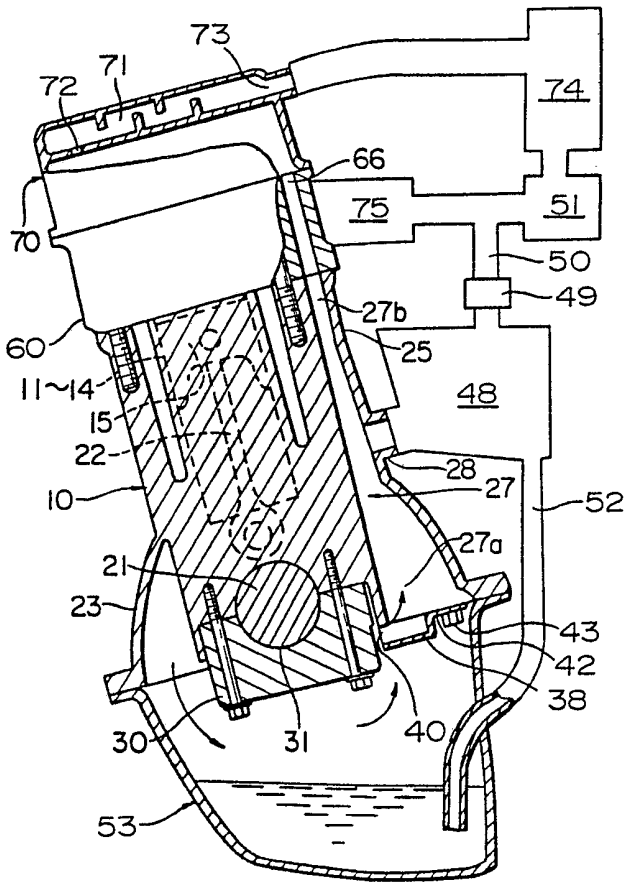
(12) UK Patent Application (19) GB (11) 2 131 484 A

(21) Application No **8330459**
(22) Date of filing **15 Nov 1983**
(30) Priority data
(31) **57/172480**
(32) **15 Nov 1982**
(33) **Japan (JP)**
(43) Application published
20 Jun 1984
(51) **INT CL³**
F01M 13/00
(52) Domestic classification
F1B 5Q3G
(56) Documents cited
GBA 2058212
GB 1572664
GB 1495870
(58) Field of search
F1B
(71) Applicant
Honda Giken Kogyo Kabushiki Kaisha (Japan), 27—8 6-chome Jingumae, Shibuya-ku, Tokyo, Japan
(72) Inventors
Susumu Toki, Kenichi Nagahiro
(74) Agent and/or Address for Service
Frank B. Dehn & Co., Imperial House, 15/19 Kingsway, London WC2B 6UZ

(54) Internal combustion engine with blow-by gas passages

(57) Blow-by gas passages (26), 27 are formed on one side of the cylinder block 10 and cylinder head 60 of an internal combustion engine and spaced longitudinally of its crankshaft 21. The passages extend from the interior of the crankcase 23 to a location above an upper face of the cylinder head, the passage 27 being provided with a mounting port 28 for an oil separator 48. The other blow-by passage (26) is connected to the intake system 75 of the engine via opening 72, breather chamber 71, air cleaner 74 and carburettor 51; the separator is connected to the intake system 75 via a pressure controlled valve 49. Passages (29*a*, 29*b*), Fig 1 (not shown), at the other side of the cylinder block are used exclusively for returning lubricant to the crankcase.

FIG. 4.



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The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

FIG. 1.

