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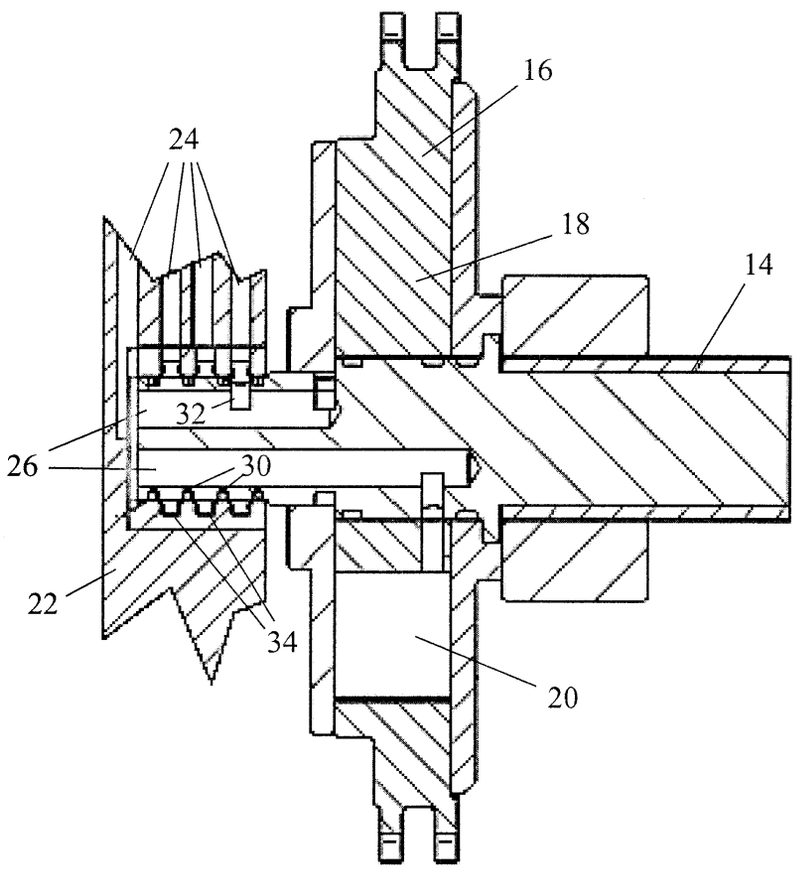
(54) Internal Combustion Engine

(57) An engine is described having a camshaft 14 formed with an oil passage 26, a cover 22 fitted to the front of the engine and overlying the front end of the camshaft 14, and an oil supply line 24 formed in the engine front cover. The camshaft 14 is formed with an axially projecting extension that is rotatably and sealingly received in an opening formed in the front cover 22 to enable the oil passage 26 in the camshaft to communicate with the oil supply line 24 in the engine cover 22.



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Description

[0001] The present invention relates to an internal combustion engine.

[0002] The optimum angles at which the inlet and exhaust valves of an internal combustion engine should open and close, both in relation to one another and in relation to the engine crankshaft, and optimum valve lift all vary with the engine speed and load conditions. In an engine with fixed camshafts, a compromise setting must be adopted in which the different performance parameters are traded off one against the other.

[0003] To achieve performance improvements over a range of engine speeds and loads, it has already been proposed to vary the cam phase, duration, lift or a combination of these parameters in relation to the crankshaft by the introduction of variable valve actuation mechanisms.

[0004] Several variable valve actuation mechanisms are known from the prior art each having its own advantages and disadvantages. The majority of these mechanisms use oil pressure to control their operation via a control valve to which the oil is supplied by way of passages in the camshaft and/or the cylinder head. A problem that is encountered with this approach is that the rate at which oil can be supplied to the control valve is restricted by the size of the passages. Furthermore, there will be a drop in oil pressure due to the cylinder head being far removed from the oil pump in the case of many engines. Consequently, the variable valve actuation mechanism can only respond slowly when a change to its current setting is required.

[0005] A still further disadvantage is that the requirement for oil passages in the engine block, cylinder head and valve train can make it difficult to retro-fit a variable valve actuation mechanism into an existing engine.

[0006] US-A-6,247,436 discloses an internal combustion engine having a crankshaft and a camshaft the ends of which project from a front end of the engine, a hydraulically operable variable valve actuation mechanism at the front end of the engine for driving the camshaft, an engine driven oil pump located at the front end of the engine and drive means located at the front end of the engine for transmitting torque from the crankshaft to the variable valve actuation mechanism. A front cover overlying the variable valve actuation mechanism comprises oil supply passages that are directly connected to the variable valve actuation mechanism, to enable the resistance to oil flow of the hydraulic circuit connecting the engine drive oil pump to the variable valve actuation mechanism to be reduced.

