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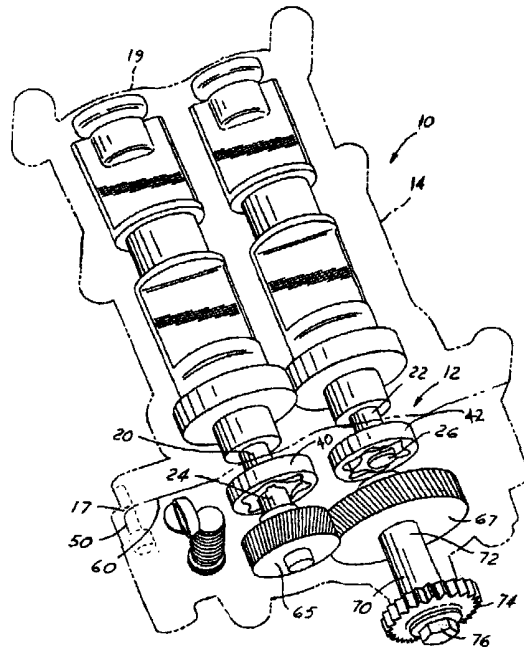
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(56) Documents Cited:  
**EP 1319809 A** **WO 2000/015976 A**  
**JP 2001099233 A** **US 6601557 B**  
**US 6189499 B** **US 5535643 A**

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UK CL (Edition V) **F1F, F1M**  
INT CL<sup>7</sup> **F04C, F16F**  
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(54) Abstract Title: **Balance shaft and fluid pump assembly**

(57) A dual fluid pump assembly 40, 42 is driven by respective shafts 20, 22 of a dual balancing shaft assembly 10 for the engine of an automotive vehicle. A shaft housing 14 comprises upper and lower portions rotatably and supports primary and secondary balancing shafts of the dual balancing shaft assembly. The shafts are coupled by gears for rotating the primary and secondary balance shafts in opposite directions. Each shaft includes a distal end 24, 26 for supporting and driving a fluid pump 40, 42. A pump housing 50 is fixedly secured to the shaft housing 14 for enclosing the fluid pump and retaining fluid therebetween. The pumps are disposed adjacent the shaft housing and within a seal formed by the shaft housing and pump housing.



**FIG. 2**

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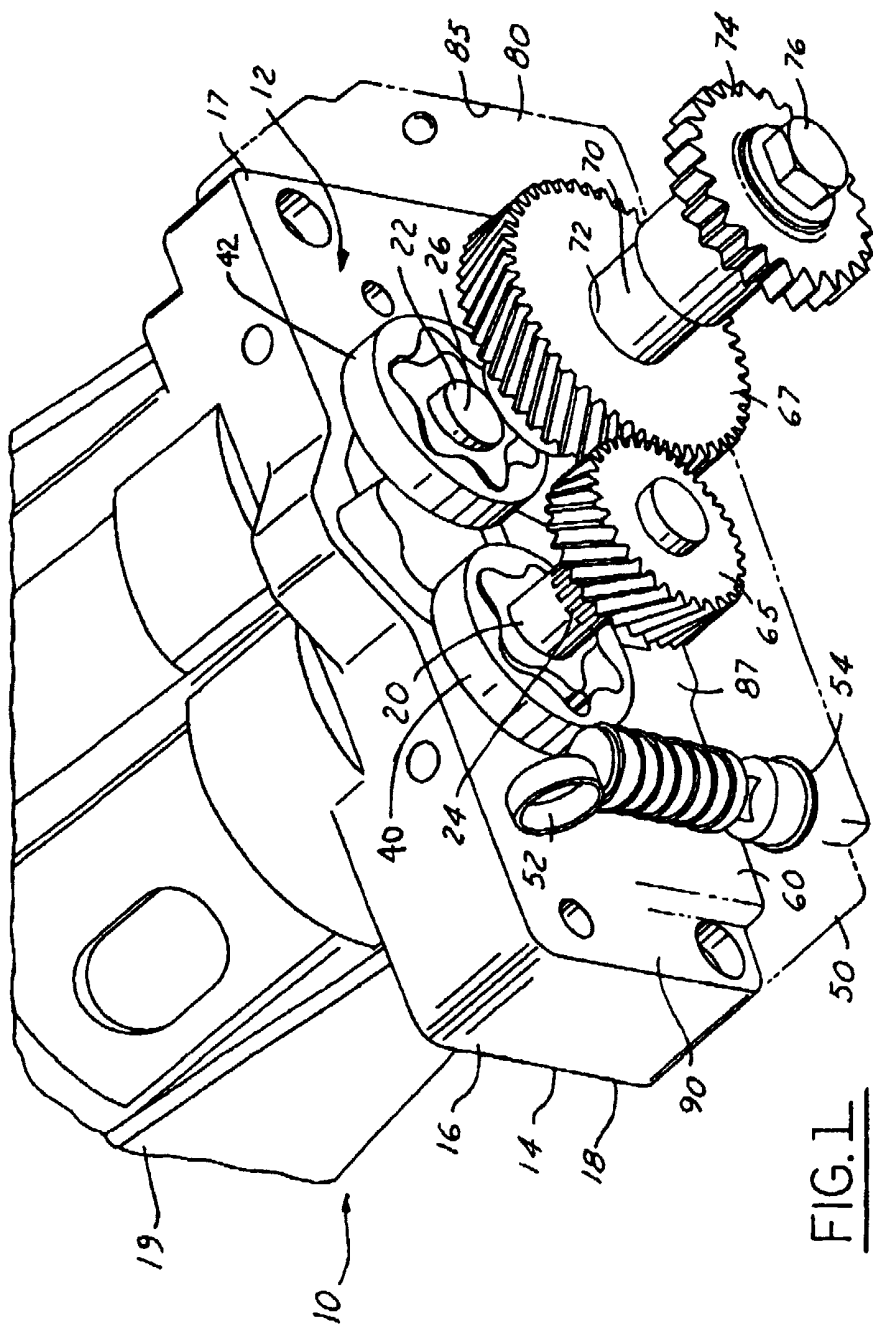


