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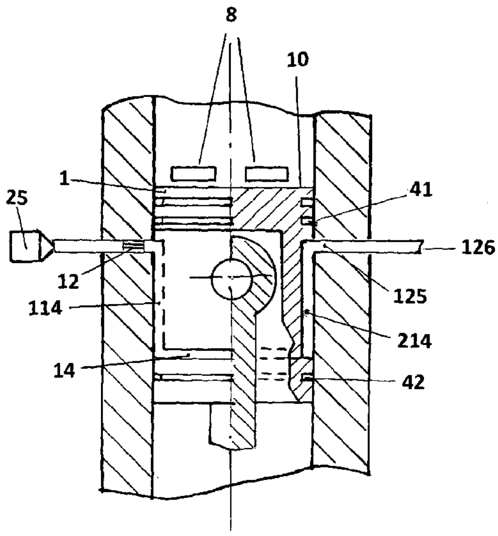

FIGURE-2

(57) Abstract: A device for reliable and effective lubrication of pistons (1) in a reciprocating internal combustion engine, particularly a two stroke engine, either gasoline or diesel, which use the crankcase as an air pump. Lubricating oil is delivered to and extracted from intercommunicating grooves (114, 14, 214) in the piston skirt situated between two piston rings and is smeared around and along the cylinder bore by piston movement. The oil can flow continuously or intermittently during the pistons movement. An additional feature for two stroke engines is the separation of the transfer ducts volume from the crankcase volume by non return one way valves. This invention aims to reduce hydrocarbon exhaust emissions by minimising contamination of combustion air with lubricating oil.

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INTERNAL COMBUSTION ENGINE

This invention relates to piston lubrication in a reciprocating internal combustion engine but particularly to an engine operating on a two stroke cycle.

Some two stroke spark engines which use the crankcase as an air pump achieves their lubrication needs by mixing oil with the gasoline which enters the crankcase together with the air intake. Such engines experience excessive emission of unburnt hydrocarbon in the exhaust. This invention seeks to provide a very effective and reliable lubricating system for piston movement in the cylinder whilst, when applied to two stroke engines, also minimising the emission of hydrocarbons in exhaust gases which originate from lubricating oil. The lubrication of the piston is done with minimal oil contamination of the air passing through the crankcase where the crankcase is used to pump air into the cylinder. This invention is applicable to two stroke engines, both spark ignited and compression ignited. It is also applicable to four stroke engines requiring reliable piston lubrication for example lubrication independent of the orientation of the engine when in use.

Accordingly this invention provides an internal combustion reciprocating engine comprising;

a piston reciprocating in a cylinder comprising piston crown and piston skirt;

a connecting rod attaching the piston to a crankshaft rotating in a crankcase;

at least one lower piston ring;

at least one upper piston ring located between the lower piston ring and the piston crown;

a lubricant dispensing means to deliver lubricant to the piston;

a lubricant supply port situated on the cylinder wall, communicating with the lubricant dispensing means;

a lubricant retrieval means provided to extract from the cylinder surplus lubricant delivered by the lubricant dispensing means;

a lubricant return port situated on the cylinder wall, communicating with the lubricant retrieval means;

characterised in that a circumferential lubricant conduit is provided in the piston's outer surface, between the at least one lower piston ring and the at least one upper piston ring, the lubricant conduit being positioned to communicate simultaneously with both the lubricant supply port and the lubricant return port during at least a portion of the duration of the piston's movement along its stroke.

This arrangement provides a flow path for lubricant such as oil through conduits in the piston's outer surface, which allows the oil to flow from the lubricant supply port through the circumferential lubricant conduit to exit the cylinder from the lubricant return port during the engine's operation and provides oil contained in the circumferential lubricant conduit to be smeared around the circumference and along the length of the cylinder bore during the movement of the piston in order to provide lubrication.

For the sake of illustration, directional terms such as upper and lower, and above and below are used in this specification in their ordinary meanings, with the engine oriented with the cylinder's longitudinal axis substantially vertical and with the piston above the crankshaft.

The terms conduit or groove or channel describe a means allowing the flow of lubricant such as oil in the space between the piston and the cylinder bore. The feature can take a number of forms, for example a groove cut into the outer surface of the piston to allow the flow of oil through it, being contained therein by the cylinder wall. It can also take the form of a clearance formed between the piston and the cylinder wall which is obtained by machining a flat surface on the curved cylindrical outer surface of the piston which can also allow a gap for the flow of oil; such a flat will also be referred to herein as a groove. The groove can also be a circumferential groove cut into the outer surface of the piston or a circumferential ledge or channel formed by a step formed by reducing the outer diameter of the piston and not confined from above or it can also be a circumferential ledge or channel formed above a piston ring and not confined from above.

