

PATENT SPECIFICATION

(11) 1 571 174

1 571 174

- (21) Application No. 10661/78 (22) Filed 17 March 1978
(31) Convention Application No. 816 627
(32) Filed 18 July 1977 in
(33) United States of America (US)
(44) Complete Specification published 9 July 1980
(51) INT CL³ F16D 1/00
(52) Index at acceptance
F2U 224 248 262 266 376 504 510 539 571
(72) Inventors ORVILLE ELMER KESSINGER and IVAN
RICHARD LAMPORT



(54) ENGINE FLYWHEEL AND INTERCONNECTING DRIVE SHAFT

(71) We, CATERPILLAR TRACTOR CO., a corporation organized and existing under the laws of the State of California, United States of America, of 100 N.E. Adams Street, Peoria, Illinois, 61629, 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 means for drivingly interconnecting a first assembly to a second assembly. In particular it relates to interconnecting the flywheel of a heavy construction vehicle to a hydrostatic transmission in the vehicle.

Interconnection of the power plant of a vehicle to the drive train of the vehicle presents a unique problem in alignment since the drive train which usually includes a transmission is usually a separate unit from the vehicle engine. Since any misalignment between the power plant and the vehicle drive train results in friction losses during operation of the power plant and drive train, minimization of the misalignment is not only desirable, but necessary. In certain instances it has been found appropriate to utilize flexible or resilient members between the power plant and the vehicle transmission. However, such flexible members can impart an undesirable load to the associated bearings causing premature failure.

Flexible or resilient interconnecting means between the vehicle engine and the vehicle drive train also present problems in assembly of the two components. It is generally necessary to provide access to both sides of the flexible member if the flexible member is to be disassembled in the field. However, since the flexible member may be molded, it may be more appropriate to provide a disassembly point on either side of the flexible member. In any event, the flexible member is an expedient that has not proved in all cases to be appropriate.

Space and weight are generally problems in the construction of any type of vehicle. The drive train length should therefore be made as short as possible commensurate with vehicle design without loss of efficiency. It is also important in internal combustion engines to include a large rotating mass to provide momentum to the engine crank shaft. This can be accomplished in any one of a number of ways. For example, in an aircraft engine the mass may be in the form of a propeller. In certain types of heavy equipment, the mass may be a large rotating portion of the drive train. In many engines it is appropriate to include a flywheel affixed to the crank shaft. In those engines which include a flywheel affixed to the crank shaft, connection of the engine flywheel to the transmission has been accomplished in some installations through the use of the resilient flexible fitting noted above. Since the entire drive train is generally separated from the engine at a point proximate the flywheel, it has proved appropriate to form the flywheel housing in two portions so that the drive train and transmission may be separated coincident with the separation of the flywheel housing. This type of separation may introduce a misalignment problem between the transmission and the flywheel. Accordingly, such misalignment should be readily absorbed in the interconnecting drive member. If the interconnecting drive member were such that separation of the transmission required a separate effort on the part of the separating mechanic to disconnect the interconnecting drive member, the length which is important, and in some instances critical, would of necessity be increased. Accordingly, it is appropriate to design the interconnecting drive member with the shortest possible length.

In providing a short length interconnecting link between a flywheel and a transmission, it would be desirable for the interconnecting link to remain with either the flywheel or the transmission during disconnection of one

50

55

60

65

70

75

80

85

90

from the other. As a corollary function to a retention means to meet this need, it has been found that the retention means may prevent a sheared interconnecting shaft from disassociating itself from the flywheel in the event of failure of the shaft.