FIG. 1

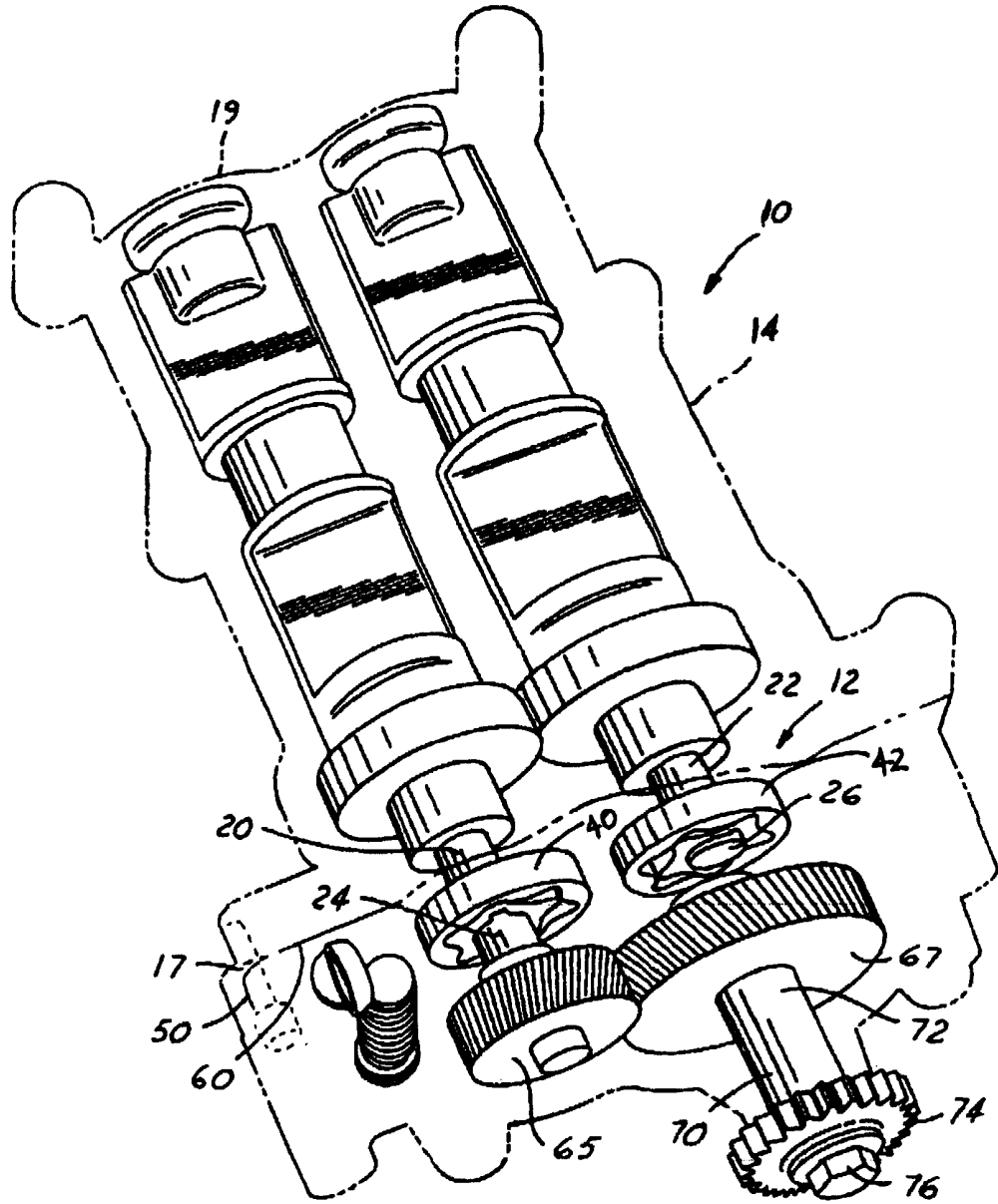


FIG. 2

## DUAL BALANCE SHAFT PUMP ASSEMBLY

### 1. Field of the Invention

The invention relates to a fluid pump system for an engine in an automotive  
5 vehicle, and more particularly, to a dual fluid pump system wherein each pump is driven  
by a respective shaft of a dual balance shaft system in the engine.

### 2. Description of the Prior Art

Automotive vehicles typically include a fluid pump assembly for circulating and  
10 delivering oil to the moving components of an engine. It is well known in the art to  
drive the fluid or oil pump assembly with a crankshaft from the engine.

An engine may also include a dual balance shaft assembly for reducing engine  
vibration and noise due to reciprocating pistons and rods in the engine. The engine  
crankshaft typically drives the dual balance shaft assembly. The dual balance shafts are  
15 driven in opposite directions by the crankshaft to offset each other's inertial moments  
and offset vibrations due to the reciprocal motion of the pistons and rods. However, it is  
common for the dual balance shaft assembly to cause vibration and noise within the  
engine. It is known to drive an oil pump assembly with a shaft from a balancing shaft  
assembly of the engine, rather than using the crankshaft for minimizing vibration and  
20 noise due to the rotation of the dual balance shafts. Typically, the dual balance shaft  
assembly is enclosed between first and second halves of a balance shaft housing and the  
oil pump assembly is enclosed between first and second halves of an oil pump housing.  
The balance shaft and oil pump housings are fixedly secured to each other by bolts.

It remains desirable to provide an oil pump assembly that reduces vibration and  
25 noise due to the dual balance shaft assembly, while providing increased oil pump  
efficiency over conventional oil pump designs. Further, it remains desirable to provide  
a simplified, cost effective dual balance shaft and oil pump assembly that uses fewer  
components than conventional dual balance shaft and oil pump assembly designs.

