) and the link bore (44), said second frustoconical surface (86) being at an angle substantially greater than the angle of said first frustoconical surface (82).

26. The apparatus (10) of claim 25 wherein said second frustoconical surface (86) is at an angle of approximately 45°.

27. A method of retaining a joint (12) of an endless track (14) for a crawler-type vehicle, said track (14) including a plurality of links (16,16' & 18,18') and pins (20) comprising the steps of:

placing a pair of metal preforms (90) adjacent an opening (85) of a respective one of a pair of retainer cavities (60,62), each of said cavities (60,62) being defined by a respective one of a pair of grooves (70) in each of said pins (20) and a respective one of a pair of sockets (72) in corresponding ones of the outboard end portions (26,27) of said links (16,16' & 18,18'); and,

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forcing a preform (90) into each cavity (60,62) and deforming said preform (90) into tight contact with the walls of said cavity (60,62) to provide a formed-in-place retainer (64,66) in each of said cavities (60,62), said retainer (64,66) being of a size and construction sufficient to maintain said outboard link end portions (26,27) in a substantially fixed relation on the pin (20) during operation of the vehicle.

10
28. A method of repairing a joint (12) of an endless track (14) of a crawler type vehicle, said joint (12) having at least one cavity (60,62) and a formed-in-place retainer (64,66) in said cavity (60,62), said cavity (60,62) being defined by a groove (70) in an end portion (40,42) of a pin (20) and a cooperating socket (72) in a link end portion (26,27) surrounding said pin end portion (40,42) and having an opening (85) at an outer side (84) of said link end portion (26,27), comprising the steps of:

15
20 pushing said pin (20) out of said link end portion (26,27) and shearing said formed-in-place retainer (64,66);

25 removing the said sheared retainer (64,66) from said joint (12);

replacing said pin end portion (40,42) into said link end portion (26,27);

30 placing a metal preform (90) adjacent said cavity openings (85); and,

forcing the preform (90) into said cavity (60,62) and deforming the preform (90) into a new formed-in-place retainer (64,66).

35 29. A preform (90) for use in retaining a track joint (12) of an endless track (14) for a crawler-type vehicle, comprising:



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a ring of material having a modulus of elasticity in the range of 131,000 to 207,000 MPa and a generally rectangular cross-sectional configuration;

5 a lead-in chamfer (92) about the periphery of one end of said preform (90), said chamfer (92) being disposed at angle in a range of between 15 to 25°;

a beveled face (94) at said one end and extending generally between said chamfer (92) and the inner periphery of said preform (90); and,

10 a plurality of generally radially oriented slots (96) extending axially from said one end a distance at least 25% of the axial length of said ring.

30. The preform (90) of claim 29 wherein said material is a wrought steel having a hardness in a range of Rockwell B60 to C35.

31. The preform (90) of claim 29 wherein said ring of material is split.

20 32. The preform (90) of claim 29 wherein said material is a powdered metal having an initial minimum density of 6.8 gram per cubic centimeter and a hardness in a range of Rockwell B40 to B100.