Finally, in design of any machinery element, it is appropriate to prevent errors which may take place during assembly. Such errors in a non-symmetrical shaft member which has similar but not identical construction at both ends may occur when the mechanic inadvertently places the non-symmetrical drive shaft in the machine in the wrong orientation. The most common way to prevent an assembly error is to ensure that the two ends of the shaft are visually dissimilar. This has the inherent drawback that the assembling mechanic may be forced to refer to an assembly drawing to determine the proper orientation of the part. A second means for ensuring proper orientation at assembly is to utilize similar structure at either end of an interconnecting shaft but to differ the shaft dimension so that assembly is only possible in one orientation. This type of structure results in the drawback that a minor dimension difference could result in a mechanic attempting to force assembly of the structure.

According to the invention a rotatable drive connection comprises a rotatable flywheel assembly including splined driving means; a driven assembly mounted for rotation a spaced distance from the flywheel assembly and substantially axially aligned therewith, the driven assembly including splined driven means; a splined drive shaft drivingly connecting the splined driving means and the splined driven means, the splined drive shaft having substantially the same mounting and engagement dimensions at both ends so that the splined drive shaft is positionable with one end connected to the splined driving means and the other end connected to the splined driven means, or with the other end connected to the splined driving means and the one end connected to the splined driven means, and retention means for retaining the splined drive shaft in position relative to the flywheel assembly.

One example of a drive connection according to the invention will now be described with reference to the accompanying drawing which depicts, partly in section, an elevation of the drive connection.

Depicted in the sole drawing, is a housing 10 comprised of a first portion 12 which may be affixed to a frame 13 by bolts or the like and a second portion 14 which may be substantially aligned with first portion 12 by means such as flange 15 and affixed thereto by bolt means. First portion 12 of housing 10 substantially encompasses a first assembly mounted for rotation therein and which includes flywheel assembly 16 driven by a

drive shaft 18. Drive shaft 18 may be the extension of a crankshaft of an internal combustion engine such as a diesel engine.

Journalled for rotation in the second portion 14 by a bearing such as tapered bearing 20 is a second assembly including driven member 22 which may drive a transmission such as a hydrostatic transmission or the like. Driven member 22 is in substantial axial alignment with flywheel assembly 16. Other bearing means such as tapered bearing 24 may further support driven member 22. Driven member 22 may be associated with a source of lubricant under relatively low pressure such as 5 lbs. per square inch (3.5×10^4 Pa), such lubricant being provided to an axial bore 26 formed in driven member 22.

Flywheel assembly 16 may be formed of a first portion 28 and a second portion 30 affixed to first portion 28 by a plurality of bolts 32. First portion 28 may in turn be affixed to drive shaft 18 by a plurality of bolts 34. A sealing member 36 may be disposed between flywheel first portion 28 and drive shaft 18 so that an oil seal 38 may be utilized between first portion 12 of housing 10 and sealing member 36. A similar oil seal 40 may be disposed between driven member 22 and second portion 14 of housing 10.

Flywheel second portion 30 is formed with a stepped axial bore 42 which terminates generally with an internal spline 44 at the end proximate drive shaft 18 and which serves to receive one end of a symmetrical splined drive shaft 56. The stepped axial bore 42 is formed with a first counterbore 46 at the end distal of internal spline 44. Intermediate the end of axial bore 42 is a counterbore 47 of relatively less diameter than counterbore 46 which in turn is followed by a third counterbore 48 distal of counterbore 46 and of relatively less diameter than counterbore 47. Formed in counterbore 46 and proximate the outer end thereof is an annular groove 49, the purpose of which will become apparent in the following discussion. Proximate internal spline 44 and formed in flywheel second portion 30, is a counterbore 50 in which a cup-like plug 52 may be disposed to retain oil, as will become apparent in the ensuing discussion.

Axial bore 26 of driven member 22 has formed at the end adjacent second portion of housing 10 an internal spline 54 adapted to receive the other end of the symmetrical splined drive shaft 56 thus interconnecting the flywheel assembly 16 with the second assembly 22.

