

PATENT SPECIFICATION

(11)

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- (21) Application No. 18900/74 (22) Filed 30 April 1974
 (31) Convention Application No. 355 476 (32) Filed 30 April 1973 in
 (33) United States of America (US)
 (44) Complete Specification published 8 Dec. 1976.
 (51) INT. CL.² F16C 11/06 27/06
 (52) Index at acceptance
 E2F 1T1 3D1 3E 3F
 F2A 6E2 7F D16
 F2B 13C2B 13C2E1C 13C2F1



(54) IMPROVEMENTS RELATING TO BALL AND SOCKET JOINTS

(71) We, CATERPILLAR TRACTOR CO., a corporation organised and existing under the laws of the State of California, United States of America, of 100 N.E. Adams Street, Peoria, State of Illinois 61602, United States of America, do hereby declare the invention, for which we pray that a Patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to ball and socket joints, and more particularly, to a ball and socket joint which allows full 360° relative rotation about an axis, and a degree of relative angular motion transverse to the axis. Positive sealing of ball and socket joints subjected to both rotation and transverse angular motion has long been a problem. For the most part, industry uses face or lip type seals which engage the outer periphery of the ball or socket surface and which run over a sealing zone alternately exposed to the internal chamber and the exterior surface open to the atmosphere. (See, for example, U.S. Patent No. 3,506,315). With rotation and transverse oscillation of the joints, such seals do not traverse over a relatively narrow band, but must follow an orbital path, at times attempting to seal on spherical surfaces that have been covered with abrasive contaminants. Often the exterior surface of such a joint deteriorates with age and service, and sustained positive sealing on such surfaces is presently extremely difficult to attain.

Another problem with such joints is that many have included a large number of parts which must be installed sequentially at the installation site, thus presenting the problem of contaminants being allowed into the sensitive bearing surfaces during such assembly. (See, for example, U.S. Patent No. 3,620,578).

45 Another requirement that must be met

for spherical bearings in certain applications is the ability to rotate unlimitedly about an axis (360° rotative sealing).

Of more general interest in this area are U.S. Patent Nos. 2,306,613, 3,680,924 and 50 3,666,332.

According to the invention, there is provided a joint comprising a shaft, retainer means disposed about the shaft and defining a continuous annular retainer surface, 55 means for maintaining the position of said retainer surface relative to said shaft along the longitudinal axis thereof, means for preventing rotation of the shaft relative to the retainer means about the longitudinal axis or the shaft, ball means fixed relative to the shaft and defining an outwardly convex surface portion shaped as a substantially spherical convex zone, socket means comprising a socket body defining a concave 65 surface portion substantially complementary to and adjacent said convex surface portion of the ball means, annular seal means disposed between the socket body and the retainer surface and in continuous annular 70 contact with the socket body and retainer surface, said seal means being in continuous annular sliding relation with at least one of the retainer surface and socket body so as to permit pivoting of the socket body with respect to the ball means about the longitudinal axis of the shaft, and means for preventing sliding displacement of the seal means relative to the retainer surface and socket body upon pivoting of the socket 80 body with respect to the ball means about axes perpendicular to said longitudinal axis, said seal means being capable of resilient deformation so as to permit such pivoting about axes perpendicular to said longitudinal axis. 85

Some embodiments of the invention will now be described by way of example and with reference to the accompanying drawings, in which:

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Fig. 1 is a sectional elevation of a first joint according to the invention;

Fig. 2 is a sectional elevation of part of a second joint according to the invention;

Fig. 3 is a sectional elevation of part of a third joint according to the invention;

Fig. 4 is a sectional view of a fourth joint according to the invention; and

Fig. 5 is a sectional view of part of a fifth joint according to the invention.

