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N. N. TILLEY

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REVERSIBLE STARTER AND GENERATOR DRIVE FOR ENGINES

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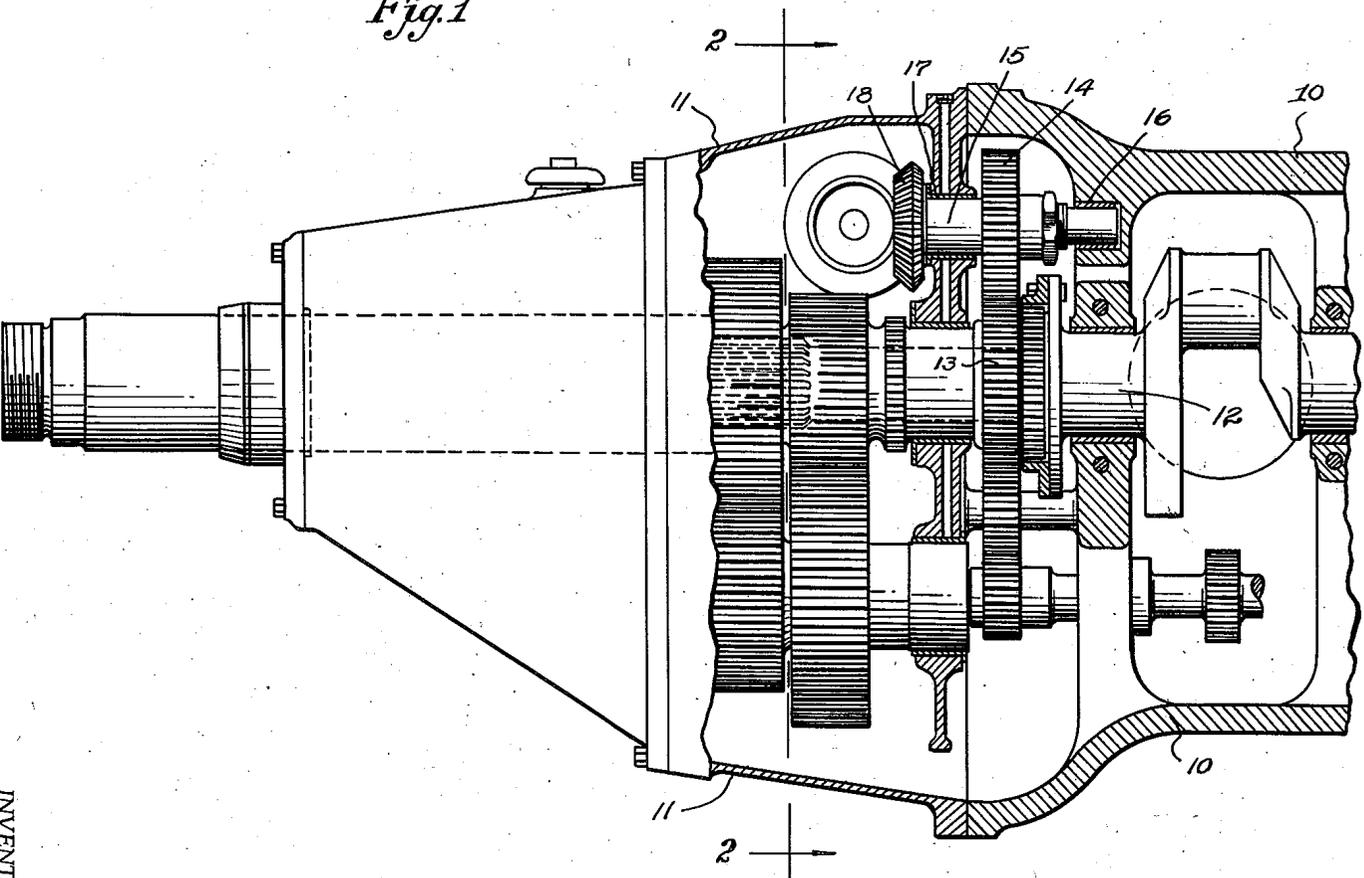


Fig. 1

INVENTOR.  
Norman N. Tilley  
BY  
*G. F. Stankle*  
ATTORNEY.



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## REVERSIBLE STARTER AND GENERATOR DRIVE FOR ENGINES

Norman N. Tilley, Detroit, Mich., assignor to  
Continental Motors Corporation, Detroit,  
Mich., a corporation of Virginia

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My invention relates to engines and more particularly to a reversible starter and generator drive for engines of the internal combustion type.

