

Coolant pump and ducts arrangement of an Engine

The present invention relates to an internal combustion engine. In particular, the engine may be used in a vehicle, such as a land vehicle, in particular an automobile.

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Automobile engines generate power primarily to propel the automobile. They also generate heat which must be dispersed. Typically automobile engines will be water cooled whereby a pump circulates a cooling fluid (the principal constituent of which is water) through the engine block and through the cylinder head whereupon the cooling
10 fluid is heated, and then through a radiator whereupon energy in the heated water is transferred to an air stream passing through the radiator. The cooled water is then returned to the engine block.

Various arrangements of water pump are known. In one embodiment an electric water
15 pump is mounted at a convenient location and is switched on and off depending upon the cooling requirement of the engine.

Other embodiments incorporate an engine driven water pump, typically driven via a belt from the crank shaft of the engine. In one embodiment a crank shaft driven water
20 pump is provided as an independent unit. The pump is movable relative to the engine block so as to be able to properly tension the drive belt.

In another embodiment a water pump is mounted on the front face of an engine block.

25 Known engines include crank shafts for transferring the motion of reciprocating pistons into rotary motion for providing power. The engine will typically include a cylinder head having one or more inlet valves per cylinder and one or more exhaust valves per cylinder. The opening and closing of the inlet and exhaust valves is typically controlled by a cam shaft which is driven from the crank shaft. Where the
30 cam shaft is an overhead cam shaft or where the cam shaft is a double overhead cam shaft the cam shaft may be driven via a chain, typically mounted at an end of the engine opposite to the end of the engine where the flywheel is mounted.

Alternatively, the cam shafts may be driven by a series of gears. In either event a timing cover is mounted on the end of the engine block to retain oil within the timing chamber and to exclude dirt and other contaminants from the timing chamber.

5 US6453868 shows an engine block at the front of which is mounted a timing cover. Mounted on the timing cover is a coolant pump. By mounting the coolant pump on the timing cover creates a relatively long engine. Relatively long engines are not suited to being mounted longitudinally in one type of vehicle and transversely in another type of vehicle.

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An object of the present invention is to provide an engine which is relatively short.

Another object of the present invention is to provide an engine which can easily be installed in a longitudinal or transverse manner in a vehicle and yet still be easily

15 connected to an associated radiator.

Thus, according to the present invention there is provided an engine including a block, a coolant pump and a timing cover, the coolant pump being mounted on the block, the timing cover having an inlet duct, an outlet duct and a bypass duct, the inlet duct being
20 in fluid communication with the outlet duct and the bypass duct, the inlet duct, outlet duct and bypass duct being integrally formed with the timing cover.

Mounting the coolant pump on the engine block creates a relatively short engine when compared with a coolant pump mounted on the timing cover. By integrally forming
25 an inlet duct, an outlet duct and a bypass duct in the timing cover allows coolant to be transferred from the cylinder head to the block mounted coolant pump (via the bypass duct) or alternatively to a radiator (via the outlet duct).

In one embodiment the inlet duct is a single inlet duct.

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Advantageously by creating a single inlet duct only a single seal is required for the single inlet duct.

In one embodiment the single inlet duct faces a cylinder head outlet.

Advantageously a single seal can be provided between the single inlet duct and the cylinder head.

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In one embodiment the timing cover is integrally cast with the inlet duct and the outlet duct and the bypass duct.

Advantageously casting the timing cover in such a manner provides an efficient method of integrally forming the inlet duct, outlet duct and bypass duct with the timing cover.

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In one embodiment the outlet duct is positioned above the bypass duct.

Advantageously positioning the outlet duct relative to the bypass duct in this manner creates a relatively short space envelope for the outlet duct and the bypass duct.

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In one embodiment the outlet duct and/or the bypass duct is/are positioned above the coolant pump.

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Advantageously positioning the outlet duct and/or the bypass duct relative to the coolant pump in this manner only requires a relatively short space envelope for these components.

