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(54) I.C. engine cylinder head rotary valve

(57) A valve shaft 1 has a plurality of circumferentially-extending grooves 11-15 along its length. Grooves 11, 13, 15 are always open to respective inlets 6, 7, 8 and grooves 12, 14 are always open to respective exhaust outlets 9, 10. The grooves open to a series of channels (16, 17, Fig. 6) which open at the periphery of the valve shaft through ducts (16A, 17A) at respective locations spaced from the circumferential grooves. The ducts communicate periodically with the cylinders during valve shaft rotation at one sixth crankshaft speed. The valve shaft may be surrounded by angularly adjustable tubes (26, Fig 5) to vary valve timing. The valve shaft may be formed of a plurality of units mounted on a tubular shaft (25, Figs. 9 and 10).

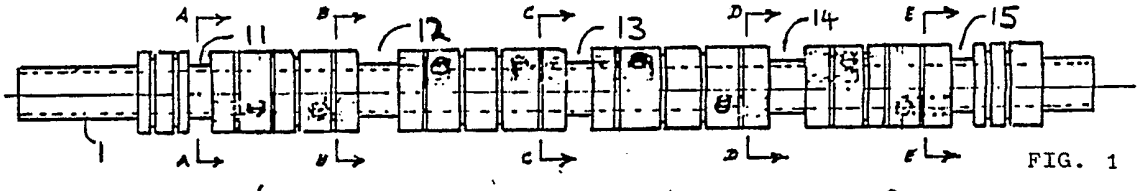

FIG. 1

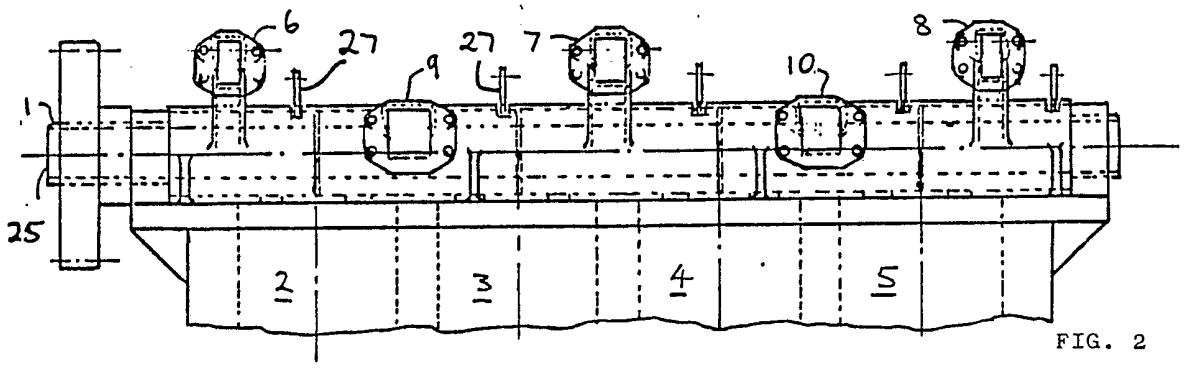

FIG. 2

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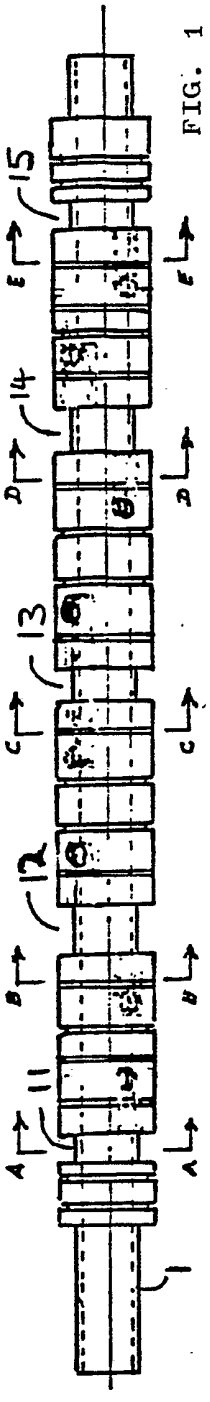

