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(71) Applicant *(for all designated States except US)*: **TVS MOTOR COMPANY LIMITED** [IN/IN]; Jayalakshmi Estate, 24 (Old No. 8), Haddows Road, Chennai 600006 (IN).

(72) Inventor; and

(75) Inventor/Applicant *(for US only)*: **NAGARAJA, Krishnabhatta** [IN/IN]; Jayalakshmi Estate, 24 (Old No. 8), Haddows Road, Chennai 600006 (IN).

(74) Agents: **LAKSHMIKUMARAN, Varadachari** et al.; B-6/10, Safdarjung Enclave, New Delhi 110029 (IN).

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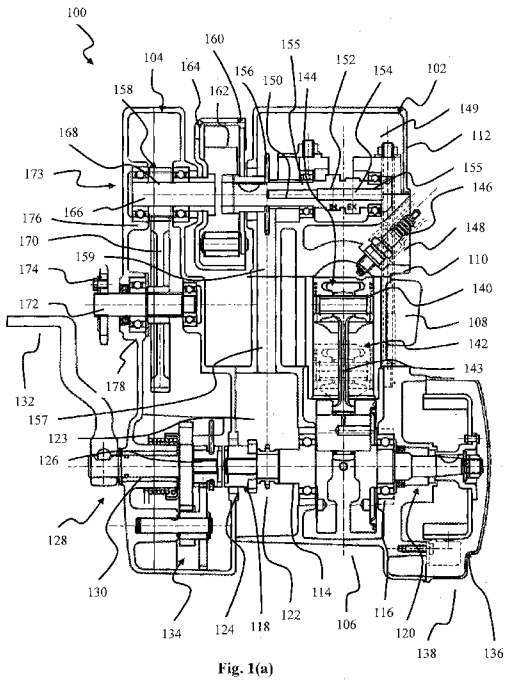


Fig. 1(a)

(57) Abstract: An internal combustion engine (100) is described herein. In an embodiment, the internal combustion engine (100) includes a first engine casing (102) and a second engine casing (104) detachably coupled to the first engine casing (102). The first engine casing (102) houses a crankshaft (114) and a camshaft (150). The crankshaft (114) is coupled to the camshaft (150) to drive the camshaft (150). The second engine casing (104) houses a transmission assembly (173) coupled to the camshaft (150) to receive a drive from the camshaft (150). Further, an output shaft (172) of the transmission assembly (173) provides an output drive.

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INTERNAL COMBUSTION ENGINE

TECHNICAL FIELD

[0001] The subject matter as described herein, in general, relates to internal combustion engines and, in particular, relates to an internal combustion engine.

BACKGROUND

[0002] Conventionally, internal combustion (IC) engines find use in industrial, transport, and marine applications. In transport applications, the IC engines may be used in cars and trucks for variable speed applications and in mopeds in case of single speed applications.

[0003] A typical IC engine includes a cylinder block having one or more cylinder bores and a piston reciprocating in each of the cylinder bore. The reciprocating motion is imparted to the piston by expanding combustion products, produced as a result of ignition of charge in a combustion chamber of the IC engine. The reciprocating motion of the piston is converted into a rotary motion of a crankshaft through a connecting rod. All the components of the IC engine are housed inside an engine casing formed by a crankcase for housing the crankshaft, the cylinder block, and a cylinder head and cylinder head cover. One end of the crankshaft is generally coupled to a clutch, through which the power from the crankshaft is transmitted for providing a final drive.

SUMMARY

[0004] The subject matter described herein relates to an internal combustion engine. In an embodiment, the internal combustion engine includes a first engine casing and a second engine casing detachably coupled to the first engine casing. The first engine casing houses a crankshaft and a camshaft. The crankshaft is coupled to the camshaft to drive the camshaft. The second engine casing houses a transmission assembly coupled to the camshaft to receive a drive from the camshaft. Further, an output shaft of the transmission assembly provides an output drive from the internal combustion engine.

[0005] These and other features, aspects, and advantages of the present subject matter will be better understood with reference to the following description. This summary is provided to introduce a selection of concepts in a simplified form. This summary is not intended to identify key features or essential features of the claimed subject matter, nor is it intended to be used to limit the scope of the claimed subject matter.

BRIEF DESCRIPTION OF DRAWINGS

[0006] The above and other features, aspects, and advantages of the subject matter will be better understood with regard to the following description, appended claims, and accompanying drawings where:

[0007] Fig. 1(a) illustrates a sectional view of an internal combustion (IC) engine, according to an embodiment of the present subject matter.

[0008] Fig. 1(b) illustrates a first housing and a second housing of the IC engine in an exploded view, according to an embodiment of the present subject matter.

