PATENT SPECIFICATION (11) 1 492 455

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(21) Application No. 11750/75 (22) Filed 20 March 1975

(31) Convention Application No. 462 379 (32) Filed 19 April 1974 in

(33) United States of America (US)

(44) Complete Specification published 23 Nov. 1977

(51) INT. CL.² F16D 3/41

(52) Index at acceptance F2U 524 526 571

(19)

(54) UNIVERSAL JOINT AND METHOD FOR MAKING THE SAME

(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 concerns a universal joint and a method of making such a joint.

A conventional universal joint normally comprises a pair of one piece yokes having a cylindrical bearing journal press-fitted or otherwise suitably secured into each arm thereof. The assembly of such a construction requires special tooling and is made difficult since the journal cross must be prepositioned prior to installation of the bearing journals. Such problem has been somewhat alleviated by the advent of universal joints utilizing an end cap for releasably attaching each such bearing journal to a support arm of a yoke assembly. However, the pre-machined yoke assemblies and end caps are normally mismatched and do not draw tightly together, giving rise to torque transmission problems.

An object of this invention is to overcome the above, briefly described problems by providing an efficient, non-complex and economical universal joint and an expeditious method of making the same.

According to the invention, there is provided a universal joint adapted to connect an input shaft to an output shaft said joint comprising: first and second yoke assemblies each having a pair of spaced support arms, a journal cross, having four cylindrical journals extending radially outwardly therefrom, universally interconnecting said first and second yoke assemblies together, and mounting means rotatably mounting each one of said journals on a respective one of said support arms comprising fastening means releasably attaching an end cap on a free end of said support arm so that a bearing surface on the end cap abuts a bearing surface on the support arm in co-planar relationship therewith, a substantially uninterrupted cylindrical bore of uniform diameter formed completely through and between said end cap and said support arm and a cylindrical bearing race closely fitted within said bore and rotatably mounting said journal therein.

There is also provided a method of making a universal joint comprising the steps of attaching an end cap to each support arm of a pair of yoke assemblies, so that a bearing surface on the end cap abuts a bearing surface on the support arm in co-planar relationship therewith, machinging a cylindrical bore of uniform diameter formed completely through and between each said end cap and support arm so that said bore intersects said bearing surfaces, closely fitting a cylindrical bearing race within each bore and universally connecting said yoke assemblies together by rotatably mounting a journal of a journal cross in a respective bearing race.

In the accompanying drawings:

Fig. 1 is a partially sectioned, side elevational view of a universal joint embodying this invention;

Fig. 2 is a reduced and partial view of the universal joint having arrows superimposed thereon to depict torque transmission forces occurring during operation thereof; and

Fig. 3 is a view similar to Fig. 2, but illustrating a prior art universal joint construction and torque transmission forces occurring during operation thereof.

Fig. 1 illustrates a universal joint 10 con-

necting an input shaft 11 to an output shaft 12. The universal joint comprises a pair of substantially identical yoke assemblies 13, each having a pair of spaced support arms 14 and 15 universally interconnected by a journal cross 16. The journal cross has four cylindrical journals 17 extending radially outwardly therefrom with each pair of circumferentially adjacent journals being disposed in perendicular relationship relative to each other.

Mounting means for rotatably mounting each journal 17 on a respective support arm 14 and 15 comprises an end cap 18 releasably attached on the support arm by a pair of cap screws 19. The end cap abuts the support arm at substantially flat bearing surfaces 20 disposed on either side of journal 17. A substantially uninterrupted cylindrical bore 21, intersecting abutting bearing surfaces 20, is defined between the end cap and support arm to retain a closely fitted cylindrical bearing race 22 therein.

The closed end of the cup-shaped bearing race is engaged by a snap ring 23 whereas the opposite, open end thereof is engaged by a ring seal 24 for lubricant sealing purposes. Journal 17 is mounted for limited rotation in the bearing race by a plurality of circumferentially disposed needle bearings 25.