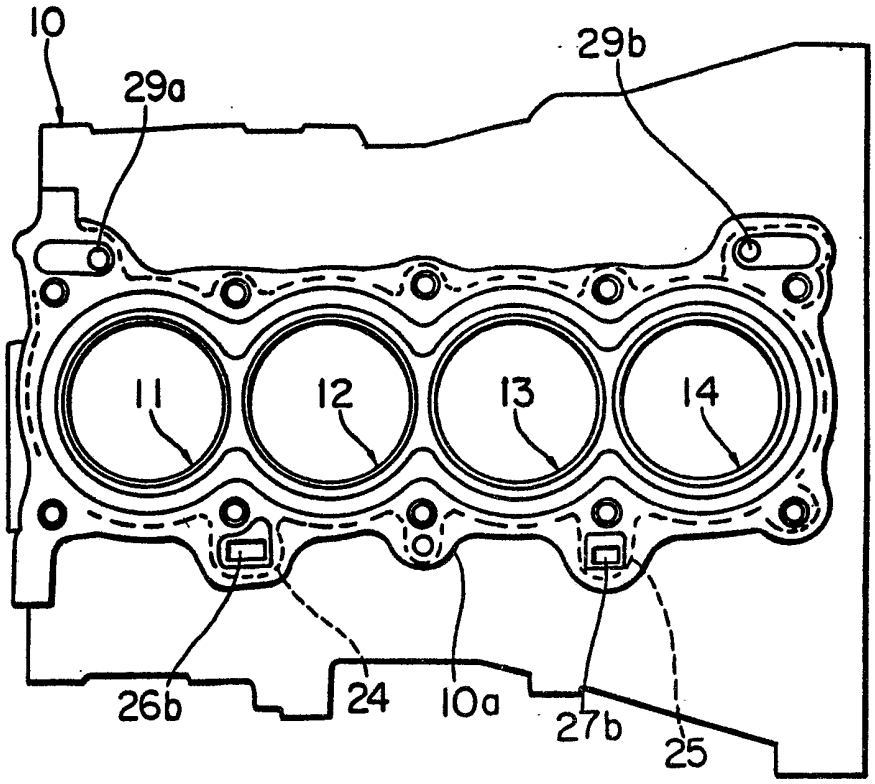

10
29a
29b
11
12
13
14
26b
24
10a
27b
25

FIG. 2.

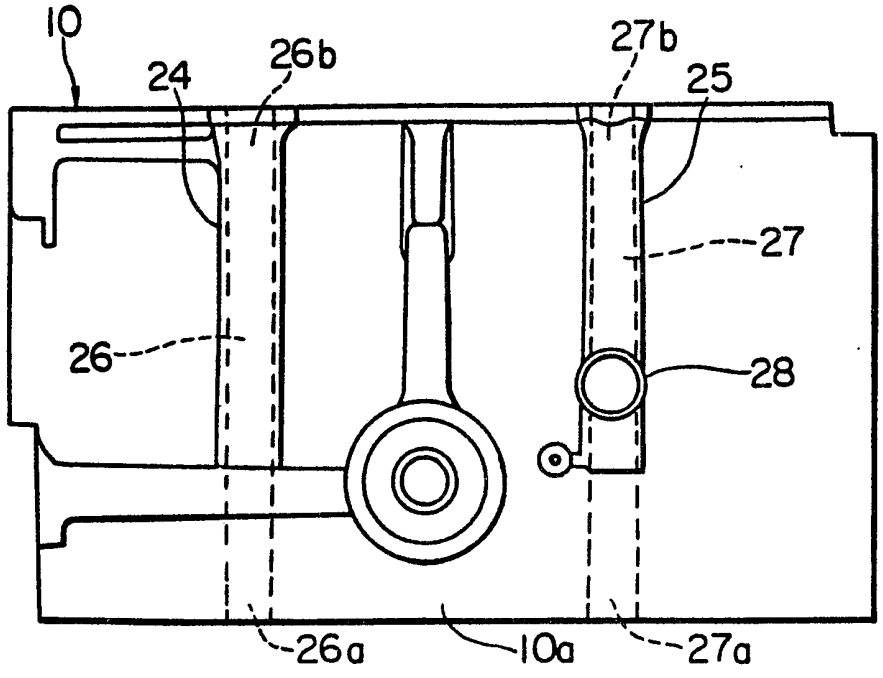

10
24
26b
27b
25
27
26
28
26a
10a
27a

FIG. 3.

