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(54) **Title:** OIL SUMP BALANCE SHAFT ASSEMBLY FOR AN ENGINE AND METHOD OF BALANCING THE ENGINE

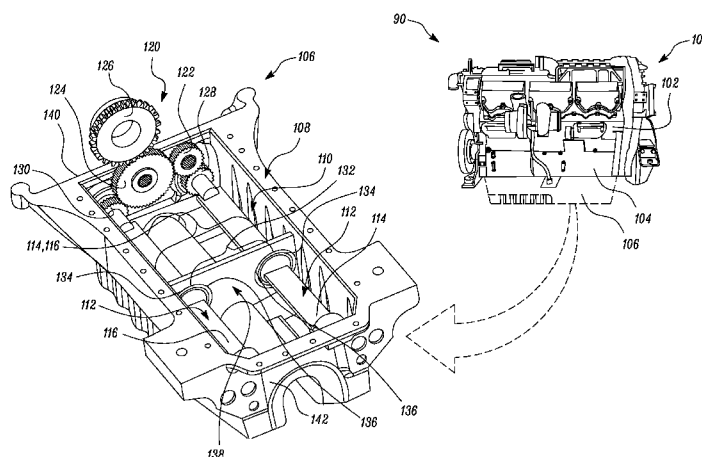


FIG. 1

(57) **Abstract:** An oil sump assembly for an engine. The oil sump assembly includes a housing defining a cavity and at least one balancing mechanism. The balancing mechanism is mounted to the housing and positioned within the cavity. The cavity is configured to store oil. The balancing mechanism is configured to at least partially support the engine.

OIL SUMP BALANCE SHAFT ASSEMBLY FOR AN ENGINE AND METHOD OF BALANCING THE ENGINE

Description5 Technical Field

The present disclosure relates to the field of engine balancing. In particular, the present disclosure relates to a balancing mechanism mounted to an oil sump of an engine.

Background

10 Some engine configurations have inherent out of balance forces causing increased NVH (Noise, vibration and harshness) in the engine which can affect the machine in which it is installed and/or its surroundings. It is therefore established practice for some engine variants to be fitted with rotating shafts and masses that develop balancing effects to oppose and counter the engine's natural
15 out of balance forces.

Some engines are "rigidly" installed in machines. Rigidly means there is no compliant medium in the mounting brackets to isolate the engine NVH from the chassis. An example of such a machine type could be a frameless agricultural tractor. Such installations commonly require an engine balancer
20 system, particularly with in line engines, to reduce the NVH impact on driver and environment.

Completely assembled engine variants may be either balanced or unbalanced. Unbalanced versions can be applied in isolated installations and balanced applied in rigid installations. Preparing every engine core to
25 accommodate a balancer system even if one is not subsequently fitted drives cost and complexity into all engine cores.

US Patent No. 8,857,399 discloses a counter rotating mass system configured to be applied to an inline-four internal combustion engine for balancing the second-order alternate forces generated on the driving shaft of said

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engine. The document discloses a counter rotating eccentric mass system projecting from the opposite sides of a central support and fixed to a fixed wall of the engine.

Summary of the Invention

5 The present disclosure provides for an oil sump assembly for an engine. The oil sump assembly includes a housing defining a cavity and at least one balancing mechanism mounted to the housing and positioned within the cavity. The cavity is configured to store oil. The balancing mechanism is configured to at least partially support the engine.

10 The present disclosure further provides for an engine system. The engine system includes an engine, an oil sump, at least one balancing mechanism mounted to and positioned within the oil sump and a drive assembly. The balancing mechanism is configured to at least partially support the engine. The drive assembly is configured to drive the balancing mechanism.

15 In yet another aspect, a method of balancing an engine in an engine system having an oil sump assembly is disclosed. The method includes mounting at least one balancing mechanism to the oil sump assembly. The method further includes drivably coupling the balancing mechanism to a crankshaft of the engine.

20 Brief Description of the Drawings

FIG. 1 illustrates an engine having an oil sump assembly in accordance with an embodiment.

FIG. 2 illustrates a partially exploded view of the oil sump assembly in accordance with an embodiment.

