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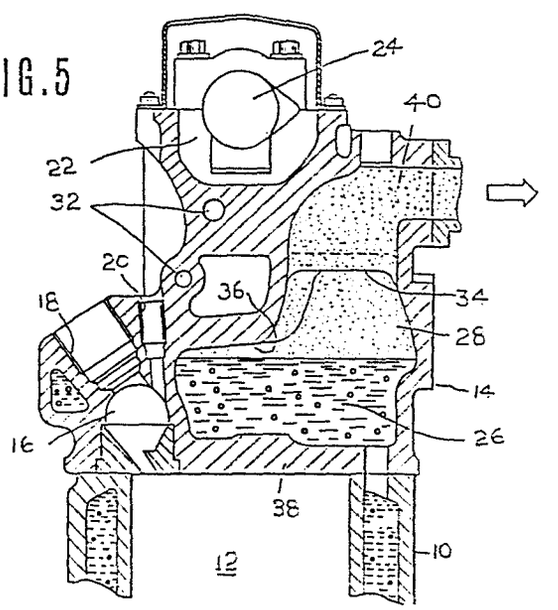
(54) Coolant jacket arrangement for vapor cooled internal combustion engine.

(57) In order to permit smooth egress of coolant vapor generated by the boiling of a liquid coolant in a coolant jacket of a "vapor cooled" internal combustion engine or the like, a gutter like structure is provided in the ceiling of the coolant jacket and arranged to extend continuously above both the structures of the engine subject to the highest heat flux (e.g. the combustion chambers, exhaust valves and ports) and the surface of the liquid coolant in which the structure is immersed. This allows the vapor to rise and subsequently flow without impedence to a vent port or ports and obviate the creation of any pressure differentials within the coolant jacket which adversely effect uniform cooling of the engine.

FIG.5



EP 0 134 579 A1

COOLANT JACKET ARRANGEMENT FOR VAPOR COOLED INTERNAL COMBUSTION ENGINE

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates generally to internal combustion engine and more specifically to a coolant jacket for an internal engine of the so called "vapor cooled" type, wherein the coolant is boiled and the vapour used as a vehicle for removing heat from the engine.

Description of the Prior Art

In currently used "water cooled" internal combustion engines, the engine coolant (liquid) is forcefully circulated by a water pump through a circuit including the engine coolant jacket and a radiator (usually fan cooled). However, in this type of system a drawback is encountered in that a large volume of water is required to be circulated between the radiator and the coolant jacket in order to remove the required amount of heat. Further, due to the large mass of water inherently required, the warm-up characteristics of the engine are undesirably sluggish. For example, if the temperature difference between the inlet and discharge ports of the coolant jacket is 4 degrees, the amount of heat which 1Kg of water may effectively remove from the engine under such conditions is 4 Kcal. Accordingly, in the case of an engine having 1800cc displacement (by way of example) is operated at full throttle, the cooling system is required to remove approximately 4000 Kcal/h. In order to acheive this a flow rate of 167 l/min (viz., 4000 - 60 x $\frac{1}{4}$) must be produced by

the water pump. This of course undesirably consumes a number of horsepower.

In order to overcome this problem it has been proposed to "boil" the coolant and use the vapor as a heat transfer medium thus taking advantage of the latent heat of evaporation of the liquid.

Examples of such arrangements are found in USP 1,376,086 issued on April 25, 1921 in the name of Fairman, European Patent Application No. 0 059 423 published on September 8, 1982 and Japanese Patent Application First Provisional Publication No. Sho 57-57608 (shown in Fig. 1).

However, with these arrangements little thought has been given to the design of the coolant jacket structure per se.

For example, with liquid cooled engines as the coolant jacket is inevitably filled completely with liquid coolant which is forced to flow through the passages. Viz., as shown in Figs. 3 and 4 (transverse sections of the diesel engine cylinder head shown in Fig. 2) the coolant jacket structure is arranged so that the passages or corridor-like arrangements 1 extend over the portions 2 of the engine subject to high heat flux so to enable the coolant to flow freely therethrough and enhance heat removal. As shown, with this arrangement, the ceiling 3 of the corridor arrangement is arranged to be essentially flat so should any vapor bubbles form, they are readily flushed out by the liquid forced to flow through the cylinder head by the water pump. That is to say, due to the forced flow the removal of any gas bubbles does not represent any particular design problem. However, in the above mentioned vapor cooled engines it is

preferred to allow the liquid coolant to stagnate in the coolant jacket and permit same to boil in this state. This accordingly, requires a vapor space to be provided above the surface of the liquid coolant and therefore the height of the ceiling to be increased so as to permit both the vapor space and an adequate depth of coolant over the combustion chambers. Further, due to the lack of any mechanical device for inducing the vapor to flow from the point of generation toward a vent or discharge port, the vapor flow tends to be sluggish and pockets of vapor tend to form within the conventional cylinder head structures. This sometimes leads to non-uniform cooling the engine and to the formation of pockets of pressurized vapor which influences the boiling point of the coolant in the vicinity thereof and reduce the amount of control which may be exercised over the cooling process.

