Nov. 21, 1933. W. F. DAVIS 1,936,350

ENGINE

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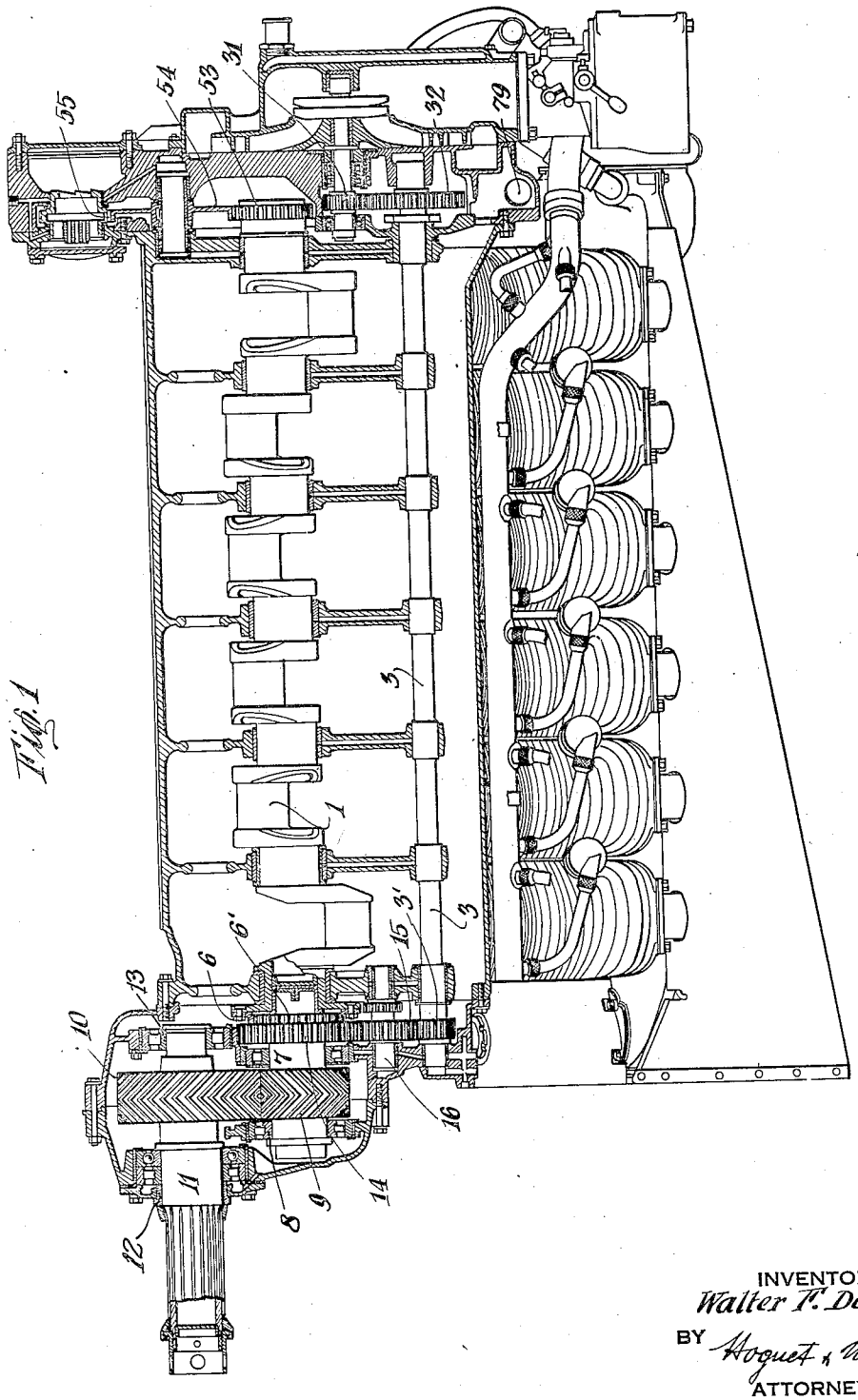