In one embodiment the outlet duct and/or the bypass duct is orientated laterally relative to a cylinder head.

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Advantageously orientating the outlet duct laterally relative to the cylinder head allows for relatively short hose connections to an associated radiator when the engine is positioned both longitudinally and laterally in a vehicle. Advantageously by orientating the bypass duct laterally relative to the cylinder head allows for relatively short hose connections to the coolant pump mounted on the block.

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In one embodiment the engine block includes a lug projecting laterally from the block, the lug defining a pump inlet on a first side and at least a part of an impeller housing on a second side, the lug including a hole to allow coolant to flow from the pump inlet through the hole to said part of said impeller housing.

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Advantageously, the coolant inlet to the pump and at least a part of the impeller housing can be integrally formed with the engine block. This is particularly advantageous when the engine block is cast.

10 In one embodiment the lug at least partially defines a pump outlet.

Advantageously, because the coolant is fed from the pump into the block, by defining a pump outlet in the lug no separate hose or the like is required to feed water from the pump to the block.

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In one embodiment the lug may include an attachment point for an engine mount.

In one embodiment the engine block defines a timing cover surface against which a timing cover fits, the lug including a pump surface against which the pump fits, the timing cover surface and the pump surface being coplanar. Advantageously, such an arrangement allows the front face of the block to be machined in a single operation.

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In one embodiment a portion of the coolant pump surface forms a bridge across part of the pump outlet.

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Advantageously, water is fed into the orifice defined by the pump outlet and the bridge and then circulates within the block. Such a bridge allows the pump body to be separate from the timing cover without the need of any further sealing components between the timing cover and the pump body.

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In one embodiment the engine block may include a thermostat mounted on said first side of said lug.

Advantageously, by mounting the thermostat on the first side (rear side) of the lug positions the thermostat part way along the block, and in particular not at the front of the engine, thereby freeing up space at the front of the engine.

5 According to another aspect of the present invention there is provided a method of assembling a first engine into a first vehicle and of assembling a second engine into a second vehicle, the block of the first engine being identical to the block of the second engine and/or the coolant pump of the first engine being identical to the coolant pump of the second engine and/or the timing cover of the first engine being identical to the
10 timing cover of the second engine, the method comprising the steps of assembling the first engine into the first vehicle in a transverse orientation, the method further comprising the step of assembling the second engine into said second vehicle in a longitudinal orientation.

15 The invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 is a part exploded view of certain components of an engine according to the present invention,

Figure 1A is an enlarged view of part of figure 1,

20 Figure 2 is a front view of a timing cover uses in association with the engine of figure 1,

Figure 3 is a rear view of timing cover of figure 2,

Figure 4 is a front isometric view of the engine of figure 1,

Figure 5 is a side isometric view of figure 4,

25 Figure 6 shows a first installation of an engine according to the present invention in a vehicle, and

Figure 7 shows a second installation of the engine of figure 6 in a second vehicle.

With reference to figures 1 to 5 there is shown an engine 10 having an engine block
30 12, a cylinder head 14 and a timing cover 16. The engine includes a crank shaft 18 upon which is mounted a drive pulley 20. The engine also includes a coolant pump 22 (also known as a water pump).

In order to assist explanation, the engine block 12 has a top 24 defined by a mating surface of the block and the cylinder head. The block has a front 26 defined by the timing cover 16. The engine has a rear 28 proximate a clutch or similar transmission component. The engine block has a bottom 30 defined by the proximity of the crank shaft 18. The terms "top", "front", "rear" and "bottom" define an "engine coordinate" system and are intended to assist in understanding the relative position of various components of the engine, and specifically are not intended to define the orientation of the engine in use, for example, when installed in a vehicle.