The design of a coolant jacket structure is rendered difficult because of the need to simultaneously provide each combustion chamber with valves, ports and for bosses and like arrangement for mounting the valve operating gear and a relatively high ceiling above the surface of the boiling liquid. In particular, it is very difficult to form a structure having a suitably high ceiling between adjacent combustion chambers due to the fact the various structural members which project into the cylinder head act as partitions which hinder vapor flow at these sites.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a coolant jacket structure for use with vapor

cooled engines which promotes smooth vapor flow therein and thus facilitates exhausting of same in a manner which obviates the tendancy for pockets of stagnant vapor to form therein.

In brief, this object is fullfilled by an arrangment wherein in order to promote smooth egress of coolant vapour generated by the boiling of a liquid coolant in a coolant jacket of a "vapor cooled" internal combustion engine or the like, a gutter like structure is provided in the ceiling of the coolant jacket and arranged to extend continuously above both the structures of the engine subject to high heat flux (e.g. the combustion chambers, exhaust valves and ports) and the surface of the liquid coolant in which the heated structure is immersed. This allows the vapor to rise and subsequently flow without impedence to a vent port or ports and obviate the creation of any pressure differentials within the coolant jacket which adversely effect uniform cooling of the engine.

More specifically, the present invention takes the form of an internal combustion engine which is characterized by a plurality of combustion chambers, a coolant jacket arranged about the combustion chambers and into which coolant is introduced in liquid form in sufficient quantity to maintain the combustion chambers immersed in liquid coolant while provide a vapor space thereabove, the coolant being permitted to boil and generate vapor which is collected in the vapor space, and a structure defining a vapor transfer gutter in the ceiling of the coolant jacket which is essentially free of vertical undulations and which extends continuously over the combustion chambers in a spaced relationship thereto.

BRIEF DESCRIPTION OF THE DRAWINGS

The features and advantages of the arrangement of the present invention will become more clearly appreciated from the following description taken in conjunction with the accompanying drawings in which:

Fig. 1 is a sectional side elevation of a prior art cooling system discussed in the opening paragraphs of the instant disclosure;

Fig. 2 is a perspective view of a prior art diesel engine cylinder block through which water or like coolant is forcefully circulated;

Fig. 3 is a transverse section of the cylinder head shown in Fig. 2;

Fig. 4 is a second transverse section of the cylinder head shown in Fig. 2;

Figs. 5 to 8 show a first embodiment of the present invention;

Fig. 9 is a side elevation showing a cylinder block equipped with a second embodiment of the present invention;

Fig. 10 is a sectional view taken along section line X - X of Fig. 9;

Fig. 11 is a sectional view taken along section line XI - XI of Fig. 9; and

Fig. 12 is a sectional taken along section line XII - XII of Fig. 10.

PREFERRED EMBODIMENTS OF THE PRESENT INVENTION

Figs. 5 to 8 of the drawings show a first embodiment of the present invention. In this instance the invention is embodied in a diesel engine comprised of a cylinder block 10 in which a plurality of cylinder bores 12 are formed (only one shown) and a cylinder head 14.

The cylinder head is formed with a plurality (note only one is shown) swirl chambers 16, fuel injector and glow plug bores 18, 20 and a plurality of bearing supports 22 on which a cam shaft 24 is journalled. The cylinder head 14 is also formed with a main coolant receiving cavity 26 which extends essentially along the whole length of the cylinder head 14. As will be appreciated from Figs. 7 and 8, the inlet and exhaust ports 28, 30 of the engine are formed to open on the same side of the cylinder head 14 and extend through the main cavity 26. Oil transfer bores 32 are formed through the cylinder head so as to convey oil under pressure from an oil pump associated with the cylinder block 10 to the cam shaft bearings, valve stems and like moving elements associated with the cylinder head 14.

In order to facilitate collection and removal of the vapor generated by the boiling of the coolant, the present invention features a gutter structure 34 which is formed in the ceiling 36 of the main cavity 26. In Fig. 5 the gutter 34 is formed so as to have an essentially flat surface.