Fig. 1

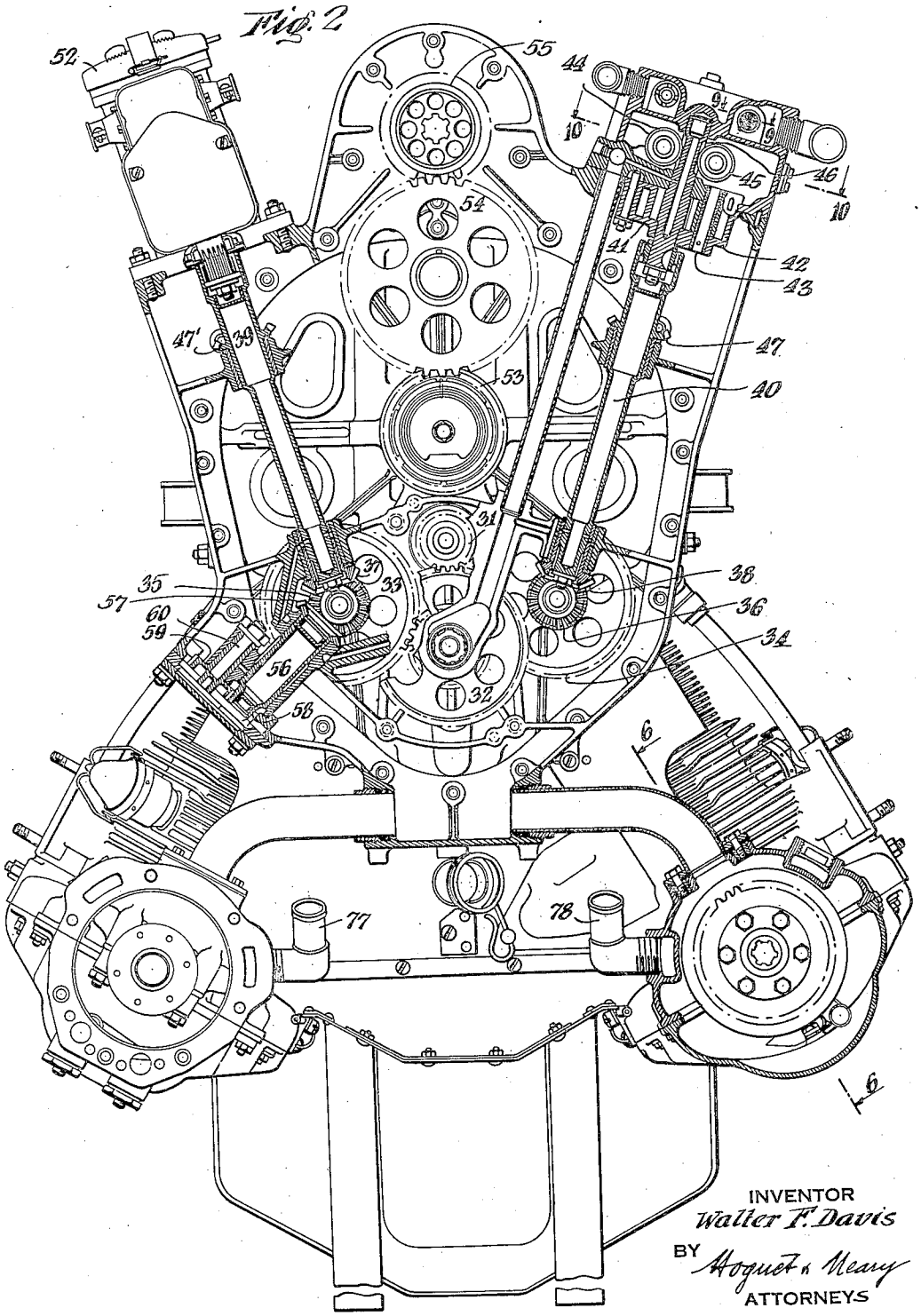
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Fig. 2



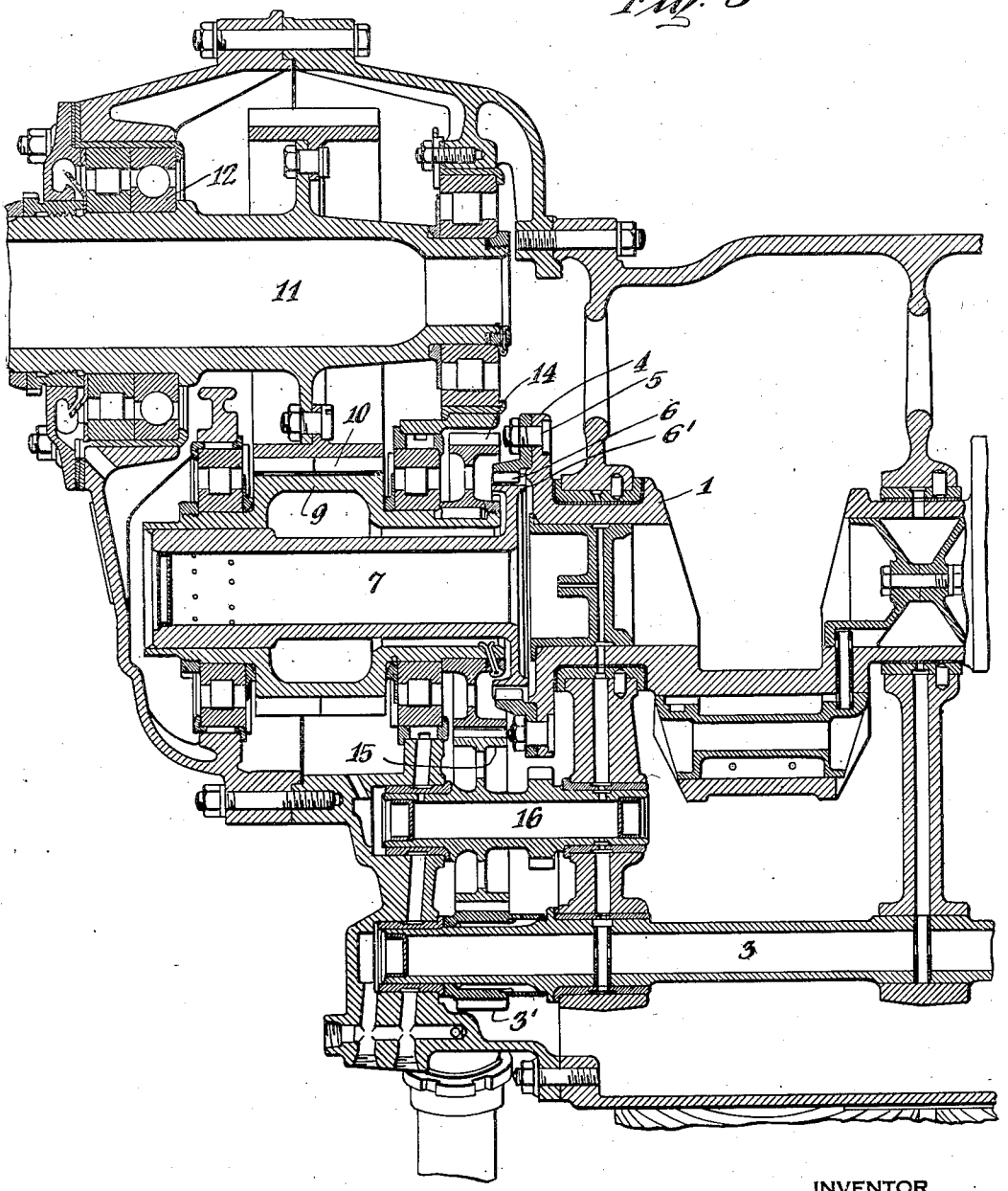
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Fig. 3