The term piston ring describes a ring capable of scraping some oil deposited on the cylinder’s inner surface, it can also be a gas compression sealing ring if found suitable. One piston ring or a number of rings may be used either above and/or below the gudgeon pin’s position depending on the piston design.

The term inner dead centre describes the piston’s position when the cylinder volume above its crown is at the minimum value during the cycle. The term outer dead centre position describes the position when the cylinder volume is at its maximum value.

Preferably the lubricant supply port is located on the face of the cylinder which experiences thrust force exerted by the connecting rod during the expansion stroke of the piston.

Preferably the lubricant return port is located diametrically opposite the lubricant supply port.

Preferably the lubricant supply port and the lubricant return port are situated to face a lubricant conduit or groove in the piston when the piston reaches its momentary dwell position either at its outer dead centre position or at its inner dead centre position depending on the design of the piston.

Preferably a longitudinal lubricant delivery groove is provided in the piston (substantially aligned with the cylinder’s longitudinal axis) to communicate with the circumferential lubricant conduit and is situated in the piston’s outer surface in a position aligning it to face the lubricant supply port during at least part of the duration of the motion of the piston. This longitudinal lubricant delivery groove can extend towards the piston’s crown over a distance but preferably it should not communicate with a piston ring groove belonging to an upper piston ring.

Preferably a longitudinal lubricant return groove is provided in the piston (also substantially aligned with the cylinder's longitudinal axis) to communicate with the circumferential lubricant conduit and is situated in the piston's outer surface in a position aligning it to face the lubricant return port during at least part of the duration of the motion of the piston, this longitudinal lubricant return groove can extend towards the piston's crown over a distance but preferably it should not communicate with a piston ring groove belonging to an upper piston.

Preferably the lubricant retrieval means applies a sub atmospheric pressure to the lubricant return port.

A two stroke engine which uses its crankcase as an air pump will have at least one gas transfer inlet port situated at suitable location(s) on the circumference of the cylinder wall to allow air to enter the cylinder when the piston is near its outer dead centre position and will also have at least one gas transfer duct connecting the crankcase with the gas transfer inlet port(s).

Preferably the gas transfer inlet port(s) are placed around the circumference of the cylinder at some distance from the said longitudinal lubricant delivery groove and longitudinal lubricant return groove on the piston so as to ensure that when these longitudinal grooves move with the piston there is sufficient distance between the gas transfer inlet port(s) and the longitudinal lubricant grooves to avoid the direct leakage of lubricant from these grooves into the gas transfer port(s).

Preferably a one way valve, such as reed valve, is situated at the crankcase end of each of the gas transfer duct(s) to allow the flow of air from the crankcase into the gas transfer duct when the piston moves during its expansion stroke but to stop the transfer duct(s) from experiencing sub atmospheric pressure when the piston moves during its compression stroke and the crankcase is experiencing sub atmospheric pressures.

Preferably the lubricant supply port is restricted by an orifice which helps to control the amount of lubricant such as oil delivered to lubricate the piston.

The invention therefore provides a flow path for lubricant (oil) supplied to the piston from a source external to the cylinder and the extraction of such oil from the cylinder to an external lubricant retrieval means in order to minimise the amount of lubricant which remains inside the cylinder. The piston's reciprocating movement is used to smear lubricant on the cylinder wall.

The invention will be further described, by way of example, with reference to the accompanying schematic drawings, which show:

Fig.1 is a cross-section through a cylinder, piston and crankcase of a two stroke engine incorporating the present invention, with the crankshaft and other componentry omitted for clarity;

Fig.2 is a cross-section through a part of a cylinder and a piston of a two stroke engine according to the First Embodiment of the present invention, the left-hand side of the drawing showing the exterior of the piston, the right-hand side of the drawing showing a section through the piston;

Fig.3 is a cross-section through a part of a cylinder and a piston of a two stroke engine according to the Second Embodiment of the present invention, the left-hand side of the drawing showing the exterior of the piston, the right-hand side of the drawing showing a section through the piston; and

Fig.4 is a partial cross-sectional view through the cylinder showing the piston of the engine of Fig.3, perpendicular to the cross-section of Fig.3.

Similar reference numbers are used for similar components in the different embodiments.