Shown generally in Fig. 1 is a first embodiment of joint 10. Such joint 10 includes a cylindrical shaft 12 having oppositely extending ends. The ends of the shaft 12 are shown mounted in bores 14, 16 defined by walls 18, 20 disposed on either side of the joint 10. The walls 18, 20 are split along and the parts of the walls are held together respective diameters of the bores 14, 16 by bolts 22. Disposed about the shaft 12 are retainer means 24, made up of a first retainer portion 26 and a second retainer portion 28. First retainer portion 26 includes a tubular portion 30 disposed about the shaft 12, and a radially outwardly extending portion 32 which defines a continuous annular retainer surface 34. The inner bore 36 of the tubular portion 30 is a slight interference fit with the shaft 12, so as to fit reasonably tightly thereon.

The second retainer portion 28 defines a radially outwardly extending portion 38 which also defines a continuous annular retainer surface 40. The retainer surfaces 34, 40 face toward each other, and are in spaced relation to each other, and are maintained in such spacing by the fact that the inner bore 42 of the second retainer portion 28 is a slight interference fit with the outer surface 43 of the tubular portion 30. The retainer surfaces 34, 40 and tubular portion 30 together define a continuous annular channel 44 about the shaft 12. Because of the interference fits between shaft 12 and tubular portion 30, and between tubular portion 30 and second retainer portion 28, the retainer means 24 are prevented from rotation relative to the shaft 12.

In this embodiment, retainer surfaces 34, 40 are substantially perpendicular to the longitudinal axis of the shaft 12.

Ball means 46 are fixed about and held relative to the tubular portion 30 by means of shoulders 48, 50 defined by the tubular portion 30 and retainer portion 28, and between which such ball means 46 are held. Such ball means define a convex surface portion 52 in the shape of a substantially spherical zone.

Socket means 54 comprising a socket body 56 are disposed about the ball means 46, and define a concave surface portion 58 substantially complementary to and adjacent the surface portion 52 of the ball means 46.

Annular seal means 60, 62 are disposed between the socket body 56 and the retainer surface 34, and between the socket body 56 and retainer surface 40, respectively. Annular seal means 60 are made up of a first annular resilient member 64 which is in continuous annular contact with the retainer surface 34 and bonded thereto, thus preventing sliding of the seal means 60 relative to the retainer surface 34, an annular seal carrier 66 having a surface 68 substantially perpendicular to the longitudinal axis of the shaft 12 and in continuous annular contact with the annular resilient member 64 and bonded thereto, and a second annular resilient member 70 carried by the seal carrier 66 and in continuous annular contact with the seal carrier 66, and also in continuous annular sliding contact with the socket body 56.

Similarly, the annular seal means 62 are made up of a first annular resilient member 72 in continuous annular contact with the retainer surface 40 and bonded thereto, an annular seal carrier 74 having a surface 76 substantially perpendicular to the longitudinal axis of the shaft 12 and in continuous contact with the annular resilient member 72 and bonded thereto, and a second annular resilient member 78 carried by the seal carrier 74 and in continuous annular contact with the seal carrier 74, and also in continuous annular sliding contact with the socket body 56. Thus, the socket body 56, when rotated or pivoted about the longitudinal axis of the shaft 12, rotates relative to the annular resilient members 64, 70, 72, 78 and the seal carriers 66, 74.

The seal carriers 66, 74 define annular ribs 80, 82 respectively, which are disposed toward each other. The ribs 80, 82 are positioned in annular stepped portions 84, 86 defined by the socket body 56 for sliding and guiding contact therewith as the socket body 56 rotates about the longitudinal axis of the shaft 12 relative to the seal carriers 66, 74.

The ribs 80, 82 and stepped portions 84, 86 position the seal carriers 66, 74 (and hence the resilient members 70, 78). Thus, the resilient members 70, 78 are kept in intimate contact with the socket body 56 in a continuous, circular manner, despite transverse rotation or oscillation of the socket body 56 about any axis perpendicular to the longitudinal axis of the shaft 12, even with simultaneous rotation of the socket body 56 more or less about the longitudinal axis of the shaft 12. In other words, engagement of the ribs 80, 82 with stepped portions 84, 86, prevents sliding displacement of the seal means 60, 62, relative to the socket body 56 upon pivoting of the socket body with respect to the ball means about axes perpendicular to said longitudinal-

inal axis.