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Fig. 4

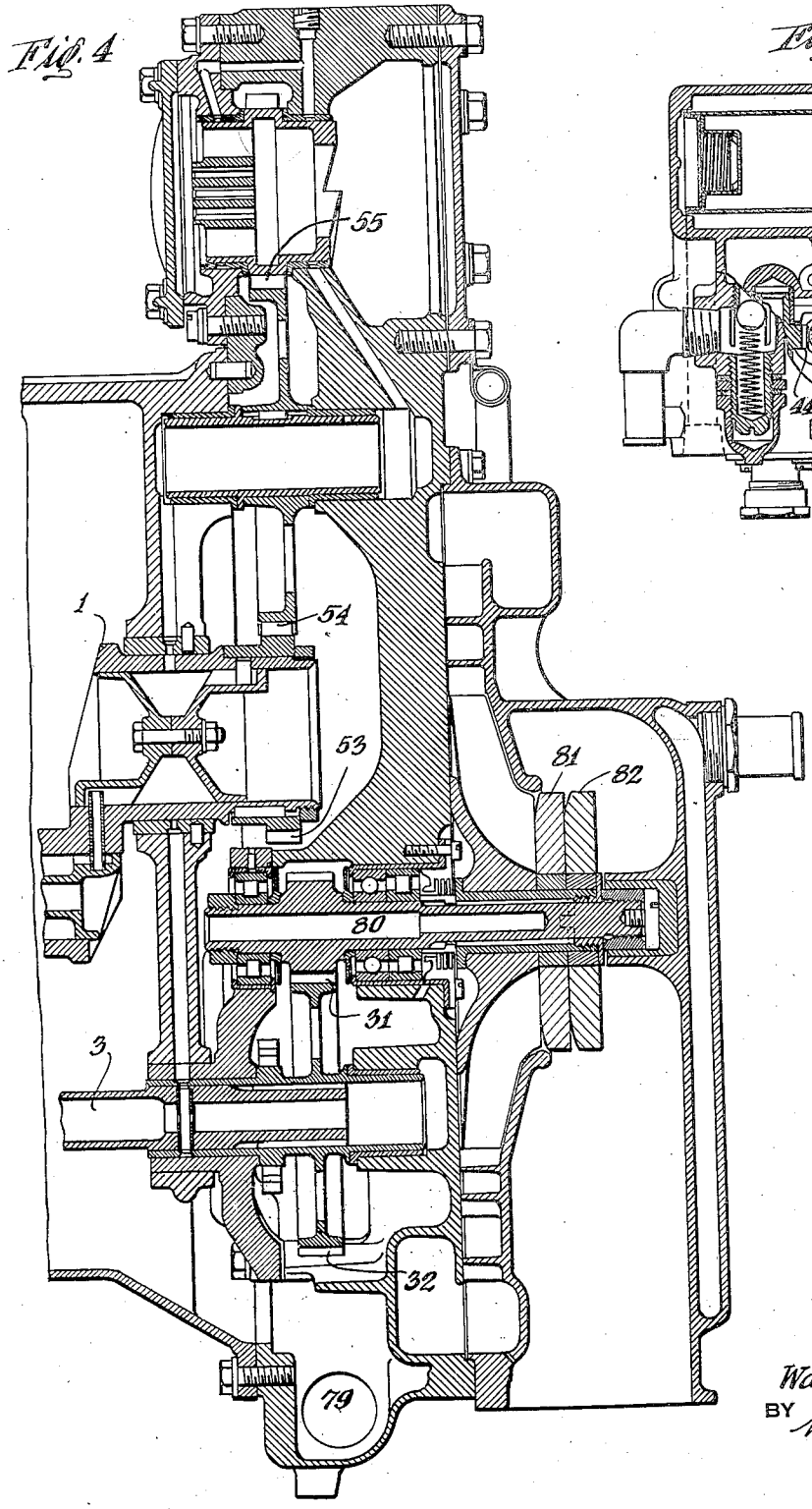
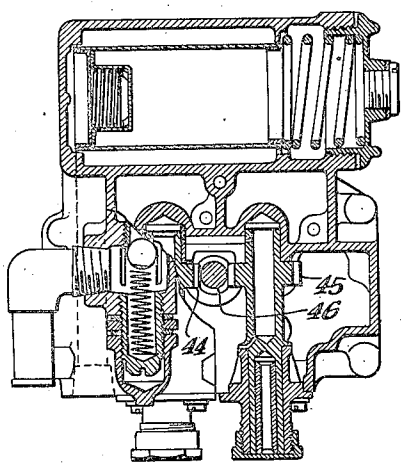


