

PATENT SPECIFICATION

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(54) IMPROVEMENTS RELATING TO RING GEAR ASSEMBLIES

(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 ring gear assemblies, and methods for the repair thereof.

Large ring gears such as those used in final drives or in transmissions are usually supplied with peripheral external splines which are intended to engage similar splines provided on an internal peripheral surface of the housing within which the ring gear is mounted. Usually, retaining rings or tab means are provided on the housing to prevent axial movement of the ring gear. The torque reaction produced by planetating pinions orbiting within the ring gear is carried by the splines provided in the housing.

Ring gears are usually formed from high-strength alloy steel which has been hardened for wear resistance and strength. On the contrary, the housing or gear case is normally manufactured from a softer material such as cast steel. Consequently, the torque load application to the housing splines results, in time, in wear or deformation of the splines in the housing but not on the splines provided on the ring gear. Such wear or deformation can result in backlash, not only in the immediate connection but in the gear train transmitting power to the ring gear, and in some cases in a complete failure of the housing splines.

Inasmuch as final drives and transmission housings are extremely expensive, especially in large moving machinery and the like, methods of repair and salvage have been devised for rejuvenating a worn ring

gear-housing assembly. One method which has been used involves the building up of worn housing spline teeth by means of welding followed by remachining of such spline teeth on the ring gear and the housing to provide proper mating. This procedure involves considerable time and expense and requires large and specialized machine tools.

It is an object of this invention to provide a new ring gear assembly wherein the ring gear is retained within the housing by inexpensive, easily replaceable means.

Thus, viewed from one aspect the invention provides a ring gear assembly comprising; a ring gear having peripherally disposed teeth for engaging gear means of a drive mechanism, a housing for supporting said ring gear, said ring gear having a first peripheral surface contiguous with a corresponding second peripheral surface of said housing, said first and second peripheral surfaces forming an annular interface between said ring gear and said housing, said first peripheral surface having a first semi-circular recess therein, said second peripheral surface having a second semi-circular recess therein corresponding to and aligned with said first recess, said first and second recesses forming a circular aperture, a rigid connecting element having a circular portion in said aperture substantially to prevent rotation of said ring gear relative to said housing, and a keeper for limiting axial movement of said connecting element and said ring gear.

Viewed from another aspect, the invention provides a method whereby such a ring gear assembly may be repaired for further use when said connecting element means causes said second recess to wear such that said ring gear can rotate with respect to said housing, comprising the steps of:

a. removing said keeper from said assembly;

b. removing said connecting element from said aperture;

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c. rotating said ring gear with respect to said housing to angularly displace said first recess with respect to said housing;

5 d. providing a third semi-circular recess in said second peripheral surface angularly spaced from said second recess and contiguous with said first recess as angularly displaced whereby to form a fresh circular aperture;

10 e. placing said connecting element in the fresh aperture; and

f. attaching said keeper to a portion of said housing for engaging said connecting element and ring gear and limiting axial movement thereof.

15 Viewed from yet another aspect the invention provides a method for repairing a conventional splined interface ring gear assembly, comprising the steps of:

20 a. providing a first plurality of semi-circular recesses in said ring gear at the interface thereof with said housing;

25 b. providing a second plurality of semi-circular recesses in said housing contiguous with said first plurality at the interface between said ring gear and said housing to form a plurality of circular apertures; and

30 c. inserting a rigid pin member in each of the circular apertures substantially to prevent rotation of said ring gear relative to said housing, a keeper being provided to limit axial movement of said pin member and said ring gear.

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

40 Figure 1 is a partial elevation view of a ring gear equipped final drive housing embodying the present invention;

Figure 2 is an enlarged partial view of a portion of the ring gear-housing shown in Figure 1;

45 Figure 3 is a sectional view taken along the line III—III in Figure 2;

Figure 4 is an enlarged elevation similar to Figure 2 but showing an alternative embodiment of the present invention;

50 Figure 5 is a sectional view taken along the line V—V in Figure 4.

55 With reference to Figure 1 in the drawings, a ring gear-housing assembly or combination is shown generally at 10. Internally of the ring gear, is disposed a planetary drive mechanism 12. The ring gear element of the combination is shown at 14. It consists of an annular ring having gear teeth 15 formed on an internal peripheral portion thereof. With reference to Figure 2, it will be seen that the ring gear is also provided with a plurality of spline teeth 16 formed on the external peripheral surface thereof. The housing element of the combination, for instance a final drive housing, is shown at 18. The housing

portion includes an internally splined portion having spline teeth 20 adapted for torque load supporting engagement with the splines 16 of the ring gear.