DETAILED DESCRIPTION

[0009] The subject matter described herein relates to an internal combustion engine.

[0010] Conventional IC engines usually include a reduction gear assembly coupled to a crankshaft, through a clutch. The reduction gear assembly usually includes an elaborate gear box and serves as a multiplier for the torque generated by the IC engine and transmitted by the crankshaft. The reduction gear assembly is further coupled to an output gear mounted on an output shaft of the IC engine. The reduction gear assembly provides a drive to the output shaft through the output gear, and finally the drive is transmitted to, for example, a wheel of a vehicle.

[0011] In such engines, the reduction gear assembly and the output gear driven by the reduction gear assembly are disposed in proximity to the crankshaft either along a length of the crankshaft or in a lateral direction at the end of the crankshaft, as a result of which the overall size of the IC engine is considerably large. The length of the crankshaft may also

cause bending of the crankshaft when a clutch drum and a clutch shoe of the clutch are fitted on the crankshaft.

[0012] The output gear and a part of the output shaft, along with the crankshaft are generally housed in an engine casing. The engine casing usually includes a crankcase, a cylinder block, a cylinder head, and a cylinder head cover of the IC engine encasing the various components of the IC engine. The crankcase, the cylinder block and the cylinder head may be integrated to form a single piece of engine casing, covered by the cylinder head on top, to allow easy servicing of components, such as valve assemblies, in the cylinder head of the engine.

[0013] Further, the engine casing housing the components of the IC engine is metallic and usually formed as an integrated unit. As a result, the IC engine lacks flexibility to accommodate any variations in the configuration of the engine, the reduction gear assembly, or both. The servicing of the components of the IC engine, such as the clutch and the reduction gear assembly, also becomes difficult as a result of such a construction of the engine casing.

[0014] Further, a cranking mechanism is coupled to the crankshaft for cranking the IC engine during starting the IC engine. For example, in case of a moped, a kick starter is provided at one end of the crankshaft for a user to crank and start the IC engine. The kick starter is usually provided on the end of the crankshaft, which protrudes outside the engine housing. The provision of the cranking mechanism on a far end of the long crankshaft may lead to further bending of the crankshaft, and hence may hamper the operation of the IC engine.

[0015] Additionally, a reduction gear assembly adds to the length of the IC engine. In the conventional setup, the clutch is generally an expanding shoe-type clutch, for example, a centrifugal clutch having expanding clutch shoe. During the operation of such a clutch, the wearing of clutch liners of the clutch shoe may cause mixing of particles of the clutch liners with the lubrication oil and may lead to contamination of the lubricating oil.

[0016] An internal combustion engine is disclosed herein. The internal combustion engine disclosed herein, (hereinafter referred to as an engine), includes a first engine casing and a second engine casing. In an embodiment, the first engine casing is formed by a crankcase, a

cylinder block, a cylinder head, and a cylinder head cover. In one embodiment, the crankcase, the cylinder block, the cylinder head, and the cylinder head cover may be formed integrally to form the first engine casing. In an example, the first engine casing can be formed in two pieces, say a right hand side first engine casing and a left hand side first engine casing, for convenient assembly of the first engine casing. Accordingly, in said embodiment, the first engine casing encloses a crankshaft, a piston connected to the crankshaft through a connecting pin and reciprocating in a cylinder bore. The cylinder bore is formed in the cylinder block. The crankshaft is supported in the first engine casing at their ends by support bearings and the cam shaft is supported in the cylinder head.

[0017] On the other hand, the second engine casing houses parts of a starting system of the vehicle, such as kick starter system, and parts of a transmission of the vehicle, such as a reduction gear assembly. In an example, as explained with reference to the first engine casing, the second engine casing can also be formed in two pieces, say a right hand side second engine casing and a left hand side second engine casing. The second engine casing is explained in detail later.

[0018] With reference to the first engine casing, according to an aspect of the present subject matter, a crankshaft sprocket wheel is mounted on one end of the crankshaft which lies in a cavity formed in an outer wall of the first engine casing. Hence, the crankshaft sprocket wheel is housed in the cavity in the first engine casing. The crankshaft sprocket wheel is coupled to a camshaft sprocket wheel mounted on the camshaft. In an implementation, the crankshaft sprocket wheel is coupled to the camshaft sprocket wheel through a drive mechanism, such as a chain drive mechanism, and the crankshaft provides a drive to the camshaft. In an embodiment, a torque multiplication ratio of about 2:1 is provided by the crankshaft to the camshaft, i.e., the camshaft rotates at half the speed of the crankshaft, and provides twice the torque as transmitted by the crankshaft. According to an embodiment, a chain drive cavity can be provided in the first engine casing for housing a chain drive mechanism. The chain drive cavity connects the cavity housing the crankshaft sprocket wheel to a camshaft cavity formed between the cylinder head and the cylinder head cover and houses the camshaft.