Fig. 10



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Fig. 5

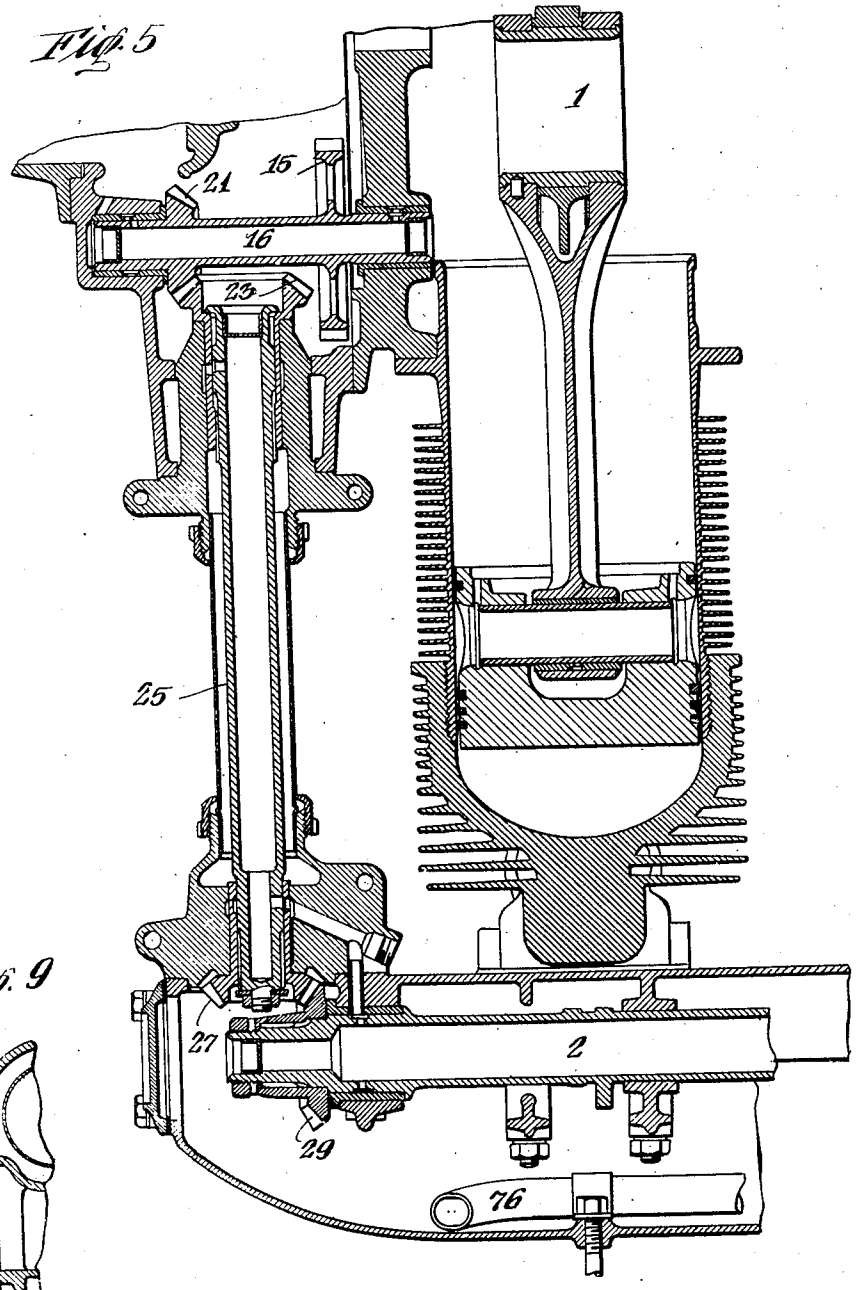
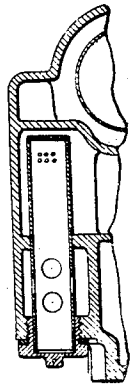


Fig. 9



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Fig. 8

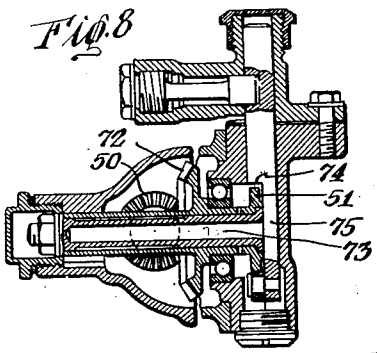


Fig. 7

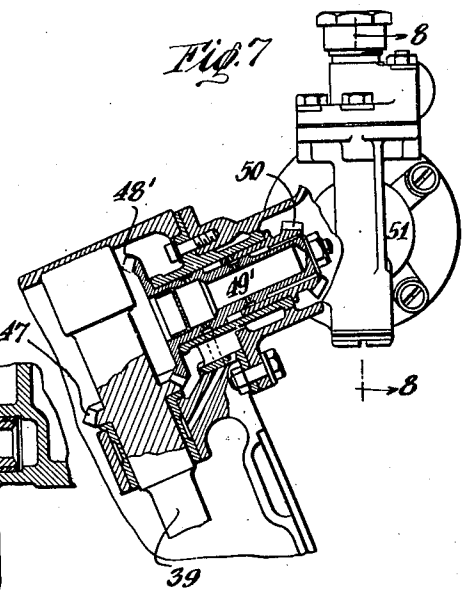
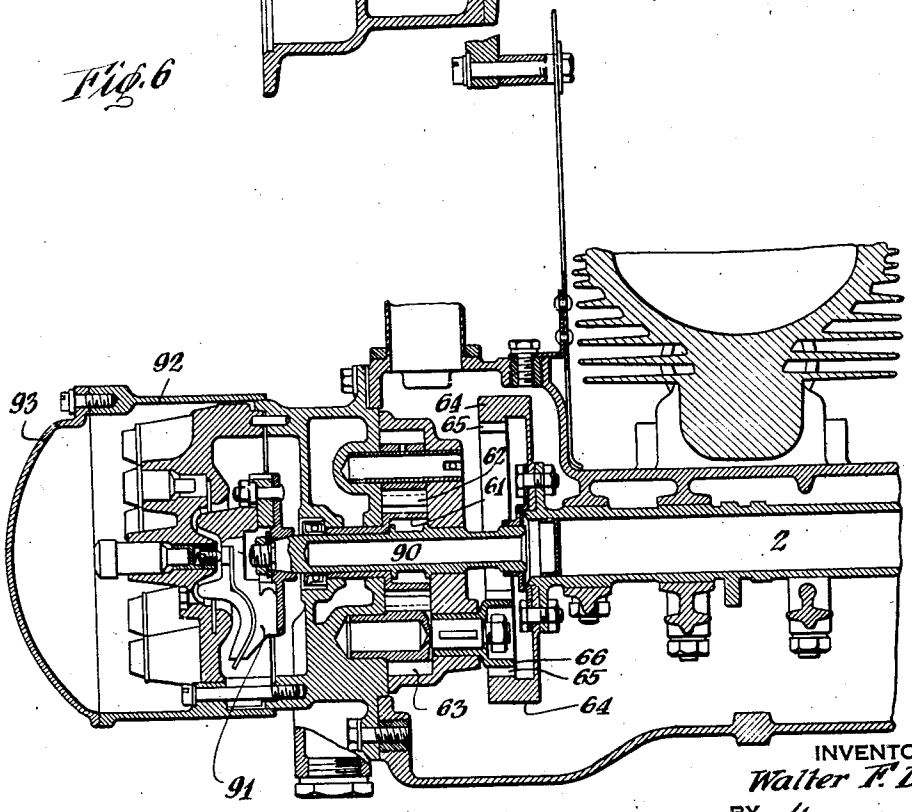


