PATENT SPECIFICATION (11) 1 561 528

1 561 528

(21) Application No. 40777/76 (22) Filed 1 Oct 1976

(31) Convention Application No's 619799 (32) Filed 6 Oct 1975 in 619798

(33) United States of America (US)

(44) Complete Specification Published 20 Feb 1980

(51) Int. Cl.[3] F02F 1/42 // 1/10

(52) Index At Acceptance F1B 2A18 2A9C 2C11 2C1A 2C3E 2C3H

(72) Inventors: NSHAN HAMPARIAN
MICHAEL BANDROWSKI JR.

(54) INTERNAL COMBUSTION ENGINE CYLINDER HEAD EXHAUST PASSAGES

(71) We, GENERAL MOTORS CORPORATION, a Company incorporated under the laws of the State of Delaware, in the United States of America, of Grand Boulevard, in the City of Detroit, State of Michigan, in the United States of America (Assignees of NSHAN HAMPARIAN and MICHAEL BANDROWSKI JR.) do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed to be particularly described in and by the following statement:–

This invention relates to internal combustion engine cylinder heads, particularly cylinder heads for diesel engines.

The present invention proposes the employment in internal combustion engine cylinder head constructions of liners which are spaced from, and extend from one end to the other of each cylinder head exhaust passage, in order to limit the loss of heat to the engine coolant through the surfaces exposed to the combustion and exhaust gases, and to improve gas flow efficiency.

The scope of the invention is defined by the appended claims; and the invention and the method by which it is to be performed are hereinafter particularly described with reference to the accompanying drawings, in which:–

Figure 1 is a part sectional plan of one embodiment of an internal combustion engine cylinder head according to the present invention;

Figures 2, 3, 4 and 5 are sections respectively on the lines 2 - 2, 3 - 3, 4 - 4, and 5 - 5, of Figure 1;

Figure 6 is a slide elevation of Figure 1, as viewed on the line 6 - 6 of Figure 1;

Figure 7 is a section on the line 7 - 7 of Figure 1;

Figure 8 is a part sectional perspective view of a modification of the cylinder head shown in Figures 1 to 7;

Figure 9 is a section on the line 9 - 9 of Figure 10, of another modified form of construction of a cylinder head according to the invention; and

Figure 10 is an inverted plan of the cylinder head shown in Figure 9, as viewed on the line 10 - 10 of Figure 9.

In the drawings, in which like numerals indicate like parts and modified parts are indicated by numerals with appended letters, there are illustrated certain embodiments of cylinder heads for use in internal combustion engines and formed according to the present invention. Although the embodiments illustrated are designed for use with a type of two-stroke cycle uniflow scavenged diesel engine of well known construction, it should be understood that the applications of the invention are not limited to engines of this type.

Figures 1 to 7 show a cylinder head 11 which includes a main body of housing 12 formed of two main components, an upper housing member 14 and a lower housing member 15. While the construction of the main housing in two sections or members is advantageous for certain purposes of the the invention, as will subsequently be more fully explained, it is not required for all purposes of the invention that the cylinder head be so constructed.

The main body 12 of the cylinder head 11 includes a lower wall of fire deck 16, an upper wall 17 and a peripheral side wall or walls 18 which interconnect the upper and lower walls. These walls combine with certain interior walls 19 to form internally an exhaust cavity 20 at each cylinder location of the cylinder head. The cylinder head is adapted in use to be mounted

upon the block, not shown, of an internal combustion engine with its lower wall or firing face 16 engaging an end wall of the block so as to close the ends of the cylinders therein and form, in part, the combustion chambers at the cylinder ends. At each cylinder location a plurality of exhaust ports 22, in the present instance four for each cylinder location, are disposed in a generally rectangular pattern in the lower wall so as to connect the combustion chamber of the associated cylinder with its respective exhaust cavity 20 within the cylinder head. If desired, the exhaust ports may be provided with valve seat inserts 23. In addition, tubular valve guides 24 are retained in the cylinder head upper wall 18 in alignment with the exhaust ports 22 so as to receive poppet exhaust valves, not shown, reciprocably disposed in the valve guides and adapted to open or close the exhaust ports.