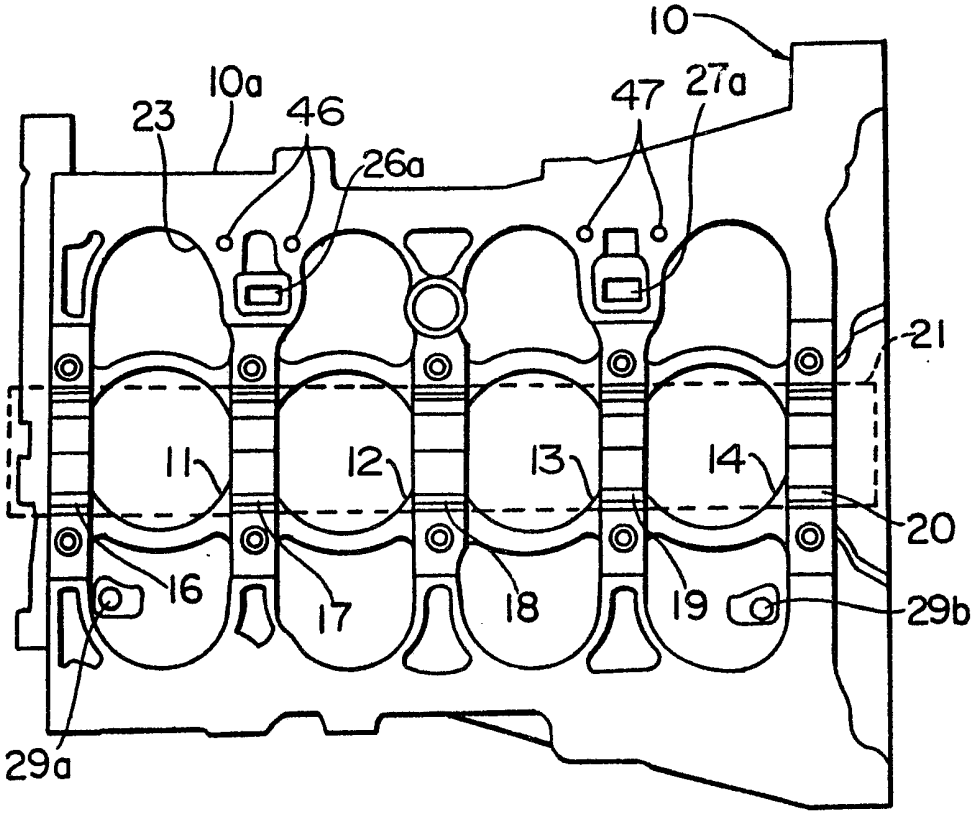

10
10a
23
46
26a
47
27a
21
11
12
13
14
20
16
17
18
19
29b
29a

FIG. 5.

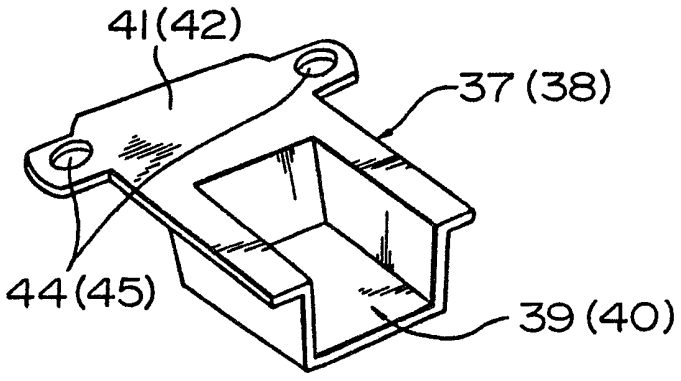

41(42)
37(38)
44(45)
39(40)

FIG. 4.