During the manufacture of the universal joint, flat bearing surfaces are preferably pre-machined on precast end caps 18 which are then each attached to a respective yoke assembly 13 by cap screws 19. Bores 21 are then suitably machined to intersect such bearing surfaces and to substantially conform to the outside diameter of cylindrical bearing race 22. If so desired, elongated reliefs 26 and 27 may be formed at the inner ends of bearing surfaces 20 to allow for a slight mismatch or centerline shift between the yoke and the cap to thereby facilitate the machining of a substantially perfect bore 21. Upon completion of such machining, the end caps are removed and the structures are reassembled to their Fig. 1 operational condition.

Referring to Fig. 2, the closely matched fit between the outer surface of bearing race 22 and the cylindrical surface defining bore 21, as well as the substantial bearing surface contact 20 between the end cap and the support arm, will function to uniformly and efficiently transmit torque therebetween, as depicted by force arrows *F*. In contrast thereto, Fig. 3 illustrates a prior art universal joint wherein corresponding force arrows F′ are shown in a non-uniform dispersion.

The illustrated mismatch in Fig. 3, between an end cap 18′ and a yoke assembly 13′, will tend to cause a journal of a journal cross 16′ to "roll-out" of contact with respect to an interrupted bore 21′ of yoke assembly 13′ to thus apply a twisting force on cap screws 19′. Thus, the magnitude of the torque transferred in the Fig. 3 universal joint is substantially less than that transferred by the universal joint of this invention.

WHAT WE CLAIM IS: —

1. A universal joint adapted to connect an input shaft to an output shaft said joint comprising:

first and second yoke assemblies each having a pair of spaced support arms,

a journal cross, having four cylindrical journals extending radially outwardly therefrom, universally interconnecting said first and second yoke assemblies together, and

mounting means rotatably mounting each one of said journals on a respective one of said support arms comprising fastening means releasably attaching an end cap on a free end of said support arm so that a bearing surface on the end cap abuts a bearing surface on the support arm in coplanar relationship therewith, a substantially uninterrupted cylindrical bore of uniform diameter formed completely through and between said end cap and said support arm and a cylindrical bearing race closely fitted within said bore and rotatably mounting said journal therein.

2. A universal joint as claimed in claim 1 wherein bearing means rotatably mount each said journal in a respective bearing race.

3. A universal joint as claimed in claim 2 wherein said bearing means comprises a plurality of needle bearings circumferentially disposed radially between said journal and said bearing race.

4. A universal joint as claimed in any preceding claim wherein said bearing race is cup-shaped to dispose a closed outer end thereof on a free end of a respective journal and an open inner end thereof adjacent to the other one of said first and second yoke assemblies.

5. A universal joint as claimed in claim 4 further comprising retaining means operatively engaged between the outer end of said bearing race and a respective support arm for preventing said bearing race from moving radially outwardly relative to a respective journal.

6. A universal joint as claimed in claim 5 wherein said retaining means comprises a snap ring.

7. A universal joint as claimed in claim 5 or 6 further comprising an annular sealing means disposed between the inner end

necting an input shaft 11 to an output shaft 12. The universal joint comprises a pair of substantially identical yoke assemblies 13, each having a pair of spaced support arms 14 and 15 universally interconnected by a journal cross 16. The journal cross has four cylindrical journals 17 extending radially outwardly therefrom with each pair of circumferentially adjacent journals being disposed in perendicular relationship relative to each other.

Mounting means for rotatably mounting each journal 17 on a respective support arm 14 and 15 comprises an end cap 18 releasably attached on the support arm by a pair of cap screws 19. The end cap abuts the support arm at substantially flat bearing surfaces 20 disposed on either side of journal 17. A substantially uninterrupted cylindrical bore 21, intersecting abutting bearing surfaces 20, is defined between the end cap and support arm to retain a closely fitted cylindrical bearing race 22 therein.