25 FIG. 3 is a flow chart illustrating a method of balancing the engine in accordance with an embodiment.

Detailed Description

Reference will now be made in detail to embodiments of the invention, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers will be used throughout the
5 drawings to refer to the same or like parts.

FIG. 1 illustrates an exemplary engine system 90 comprising an engine 100. The engine 100 may include a spark ignited engine or a compression ignition engine. The engine 100 can be operating on a two stroke cycle, four stroke cycle or on multiple cycles. One may also contemplate that the engine 100
10 may be operated on petrol, diesel, gas, methanol, biodiesel or any other suitable fuel. The engine 100 may be configured to be used in various industries such as, for example, construction, underground mining, open pit mining, power generation etc. The engine 100 may also be fitted in a passenger car or an off-highway vehicle or a construction machine or a heavy earth mover or in a power
15 plant or an agricultural tractor.

As shown in FIG. 1, the engine 100 may include a cylinder block 102, a crankcase 104 and an oil sump assembly 106. The cylinder block 102 is coupled to the crankcase 104. The crankcase 104 is coupled to the oil sump assembly 106. In an alternate embodiment of the engine 100, the cylinder block
20 102 and the crankcase 104 may be integrated. The cylinder block 102, the crankcase 104 and the oil sump assembly 106 may be coupled by any temporary coupling means such as a coupler, a pin, a bolt, a screw etc. or by permanent coupling means like brazing, soldering, welding, adhesives or any other mechanism generally known in the art. Although in the embodiment described
25 here there is no sealing means shown, a sealing means like a gasket, a seal or any such sealing material or device may be used.

FIG. 1 further shows the oil sump assembly 106 according to an embodiment of the present disclosure. The oil sump assembly 106 may include a housing 108. The housing 108 may be made using sheet metal, cast iron,

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synthetics, a combination of metal and synthetics or any other material known in the art. The housing 108 may define a cavity 110 configured to store oil. The cavity 110 may be of any shape feasible to store lubricating oil for the engine 100. The lubricating oils thwart conversion of kinetic energy into heat by
5 reducing friction between various components of the engine 100 and consequently protects the engine 100 from any substantial wear. The creation of a film of lubricating oil on various components of the engine 100 inhibits oxidation and prevents corrosion. The commonly used lubricating oils are petroleum hydrocarbon based with additives to have an optimum viscosity,
10 higher flash point and better cooling properties.

The housing 108 may include at least one balancing mechanism 112 mounted to the housing 108 and positioned within the cavity 110. The balancing mechanism 112 is configured to reduce vibrations being created due to inherent unbalanced forces of the engine 100. Further, the balancing mechanism
15 112 is configured to at least partially support the engine 100. The balancing mechanism 112 may include a pair of balancer shafts (114, 116). The pair of balancer shafts (114, 116) may be equally sized eccentric weights. The pair of balancer shafts (114, 116) include a first balancer shaft 114 and a second balancer shaft 116. Furthermore, the first balancer shaft 114 and the second balancer shaft
20 116 are disposed substantially parallel to a crankshaft 118 (shown in FIG. 2) and also lie substantially parallel to each other inside the housing 108 of the oil sump assembly 106. The first balancer shaft 114 and the second balancer shaft 116 may be rotatably mounted in the housing 108. The first balancer shaft 114 and the second balancer shaft 116 may rotate in opposite directions to substantially
25 balance out any unbalanced force of the engine 100 creating NVH (Noise, vibration and harshness) issues. In an embodiment, the first balancer shaft 114 and the second balancer shaft 116 may rotate at twice the speed of the engine 100.

As shown in FIG. 1, the housing 108 may include a drive assembly 120. The drive assembly 120 may be configured to drive the balancing

mechanism 112. In an embodiment, the drive assembly 120 may include a first idler gear 122 and a second idler gear 124. The first idler gear 122 and the second idler gear 124 are rotatably coupled to the crankshaft 118 (shown in FIG. 2). In an embodiment of the present disclosure, the first idler gear 122 and the second idler gear 124 may be rotatably coupled to the crankshaft 118 (shown in FIG. 2) via a crankshaft gear 126.

