APPLARATUS AND METHOD FOR RAPID WARMING OF THE OIL IN AN OIL PAN OF AN INTERNAL COMBUSTION ENGINE

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ABSTRACT

A lubrication system for an internal combustion engine includes a baffle assembly for disposition in the oil pan sump region comprising an upper flange partially closing the oil sump region having an oil pick-up well opening therethrough that is defined by a wall portion, for receipt of heated oil returning from the internal combustion engine. An oil reservoir is defined in the oil sump region by the wall portion wherein oil in the oil reservoir is separated from heated oil in the oil pickup well. A viscosity sensitive oil flow restrictive passage extends between the oil pick-up well and the oil reservoir and defines fluid communication therebetween. An oil pick-up for fluid communication with an oil pump of the internal combustion engine, and having a pick-up inlet disposed in the oil pick-up well, is configured to withdraw the heated oil therefrom.
APPARATUS AND METHOD FOR RAPID WARMING OF THE OIL IN AN OIL PAN OF AN INTERNAL COMBUSTION ENGINE

FIELD OF THE INVENTION

[0001] Exemplary embodiments of the present invention are directed to an internal combustion engine lubrication system and, more particularly an oil pan for an internal combustion engine having an insert including an oil sump that facilitates rapid warm-up of oil therein.

BACKGROUND

[0002] Customer demand driven by high fuel prices as well as governmental regulations relating to the fuel efficiency of internal combustion engines, especially those used in vehicular applications, are driving fuel economy considerations into the design and operation of engines. In addition, environmental and customer concerns are dictating longer intervals between vehicle servicing, such as oil changes, often resulting in an increase in engine oil volume.

[0003] Increases in engine oil volume may run contrary to the desire for higher fuel efficiency and improved emissions performance in that larger volumes of oil require a longer warming period following an initial cold start of the engine.

[0004] Internal combustion engines operate at peak efficiencies when the oil used for lubrication of its moving parts has reached a steady state operating temperature.

[0005] The need exists for an internal combustion engine lubrication system that facilitates higher oil volumes for longer service intervals but rapidly heats the oil to normal, steady state operating temperatures.

SUMMARY

[0006] In an exemplary embodiment of the present invention, a baffle assembly for disposition in the oil pan sump region of an internal combustion engine comprises an upper flange partially closing the oil sump region, an oil pick-up well, opening through the upper flange and defined by a wall portion, for receipt of heated oil returning from the internal combustion engine, an oil reservoir defined in the oil sump region by the wall portion wherein oil in the oil reservoir is separated from oil in the oil pickup well, a viscosity sensitive oil flow restrictive passage extending between the oil pick-up well and the oil reservoir defining fluid communication therebetween and an oil pick-up for fluid communication with an oil pump of the internal combustion engine and having a pick-up inlet disposed in the oil pick-up well that is configured to withdraw oil therefrom.

[0007] In yet another exemplary embodiment of the present invention a method for rapidly warming the engine oil in the oil pan of an internal combustion engine comprises defining an oil pick-up well in the oil pan, disposing an oil pick-up, in fluid communication with an oil pump of the internal combustion engine, in the oil pick-up well to withdraw oil therefrom, directing oil returning from the internal combustion engine to the oil pick-up well and defining a viscosity sensitive oil flow restrictive passage in the oil pick-up well to define fluid communication with oil in the oil reservoir in the oil pan.

[0008] The above features and advantages, and other features and advantages of the present invention are readily apparent from the following detailed description of the best modes for carrying out the invention when taken in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] Other objects, features, advantages and details appear, by way of example only, in the following detailed description of embodiments, the detailed description referring the drawings in which:

[0010] FIG. 1 is a longitudinal sectional view of an oil pan assembly embodying exemplary features of the present invention;

[0011] FIG. 2 is a top plan view of the oil pan assembly of FIG. 1;

[0012] FIG. 3 is an enlarged, partial sectional view of the oil pan assembly of FIG. 1 illustrating an exemplary mode of operation;

[0013] FIG. 4 is an enlarged, partial sectional view of the oil pan assembly of FIG. 1 illustrating another exemplary mode of operation;

[0014] FIG. 5 is an enlarged, partial sectional view of an oil pan assembly embodying exemplary features of the present invention;

[0015] FIG. 6 is a bottom facing perspective view of an oil pan baffle assembly embodying exemplary features of the present invention; and

[0016] FIG. 7 is an enlarged, partial sectional view of an oil pan assembly embodying exemplary features of the present invention.

