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(56) Documents cited  
EP 0219746 A1 EP 0187099 A1 US 4467770 A

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(54) Internal combustion engine fuel supply

(57) The engine comprises two sets of adjacent cylinders, each set having an inlet duct 12, 14, each inlet duct being associated with a fuel injector 52, 54. The inlet ducts are connected to their associated sets of cylinders by means of siamesed inlet ports (44, 46 Fig. 2) or separate branches (128, 129, 146, 147 Fig. 3) from the main inlet ducts (112, 114 Fig. 3). The fuel injectors are controlled by an engine management system 66 and the fuel injection is timed to provide either two separate injection operations per engine cycle, one for each cylinder in a given set, or one single injection operation per engine cycle to provide both cylinders in a set with fuel.

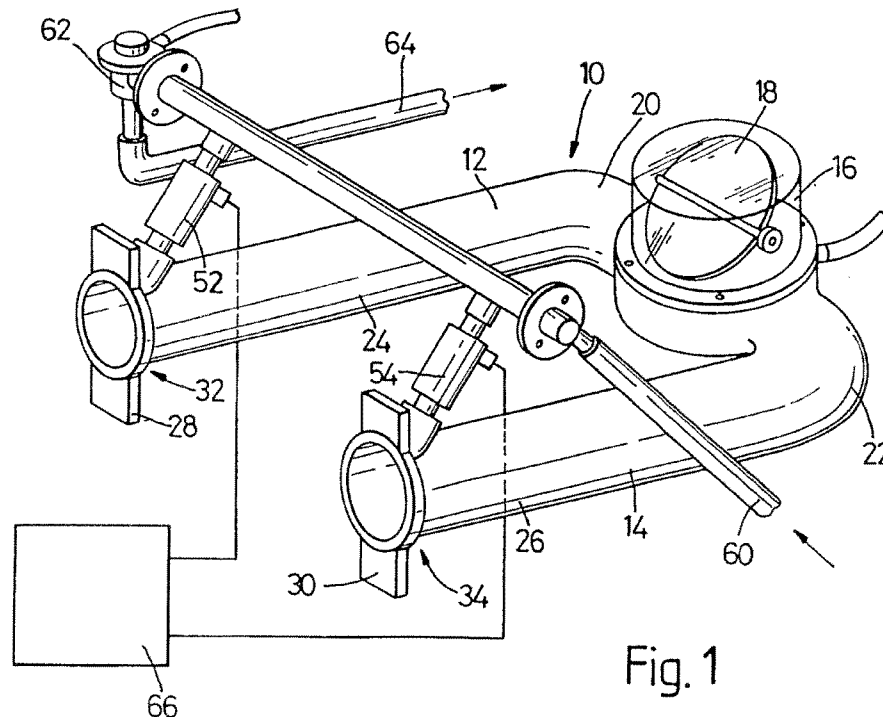


Fig. 1

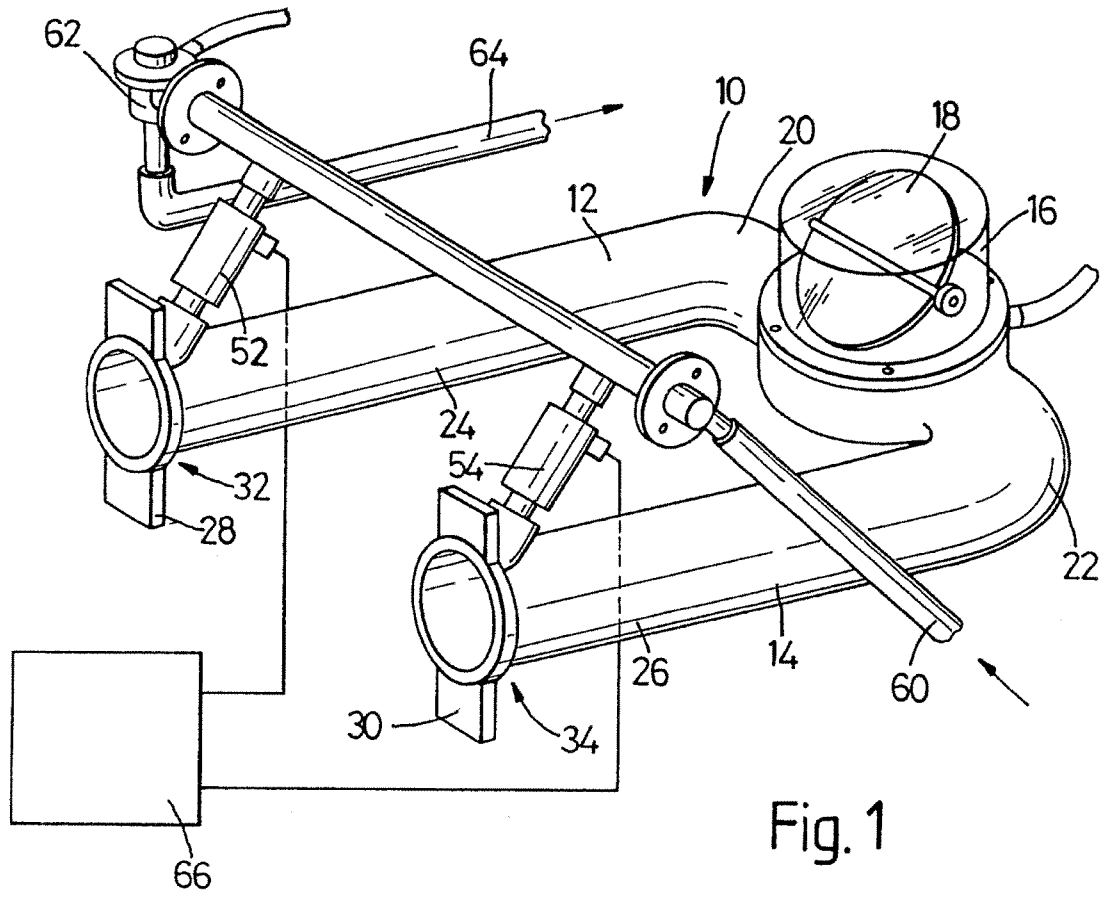


Fig. 1

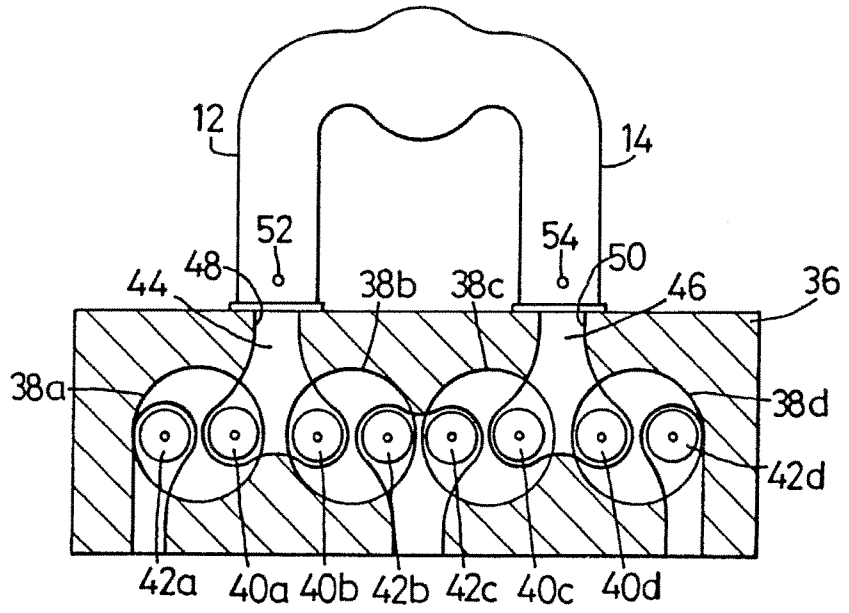