FIG. 1

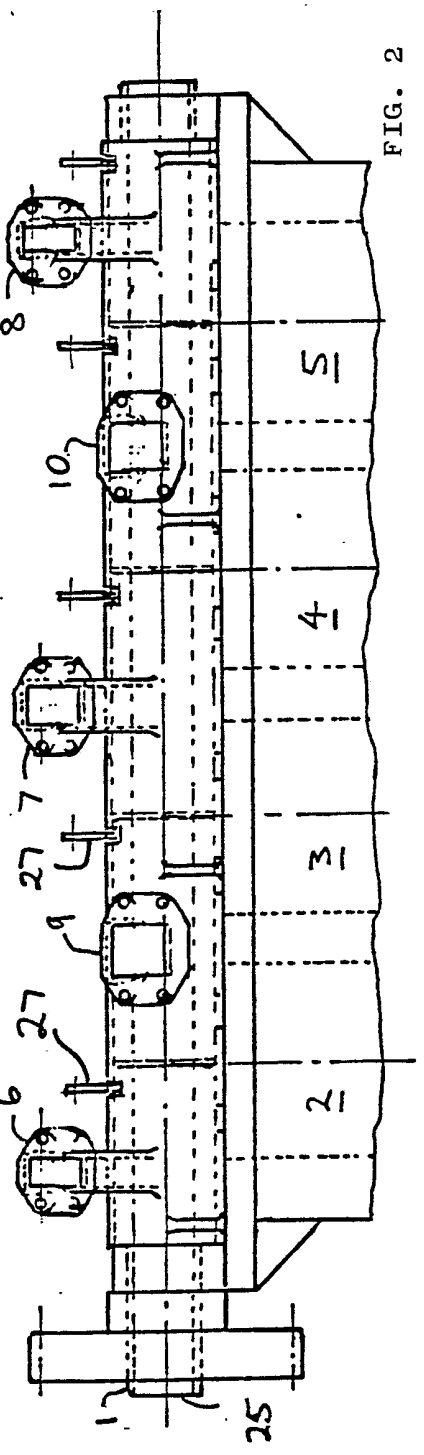

FIG. 2

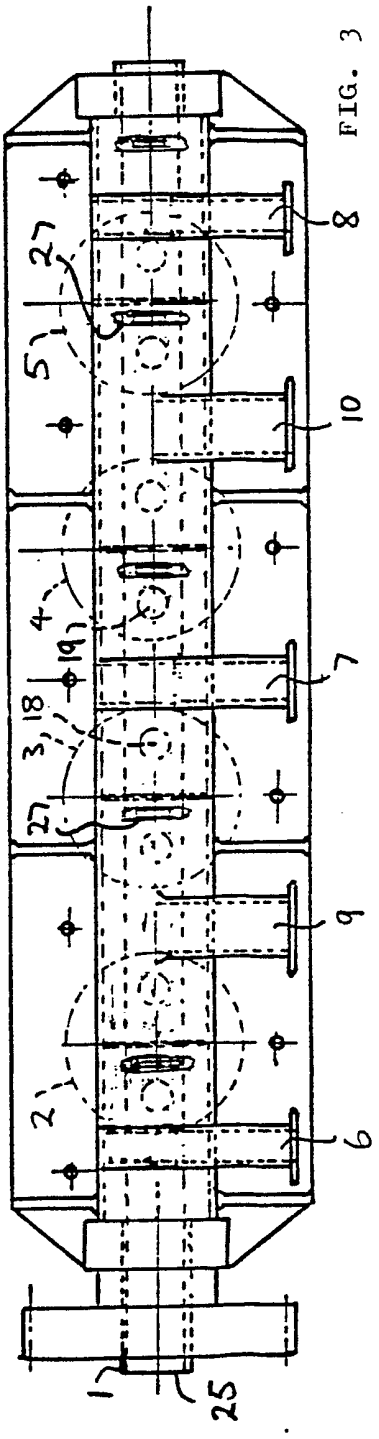

FIG. 3

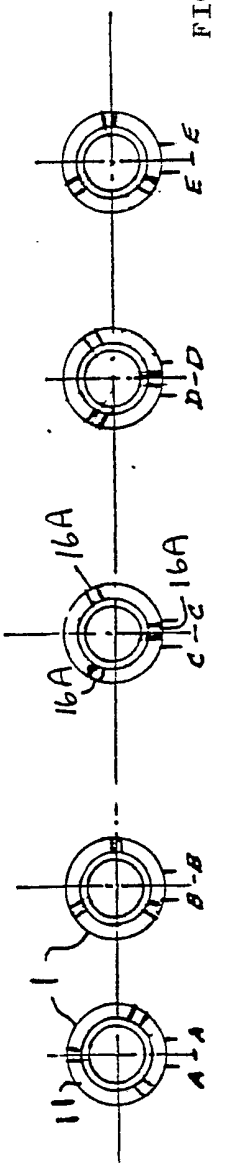