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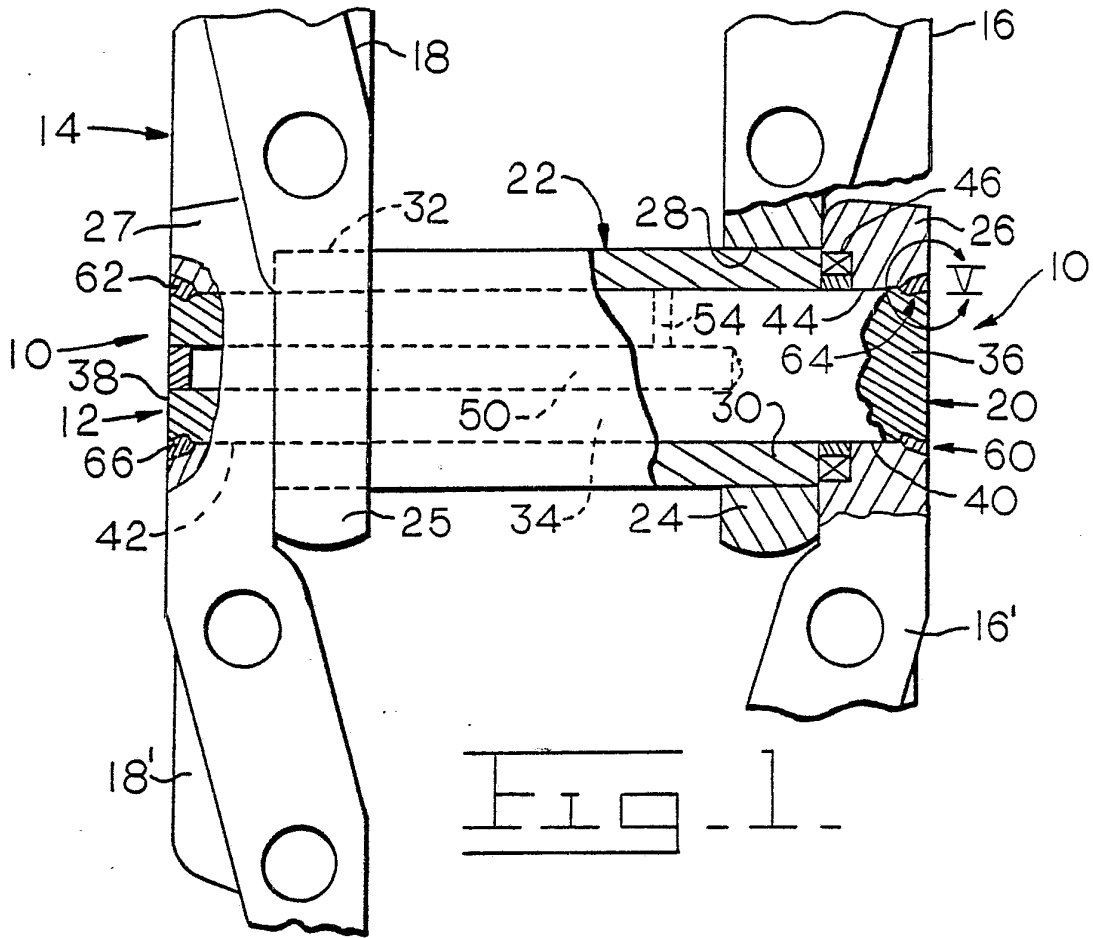
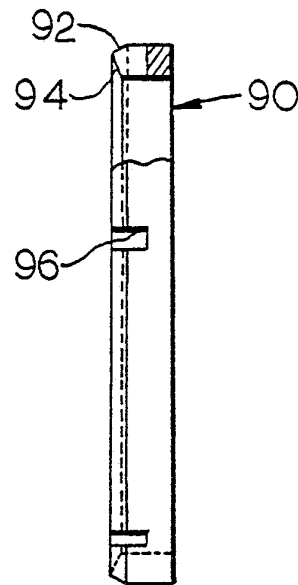
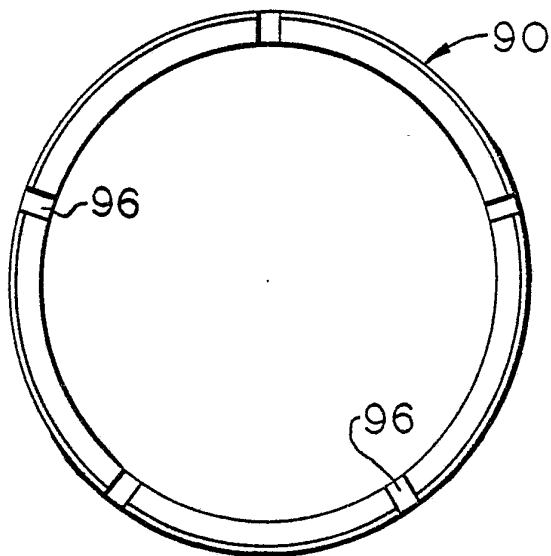


Fig. 1.

Fig. 2.

Fig. 3.