[0019] According to an aspect of the present subject matter, the camshaft is connected to a transmission assembly to transfer the drive to the transmission assembly. In an embodiment, the coupling of the camshaft and the transmission assembly is achieved through a disengagable coupler, and the disengagable coupler controls the transmission of drive from the camshaft to the transmission assembly. Accordingly, the disengagable coupler is partly mounted on a distal end of the camshaft, the distal end being the end of the camshaft farther from the piston and extending outside the first engine casing. Additionally, the disengagable coupler is partly mounted on a shaft of the transmission assembly. The transmission assembly can include a reduction gear assembly, an output gear, and an output shaft.

[0020] In an implementation of the present subject matter, the disengagable coupler is a clutch, for example, a centrifugal clutch. Accordingly, a clutch shoe of the clutch is mounted on the camshaft and forms a part of the first engine casing, whereas the clutch drum is mounted on a shaft of the transmission assembly. Further, in said embodiment, the transmission assembly is enclosed in the second engine casing, and hence, a clutch drum of the clutch is present in the second engine casing and is engageable with the clutch shoe. The second engine casing encloses a transmission assembly of the engine. The transmission assembly includes a reduction gear assembly and an output gear mounted on an output shaft. A shaft of the reduction gear assembly and the output shaft are supported by bearings at both ends, in the second engine casing.

[0021] In an embodiment, the clutch drum of the clutch is mounted on a reduction gear shaft of the reduction gear assembly in the second engine casing. The reduction gear assembly is further coupled to the output gear and provides a drive to the output shaft. Hence, the output shaft provides an output drive from the engine. In an example, the output shaft can be further coupled to a drive shaft to provide a final drive to the drive shaft. Say the output shaft can be coupled to the drive shaft of a two wheeler in which the engine is implemented. In an embodiment, an end of the output shaft projects out of the second engine casing, and has an output sprocket wheel mounted thereon, and the output shaft is coupled to the drive shaft through the output sprocket wheel for providing the final drive. For example, the output sprocket wheel can be coupled to a wheel of a vehicle on which the engine is mounted, in case the engine is implemented in the vehicle, say a two wheeler. As a result of the provision of the

reduction gear assembly coupled to the camshaft instead of the crankshaft for transferring the drive to the output shaft, the crankshaft having a small length can be used.

[0022] In one embodiment, the drive from the reduction gear assembly to the output shaft provides a torque multiplication of a factor of about 4, i.e., the output shaft provides a torque about 4 times the torque provided by the camshaft. Hence, in said embodiment, the output drive at the output shaft provides 8 times the torque provided by the crankshaft of the engine.

[0023] In an embodiment, the second engine casing also includes cranking mechanism of the engine. The cranking mechanism includes a cranking gear assembly connected to a cranking lever, such as a kick starter, and both, the cranking gear assembly and the cranking lever, mounted on a crank drive shaft. The crank drive shaft is further coupled to the crankshaft of the engine through a unidirectional drive mechanism. In an implementation, the unidirectional drive mechanism can be a ratchet gear-nut assembly having a crankshaft ratchet nut which can mesh with a crank drive ratchet gear complementing the crankshaft ratchet nut. In said implementation, the ends of the crank drive shaft and the crank shaft are in proximity of each other, the crank drive shaft having the crank drive ratchet gear mounted thereon and the crankshaft having the crank ratchet nut mounted thereon. When the cranking mechanism is actuated to crank the engine, the crank drive ratchet gear on the crank drive shaft engages with the crankshaft ratchet nut on the crankshaft and actuates the crankshaft.

[0024] The cranking lever being mounted on the crank drive shaft, instead of the crankshaft, provides for a smaller crankshaft. With the smaller crankshaft, the weight of the crankshaft reduces and the likelihood of the bending of the crankshaft is avoided or considerably reduced. Further, less weight of the crankshaft reduces inertia of the crankshaft, which further improves the vibrations caused by the engine. With the use of the smaller crankshaft, the overall size of the engine is also reduced, in comparison to a conventional engine of equivalent capacity.

[0025] Further, with the provision of the first engine casing and the second engine casing, the servicing of the engine is convenient. Furthermore, the configuration of the reduction gear assembly and the cranking mechanism can be modified based on the requirement. For example, based on the output torque required at the output shaft or that at the drive shaft, the configuration of the reduction gear and the output gear can be changed.