FIG. 4

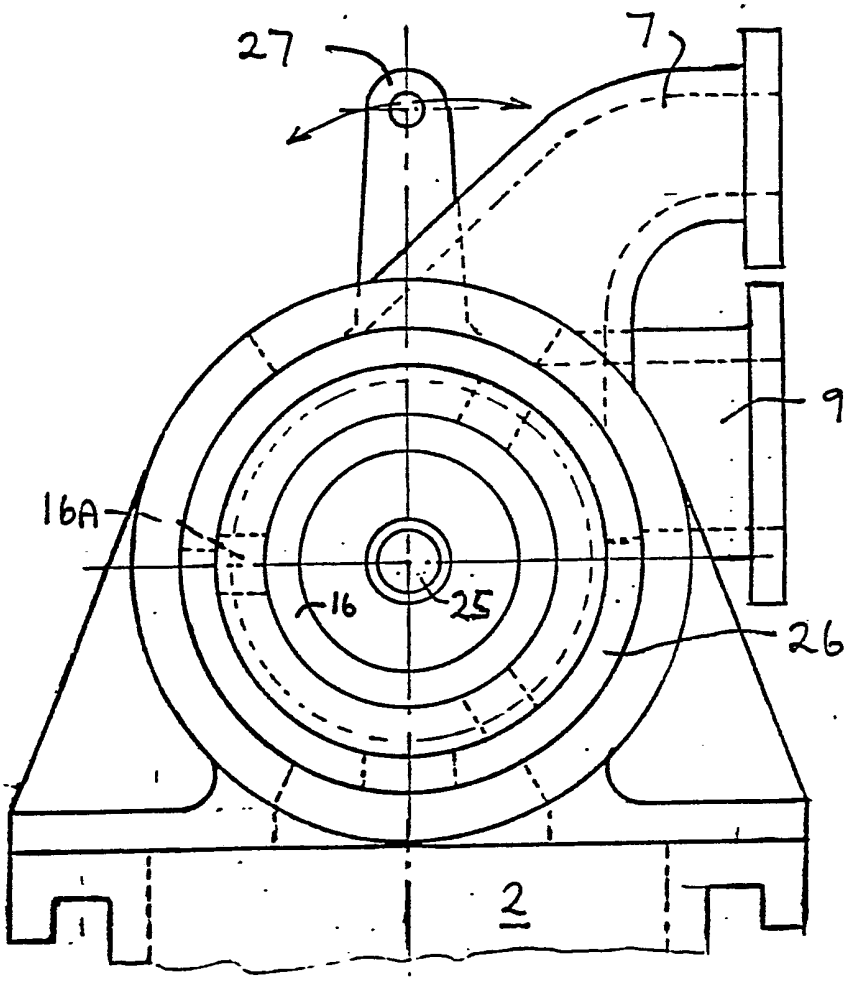

FIG. 5

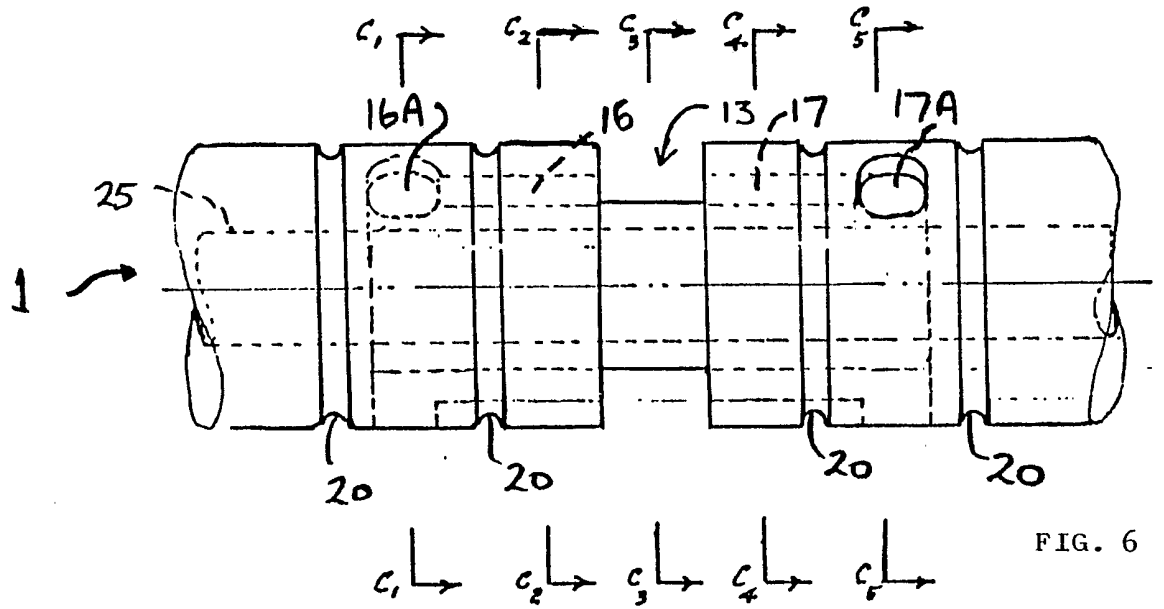
C1
C2
C3
C4
C5
16A
16
13
17
17A
25
1
20
20
20
20