As shown in FIG. 1, the first idler gear 122 may be rotatably coupled to a first driven gear 128 and the second idler gear 124 may be rotatably coupled to a second driven gear 130. The first driven gear 128 may be driving the first balancer shaft 114 and the second driven gear 130 may be driving the second balancer shaft 116. Although the drive assembly 120 is contemplated for driving the pair of balancer shafts (114, 116), other suitable driving assemblies known to a person skilled in the art would also apply.

The housing 108 may include at least one support structure 132. The support structure 132 may enable the rotatable mounting of the balancing mechanism 112 or the drive assembly 120. One may contemplate that one support structure 132 may be placed at each location on the housing 108 where the balancing mechanism 112 is rotatably mounted. The support structure 132 may include at least one bearing 134. The bearing 134 may be a ball bearing, a roller bearing, a magnetic bearing or any other bearing enabling rotational movement. The support structure 132 may include at least one hole 136 or at least one mounting member 138. In the embodiment, two holes 136 are placed in the mounting member 138 for rotatably supporting the pair of balancer shafts (114, 116). The bearing 134 is placed in the hole 136.

The housing 108 may further include at least one mounting member 138. The mounting member 138 may be placed between a first end 140 and a second end 142 of the housing 108. The mounting member 138 may be used to further rotatably support the balancing mechanism 112. The mounting member 138 may include the support structure 132. It must be understood that

although only one mounting member 138 is shown in the embodiment, the actual number may depend upon the shape and size of the balancing mechanism. Also, one may contemplate that a need for the mounting member 138 may only arise in a case of wobbling of the balancing mechanism 112, which generally depends on
5 shape and size of the balancing mechanism 112.

In an embodiment of the present disclosure, a partially exploded oil sump assembly 106 is illustrated in FIG. 2. As shown in FIG. 2, the crankshaft gear 126 is mounted on the crankshaft 118. The housing 108 may include support structures for mounting the balancing mechanism 112 or the first
10 idler gear 122 or the second idler gear 124. Such support structures may be brackets or holes defined in the housing 108. As illustrated in FIG. 2, the hole 136 may be defined in the housing 108 of the oil sump assembly 106 for mounting the balancing mechanism 112 and/or the first idler gear 122 and the second idler gear 124. In the embodiment, six holes 136 are defined in the
15 housing 108. Two holes 136 are required to mount the first driven gear 128 and the second driven gear 130. Two more holes 136 are required to mount the ends of the pair of balancer shafts (114,116) opposite to the first driven gear 128 and the second driven gear 130. Two holes 136 are for the mounting of the first idler gear 122 and the second idler gear 124.

20 As shown in FIG. 2, the six holes 136 may individually include the bearing 134 to rotatably mount the balancing mechanism 112. In the embodiment, the housing 108 may include at least one core plug 144. In the embodiment, four core plugs are defined in the housing 108 of the oil sump assembly 106. Two core plugs 144 are required for the first idler gear 122 and
25 the second idler gear 124. Two more core plugs 144 are required for the first balancer shaft 114 and the second balancer shaft 116.

Industrial Applicability

The present disclosure discloses the engine system 90 having an engine 100. The disclosure provides balancing of the engine 100 to be facilitated

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by the oil sump assembly 106. The disclosure provides for the balancing mechanism 112 to be mounted to and positioned within the oil sump assembly 106 of the engine 100 so that the engine balancing can be effected.

In an aspect of the present disclosure, the oil sump assembly 106
5 having a balancing mechanism 112 is attached to the engine 100 for balancing any unbalanced forces of the engine 100 causing increased NVH (Noise, vibration and harshness) affecting the overall performance. Further the balancing mechanism 112 at least partially supports the engine 100.

The oil sump assembly 106 with the balancing mechanism 112
10 provides for an option to retrofit existing engines without any balancing mechanisms. This is achieved because of the possibility of replacing oil sump of any existing engine with the integral oil sump assembly 106. This also obviates any need of modifying cores of existing engines to place balancing mechanism 112 inside their crankcases or cylinder blocks.