Symmetrical splined drive shaft 56 is formed with splines 58 at either end thereof which serve to allow a small misalignment between the flywheel assembly 16 and the driven assembly 22. Since drive shaft 56 is symmetrical, it is appropriate to refer to the features of one end only. The symmetry of the

23

splined drive shaft permits installation, either as indicated in the figure or in a reverse of the indication in the figure. Thus, the splines 58 may mate either with the splines 54 of the driven member or the splines 44 of the second portion 30 of flywheel assembly 16. The symmetrical splined drive shaft 56 has formed generally at the mid-point thereof a shoulder 60 circumferentially surrounding the drive shaft. Shoulder 60 is formed on center portion 62 of drive shaft 56. Center section 62 extends in either direction from shoulder 60 to an intermediate portion 64 of drive shaft 56 and of lesser diameter than center section 62. Intermediate portions 64 are adapted to fit either the axial bore 26 of the driven member 22 or the third counterbore 48 of flywheel second portion 30, while the center portion 62 is adapted to be received in the second counterbore 47 of the flywheel second portion with the shoulder 60 adapted to be received in the first counterbore 46 of the flywheel second portion.

An annular groove 66 is formed in each intermediate portion 64 and may have disposed therein a seal member such as O-ring 68. O-ring 68 serves to seal axial bore 26 of driven assembly 22 and the corresponding O-ring 68, when disposed in third counterbore 48, serves to seal stepped third axial bore 42 of second portion 30.

In use the symmetrical splined shaft is positioned in the socketed flywheel second portion 30, as indicated in the figure, and retained therein by a retention means such as split ring 70 disposed in annular groove 49. At the opposite end splines 58 mate with splines 54 of driven member 22. The splines 58 mating with the flywheel second portion 30 are lubricated by an axial bore 72, communicating lubricating fluid from axial bore 26 of driven member 22 to the splines 44. The cup-like plug 52 serves to retain the lubricating fluid in the vicinity of the splines 44. Due to the limited amount of friction developed in this coupling, a pressurized lubricating system is not necessary. However, the slight pressure maintained in axial bore 26 is sufficient to provide lubricant to the splines. Since housing 10 may be dry housing, that is a housing in which lubricant is not accumulated, a drain port 74 may be provided to drain leakage lubricant from housing 10. It should be apparent to those in the art that the use of the splines 58 on the symmetrical drive shaft and the mating with the splines 44 and 54 allows for a certain degree of misalignment between the flywheel's second portion 30 and the driven member 22 without imparting an unnecessary load to either the bearing 20 or the bearing 24. In addition to the normal splined 58, it has been found appropriate to provide a certain degree of "crowning" to each spline which may be seen in exaggerated form in the drawing as the surved outer

portion of the spline. This crowning allows for a certain additional amount of misalignment between the two elements, as noted above.

The split ring 70 serves several useful purposes. During assembly, the symmetrical splined drive shaft 56 is positioned in the flywheel second portion. As previously noted, the symmetry of the splined drive shaft is such that a mechanic need not worry about which end is positioned in socketed flywheel second portion 30. The socketed portion permits lubricant to be received at the splined end through the hollow splined drive shaft 56 while a split ring 70 is positioned in the annular groove 49 to act on shoulder 60. Thus, the symmetrical splined drive shaft 56 is retained in the flywheel second portion in the manner indicated in the figure. The driven member 22 and the housing 14, which may have been previously preassembled, may then be mated with the symmetrical drive shaft 56 with the spline 58 mating with the spline 54 of the driven member. During this assembly it should be apparent that the symmetrical splined drive shaft 56 will be retained in the flywheel second portion 30 thus preventing damage occurring to the splines during such assembly or if the drive shaft were inadvertently dropped during subsequent withdrawal of the driven member.

In the past, it has been appropriate to provide access to the interconnecting means analogous to symmetrical splined drive shaft 56 before the driven member is disassembled from the driving member in order to prevent damage to the interconnecting member. This is obviated in this invention by providing the elongated symmetrical splined drive shaft fitted in the socketed flywheel second portion and retained therein by retainer 70. Finally, the retainer 70 serves to retain a portion of the symmetrical splined drive shaft 56 in the event the splined drive shaft is sheared during operation. Since shear would normally occur at the smallest diameter point, that is annular groove 66, a break at either annular groove will retain at least the major portion of the symmetrical splined drive shaft 56 within the flywheel second portion without the remaining portion damaging the flywheel housing or the like.