The planetary drive mechanism 12 includes a plurality of pinion gears 24 which are carried upon equally angularly spaced means 26 and which are adapted for engagement with the teeth of the ring gear. The shafts 26 are fixed for rotation with a common carrier 31. A sun gear 28 is rotatably supported upon a tubular input drive shaft 30 in which is concentrically journaled an axle 32. The teeth of the sun gear 28 mesh with the teeth of each of the planetating gears 24.

Upon rotation of the sun gear 28, the planetary gears 24 orbit around the interior of the ring gear in meshing relation to the teeth 15 to drive the planet carrier 31 to cause rotation of an output shaft (not shown) connected thereto.

After a given period of use, the hardened spline teeth of the ring gear gradually wear down the relatively soft spline teeth 20 of the housing 18 and eventually cause backlash or failure such that either replacement of the housing or repair thereof is required. In accordance with the present invention the repair of the assembly may be readily accomplished.

The first repair step is to remove the ring gear 14 from the housing 18. Next, a plurality of semi-circular recesses 34 (see Figures 2 and 3) are ground into the outer peripheral splined surface of the ring gear. Subsequently, the ring gear is reinstalled within the housing. Next, complementary semi-circular recesses 35 are drilled into the housing 18 to form with the semi-circular recesses of the ring gear a plurality of circular apertures which span the peripheral interface between the ring gear and the housing. Hardened cylindrical drive pins 36 are then placed within the circular apertures 10 to form a driving load supporting connection between the ring gear and the housing and prevent rotation of the ring gear relative to the housing. Finally, in order to prevent axial movement of the pins or the ring gear, keeper plates 37 are installed in covering relation to the end portions of the pins. The keeper plates are secured to the housing by means of a pair of cap screws 38 and locking means 39, or the like.

Figures 4 and 5 of the drawings illustrate the present invention as it relates to an original article of manufacture. That is, instead of applying the present invention to the repair of a splined ring gear-housing assembly, the present invention can be used to provide original connection means in lieu of the previously utilized splined connections. As shown, a ring gear 40 is

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provided with a plurality of teeth 42 on the inner peripheral surface thereof and is provided with a substantially smooth external peripheral surface 44. Final drive casing or housing 46 is provided with a smooth inner peripheral surface 48 which mates with the surface 44, and also with a plurality of threaded holes 50. The hardened ring gear 40 is provided with a plurality of semi-circular recesses 52 which are machined therein and which are used as guides, after installation of the ring gear, for drilling complementary semi-circular recesses 54 in the housing 46. A cylindrical drive pin 56 is installed in each of the holes formed by the complementary recesses 52 and 54 to drivingly connect the ring gear to the housing 46 as described with reference to Figures 2 and 3. Keeper plates 58 are then secured to the housing 46 by means of pairs of bolts 60 to retain the pins 56 axially within the respective holes and to constrain axial movement of the ring gear relative to the housing.

Initial installation of the ring gear 40 within the housing 46 first involves the formation of the semi-circular recesses 52 within the outer peripheral surface of the ring gear 40. Next, the ring gear is installed within the inner surface 48 of the housing. The semi-circular recesses 54 in the housing are drilled using the recesses 52 as guides so as to provide circular apertures spanning the peripheral interface between the ring gear and the housing. The drive pins 56 are then installed within the circular apertures and the keeper plates 58 are affixed.