15 In yet another aspect of the present disclosure, a method 300 for balancing the engine 100 having the oil sump assembly 106 is disclosed. Referring to FIG. 3, the method 300 includes following steps. In step 302, at least one balancing mechanism 112 is rotatably mounted to the oil sump assembly 106 of the engine 100. In step 304, the balancing mechanism 112 is
20 drivably coupled to the crankshaft 118 of the engine. In an embodiment, the disclosed method 300 may further include rotatably mounting a first idler gear 122 and a second idler gear 124 between the balancing mechanism 112 and the crankshaft gear 126.

The positioning of the balancing mechanism 112 inside the cavity
25 110 of the housing 108 of the oil sump assembly 106 eases the process of routine repair of the balancing mechanism 112 without the need to disassemble the whole engine. This also obviates the need of any special tool to replace the balancer mechanism 112.

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Claims

1. An oil sump assembly for an engine comprising:
a housing defining a cavity for storing oil; and
5 at least one balancing mechanism mounted to the housing and
positioned within the cavity, the balancing mechanism configured to at least
partially support the engine.
2. The oil sump assembly of claim 1, wherein the balancing
10 mechanism includes a pair of balancer shafts.
3. The oil sump assembly of claim 2, wherein the pair of
balancer shafts are configured to rotate in opposite directions.
- 15 4. The oil sump assembly of any preceding claim, wherein
the housing includes at least one support structure for rotatably mounting the
balancing mechanism.
- 20 5. The oil sump assembly of claim 4, wherein the support
structure includes at least one bearing.
6. The oil sump assembly of any preceding claim, wherein
the oil sump assembly includes a drive assembly.
- 25 7. The oil sump assembly of claim 6, wherein the drive
assembly includes at least one idler gear.
8. An engine system comprising:
an engine;

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an oil sump;

at least one balancing mechanism mounted to the oil sump and positioned within the oil sump, the balancing mechanism configured to at least partially support the engine; and

5 a drive assembly configured to drive the balancing mechanism.

9. The engine system of claim 8, wherein the oil sump assembly includes at least one support structure for mounting the balancing mechanism.

10

10. The engine system of claim 9, wherein the support structure includes at least one bearing.

11. The engine system of any of claims 8 to 10, wherein the
15 balancing mechanism includes a pair of balancer shafts.

12. The engine system of claim 11, wherein the pair of balancer shafts are mounted substantially parallel to each other.

13. The engine system of claim 11 or 12, wherein the pair of
20 balancer shafts rotate in opposite directions.

14. The engine system of any of claims 8 to 13, wherein the drive assembly includes at least one idler gear.

25

15. The engine system of claim 14, wherein the idler gear is rotatably coupled to a crankshaft.

16. The engine system of any of claims 8 to 15, wherein the oil
30 sump assembly is configured to be coupled to a crankcase of the engine.

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17. A method of balancing an engine in an engine system having an oil sump assembly, the method comprising:
- mounting at least one balancing mechanism to the oil sump
5 assembly; and
drivably coupling the balancing mechanism to a crankshaft of the engine.
18. The method of claim 17, wherein drivably coupling the
10 balancing mechanism to the crankshaft includes rotatably mounting at least one idler gear between the balancing mechanism and a crankshaft gear.