WHAT WE CLAIM IS:—

1. A rotatable drive connection comprising a rotatable flywheel assembly including splined driving means; a driven assembly mounted for rotation a spaced distance from the flywheel assembly and substantially axially aligned therewith, the driven assembly including splined driven means; a splined drive shaft drivingly connecting the splined driving means and the splined driven means, the splined drive shaft having substantially the same mounting and engagement dimensions



23

splined drive shaft permits installation, either as indicated in the figure or in a reverse of the indication in the figure. Thus, the splines 58 may mate either with the splines 54 of the driven member or the splines 44 of the second portion 30 of flywheel assembly 16. The symmetrical splined drive shaft 56 has formed generally at the mid-point thereof a shoulder 60 circumferentially surrounding the drive shaft. Shoulder 60 is formed on center portion 62 of drive shaft 56. Center section 62 extends in either direction from shoulder 60 to an intermediate portion 64 of drive shaft 56 and of lesser diameter than center section 62. Intermediate portions 64 are adapted to fit either the axial bore 26 of the driven member 22 or the third counterbore 48 of flywheel second portion 30, while the center portion 62 is adapted to be received in the second counterbore 47 of the flywheel second portion with the shoulder 60 adapted to be received in the first counterbore 46 of the flywheel second portion.

An annular groove 66 is formed in each intermediate portion 64 and may have disposed therein a seal member such as O-ring 68. O-ring 68 serves to seal axial bore 26 of driven assembly 22 and the corresponding O-ring 68, when disposed in third counterbore 48, serves to seal stepped third axial bore 42 of second portion 30.

In use the symmetrical splined shaft is positioned in the socketed flywheel second portion 30, as indicated in the figure, and retained therein by a retention means such as split ring 70 disposed in annular groove 49. At the opposite end splines 58 mate with splines 54 of driven member 22. The splines 58 mating with the flywheel second portion splines 44 are lubricated by an axial bore 72, communicating lubricating fluid from axial bore 26 of driven member 22 to the splines 44. The cup-like plug 52 serves to retain the lubricating fluid in the vicinity of the splines 44. Due to the limited amount of friction developed in this coupling, a pressurized lubricating system is not necessary. However, the slight pressure maintained in axial bore 26 is sufficient to provide lubricant to the splines. Since housing 10 may be dry housing, that is a housing in which lubricant is not accumulated, a drain port 74 may be provided to drain leakage lubricant from housing 10. It should be apparent to those in the art that the use of the splines 58 on the symmetrical drive shaft and the mating with the splines 44 and 54 allows for a certain degree of misalignment between the flywheel's second portion 30 and the driven member 22 without imparting an unnecessary load to either the bearing 20 or the bearing 24. In addition to the normal splined 58, it has been found appropriate to provide a certain degree of "crowning" to each spline which may be seen in exaggerated form in the drawing as the surved outer

portion of the spline. This crowning allows for a certain additional amount of misalignment between the two elements, as noted above.

The split ring 70 serves several useful purposes. During assembly, the symmetrical splined drive shaft 56 is positioned in the flywheel second portion. As previously noted, the symmetry of the splined drive shaft is such that a mechanic need not worry about which end is positioned in socketed flywheel second portion 30. The socketed portion permits lubricant to be received at the splined end through the hollow splined drive shaft 56 while a split ring 70 is positioned in the annular groove 49 to act on shoulder 60. Thus, the symmetrical splined drive shaft 56 is retained in the flywheel second portion in the manner indicated in the figure. The driven member 22 and the housing 14, which may have been previously preassembled, may then be mated with the symmetrical drive shaft 56 with the spline 58 mating with the spline 54 of the driven member. During this assembly it should be apparent that the symmetrical splined drive shaft 56 will be retained in the flywheel second portion 30 thus preventing damage occurring to the splines during such assembly or if the drive shaft were inadvertently dropped during subsequent withdrawal of the driven member.

