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# (54) I.C. engine inlet and exhaust valving

(57) The cylinder has a single port controlled by a poppet valve 12 through which an inlet charge is admitted into the cylinder and exhaust gases escape to the exhaust system. The single port is connected to the inlet system of the engine by way of a rotary valve 18 or a reed valve (118 Fig. 3) and to the exhaust system by way a rotary valve 20.

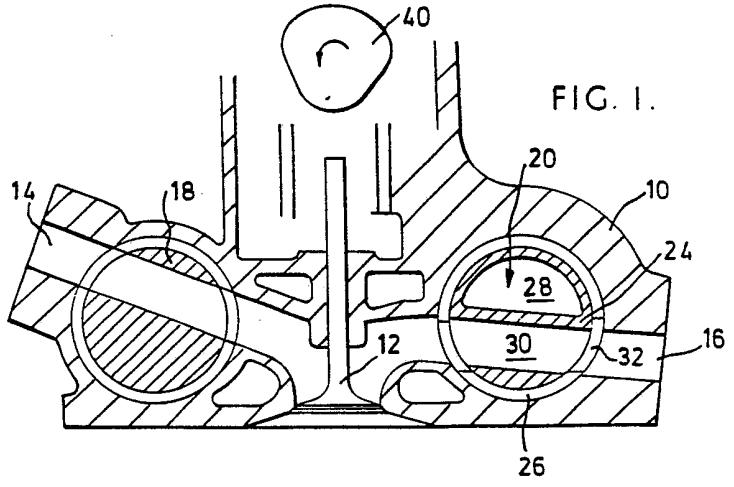


FIG. 1.

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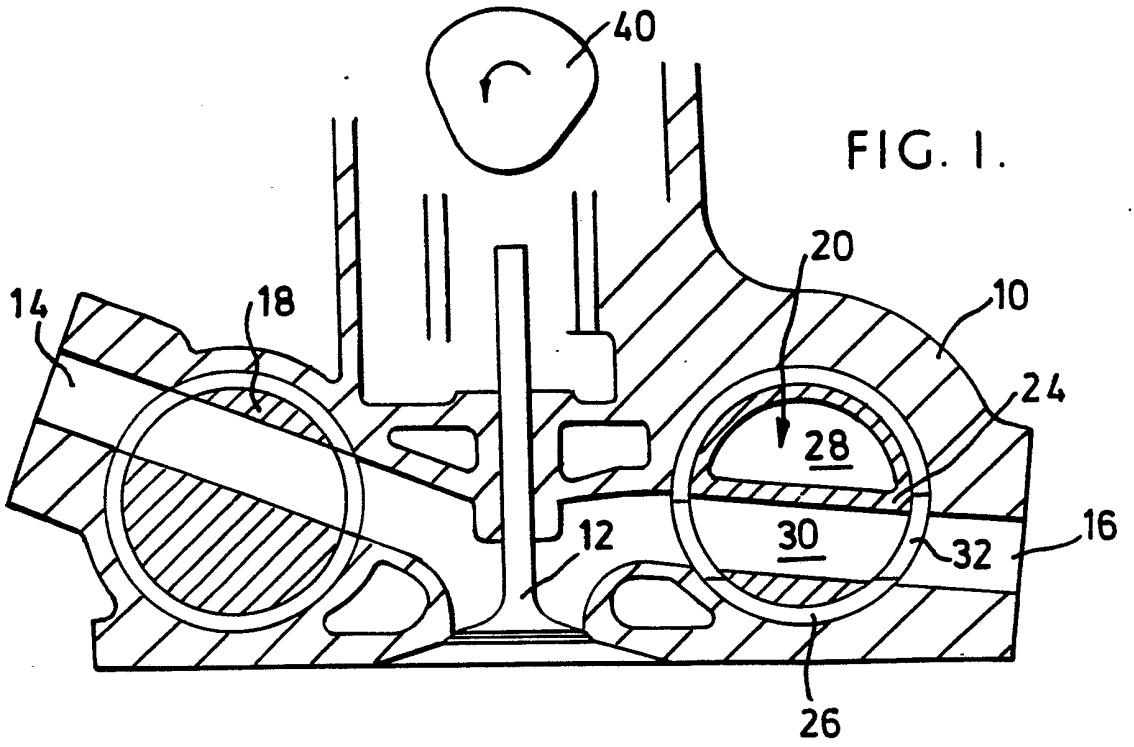


FIG. 1.