The invention can be implemented in a number of embodiments. One preferential embodiment, applicable to both two stroke engines and four stroke engines, is referred to herein as the First Embodiment, and is illustrated in Figure 2. The piston may be constructed substantially as a cylinder whose length exceeds the stroke of the piston at least by the length required to accommodate the piston rings and the circumferential lubricant conduit 14 which is placed above a lower piston ring (or rings) 42 situated near the lower end of this cylinder as shown in Figure 2. In such embodiment the lubricant supply port 12 is situated a short distance below the lowest upper piston ring 41 when the piston 1 reaches its outer dead centre position to face the upper end of the longitudinal lubricant delivery groove 114 and is situated to face the circumferential lubricant conduit 14 when the piston is at its inner dead centre position. The lubricant return port 125 and the longitudinal lubricant return groove 214 are similarly positioned diametrically opposite in relation to the piston 1. Such embodiment allows the longitudinal lubricant delivery groove 114 to face the lubricant supply port 12 during the motion of the piston over a complete engine cycle and similarly allows the longitudinal lubricant return groove 214 to face the lubricant return port 125 during a complete engine cycle. Both longitudinal grooves 114 and 214 extend towards the piston's crown over a distance which ensures that their upper ends do not reach the groove of the upper piston ring 41 but to best advantage allows their upper ends to extend to a position where each face the respective lubricant supply port 12 or the lubricant return port 125 when the piston is at its outer dead centre position. The advantage this confers is the ability to deliver and extract lubricant (typically oil) to and from the piston continuously during the engine's operation. A piston 1 so constructed will also allow the positioning of exhaust ports in the face of the cylinder.

In such an embodiment oil can be delivered to the lubricant supply port 12 by the lubricant dispensing means 25 either continuously or intermittently. The duration of delivery is dictated by the quantity of lubricating oil required to meet the piston's lubrication needs. Intermittent lubrication can start and stop without regard to the position of the piston at those instants. The delivery can be separated by an appreciable interval of time, for example several minutes, or by a predetermined number of engine revolutions.

Another embodiment according to this invention, to be referred to herein as the Second Embodiment, is illustrated in Figures 3 and Figure 4 which show two longitudinal cross sections through the piston and cylinder of a two stroke engine, ninety degrees apart. A similar embodiment can also be applied to four stroke engines which use short pistons as well as to the two stroke engine shown, which uses an exhaust valve and inlet ports and is constructed with shorter pistons where the lower end of the piston 100 is elongated only at the thrust faces of the piston and is cut away elsewhere below the cylindrical crown so that the lowest part of the piston 1 does not form a continuous cylinder. In such a two stroke engine the inlet ports 8 can be exposed to the crankcase when the piston crown rises above them when moving towards it inner dead centre position. In such an engine the upper and lower piston rings 41 and 42 may be situated in the cylindrical part of the piston at its upper end adjacent to the crown and the circumferential conduit 14 may be situated above the lower ring 42 or indeed be the ledge formed by the uppermost lower piston ring itself.

In this embodiment the lubricant supply port 12 and the lubricant oil return port 125 are best positioned to align with the upper end of the longitudinal lubricant delivery groove 114 and the longitudinal lubricant return groove 214 when the piston reaches its outer dead centre position, when there is a short time dwell in the piston’s movement. In this embodiment oil delivery is best made intermittently with each delivery carried out over a short time period and timed to start during the expansion stroke when the piston reaches a position where the circumferential lubricant conduit 14 is facing the lubricant supply port 12, and timed to end when the piston returns to that position during the compression stroke of the piston. Suction may be applied to the lubricant return port 125 continuously to avoid the need for timing it to take place over a short time period.

Timing the delivery of oil in relation to piston position and the short delivery time duration needed at higher engine speeds can be achieved by using an electronic injector, of the type used to inject fuel to an engine at a given instant and over a predetermined duration.

Another solution available for engines designed according to this Second Embodiment is to deliver oil intermittently but on each occasion to do so over a predetermined short time interval but not to synchronise the start and end of delivery with the position of the piston. If the quantity of oil delivered per oil injection is small the penalty of delivering some of this oil directly into the crankcase after the piston elongation 100 clears the lubricant supply port 12 may be tolerable in terms of increasing hydrocarbon exhaust emission, particularly if the engine sump is kept dry.

As shown in Figure 1, the lower part of the cylinder may be provided with a circumferential channel functioning as a gutter 15 to collect any oil if found leaking from the cylinder bore through the lower piston ring and such oil leakage may be extracted from the crankcase through a piped passage 17.

The piston rings 41 and 42 are preferably respective stacks of two or more rings, some of the rings being thin compared with the others. Ring gaps are positioned at different circumferential locations in each stack in order to minimise oil leakage through the gaps.

The operation of this invention is described by way of an example using figures. The invention is particularly suitable to any two stroke engine which uses its crankcase as an air pump. Figure 1 shows one possible two stroke engine suitable for the use of this invention in which the fuel is injected into an indirect combustion chamber 6, containing spark plug 9, by injector 11, as described in patent publication number WO2005/052335 and also patent application WO2007/080366. This engine is known as the MUSIC engine, short for Merritt Unthrottled Spark Ignition Combustion engine.

The MUSIC engine is particularly suitable for the use of the current invention since the air pumped through the crankcase does not contain either fuel or lubricating oil and the lubrication of the piston requires a special provision which avoids contamination of the air with oil. The MUSIC engine uses stratified charge combustion which yields high thermal efficiency either in four stroke or in two stroke embodiments.