In the past, it has been appropriate to provide access to the interconnecting means analogous to symmetrical splined drive shaft 56 before the driven member is disassembled from the driving member in order to prevent damage to the interconnecting member. This is obviated in this invention by providing the elongated symmetrical splined drive shaft fitted in the socketed flywheel second portion and retained therein by retainer 70. Finally, the retainer 70 serves to retain a portion of the symmetrical splined drive shaft 56 in the event the splined drive shaft is sheared during operation. Since shear would normally occur at the smallest diameter point, that is annular groove 66, a break at either annular groove will retain at least the major portion of the symmetrical splined drive shaft 56 within the flywheel second portion without the remaining portion damaging the flywheel housing or the like.

WHAT WE CLAIM IS:—

1. A rotatable drive connection comprising a rotatable flywheel assembly including splined driving means; a driven assembly mounted for rotation a spaced distance from the flywheel assembly and substantially axially aligned therewith, the driven assembly including splined driven means; a splined drive shaft drivingly connecting the splined driving means and the splined driven means, the splined drive shaft having substantially the same mounting and engagement dimensions



1,571,174

at both ends so that the splined drive shaft is positionable with one end connected to the splined driving means and the other end connected to the splined driven means, or with the other end connected to the splined driving means and the one end connected to the splined driven means, and retention means for retaining the splined drive shaft in position relative to the flywheel assembly.

2. A rotatable drive connection according to claim 1, including a housing having a first portion and a second portion removably engagable with the first portion; and wherein the flywheel assembly is mounted for rotation in the first housing portion; and the second, driven assembly being mounted for rotation in the second housing portion.

3. A drive connection according to claim 1 or claim 2, wherein the flywheel assembly comprises an axially socketed flywheel.

4. A drive connection according to any of claims 1 to 3, wherein the driven assembly includes a hollow shaft portion splined internally to receive an end of the splined drive shaft.

5. A drive connection according to claim 3, wherein the flywheel assembly also includes a drive shaft, and comprises a first flywheel portion removably affixed to the said drive shaft and an axially socketed second portion, the axially socketed second portion defining an axial bore with at least a portion of the axial bore having a plurality of inwardly extending splines adapted to receive either end of the splined drive shaft.

6. A drive connection according to claim 5, wherein the splined drive shaft has an axial bore and an enlarged center portion, the enlarged center portion forming an annular

shoulder substantially at the midpoint of the splined drive shaft, the shoulder being positionable in the axial bore of the socketed second portion of the flywheel assembly, the axial bore of the splined drive shaft being arranged to communicate lubricant from the second assembly to the axial bore of the socketed second portion.

7. A drive connection according to claim 6, wherein the axial bore of the socketed second portion of the flywheel includes an annular groove adjacent a first end thereof, the first end being proximate the driven assembly, and further wherein the retention means comprises a split ring resiliently positionable in the annular groove in abutting relation with the splined drive shaft shoulder whereby the splined drive shaft shoulder is retained relative to the socketed second portion of the flywheel.

8. A drive connection according to any of claims 5 to 7, further comprising cap means for sealing the second opposite end of the axial bore of the socketed second portion of the flywheel, the splined drive shaft having a first seal member disposed thereabout internally of the axial bore of the socketed second portion of the flywheel and second seal means disposed about the splined drive shaft internally of the second assembly.

9. A drive connection according to claim 1, substantially as described with reference to the accompanying drawings.

For the Applicants:
GILL JENNINGS & EVERY,
Chartered Patent Agents,
53 to 64 Chancery Lane,
London WC2A 1HN