The parts described are sized and positioned so that the annular resilient members 64, 72 are each in a compressed state, in fact, sufficiently compressed to allow 20° of movement of the socket body 56 from a centered state (i.e. from a state in which the socket body 56 is positioned only by the compressive forces of the annular resilient members 64, 72) about any axis perpendicular to the longitudinal axis of the shaft 12 without completely releasing compressive force on either of the annular resilient members 64, 72 (i.e., without placing either annular resilient member 64, 72 in tension) at any point.

The joint 10 may be pre-assembled in the following manner. The annular seal means 60 are positioned about tubular portion 30, with the surfaces being bonded as described above. The socket body 56 made up of split halves as shown, is assembled on the ball means 46 as shown, and the halves are fixed together. The ball means 46 and socket body 56 are then urged leftwardly until the rib 80 engages the stepped portion 84, and the annular resilient member 64 is compressed until the ball means 46 abut the shoulder 48. The similar seal means 62 are then moved leftward about the tubular portion 30, and second retainer portion 28 is pressed leftward on the tubular portion 30 until shoulder 50 is in contact with ball means 46 (the proper surfaces being bonded together, of course, as described above), which compresses annular member 72 to the extent necessary. This entire assembly may be pressed onto shaft 12, and the socket body 56 may be pressed into the bore 88 of a central arm 90. The joint may then be fitted to the walls 18 and 20.

The first retainer portion 26 defines passage means 92 for allowing introduction of lubricating fluid therethrough to the surfaces 52, 58.

A dry form of sealed cartridge joint 100 is shown in Fig. 2. In this embodiment, the ball means 102 are a press fit on the shaft 104, as are the two retainer portions (one shown at 106). The retainer surfaces (one shown at 108) are substantially spherical zones whose centres are at the centre of the ball means 102. Also, the surfaces 110 of the seal carriers (one shown at 112) are substantially spherical zones with centres at the centre of the ball means 102. The annular resilient member 114 defines surfaces 116, 118, which are also substantially spherical zones centred at the centre of the ball means 102, and which are bonded to the surfaces 108 and 110 respectively. (A similar annular resilient member is shaped likewise and associated similarly with the seal carrier and retainer surface on the other side of the ball means 102.)

The annular resilient members (one shown at 114) are in a compressed state, as previously described. Since the surfaces 108, 110, 116 and 118 are substantially spherical zones centred at the centre of the ball means 102, the compressive force on each annular resilient member between the bonded surfaces thereof is not increased upon pivoting of the socket body about any axis of rotation perpendicular to the longitudinal axis of the shaft 104.

In this embodiment, the shaft 104 acts to interconnect the two retainer portions, the retainer portions being press-fitted over the shaft 104 to prevent rotation of the shaft 104 relative to the retainer portions about the longitudinal axis of the shaft 104.

The joint requires no lubrication because in this embodiment a resin-impregnated fibrous bearing liner 120 is fixed to the substantially concave surface portion 122 in facing relation to the substantially convex surface portion 124 of the ball means 102, and between the surfaces 122 and 124. These moulded bearing liners include various cloth and/or filament arrangements disposed therein so that no lubrication is required because of the liners' self-lubricating properties.

In this embodiment, the socket means are of a reinforced plastics material. The resilient members (one shown at 123) carried by the seal carriers are actually in sliding engagement with a metal washer 125 which makes up part of the socket means. The socket means define stepped portions (one shown at 127) as described in the previous embodiment. The bearing liner 120 extends as shown to provide lubrication in these areas in relation to the ribs which are disposed therein.