Even the improved ring gear-housing assembly of the present invention is subject to wear after prolonged use. The drive pins 56, continually bearing against the recesses 54, can wallow out such recesses such that a repair or salvage operation is required. With concurrent reference to Figures 4 and 5, it is apparent that such repair of the assembly may be readily accomplished by removing the pins 56 from between the ring gear and the housing, removing the ring gear from the housing, rotating the ring gear so that the semi-circular recesses 52 would be disposed in angularly spaced relation to the recesses 54 within the housing, drilling new semi-circular recesses 64 (shown in phantom), to complement the repositioned recesses in the ring gear so as to again form circular apertures, and reinstalling the drive pins and keeper plates 58, as previously described.

There is thus provided an improved and efficient ring gear-housing assembly which may be readily fabricated and repaired when necessary. The present invention eliminates the need for expensive spline machining and the expensive tooling and time consumption relates thereto.

WHAT WE CLAIM IS:—

1. A ring gear assembly comprising; a ring gear having peripherally disposed teeth for engaging gear means of a drive mechanism, a housing for supporting said ring gear, said ring gear having a first peripheral surface contiguous with a corresponding second peripheral surface of said housing, said first and second peripheral surfaces forming an annular interface between said ring gear and said housing, said first peripheral surface having a first semi-circular recess therein, said second peripheral surface having a second semi-circular recess therein corresponding to and aligned with said first recess, said first and second recesses forming a circular aperture, a rigid connecting element having a circular portion in said aperture substantially to prevent rotation of said ring gear relative to said housing, and a keeper for limiting axial movement of said connecting element and said ring gear.

2. A gear assembly as claimed in claim 1 wherein said keeper includes a plate member fastened to said housing and extending across said interface.

3. A gear assembly as claimed in claim 1 or 2 wherein said housing surrounds said ring gear and wherein said first peripheral surface is the radially outermost portion of said ring gear.

4. A gear assembly as claimed in claim 1, 2 or 3 wherein said first and second peripheral surfaces each have spline means for interaction to prevent relative rotation between said ring gear and said housing.

5. A gear assembly as claimed in any of claims 1 to 4, wherein said connecting element comprises a hardened pin.

6. A gear assembly as claimed in any preceding claim, including a plurality of said first and second recesses spaced about the circumference of said first and second peripheral surfaces.

7. A gear assembly substantially as described, with reference to Figures 1 to 3, or 4 and 5 of the accompanying drawings.

8. In a ring gear assembly having an annular ring gear and a housing for supporting said ring gear wherein the ring gear and housing are provided with engaging splines for preventing relative rotation of said ring gear with respect to said housing, a method of repairing said ring gear assembly when the housing splines become worn and unable to prevent said relative rotation comprising the steps of;

a. providing a first plurality of semi-circular recesses in said ring gear at the interface thereof with said housing;

b. providing a second plurality of semi-circular recesses in said housing contiguous with said first plurality at the interface



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provided with a plurality of teeth 42 on the inner peripheral surface thereof and is provided with a substantially smooth external peripheral surface 44. Final drive casing or housing 46 is provided with a smooth inner peripheral surface 48 which mates with the surface 44, and also with a plurality of threaded holes 50. The hardened ring gear 40 is provided with a plurality of semi-circular recesses 52 which are machined therein and which are used as guides, after installation of the ring gear, for drilling complementary semi-circular recesses 54 in the housing 46. A cylindrical drive pin 56 is installed in each of the holes formed by the complementary recesses 52 and 54 to drivingly connect the ring gear to the housing 46 as described with reference to Figures 2 and 3. Keeper plates 58 are then secured to the housing 46 by means of pairs of bolts 60 to retain the pins 56 axially within the respective holes and to constrain axial movement of the ring gear relative to the housing.

Initial installation of the ring gear 40 within the housing 46 first involves the formation of the semi-circular recesses 52 within the outer peripheral surface of the ring gear 40. Next, the ring gear is installed within the inner surface 48 of the housing. The semi-circular recesses 54 in the housing are drilled using the recesses 52 as guides so as to provide circular apertures spanning the peripheral interface between the ring gear and the housing. The drive pins 56 are then installed within the circular apertures and the keeper plates 58 are affixed.