Fig. 6



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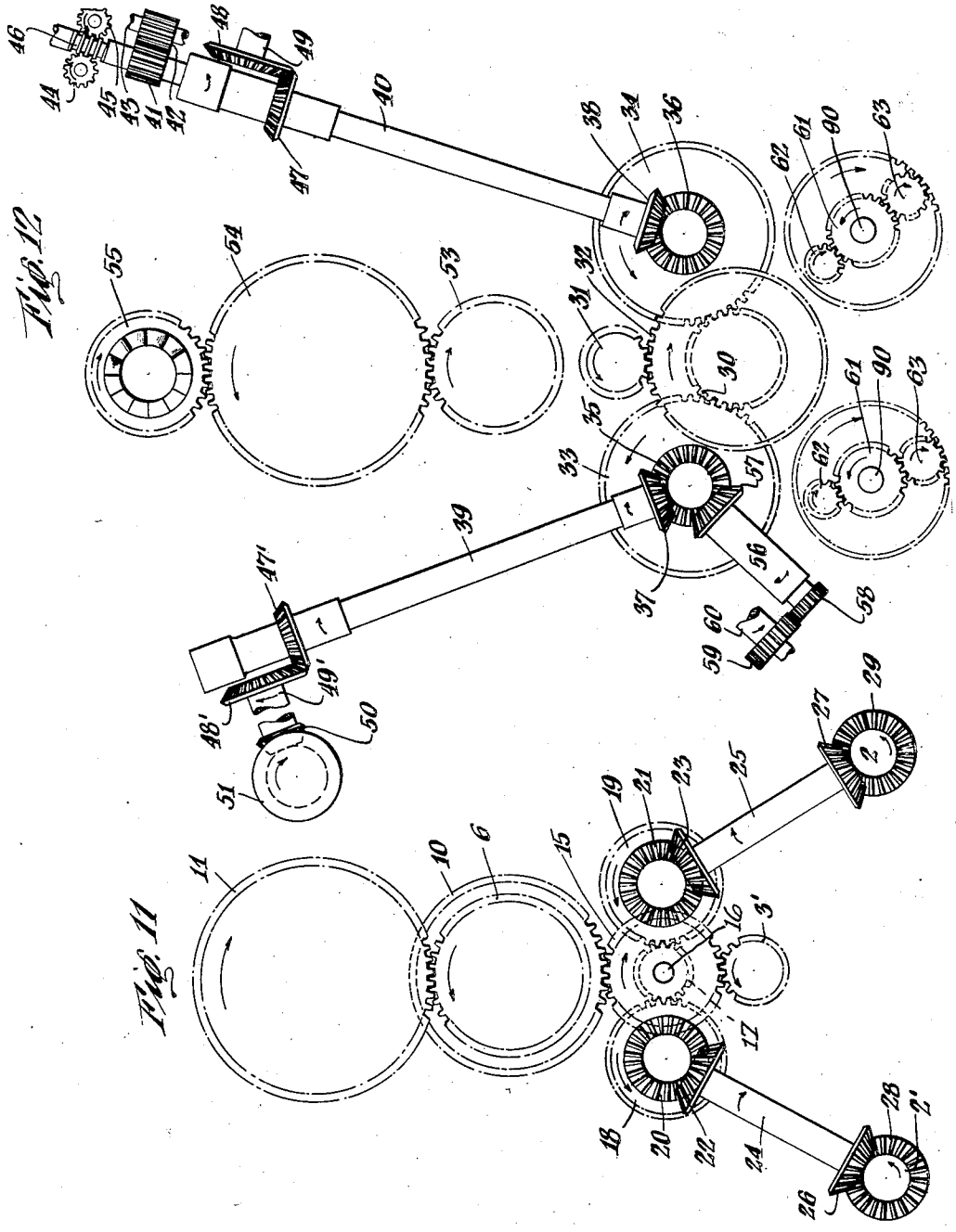


Fig. 12

Fig. 11

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UNITED STATES PATENT OFFICE

1,936,350

ENGINE

Walter F. Davis, Farmingdale, N. Y.

Application March 29, 1932. Serial No. 601,785

14 Claims. (Cl. 123—195)

This invention relates in general to internal combustion engines of the multicylinder type and more particularly to such engines especially adpted for use in aeronautics.

An object of this invention is to provide an engine which will be compact, efficient and rugged, the lubrication of which will be positive in nature as to the elimination of grease cups or the like, and be capable of carrying and driving a number of accessories without setting up any torsional oscillations.

Another object is to provide an engine wherein, by the use of an arrangement of auxiliary shafts and reduction gears and efficient gear trains, a drive may be imparted indirectly from such a point on the crankshaft to the propeller, supercharger, oil and gas pressure system, and other accessories, that torsional oscillation usually incident to such drive will be eliminated.

With the foregoing and other objects in view, the invention consists in the combination of parts and in the details of construction hereinafter set forth in the following specification and appended claims, certain embodiments thereof being illustrated in the accompanying drawings, in which:

Figure 1 is a view in longitudinal section through the crankcase of an inverted V-type multicylinder engine showing one bank of cylinders in elevation.

Figure 2 is a view in rear elevation partly in section of the engine and accessories.

Figure 3 is an enlarged view in longitudinal section through the front part of the engine and the propeller shaft driving connections.