[0026] In addition, with the provision of the crankshaft sprocket wheel providing torque multiplication for the drive to the camshaft through the camshaft sprocket wheel and the reduction gear assembly providing further torque multiplication for the drive to the output shaft, the engine does not require an elaborate gear box for providing torque multiplication for the output drive at the output shaft. Hence, the overall cost of the engine is less. Additionally, in case in an example the engine is implemented in a vehicle, say a two wheeler, the aforementioned feature of the engine eliminates the need of the gear box in the vehicle, and hence, improves the performance of the vehicle as a result of reduction in the overall weight of the vehicle.

[0027] Fig. 1(a) illustrates a sectional view of an internal combustion engine 100. In an embodiment, the internal combustion engine 100, referred to as engine 100 hereinafter, includes a first engine casing 102 and a second engine casing 104, such that the first engine casing 102 and the second engine casing 104 are disengageably attached. The first engine casing 102 and the second engine casing 104 are shown in exploded view in Fig. 1(b). The features of the engine 100 are explained with reference to Fig. 1(a) and Fig. (b) in conjunction.

[0028] According to an embodiment, the first engine casing 102 is formed by a crankcase 106, a cylinder block 108, a cylinder head 110, and a cylinder head cover 112. The crankcase 106 houses a crankshaft 114, which is supported in the crankcase 106 at crankshaft support bearings 116 in proximity of a first end 118 and a second end 120 of the crankshaft 114.

[0029] In one embodiment, the second end 120 of the crankshaft 114 extending outside the first engine casing 102 has a magneto assembly 136 mounted thereon. The magneto assembly 136 can be connected to a power source (not shown in figure), such as a battery, for recharging the power source. In an embodiment, the magneto assembly 136 is housed inside the first engine casing 102 and a cover 138.

[0030] Further, the crankshaft 114 is connected to a piston 140, reciprocably disposed in a cylinder bore 142 formed in the cylinder block 108, through a connecting rod 143. Further, the piston 140, when at its extreme position, close to the cylinder head 110, forms a combustion chamber 144. The combustion chamber 144 is defined by a top surface of the piston 140, lateral walls of the cylinder bore 142, and the cylinder head 110. Further, one or

more inlet ports (not shown in figure) opening in the cylinder bore 142 are provided in the cylinder head 110 for the inlet of charge from a fuelling device, for example, a carburettor or a fuel pump. Further, an ignition element 146 is provided in the combustion chamber 144 to achieve combustion of compressed charge in the combustion chamber 144. In an example, in case the engine 100 is a spark ignition engine, then the ignition element 146 can be a spark plug and, in case the engine 100 is a compression ignition engine, then the ignition element 146 can be a glow plug. In one embodiment, the cylinder head 110 can include an ignition element aperture 148 for disposing the ignition element 146 in the combustion chamber 144. Further, the cylinder head 110 also includes one or more exhaust ports (not shown in figure) for exit of combustion products produced as a result of the combustion of charge in the combustion chamber 144.

[0031] Additionally, in one embodiment, the cylinder head 110 houses an inlet valve assembly and an exhaust valve assembly (both not shown in figure) for opening and closing the inlet ports and the exhaust ports, respectively. In one embodiment of the present subject matter, each of the inlet valve assembly and the exhaust valve assembly includes a tappet and a rocker arm assembly. Further, the cylinder head 110 and the cylinder head cover 112 form a camshaft cavity 149, which encases a camshaft 150. The camshaft 150 has an inlet cam 152 and an exhaust cam 154 formed thereon. Hence, in one embodiment, the camshaft 150 is disposed in the camshaft cavity 149 in the first engine casing 102 and is supported at camshaft support bearings 155 in the cylinder head 110. The inlet cam 152 can regulate an opening and closing of the inlet ports by actuating the inlet valve assembly and the exhaust cam 154 can regulate an opening and closing of the exhaust ports by actuating the exhaust valve assembly.

[0032] In one embodiment, the camshaft 150 is coupled to the crankshaft 114 through a drive mechanism to obtain a drive from the crankshaft 114. In an implementation, the drive mechanism coupling the crankshaft 114 and the camshaft 150 is a chain drive mechanism. In said implementation, the chain drive mechanism includes a crankshaft sprocket wheel 122 mounted on the first end 118 of the crankshaft 114. Further, a cavity 123 of the first engine casing 102 is formed by indenting an outer wall of the first engine casing 102 in proximity of the first end 118 of the crankshaft 114. In said embodiment, the cavity 123 houses the first end 118 of the crankshaft 114 and the crankshaft sprocket wheel 122 mounted thereon.