DESCRIPTION OF THE EMBODIMENTS

[0017] The following description is merely exemplary in nature and is not intended to limit the present disclosure, application or uses. It should be understood that throughout the drawings, corresponding reference numerals indicate like or corresponding parts and features.

[0018] In accordance with an exemplary embodiment of the present invention, FIG. 1 illustrates an oil pan assembly 14 for application to an internal combustion engine 5. The oil pan 14 may be constructed of stamped steel, plastic, composite or may be of a cast metal composition and includes an open top end 18, having an upper flanged surface 16 that is configured to mate with a corresponding mating surface 7 of the internal combustion engine 5 in a sealing arrangement, a closed lower end 20 and sides 22. The oil pan is configured to collect engine oil 24 that drains from the engine block following lubrication thereof. The oil pan includes an oil sump region 26...
that is fed by an engine oil return system including angled, oil collection ramps or surfaces 28 that are configured to collect the engine oil 24 and direct the oil towards the sump region 26. An oil pump (not shown) is fluidly connected to an oil pick-up 30 having a pick-up inlet 32 disposed in the oil pan, preferably in the oil sump region 26. The oil pump may be electrically operated or engine operated (such as through mechanical connection to the crankshaft, the camshaft, an accessory drive or another rotatable component of the internal combustion engine 5) and functions to withdraw engine oil 24 from the oil pan 14 through the oil pick-up 30 for distribution throughout the internal combustion engine 5 during engine cranking and operation, for lubrication of various moving parts.

[0019] Referring to FIGS. 1 and 2, in an exemplary embodiment, disposed within the oil pan assembly 14, preferably within the oil sump region 26, is a baffle assembly, designated generally as 34. The baffle assembly 34 includes an upper flange 36, a lower flange 38, and an interconnecting wall portion 40 extending between, and connecting, the upper and the lower flanges. The baffle assembly 34 is disposed within the oil sump region 26 such that the lower flange 38 is positioned in a closely spaced orientation with the bottom 42 of the oil sump region 26 to define a viscosity sensitive oil flow restrictive passage 44 therebetween. The upper flange 36 is configured to at least partially close the oil sump region against the ingress of engine oil 24 from around the baffle perimeter 46. Mounting bolts 48 may engage corresponding oil pan mounting bosses (not shown) to retain the baffle assembly 34 securely and sealingly in position within the oil pan 14.

[0020] The baffle assembly 34 partitions the sump region 26 into an oil reservoir 52, and an oil pick-up well 53, FIGS. 1 and 4 that is configured to receive the pick-up inlet 32 of the oil pick-up 30. A mounting flange 54, FIG. 2, may be associated with oil pick-up inlet 32 and receives attachment bolts 56 that are operable to securely retain the oil pick-up 30 within the oil pan 14.

[0021] In an exemplary embodiment, upon engine start-up, especially following a cold engine start-up, supply oil 60 is drawn from the oil pick-up well 53 by the engine oil pump (not shown) through the pick-up inlet 32 of the oil pick-up 30. The supply oil 60 is circulated through the lubrication system of the internal combustion engine 5, where it is warmed, and subsequently returned to the oil pan 14 as indicated by return oil flow 58. Due to the at least partial closure of the oil sump region 26 by the baffle perimeter 46 of the upper flange 36, return oil flow 58 is directed back to the oil pick-up well 53 rather than to the oil reservoir 52. The result is that heated engine oil 24 returning to the oil pick-up well 53 as return oil flow 58 will be preferentially available to the pick-up inlet 32 of the oil pick-up 30 and thus, the oil pump and engine lubrication system. As such, a reduction in the time required for the internal combustion engine 5 to reach steady state operating temperature is achieved, thereby improving the efficiency and emissions performance of the engine. In an exemplary embodiment the baffle assembly 34, or at least the portion of the assembly defining the oil pick-up well 53 such as interconnecting wall portion 40, may be constructed of an insulative material defining an additional thermal barrier between the warm oil in the oil pick-up well 53 and the cooler oil in the oil reservoir 52. The material may comprise a high density, temperature tolerant plastic or composite material or may comprise a double walled sheet assembly constructed of metal or a plastic or composite material.