In the illustration of a two stroke engine shown in Figure 1, an exhaust valve 43 is used but two stroke engines using exhaust ports are also able to use the lubrication system according to the First Embodiment of this invention. If lubricating oil were to be mixed with the air in the crankcase some of it will contaminate the exhaust gases with hydrocarbon emissions but the use of this invention can reduce or even eliminate that. The lubrication of the main crankshaft bearings and the big end bearings can be achieved in a way which minimises the ingress of lubricating oil into the air in the crankcase, by the use of rolling element bearings and possibly intermittent lubrication techniques.

Figure 1 does not show many details of the lubrication system, but these are shown in Figure 2. Figure 2 illustrates the First Embodiment and is identified as a two stroke engine by the gas transfer inlet ports 8. If these ports are omitted the diagram can also represent a four stroke engine. Figure 2 shows piston 1 in cylinder 2 at its outer dead centre position uncovering the gas transfer ports 8 which allow air to flow into the cylinder from the crankcase 35 through the gas transfer duct 31 (Figure 1). The gas transfer duct 31 is used primarily to admit air into the cylinder 2 prior to the commencement of the compression stroke. The gas transfer duct 31 is shown only on one side of the cylinder in Figure 1 but it can take an alternative form of a concentric annular space surrounding the cylinder or as number of distinct ducts placed around the cylinder which connect the crankcase with the gas transfer ports 8.

One feature included in this invention which can be used in a two stroke engine using the lubrication system according to this invention, particularly a ported two stroke engine, is the non return valve 33, shown in Figure 1, in the form of a reed valve, which is placed at the lower end of the gas transfer duct. The reed valve 33 opens when the piston moves towards its outer dead centre position to allow air from the crankcase 35 to enter the gas transfer duct after the other reed valve 32, which admits air into the crankcase, closes. Reed valve 33 closes and reed valve 32 opens when the piston move towards its inner dead centre position and so avoids subjecting the gas transfer duct 31 to the reduction of pressure experienced in the crankcase during the air intake process when the second reed valve 32 opens to allow air into the crankcase. It is understood that the use of the non return or reed valve 32 to control air intake into the crankcase is standard practice in the design of two stroke engines but the use of reed valve 33 to control air flow into the gas transfer ducts is a feature which can improve the current invention by reducing the likelihood of the suction of lubricating oil from the longitudinal lubricant delivery groove 114 and the longitudinal lubricant return groove 214 into the gas transfer ports 8 when the crankcase 35 is under vacuum during the compression stroke of the piston. Moreover the reed valves 33 can promote a positive pressure in the gas transfer duct 31 throughout the engine cycle and this can help reduce or even eliminate oil suction into the gas transfer ports 8. The lubrication system described in this invention promotes the coating of the piston's surface with lubricating oil and this may be scraped into the gas transfer inlet ports 8 when the piston's skirt moves over them. Without non return valve 33 such scraped oil may be sucked into the transfer ports during the compression stroke when the ports may experience sub atmospheric pressure and the purpose of valve 33 is to avoid this happening.

A further advantage offered by non return valve 33 is the removal of the substantial volume contained in the gas transfer duct 31 from the total volume of the crankcase 35 during the induction stroke experienced by the crankcase, which coincides with the compression stroke experienced in the cylinder. This enhances the pressure reduction in the crankcase and increases the volume of air inhaled into the engine.

The lubrication of the longer cylindrical piston referred to in relation to the First Embodiment is explained with the aid of Figure 2. The piston 1 has an upper piston ring 41 and a lower piston ring 42 situated on either side of the gudgeon pin and a circumferential lubricant groove 14. It is also shown with both a longitudinal lubricant delivery groove 114 and a longitudinal lubricant return groove 214 which represent a preferred option. The cylinder bore has a lubricant supply port 12 facing the longitudinal lubricant delivery groove 114, so that the supply of oil into the longitudinal lubricant delivery groove 114 can take place wherever the piston happens to be along its stroke. The cylinder bore has a lubricant return port 125 facing the longitudinal lubricant return groove 214, shown as preferred option, so that oil return into the return port 125 can take place wherever the piston happens to be along its stroke. Therefore a continuous oil circuit exists starting from the lubricant dispensing means 25, through the lubricant supply port 12 into the longitudinal lubricant delivery groove 114 in the piston, into the circumferential lubricant conduit 14 wherefrom it returns through the longitudinal lubricant return groove 214 and into the lubricant return port 125 situated in the cylinder wall. The oil is piped from the lubricant return port 125 into a lubricant retrieval means preferably a vacuum pump, not shown, which sucks the oil as it returns from the cylinder creating a reduced pressure at the lubricant return port 125. The size of the lubricant supply port 12 ensures that the suction applied at return port 125 maintains a low pressure, preferably a sub atmospheric pressure, along the oil grooves circuit described above and in doing so avoids oil seeping from the piston grooves into the gas transfer ports 8.