[0033] Additionally, in said implementation, the chain drive mechanism further includes a camshaft sprocket wheel 156 mounted on a distal end of the camshaft 150. The distal end of the camshaft 150 can be understood as the end of the camshaft 150 lying away from the magneto assembly 136. Further, in an embodiment, the camshaft sprocket wheel 156 is coupled to the crankshaft sprocket wheel 122 through a chain (represented as line 159) of the chain drive mechanism. According to said embodiment, the first engine casing 102 includes a chain drive cavity 157 which at least partially houses the chain drive mechanism. For example, the chain 159 of the chain drive mechanism is partially housed in the chain drive cavity 157. It will be understood that according to said embodiment, the chain drive cavity 157 connects the cavity 123 housing the crankshaft sprocket wheel 122 to the camshaft cavity 149 housing the camshaft 150 and the camshaft sprocket wheel 156 mounted thereon.

[0034] As will be understood, the camshaft 150 obtains a drive from the crankshaft 114 through the sprocket wheels 122 and 156 and the chain drive mechanism. In said embodiment, the drive from the crankshaft 114 to the camshaft 150 provides a torque multiplication of a factor of about 2 at the camshaft 150, i.e., the camshaft 150 is driven at a speed half of that of the crankshaft 114 but can provide an output torque twice as that provided by the crankshaft 114. Further, it will be understood that in other implementations the drive from the crankshaft 114 can be transmitted to the camshaft 150 through other drive mechanisms, such as gear trains or belt drives.

[0035] Further, in an embodiment, the crankshaft 114 is coupled to a cranking mechanism 128 of the engine 100. The cranking mechanism 128, for example, a kick starter mechanism, provides for cranking the engine 100 while starting the engine 100. In said embodiment, the coupling of the crankshaft 114 and the cranking mechanism 128 is achieved through a unidirectional drive mechanism. In an implementation, the unidirectional drive mechanism is a ratchet gear-nut assembly. In said implementation, at the first end 118 of the crankshaft 114, a crankshaft ratchet nut 124 is mounted. On a radial face of the crankshaft ratchet nut 124, a ratchet is formed. The crankshaft ratchet nut 124 is operatively coupled, say meshed, to a crank drive ratchet gear 126. The crank drive ratchet gear 126 is fixed to a cranking mechanism 128 of the engine 100 and has a corresponding ratchet formed on a radial face, which faces the crankshaft ratchet nut 124.

[0036] In an embodiment, the cranking mechanism 128 is housed inside the second housing 104 and includes a crank drive shaft 130, and a cranking lever 132 to actuate the crank drive shaft 130. The crank drive shaft 130 further cranks or rotates the crankshaft 114 upon engagement of the crankshaft ratchet nut 124 and the crank drive ratchet gear 126. In an embodiment, the cranking mechanism 128 includes a cranking gear assembly 134 and the cranking lever 132 is coupled to and provides a drive to the crank drive shaft 130 through the cranking gear assembly 134, for example, upon actuation of the cranking lever 132 by a user. In said embodiment, the cranking gear assembly 134 can be a reverted gear-train assembly. In another embodiment, the cranking lever 132 is mounted directly on the crank drive shaft 130.

[0037] According to an aspect of the present subject matter, the second engine casing 104 houses a reduction gear assembly 158. In an embodiment, the reduction gear assembly 158 is housed inside the second engine casing 104 of the engine 100. In said embodiment, the distal end of the camshaft 150 is coupled to the reduction gear assembly 158 through a disengagable coupler 160. In an implementation, the disengagable coupler 160 is a centrifugal clutch having a clutch shoe 162 mounted on a distal end of the camshaft 150 and a clutch drum 164 mounted on a reduction gear shaft 166 of the reduction gear assembly 158. In said implementation, the clutch shoe 162 is connected to the first engine casing 102 and forms a part thereof, and is engageable with the clutch drum 164, which is connected to the second engine casing 104 and forms a part thereof. Through the disengagable coupler 160, the camshaft 150 provides a drive to the reduction gear assembly 158 and the transmission of the drive to the reduction gear assembly 158 is controlled by controlling the disengagable coupler 160.

[0038] In an embodiment, the camshaft 150 provides the drive to a reduction gear 168 of the reduction gear assembly 158, the reduction gear 168 being mounted on the reduction gear shaft 166. The reduction gear assembly 158 further provides a drive to an output gear 170 mounted on an output shaft 172. In an embodiment, the output gear 170 directly meshes with the reduction gear assembly 158. In another embodiment, the output gear 170 may mesh indirectly with the reduction gear assembly 158 through a gear train. In one embodiment, the drive from the reduction gear assembly 158 to the output shaft 172 provides a torque multiplication of a factor of about 4. Hence, according to an embodiment, the total torque multiplication of the drive from the crankshaft 114 achieved at the output shaft 172 is about 8,

i.e., the output shaft 172 rotates at one-eighth speed of speed of the crankshaft 114 but provides an output torque 8 times the output torque provided by the crankshaft 114.