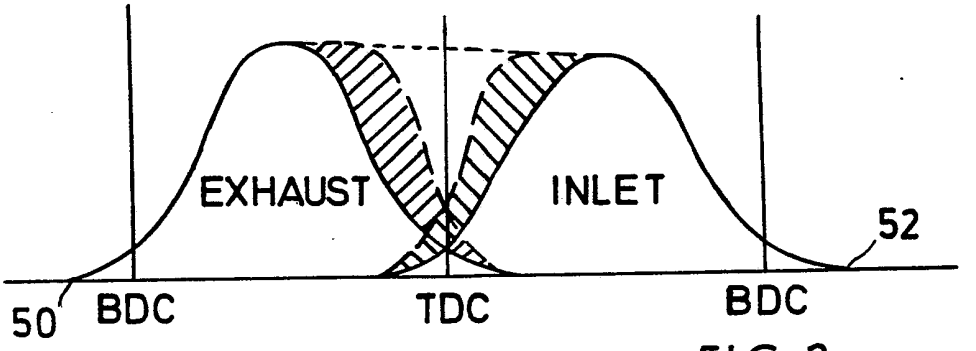


FIG. 2.

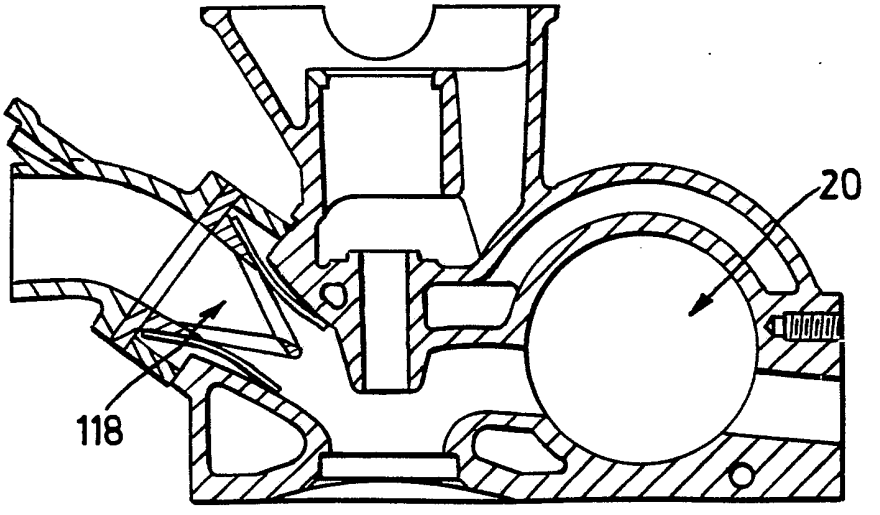


FIG. 3.

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# INTERNAL COMBUSTION ENGINE

The present invention relates to an internal combustion engine.

It is usual for a four stroke internal combustion engine, be it a spark ignited engine or a diesel engine, to be provided with an inlet valve to permit a fresh charge to be admitted into the cylinder during each combustion cycle and a separate exhaust valve to permit the exhaust gases to escape through the exhaust system to atmosphere. These valves have to be able to withstand severe temperature and pressure and are usually constructed as poppet valves controlling ports which open directly into the combustion chamber.

This configuration is not however, the only possible one and various alternatives have been proposed. For example, it has been previously proposed to increase the number of valves per cylinder in order to improve breathing.

There has also been a proposal by Vicente Valliciergo (see CME July/August 1984. page 45) to reduce the number of valves to only one so that the the same valve acts as inlet exhaust valve. This last proposal has the advantage that the valve will be cooled by the inlet gases and will run at a lower temperature and furthermore a larger valve can be employed allowing for easier breathing, especially at high engine speeds.