In engines employed for propelling aircraft it is necessary in many instances to provide engines which may be readily converted from a right hand to a left hand drive engine, and in so doing it becomes necessary to accommodate the engine for starters and generators of conventional and standard design which may be interchanged between said right and left hand engines.

It is an object of my present invention to provide a simple and convenient starter and generator drive which may be selectively arranged for assembly with either a right or left hand engine, whereby to facilitate the manufacture and maintenance of such engines.

A further object of my invention relates more particularly to the assembly of a starter drive shaft which is constructed and arranged to be provided with a starter jaw type of clutch at one end and a generator driving connection at the other end, said starter shaft being adapted to be selectively positioned end for end in the assembly with the engine to facilitate the reversing of the driving connections between the starter and crankshaft starter gear.

For a further understanding of my invention reference may be had to the accompanying drawings which illustrate one form which my invention may assume, and in which:

Fig. 1 is a fragmentary longitudinal sectional view through an engine showing the gear case and the gearing therein for operatively connecting the starter and generator with the engine crankshaft.

Fig. 2 is a transverse sectional view through the engine taken substantially on the line 2-2 of Fig. 1, and showing in detail the assembly of the reversible starter and generator drive.

Fig. 3 is a horizontal detail fragmentary sectional view through the starter shaft taken substantially on the line 3-3 of Fig. 2, and

Fig. 4 is a similar horizontal fragmentary sectional view through the starter shaft, showing said shaft reversed in position and adapted for a reverse driving connection.

I have preferably illustrated my present invention in connection with an aircraft internal combustion engine of the type having aligned cylinders and which in general includes a crankcase 10 to which is secured a gear case 11 for housing the various accessory drive gears including the starter and generator driving mechanism. The

crankcase is arranged to support the crankshaft 12 in a manner that is well known in the art, this crankshaft carrying a crankshaft starter gear 13 which is driven through a suitable intermediate gearing from the starter shaft, said intermediate gearing comprising a gear 14 meshing with the starter gear 13 and carried by the stub shaft 15 supported in suitable bearings 16 and 17 carried by the crankcase 10 and gear case structure 11 respectively. One end of the stub shaft 15 carries a bevelled driven gear 18 adapted for permanent driving connection with the driving bevelled gear 19 carried and driven by the starter shaft as hereinafter described.

The reversible starter and generator drive for the present engine is preferably housed within the gear case structure 11 and comprises in general a starter shaft structure or assembly supported in spaced bearing portions 21 and 22 carried by the gear case structure in such a manner as to permit the starter shaft 20 to be reversed end for end in accordance with a prearranged plan for adapting the same for assembly with a right or left hand engine. Preferably these spaced bearing portions 21 and 22 are disposed on opposite sides of the stub shaft 15 and preferably diametrically opposite with respect to said shaft and the driven bevelled gear 18 as clearly shown in Figs. 3 and 4.

This starter shaft is preferably provided with a starter driving clutch 9 at one end and a generator driving connection 8 at the other end, the gear case being provided with suitable flanges and concentric pilot portions 24 and 25 for respectively supporting the starter and generator. Bearing sleeves or bushings 26 are arranged and constructed of such a size and diameter as to be fitted and supported in either of the spaced bearing portions 21 and 22 carried by the gear case structure. As shown in Figs. 2 and 3 the starter shaft 20 is provided with bearing portion 20' and is supported in the bearing sleeve or bushing 26 carried by said bearing portion 22. The starter shaft portion beyond said bearing portion 20' is reduced in diameter and carries a driving portion which, in this case, comprises the splined teeth 27. Beyond the said splined teeth 27 the starter shaft is further reduced in diameter and extended through the other bearing portion 21. A driving member or sleeve 28 is supported on the starter shaft and is provided with internal splined teeth 29 adapted for engagement with the splined teeth 27 of the starter shaft, said driving sleeve 28 having the bearing on the starter shaft intermediate the teeth and bearing portion 20' and abut-

ting the shoulder 30 carried by said starter shaft. This driving sleeve is preferably constructed to carry the aforesaid driving bevelled gear 19 and as shown in the present embodiment of my invention, this driving bevelled gear 19 is preferably integrally formed with the driving sleeve 28.