C1
C2
C3
C4
C5

FIG. 6

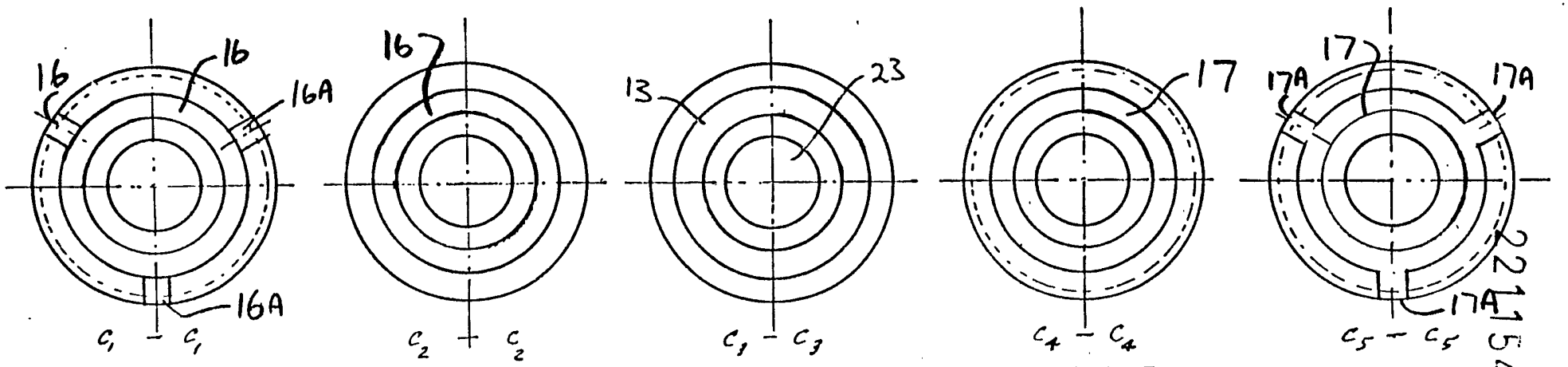
16
16
16A
16A
C1 – C1
16
C2 – C2
13
23
C3 – C3
17
C4 – C4
17
17A
17A
17A
C5 – C5