In an engine having a single poppet valve per cylinder, further valving is required to connected the cylinder sequentially with the inlet system and the exhaust system. In the Valliciergo proposal, this has been achieved by a distributor in the form of a rotary valve rotating about the axis of the poppet valve. Such a configuration is not entirely satisfactory as the same profile is used to control both intake and exhaust. Furthermore driving of the distributor valve is complex and its positioning makes

it prone to wear and necessitates the use of a desmodromic valve train.

According to the present invention, there is provided an internal combustion engine having a cylinder with a single port controlled by a poppet valve through which an inlet charge is admitted into the cylinder and exhaust gases escape to the exhaust system, wherein the single port is connected to the inlet system of the engine by way of a first valve and to the exhaust system by way an independent rotary valve.

The rotary valve leading to the exhaust system preferably comprises a cooled central stator core surrounded by a rotary cylindrical sleeve having holes which align with holes in the stator to permit through flow of exhaust gases only in predetermined angular positions of the rotary sleeve.

If desired a rotary valve may also be used to connect the single poppet valve to the inlet system, and in this case the central stator core would not need to be cooled. However, it is preferred to employ a reed valve in the intake system to serve as a non-return valve which permits the intake charge to be aspirated into the cylinder during the induction stroke but prevents the exhaust gases from entering the inlet system during the exhaust stroke.

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

Figure 1 is a schematic section through a cylinder head of an engine constructed in accordance with a first embodiment of the invention,

Figure 2 is a valve timing graph, and

Figure 3 is a schematic section through a cylinder head of an engine in accordance with a second embodiment of the invention.

Poppet valves, as used on conventional four stroke engines provide excellent sealing characteristics but have limited control of the inlet and exhaust flows. Rotary valves, on the other hand, provide good valve time-area but give relatively poor sealing. The preferred embodiment of the invention, described below with reference to the drawings, combines the use of both valves types to gain the advantages of both valve systems.

In Figure 1, there is shown a section through a cylinder head 10 having a single poppet valve 12 per cylinder. The engine in question may be a spark ignited engine or a diesel engine. If spark ignited, the engine may be a carburetted or a fuel injected engine and in the case of fuel injection, the fuel may be injected either into the cylinder or into the intake manifold.

The single poppet valve 12 is arranged in a port which communicates with a first passage 14 leading to the inlet system and a second passage 16 leading to the exhaust system. Each of the two passages 14, 16 contains a respective rotary valve 18, 20 which consists of a stator 24 and a rotor 26. In the case of the exhaust rotary valve 20, the stator 24 is water cooled and is formed with a through bore 28 for the circulation of a coolant.

The stators of the rotary valves 18 and 20 are formed with eccentric transverse bores 30 aligned with the passages 14 and 16 and the sleeves 26 have asymmetrically disposed holes 32 which allow flow through the respective passages 14, 16 only once during each revolution.

In the case of an engine having several cylinders in line in a block, a single rotary valve is required for all the exhaust valves and similarly a single rotary valve is

required for all the inlet valves. The holes 32 in the rotors 26 will be differently positioned for each cylinder to suit the individual cylinder timing and both rotors can be commonly driven by the same drive as used for the cam shaft 40. It can thus be seen that the invention can be implemented without the addition of a large number of moving parts and without modification other than to the engine cylinder head.

The opening and closing times of the various valves is shown in the graph of Figure 2. The poppet valves 12 has an opening event which extends over virtually the entire duration of the exhaust and induction strokes of the engine. Thus the poppet valve opens at 50, shortly before BDC at the commencement of the exhaust stroke and closes at 52 shortly after BDC at the end of the induction stroke. During the compression and power strokes, the cylinder is sealed by the poppet valve and the rotary valves are not subjected to high pressure.