According to one aspect of the invention, a balance shaft and fluid pump  
5 assembly for an engine of an automotive vehicle is provided including a balance shaft  
housing extending between opposite first and second ends. The balance shaft housing  
terminates at the first end at a face. A balance shaft is journaled between the first and  
second ends of the balance shaft housing and has a distal end extending axially from the  
first end beyond the face of the balance shaft housing. A fluid pump housing is fixedly  
10 secured to the first end of the balance shaft housing for defining a fluid seal. A fluid  
pump is operatively coupled to the distal end of the balance shaft for driving the fluid  
pump by rotation of the balance shaft. The fluid pump is disposed within the seal and  
adjacent the face of the balance shaft housing.

15 By way of example only, a specific embodiment of the present invention will  
now be described, with reference to the accompanying drawings, in which:-

Figure 1 is a partial perspective view of a dual balance shaft and fluid pump  
assembly for an engine of an automotive vehicle;

20 Figure 2 is a top perspective view of a dual balance shaft and fluid pump  
assembly for an engine of an automotive vehicle.

Referring to Figure 1, there is shown a dual balance shaft assembly 10 and a  
dual oil pump assembly 12 for an automotive engine of the present invention. The dual  
balance shaft assembly 10 includes a shaft housing 14 having upper and lower halves  
25 16, 18 each extending between opposite first and second ends 17, 19. A primary shaft  
20 and a secondary shaft 22 are rotatably journaled between the upper and lower halves  
16, 18 at the first and second ends 17, 19 of the shaft housing 14 for rotational  
movement within a cavity defined between the upper and lower halves 16, 18. Within  
the cavity of the shaft housing 14, the primary and secondary shafts 20, 22 are coupled  
30 by a gear assembly as best seen in Figure 2, for rotating the secondary shaft 22 in the  
opposite direction to the primary shaft 20 in response to rotation of the primary shaft 20.