FIG. 7

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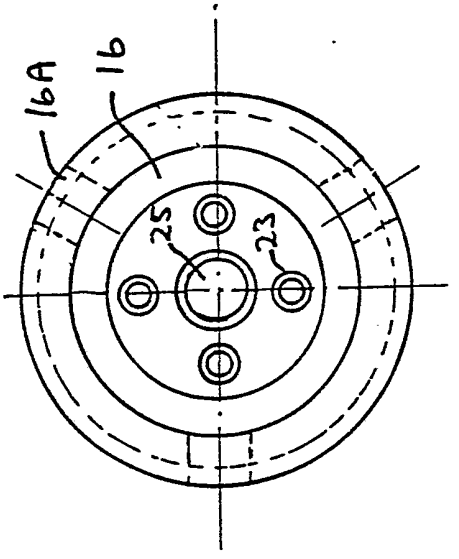

FIG. 9

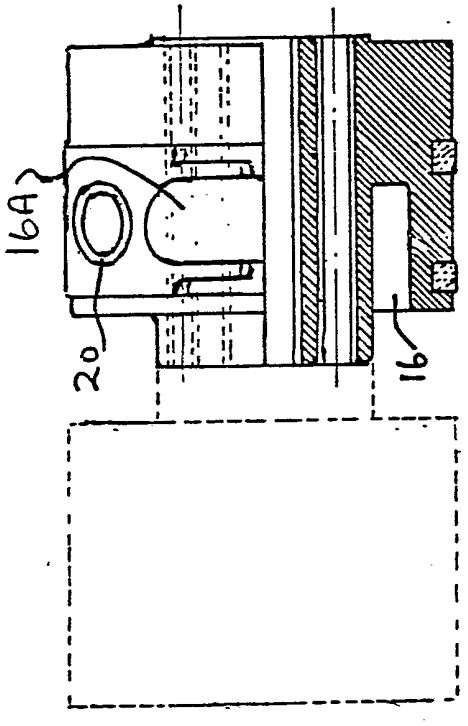

FIG. 8

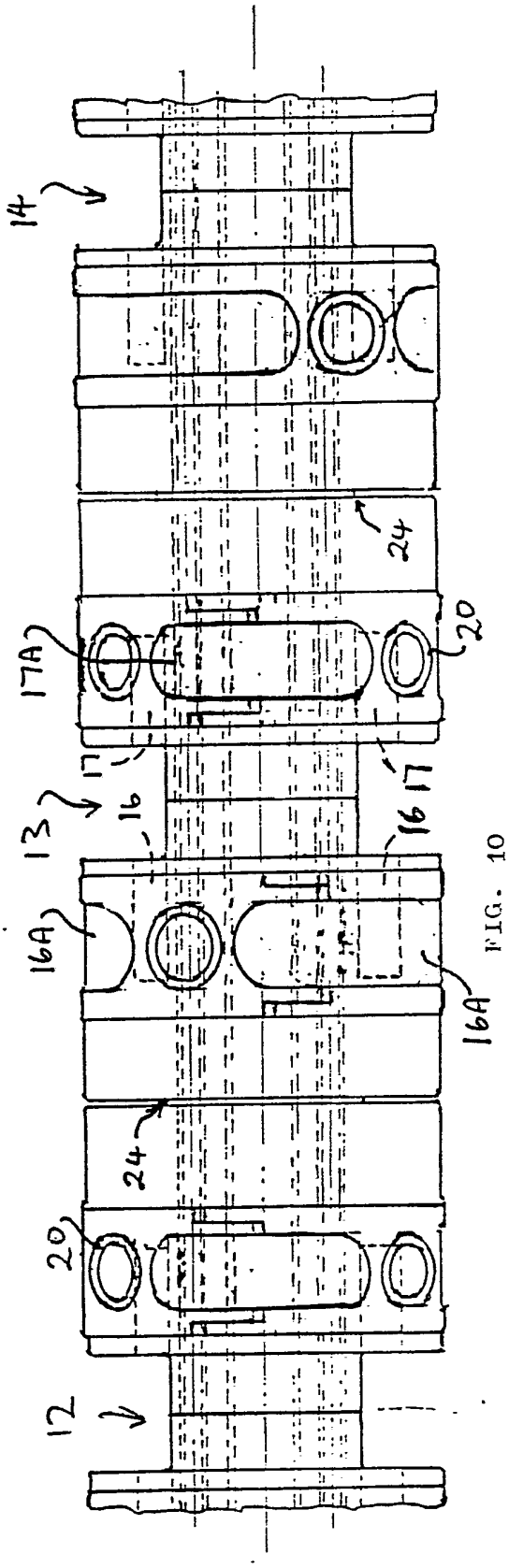

FIG. 10

INTERNAL COMBUSTION ENGINE CYLINDER HEAD

This invention relates to an internal combustion engine cylinder head.

More particularly, the invention is concerned with a rotary valve arrangement for internal combustion engines, which arrangement can be used to replace the present poppet valve arrangements and can incorporate a variable timing facility.

According to one aspect of the present invention, there is provided an internal combustion engine cylinder head including a bore in which a valve shaft is rotatably mounted, the bore being open for communication with a cylinder chamber and having a fuel inlet port for serving said cylinder chamber and an exhaust port for exhausting said cylinder chamber, said valve shaft having a first circumferential groove opposite said inlet port and a second circumferential groove opposite said exhaust port and said valve shaft defining a channel leading from each circumferential groove, each channel being positioned to open and close communication between the cylinder chamber and said inlet or outlet port, respectively, and there being sealing means in said bore between said inlet and outlet ports.

According to another aspect of the present invention, there is provided an internal combustion engine cylinder head including a bore in which a valve shaft is rotatably mounted, the bore being open for communication with cylinder chambers and having a fuel inlet port for

serving two said cylinder chambers and an exhaust port for exhausting said two cylinder chambers, said valve shaft having a first circumferential groove opposite said inlet port and a second circumferential groove opposite said exhaust port, and said valve shaft defining two channels leading in opposite directions from each circumferential groove, each channel being positioned to open and close communication between a respective cylinder chamber and said inlet or outlet port, respectively, and there being sealing means in said bore between said inlet and outlet ports.

The invention also extends to an internal combustion engine including a cylinder head according to the invention.