Centrally disposed between the exhaust ports 22 of each cylinder location and preferably located axially of the associated engine cylinder, not shown, the cylinder head body has a vertical opening 27 in which there is received a component receiving tube or wall in the form of a copper injector tube 28 which, in the present instance, is adapted to receive a fuel injector, not shown. The lower end of the injector tube is necked down to a small diameter 30 where it penetrates the lower wall, and is flared outwardly at 31 into a countersunk area of the cylinder head lower wall, thereby retaining the tube 28 in place in sealing engagement with the lower wall. At its upper end a flanged portion 32 of the injector tube engages an O-ring seal 34 for sealing the upper wall opening 35 against leakage around the tube.

Within the portion of the cylinder head body surrounding the injector tube, exhaust ports and valve guides, the interior and exterior walls of the cylinder head form a lower coolant jacket 36 and an upper coolant jacket 38. Lower jacket 36 extends along the lower wall 16 and surrounds the exhaust ports 22, as well as the lower portion of the injector tube 28, to provide for cooling of these areas with liquid coolant during operation of the associated engine. The upper coolant jacket 38 extends along the upper wall 17, around the valve guides 24 and the upper portion of the injector tube 28 for cooling these portions of the cylinder head construction. The upper and lower jackets 36, 38 are interconnected at each cylinder location only by an annular opening 39, which extends around the intermediate portion of the injector tube 28, providing clearance between it and the interior walls 19 of the cylinder head. If desired, however, additional passages could be provided connecting the upper and lower jackets.

In the two-piece construction of the cylinder head main body or housing illustrated, the upper and lower portions are divided along a horizontal plane 40 that defines opposed engaging surfaces 42, 43 of the upper and lower housing members, respectively. An O-ring seal 44 is preferably provided between the upper and lower housing members, around the annular opening 39 that forms a part of the engine coolant jacket to prevent leakage of coolant through the joint. The remainder of the opposing surfaces 42, 43 may be maintained in metal-to-metal contact without a gasket, if desired, and are preferably so arranged for control of the cylinder head vertical dimensions, since the exhaust cavity 20 enclosed by the engaging surfaces either does not form an active gas passage or it provides only a passage for cooling air, as will be subsequently explained. The upper and lower members making up the main cylinder head housing are removably retained together by bolts 46 or other suitable fastening means.

Exhaust Passage Liners

A feature of the invention as illustrated in Figures 1 to 7 is the provision of prefabricated exhaust passage liners 47, which are located at each of the cylinder locations. Liners 47 are formed from a high temperature alloy such as stainless steel or the like and may be fabricated from stamped or pressed metal components welded together, by investment casting or by any other suitable means of construction. Since the liners are separately formed, it is possible to provide intricate and accurate passage shapes and smooth internal surfaces which increase the efficiency of gas flow over that which is possible in conventional cast cylinder head exhaust passages.

Each liner 47 is formed with a large outlet portion 48 from which extend in "Y" fashion a pair of legs 50. The legs encircle the injector tube 28 and lead to downwardly protruding port engaging extensions 51. The extensions are preferably closely fitted within bored out enlargements 52 at the upper ends of the respective exhaust ports 22 so that no seals are required at these locations. The outlet portion of the passage liner extends through an exhaust opening 54 provided in the side wall 18 of the cylinder head and formed partially in each of the upper and lower portions. The opening is preferably sealed by a high temperature material 56 such as asbestos or the like retained in a suitable groove 57. Suitable openings 58 are also provided in the upper portions of the contoured passage liners through which the valve guides 24 extend.