Figure 4 is an enlarged view in longitudinal section through the rear part of the engine and the supercharger driving connections.

Figure 5 is an enlarged view in longitudinal section through the lower front part of the engine showing the relationship of the camshaft to the rest of the engine and a portion of the oiling system.

Figure 6 is an enlarged view in longitudinal section taking along line 6—6 of Figure 2.

Figure 7 is an enlarged view in longitudinal section through the gun synchronizer drive.

Figure 8 is a view in section taken along line 8—8 of Figure 7.

Figure 9 is an enlarged view in detail of the oil strainer of the oil pressure pump.

Figure 10 is a view in section taken along line 10—10 of Figure 2.

Figure 11 is a diagrammatical front end view showing the engine gear train.

Figure 12 is a diagrammatical rear end view showing the engine gear train.

Referring more particularly to the drawings, the particular embodiment of my invention shown in the drawings comprises an inverted 12 cylinder V-type internal combustion engine, in each bank of cylinders of which there is arranged a crankshaft 1, a camshaft 2 and a flexible shaft 3, which is capable of longitudinal flexing, through which all of the accessories of the engine are driven.

By reference to Figures 1 and 3 it will be noted that the crankshaft terminates forwardly in a flange 4 to which there is bolted at 5 a spline 6 for driving a short flexible shaft 7 which is also capable of longitudinally flexing. This shaft 7 is suitably mounted in frictionless bearings 8 within the forward part of the engine crankcase and is provided with a reduction gear pinion 9 adapted to mesh with a reduction gear 10 carried by the propeller shaft 11 for driving the latter, which is mounted in suitable bearings 12 and 13. The drive from the crankshaft is taken at a point thereon where there is a minimum degree of torsional oscillation, any of which, if present, would be further absorbed by the short flexible shaft 7, which is sufficiently flexible for that purpose and which virtually floats between the pinion 10 and the crankshaft, and the gear train 9, 10 between the short shaft 7 and the propeller shaft 11 which is in close proximity to and forward of the connecting drive between the crankshaft and the short shaft, which latter is slightly forward of the front main bearing.

The short shaft 7 is provided with a gear 14 which meshes with an idler gear 15 carried by a short shaft 16. Gear 15 is adapted to mesh with gear 3' carried by the flexible accessory drive shaft 3 for driving the latter. This drive between the short shaft and the flexible accessory drive shaft 3 is also slightly forward of the front main bearing and consequently subjects the accessory drive shaft to the minimum amount of torsional oscillation. The flexible accessory drive shaft is located near the bottom of the crankcase and extends to the rear of the engine, where it forms the drive unit for the accessories which are located at the rear end of the engine. As shown in Figure 11, shaft 16 also carries a small gear 17 adapted to mesh with gears 18 and 19, which in turn carry bevel gears 20 and 21, which mesh with gears 22 and 23 carried by hollow shafts 24 and 25. These hollow shafts carry lower beveled gears 26 and 27, the latter mesh-

ing with beveled gears 28 and 29, the latter of which is carried by one of the camshafts 2, shown in Figure 5, and the former carried by the other camshaft 2'.

Now referring to Figure 12, which is a diagrammatic view of the rear end, there is provided a gear 30 on the rear end of the flexible accessory drive shaft, which in turn drives a supercharger gear 31, through a gear 32 also carried by the accessory drive shaft. Gear 30 also meshes with a pair of large gears 33 and 34 which carry bevel gears 35 and 36, meshing with gears 37 and 38, carried by rear vertical drive shafts 39 and 40 for driving the various accessories. Drive shaft 40 is adapted to drive an oil pressure pump by means of the latter carrying an oil pressure pump gear 41 and an idler 42 meshing therewith and being carried by the shaft 43. The shaft 40 extends further and may be fitted with a suitable tachometer gear, including the two gears 44 and 45, adapted to mesh with spiral gear 46 carried by the shaft 40. The vertical shaft 40 also carries a bevel gear 47 meshing with a bevel gear 48 carried by a shaft 49 to which a gun synchronizer, as shown in Figures 7 and 8 may be attached. Shaft 39 carries similar bevel gears 47' and 48', the latter of which is carried by a shaft 49', which is also a gun synchronizer shaft and is adapted to drive a bevel gear 50 for causing the operation of the gun synchronizer cam 51. This is actually brought about, as shown in Figures 7 and 8, by the meshing of bevel gear 50 with a large bevel gear 72, which is mounted on the same shaft 73 as the cam 51, which is fitted in the recess 74 of the follower 75. The upper end of shaft 39 forms the means of a connecting drive with the magneto 52, the position of which is shown in Figure 2. The rear end of the crankcase is adapted to be provided with a gear 53 for driving a large idler gear 54 and therethrough a gear 55 carried by a shaft which may drive the generator and starter.

There is also provided a rear downwardly extending drive shaft 56 which is driven by gear 35 through the intermediate bevel gear 57. This shaft 56 carries on its lower extremity a fuel pressure pump gear 58 which, with the idler gear 59 mounted on the shaft 60, constitutes a fuel pressure pump as shown in Figs. 2 and 12.

There is also diagrammatically shown in Figure 12 a pair of oil pressure pumps, one of which is located in the rear end of the crankcase of each bank of cylinders. Each of these pressure oil pumps consists of a central gear 61, an idler gear 62 and a driving gear 63.

Referring now to Figure 6, it will be seen that each scavenger oil pump is driven by the camshaft. In order, however, to further the general purpose of taking off the drive for all of the accessories from shafts at a point where there is the minimum amount of torsional oscillation, I have, instead of locating the point of drive of the oil pumps from the forward end of the camshaft, provided the rear end thereof with a flywheel 64, which I internally spline at 65 so as to provide a small gear 66, which is carried by the same shaft as gear 63, so that the oil pressure pumps may be driven, not directly from the camshaft but indirectly, so that such drives will be effected after the small amount of remaining torsional oscillations of the camshaft have been broken up by the added weight of the flywheel.

