(12) UK Patent Application (19) GB (11) 2523843 (13) A

(43) Date of A Publication 09.09.2015

(21) Application No: 1404114.9

(22) Date of Filing: 08.03.2014

(71) Applicant(s):
Robert Cooper
Durham Lodge, 167 Coulsdon Road,
OLD COULSDON, Surrey, CR5 1EG, United Kingdom

Russell Glyn Cooper
Merryfields, 42 Highfield Close,
AMERSHAM ON THE HILL, Buckinghamshire,
HP6 6PQ, United Kingdom

(72) Inventor(s):
Robert Cooper
Russell Glyn Cooper

(74) Agent and/or Address for Service:
Agile IP LLP
Airport House, Purley Way, Croydon, Surrey,
CR0 0XZ, United Kingdom

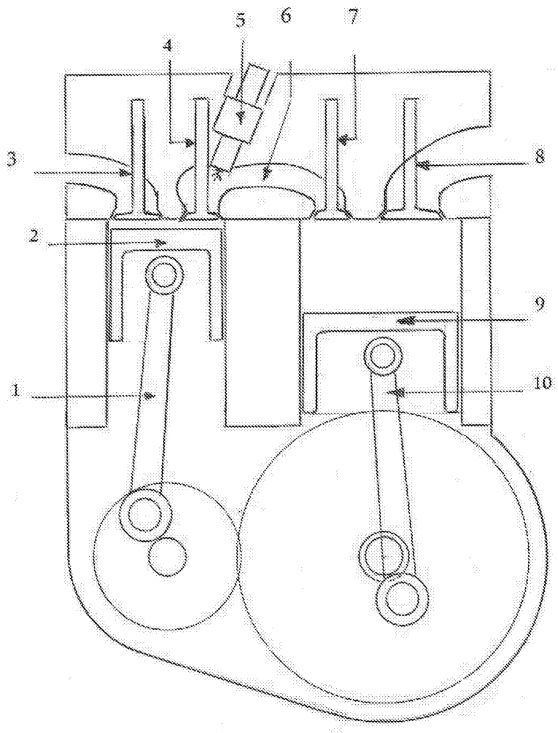
(51) INT CL:
F02B 47/02 (2006.01)

(56) Documents Cited:
CN 201354676 Y
DE 004300264 A1
GB 191219547
CN 001553046 A
DE 004032630 A1

(58) Field of Search:
INT CL **F01C, F02B**
Other: **EPODOC, WPI**

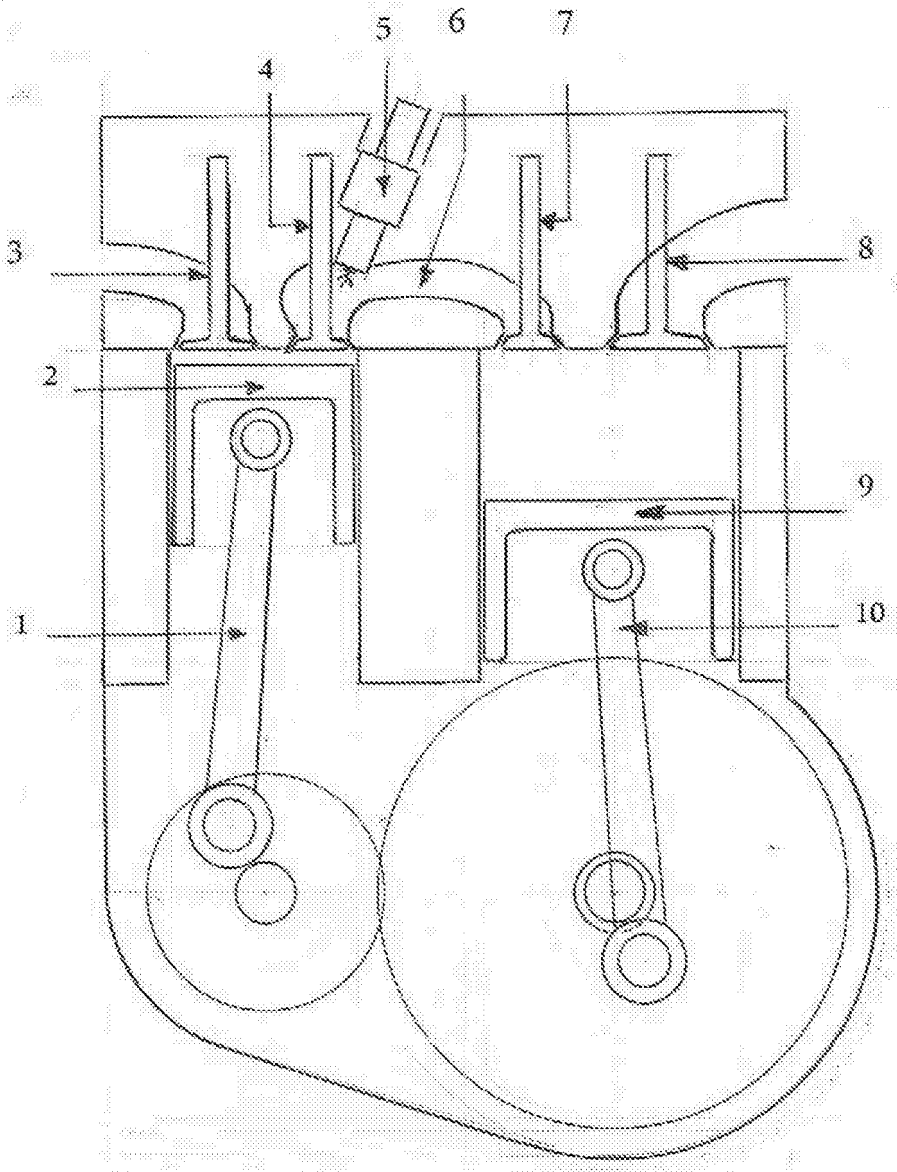
(54) Title of the Invention: **A development of the construction and operation of a four stroke internal combustion engine**
Abstract Title: **Internal combustion steam engines**