Both the primary and secondary shafts 20, 22 include distal ends 24, 26 extending axially outwardly from the first end 17 beyond a face 60 of the shaft housing 14.

In a preferred aspect of the present invention, the distal end 24 of the primary shaft 20 extends axially beyond the pump housing 50 and includes a sprocket 65 that mates with a sprocket 67 of an intermediate shaft 70. The intermediate shaft 70 has the sprocket 67 disposed at a first end 72 and a gear 74 disposed on the second end 76. The gear 74 is driven by a crankshaft (not shown), or alternatively a belt or chain from the engine. In this manner a rotational force is transferred to the primary shaft 20 which in turn drives the secondary shaft 22 of the dual balance shaft assembly 10. While the pictured preferred embodiment utilizes an intermediate shaft 70 to transfer force from a crankshaft, other drive mechanisms may be utilized by the present invention. For example, the primary shaft 20 may be directly linked to the crankshaft without the use of an intermediate shaft 70.

A pump housing 50 is fixedly secured to the first end 17 of the shaft housing 14 by bolts to form a seal 90 and retain fluid between the shaft and pump housings 14, 50. In a preferred aspect of the present invention the pump housing 50 comprises a single piece body having inner and outer surfaces 80, 85. The seal 90 comprises a cavity 87 defined by the face 60 of the balance shaft housing 14 and the inner surface 80 of the pump housing 50. A gasket may be sandwiched between the shaft and pump housings 14, 50 to improve the retention of fluid within the seal 90.

The pump housing 50 includes an inlet 52 and outlet 54 for allowing circulation of fluid in and out of the housing 50 caused by the operation of the pumps 40, 42, which will be discussed in more detail below. In a preferred aspect, the outlet 54 includes a pressure relief valve associated therewith to maintain an oil demand for the engine.

A primary fluid pump 40 is mounted to and driven by the primary shaft 20 at the distal end 24 of the shaft 20 beyond the first end 17 of the shaft housing 14 and adjacent the face 60. Similarly, a secondary fluid pump 42 is mounted to and driven by the distal end 26 of the secondary shaft 22, adjacent the face 60. The primary and secondary fluid pumps 40, 42 are positioned within the seal 90 to transport fluid within the seal to the engine. The positioning of the primary and secondary pumps adjacent the face 60 of the shaft housing 14 reduces the overall size of the dual oil pump assembly

12. Also a cost savings may be realized by eliminating pumps having a separate two-piece housing that is mounted to the dual balance shaft assembly 12. In a preferred aspect of the present invention, the primary and secondary fluid pumps 40, 42 are gerotor-type fluid pumps, as commonly known by those having ordinary skill in the art. Other pumps, such as gear pumps, vane pumps or crescent pumps may be utilized by the present invention. Also, while the pictured preferred embodiment utilizes primary 40 and secondary 42 pumps, a single pump may also be utilized that is linked to the primary shaft, as previously described above, without the use of a secondary pump 42.

10 In operation, the primary shaft 20 is driven by the intermediate shaft 70 which in turn is driven by the crankshaft from the engine. The gear assembly within the balance shaft housing 14 linking the primary 20 and secondary 22 shafts causes the secondary shaft 22 to rotate in response to the rotation of the primary shaft 20. The primary and secondary shafts 20, 22 rotate in opposite directions. The rotational speed of the primary and secondary shafts 20, 22 changes in direct proportion to the rotational speed of the crank shaft 32. Rotation of the primary and secondary shafts 20, 22 actuates the primary and secondary pumps 40, 42 located adjacent the front face 60 of the shaft housing 14 to circulate fluid between the inlet and outlet 52, 54 of the pump housing 50. The seal 90 formed between the shaft and pump housing 14, 50 retains the fluid between the shaft and pump housings 14, 50 for movement by the pumps 40, 42.

The invention has been described in an illustrative manner, and it is to be understood that the terminology, which has been used, is intended to be in the nature of words of description rather than of limitation.

25 Many modifications and variations of the present invention are possible in light of the above teachings. It is, therefore, to be understood that within the scope of the appended claims, the invention may be practised other than as specifically described.