[0007] US Patent Application 2002/0029910 also shows a camshaft that is fitted with a vane-type phaser, i.e. a phase changing mechanism, to which oil is supplied through a cover fitted to the front of the engine.

[0008] In both these prior art proposals, a spigot projecting from the engine front cover fits inside part of the phaser or the camshaft to supply oil to the phaser. Such a configuration necessarily increases the diameter of at least part of the phaser and in the case of the phaser described in US Patent Application 2002/0029910, this spigots extends most of the way into the phaser and forces the diameter of the entire assembly to be increased.

[0009] With a view to mitigating this problem, the present invention provides an engine having a camshaft formed with an oil passage, a cover fitted to the front of the engine and overlying the front end of the camshaft, and an oil supply line formed in the engine front cover, wherein the camshaft is formed with an axially projecting extension that is rotatably and sealingly received in an opening formed in the front cover to enable the oil passage in the camshaft to communicate with the oil supply line in the engine cover.

[0010] In the invention, the camshaft is extended forwards to project into the front cover instead of there being a spigot on the front cover that projects into the camshaft. In this way, the desired fluid communication between the oil supply line of the front cover and the oil passage of the camshaft is achieved without the need to increase the diameter of any part of the camshaft or the phaser.

[0011] The invention will now be described further, by way of example, with reference to the accompanying drawing, which is a partial section through a camshaft fitted with a vane-type phaser.

[0012] The accompanying drawing shows a camshaft 14 coupled to a drive pulley 16 through a vane-type phaser having vanes 18 and vane cavities 20. The pulley 16 has inwardly extending vanes 18 each of which extends into a respective arcuate recess defined by the camshaft 14 and divides the recess into two variable volume cavities 20 or working chambers. Torque is transmitted from the pulley 16 to the camshaft 16 through oil filling the cavities 20. When no oil can flow into or out of the cavities, the pulley 16 and the camshaft 14 are hydraulically locked to one another. To vary the angular position of the pulley 14 relative to the camshaft and thereby effect a change in the phase of the camshaft 14 relative to the engine crankshaft that drives the pulley 16, oil is admitted into the cavity on one side of a vane while at the same time allowing oil to escape from the cavity on the opposite side of the vane.

[0013] A camshaft having this type of phaser is more fully described in US 2002/0059910, Figure 4 of which shows a similar section to that shown in the accompanying drawing. For this reason, it is not deemed necessary to describe the camshaft 14 nor the vane-type phaser in greater detail within the present context. It is also not necessary to dwell on the construction and operation of a vane-type phaser because it is not fundamental to the present invention. The invention is concerned with the manner of introducing oil into a rotating camshaft rather than with the function served by the oil after it has been so introduced.

[0014] The engine of the present invention is fitted

with a front cover 22 having various oil supply lines 24 that communicate through a control valve (not shown) with main oil supply and return galleries that lead to the engine oil pump. The supply lines 24 in turn communicate with various passages 26 that lead to different ones of the vane cavities 20. As a suitable engine front cover is described fully in the prior art (see US Patent 6,247,436) it is not necessary for it to be described in detail within the present context.

[0015] The camshaft 14 and the front cover 22 shown in the accompanying drawings differ from the prior art designs in that the camshaft 14 has an end that projects axially beyond the phaser and is received in an opening in the front cover 12. The end of the camshaft 14 can rotate within the front cover 22 and continuous communication between the passages 26 and the supply lines 24 is achieved through radial bores 32 in the camshaft and circumferentially extending grooves 34 in the wall of the cylindrical opening. The shaft is further provided with seals 30 that seal against the lands defined between the grooves in the opening.

[0016] Because no part of the cover 22 extends into the camshaft, the diameter of the camshaft 14 and of the phaser need not be increased to allow a rotary hydraulic connection to be achieved between the camshaft and the engine front cover.