(57) An internal combustion steam engine comprises primary and working sections 1, 10 and means for injecting water or steam, wherein the engine is configured so that a mixture of steam and exhaust gases from the primary section are supplied to the working section. The primary section may comprise a small capacity engine having an inlet valve 3 for entry of air and an exhaust valve 4 for the outlet of exhaust gases following ignition of a mixture of air and fuel. The exhaust valve may be connected to an inlet valve 7 of the working section via a passage 6, which preferably comprises an enlarged section forming an annular chamber. The water or steam injection means may be a water injector 5 that provides water to the passage, where the water is converted to steam.



Diagrammatic Section of Proposed Engine

GB 2523843 A



Diagrammatic Section of Proposed Engine

A Development of the construction and operation of a Four Stroke Internal Combustion Engine

This new internal combustion engine can be described as two sets of cylinder, piston, crankshaft, connecting rod, cylinder head and valve gear which are all separately the same as engine components which are established parts, and which can be found in all current modern engines.The developments here described are applicable to both petrol and diesel engines working on the four-stroke principle.
A diagrammatic section through the new engine is shown in the Drawing on page 6. In this diagram, minor parts which do not differ from the current normal engine mechanism, for example the valve operating cams and followers, which are not different to common practise, are not shown for clarity and simplicity.

For convenience the smaller set of basic parts will be referred to as the Primary mechanism, (Drawing Ref. No. 1), the larger set the Working mechanism (Ref. No. 10), . The two crankshafts are connected by gears or chain so that the Primary crankshaft rotates twice as fast as the Working crankshaft.

The layout and operation of the engine is designed to provide an increase of the efficiency of the power unit using a new operating cycle which also provides for a method of controlling the quality of the emission of the exhaust fumes, which with current internal combustion engines are contributing to atmospheric pollution.

The Primary part shows a small capacity, almost normal, engine in which, the piston, (Ref. No. 2), moves down with the inlet valve (Ref, No. 3) open and sucks in the air/fuel mix, or plain air if a diesel, metered by a computer control unit (C.C.U.). As the piston nears bottom dead centre the valve shuts and gasses in the cylinder are compressed as the piston moves up and the air/fuel mixture ignited by electric spark for a petrol engine or compression heat if a diesel. The exhaust valve (Ref. No. 4) opens to a passage (Ref. No. 6) which leads to the inlet valve (Ref. No. 7) of the working cylinder. Where this passage meets the primary exhaust valve it is slightly enlarged to form an annular chamber into which is mounted an injector (Ref. No. 5), similar to those used to inject fuel into normal engines. This injector is fixed to direct a water jet onto the primary exhaust valve.

This injector is controlled by the C.C.U. to inject water under pressure into the annular chamber. The primary exhaust and working inlet valves can be smaller than normal exhaust valves but of a size consistent with the need to be able to pass the generated gasses from the primary cylinder to the working cylinder, where they generate useful work before being released, on the upward stroke of the piston (Ref. 9), by the opening of the working exhaust valve (Ref. No. 8), into the final exhaust pipe. Experiment has shown no need for a silencer in this pipe, but means of cooling and condensing the steam for re-use by the engine or trapping the dangerous products of combustion is indicated.

The sequence of operation of the new engine cycle is as follows.