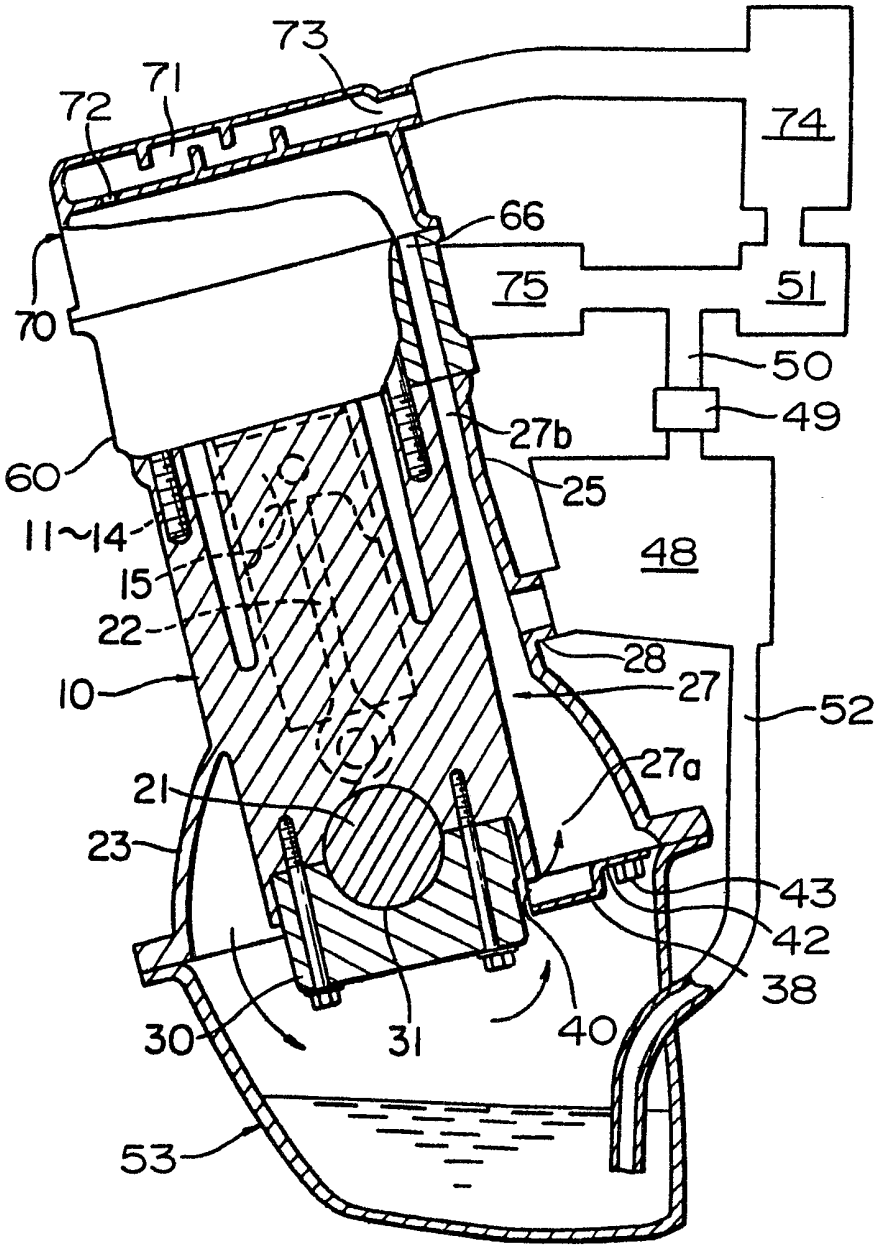

73
71
72
74
66
70
75
51
50
49
27b
60
25
11~14
48
15
22
28
10
27
52
27a
21
23
43
42
38
30
31
40
53

FIG. 6.