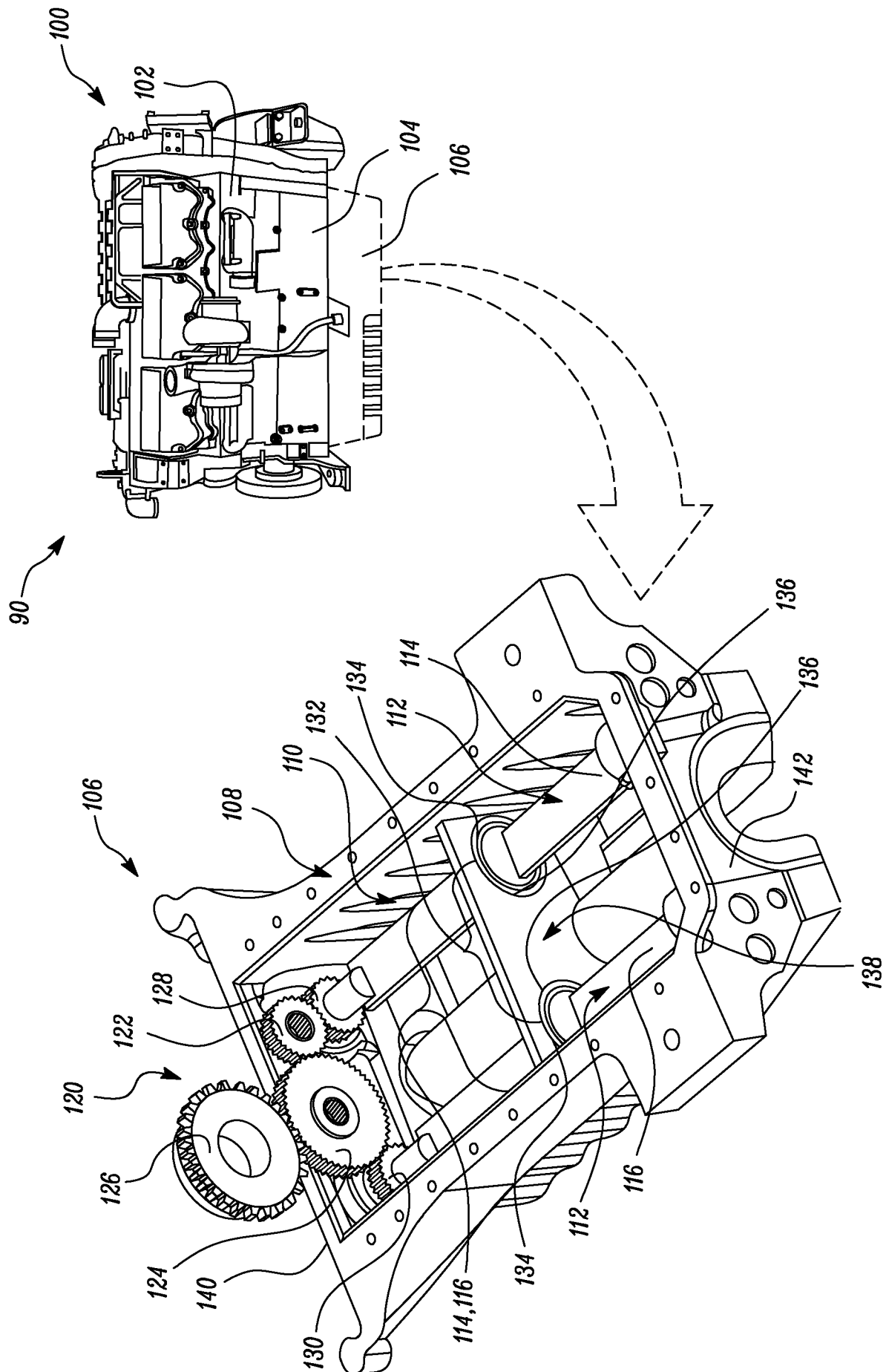


FIG. 1

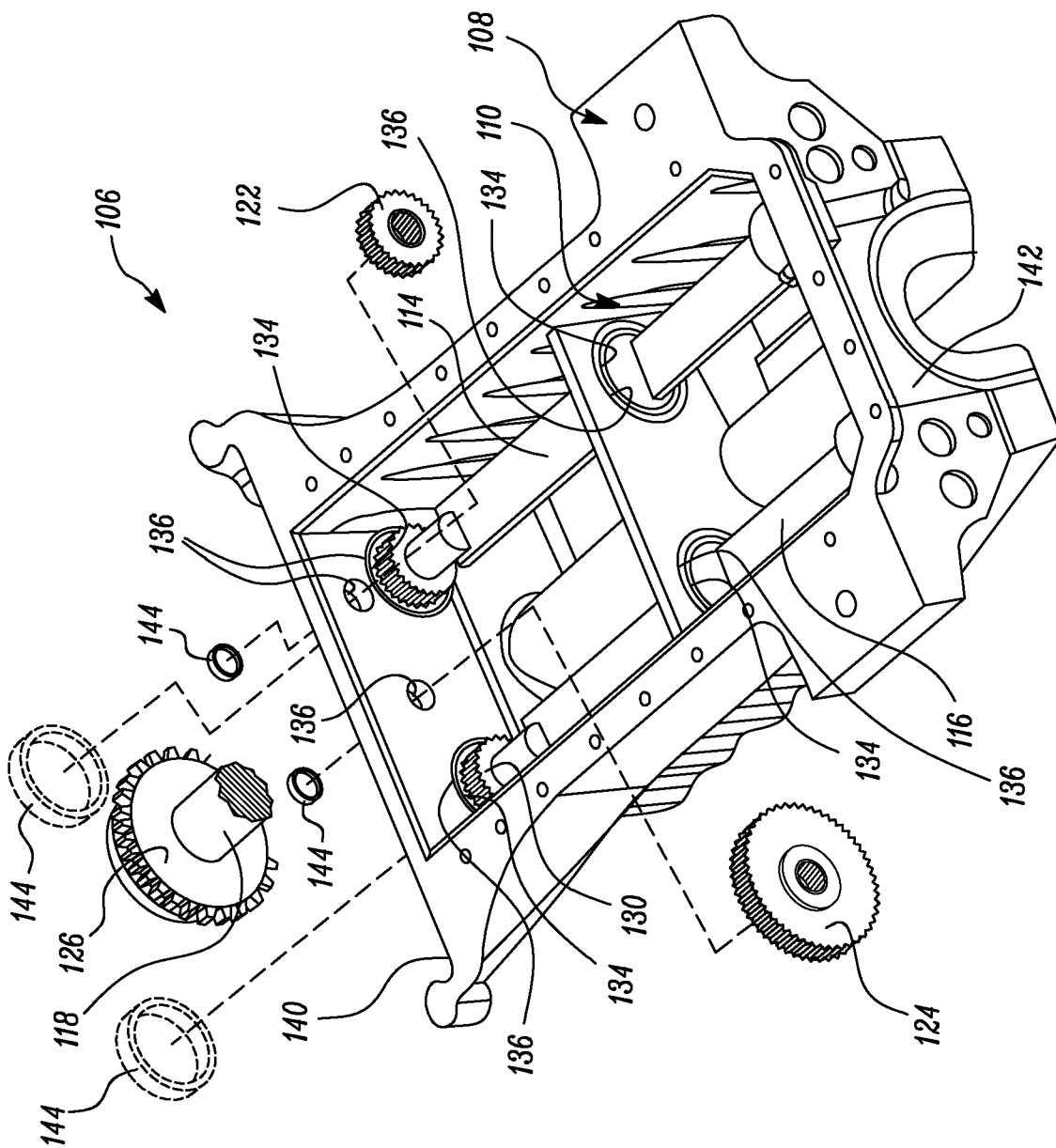


FIG. 2

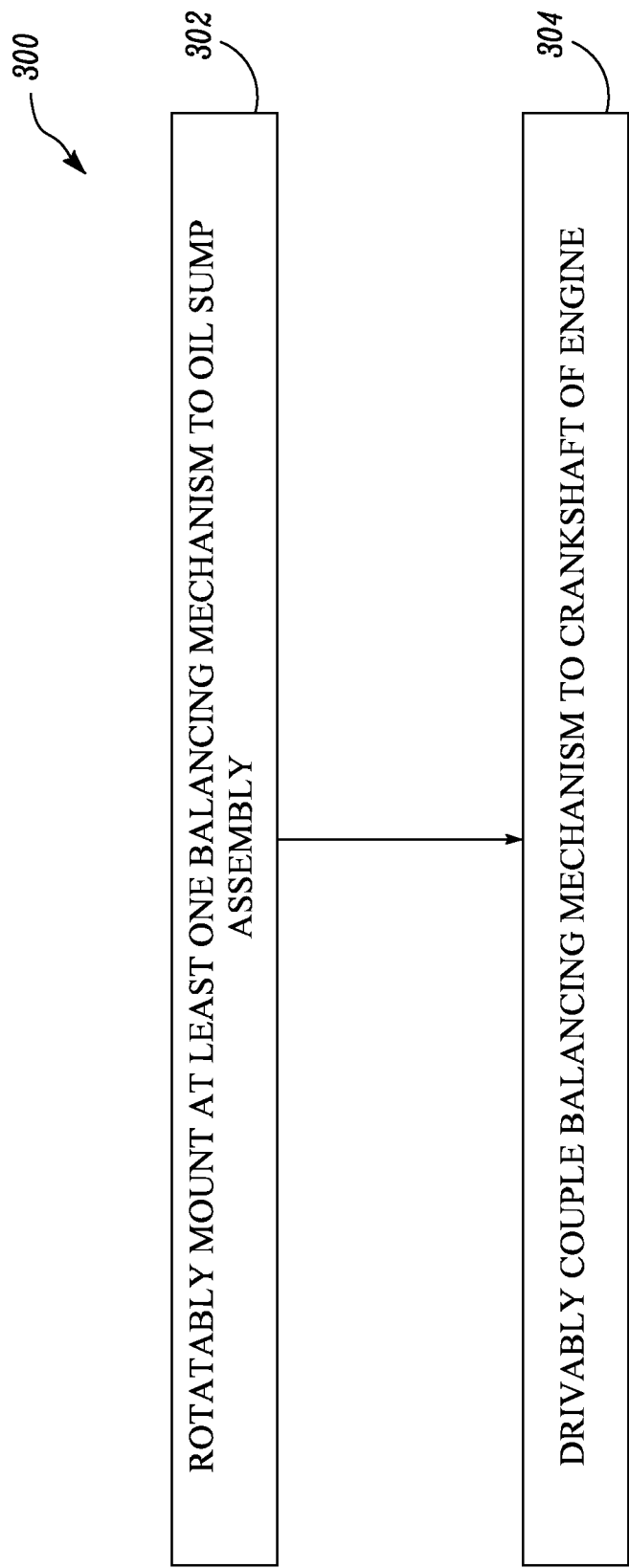


FIG. 3

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/077612

A. CLASSIFICATION OF SUBJECT MATTER
INV. F16F15/26
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F16F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP H05 87193 A (NISSAN MOTOR) 6 April 1993 (1993-04-06) figures 1, 4, 5 paragraphs [0007], [0011], [0014] -----	1-18