The operation of the lubricating system according to this invention is possible, without the provision of the longitudinal lubricant delivery groove 114 and the longitudinal lubricant return groove 214. Such operation will benefit from intermittent oil delivery from the lubricant dispensing means 25. In this case the delivery of oil from the lubricant supply port 12 will be impeded during most of the piston's stroke when the port 12 faces the piston's skirt with only a small clearance available to receive any oil. However when the piston reaches its inner dead centre position both the lubricant supply port 12 and the lubricant return port 125 face the circumferential lubricant conduit 14 at the same time so that momentarily there will be a direct flow path for the oil between the two holes via the circumferential conduit 14. This may in some engines suffice to provide oil for the lubrication of the piston. Such an arrangement may be very suitable for a four stroke engine. However, in the case of a two stroke engine, the absence of the axial grooves may cause oil to be smeared around the cylinder wall and enter the transfer ports 8 when the piston is moving, whereas if both longitudinal lubricant grooves 114 and 214 are present they can channel this oil away from the transfer ports 8, particularly when reduced pressure is applied to the interconnected grooved system from the port 125 and when the pressure applied to the port 12 is minimised.

The lubrication of the complete piston circumference occurs as the circumferential lubricant conduit 14, which may be full of oil, moves up and down along the cylinder bore. This smears oil on the cylinder bore which in turn wets the piston skirt as it moves along the bore during subsequent cycles. The upper and lower piston rings ensure that the oil circulating through the grooves in the piston remains trapped between the rings as the piston moves during the cycle and the rings also control the thickness of the oil film remaining on the cylinder wall after the piston rings have moved elsewhere.

It is advisable that the lubricant supply port 12 is placed on the thrust face of the cylinder, which experience a side force during the expansion stroke preferably at its centre, and that the lubricant return port 125 is positioned on the opposite side of the cylinder, preferably 180 degrees away.

Figure 3 and Figure 4, which are applicable to both two stroke and four stroke engines, illustrate two cross sectional views at ninety degrees to each other when the piston is at its outer dead centre position, having uncovered the gas transfer ports 8 of the two stroke engine shown. The illustration applies to the engine described above as the Second Embodiment. If a two stroke engine is provided with an exhaust valve instead of exhaust ports there is no need to separate the two types of ports using the piston's skirt. Indeed the inlet air ports 8 can communicate with the crankcase 35 throughout the engine cycle and the piston need not be shaped as a complete cylinder and can be made much shorter, as is standard practice now with four stroke engines. The gas transfer ducts can be much shorter, indeed they can be carved into the cylinder liner at the appropriate location and can be made to avoid the thrust face of the piston to minimise oil entrainment. In this Second Embodiment it is not possible to allow oil to flow continuously through grooves in the piston throughout the engine cycle because the length of the longitudinal lubricant delivery groove 114 and the longitudinal lubricant return groove 214 cannot extend to the length of the piston's stroke. The distance between the upper piston ring 41 and lower piston ring 42, within which the lubricating oil is trapped, is shorter than the piston's stroke. Consequently, in order to ensure that oil is delivered to the piston the delivery must take place over a predetermined time interval which starts and ends when the piston reaches a certain position in the cycle, for example in a manner similar to the delivery of fuel to a diesel engine. To maximise the duration of lubricating oil injection through the lubricant dispensing means 25, it should start when the circumferential lubricant conduit 14 reaches the position opposite the lubricant supply port 12 during the expansion stroke. Oil delivery continues when the piston reaches its outer dead centre position when the top end of the longitudinal lubricant delivery groove 114 will be opposite the lubricant supply port 12 and then continues during the early part of the compression stroke until the circumferential lubricant conduit 14 is opposite the lubricant supply port 12 when oil delivery should stop.

The same piston positions also apply to the lubricant return port 125 and the longitudinal lubricant return port 214 but the lubricant retrieval means 126 in Figure 2 can be allowed to operate without interruption particularly if it is restricted by a suitable orifice.

As mentioned earlier, oil delivery can be made intermittently, separated by a number of engine cycles, to suit the piston's lubrication requirement. It may be possible to deliver oil intermittently over a duration of a number of engine cycles without regard to the piston's position at the start and end of delivery as this will only result in the intermittent delivery of some oil into the crankcase in small quantities when the piston does not obscure the lubricant supply port 12. This may not contribute a great amount to harmful exhaust emissions.

In summary this invention seeks to provide a very reliable and effective piston lubrication method for all reciprocating engines operating on either the two stroke or the four stroke cycles. The application to two stroke engines is attractive in that it offers the additional advantage of minimising the contamination of air used in combustion with lubricating oil when the crankcase is used as an air pump. The application to four stroke engines allows such engines to run with oil free sumps whilst ensuring reliable piston lubrication particularly when subjected to unusual operational conditions.