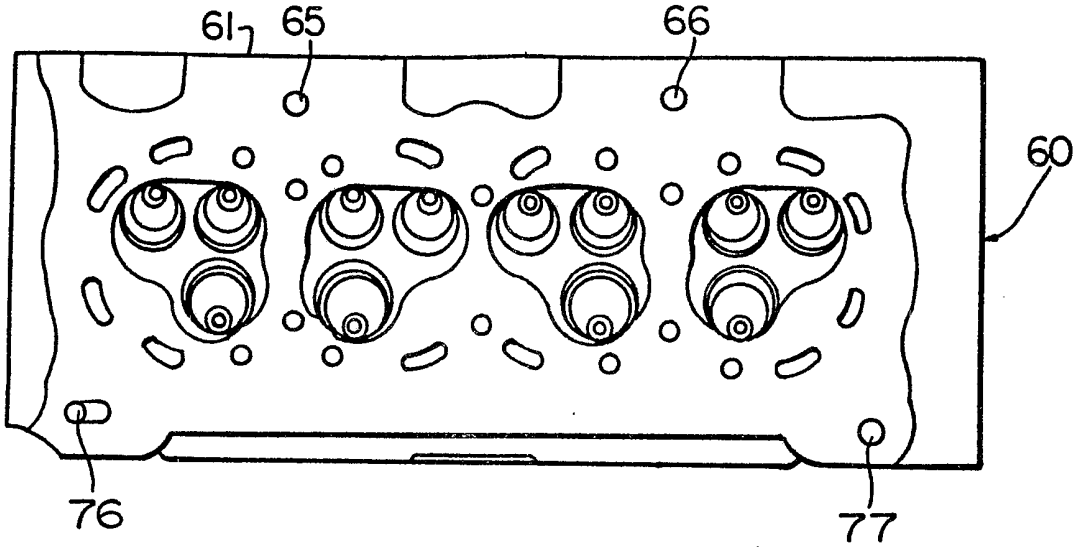
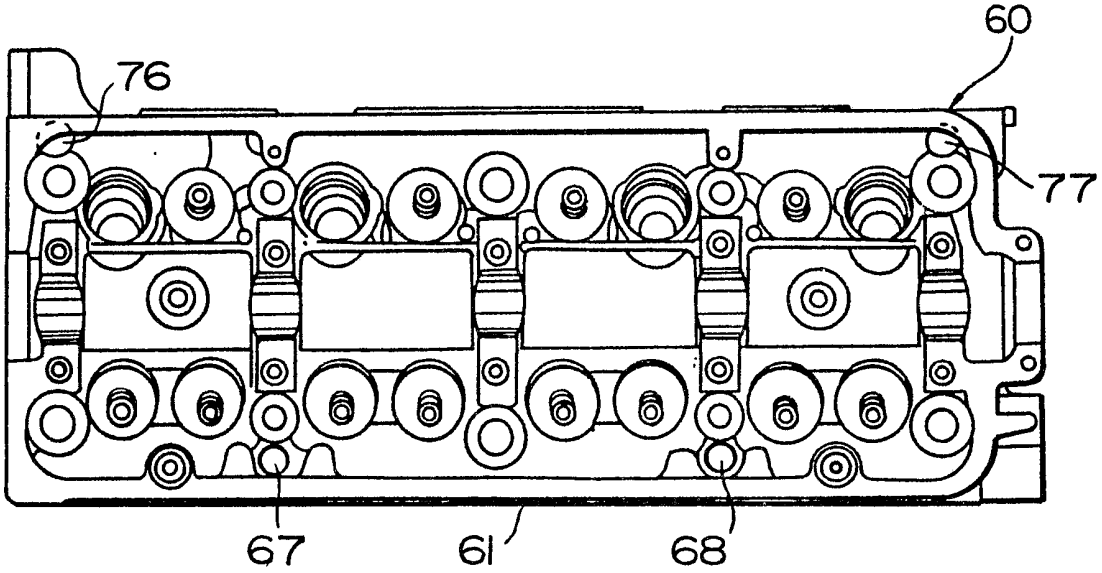


FIG. 7.



SPECIFICATION

Internal combustion engine with blow-by gas passages

This invention relates to a blow-by gas passage system in an internal combustion engine and, more particularly, to such a blow-by gas passage system in which a plurality of improved blow-by gas passages are formed in the cylinder block and the cylinder head.

An air-fuel mixture drawn into the combustion chamber of an internal combustion engine is ignited and burned before being discharged to the atmosphere outside of the engine. Generally speaking, however, not all of the air-fuel mixture is completely burned and discharged, but a portion of the unburned mixture during the compression stroke and a portion of the burned gas during the power stroke leak through the clearance space between the piston and the cylinder wall into the crankcase. This leak gas is referred to as "blow-by gas" herein.