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Fig. 4

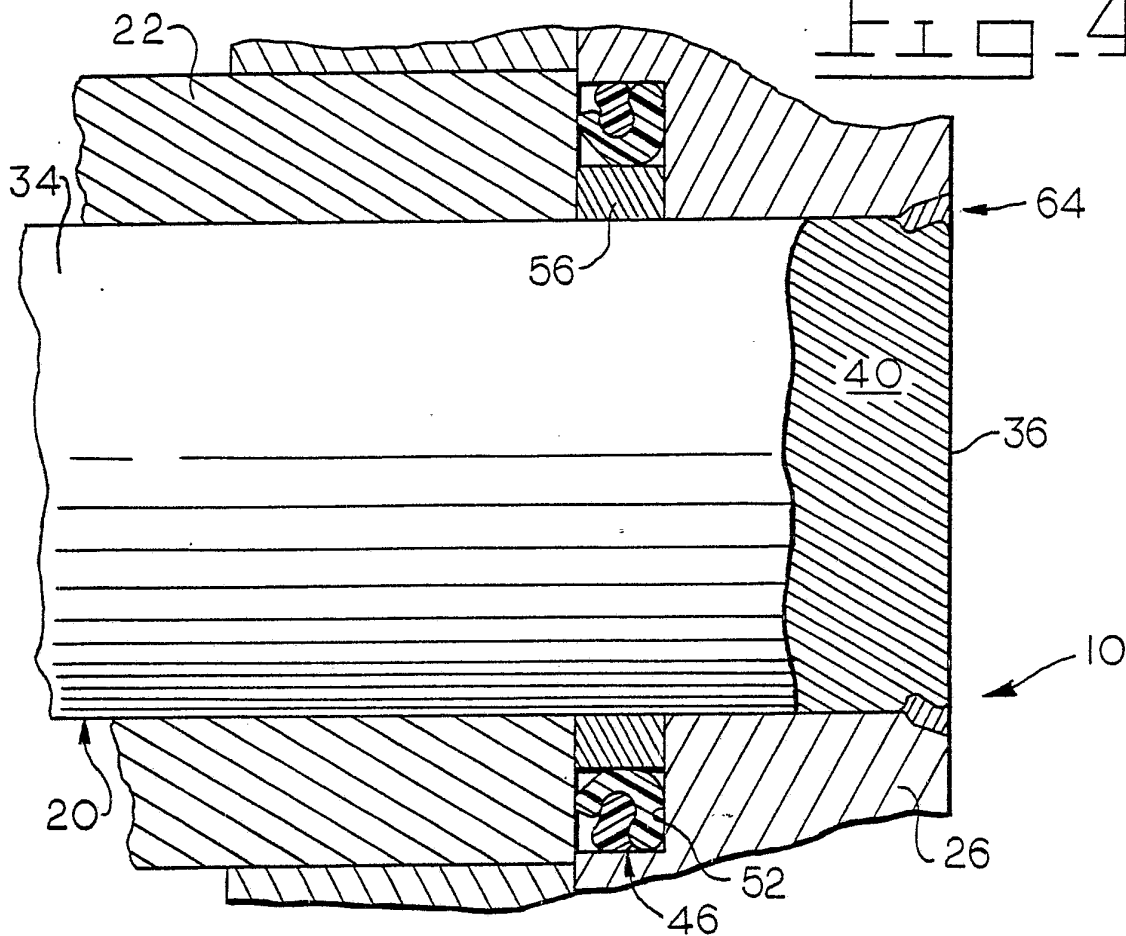
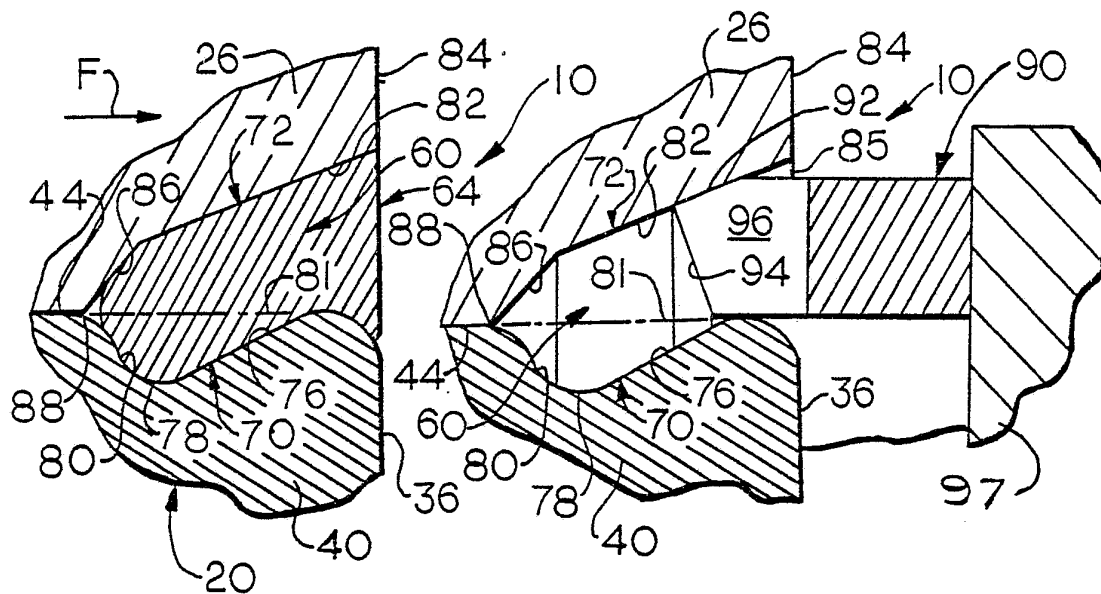