The oiling system is of the full force pressure feed type in which the camshaft housing is used as a dry oil sump. Suitable drain pipes, such as that shown at 76 in Figure 5, are employed in each camshaft housing of its respective cylinder bank for carrying off the scavenging oil. The oil, thus collected, is pumped under pressure by a triple gear pressure pump, such as that shown in Figure 6, there being one located on the rear end of each camshaft. This oil is pumped through the discharge pipes 77 and 78 into an exterior tank and again brought into the crankcase through the inlet pipe 79 and forced by the upper oil pressure pump, shown in Figures 2 and 10 into the engine. The oiling system is otherwise similar to that described in my copending application relating to internal combustion engine, Serial Number 582,085, filed December 19, 1931, with the exception that in the present case the accessory drive shaft is located beneath the crankshaft instead of above the same, as in the case of the aforementioned application. In other words the crankshaft, the flexible accessory drive shaft 3 and the camshaft, in the present invention, all act as conveyors for the lubricating medium, and further the driving shafts 25 which extend downwardly to the camshaft to drive the latter are also conveyors for scavening oil from the crankcase as was the case in the aforementioned application.

The supercharger which is driven by the flexible accessory drive shaft at its rear end may be of any suitable construction, comprising essentially the driving shaft 80 upon which its driving gear 31 is mounted, and also a pair of impellers 81 and 82, and the usual baffles, inlets and discharge passages, as shown in Figure 4.

As shown in Figures 6 and 12 the camshaft, besides being the source of drive of the cams and the scavenging oil pumps, also forms the driving means for the distributors. This drive is brought about by introducing a short shaft 90 so as to be co-extensive with the cam shaft and to be driven thereby, so that shaft 90 will rotate a distributor 91 which is suitably arranged in a housing 92, which is located at the rear end of each bank of cylinders and provided with a detachable cover 93.

It is the usual practice in aeronautical engines, because of frontal area in streamlining, to mount the accessories at the anti-flywheel or anti-propeller end and to obtain the accessory drive from the free end of the crankshaft. This is the point, however, in the crankshaft where the maximum torsional oscillation takes place and consequently the rotating masses of the accessory units are thus subjected to this rapid change in angular velocity with the resultant increased wear and decreased life of all these parts. One of the underlying purposes in the present invention that has brought about the substantial rearrangement of the aeronautical internal combustion engine, above described as forming my invention, is to eliminate this because of wear and decreased life of these parts, by relieving the accessory drive gears and shafts and rotating masses of the accessory units from any change in angular velocity, even though these parts do obtain their drive from the actual crankshaft indirectly.

In summary, it will be seen, that first of all the introduction of the short, straight, flexible shaft at the flywheel end of the crankshaft and the provision of the reduction gears between the latter and the propeller shaft provides for a uniform drive of the propeller shaft, with the minimum torsional strain on the driving parts. It will also be seen, that the provision of the flex-

ible accessory drive shaft for driving the accessories located at the rear of the engine and the fact that this drive is transmitted through reduction gears from the short shaft and not the crankshaft, makes for a substantial decrease and practical elimination of any torsional oscillation which might otherwise be transmitted to the various accessories and driving gears and shafts. It will also be seen that the drive for the camshaft is taken from the front end of the engine and that even though the camshaft should not be capable of setting up any great amount of torsional oscillation throughout its length during rotation, still in driving the scavenging oil pumps and distributors at the rear end of each camshaft, precaution is taken against such possibility. In the instance of the scavenging oil pump, a flywheel is provided at the rear end of the camshaft for the purpose of dampening out such oscillations and forms the driving connection between the cam shaft and the driving pinion for the oil pump. The precaution taken in the driving of the distributors consists in the introduction of an additional short shaft co-extensive with the camshaft, so as to dampen out any frequency of oscillation. The gun synchronizers, magneto, pressure oil pump and fuel pressure pump are all directly driven by the rotation of a driving gear located at the rear end of the flexible accessory drive shaft and all of these drives, although indirect, take place in substantial alignment with the rotation of the accessory shaft driving gear. The rear end of the crankshaft is relied upon as a source of drive only for the generator and starter, it being considered ill-advised, in the present specific construction involving such a multiplicity of accessories, to load the drive with any further accessories on the accessory drive shaft. Even in this instance, however, the precaution has been taken to extend the rear end of the crankshaft substantially past the rear main bearing, and to introduce an idler gear between that on the rear end of the crank shaft and the driving gear for the starter and generator.

A further advantageous feature consists in the compact arrangement of the supercharger and the arrangement of its driving shafts and gear, so that its drive is obtained directly from the rear end of the flexible accessory drive shaft and not from the rear end of the crank shaft, for the reasons mentioned in connection with the other accessories arranged at the rear end of the engine.

Having thus described my invention, I claim:

1. In an internal combustion engine having a camshaft, a flywheel mounted on the rear end thereof so as to be driven thereby, and an oil pressure pump driven by said flywheel.

2. In an internal combustion engine having a camshaft, a flywheel mounted on the rear end thereof so as to be driven thereby, an oil pressure pump driven by said flywheel, and a driving shaft connected co-extensively to said camshaft and a distributor driven by said driving shaft.

3. In an aeronautical engine having a propeller shaft, a crankshaft and a short, flexible shaft in alignment with and driven thereby and parallel to said propeller shaft, and reduction driving gears for driving said propeller shaft by said short shaft.

4. In an aeronautical engine having a propeller shaft, a crankshaft and a short, flexible shaft in alignment with and driven thereby and parallel to said propeller shaft, reduction driving gears for driving said propeller shaft by said short shaft, and a flexible accessory drive shaft extending parallel to said crankshaft, reduction and idler gears, for effecting a drive of said accessory drive shaft by said short shaft.