This blow-by gas has to be discharged to the atmosphere outside of the engine, partly because it deteriorates the quality of the lubricating oil in the crankcase, and partly because the leak pressure tends to increase the pressure in the crankcase. Such unwanted pressure increase may cause leakage of lubricating oil, and back flow of lubricating oil into the cylinder head overlying the engine. Generally speaking, therefore, a passage system is required for removing the blow-by gas from within the crankcase and for returning it into the combustion chamber, in particular from the standpoint of reduction of air pollution.

In the prior art, a first blow-by gas passage having one end opening in the crankcase and its other end communicating with an oil separator is disposed in a predetermined position at one side of the cylinder block, and blow-by gas flows from a crankcase side opening into this first blow-by gas passage. Thence the blow-by gas is introduced into an oil separator, where the lubricating oil is separated out, and the blow-by gas is then conveyed into the intake manifold, to be returned to the combustion chamber together with the incoming air-fuel mixture. A second blow-by gas passage is disposed in the side portions of the cylinder block and the cylinder head, and has one end opening in the crankcase and its other end communicating with the upper face of the cylinder head fixed on the cylinder block. This second blow-by gas passage is also used as a return passage to the oil pan for lubricating oil remaining on the upper face of the cylinder head. Furthermore the said other end of the second blow-by gas passage communicates with the combustion chamber through a breather chamber, an air cleaner, the carburettor and the said inlet manifold.

With such an arrangement, during low load operation the blow-by gas in the crankcase is drawn into the oil separator through the said first passage by the action of the relatively high vacuum prevailing in the inlet manifold, and since a vacuum is thereby established in the crankcase at this time, fresh air is introduced thereinto from the air cleaner by way of the said second passage. During high load operation of the engine, on the other hand, the flow rate of air to be drawn through the air cleaner into the inlet manifold is increased so that the blow-by gas accordingly flows in the other direction through said second passage and breather chamber and into the air cleaner.

The above arrangement has certain disadvantages. Thus especially during high load operation of the engine, the second passage acts as a return passage for flow of lubricating oil from the valve actuating mechanism in the cylinder head, so that such lubricating oil is blown into the intake system, and this has the disadvantage that oil mist wets and damages the air cleaner element. Furthermore, since the aforementioned blow-by gas passages must have a certain total cross-sectional area, the cylinder block and the cylinder head require a larger space than is readily available, with the result that they interfere with other accessories and enlarge the overall size of the engine.

According to the present invention there is provided, in an internal combustion engine having a plurality of cylinders, a crankshaft, a crankcase, a cylinder block and a cylinder head; at least two blow-by gas passages formed on one side of the cylinder block and cylinder head and mutually spaced longitudinally of the crankshaft, said blow-by gas passages communicating with the interior of the crankcase and extending to an upper face of the cylinder head, one of said blow-by passages being provided with a mounting port, an oil separator carried on said mounting port, means connecting another of said blow-by gas passages to said separator, and means connecting the separator to the intake system of the engine.

In a preferred form of the invention a blow-by gas passage system of an internal combustion engine is disposed in the side portions of the cylinder block and the cylinder head fixed thereto and has one end opening to the inside of the crankcase and its other end opening in the upper face of said cylinder head. The system comprises two or more blow-by gas passages formed in said one side of the cylinder block and cylinder head, and one of said passages is formed with a mounting port for an oil separator, whereby the face pressure of the blow-by gas passage system at the mating faces of the cylinder block and cylinder head is raised. The cross-sectional area of one passage is reduced while maintaining the necessary cross-sectional area of the blow-by gas system, to improve the sealability and to alleviate the problem of the space occupied by the side faces of the cylinder block and the cylinder head. Accordingly, during the low load operation of the engine the blow-by gas passage not having the oil separator is supplied only with fresh air to promote cleansing of the inside of the crankcase, whereas during the high load operation lubricating oil is prevented from being blown out of the

crankcase.