10 Engine 10 is an inline four cylinder engine, though the present invention relates to any configuration of engine including an engine having any number of cylinders. The present invention also relates to engines having any type of cylinder orientation, for example, inline engines, V-engines, W-engines, opposed cylinder engines (flat engines) etc.

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Engine block 12 includes a lug 32 which projects laterally from the engine block 12. The lug 32 has a central hole 34 surrounded by a generally planar surface 36. The lug also includes a generally cylindrical surface 38. The surface 36 and surface 38 define part of an impeller housing 40. The lug 32 also includes a recess 42 which partially defines an outlet from the water pump 22. Recess 42 is orientated generally tangentially relative to the generally cylindrical surface 38. The lug 32 includes holes which are threaded and receive bolts 46 as will be further described below.

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The lug 32 includes an alternator mounting lug 48 including a hole 50.

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The engine block 12 includes a front face 52 which is flat and includes portions 53 against which the timing cover abuts and portions 54 against which the coolant pump 22 abut.

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Mounted on the top of the engine block 12 is cylinder head 14 which has an inlet side 55 defined by air inlet ducts 56. The cylinder 12 also has an exhaust side 57 defined by exhaust ducts (not shown) which in turn are connected to an exhaust manifold 23 (see figures 6 and 7). The cylinder head 14 includes a coolant passage 58 (also known

as a cylinder head outlet). A cylinder head gasket may be interposed between the cylinder head and the block.

5 The timing cover 16 is made from a casting and includes a hole 60 through which a part of the crank shaft projects. The timing cover 16 includes a timing cover inlet duct 62. The timing cover coolant passage includes an outlet duct 64 and a bypass duct 66. A sealing surface 68 is defined around a periphery of the timing cover and is flat. Sealing surface 68 engages portion 53 of the front face 52 of the engine block so as to retain oil within the void formed between the timing cover and the engine block and
10 so as to exclude contaminants such as dirt and dust etc from the void. The void receives a timing chain, a crank shaft sprocket, an overhead inlet cam shaft sprocket and an overhead exhaust cam shaft sprocket in a known manner. In alternative embodiments the void may receive alternative timing arrangements, for example the timing arrangement to drive a single overhead cam shaft, a timing arrangement to
15 drive a cam shaft which in turn operates push rods and rockers to open the valves, a timing arrangement operating via gears rather than chains, a toothed belt may be used instead of a chain etc.

Grooves 70 are defined on a sealing surface 71 of the timing cover 16. The grooves
20 70 receive a sealant such as an RTV sealant. The sealant engages portion 53A of the engine block 12 in a water tight manner. Bolt holes 73 receive bolt 74 which secure the timing cover 16 to the engine block 12. Bolt holes 75 receive bolts 76 to ensure sealant 70 is pressed firmly against portion 73A to ensure a water tight connection between the timing cover and the engine block. In an alternative embodiment a gasket
25 may be used in place of or in addition to sealant 70.

The coolant pump 22 is directly mounted on the block 12. The coolant pump 22 includes a pump body 78 having bearings (not shown) which rotatably mount an impeller shaft 80. An impeller (not shown) is positioned within the generally
30 cylindrical surface 38 with edges of the impeller blades being positioned proximate though not in contact with generally cylindrical surface 38 and the generally planar surface 36. A drive pulley 82 is connected to the impeller shaft 80 and is driven via a belt (not shown) from the drive pulley 20. The pump body 78 includes sealing surface