[0039] The reduction gear assembly 158, the output gear 170, and the output shaft 172 are collectively referred to as transmission assembly 173 of the engine 100.

[0040] Further, the output shaft 172 can extend outside the second engine casing 104 and have an output sprocket wheel 174 mounted thereon, outside the second engine casing 104. The output sprocket wheel 174 can be further coupled to a drive sprocket wheel (not shown in figure), which provides a final drive to a drive shaft, say of a vehicle on which the engine 100 is mounted.

[0041] In an embodiment, the reduction gear shaft 166 and the output shaft 172 are supported in the second engine casing 104 at reduction gear shaft support bearings 176 and output shaft support bearings 178, respectively.

[0042] The previously described versions of the subject matter and its equivalent thereof have many advantages, including those which are described henceforth. As a result of the provision of the reduction gear assembly 158 coupled to the camshaft 150 instead of the crankshaft 114, the crankshaft 114 having a small length can be used in the engine 100. Further, the cranking lever 132 is mounted on the crank drive shaft 130 instead of the crankshaft 114, which assists in using a smaller crankshaft 114. With the smaller crankshaft 114, the weight of the crankshaft 114 reduces and the bending of the crankshaft 114 is avoided or considerably reduced. Further, less weight of the crankshaft 114 reduces inertia of the crankshaft 114, which further improves the vibrations caused by the engine 100.

[0043] In addition, with the provision of the crankshaft sprocket wheel 122 providing torque multiplication for the drive to the camshaft 150 through the camshaft sprocket wheel 156 and the reduction gear assembly 158 providing further torque multiplication for the drive to the output shaft 172, the engine 100 does not require an elaborate gear box for providing torque multiplication for the drive at the output shaft 172. Hence, the overall cost of the engine 100 and the weight of the engine 100 is less.

[0044] Further, with the provision of the first engine casing 102 and the second engine casing 104, the servicing of the engine 100 is convenient. Further, the configuration of the

cranking mechanism 128 and the reduction gear assembly 158 can be modified based on the requirement. For example, based on the output torque required at the output shaft 172, the configuration of the reduction gear 168 and the output gear 170 can be changed.

I/We claim:

1. An internal combustion engine (100) comprising:

a first engine casing (102) housing a crankshaft (114) and a camshaft (150), the crankshaft (114) being coupled to the camshaft (150) to drive the camshaft (150); and

a second engine casing (104) detachably coupled to the first engine casing (102), wherein the second engine casing (104) houses a transmission assembly (173) coupled to the camshaft (150) to receive a drive from the camshaft (150), and wherein an output shaft (172) of the transmission assembly (173) provides an output drive from the internal combustion engine (100).

2. The internal combustion engine (100) as claimed in claim 1, wherein the transmission assembly (173) is coupled to the camshaft (150) through a disengagable coupler (160), the disengagable coupler (160) controlling transmission of the drive from the camshaft (150) to the transmission assembly (173).

3. The internal combustion engine (100) as claimed in claim 2, wherein the disengagable coupler (160) is a centrifugal clutch.

4. The internal combustion engine (100) as claimed in claim 3, wherein a clutch shoe (162) of the centrifugal clutch is mounted on the camshaft (150) and a clutch drum (164) of the centrifugal clutch is mounted on a reduction gear shaft (166) of the transmission assembly (173).

5. The internal combustion engine (100) as claimed in claim 1, wherein the transmission assembly (173) comprises:

a reduction gear assembly having a reduction gear (168) and a reduction gear shaft (166) coupled to the camshaft (150) through a disengagable coupler (160);

an output gear meshing with the reduction gear (168) of the reduction gear assembly to obtain a drive from the reduction gear assembly; and

the output shaft (172) connected to the output gear, wherein the output shaft (172) provides the output drive.

6. The internal combustion engine (100) as claimed in claim 1, wherein the crankshaft (114) is coupled to the camshaft (150) through a chain drive mechanism, the chain drive mechanism comprising:

a crankshaft sprocket wheel (122) mounted on the crankshaft (114) and housed in a cavity (123) of the first engine casing (102);

a camshaft sprocket wheel (156) mounted on the camshaft (150); and

a chain coupling the crankshaft sprocket wheel (122) and the camshaft sprocket wheel (156) and partially housed in a chain drive cavity (157) in the first engine casing (102).

7. The internal combustion engine (100) as claimed in claim 1, wherein transfer of the drive from the crankshaft (114) to the camshaft (150) provides a torque multiplication of a factor of about 2.