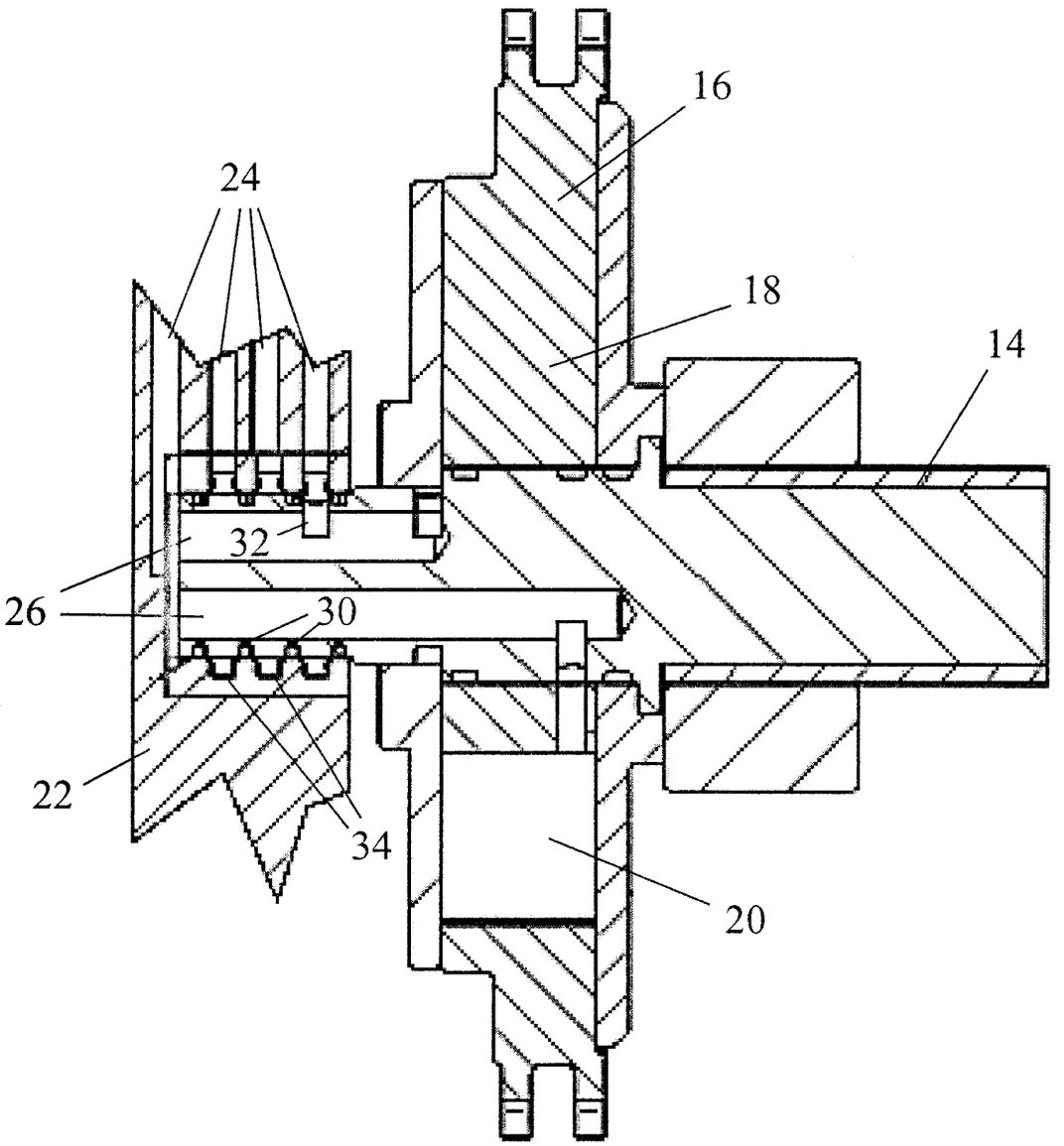
[0017] In this way, the invention permits a phaser to be contained within a pulley having the same size as a conventional camshaft drive pulley and no modification is required to the engine block to provide an adequate oil supply to the phaser other than to fit a front cover to the engine block, as has been proposed previously.

Claims

1. An engine having a camshaft formed with an oil passage, a cover fitted to the front of the engine and overlying the front end of the camshaft, and an oil supply line formed in the engine front cover, wherein the camshaft is formed with an axially projecting extension that is rotatably and sealingly received in an opening formed in the front cover to enable the oil passage in the camshaft to communicate with the oil supply line in the engine cover.

2. An engine as claimed in claim 1, wherein the camshaft is fitted with a variable valve timing mechanism actuated by means of the oil in the oil passage.

3. An engine as claimed in claim 2, wherein the variable valve timing mechanism is a vane-type phaser.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