- 83 which engages sealant 84 and portions 54 in a water tight manner. The water pump is secured in place via bolts 46. Portions 54, against which sealing surface 83 of the pump engage and portions 53, against which the sealing surface 68 of the timing cover engage are coplanar. Advantageously, this allows for a single machining operation to simultaneously machine portions 54 and 53. Also, portion 53A is coplanar with portion 53. Advantageously this allows for portions 53A, 53 and 54 to be machined as a single operation. In an alternative embodiment a gasket may be used in place of or in addition to sealant 84.
- Both the impeller housing 40 and the recess 42 are open on one side and are closed by the pump body 78. Thus a pump outlet 41 is defined by the recess 42 and an adjacent portion of the pump body 78. Note that portion 54A of the block forms a bridge across the end of recess 42. Portion 54A and the adjacent portion of sealant 84 are engaged by the sealing surface 83 of the pump body 78. The bridge formed by portion 54A allows there to be a gap 86 between the pump body 78 and the timing cover 16. The timing cover 16 and pump body 78 can therefore be completely separate components assembled onto the engine at separate times. The bridge formed by portion 54A and the gap 86 mean that coolant within the recess 42 is separated from the void within the timing chest by firstly the seal formed between sealant 84 and the sealing surface 83 of the pump body 78 and secondly by the sealing surface 71 engaging portions 53 of the block. As such contamination of the oil within a timing chest by the coolant is extremely unlikely as is contamination of the coolant by the oil within the timing chest.
- Situated on the coolant inlet side of the lug 32 (the rear side of the lug) is a housing 90 containing a thermostat (not shown). The housing 90 includes an inlet 91, an inlet 92 and an inlet 93. The outlet 94 of the housing is connected to the engine block 12 adjacent the hole 34.
- With the engine running and the thermostat closed, coolant flow travels through hole 34 into the impeller housing 14 wherein it is pumped via the rotating impeller (being driven from the crank shaft drive via a belt and pulley 82) into the pump outlet 41 into the coolant passage of the block. The coolant then circulates through the block,

through the cylinder head, out of the cylinder head outlet 58 into the timing cover inlet duct 62, and in particular into the bypass duct 66 where it is fed via hose 95 to inlet 92 where it can then again be recirculated around the engine.

- 5 When the thermostat is open (i.e. when the engine is warm) the majority of flow will enter housing 90 via inlet 91 and then pass into the impeller housing where it will again be circulated around the block and the cylinder head and enter the timing cover inlet duct 62. Under these circumstances the majority of the flow will enter the outlet duct 64 where it will be fed to a radiator. The outlet from the radiator will feed the
- 10 water back into inlet 91 to allow the now cooled coolant to recirculate around the engine. Even with the thermostat housing open, a limited amount of coolant will recirculate via the bypass duct 66 as is conventional with known engines. When cabin heating is required a certain amount of coolant will be fed from the engine to the cabin heating radiator and will be returned via inlet 93.

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The particular location of the connections to the engine radiator (i.e. outlet duct 64 and inlet 91) allow the engine to be easily installed longitudinally relative to a vehicle or transversely relative to a vehicle.

- 20 With reference to figure 6 there is shown (schematically) an engine bay 96 of a first vehicle. Arrow A indicates the normal direction of movement of the vehicle and it will be appreciated that in this case the engine 10 has been fitted transversely relative to the vehicle, in other words the engine crank shaft is positioned at 90 degrees to the direction of movement. In this case a radiator 97 is provided in front of the engine
- 25 and because both the outlet duct 64 and inlet 91 are orientated laterally relative to the engine coordinates, and in this case longitudinally relative to the vehicle coordinates the pipe work required to connect the outlet duct 64 to the radiator and pipe work required to connect the inlet 91 to the radiator is relatively short.

- 30 With reference to figure 7 there is shown an engine bay 98 of a second vehicle. Arrow A indicates the normal direction of movement of the vehicle. As will be appreciated, the engine has been fitted longitudinally relative to the vehicle, in other words the crankshaft of the engine is parallel to the longitudinal axis of the vehicle. In

this case a radiator 99 has been fitted in front of the engine and because the outlet duct 64 and inlet 91 are orientated laterally relative to the engine (when considering the engine coordinates) only relatively short hoses are required to connect the outlet duct to the radiator and only relatively short hoses are required to connect the inlet 91 to the radiator 99. Thus, it is possible to use the same engine and install it transversely in one vehicle and longitudinally in another vehicle and still maintain relatively short hose connections between the radiator and the engine. In particular the invention provides for engines (either identical or different) having identical blocks and/or identical coolant pumps and/or identical timing covers to be installed transversely in one vehicle or longitudinally in another vehicle.