X	US 5 000 140 A (BATES KENT C [US] ET AL) 19 March 1991 (1991-03-19) figure 2 -----	1-18
X	DE 102 40 713 A1 (DEUTZ AG [DE]) 18 March 2004 (2004-03-18) figure 1 -----	1-18
X	US 2007/177837 A1 (TISCH SIEGFRIED [DE] ET AL) 2 August 2007 (2007-08-02) figure 5 -----	1-18



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP H0587193	A	06-04-1993	NONE
US 5000140	A	19-03-1991	NONE
DE 10240713	A1	18-03-2004	NONE
US 2007177837	A1	02-08-2007	AT 453806 T 15-01-2010
		AT 453807 T 15-01-2010	
		AT 453808 T 15-01-2010	
		CN 1955500 A 02-05-2007	
		CN 101457708 A 17-06-2009	
		CN 101469645 A 01-07-2009	
		DE 202006020120 U1 11-10-2007	
		DE 202006020558 U1 18-12-2008	
		DE 202006020559 U1 18-12-2008	
		EP 1775484 A2 18-04-2007	
		EP 2014935 A1 14-01-2009	
		EP 2017486 A1 21-01-2009	
		ES 2337076 T3 20-04-2010	
		ES 2337105 T3 20-04-2010	
		ES 2337106 T3 20-04-2010	
		JP 5288086 B2 11-09-2013	
		JP 2007107718 A 26-04-2007	
		KR 20070041345 A 18-04-2007	
		US 2007177837 A1 02-08-2007	