Fig. 2

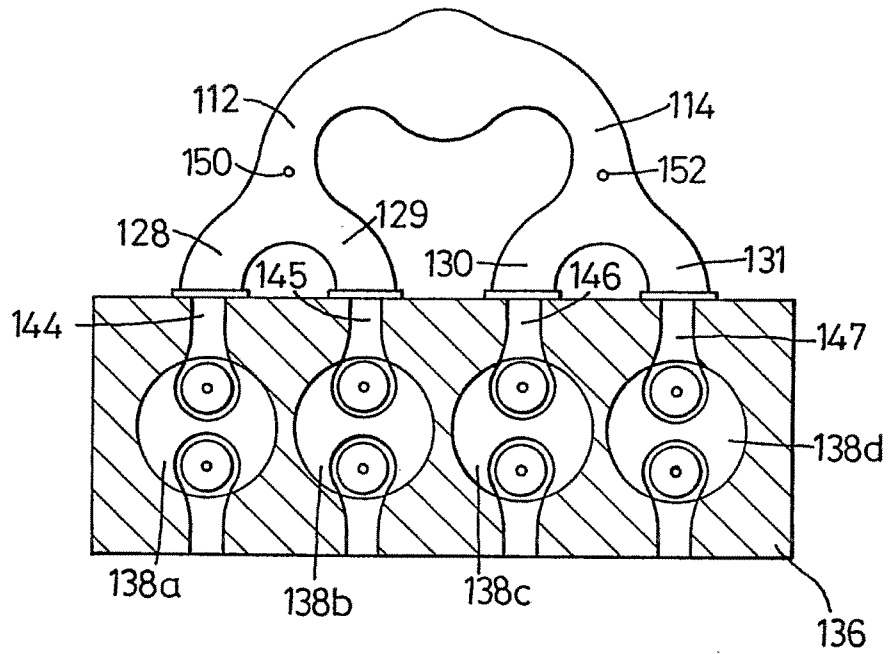


Fig. 3

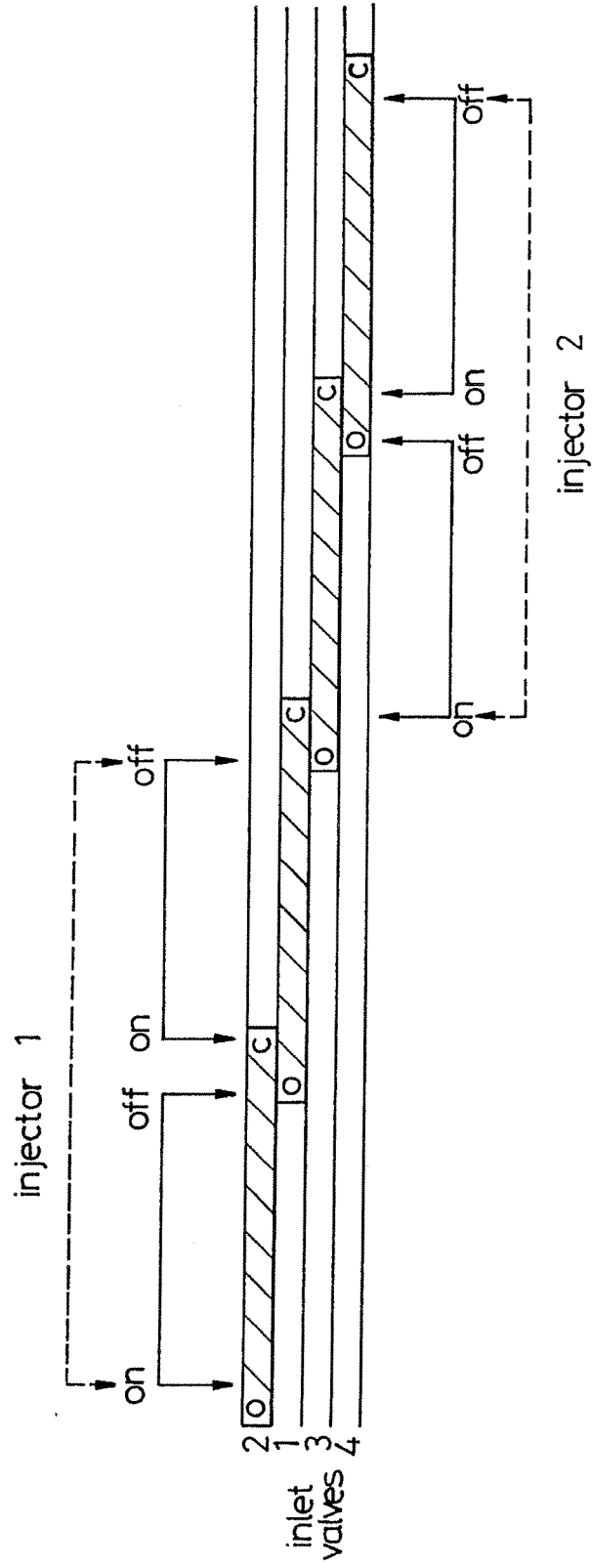


Fig. 4

INTERNAL COMBUSTION ENGINE FUEL SUPPLY

The present invention relates to fuel supply to internal combustion engines.

Fuel is normally supplied to the combustion chambers of internal combustion engines from either a single carburettor, a single injector or multiple injectors, one for each cylinder.

Multi-point injection is expensive because of the number of injectors required.