The cylinder head may be intended for a four-cylinder engine, in which case it will be provided with five of said circumferential grooves, preferably three of them being open to respective inlet ports and two of them being open to respective exhaust ports. Preferably, whilst both of the exhaust ports serve to exhaust two cylinder chambers each, only the central inlet port is for serving two cylinder chambers.

In all cases, an upper part of the bore is intended to be permanently ported open opposite the circumferential grooves whilst the lower part of the bore is ported opposite the channels and is opened and closed by rotation of the valve shaft in the bore.

For a better understanding of the invention and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which:-

Figure 1 is a side view of a valve shaft of a cylinder head according to the invention,

Figure 2 is a side view of the cylinder head mounted on a cylinder assembly,

Figure 3 is a plan view of the construction shown in Figure 2,

Figure 4 illustrates the valve shaft cross-sections as indicated by the letters A-A etc. in Figure 1,

Figure 5 is a cross-sectional view of the construction shown in Figure 2,

Figure 6 is an enlarged view of part of the valve shaft,

Figure 7 shows a series of sectional views corresponding to lines C_1, C_2, etc. in Figure 6,

Figure 8 is a side view, partly in section, of a modified form of a valve shaft unit,

Figure 9 is an end view of the unit shown in Figure 8, and

Figure 10 is a side view of several of the valve shaft units of Figure 8 coupled together.

Referring to Figures 1 to 7 of the drawings, the internal combustion engine cylinder head illustrated includes a barrel or bore extending along the length of the cylinder head. A valve shaft 1 is rotatably mounted in the bore and the bore is in open communication with cylinder chambers 2, 3, 4 and 5 as illustrated best in Figure 4. The cylinder head also includes three fuel inlets 6, 7 and 8 and two exhaust outlets 9 and 10 interposed between the inlets 6, 7 and 7, 8, respectively. All ports of the inlets and outlets open into the upper half of the bore. The inlets and outlets are sufficiently large to suit fuel injection or turbo-charged engines.