8. The internal combustion engine (100) as claimed in claim 1, wherein transfer of the drive through the transmission assembly (173) to the output shaft (172) provides a torque multiplication of a factor of about 4.

9. The internal combustion engine (100) as claimed in claim 1, wherein the output drive at the output shaft (172) achieved by transfer of the drive from the crankshaft (114) to the output shaft (172) through the camshaft (150) and the transmission assembly (173) has a torque multiplication of a factor of about 8.

10. The internal combustion engine (100) as claimed in claim 1, wherein a distal end of the crankshaft (114) coupled to a cranking mechanism through a unidirectional drive mechanism.

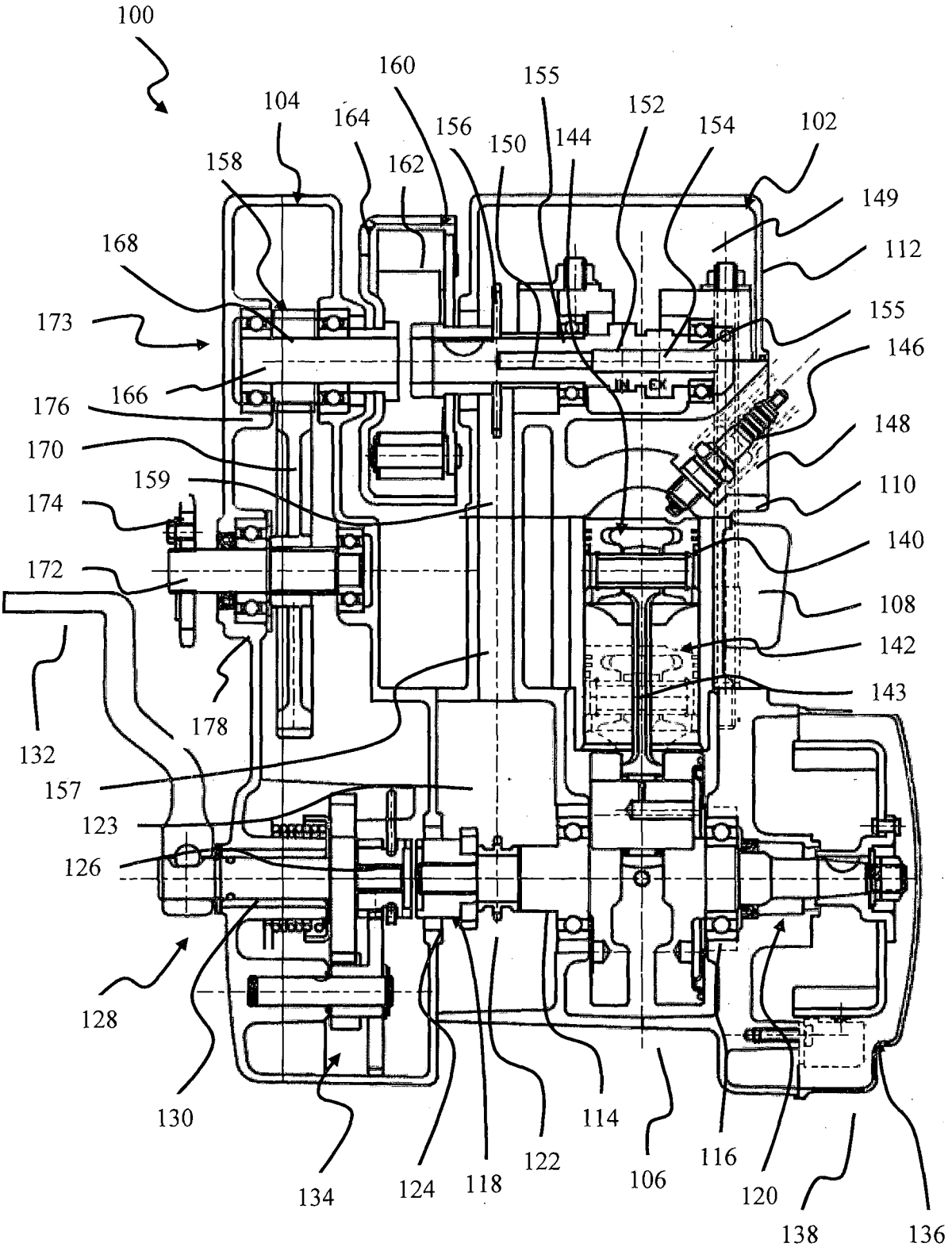

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Fig. 1(a)