5. In an internal combustion engine having a crankshaft, a flexible accessory drive shaft arranged parallel thereto and driven by means mounted on the flywheel end of said crankshaft, a camshaft driven from the flywheel end of said accessory drive shaft, a plurality of accessories driven directly and indirectly by the anti-flywheel end of said accessory drive shaft, a flywheel arranged on the anti-propeller end of said camshaft, and a gear oil pump driven by said flywheel.

6. In an internal combustion engine having a crankshaft, a flexible accessory drive shaft arranged parallel thereto and driven by means mounted on the flywheel end of said crankshaft, a camshaft driven from the flywheel end of said accessory drive shaft, a plurality of accessories driven directly and indirectly by the anti-flywheel end of said accessory drive shaft, a flywheel arranged on the anti-propeller end of said camshaft, and a gear oil pump driven by said flywheel, a short shaft arranged co-extensive with the anti-propeller end of said camshaft and a distributor driven by said last named shaft.

7. In an internal combustion engine having a crankshaft, a flexible accessory drive shaft arranged parallel thereto and driven by means mounted on the flywheel end of said crankshaft, a camshaft driven from the flywheel end of said accessory drive shaft, a plurality of accessories driven directly and indirectly by the anti-flywheel end of said accessory drive shaft, a flywheel arranged on the anti-propeller end of said camshaft, and a gear oil pump driven by said flywheel, a short flexible shaft in alignment with and driven by said crankshaft in parallel relation to said propeller shaft, and reduction driving gears for driving said propeller shaft by said short shaft.

8. In an internal combustion engine having a crankshaft, a flexible accessory drive shaft arranged parallel thereto and driven by means mounted on the flywheel end of said crankshaft, a camshaft driven from the flywheel end of said accessory drive shaft, a plurality of accessories driven directly and indirectly by the anti-flywheel end of said accessory drive shaft, a flywheel arranged on the anti-propeller end of said camshaft, and a gear oil pump driven by said flywheel, a short shaft arranged co-extensive with the anti-propeller end of said camshaft and a distributor driven by said last named shaft.

9. In an internal combustion engine having a plurality of accessories located at the anti-propeller end thereof, a crankshaft and a flexible accessory drive shaft driven by said crankshaft by means located at the flywheel end of said crankshaft, said accessories being driven by means located at the anti-propeller end of said flexible accessory drive shaft and consisting of gun synchronizers, fuel pressure pump, pressure oil pump, supercharger, and a tachometer.

10. In an internal combustion engine having a plurality of accessories located at the anti-propeller end thereof, a crankshaft and a flexible accessory drive shaft driven by said crankshaft by means located at the flywheel end of said crankshaft, said accessories being driven by means located at the anti-flywheel end of said flexible accessory drive shaft and consisting of gun synchronizers, fuel pressure pump, pressure

oil pump, supercharger, a tachometer, and a propeller shaft indirectly driven by said crankshaft through the medium of a short flexible shaft arranged co-extensive with the flywheel end of said crankshaft so as to be driven thereby, and reduction gears on said propeller shaft and said short shaft in operating engagement with each other.

11. In an internal combustion engine having a plurality of accessories located at the anti-propeller end thereof, a crankshaft and a flexible accessory drive shaft driven by said crankshaft by means located at the flywheel end of said crankshaft, said accessories being driven by means located at the anti-flywheel end of said flexible accessory drive shaft and consisting of gun synchronizers, fuel pressure pump, pressure oil pump, supercharger, a tachometer, and a propeller shaft indirectly driven by said crankshaft through the medium of a short flexible shaft arranged co-extensive with the flywheel end of said crankshaft so as to be driven thereby, reduction gears on said propeller shaft and said short shaft in operating engagement with each other, a camshaft driven by means extending from the propeller end of said flexible accessory drive shaft, said camshaft being provided with a flywheel at its anti-propeller end, and a scavenging oil pump adapted to be driven by said flywheel.

12. In an internal combustion engine having a plurality of accessories located at the anti-propeller end thereof, a crankshaft and a flexible accessory drive shaft driven by said crankshaft by means located at the flywheel end of said crankshaft, said accessories being driven by means located at the anti-flywheel end of said flexible accessory drive shaft and consisting of gun synchronizers, fuel pressure pump, pressure oil pump, supercharger, a tachometer, and a propeller shaft indirectly driven by said crankshaft through the medium of a short flexible shaft arranged co-extensive with the flywheel end of said crankshaft so as to be driven thereby, reduction gears on said propeller shaft and said short shaft in operating engagement with each other, a camshaft driven by means extending from the propeller end of said flexible accessory drive shaft, said camshaft being provided with a flywheel at its anti-propeller end, and a scavenging oil pump adapted to be driven by said flywheel, a short shaft arranged co-extensive with said anti-propeller end of said camshaft so as to be driven thereby, and a distributor adapted to be driven by said last named short shaft.

13. In an internal combustion engine having a plurality of accessories located at the anti-propeller end thereof, a crankshaft and a flexible accessory drive shaft driven by said crankshaft by means located at the flywheel end of said crankshaft, said accessories being driven by means located at the anti-propeller end of said flexible accessory drive shaft and consisting of gun synchronizers, fuel pressure pump, pressure oil pump, supercharger, and a tachometer, a camshaft driven by means extending from the propeller end of said flexible accessory drive shaft, said camshaft being provided with a flywheel at its anti-propeller end, and a scavenging oil pump adapted to be driven by said flywheel.

14. In an internal combustion engine having a plurality of accessories located at the anti-propeller end thereof, a crankshaft and a flexible accessory drive shaft driven by said crankshaft by means located at the flywheel end of said crankshaft, said accessories being driven by means located at the anti-propeller end of said flexible accessory drive shaft and consisting of gun synchronizers, fuel pressure pump, pressure oil pump, supercharger, and a tachometer, a short shaft arranged co-extensive with said anti-propeller end of said camshaft so as to be driven thereby, and a distributor adapted to be driven by said last named short shaft.

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