[0022] In an exemplary embodiment illustrated in FIG. 1, during engine startup and steady state operation thereof, return oil flow 58 and supply oil flow 60 are relatively equal and, as such, the oil level in the sump region 26 will remain at relatively equal levels in the oil reservoir 52 and the oil pick-up well 53 as indicated by the oil level 27. However, referring to FIG. 3, during operation of the internal combustion engine 5 at high speeds (i.e. high RPM) or during rapid transient operation of the engine, oil draw down may occur in the oil pick-up well 53 resulting in a difference in oil levels 62a and 62b between the oil pick-up well 53 and the oil reservoir 52, respectively. The resulting pressure differential between the differing oil level “fluid columns”, 62a, 62b, will cause replacement oil 64 to flow from the oil reservoir 52 to the oil pick-up well 53 through viscosity sensitive oil flow restrictive passage 44, resulting in fluid leveling throughout the oil sump region 26. A vent opening (not shown) in the baffle assembly 34 provides equal pressures in the oil reservoir 52 and the oil pick-up well 53 thereby allowing rapid leveling of the oil levels 62a and 62b by preventing a partial vacuum in the oil reservoir during times of unequal fluid levels. As shown in FIG. 4, during operating conditions which may result in a larger return oil flow 58 than is required by the engine oil pump as supply oil 60, the fluid the oil pick-up well may rise, resulting in a difference in oil levels 62a and 62b between the oil pick-up well and the oil reservoir 52, respectively. Again, the pressure differential between the differing oil level “fluid columns” will cause replacement oil 64 to flow from the oil pick-up well 53 to the oil reservoir 52 resulting in fluid leveling throughout the oil sump region 26.

[0023] In an exemplary embodiment, the flow characteristics of the replacement oil 64 is determined by the viscosity of the oil, the nature of the fluid flow (e.g. laminar or turbulent flow) the shape and the dimensions of the viscosity sensitive oil flow restrictive passage 44 which is defined by the distance “d,” between the lower flange 38 and the bottom 42 of the oil sump region 26 or by the distance “d,” between the perimeter 66 of the lower flange 38 and the outer wall 68 of the oil sump region 26, or both (FIG. 3). As a result, the flow characteristics, or rate of flow, of the replacement oil 64 may be customized for a particular engine application by varying the dimensions “d1” and/or “d2” of the viscosity sensitive oil flow restrictive passage 44 such that the viscosity sensitive oil flow rate may be configured to regulate the rate of oil flow there through.

[0024] In an exemplary embodiment shown in FIGS. 5 and 6, a series of flow modifiers such as the ribs 70 extending between the lower flange 38 of the baffle assembly 34 into the viscosity sensitive oil flow restrictive passage 44 may be utilized to further customize the flow characteristics of the supply oil flow 64 between the oil reservoir 52 and the oil pick-up well 53. In this embodiment of the baffle assembly 34, the ribs 70 extend from the lower surface of the lower flange 38 and direct the supply oil flow 64 to the pick-up inlet 32 of the oil pick-up 30 under dynamic/high performance engine operating conditions. It is also contemplated that the flow modifiers or ribs 70 may extend from the bottom 42 of the oil sump region as an integral feature of the oil pan. In addition, the spacing of the ribs will, through fluid friction with the supply oil flow 64, determine the flow rate of the oil under cold conditions.

