

Engine Lubrication System

This invention relates to lubrication systems for internal combustion engines. Such engines have been established for over 100 years, and there has been no fundamental change to their lubrication system over the years. Thus, it is traditional
5 to provide an oil lubrication system in which a separate oil pump is provided for circulating the oil to the various moving parts thereof.

An object of the invention is to provide a lubrication system in which oil is circulated without the need for a separate oil pump.

According to the invention, in an internal combustion engine comprising a
10 crankshaft and an associated oil sump, a camshaft in a cylinder head above the oil sump, and a timing belt connecting these shafts via respective pulleys, the timing belt is adapted to entrain a sufficient quantity of oil from the oil sump to lift it to the cylinder head for lubricating purposes.

Conveniently, oil is returned to the sump via an oil cooler, to enable the
15 entrained oil to be used additionally for cooling purposes.

As known per se, the camshaft and crankshaft pulleys have similarly formed tooth sets, but are of different diameters to effect the timing required, and the timing belt is of an impermeable material over its width and formed with a set of teeth around its inner face for meshing with said toothed pulleys.

20 In accordance with a feature of the invention, an additional oil pulley is provided immersed in oil within the oil sump, and below the level of the crankshaft pulley, the oil pulley also being toothed and the timing belt having an additional set of teeth extending around its outer face for meshing with the teeth of the oil pulley, said outer teeth providing the means for entraining oil to the cylinder head.

25 In one form, the additional set of teeth may be formed with scoops for entraining the oil.

Preferably, said additional teeth are designed to run closely within a closed passage, whereby they act with the wall of said passage to entrap and entrain said oil.

According to another aspect of this invention an engine lubrication system
5 includes a toothed pulley, the teeth of which run over a part of the rotation within a restricted passage and a belt having matching teeth which also runs for part of its movement within a restricted passage, these runs being guided to a meshing point at which oil under pressure as a result of the meshing action is available.

In order that the invention may be readily understood, one preferred
10 embodiment and a modification thereof will now be described with reference to the accompanying drawings, in which:

Figure 1 is a diagrammatic cross-section showing the timing/lubrication arrangement;

Figure 2 is an enlarged cross-section of part of Figure 1;

15 Figure 3 is a side view of the part shown in Figure 2, and;

Figure 4 is a top plan view of the cylinder head.

Figure 5 is an enlarged cross-section of the lower half of the modified arrangement, and

Figure 6 is an enlarged cross-section of the upper half of the modified
20 arrangement.

Referring to Figure 1, a preferred timing/lubrication arrangement comprises the crankshaft 1 having a toothed pulley 2. The axis of the crankshaft, and hence the pulley, is located immediately above an oil sump 3, the oil level of which is indicated at 3A when stopped, and 3B when running. As known per se, the pulley 2 is
25 connected to a larger diameter, toothed pulley 4 connected to the camshaft (not shown) by a timing belt 5; the tooth profile size of the teeth of each pulley 2, 4 is

substantially the same, but there is a different number of teeth on each pulley, to produce the difference in rotation required between the crankshaft and camshaft for timing.

Referring also to Figures 2 and 3, as known per se, the timing belt 5 is of a flexible, impervious material, with a set of teeth 6 running around its inner face for meshing with the teeth of both pulleys 2, 4. In accordance with the invention, a further, toothed, oil pulley 7 is provided which extends below the running oil level 3B to be continuously immersed. The oil pulley is located immediately beneath the crankshaft pulley 2 and its teeth 8 are adapted to engage and be driven by a further set of teeth 9 running around the outer face of the timing belt 5. As shown particularly in Figure 2, the timing belt 5 and pulleys 2, 4 and 7 are enclosed within a waisted casing 10, the lower end providing a mouth 11 in the sump 3, the waist 12 defining the area where meshing takes place with the pulleys 2 and 7, and the upper end providing an outlet 13 (see Figure 4) to an oil gallery 14 in the cylinder head 15 as discussed below. It will be noted that the casing 10 provides a closed path 16 at least for the upward run of the timing belt, and the teeth 9 of the belt move closely within this passage.