As shown in Fig. 6 the width of the gutter 34 reduces markedly. However, as the vapor generation at this site (between combustion chambers) tends to be less than directly over the top of a cylinder (e.g. Fig. 5) an abnormally high pressure does not tend to form despite the relative narrowness of the structure at this point. At the locations above the inlet and outlet ports (see Figs. 7 and 8) the gutter section 34 is widened.

It should be noted that the height of gutter 34 is essentially constant throughout the cylinder head

14 and thus free from pockets, or the like, into which hot vapor can rise and get trapped. In this particularly embodiment the gutter 34 is arranged essentially parallel with the lower deck 38 of the cylinder head 14. However, this relationship can be varied with the type of engine to which the invention is applied. Viz., it should be kept in mind that the most essential feature is that the gutter be free from vertical vertical undulations. The gutter is advantageously but not necessarily arranged parallel with the level assumed by the coolant when the vehicle or like in which the engine equipped with the present invention is running on a level surface (or alternatively the most common orientation.

As shown in Figs. 5 and 7, the gutter section 34 merges with a vapor outlet ports 40, 42 through which the heated vapor is vented to a suitable condenser or radiator.

As will be appreciated, as the pressure prevailing at the outlet ports 40, 42 tends to be lower than that prevailing at the sites of most vigorous boiling, the vapor collected in the gutter shown in Fig. 5 tends to flow smoothly therealong and vent through port 40. The vapor collected in the gutter section 34 shown in Fig. 6 may flow either way along the gutter toward one or both of the vent ports.

Fig. 9 shows a second embodiment of the present invention. This arrangement differs from the first in that a vent port 44 is provided per cylinder. In this embodiment the vent ports 44 are each arranged to communicate with the gutter 34 at locations essentially above and intermediate of the inlet and exhaust ports 28, 30. With this arrangement the

formation of high pressure vapor pockets within the cylinder head structure is surely prevent.

With the above disclosed embodiments, the casting or moulding of the cylinder head embodying the present invention may be carried out with essentially the same ease as conventional head and without any special and/or additional machining processes. Viz., as the vapor collection manifold mounting flanges 48 are located on the same side as the flanging 50 on which the inlet and exhaust manifolds are mounted and coplaner therewith, the milling of these surfaces after casting can be carried out with approximately the same ease as with conventional heads.

It will also be appreciated that, although not shown, that with the illustrated embodiments, a suitable coolant level sensor/level control arrangement will be used in order to maintain the illustrated depth of liquid coolant over the cylinder heads during operation thereof.

WHAT IS CLAIMED IS:

1. In an internal combustion engine

a plurality of combustion chambers;

a coolant jacket arranged about said combustion chambers and into which coolant is introduced in liquid form in sufficient quantity to maintain said combustion chambers immersed in liquid coolant while provide a vapor space thereabove, said coolant being permitted to boil and generate vapor which is collected in said vapor space; and

a structure defining a vapor transfer gutter in the ceiling of said coolant jacket which gutter is essentially free of vertical undulations and which extends continuously over said combustion chambers in a spaced relationship thereto.

2. An internal combustion engine as claimed in claim 1, further comprising a vapor discharge port which opens into said ceiling for venting vapor collected in said gutter to a condenser.

3. An internal combustion engine as claimed in claim 1, further comprising a plurality of vapor discharge ports, each of said ports being arranged to open into said ceiling in proximity to a combustion chamber and in a manner to vent vapor collected in said gutter.

4. An internal combustion engine as claimed in claim 1, wherein said coolant jacket is formed in the cylinder head of a multicylinder inline engine wherein each of said combustion chambers is provided with a valve which extends through said cylinder head and which controls fluid communication between each of

said combustion chambers and and associated conduit formed in said cylinder head.