In the Fig. 3 embodiment, the shaft 130 includes ball means 132 formed as an integral part thereof. The shaft 130 further defines a central longitudinal passage 134 and a plurality of centrally disposed radial passages 136 for allowing introduction of lubricating fluid therethrough to the ball and socket surfaces. A plug 138 is removably secured in the end of the passage 134 for the purpose of adding lubricant within the joint.

Under some conditions, it is difficult to field service a joint, and more particularly, difficult to remove a shaft thereof which is pressed into apertures in the retainer means. The construction of Fig. 4 solves this problem by providing a flanged shaft 140 which is removably secured to a wall 142 by a plurality of retaining bolts 144. An external cylindrical surface 146 of the shaft 140 is disposed as a freely slidable fit in a bore 148 in the wall 142. The retainer means are in slightly tight press-fit relation with the central portion of the flanged shaft 140. An end cap 152 embraces the extremity of the

shaft 140 and is held in contact with the retainer means 150 of the joint by a plurality of bolts 154 threadedly engaged in the shaft 140. Such a construction allows relative motion to occur between the adjacent bearing surfaces of the ball and socket. The diametrical clearances at adjacent cylindrical surfaces 156 and 158 are relatively loose to allow more convenient and easy field servicing of the joints. It is to be noted that the joint of this embodiment can be easily installed in the field without the danger of contamination by dirt.

In the embodiment of Fig. 5, another easily removable shaft 160 is provided with the joint. The shaft 160 is a freely slidable fit within the bores 162, 164 defined by walls 166, 168. The shaft 160 defines splines 170 in engagement with splines 172 defined by the inner surface of the tubular portion 174, so that the shaft 160 is a freely slidable fit within the tubular portion 174, but is prevented from rotation relative thereto by the engagement of splines 170, 172. The shaft 160 is suitably removably secured to the wall 166 by a lock arrangement generally shown at 176. The retainer means 178 in this embodiment are assembled by welding a retainer portion 180 to tubular portion 174 after the ball means 184, socket body 186, and annular seal means 188, 190 have been positioned about the tubular portion 174. Retainer portion 182 may be integrally formed with the tubular portion 174.

Thus it may be seen that the invention provides a simple, efficient and easily-assembled joint in which positive sealing is provided while allowing 360° relative rotation about an axis and a degree of rotation transverse to the axis and which may be assembled to an extent in a controlled environment, thus reducing the risk of contaminants getting into the sensitive bearing surfaces.

WHAT WE CLAIM IS:—

1. A joint comprising a shaft, retainer means disposed about the shaft and defining a continuous annular retainer surface, means for maintaining the position of said retainer surface relative to said shaft along the longitudinal axis thereof, means for preventing rotation of the shaft relative to the retainer means about the longitudinal axis of the shaft, ball means fixed relative to the shaft and defining an outwardly convex surface portion shaped as a substantially spherical convex zone, socket means comprising a socket body defining a concave surface portion substantially complementary to and adjacent said convex surface portion of the ball means, annular seal means disposed between the socket body and the retainer surface and in continuous annular contact with the socket body and retainer surface, said seal means being in continuous annular

sliding relation with at least one of the retainer surface and socket body so as to permit pivoting of the socket body with respect to the ball means about the longitudinal axis of the shaft, and means for preventing sliding displacement of the seal means relative to the retainer surface and socket body upon pivoting of the socket body with respect to the ball means about axes perpendicular to said longitudinal axis, said seal means being capable of resilient deformation to permit such pivoting about axes perpendicular to said longitudinal axis.

2. A joint as claimed in claim 1 wherein and retainer means further defines a second continuous annular retainer surface facing toward the first retainer surface and in spaced relation thereto and includes means interconnecting the retainer surfaces to maintain the retainer surfaces in spaced relation and to define therewith a continuous annular channel about the shaft, the joint further comprising a second annular seal means, the first and second annular seal means being disposed between and in continuous annular contact with the socket body and the first or second retainer surface respectively.