[0025] In another exemplary embodiment illustrated in FIG. 7, it is contemplated that the baffle assembly 34 may include an upper flange 36 and a wall portion 40 extending between the upper flange and the bottom 42 of the oil sump
region 26. The upper flange 36 is configured to at least partially close the oil sump region against the ingress of engine oil 24 from around the baffle perimeter 46. Mounting bolts 48 may engage corresponding oil pan mounting bosses (not shown) to retain the baffle assembly 34 securely and seatingly in position within the oil pan 14. The baffle assembly 34 partitions the sump region 26 into an oil reservoir 52, and an oil pick-up well 53 that is configured to receive the pick-up inlet 32 of the oil pick-up 30. A series of viscosity sensitive oil flow restrictive passages 80 fluidly connect the oil pick-up well 53 with the oil reservoir 52. [0026] Upon engine start-up, especially following a cold engine start-up, supply oil 60 is drawn from the oil pick-up well 53 by the engine oil pump (not shown) through the pick-up inlet 32 of the oil pick-up 30. The supply oil 60 is circulated through the lubrication system of the internal combustion engine 5, where it is warmed, and subsequently returned to the oil pan 14 as indicated by return oil flow 58. Due to the at least partial closure of the oil sump region 26 by the baffle perimeter 46 of the upper flange 36, return oil flow 58 is directed back to the oil pick-up well 53 rather than to the oil reservoir 52. The result is that heated engine oil 24 returning to the oil pick-up well 53 as return oil flow 58 will be preferentially available to the pick-up inlet 32 of the oil pick-up 30 and thus, the oil pump and engine lubrication system. As such, a reduction in the time required for the internal combustion engine 5 to reach steady state operating temperature is achieved, thereby improving the efficiency and emissions performance of the engine. During engine startup and steady state operation thereof, return oil flow 58 and supply oil flow 60 are relatively equal and, as such, the oil level in the sump region 26 will remain at relatively equal levels in the oil reservoir 52 and the oil pick-up well 53. As illustrated in FIG. 7, during operation of the engine at high speeds (i.e. high RPM) or during rapid transient operation of the engine, oil draw down may occur in the oil pick-up well 53 resulting in a difference in oil levels 62a, 62b between the oil pick-up well 53 and the oil reservoir 52, respectively. The resulting pressure differential between the differing oil level “fluid columns” 62a, 62b will cause replacement oil 64 to flow from the oil reservoir 52 to the oil pick-up well 53 through the viscosity sensitive oil flow restrictive passages 80 resulting in fluid leveling throughout the oil sump region 26. As discussed in the earlier described embodiment, during operating conditions which may result in a larger return oil flow 58 than is required by the engine oil pump as supply oil 60, the fluid level in the oil pick-up well may rise, resulting in a difference in oil levels 62a, 62b between the oil pick-up well and the oil reservoir 52, respectively. Again, the pressure differential between the differing oil level “fluid columns” will cause replacement oil 64 to flow from the oil pick-up well 53 to the oil reservoir 52 resulting in fluid leveling throughout the oil sump region 26. [0027] The flow characteristics of the replacement oil 64 is determined by the viscosity of the oil, the nature of the fluid flow (e.g. laminar or turbulent flow) the shape and the dimensions of the oil flow restrictive passages 80 which are defined by the length of the passages as a function of the thickness of the wall portion 40 and the diameter thereof. As a result, the flow characteristics, or rate of flow, of the replacement oil 64 may be customized for a particular engine application by varying the length and the diameters of the oil flow restrictive passages 80. [0028] While the invention has been described with reference to exemplary embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiments disclosed as the best mode contemplated for carrying out this invention, but that the invention will include all embodiments falling within the scope of the present invention.

What is claimed is:

1. A baffle assembly for disposition in the oil pan sump region of an internal combustion engine comprising:
   - an upper flange partially closing the oil sump region;
   - an oil pick-up well opening through the upper flange and defined by a wall portion extending from the upper flange and associated with an engine oil return for receipt of oil returning from the internal combustion engine;
   - an oil reservoir defined in the oil sump region by the wall portion;
   - a viscosity sensitive oil flow restrictive passage extending between the oil pick-up well and the oil reservoir defining fluid communication therebetween; and
   - an oil pick-up for fluid communication with an oil pump of the internal combustion engine and having a pick-up inlet disposed in the oil pick-up well that is configured to withdraw the oil therefrom.