The valve shaft 1 is provided with a number of circumferentially-extending grooves along its length. These grooves are positioned so that the groove 11 is always open to the inlet 6, the groove 12 is always open to the exhaust outlet 9, the groove 13 is always open to the inlet 7, the groove 14 is always open to the exhaust outlet 10 and the groove 15 is always open to the inlet 8. These circumferential grooves open to a series of circular channels in the valve shaft. These channels can be defined by peripheral grooves in the valve shaft 1 and covered by the bore or, as shown, they can extend in the body of the valve shaft, each connecting with three ducts which rise to a respective opening at the periphery of the valve shaft at respective locations axially spaced from the circumferential grooves 11-15. Thus, as can be best seen in Figures 6 and 7, if one takes by way of example the central circumferential

groove 13, two circular channels 16 and 17 lead from the groove 13 inside the body of the valve shaft 1 in opposite directions and open at the periphery of the valve shaft 1 through three ducts 16A, 17A at respective locations spaced from the groove 13.

In the case of the groove 13, which is open to the inlet 7, the channel 16 serves to feed fuel to the cylinder chamber 3 via a port 18 between the bore and the cylinder chamber, whilst the channel 17 serves to feed fuel from the inlet 7 to the cylinder chamber 4 via a port 19 between the bore and the cylinder chamber 4. A similar arrangement applies for the two exhaust ports. It will be seen that the inlets 6 and 8 only respectively serve a single cylinder 2 and 5.

The various locations of the circular channels determine the firing order of the engine and, in the form illustrated, the firing order is cylinders 2, 4, 3, 5 with clockwise rotation of the valve shaft 1 as viewed in Figure 4.

It is intended that the valve shaft 1 be rotated by the crankshaft at one sixth of the revolutions of the crankshaft to protect gas seals from excessive wear on the housing due to centrifugal forces. If only one duct 16A, 17A etc. is provided, then the valve shaft 1 would be rotated at one half of the rate of rotation of the crankshaft.

The valve shaft 1 is provided with sealing means 20 in or at the grooves such as those indicated in Figure 6 in

order to prevent leakage of gases etc. between the various ports. Pairs of sealing rings 20 are joined together around the ends of the ports of the valve shaft opening onto the combustion chambers (see Figures 8 and 10). The sealing rings can be slotted to ensure that forces from compression and ignition are resisted by the valve shaft body and not by the sealing rings. The valve shaft 1 is also arranged to be substantially perfectly balanced in order to minimise vibration and to provide quieter performance.

As best seen in Figure 5 but also in Figures 2 and 3, provision can be made to vary the timing of the valve phase, this being achieved by surrounding the valve shaft with tubes 26 which can be rotated about their own axes through a few degrees in the housing bore by means of levers 27 protruding through slots in the housing, each tube 26 having an inlet port opening onto the inlet port 6, 7 or 8 and, circumferentially offset from that, an outlet port opening onto one of the grooves 11, 13 or 15, respectively. There is accordingly one tube 26 for each valve or each pair of valves. Each lever 27 is coupled by linkages to operating means (not shown) thereby to adjust the intake timings (advance and retard). The operating means may be computer controlled.

A similar arrangement can be provided as shown for the exhaust side.

It will be appreciated that the basic housing and valve shaft can be respectively formed as a plurality of identical units joined together. As illustrated in Figure 10, the shaft can be joined by means such as tubular rivets 23, tie rods 24 and other means so that the combustion parts are in the desired positions to suit the firing order. The units with the valve shaft can be mounted on a thin tubular spindle 25 to allow a degree of flexibility in the valve shaft thereby to adapt to a housing which has become distorted in use by hot spots and uneven hold-down on the cylinder gaskets.

On one particular internal combustion engine, the illustrated cylinder head occupies a height of some 50 mm above the cylinder chambers whereas the same engine as now manufactured using conventional poppet valve arrangements and an overhead camshaft occupies a height of some 250 mm. There is accordingly not only a space saving but a materials saving and the number of moving components is substantially reduced compared with conventional poppet valve arrangements. Of course, the cylinders are so provided with means in a petrol engine for firing the fuel mixture.