On starting the engine the primary inlet valve (Ref. 3), starts to open as the primary piston (Ref. 2), reaches top dead centre followed by it's downward movement causing the input of the air or air/fuel mix. With the valve closed, the next upward movement of the piston compresses the gasses and ignition of the explosive mixture takes place. Very soon after ignition the primary exhaust valve (Ref. 4), opens releasing the hot high pressure gasses into the passage to the working cylinder (Ref. 6) and remains open until the primary piston completes it's upward exhaust stroke. The working inlet valve (Ref. 7), opens very slightly later than the opening of the primary exhaust valve as the working piston (Ref. 9), travelling upwards, reaches top dead centre. Pressure from the expanding gasses forces the working piston down performing the power stroke. The working cylinder exhaust valve (Ref. 8), opens as the working piston approaches bottom dead centre and remains open only for the following upward exhaust stroke. The gearing of the two crankshafts ensures that while the working piston is doing it's working and exhaust strokes, the primary piston carries out the four strokes of it's function.

When running the C.C.U. monitors the rotational speed, and when a satisfactory tick- over speed is reached, generates the signal to the injector (Ref. 5), and injection of water under pressure occurs, timed to take place when the primary exhaust valve and the working inlet valve are both closed.

Initially the injected water is heated by the hot exhaust valve and surrounding metal, in so doing cools what is otherwise one of the hottest parts of an engine. The release of the results of the explosion in the primary cylinder head finally raises the temperature of the water and vapour surrounding the exhaust valve, to produce high pressure steam which passes to the working cylinder when the inlet valve in that cylinder opens. While the primary exhaust valve is open the final resultant gas and steam pressure acts on both pistons with the primary piston contributing to the power developed whilst it is moving downwards.

Any speed change prompted by the injection of water is corrected by the C.C.U. by modifying the air/fuel/water rates of input calculated by the C.C.U.

The water under pressure delivered to the injector is generated by a pump which may be driven by the engine mechanism or be an external electric device. The quantity of water injected is calculated by the C.C.U. and is related to the quantity of fuel injected. The relation between these two quantities defines the quality of steam, generated to achieve the design purpose for which the engine is to be used. As an intuitive guide, less water will tend to give high pressure superheated steam for high torque and power, whereas more water will tend to give wetter steam which may be capable of absorbing more of the products of combustion leading to a cleaner engine. A further factor is the relative volumes of the primary and working cylinders. Experiment has indicated that a factor of three may be applicable but may not be optimal.

Thus in this evolution of the 4 stroke internal combustion engine, the prime function of the Primary part of the engine is to provide a core of hot gases which in turn evaporate the injected water. The resultant mixture of hot air, burnt fuel and steam then has a large swept volume available in which usable work can be generated. With the working parts operating at half the speed of the primary parts the resultant power output, of the engine, from the working crankshaft, is of a low speed, high torque nature.

This proposed engine therefore may be called an internal combustion steam engine

Claims

1/ This invention allows for a much greater recovery of energy from the fuel burned in the combustion chamber by providing a larger swept volume for expansion together with the addition of the working qualities of steam, which combined, improve the overall efficiency of the engine.

2/ Injection of water adjacent to the Primary exhaust valve cools that area and allows a higher compression ratio to be used before ignition thus improving combustion.

3/ Transferring the heat produced by combustion to steam reduces the risk of waste due to heat loss. The new engine design loses less heat in the wasteful process of cooling the working parts.

4/ Production of power as low speed torque from the working crankshaft is advantageous for many applications, in vehicles, for example, drive mechanisms can be much more simple.

5/ Exhaust noise is much reduced, silencers are unlikely to be needed but may be replaced by condensers to recover the water used. This may be re-used in the proposed new engine cycle.

6/ Introduction of steam into the engine cycle allows the volume of water injected to be varied to alter the quality of the steam produced. This will make it possible to control the exhaust emissions by providing in the final exhaust pipe means by which the steam/hot water is encouraged to absorb some of the more dangerous products emitted to the atmosphere by current internal combustion engines.

Intellectual Property Office

Application No:	GB1404114.9	**Examiner:**	Dr Karen Payne
Claims searched:	1 - 6	**Date of search:**	28 May 2014

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1 - 6	GB 191219547 A (DEAM) See page 4 and figure 1.
X	1 - 6	DE 4300264 A1 (GATHMANN) See WPI Abstract Accession No. 1994-226123 and figure 4.
X	1 - 6	DE 4032630 A1 (GERHARD) See WPI Abstract Accession No. 1991-134129 and figure 1.
X	1 - 6	CN 201354676 Y (ZHIPENG) See WPI Abstract Accession No. 2009-S22217 and figure 1.
X	1 - 6	CN 1553046 A (WANG) See WPI Abstract Accession No. 2005-165359 and figure 1.

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

Worldwide search of patent documents classified in the following areas of the IPC

F01C; F02B

The following online and other databases have been used in the preparation of this search report

EPODOC, WPI

International Classification:

Subclass	Subgroup	Valid From
F02B	0047/02	01/01/2006