2. The baffle assembly for disposition in the oil pan sump region of an internal combustion engine of claim 1, wherein the wall portion of the oil pick-up well opens through a lower flange extending outwardly from the wall portion in spaced relationship from a surface of the oil sump region to define the viscosity sensitive oil flow restrictive passage therebetween.

3. The baffle assembly for disposition in the oil pan sump region of an internal combustion engine of claim 2, further comprising a plurality of flow modifiers extending between the lower flange and the bottom surface of the oil sump region.

4. The baffle assembly for disposition in the oil pan sump region of an internal combustion engine of claim 3, wherein the fluid modifiers comprise a plurality of ribs extending between the lower flange of the baffle assembly into the viscosity sensitive oil flow restrictive passage.

5. The baffle assembly for disposition in the oil pan sump region of an internal combustion engine of claim 1, wherein at least a portion of the baffle assembly is constructed of an insulative material configured to reduce thermal transfer between the oil reservoir and the oil pick-up well.

6. The baffle assembly for disposition in the oil pan sump region of an internal combustion engine of claim 5, wherein the insulative material comprises a double wall.

7. The baffle assembly for disposition in the oil pan sump region of an internal combustion engine of claim 1, wherein the wall portion extends to a location adjacent a bottom surface of the oil sump region to thereby close one end of the oil pick-up well.

8. The baffle assembly for disposition in the oil pan sump region of an internal combustion engine of claim 7, further comprising a series of viscosity sensitive oil flow restrictive passages extending through the wall portion.
9. An internal combustion engine lubrication system comprising:
an internal combustion engine;
an oil pan attached to the internal combustion engine and
having a bottom and a plurality of sides extending from
the bottom to define an open top end for sealing engage-
ment with a mating surface of the internal combustion
engine and an oil sump region therein;
a baffle assembly disposed in the oil sump region and
configured to divide the oil sump region into an oil
pick-up well located within an oil reservoir;
an oil pick-up for fluid communication with an oil pump of
the internal combustion engine and having a pick-up
inlet disposed in the oil pick-up well; and
a viscosity sensitive oil flow restrictive passage disposed
between the oil pick-up well and the oil reservoir for
fluid communication therebetween.

10. The internal combustion engine lubrication system of
claim 9, the baffle assembly further comprising:
an upper flange configured to partially close the oil sump
region and associated with an engine oil return;
a lower flange disposed in spaced relationship with a sur-
face of the oil sump region; and
an interconnecting wall portion opening through the upper
flange to define the oil pick-up well.

11. The internal combustion engine lubrication system of
claim 10, wherein the lower flange of the baffle assembly and
a surface of the oil sump region define the viscosity sensitive
oil flow restrictive passage therebetween.

12. The internal combustion engine lubrication system of
claim 11, further comprising a plurality of oil flow modifiers
extending between the lower flange of the baffle and the
bottom of the oil pan.

13. The internal combustion engine lubrication system of
claim 12, wherein the flow modifiers comprise a plurality of
ribs extending between the lower flange of the baffle assembly
and the bottom of the oil sump region.

14. The internal combustion engine lubrication system of
claim 9, wherein at least a portion of the baffle assembly is
constructed of an insulative material configured to reduce
thermal transfer between the oil reservoir and the oil pick-up
well.

15. The internal combustion engine lubrication system of
claim 14, wherein the insulative material comprises a double
wall.

16. A method for rapidly warming the engine oil in the oil
pan of an internal combustion engine comprising:
deﬁning an oil pick-up well in an oil pan;
disposing an oil pick-up, in fluid communication with an
oil pump of an internal combustion engine in the oil
pick-up well to withdraw oil therefrom;
directing heated oil returning from the internal combustion
engine to the oil pick-up well; and
defining a viscosity sensitive oil flow restrictive passage in
the oil pick-up well to deﬁne fluid communication with
oil in the oil pan.

17. The method for rapidly warming the engine oil in the oil
pan of an internal combustion engine of claim 14 further
comprising selecting the dimensions of the viscosity sensitive
oil flow restrictive passage to control the direction of oil flow,
the rate of oil flow or both through the viscosity sensitive oil
flow restrictive passage and between the oil in the oil pan and
the oil pick-up well.

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