As shown in the drawings, the exhaust cavity 20, within which the exhaust liners are disposed, is shaped so that the liner walls are spaced from the cavity walls and from the internal cylinder head walls that define the coolant jacket, except at certain portions where necessary to seal and support the liners within the head. These contacting portions include the end of the outlet portion 48, the part extension ends 51 and the portions of the upper wall adjacent the valve guide openings 58. In the

other locations, the clearance between the liners 47 and the other walls of the cylinder head provides an insulating space which limits the transfer of heat from the exhaust gases passing through the liners to the coolant jackets in the upper and lower portions of the cylinder head and around the injector tube. In this way, loss of heat from the exhaust gases in the cylinder head is controlled, yielding potential efficiency improvements, especially in turbocharged engines, as well as possible gains in exhaust emission control. In addition, the reduced rejection of heat to the engine coolant permits the use of lower cooling fan speeds and/or a smaller external cooling system than would be needed for a conventional engine of comparable power.

Figure 8 illustrates an arrangement similar to that of Figures 1 to 7 but shown in a cutaway pictorial view with poppet exhaust valves 59 shown in the assembly. This arrangement, includes a further modification in that a longitudinal air gallery 60 is provided in the upper wall 17*a* of the upper housing member 14*a*. Gallery 60 is connected with the exhaust cavity 20 through lateral passages 61 extending through ducts 62. With this construction a small amount of cooling air may be supplied to the air gallery from external means, such as a turbocompressor, and in turn distributed to the exhaust cavity 20 for providing limited cooling in the insulating spaces. This cooling air could be dispersed by leakage through the various joints between the exhaust liners and the cylinder head walls or, if desired, suitable vent openings 64 may be provided for exhaust of the cooling air, preferably to the turbocharger or another part of the engine exhaust system.

Valve Seat and Port Inserts

Figures 9 and 10 illustrate an alternative embodiment of cylinder head construction according to the invention. In general, the alternative embodiment of Figures 9 and 10 has a construction identical to that of the first described embodiment of Figures 1 to 7 with respect to the inclusion of exhaust passage liners 47. However, certain additional features are also included.

One additional feature of the alternative embodiment is the provision of air gap insulated exhaust valve seat and port inserts 66 in modified exhaust port openings 22*b*. With this arrangement, the exhaust ports 22*b* are bored out to receive the inserts which include an enlarged annular ring portion 67 and a smaller diameter tubular extension 68. The annular ring portion 67 defines a valve seat 69 and is received in conventional fashion in a recess 70 on the bottom of the lower wall 16*b*. The ring may be arranged to end flush with the face of the lower wall, as would be usual in a conventional construction; but in the present instance, for reasons which will subsequently be made apparent, the ring portion 67 extends slightly below the wall surface surrounding its respective exhaust port.

The tubular extension 68 of the insert extends upwardly in the exhaust port to a point closely approaching the associated port extension 51 of the respective port liner 47. As a feature of the design, the outer diameter of the tubular extension is reduced at 72, intermediate the annular ring portion 67 and the other end of the extension 68 to provide an air gap or insulating space that limits the flow of exhaust heat from the exhaust port area to the adjacent lower coolant jacket 36.

Fire Deck Inserts

An additional feature of the construction illustrated in Figures 9 and 10 is the provision of a fire deck insert 74 to limit heat loss from the combustion chamber of an associated engine. For this feature, the lower wall 16*b* of the cylinder head is provided with a recess 75 which is preferably circular and, in any event, has a minimum outer dimension, in this case the diameter, which is no less than the diameter of the associated engine cylinder liner 76 indicated in phantom lines.

Insert 74 comprises a disc-like member, having a flat lower surface 78 that sealingly engages the end of the cylinder liner 76 so as to form the upper wall of an associated combustion chamber 79. Openings 80 are provided in the disc at each of the exhaust ports to permit the passage of exhaust gases from the combustion chambers. When exhaust port inserts 66 are utilized with this construction as shown, the inserts extend downwardly into the openings 80 part way toward the flat lower surface 78 so that the exhaust valves will clear the lower surface of the fire deck insert promptly after opening, but the edges of the valve seat and port inserts are partially protected from the combustion chamber gases, except when the valves are open.