The closed end of the cup-shaped bearing race is engaged by a snap ring 23 whereas the opposite, open end thereof is engaged by a ring seal 24 for lubricant sealing purposes. Journal 17 is mounted for limited rotation in the bearing race by a plurality of circumferentially disposed needle bearings 25.

During the manufacture of the universal joint, flat bearing surfaces are preferably pre-machined on precast end caps 18 which are then each attached to a respective yoke assembly 13 by cap screws 19. Bores 21 are then suitably machined to intersect such bearing surfaces and to substantially conform to the outside diameter of cylindrical bearing race 22. If so desired, elongated reliefs 26 and 27 may be formed at the inner ends of bearing surfaces 20 to allow for a slight mismatch or centerline shift between the yoke and the cap to thereby facilitate the machining of a substantially perfect bore 21. Upon completion of such machining, the end caps are removed and the structures are reassembled to their Fig. 1 operational condition.

Referring to Fig. 2, the closely matched fit between the outer surface of bearing race 22 and the cylindrical surface defining bore 21, as well as the substantial bearing surface contact 20 between the end cap and the support arm, will function to uniformly and efficiently transmit torque therebetween, as depicted by force arrows *F*. In contrast thereto, Fig. 3 illustrates a prior art universal joint wherein corresponding force arrows F′ are shown in a non-uniform dispersion.

The illustrated mismatch in Fig. 3, between an end cap 18′ and a yoke assembly 13′, will tend to cause a journal of a journal cross 16′ to "roll-out" of contact with respect to an interrupted bore 21′ of yoke assembly 13′ to thus apply a twisting force on cap screws 19′. Thus, the magnitude of the torque transferred in the Fig. 3 universal joint is substantially less than that transferred by the universal joint of this invention.

WHAT WE CLAIM IS:—

1. A universal joint adapted to connect an input shaft to an output shaft said joint comprising:

first and second yoke assemblies each having a pair of spaced support arms,

a journal cross, having four cylindrical journals extending radially outwardly therefrom, universally interconnecting said first and second yoke assemblies together, and

mounting means rotatably mounting each one of said journals on a respective one of said support arms comprising fastening means releasably attaching an end cap on a free end of said support arm so that a bearing surface on the end cap abuts a bearing surface on the support arm in coplanar relationship therewith, a substantially uninterrupted cylindrical bore of uniform diameter formed completely through and between said end cap and said support arm and a cylindrical bearing race closely fitted within said bore and rotatably mounting said journal therein.

2. A universal joint as claimed in claim 1 wherein bearing means rotatably mount each said journal in a respective bearing race.

3. A universal joint as claimed in claim 2 wherein said bearing means comprises a plurality of needle bearings circumferentially disposed radially between said journal and said bearing race.

4. A universal joint as claimed in any preceding claim wherein said bearing race is cup-shaped to dispose a closed outer end thereof on a free end of a respective journal and an open inner end thereof adjacent to the other one of said first and second yoke assemblies.

5. A universal joint as claimed in claim 4 further comprising retaining means operatively engaged between the outer end of said bearing race and a respective support arm for preventing said bearing race from moving radially outwardly relative to a respective journal.

6. A universal joint as claimed in claim 5 wherein said retaining means comprises a snap ring.

7. A universal joint as claimed in claim 5 or 6 further comprising an annular sealing means disposed between the inner end

of said bearnig race and a respective journal.

8. A universal joint substantially as described with reference to Figures 1 and 2 of the accompanying drawings.

9. A method of making a universal joint comprising the steps of attaching an end cap to each support arm of a pair of yoke assemblies, so that a bearing surface at the end cap abuts a bearing surface on the support arm in co-planar relationship therewith, machining a cylindrical bore of uniform diameter formed completely through and between each said end cap and support arm so that said bore intersects said bearing surfaces,

closely fitting a cylindrical bearing race within each bore and

universally connecting said yoke assemblies together by rotatably mounting a journal of a journal cross in a respective bearing race.

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Printed for Her Majesty's Stationery Office by The Tweeddale Press Ltd., Berwick-upon-Tweed, 1977.
Published at the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.