CLAIMS

1 An internal combustion reciprocating engine comprising;

a piston reciprocating in a cylinder comprising piston crown and piston skirt;

a connecting rod attaching the piston to a crankshaft rotating in a crankcase;

at least one lower piston ring;

at least one upper piston ring located between the lower piston ring and the piston crown;

a lubricant dispensing means to deliver lubricant to the piston;

a lubricant supply port situated on the cylinder wall, communicating with the lubricant dispensing means;

a lubricant retrieval means provided to extract from the cylinder surplus lubricant delivered by the lubricant dispensing means;

a lubricant return port situated on the cylinder wall, communicating with the lubricant retrieval means;

characterised in that a circumferential lubricant conduit is provided in the piston's outer surface, between the at least one lower piston ring and the at least one upper piston ring, the lubricant conduit being positioned to communicate simultaneously with both the lubricant supply port and the lubricant return port during at least a portion of the duration of the piston's movement along its stroke.

2. An engine according to claim 1 operating on the two stroke cycle comprising at least one gas transfer inlet port situated in the cylinder wall to allow air to enter the cylinder when the piston is near its outer dead centre position.

3. An engine according to claim 2 comprising at least one gas transfer duct connecting the crankcase with the at least one gas transfer inlet port.

4. An engine according to claim 1 which is provided with a longitudinal lubricant delivery groove which communicates with the circumferential lubricant conduit and is situated in the piston's outer surface substantially parallel with

the longitudinal axis of the cylinder to face the lubricant supply port during at least a portion of the piston's movement along its stroke.

5. An engine according to claim 4 wherein the longitudinal lubricant delivery groove communicates with the lubricant supply port during the complete stroke of the piston.

6. An engine according to claim 1 which is provided with a longitudinal lubricant return groove which communicates with the circumferential lubricant conduit and is situated in the piston's outer surface substantially parallel with the longitudinal axis of the cylinder to face the lubricant return port during at least a portion of the piston's movement along its stroke.

7. An engine according to claim 6 wherein the longitudinal lubricant return groove communicates with the lubricant return port during the complete stroke of the piston

8. An engine according to claim 1 wherein the lubricant supply port is situated on the thrust face of the cylinder bore and the lubricant return port is situated diametrically opposite the lubricant supply port.

9. An engine according to claim 1 wherein the lubricant retrieval means applies a sub atmospheric pressure to the lubricant return port.

10. An engine according to claim 3 wherein a one way valve is situated at the crankcase end of each gas transfer duct to allow the flow of air from the crankcase into the gas transfer duct when the piston moves during its expansion stroke but to prevent the transfer duct from experiencing sub atmospheric pressure when the piston moves during its compression stroke and the crankcase is experiencing sub atmospheric pressure.

11. An engine according to claim 1 wherein the lubricant supply port is restricted by an orifice whereby to control the quantity of lubricant flowing through it.

12. An engine according to claim 1 wherein the lubricant dispensing means delivers lubricant intermittently at predetermined intervals.

13. An engine according to claim 1 wherein the lubricant dispensing means deliverslubricant over a predetermined crank angle synchronised with the position of the piston along its stroke.

14. An engine according to claim 1 wherein the lower end of the cylinder is fitted with a circumferential channel or gutter to collect lubricant leakage and deliver it to a lubricant extraction means.

15. An engine according to claim 1 wherein the internal combustion engine is constructed using the spark ignition method for the initiation of combustion.

16. An engine according to claim 1 wherein the internal combustion engine is constructed using the compression ignition method for the initiation of combustion.