CLAIMS

1. A balance shaft and fluid pump assembly for an engine of an automotive vehicle comprising:
  - a balance shaft housing extending between opposite first and second ends, the  
5 housing terminating at a face at the first end;
  - a balance shaft journaled between the first and second ends of the balance shaft housing and having a distal end extending axially from the face of the balance shaft housing;
  - a fluid pump housing fixedly secured to the first end of the balance shaft housing  
10 for defining a fluid seal;
  - a fluid pump operatively coupled to the distal end of the balance shaft for driving the fluid pump by rotation of the balance shaft, the fluid pump being disposed within the seal and adjacent the face of the balance shaft housing.
2. The balance shaft and fluid pump assembly of Claim 1 wherein the balance shaft  
15 housing comprises upper and lower portions extending between the opposite first and second ends.
3. The balance shaft and fluid pump assembly of Claim 1 or claim 2 wherein first and second balance shafts are positioned parallel to each other and are journaled  
20 between the first and second ends of the balance shaft housing for rotation in opposite directions.
4. The balance shaft and fluid pump assembly of Claim 3 wherein main and secondary fluid pumps are coupled to the first and second balance shafts at distal ends of the shafts.
5. The balance shaft and fluid pump assembly of any of Claims 1 to 4 wherein the  
25 fluid pump comprises a gerotor fluid pump.
6. The balance shaft and fluid pump assembly of any of Claims 1 to 5 wherein the fluid pump housing comprises a single piece body attached to the balance shaft housing.
7. The balance shaft and fluid pump assembly of any of Claims 1 to 6 wherein the fluid seal comprises a cavity defined by the face of the balance shaft housing and an  
30 inner surface of the fluid pump housing.



8. The balance shaft and fluid pump assembly of Claim 7 wherein the fluid pump housing includes an inlet and outlet formed from an outer surface of the housing through the inner surface of the housing.
9. The balance shaft and fluid pump assembly of Claim 8 wherein the outlet  
5 includes a pressure relief valve for maintaining an oil demand in an engine.
10. A balance shaft and fluid pump assembly for an engine of an automotive vehicle comprising:  
a balance shaft housing extending between opposite first and second ends, the housing terminating at a face at the first end;
- 10 a balance shaft journaled between the first and second ends of the balance shaft housing and having a distal end extending axially from the face of the balance shaft housing;
- a fluid pump housing fixedly secured to the first end of the balance shaft housing for defining a fluid seal, the seal comprising a cavity defined by the face of the balance  
15 shaft housing and an inner surface of the fluid pump housing;
- a fluid pump operatively coupled to the distal end of the balance shaft for driving the fluid pump by rotation of the balance shaft, the fluid pump being disposed within the seal and adjacent the face of the balance shaft housing.
11. A balance shaft and fluid pump assembly for an engine of an automotive vehicle  
20 comprising:  
a balance shaft housing extending between opposite first and second ends, the housing comprising upper and lower portions extending between the opposite first and second ends and terminating at a face at the first end;
- a balance shaft journaled between the first and second ends of the balance shaft  
25 housing and having a distal end extending axially from the face of the balance shaft housing;
- a fluid pump housing comprising a single piece body fixedly secured to the first end of the balance shaft housing for defining a fluid seal;
- a fluid pump operatively coupled to the distal end of the balance shaft for  
30 driving the fluid pump by rotation of the balance shaft, the fluid pump being disposed within the seal and adjacent the face of the balance shaft housing.

12. A balance shaft and fluid pump assembly substantially as herein described with reference to, and as illustrated in, the accompanying drawings.
13. An automotive vehicle engine comprising a balance shaft and fluid pump assembly as claimed in any of the preceding claims.
- 5 14. An automotive vehicle comprising an engine as claimed in claim 13.



INVESTOR IN PEOPLE

Application No: GB 0312422.9  
Claims searched: 1-14

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Examiner: Peter Middleton  
Date of search: 13 November 2003

### Patents Act 1977 : Search Report under Section 17

#### Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1-11,13-14	EP 1319809 A (HONDA) see figure 8 and
X	1-11,13-14	US 5535643 A (GARZA) See figures and column 2 line 52
X	1-5, 7-10, 13-14	US 6189499 B (HONDA) see figures
A		JP 2001099233 A (KUBOTA) see WPI abstract Accession Number 2001-350940
A		WO 0015976 A (TROCHOCENTRIC) see WPI abstract Accession Number 2000-196637
A		US 6601557 B (HAYMAN)

#### Categories:

X Document indicating lack of novelty or inventive step	A Document indicating technological background and/or state of the art.
Y Document indicating lack of inventive step if combined with one or more other documents of same category.	P Document published on or after the declared priority date but before the filing date of this invention.
& Member of the same patent family	E Patent document published on or after, but with priority date earlier than, the filing date of this application.

#### Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC<sup>y</sup>:

F1F  
F1M

Worldwide search of patent documents classified in the following areas of the IPC<sup>7</sup>:

F16F

The following online and other databases have been used in the preparation of this search report:

EPODOC, WPI, JAPIO