The oil pulley has a series of open-ended pick-up ports 17 disposed circumferentially, each with a radial transfer port 18 extending through its outer wall 19, and the front and rear walls 20, 21 of the casing 10, see Figure 3, define ports 22 adjacent the meshing area of the pulleys and belt 2, 7, 5.

Referring to Figure 4, and also to Figure 1, the cylinder head 15 is provided with an oil gallery 14 which is fed from the outlet 13 of the casing 10. The gallery includes a branch 14A for feed to the crankshaft big end, branches 14B for the cylinders and return via the branch 14A to the big end, branch 14C for ancillary

equipment such as the engine valves and associated tappets, and a branch 14D for overflow back to the oil sump 3.

In use, oil from sump 3 is picked up in the oil pulley main pick-up ports 17, and to a certain extent by the oil pulley driven teeth 8. On rotation of the oil pulley 7, oil is carried to its meshing area with crankshaft pulley 2. At this point, the teeth 9 of the timing belt 5 block oil progress. Consequently, the oil is then forced through the ports 22 by its own inertia and a squashing action of the toothed timing belt engaging with the oil pulley. Oil from the oil pulley pick-up ports 17 flows out of the transfer ports 18 effectively formed between the oil pulley teeth 8, before and after meshing with the teeth 9 of the timing belt. Consequently, the outside run of this belt is filled not only with oil from the ports 22, but also by centrifugal force acting on the oil as a result of the meshing action with the oil pulley. When oil has been transferred to the outside run of the belt, it is thus forcibly lifted through the closed passage 16 to the outlet 13 in the cylinder head 15. At this point, oil under pressure is then directed, as required, through the oil gallery 14 for the purpose of lubrication and, in the case where an oil cooler is included in the system, also for cooling. When the cooling and lubrication functions are complete, oil is returned to the sump 3 via the branches 14A, 14C and 14D.

For a cold start, the big end bearing is lubricated by splash for the short time it takes for oil pumped via the timing belt 5, to reach it. With a cold engine, initially most of the oil is returned to the sump 3 via the overflow 14D. As the cylinder head 15 and cylinders warm up, the oil's viscosity drops and circulation is progressively stepped up. Until normal temperature is reached the big end bearing still receives a degree of splash lubrication. When normal running temperature is reached the crankshaft runs substantially free of oil drag and lubrication is supplied entirely by the pump arrangement; the hotter the oil the quicker its circulation.

When the engine has reached normal operating temperature, the overflow 14D will only be in use at speeds over tickover or idle. This is so that full cooling capacity is available for heavy traffic conditions at low engine speeds.

It will be appreciated that air breathers 24 can be provided at appropriate 5 locations. For emission requirements, these breathers will preferably be connected to an engine intake cleaner, so as to eliminate air pollution by burning fumes from the engine.

Referring to Figures 5 and 6, in a modification of the arrangement described above, the casing 10 defines a reservoir 30 above the timing pulley 2 to which oil can 10 be fed from the oil sump, and/or be collected as recovered oil from the cylinder head e.g. via the branch 14C (see Figure 1). Oil is fed from the reservoir, in this embodiment to three locations as shown by the arrows 30A, B and C.

With regard to the downward movement of the pulley 2, as shown to the right of Figure 5, it will be noted that oil fed via location 30A primes the toothed inner run 15 31 of the timing belt 5, which is restricted by casing 10 over part of its rotation, whilst that fed through location 30B is fed via a restricted run 32 towards the teeth of the pulley 2. In operation these two restricted oil feeds are respectively guided towards a meshing point at which an outlet 33 is provided. It will be appreciated that the meshing action compresses the oil, which is forced out of the outlet under pressure, 20 and can therefore be used for appropriate additional functions, e.g. crankshaft, or gearbox lubrication; initial testing has shown that pressures in the region of 30 PSI can be achieved.