5. An internal combustion engine as claimed in claim 4, wherein said gutter extends over the top of said conduit.

FIG.1

PRIOR ART

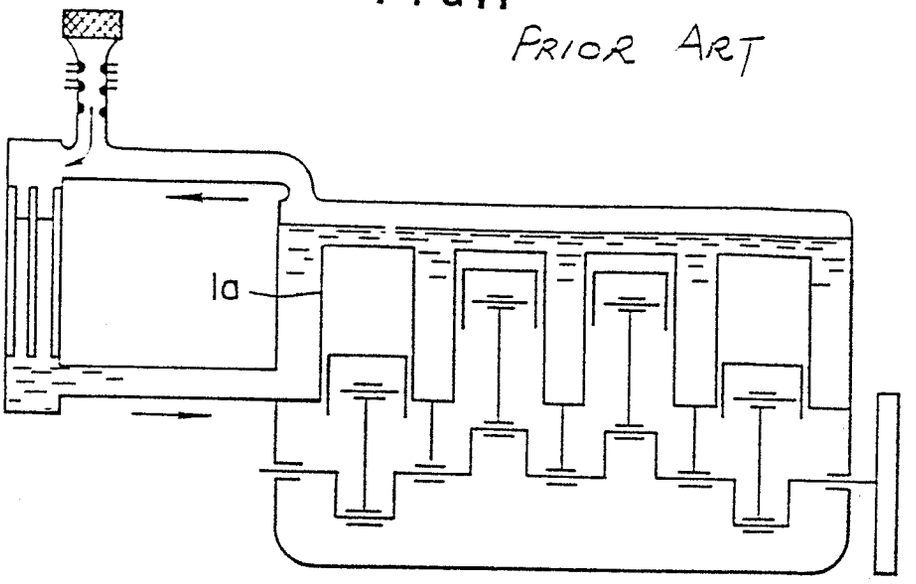


FIG.2

PRIOR ART