The fire deck insert is also provided with a central opening 81 which receives the lower end 30 of the injector tube 28. The tube end is flared into a counter-sunk portion at 31 which retains the insert 74 in position on the cylinder head face. Around each of the openings and at its outer edge, the back of the insert 74 has raised portions 82 which contact the bottom of the cylinder recess 75 and positively locate the outer surface 78 of the insert with respect to the main body of the cylinder head. However, intermediate these raised portions 82 the insert 74 is cut away, as at 83, to form an insulating space or air gap between the insert 74 and the recessed portion of the lower wall 16*b*. This air gap limits the transmission of heat from the combustion chamber to the lower wall and thus to the lower coolant jacket of the cylinder head, thereby increasing the wall temperature of that portion of the combustion chamber wall formed by the fire deck insert and raising engine efficiency accordingly.

It should be apparent that, if desired, the

raised portions 82 of the fire deck insert could be eliminated by providing similar raised areas in the machining of the lower wall recess 75 in which case the fire deck insert could be made in the form of a flat plate. Obviously, other suitable shapes might also be utilized.

WHAT WE CLAIM IS:—

1. An internal combustion engine cylinder head having a lower wall with at least one exhaust port therein opening into an exhaust cavity which extends to an opening in a side wall of the head, and having in said exhaust cavity a liner preformed to form a smooth surface exhaust passage connecting each said exhaust port with said side wall opening, said liner being spaced from the walls of said cavity, except at the ends of the liner and at intermediate support points, so as to provide an insulating space around said liner and thereby limit the loss of exhaust heat to said cavity walls and to coolant passages in said cylinder head.

2. An internal combustion engine cylinder head according to claim 1, including a combined exhaust port and valve seat insert arranged in each said exhaust port and extending to a location adjacent the respective exhaust passage liner, said insert having an annular valve seat ring portion seated in said port in the lower wall of the cylinder head, and a reduced diameter tubular passage portion extending into, and at least partially spaced from, said exhaust cavity so as to limit heat transfer from exhaust gases in said passage portion to the adjacent portions of the cylinder head.

3. An internal combustion engine cylinder head according to any of claims 1 or 2, in which the lower wall of the cylinder head is formed with a recess substantially filled by a high temperature metal alloy fire deck insert which has an outer surface engageable with and adapted to close the end of an associated cylinder and an exhaust opening in alignment with each said exhaust port, said fire deck insert including an inner surface opposed to the outer surface of the lower wall recess and having means separating said opposed surfaces to provide an insulating air gap between said insert and said head over a major portion of the fire deck insert.

4. An internal combustion engine cylinder head according to claim 3, in which spacer formations are provided along the periphery of said insert and of each exhaust opening therein so as to enclose said air gap.

5. An internal combustion engine cylinder head according to claim 3 or 4, in which each said valve seat ring portion protrudes from the recessed portion of the lower wall of the cylinder head into its respective exhaust opening in said fire deck insert.

6. An internal combustion engine cylinder head according to any of claims 1 to 5, in which said lower wall and the wall of the exhaust cavity adjacent said exhaust port form part of a coolant jacket.

7. An internal combustion engine cylinder head according to any of claims 1 to 5, in which said cylinder head has internal walls forming a lower coolant jacket along the lower wall of the head, an upper coolant jacket along the upper wall of the head and an annular connecting passage around a tubular wall which is adapted to receive a component and extends through the upper and lower walls and between a plurality of said exhaust ports, said annular passage connecting the upper and lower jackets to allow coolant flow therebetween.

8. An internal combustion engine cylinder head according to claim 7, in which said head is formed as an upper and a lower member secured together along abutting side and interior walls to form said upper and lower coolant jackets and said annular connecting passage, a seal being provided around said connecting passage and in engagement with said abutting walls to seal the joint against leakage from said connecting passage.