With regard to upward movement of the pulley 2, as shown to the left of Figure 5, oil is fed at location 30C to both the inner run 31 and outer run 34 of the belt 25 5 and is entrained between these runs and the casing 10 and guided upwardly towards the cylinder head.

Referring now to Figure 6, a further outlet 35 may be provided, if required, where the inner run 31 meshes with the teeth 36 of the camshaft pulley 4; thus, in a similar manner as described above, oil can be fed to a further location 30D where it is entrained between said teeth 36 and casing 10 to provide a further pressurised oil source via the outlet 35 for additional lubrication purposes. Thereafter, the oil left entrained between the belt 5 and casing 10, is fed via the outlet 13 to the oil gallery of the cylinder head as described hereinbefore.

It will be appreciated that the system and modification described above have the following advantages:

1. drives and times the camshaft
2. pumps oil to the cylinder head
3. delivers oil to the big end bearing
4. delivers oil to the main bearings
5. delivers oil to the camshaft
6. delivers oil to the camshaft bearings
7. delivers oil through oil galleries and cooling ducts
8. delivers oil if required to the gearbox
9. the oil takes heat from the cylinder head and/or cylinder and returns it to the sump, by way of various components that are lubricated on the oil's return
10. acts as an oil pump and a coolant pump
11. the oil effectively damps out mechanical noise to a very large extent, the integrated cam drive, lubrication and cooling system effectively formed being extremely quiet in operation.
12. significant gains in torque, acceleration and horse power; significant reductions in noise, cost and lost power with full lubrication of vulnerable parts on cold start up.

**CLAIMS**

1. An internal combustion engine comprising a crankshaft and an associated oil sump, a camshaft in a cylinder head above the oil sump, and a timing belt connecting the crankshaft and camshaft via respective pulleys, wherein the timing belt is adapted
5 to entrain a sufficient quantity of oil from the oil sump to lift it to the cylinder head for lubricating purposes.
2. An internal combustion engine according to Claim 1, wherein an oil pulley is provided below the crankshaft pulley positioned to be immersed in oil within the oil sump for entraining oil therefrom.
- 10 3. An internal combustion engine according to Claim 2, and in which the crankshaft and camshaft pulleys have similarly formed tooth sets of different diameters to effect the timing required, wherein the timing belt is of an impermeable material over its width and is formed with a set of teeth around its inner face for meshing with said toothed pulleys, and wherein the oil pulley is also toothed and the
15 timing belt has an additional set of teeth extending around its outer face for meshing with the teeth of the oil pulley, said outer teeth providing the means for entraining oil to the cylinder head.
4. An internal combustion engine according to Claim 3, wherein the teeth of the additional set of teeth are formed with scoops for entraining the oil.
- 20 5. An internal combustion engine according to Claim 3 or 4, wherein said additional teeth are designed to run closely within a closed passage, whereby they act with the wall of said passage to entrap and entrain said oil.
6. An internal combustion engine according to any one of the preceding Claims, wherein a cooler is provided in a return line to the sump to enable the entrained oil to
25 be used additionally for cooling purposes.

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7. An internal combustion engine as claimed in any preceding Claim further comprising a toothed pulley, the teeth of which run over a part of the rotation within a restricted passage and a belt having mating teeth which also run for part of their movement within a restricted passage, these runs being guided to a meshing point at
5 which oil under pressure is available as a source as a result of the meshing action.

8. An engine lubrication system including a toothed pulley, the teeth of which run over a part of the rotation within a restricted passage and a belt having mating teeth which also run for part of their movement within a restricted passage, these runs being guided to a meshing point at which oil under pressure is available as a
10 source as a result of the meshing action.

9. An internal combustion engine constructed, arranged and adapted for use substantially as hereinbefore described with reference to Figures 1 to 4 of the accompanying drawings, or modified as described with reference to Figures 5 and 6.

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