Fig. 5

Fig. 6



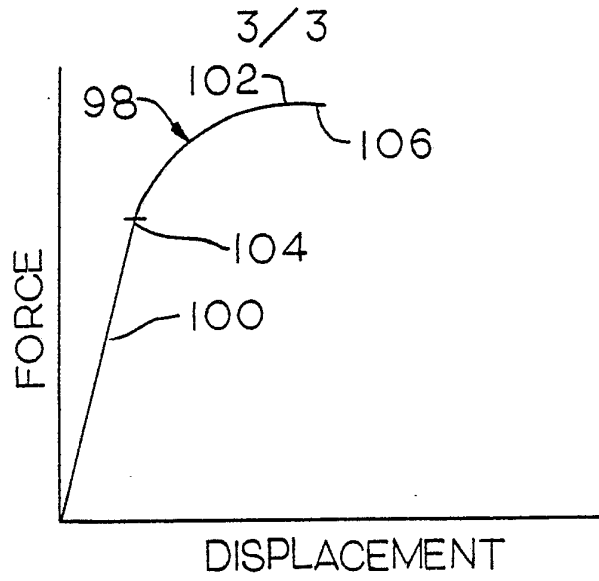


FIG. 7

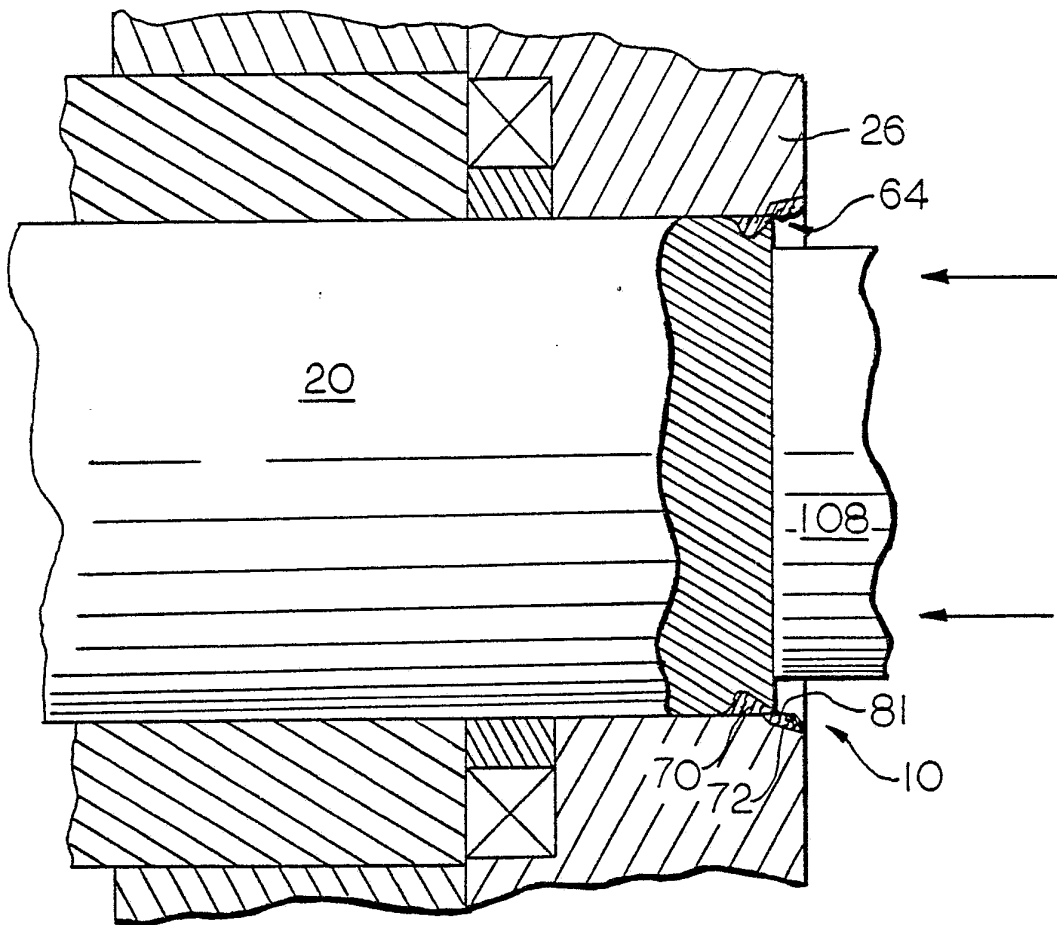
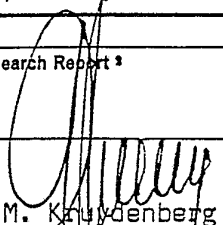


FIG. 8

INTERNATIONAL SEARCH REPORT

International Application No PCT/US 84/00058

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ³		
According to International Patent Classification (IPC) or to both National Classification and IPC		
IPC ³ : B 62 D 55/20		
II. FIELDS SEARCHED		
Minimum Documentation Searched ⁴		
Classification System	Classification Symbols	
IPC ³	B 62 D	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁵		
III. DOCUMENTS CONSIDERED TO BE RELEVANT ¹⁴		
Category ⁶	Citation of Document, ¹⁶ with indication, where appropriate, of the relevant passages ¹⁷	Relevant to Claim No. ¹⁸
X	US, A, 4182578 (LIVESAY et al.) 8 January 1980 see the whole document (cited in the application) --	1,2
X	FR, A, 1167081 (CATERPILLAR) 20 November 1958 see the whole document --	1,2,13,14, 15
X	EP, A, 0008959 (GRANDA) 19 March 1980 see claims 1(e),4,5,10 --	1,8,9,13,14
A	WO, A, 8100545 (ROUSSIN) 5 March 1981 --	1
A	GB, A, 1079769 (K.H.D.) 16 August 1967 --	1
A	FR, A, 1063621 (CATERPILLAR) 5 May 1954 --	1
A	US, A, 4084423 (SCHLECHT) 18 April 1978 -----	
<p>⁶ Special categories of cited documents: ¹⁵</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"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</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention 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.</p> <p>"&" document member of the same patent family</p>		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search ³	Date of Mailing of this International Search Report ³	
9th May 1984	13 JUN 1984	
International Searching Authority ¹	Signature of Authorized Officer ²⁰	
EUROPEAN PATENT OFFICE	 G.L.M. Kruidenberg	

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON

INTERNATIONAL APPLICATION NO. PCT/US 84/00058 (SA 6533)

This Annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 07/06/84

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GB-A- 1079769		None	
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