The rotary exhaust valve may already be open when the poppet valve opens or it may open at the same time. In the graph of Figure 2, it is assumed that the opening times are coincident. Similarly, the inlet valve is assumed to be closing at the same time as the poppet valve, though it may close later. Near the end of the exhaust stroke, the rotary valve 20 commences to close and is closed completely shortly after TDC. The inlet rotary valve on the other hand starts to open shortly before TDC and opens fully after TDC. The typical curves obtained from poppet inlet and exhaust valves are shown in solid lines. It is however desirable to close the exhaust valve and open the inlet valve more abruptly, as shown by the dotted lines as this provides the increased area underneath the two curves shown shaded in Figure 2. To achieve such improved curves using poppet valves increases valve train friction and wear on the camshaft but in the present invention, this can be achieved by suitably contouring the holes in the sleeves 26 of the rotary valves.

The valve timing may readily be altered to vary the valve overlap, for example as a function of engine speed, since little force is experienced by the rotary valves and their phases can be altered without incurring a penalty in the form of increased friction in the valve train.

The small volume between the inlet and exhaust rotary valves traps some exhaust gases and these are reintroduced into the cylinder in the next combustion cycle. The engine thus provides a form of internal exhaust gas recirculation (EGR) and the amount of EGR can be varied by altering the rotary valve timing as indicated above.

The cylinder head shown in Figure 3 differs from that of Figure 1 in that the inlet rotary valve 18 has been replaced by a reed valve 118. This valve is known per se and comprises a resilient reed or tongue which permits gas flow in only one direction depending upon the pressure difference across the valve. When air is flowing towards the combustion chamber, the reed is automatically retracted whereas the back pressure occurring during the exhaust stroke causes the reed to close and block off the inlet system. This valve creates even less drive friction than a rotary valve but its disadvantage is that its timing is entire dictated by the gas flow conditions and cannot be externally determined.

The systems described above have many advantages and certain disadvantages some of which have already been touched upon but which will now be discussed in greater detail.

An important advantage is that the poppet valve is that the poppet valves remains cooler than the exhaust poppet valve in a conventional engine. This provides a material cost advantage and permits the use of higher compression ratios because of the reduced detonation tendency and also permits the use of fuel having a lower octane rating.

The combination of rotary and poppet valves gives a large time area while using a short period camshaft. This can lead to good low speed and high speed performance.

Valve train friction and durability are improved because lower accelerations and decelerations are required.

Variable valve timing as previously discussed can be achieved because less force is required to vary the timing of the rotary valves. For this purpose, it becomes possible to use conventional vacuum and servo motors.

Other advantages which may be mentioned briefly is that variable compression ration protection is easier, inlet valve cut-off is possible, and the design may be used to achieve a high performance long stroke engine.

The main problem envisaged with the valve system is that high hydocarbon emissions may result from the fresh charge being trapped above the poppet valve but this problem is minimized if fuel is injected directly into the combustion chamber and only air is admitted through the inlet system.

## CLAIMS

1. An internal combustion engine having a cylinder with a single port controlled by a poppet valve through which an inlet charge is admitted into the cylinder and exhaust gases escape to the exhaust system, wherein the single port is connected to the inlet system of the engine by way of a first valve and to the exhaust system by way an independent rotary valve.

2. An internal combustion engine as claimed in claim 1, wherein the rotary valve leading to the exhaust system comprises a cooled central stator core surrounded by a rotary cylindrical sleeve having holes which align with holes in the stator to permit through flow of exhaust gases only in predetermined angular positions of the rotary sleeve.

3. An internal combustion engine as claimed in claim 1 or claim 2, wherein a rotary valve is be used to connect the single poppet valve to the inlet system.

4. An internal combustion engine as claimed in claim 3, wherein the stator of the rotary valve leading to the inlet system is not cooled.

5. An internal combustion engine as claimed in claim 1 or claim 2, wherein a reed valve is provided in the intake system to serve as a non-return valve which permits the intake charge to be aspirated into the cylinder during the induction stroke but prevents the exhaust gases from entering the inlet system during the exhaust stroke.

6. An internal combustion engine substantially as herein described with reference to and as illustrated in the accompanying drawings.

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