Use of single point injection or a carburettor results in uneven supply of fuel to the cylinders. In a four cylinder engine with a standard 1342 firing sequence, the inlet valve for cylinder 2 opens and draws fuel from the manifold and then the inlet valve for cylinder 1 opens before the fuel in the manifold is fully replenished. Cylinder 2 therefore does not produce as much power as cylinder 1. The same inequality occurs between cylinders 3 and 4.

It is an aim of the present invention to provide an internal combustion engine having a fuel supply system which is cheaper than a full multi-point injection system, but more efficient than a single point injection system or a carburettor.

The present invention provides a fuel supply system for an internal combustion engine having a plurality of sets of cylinders formed in an engine body member, the fuel supply system comprising a plurality of inlet ducts each for supplying air to all of the cylinders in one of the sets and a plurality of fuel supply means each associated with a respective one of the inlet ducts for supplying fuel to all of the cylinders in one of the sets.

This arrangement can be used either with a siamese inlet port system, in which the inlet ducts are each arranged for direct connection to a respective inlet in the engine body member, or with a 'double Y' inlet manifold and eight port arrangement wherein the inlet ducts form part of an inlet manifold which further comprises a plurality of branch ducts connected to each inlet duct, each branch duct being arranged for connection to the engine body member.

The fuel supply means may be arranged to supply fuel for one continuous period during each cycle of the engine.

Alternatively each fuel supply means may be arranged to supply fuel for a plurality of discreet periods, one for each cylinder in the respective set, during each cycle of

the engine.

The control of the fuel supply means can conveniently be performed by known engine management systems.

Preferred embodiments of the present invention will now be described by way of example only with reference to the accompanying drawings in which:-

Figure 1 is a perspective view of a fuel supply system according to a first embodiment of the present invention; Figure 2 is a section through the fuel supply system of Figure 1 and an engine; Figure 3 is a section similar to Figure 2 through a fuel supply system according to a second embodiment of the present invention; and Figure 4 is a graphic representation of the timing of the system of Figures 1 and 2.

Referring to Figures 1 and 2, the fuel supply system according to the first embodiment of the invention comprises an inlet manifold 10 having two inlet ducts 12, 14 connected to opposite sides of a single throttle body 16 which has a butterfly valve 18 therein. Each inlet duct 12, 14 has a 90° bend 20, 22 near the throttle body and a straight section 24, 26. The straight sections 24,

26 are parallel to one another, each having a bracket 28, 30 at its free end 32, 34 for connection to an engine body member 36. The engine body member 36 comprises a cylinder block and cylinder head assembly and has a first set of two adjacent cylinders 38a, 38b and a second set of two adjacent cylinders 38c, 38d formed in it. Each cylinder has an inlet valve 40a, 40b, 40c, 40d on one side and an exhaust valve 42a, 42b, 42c, 42d on the other side arranged such that the inlet valves 40a, 40b on the first set of cylinders are adjacent one another and those 40c, 40d on the second set of cylinders are adjacent one another. The exhaust valves 42b, 42c on the middle two cylinders 38b, 38c are adjacent one another.

First and second inlets 44, 46 are formed in the engine body member, the first inlet 44 joining the inlet valves 40a, 40b of the first set of cylinders 38a, 38b to a common first inlet port 48 and the second inlet 46 joining the inlet valves 40c, 40d of the second set of cylinders 38c, 38d to a common second inlet port 50. The first and second inlet ducts 12, 14 are mounted against and connected to the first and second inlet ports 48, 50 respectively.

Each inlet duct 12, 14 has a fuel injector 52, 54 mounted near its free end 32, 34 for injecting fuel into the inlet



duct. The injectors 52, 54 are supplied with fuel from a fuel rail 56 which is connected to a fuel feed 60 at one end and via a fuel pressure regulator 62 to a fuel return 64 at the other end.

An engine management system control unit 66 is connected by wires 68, 70 to the two injectors 52, 54 to control the timing of fuel injection.

Referring to Figure 4 the operation of the fuel supply system will now be described.

The cylinders 38a, 38b, 38c and 38d will be referred to as cylinders 1, 2, 3 and 4 respectively.

Each inlet valve opens slightly before its cylinder reaches top dead centre before the induction stroke and closes shortly after its cylinder reaches bottom dead centre after the induction stroke. The shaded areas on Figure 4 therefore represent the periods when the inlet valves are open.

The fluid injector 52 which supplies fuel via the first inlet duct 12 to cylinders 1 and 2 injects fuel over two discreet periods. The first period starts approximately when cylinder 2 is at top dead centre and ends between the

opening of inlet valve 1 and when cylinder 2 reaches bottom dead centre. The second period starts between the time when cylinder 1 is at top dead centre and the closing of inlet valve 2 and ends between the opening of inlet valve 3 and when cylinder 1 reaches bottom dead centre.