9. An internal combustion engine cylinder head according to any of claims 1 to 8, including an air manifold in the upper or lower part of the cylinder head, connected with said insulating space so as to direct cooling air into said space.

10. An internal combustion engine cylinder head substantially as hereinbefore particularly described and as shown in Figures 1 to 7 of the accompanying drawings.

11. An internal combustion engine cylinder head substantially as hereinbefore particularly described and as shown in Figures 1 to 7 modified as shown in Figure 8 of the accompanying drawings.

12. An internal combustion engine cylinder head substantially as hereinbefore particularly described and as shown in Figures 1 to 8 modified as shown in Figures 9 and 10 of the accompanying drawings.

J N B BREAKWELL
Chartered Patent Agent

Printed for Her Majesty's Stationery Office by MULTIPLEX techniques ltd., St. Mary Cray, Kent. 1979. Published at the Patent Office, 25 Southampton Buildings, London WC2 1AY, from which copies may be obtained.

1561528 COMPLETE SPECIFICATION
4 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 1

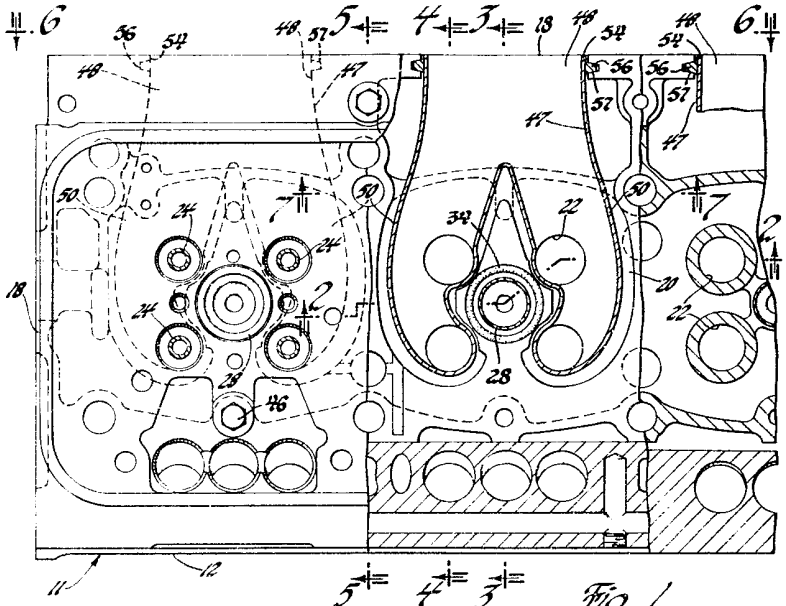

Fig. 1

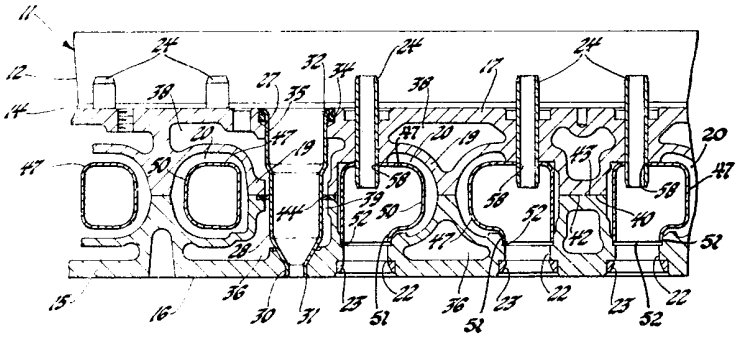