Even the improved ring gear-housing assembly of the present invention is subject to wear after prolonged use. The drive pins 56, continually bearing against the recesses 54, can wallow out such recesses such that a repair or salvage operation is required. With concurrent reference to Figures 4 and 5, it is apparent that such repair of the assembly may be readily accomplished by removing the pins 56 from between the ring gear and the housing, removing the ring gear from the housing, rotating the ring gear so that the semi-circular recesses 52 would be disposed in angularly spaced relation to the recesses 54 within the housing, drilling new semi-circular recesses 64 (shown in phantom), to complement the repositioned recesses in the ring gear so as to again form circular apertures, and reinstalling the drive pins and keeper plates 58, as previously described.

There is thus provided an improved and efficient ring gear-housing assembly which may be readily fabricated and repaired when necessary. The present invention eliminates the need for expensive spline machining and the expensive tooling and time consumption relates thereto.

WHAT WE CLAIM IS:—

1. A ring gear assembly comprising; a ring gear having peripherally disposed teeth for engaging gear means of a drive mechanism, a housing for supporting said ring gear, said ring gear having a first peripheral surface contiguous with a corresponding second peripheral surface of said housing, said first and second peripheral surfaces forming an annular interface between said ring gear and said housing, said first peripheral surface having a first semi-circular recess therein, said second peripheral surface having a second semi-circular recess therein corresponding to and aligned with said first recess, said first and second recesses forming a circular aperture, a rigid connecting element having a circular portion in said aperture substantially to prevent rotation of said ring gear relative to said housing, and a keeper for limiting axial movement of said connecting element and said ring gear.

2. A gear assembly as claimed in claim 1 wherein said keeper includes a plate member fastened to said housing and extending across said interface.

3. A gear assembly as claimed in claim 1 or 2 wherein said housing surrounds said ring gear and wherein said first peripheral surface is the radially outermost portion of said ring gear.

4. A gear assembly as claimed in claim 1, 2 or 3 wherein said first and second peripheral surfaces each have spline means for interaction to prevent relative rotation between said ring gear and said housing.

5. A gear assembly as claimed in any of claims 1 to 4, wherein said connecting element comprises a hardened pin.

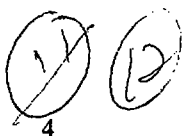
6. A gear assembly as claimed in any preceding claim, including a plurality of said first and second recesses spaced about the circumference of said first and second peripheral surfaces.

7. A gear assembly substantially as described, with reference to Figures 1 to 3, or 4 and 5 of the accompanying drawings.

8. In a ring gear assembly having an annular ring gear and a housing for supporting said ring gear wherein the ring gear and housing are provided with engaging splines for preventing relative rotation of said ring gear with respect to said housing, a method of repairing said ring gear assembly when the housing splines become worn and unable to prevent said relative rotation comprising the steps of;

a. providing a first plurality of semi-circular recesses in said ring gear at the interface thereof with said housing;

b. providing a second plurality of semi-circular recesses in said housing contiguous with said first plurality at the interface



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- between said ring gear and said housing to form a plurality of circular apertures; and
- 5 c. inserting a rigid pin member in each of the circular apertures substantially to prevent rotation of said ring gear relative to said housing, a keeper being provided to limit axial movement of said pin member and said ring gear.
- 10 9. A method as claimed in claim 8 wherein said keeper comprises a plate attached to said housing in overlapping relationship with said interface.
- 15 10. In a ring gear assembly as claimed in any of claims 1 to 7, a method of repairing said assembly when said connecting element means causes said second recess to wear such that said ring gear can rotate with respect to said housing comprising the steps of;
- 20 a. removing said keeper from said assembly;
- b. removing said connecting element from said aperture;
- c. rotating said ring gear with respect to said housing to angularly displace said first recess with respect to said housing;
- 25 d. providing a third semi-circular recess in said second peripheral surface angularly spaced from said second recess and contiguous with said first recess as angularly displaced whereby to form a fresh circular aperture;
- 30 e. placing said connecting element in the fresh aperture; and
- 35 f. attaching said keeper to a portion of said housing for engaging said connecting element and ring gear and limiting axial movement thereof.
- 40 12. Methods of repairing ring gear assemblies, substantially as described and with reference to the accompanying drawings.
- For the Applicants,
FRANK B. DEHN & CO.,
Chartered Patent Agents,
Imperial House,
15—19, Kingsway,
London, WC2B 6UZ.