The assembly and positioning of the driving sleeve 28 on the starter shaft is preferably completed by the assembly therewith of a second sleeve 31 which is supported on the reduced end portion of the starter shaft as at 31a and is provided with a reduced bearing portion 32 for axial assembly within the end of the driving sleeve 28, this second sleeve 31 having a shoulder 33 abutting the end of the driving sleeve 28 and being further provided with the extension 31b extending within the sleeve and carrying one or more lugs 34, which are adapted to be axially assembled between a pair of teeth of the starter shaft whereby to effect a driving connection between said starter shaft and said second sleeve. A lock nut 35 is secured to the starter shaft and adjustably positioned to lock the driving sleeve and second sleeve in position with respect to said starter shaft, this nut when drawn down forcing the driving sleeve against the shoulder 30 and the shoulder 33 of the second sleeve against the end of the driving sleeve and at the same time forcing the lug 34 into engagement with the splined teeth on the starter shaft.

It will thus be noted that the second sleeve 31 is driven with the starter shaft and has a bearing within the bearing 26 carried by the gear case comprising the shaft, and the sleeves 28 and 31, all held together in a unitary assembly by the lock nut 35.

A left hand engine of the type herein described is such as to rotate the crankshaft in the opposite direction from a right hand engine and thus it is necessary in providing a reversible starter drive mechanism in order to have the starter shaft rotate in a direction as to initially drive the stub shaft 15 in the opposite direction.

In Fig. 4 I have shown an arrangement for reversing the drive and it will be noted that the stub shaft 15 is herein driven in the opposite direction than is the case with the stub shaft shown in Fig. 3, the direction of rotation of the stub shafts in said figures being indicated by the arrows.

In the present embodiment of my invention this reverse drive is accomplished by turning the starter shaft 20 end for end, and it will be noticed that the bearing portion 20' of the starter shaft is now engaged or supported in bearing sleeve 26 carried by the bearing portion 21 of the gear case structure. (Refer particularly to Fig. 4.) The reduced end portion of the starter shaft is extended through the bearing portion 22 of the gear case and the second sleeve 31 is supported on the reduced portion of the starter shaft in a manner similar to the construction shown in Fig. 3, but in this case the driving sleeve 28 is supported in a reverse manner than shown in Fig. 3, relative to the starter shaft, that portion of the driving sleeve 28 underneath the driving bevelled gear 19 being now supported on the starter shaft 20 while the extreme end portion of the bearing sleeve is supported on said second sleeve 31, a condition which is directly opposite to the structure shown in Fig. 3.

The starter and generator are interchangeable with respect to the pilot and flanges 24 and 25 as will be quite evident, and are thus selectively

accommodated for both right hand and left hand engines.

Although I have illustrated but one form of my invention and have described in detail but a single application thereof, it will be apparent to those skilled in the art to which my invention pertains that various modifications and changes may be made therein without departing from the spirit of my invention or from the scope of the appended claims.

What I claim as my invention is:

1. In an internal combustion engine having a crankshaft and a crankshaft starter gear secured to said crankshaft, a reversible starter and generator drive assembly comprising a starter shaft supported for selective positioning end for end, a driving member driven by said starter shaft from both positions of the starter shaft, said starter shaft having a starter drive clutch at one end and a generator driving connection at the other end thereof, and means drivingly connecting said driving member with the crankshaft starter gear.

2. In an internal combustion engine having a gear case structure, a crankshaft and a crankshaft starter gear secured to said crankshaft, a reversible starter and generator drive assembly comprising spaced bearing portions carried by the gear case structure and constructed substantially equal in diameter, a starter shaft supported for selective positioning end for end, said starter shaft having a starter drive clutch at one end and a bearing portion adjacent to the clutch arranged to fit either of the gear case bearing portions and having reduced portion, a driving member secured in driving relation to said reduced portion and selectively reversible relative to the starter shaft, a sleeve carried by said reduced portion and having a bearing portion supported in said other gear case bearing portion, said sleeve having a shoulder forming an abutment for positioning said driving member, means for locking said sleeve in position, and means drivingly connecting said driving member with the crankshaft starter gear.