3. A joint as claimed in claim 1 or 2 wherein the or each annular seal means comprise a first annular resilient member in continuous annular contact with the respective retainer surface, an annular seal carrier in continuous annular contact with the first annular resilient member, and a second annular resilient member carried by the annular seal carrier and in continuous annular contact with the annular seal carrier.

4. A joint as claimed in claim 3 wherein the or each second annular resilient member is in continuous annular sliding contact with the socket body.

5. A joint as claimed in claim 4 wherein the or each first annular resilient member is bonded to the respective retainer surface, and the or each annular seal carrier is bonded to the respective first annular resilient member, so that the socket body, when rotated about the longitudinal axis of the shaft, rotates relative to the or each first and second annular resilient members and seal carrier.

6. A joint as claimed in claim 3, 4 or 5 wherein the or each annular seal carrier defines an annular rib disposed toward the socket body and positioned in an annular stepped portion defined by the socket body for sliding and guiding contact therewith as the socket body rotates relative to the annular seal carrier.

7. A joint as claimed in any of claims 3 to 6 wherein the or each first annular resilient member is in a compressed state between the respective retainer surface and seal carrier.

shaft 140 and is held in contact with the retainer means 150 of the joint by a plurality of bolts 154 threadedly engaged in the shaft 140. Such a construction allows relative motion to occur between the adjacent bearing surfaces of the ball and socket. The diametrical clearances at adjacent cylindrical surfaces 156 and 158 are relatively loose to allow more convenient and easy field servicing of the joints. It is to be noted that the joint of this embodiment can be easily installed in the field without the danger of contamination by dirt.

In the embodiment of Fig. 5, another easily removable shaft 160 is provided with the joint. The shaft 160 is a freely slidable fit within the bores 162, 164 defined by walls 166, 168. The shaft 160 defines splines 170 in engagement with splines 172 defined by the inner surface of the tubular portion 174, so that the shaft 160 is a freely slidable fit within the tubular portion 174, but is prevented from rotation relative thereto by the engagement of splines 170, 172. The shaft 160 is suitably removably secured to the wall 166 by a lock arrangement generally shown at 176. The retainer means 178 in this embodiment are assembled by welding a retainer portion 180 to tubular portion 174 after the ball means 184, socket body 186, and annular seal means 188, 190 have been positioned about the tubular portion 174. Retainer portion 182 may be integrally formed with the tubular portion 174.

Thus it may be seen that the invention provides a simple, efficient and easily-assembled joint in which positive sealing is provided while allowing 360° relative rotation about an axis and a degree of rotation transverse to the axis and which may be assembled to an extent in a controlled environment, thus reducing the risk of contaminants getting into the sensitive bearing surfaces.

WHAT WE CLAIM IS:—

1. A joint comprising a shaft, retainer means disposed about the shaft and defining a continuous annular retainer surface, means for maintaining the position of said retainer surface relative to said shaft along the longitudinal axis thereof, means for preventing rotation of the shaft relative to the retainer means about the longitudinal axis of the shaft, ball means fixed relative to the shaft and defining an outwardly convex surface portion shaped as a substantially spherical convex zone, socket means comprising a socket body defining a concave surface portion substantially complementary to and adjacent said convex surface portion of the ball means, annular seal means disposed between the socket body and the retainer surface and in continuous annular contact with the socket body and retainer surface, said seal means being in continuous annular

sliding relation with at least one of the retainer surface and socket body so as to permit pivoting of the socket body with respect to the ball means about the longitudinal axis of the shaft, and means for preventing sliding displacement of the seal means relative to the retainer surface and socket body upon pivoting of the socket body with respect to the ball means about axes perpendicular to said longitudinal axis. said seal means being capable of resilient deformation to permit such pivoting about axes perpendicular to said longitudinal axis.

2. A joint as claimed in claim 1 wherein and retainer means further defines a second continuous annular retainer surface facing toward the first retainer surface and in spaced relation thereto and includes means interconnecting the retainer surfaces to maintain the retainer surfaces in spaced relation and to define therewith a continuous annular channel about the shaft, the joint further comprising a second annular seal means, the first and second annular seal means being disposed between and in continuous annular contact with the socket body and the first or second retainer surface respectively.