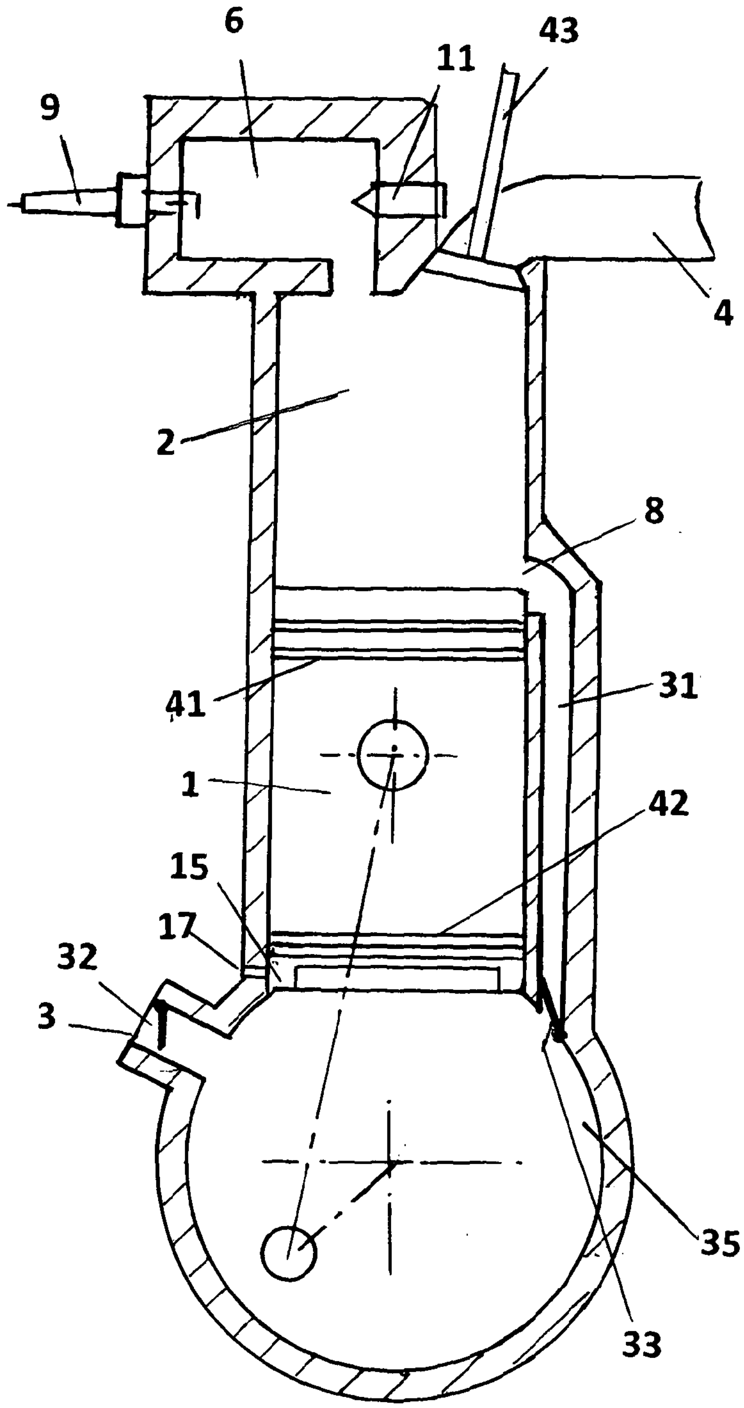

FIGURE-1

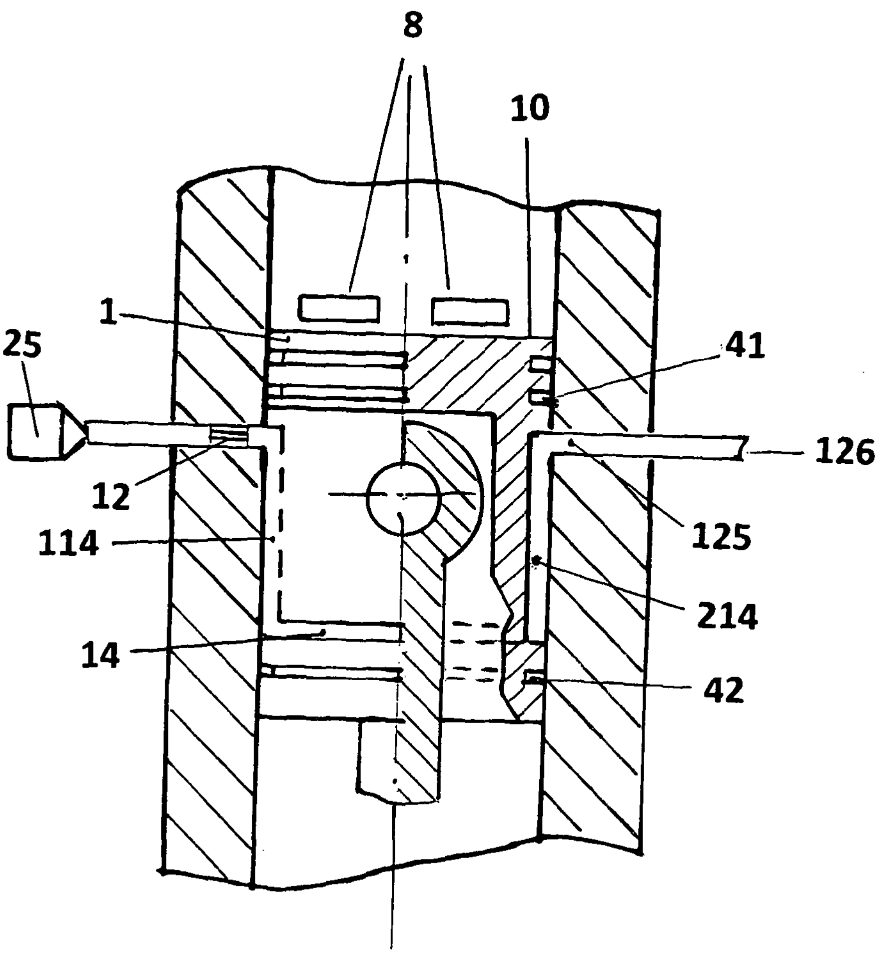

FIGURE-2

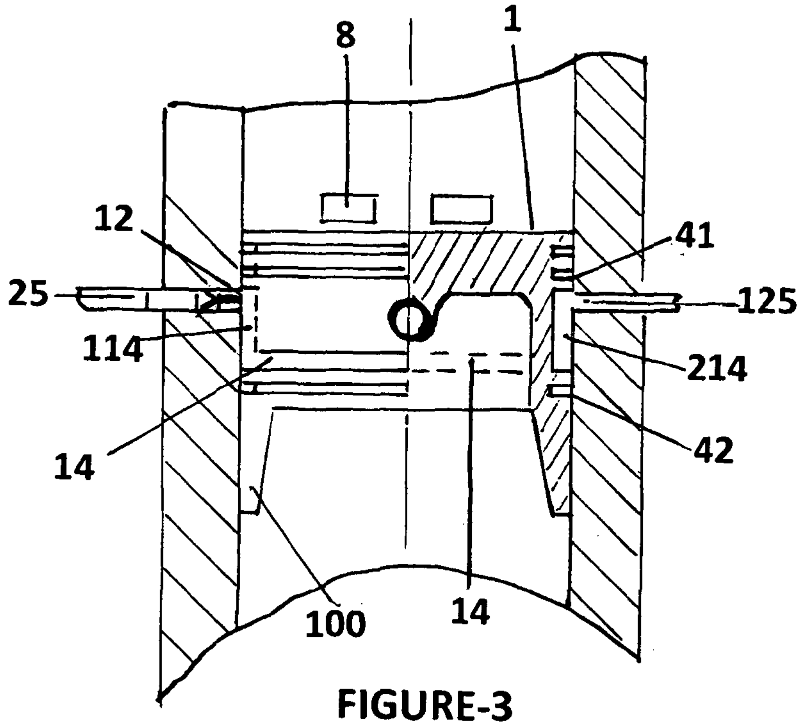

FIGURE-3

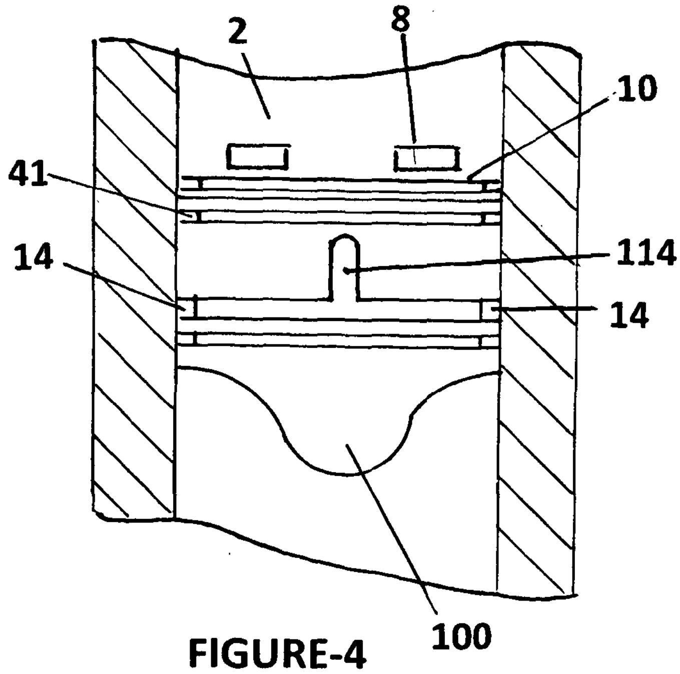

FIGURE-4

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2010/051401

A. CLASSIFICATION OF SUBJECT MATTER
INV. F01M1/08 F02F3/00
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)
F02F F01M

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 practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 204 669 A2 (BART SAS [IT]) 10 December 1986 (1986-12-10) page 5, line 10 - page 7, line 18; figures -----	1-3,12, 13,15,16
A	US 4 280 455 A (YAMAGUCHI HIROSHI ET AL) 28 July 1981 (1981-07-28) * abstract; figure 6 -----	1,4-7
A	US 5 588 504 A (SPIEGEL LEO [DE] ET AL) 31 December 1996 (1996-12-31) figures -----	1
A	DE 355 070 C (FRANZ L MAEDLER) 20 June 1922 (1922-06-20) figure -----	1
A	DE 197 55 687 A1 (DOLMAR GMBH [DE]) 17 June 1999 (1999-06-17) * abstract; figures -----	1

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

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance
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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
27 January 2011	03/02/2011

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	Mouton, Jean

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/GB2010/051401

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