During the second half of the engine cycle the second injector 54 injects fuel into the second inlet duct 14 in two discreet periods during the induction stroke of cylinders 3 and 4. The sequence corresponds exactly to that described above for cylinders 1 and 2 and will not be described in detail.

Because the injections are near to the combustion chambers and fire once for each cylinder it is possible to control accurately the amount of fuel fed to each cylinder so that all cylinders produce similar power.

An alternative sequence of operation of the injectors 52, 54 is shown in the dotted lines of Figure 4. Each injector only injects fuel over a single period during each complete engine cycle. The first injector 52 starts to inject fuel just after the inlet valve on cylinder 1 has opened and stops between the opening of the inlet valve on cylinder 3 and the closing of that on cylinder 2. The second injector 54 operates in a similar way for

cylinders 3 and 4.

Using this sequence, although the injectors do not fire once for each cylinder, because the injectors are close to the cylinders there is very little delay in fuel reaching the second cylinder in each pair, ie cylinders 1 and 4, after the respective inlet valves have opened. The amount of fuel reaching each of the cylinders is therefore approximately equal.

Figure 3 shows a second embodiment of the invention which is similar to the first embodiment except that the inlet manifold is a 'double Y' manifold having two inlet ducts 112, 114 each of which splits into two branch ducts 128, 129, 130, 131. Four inlets 144, 145, 146, 147 are formed in the engine body member 136 each connecting one of the cylinders 138a, 138b, 138c, 138d to one of the branch ducts 128, 129, 130, 131. Two injectors 150, 152 are arranged such that each one injects fuel into one of the inlet ducts 112, 114 at a point near to where it splits into two branch ducts 128, 129, 130, 131. Operation of the second embodiment is the same as the first embodiment and will not be described in detail.

CLAIMS

1. A fuel supply system for an internal combustion engine having a plurality of sets of cylinders formed in an engine body member, the fuel supply system comprising a plurality of inlet ducts each for supplying air to all of the cylinders in one of the sets and a plurality of fuel supply means each associated with a respective one of the inlet ducts for supplying fuel to all of the cylinders in one of the sets.
2. A fuel supply system according to claim 1 wherein each fuel supply means comprises a fuel injector.
3. A fuel supply system according to claim 1 or claim 2 wherein the inlet ducts are each arranged for direct connection to a respective inlet in the engine body member.
4. A fuel supply system according to claim 1 or claim 2 wherein the inlet ducts form part of an inlet manifold which further comprises a plurality of branch ducts connected to each inlet duct, each branch duct being arranged for connection to the engine body member.

5. An internal combustion engine including a fuel supply system according to any foregoing claim and having a plurality of sets of cylinders formed in an engine body member.
6. An internal combustion engine according to claim 5 wherein each set comprises two cylinders.
7. An internal combustion engine according to claim 5 or claim 6 wherein the cylinders forming a set are adjacent one another.
8. An internal combustion engine according to any one of claims 5 to 7 wherein each fuel supply means is arranged to supply fuel for one continuous period during each cycle of the engine.
9. An internal combustion engine according to any one of claims 5 to 7 wherein each fuel supply means is arranged to supply fuel for a plurality of discrete periods, one for each cylinder in the respective set, during each cycle of the engine.
10. An internal combustion engine according to any one of claims 5 to 9 wherein the fuel supply means are controlled by an engine management control unit.

**Patents Act 1977**  
**Examiner's report to the Comptroller under**  
**Section 17 (The Search Report)**

- 10 -

Application number

9209853.2

**Relevant Technical fields**

- (i) UK CI (Edition K ) F1B  
(ii) Int CI (Edition 5 ) F02M 69/04, 61/14, F02F 1/42

**Search Examiner**

S WALLER

**Databases (see over)**

- (i) UK Patent Office  
(ii) ONLINE DATABASES: WPI

**Date of Search**

13 JULY 1992

Documents considered relevant following a search in respect of claims

1 TO 10

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
X, Y	EP 0219746 A1 (HITACHI LTD)	1, 2, 3, 4, 5, 6, 7, 9, 10
Y	EP 0187099 A1 (REGIE NATIONALE DES USINES RENAULT)	3
Y	US 4467770 (NIPPON DENSO CO LTD)	10



Category	Identity of document and relevant passages	Relevant to claim(s)

**Categories of documents**

X: Document indicating lack of novelty or of inventive step.

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