Fig. 2

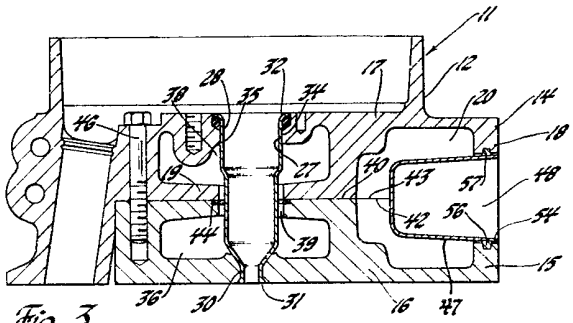

Fig. 3

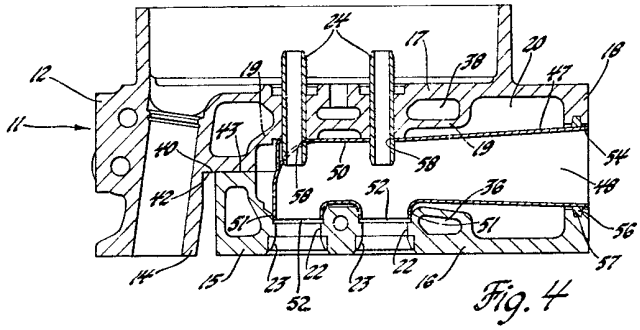

Fig. 4

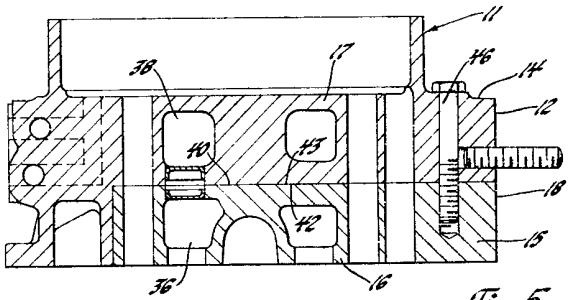

Fig. 5

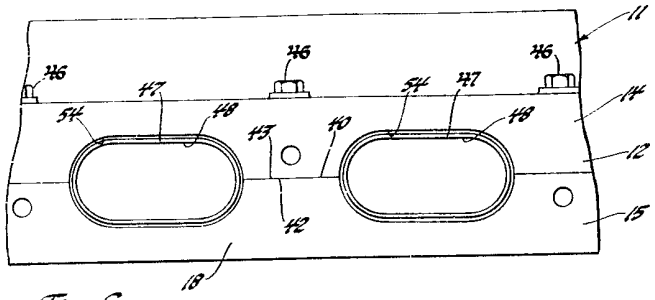

Fig. 6

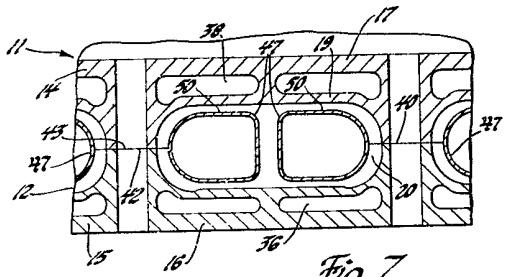

Fig. 7

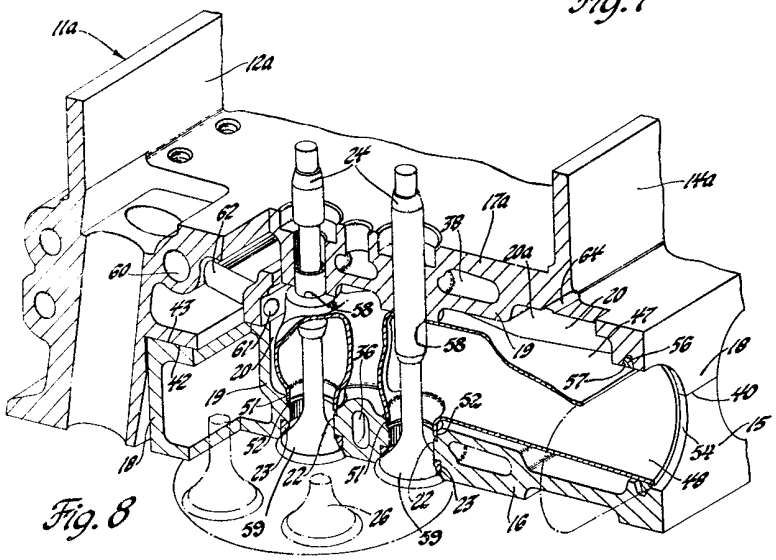

Fig. 8

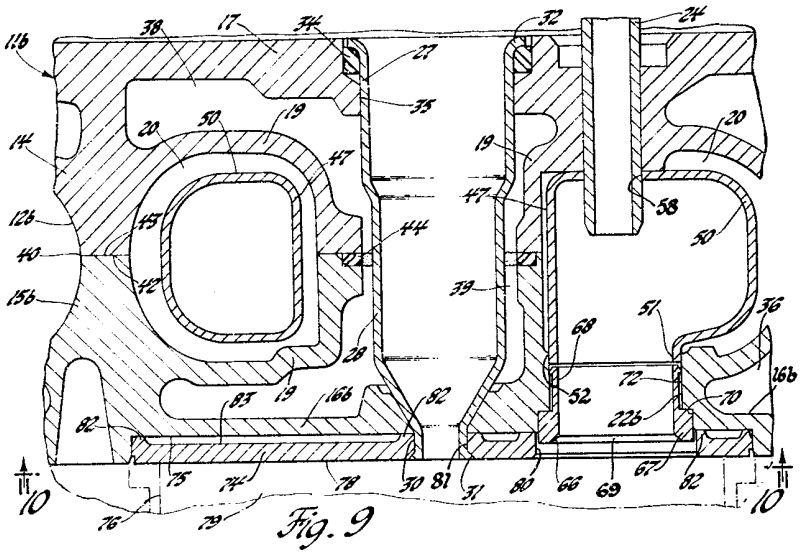
116
38
17
34
32
24
27
35
20
50
19
47
14
126
45
44
40
42
156
39
58
50
51
36
68
72
166
52
70
226
83
19
166
82
82
75
74
78
30
81
31
80
66
69
67
82
10
10
76
79

Fig. 9

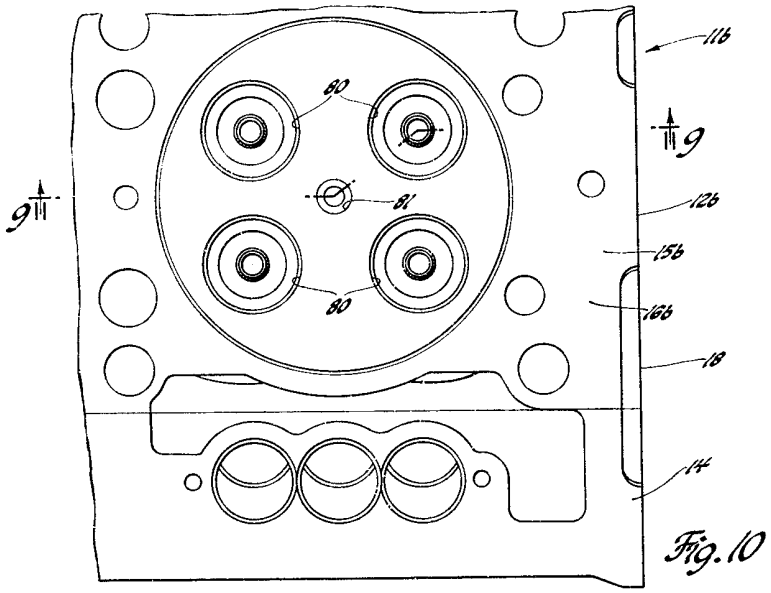
116
9
9
80
81
126
156
166
18
14
80

Fig. 10