As mentioned above the timing cover 16 is made from a casting. Typically the casting may be an aluminium alloy casting, though other materials are envisaged. The inlet duct, outlet duct and bypass duct of the timing cover are integrally formed with the timing cover. In alternative embodiments the inlet duct, outlet duct and bypass duct can be integrally formed with the timing cover, for example by fabrication and welding.

Claims

1. An engine (10) including a block (12), a coolant pump (22) and a timing cover(16), the coolant pump being mounted on the block, the timing cover having an inlet duct, an outlet duct and a bypass duct, the inlet duct being in fluid communication with the outlet duct and the bypass duct, wherein the inlet duct, outlet duct and bypass duct being integrally formed with the timing cover; wherein mounting surfaces of the timing cover and of the coolant pump are coplanar.
2. An engine as defined in claim 1 wherein the inlet duct is a single inlet duct.
3. An engine as defined in claim 2 wherein the single inlet duct faces as a cylinder head outlet.
4. An engine as defined in claim 1 wherein the outlet duct is a single outlet duct and/or the bypass duct is a single bypass duct.
5. An engine as defined in claim 1 wherein the timing cover is integrally cast with the inlet duct and outlet duct and bypass duct.
6. An engine as defined in claim 1 wherein the outlet duct is positioned above the bypass duct.
7. An engine as defined in claim 1 wherein the outlet duct and/or the bypass duct is/are positioned above the coolant pump.
8. An engine as defined in claim 1 wherein the outlet duct and/or the bypass duct is orientated laterally relative to a cylinder head.

9. An engine as defined in claim 8 in which the cylinder head has a gas inlet side and exhaust side and said outlet duct and/or said bypass duct are orientated laterally on said gas inlet side.
10. An engine as defined in claim 1 wherein the engine block includes a lug projecting laterally from the block, the lug defining a pump inlet on a first side and at least a part of an impeller housing on a second side, the lug including a hole to allow coolant to flow from the pump inlet through the hole to said part of said impeller housing.
11. An engine as defined in claim 10 in which the lug at least partially defines a pump outlet.
12. An engine as defined in claim 11 in which said part of said impeller housing includes a generally cylindrical portion and said pump outlet is orientated tangentially relative to said generally cylindrical portion.
13. An engine block as defined in claim 10 including a cylinder head surface defining a top of the block, said part of said impeller housing being below the cylinder head surface.
14. An engine as defined in claim 13 in which the lug at least partially defines a pump outlet, and said part of said impeller housing is below said pump outlet.
15. An engine as defined in claim 10, the lug including the mounting surface of the coolant pump.
16. An engine as defined in claim 11 wherein a portion of a pump surface forms a bridge across a portion of the pump outlet.
17. An engine as defined in claim 1 in which the coolant pump includes a pump body and an impeller rotatably mounted, relative to the pump body.

18. An engine as defined in claim 12 wherein the coolant pump includes a pump body and an impeller rotatably mounted, relative to the pump body, and the impeller is positioned in the generally cylindrical portion.
19. An engine as defined in claim 11 wherein the coolant pump includes a pump body and an impeller rotatably mounted, relative to the pump body, and the pump body at least partially defines said pump outlet.
20. An engine as defined in claim 10 including a thermostat mounted on said first side of said lug.
21. An engine block as defined in claim 20 wherein said thermostat is mounted in a housing having a first housing inlet on an upstream side of the thermostat.
22. An engine block as defined in claim 21 wherein the housing has a second housing inlet connected to said bypass duct.
23. An engine block as defined in claim 22 wherein said housing has a third housing inlet connected to a cabin heater.