Two embodiments of the invention will now be described by way of example and with reference to the accompanying drawings, in which:—

Figure 1 is a plan view of the cylinder block of a first embodiment of an engine according to the invention;

Figure 2 is a side elevation thereof;

Figure 3 is a bottom plan view;

Figure 4 is an end elevation partly in section and partly in diagrammatic form;

Figure 5 is a perspective detail showing one of the cover parts used for restricting entry of lubricating oil into a blow-by gas passage;

Figure 6 is a bottom plan view of a modified form of cylinder head; and

Figure 7 is a plan view of the head shown in Figure 6.

Referring to the drawings, as shown as Figure 1, cylinders 11, 12, 13 and 14 are longitudinally juxtaposed in a cylinder block 10 which has a generally rectangular upper face. In each of the cylinders 11 to 14, as shown in Figures 3 and 4, there is fitted a piston 15 which is connected through a connecting rod 22, as indicated by broken lines in Figure 4, to a crankshaft 21. The crankshaft 21 is borne by crankshaft bearing portions 16, 17, 18, 19 and 20 of the cylinder block 10 and crankshaft bearing portions 31 of bearing caps 30.

The cylinder block 10 has its one side portion 10*a* formed with passages 26 and 27 which are located in two vertical boss portions 24 and 25 positioned at one side of the crankshaft bearing portions 17 and 19 and bulging outwardly of the cylinder block 10. The passages 26 and 27 have lower end portions 26*a* and 27*a* expanded and opened in one side of the bearing portions 17 and 19 at the lower faces of the boss portions 24 and 25. The passages 26 and 27 have upper portions 26*b* and 27*b* opened in the upper face of the cylinder block 10. The effective cross-sectional areas of the two passages 26 and 27 are each made about one-half of that of the aforementioned first blow-by gas passage of the prior art. In other words the sum of the areas of these two passages 26 and 27 is substantially equal to the area of the first passage of the prior art. Because of this reduction in the effective areas of the passages 26 and 27, the face pressure of these passages at the mating faces 32 between the cylinder block 10 and the cylinder head 60 is raised, which improves the sealability of these mating faces, and furthermore the extent of the bulging of the boss portions 24 and 25 can be reduced so as to reduce the overall width of the cylinder block 10 and the cylinder head 60. At the same time the necessary effective area of the blow-by gas passage system is maintained as the sum of the effective areas of the two passages 26 and 27. Moreover, the lower end portions 26*a* and 27*a* of the passages 26 and 27, where they extend through the crankshaft bearing portions 17 and 19, are expanded as shown in Figure 4 so as to reduce the thicknesses of the bearing portions 17 and 19.

The crankshaft bearing portions 16 to 20 are not severely splashed with droplets of the lubricant which is contained within the crankcase, during rotation of the crankshaft 21, and the bearing portions 17 and 19 are less loaded by the rotation of the crankshaft 21 than the bearing portion 18. The boss portions 24 and 25 containing the passages 26 and 27 are provided on their lower faces with covers 37 and 38 for restricting entry of lubricant splash into the passages 26*a* and 27*a*. These covers 37 and 38 are, as shown in Figure 5, generally box-shaped having their sides 39 and 40 open. Their upper faces 41 and 42 are fixedly fastened to the lower faces of these boss portions 24 and 25 by means of threaded fastenings 43 which are screwed through bolt holes 44 and 45 and into threaded holes 46 and 47 (as shown in Figure 3) formed in the lower faces of the boss portions 24 and 25.

The boss 25 is formed, substantially centrally of its height, as shown in Figures 2 and 4, with a cylindrical oil separator mounting port 28 which has one end communicating with the passage 27 and its other end communicating with the suction port of an oil separator 48. To this oil separator 48 there are connected through a pressure controlled valve 49 both a pipe 50 communicating with the downstream end of a carburettor 51 and a pipe 52 communicating with the oil pan 53. Thus, by shortening the passage from the crankcase 23 to the oil separator 48 and by thus making it possible to attach the oil separator 48 directly to the side of the engine, space requirements in the engine compartment, especially for the pressure controlled valve system, can be reduced.

As shown in the modification of Figures 6 and 7, the cylinder head 60 is fixedly secured on the upper portion of the cylinder block. The cylinder head 60 has one side portion 61 thereof formed with passages which have their lower end portions 65 and 66 communicating with the upper end portions of the aforementioned passages 26 and 27 of the cylinder block 10, and their upper end portions 67 and 68 opening in the upper face of the cylinder head 60.