The circumferential grooves with their connecting channels are arranged to provide the cylinders with the fuel mixture in adequate volumes continuously with only one cut-off in each cylinder chamber. Similarly, the circumferential grooves opposite the exhaust ports can discharge the exhaust gases in an unobstructed manner away from the cylinders. The inlet areas are physically separated from the exhaust areas and this means that the

cooling system can be more efficient. The cooling system can include a forced air or water circulation through the centre of the valve shaft 1 and the air circulation could be provided by equipping the end 21 of the valve shaft 1 with a small fan (not shown). If additional cooling is required, a small fan could be incorporated into the design of the sprocket wheel drive, illustrated diagrammatically at 22, to enable air to pass over and through the valve shaft 1. In addition, water cooling jackets (not shown) could be provided on the outside on the valve shaft housing.

When adjacent cylinders are paired together on any "in line" multi-cylinder engine, it is arranged that there will be sufficient space along the length of the valve shaft to allow for the necessary separating space between exhausts and inlets for gas sealing rings.

As intimated above, it is intended that the present cylinder head be fitted to existing overhead camshaft engines without requiring substantial engine modification.

CLAIMS:

1. An internal combustion engine cylinder head including a bore in which a valve shaft is rotatably mounted, the bore being open for communication with a cylinder chamber and having a fuel inlet port for serving said cylinder chamber and an exhaust port for exhausting said cylinder chamber, said valve shaft having a first circumferential groove opposite said inlet port and a second circumferential groove opposite said exhaust port and said valve shaft defining a channel leading from each circumferential groove, each channel being positioned to open and close communication between the cylinder chamber and said inlet or outlet port, respectively, and there being sealing means in said bore between said inlet and outlet ports.

2. An internal combustion engine cylinder head including a bore in which a valve shaft is rotatably mounted, the bore being open for communication with cylinder chambers and having a fuel inlet port for serving two said cylinder chambers and an exhaust port for exhausting said two cylinder chambers, said valve shaft having a first circumferential groove opposite said inlet port and a second circumferential groove opposite said exhaust port, and said valve shaft defining two channels leading in opposite directions from each circumferential groove, each channel being positioned to open and close communication between a respective cylinder chamber and said inlet or outlet port, respectively, and there being sealing means in said bore between said inlet and outlet ports.

3. A cylinder head according to claim 1, wherein there are five of said circumferential grooves.

4. A cylinder head according to claim 1, 2 or 3, wherein three of said circumferential grooves are open to respective inlet ports and the other two grooves and open to respective exhaust ports.

5. A cylinder head according to claim 4, wherein the central one of the three inlet ports is for serving two cylinder chambers.

6. A cylinder head according to any one of the preceding claims, wherein each channel leading from the circumferential grooves is open to the periphery of the valve shaft through at least one duct at a location spaced from the associated circumferential groove.

7. A cylinder head according to any one of the preceding claims, wherein an upper part of the bore is permanently ported open opposite the circumferential grooves and a lower part of the bore is ported opposite the channels and is opened and closed by rotation of the valve shaft in the bore.

8. A cylinder head according to any one of the preceding claims, wherein said sealing means comprises sealing rings.

9. A cylinder head according to claim 8, wherein said sealing rings are slotted to cause forces from compression and ignition to be resisted by the body of the valve shaft and not by the sealing rings.

10. A cylinder head according to any one of the preceding claims, wherein means are provided to vary the timing of the valve shaft, said means comprising tubes surrounding said valve shaft, said tubes being rotatable about their own axes by a few degrees in the housing bore by means of levers protruding through slots in the housing.

11. A cylinder head according to claim 10, wherein said levers are coupled by linkages to operating means thereby to adjust the timings.

12. A cylinder head according to any one of the preceding claims, wherein said valve shaft is formed as a plurality of units joined together.

13. A cylinder head according to claim 12, wherein said units are mounted on a tubular spindle.

14. An internal combustion engine cylinder head, substantially as hereinbefore described with reference to Figures 1 to 7 or Figures 8 to 10 of the accompanying drawings.

15. An internal combustion engine including a cylinder head according to any one of the preceding claims.

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