3. In an internal combustion engine having a gear case structure, a crankshaft and a crankshaft starter gear secured to said crankshaft, a reversible starter and generator drive assembly comprising spaced bearing portions carried by the gear case structure and constructed substantially equal in diameter, a starter shaft supported for selective positioning end for end, said starter shaft having a starter drive clutch at one end and a bearing portion adjacent to the clutch arranged to fit either of the gear case bearing portions and having reduced portion, a driving member secured in driving relation to said reduced portion and selectively reversible relative to the starter shaft, a sleeve carried by said reduced portion and having a bearing portion supported in said other gear case bearing portion, said sleeve having a shoulder forming an abutment for positioning said driving member, and locked in driving engagement with said starter shaft, means for locking said sleeve in position on said starter shaft, and means drivingly connecting said driving member with the crankshaft starter gear.

4. In an internal combustion engine having a gear case structure, a crankshaft and a crankshaft starter gear secured to said crankshaft, a reversible starter and generator drive assembly comprising spaced bearing portions carried by the gear case structure, a starter shaft supported by said spaced bearing portions for selective positioning end for end and having a driving portion, said starter shaft having a starter drive

clutch at one end, a generator drive connection at the other end, a driving member supported for driving connection with the driving portion of said starter shaft for each position of said starter shaft, and means drivingly connecting said driving member with the crankshaft starter gear.

5. In an internal combustion engine having a gear case structure, a crankshaft and a crankshaft starter gear secured to said crankshaft, a reversible starter and generator drive assembly comprising spaced bearing portions carried by the gear case structure, a starter shaft supported by said spaced bearing portions for selective positioning end for end and having a driving portion, said starter shaft having a starter drive clutch at one end, a generator drive connection at the other end, a driving sleeve supported on said starter shaft and drivingly connected with the driving portion of said starter shaft for each position of said starter shaft, and intermediate gearing providing a permanent driving connection with said crankshaft starter gear.

6. In an internal combustion engine having a gear case structure, a crankshaft and a crankshaft starter gear secured to said crankshaft, a reversible starter and generator drive assembly comprising spaced bearing portions carried by the gear case structure, a starter shaft supported by said spaced bearing portions for selective positioning end for end and having a driving portion, said starter shaft having a starter drive clutch at one end, a generator drive connection at the other end, a gear mechanism operatively connected with crankshaft starter gear and including a driven beveled gear, and a driving sleeve supported on said starter gear for driving connection with the driving portion of the starter shaft for each position of said starter shaft, said sleeve having a beveled driving gear connected in permanent driving relation with the driven beveled gear of said gear mechanism.

7. In an internal combustion engine having a gear case structure, a crankshaft and a crankshaft starter gear secured to said crankshaft, a reversible starter and generator drive assembly comprising spaced bearing portions carried by the gear case structure, a starter shaft supported by said spaced bearing portions for selective positioning end for end and having a portion

reduced in diameter carrying a driving portion, said starter shaft having a starter drive clutch at one end and a generator drive connection at the other end, a driving sleeve supported on the starter shaft portion of reduced diameter and drivingly connected with the starter shaft driving portion for each position of said starter shaft, a second sleeve supported on said starter shaft portion of reduced diameter and provided with a shoulder abutting said driving sleeve and with a bearing portion engaging one of the spaced bearing portions of said gear case structure, a lock nut secured to said starter shaft to lock said driving sleeve and said second sleeve on said starter shaft against axial displacement, and means drivingly connecting said driving sleeve with the crankshaft starter gear.

8. In an internal combustion engine having a gear case structure, a crankshaft and a crankshaft starter gear secured to said crankshaft, a reversible starter and generator drive assembly comprising spaced bearing portions carried by the gear case structure, a starter shaft supported by said spaced bearing portions for selective positioning end for end and having a portion reduced in diameter carrying splined teeth, said shaft having a starter drive clutch at one end and a generator drive connection at the other end, a driving sleeve supported on the starter shaft portion of reduced diameter and having internal splined teeth drivingly connected with the splined teeth carried by the starter shaft and reversibly positioned relative to said starter shaft, a second sleeve supported on said starter shaft portion of reduced diameter and provided with one or more lugs telescopically engaged between the gear teeth on said starter shaft to drivingly connect the said second sleeve with the starter shaft, said second sleeve being also provided with a shoulder abutting said driving sleeve and with a bearing portion engaging one of the spaced bearing portions of said gear case structure, a lock nut secured to said starter shaft to lock the driving sleeve and said second sleeve in driving connection with said starter shaft and against axial displacement therewith, and means drivingly connecting said driving sleeve with the crankshaft starter gear.

NORMAN N. TILLEY. 50