3. A joint as claimed in claim 1 or 2 wherein the or each annular seal means comprise a first annular resilient member in continuous annular contact with the respective retainer surface, an annular seal carrier in continuous annular contact with the first annular resilient member, and a second annular resilient member carried by the annular seal carrier and in continuous annular contact with the annular seal carrier.

4. A joint as claimed in claim 3 wherein the or each second annular resilient member is in continuous annular sliding contact with the socket body.

5. A joint as claimed in claim 4 wherein the or each first annular resilient member is bonded to the respective retainer surface, and the or each annular seal carrier is bonded to the respective first annular resilient member, so that the socket body, when rotated about the longitudinal axis of the shaft, rotates relative to the or each first and second annular resilient members and seal carrier.

6. A joint as claimed in claim 3, 4 or 5 wherein the or each annular seal carrier defines an annular rib disposed toward the socket body and positioned in an annular stepped portion defined by the socket body for sliding and guiding contact therewith as the socket body rotates relative to the annular seal carrier.

7. A joint as claimed in any of claims 3 to 6 wherein the or each first annular resilient member is in a compressed state between the respective retainer surface and seal carrier.



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8. A joint as claimed in claim 7 wherein the or each first annular resilient member is sufficiently compressed to allow 20° of movement in either direction from a centered state of the socket body about any axis of rotation substantially perpendicular to the longitudinal axis of the shaft without completely releasing compressive force on the first annular resilient member at any point.

9. A joint as claimed in claim 2 and any of claims 3 to 8 wherein the first and second retainer surfaces are substantially perpendicular to the longitudinal axis of the shaft, against which surfaces the respective first annular resilient members are in continuous annular contact, and the respective seal carriers define surfaces substantially perpendicular to the longitudinal axis of the shaft and against which the respective first annular resilient members are in continuous annular contact.

10. A joint as claimed in claim 2 and any of claims 3 to 8 wherein the first and second retainer surfaces are substantially spherical zones having their centres at the centre of the ball means, against which retainer surfaces the respective first annular resilient members are in continuous contact and the seal carriers also define surfaces which are substantially spherical zones having their centres at the centre of the ball means, and against which the respective first annular resilient members are in continuous annular contact.

11. A joint as claimed in claim 9 or 10 wherein the means interconnecting the retainer surfaces comprise the shaft, the retainer means being fixed relative to the shaft to prevent rotation of the shaft relative to the retainer means about the longitudinal axis of the shaft.

12. A joint as claimed in claim 9 or 10 wherein the means interconnecting the retainer surfaces comprise tubular means dis-

posed about the shaft, the first and second retainer surfaces being fixed relative thereto.

13. A joint as claimed in claim 12 and further comprising first and second walls on either side of the retainer means and defining first and second bores in which said shaft is a freely slidable fit, and means for releasably securing the shaft relative to one of the walls.

14. A joint as claimed in claim 12 or 13 wherein the shaft is a freely slidable fit within the tubular means longitudinally thereof.

15. A joint as claimed in claim 12, 13 or 14 wherein the means for preventing rotation of the shaft relative to the retainer means comprise spline means defined by the shaft and in engagement with spline means defined by the inner surface of the tubular means.

16. A joint as claimed in any preceding claim wherein the shaft and ball means define passage means for allowing introduction of lubricating fluid therethrough to the ball and socket surfaces.

17. A joint as claimed in any preceding claim wherein the retainer means define passage means for allowing introduction of lubricating fluid therethrough to the ball and socket surfaces.

18. A joint as claimed in any of claims 1 to 15 further comprising a liner fixed to the concave surface portion defined by the socket body, and disposed between said concave surface portion and the convex surface portion of the ball means.

19. A joint substantially as hereinbefore described with reference to any figure of the accompanying drawings.

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