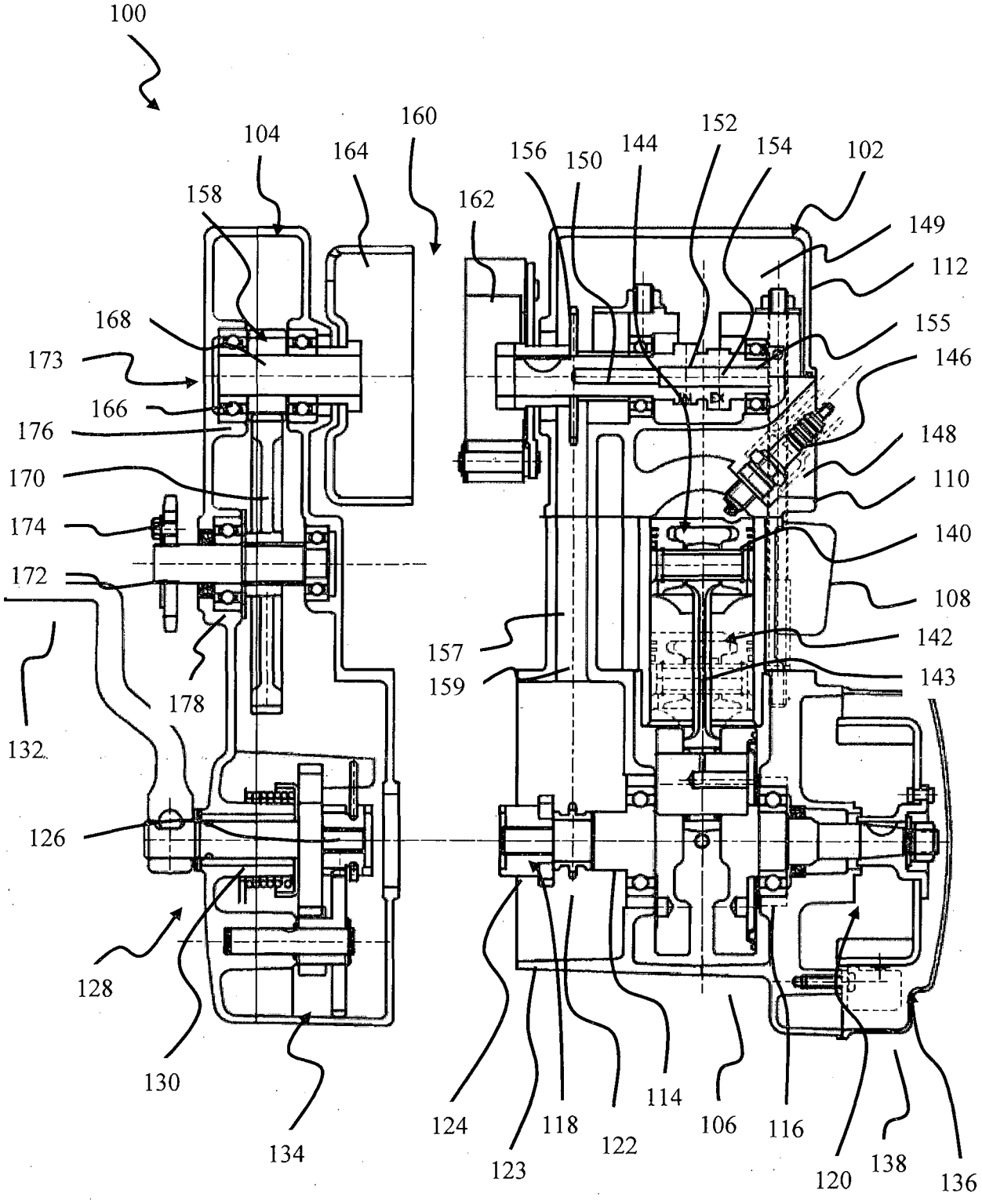

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Fig. 1(b)

INTERNATIONAL SEARCH REPORT

International application No
PCT/IN2012/000285

A. CLASSIFICATION OF SUBJECT MATTER
INV. F01L1/46 F02B61/02
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)
F01L F02B

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	GB 1 327 281 A (SHEPPARD E F) 22 August 1973 (1973-08-22) page 1, lines 80-81; figure 1	1,2,5, 7-9
X	US 4 781 635 A (KINOUCHI SOSUKE [JP] ET AL) 1 November 1988 (1988-11-01)	1,5,6,10
Y	figure 2	3,4
X	EP 0 223 248 A2 (BAYERISCHE MOTOREN WERKE AG [DE]) 27 May 1987 (1987-05-27) figure 1	1,2,5, 7-10
Y	US 4 378 219 A (TANAKA KOHYA [JP]) 29 March 1983 (1983-03-29) figures 1,3	3,4

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 September 2012	25/09/2012

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Flamme, Emmanuel

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IN2012/000285

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