The cylinder head 60 is topped with a cylinder head cover 70, as shown in Figure 4. This cylinder head cover 70 is formed in its upper portion with a breather chamber 71 having the illustrated shape, which chamber has an opening 72 at one side communicating it with the cylinder head cover 70 and an opening 73 at the other side communicating it with an air cleaner 74. The air cleaner 74 communicates with the carburettor 51 and thence with an inlet manifold 75 which is secured to one side of the cylinder head 60.

The cylinder block 10 and the other side of the cylinder head 60 are formed with a series of passage 29*a*, 29*b* (in the first embodiment) and 76, 77 (in the second) exclusively for returning lubricant, each of which passages has one end opening in the crankcase 23 and its other end opening in the upper face of the cylinder head 60.

During high load operation of the engine, blow-by gas leaking into the crankcase 23 is drawn into the two passages 26 and 27 of the cylinder block 10, through the openings 39 and 40 of the lubricant splash restricting covers 37 and 38. Since the openings 26*a* and 27*a* of the passages 26 and 27 open in the vicinity of the bearings 17 and 19 which tend not to be splashed with the lubricant during rotation of the crankshaft, and since the lubricant splash restricting covers 37 and 38 provide blocking walls, lubricant splash into the passages 26 and 27 is restricted. Because the passages 26, 27 and 65, 66 are formed separately from the passages 29*a*, 29*b* and 76, 77 that are especially provided for the return of lubricating oil, lubrication of the valve actuating mechanism disposed in the upper portion of the cylinder head 60 is efficiently achieved. Accordingly, very little of the lubricating oil is carried by the blow-by gas into the air cleaner 74.

During low load operation of the engine, blow-by gas is drawn from the crankcase by the vacuum in the inlet manifold, through the passage 27 and the oil separator mounting port 28, into the oil separator 48 in which the lubricating oil contained in the blow-by gas is removed. The blow-by gas is then introduced through the pressure controlled valve 49, the pipe 50, and the inlet manifold 75 into the combustion chamber, not shown. The lubricant which is separated from the blow-by gas in the oil separator 48 is returned through the pipe 52 to the oil pan 53. Further, during such low load operation, cleaned ambient air is sucked from the air cleaner 74, through the breather chamber 71 and the inside of the cylinder head cover 70, and thence through the passages 65 and 26, into the crankcase 23. In this way clean air flows into the crankcase 23. In addition, some clean air may be drawn through passages 66 and 27 to port 28 and into the oil separator 48, during low load operation.

CLAIMS

1. In an internal combustion engine having a plurality of cylinders, a crankshaft, a crankcase, a cylinder block and a cylinder head; at least two blow-by gas passages formed on one side of the cylinder block and cylinder head and mutually spaced longitudinally of the crankshaft, said blow-by gas passages communicating with the interior of the crankcase and extending to an upper face of the cylinder head, one of said blow-by passages being provided with a mounting port, an oil separator carried on said mounting port, means connecting another of said blow-by gas passages to said separator, and means connecting the separator to the intake system of the engine.

2. An engine as claimed in claim 1, wherein at least said one of said blow-by gas passages is provided with a baffle at the lower end thereof to restrict entry of gases and splash oil from the crankcase.

3. An engine as claimed in claim 1 or 2, wherein only two said blow-by gas passages are provided on said one side of the cylinder block and cylinder head.

4. An engine as claimed in claims 2 and 3, wherein both of said blow-by gas passages are provided with a said baffle.

5. An engine as claimed in any preceding claim, having further passages extending between the crankcase and the upper face of the cylinder head on the other side of the cylinder block and cylinder head, for the return of lubricant from the cylinder head to the crankcase.

6. An internal combustion engine as claimed in claim 1, substantially as hereinbefore described with reference to Figures 1 to 5 of the accompanying drawings.

7. An engine as claimed in claim 6 but modified substantially as hereinbefore described with reference to Figures 6 and 7 of the accompanying drawings.

Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1984. Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.