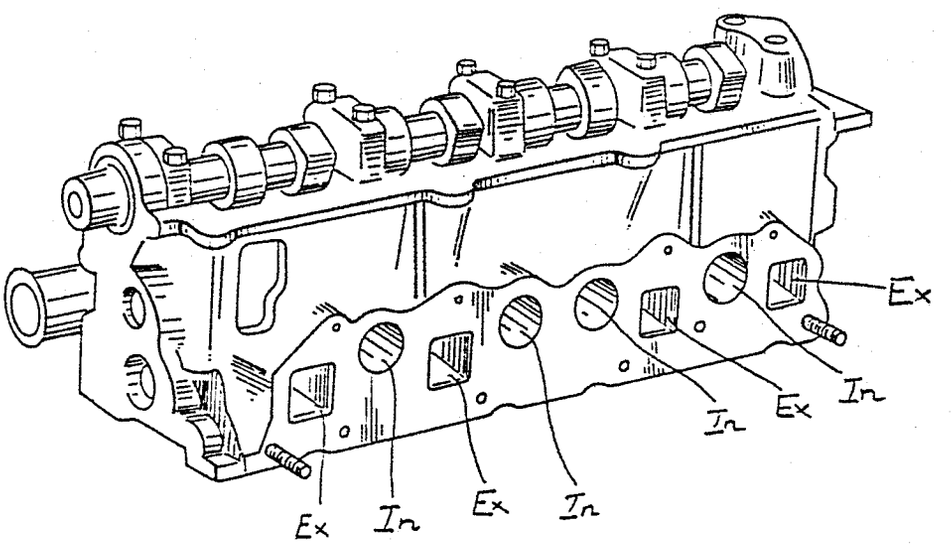


FIG.3

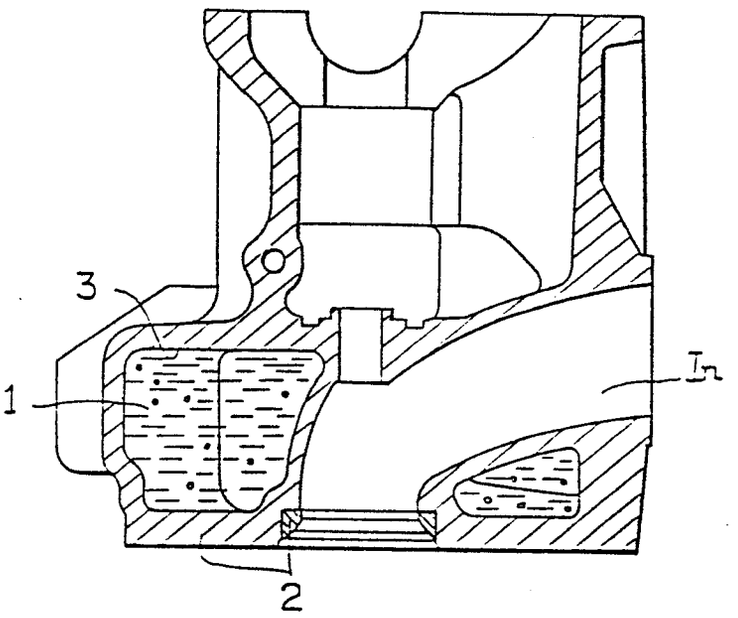


FIG.4

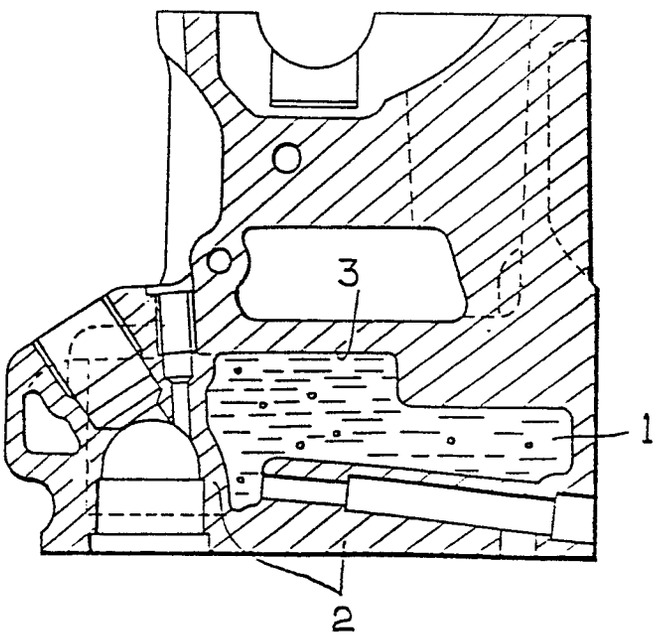


FIG.5

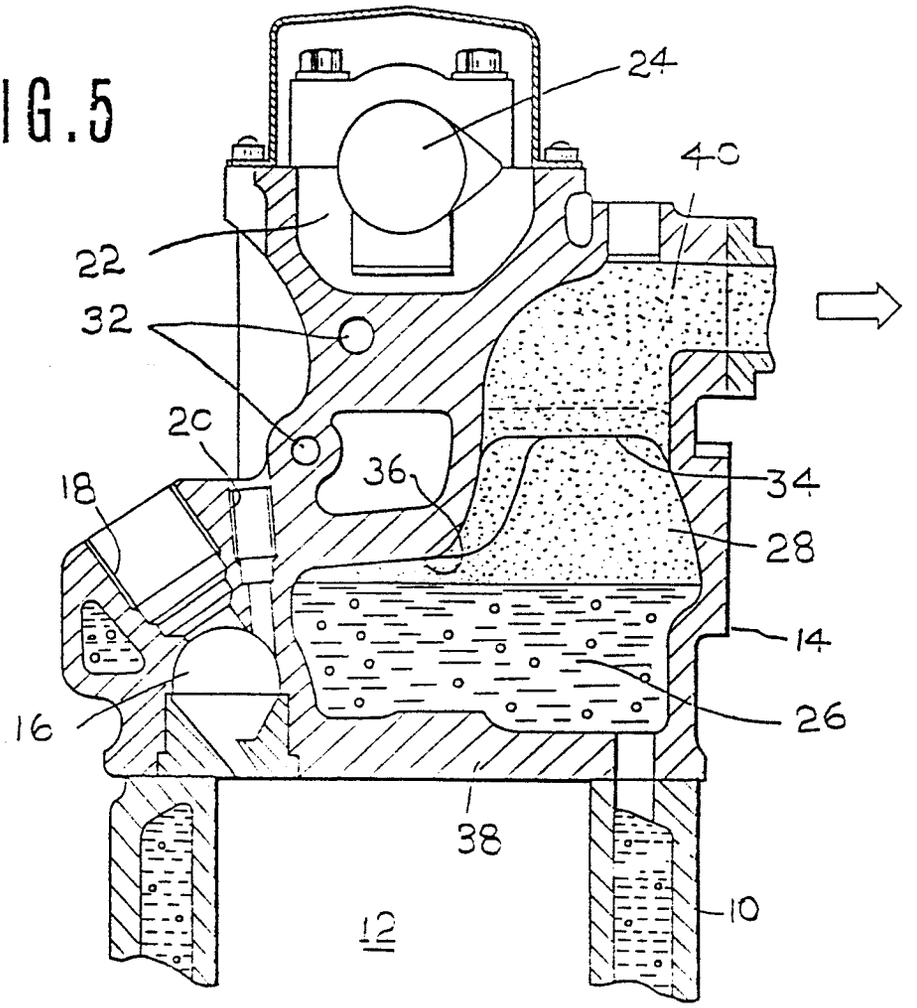


FIG.6

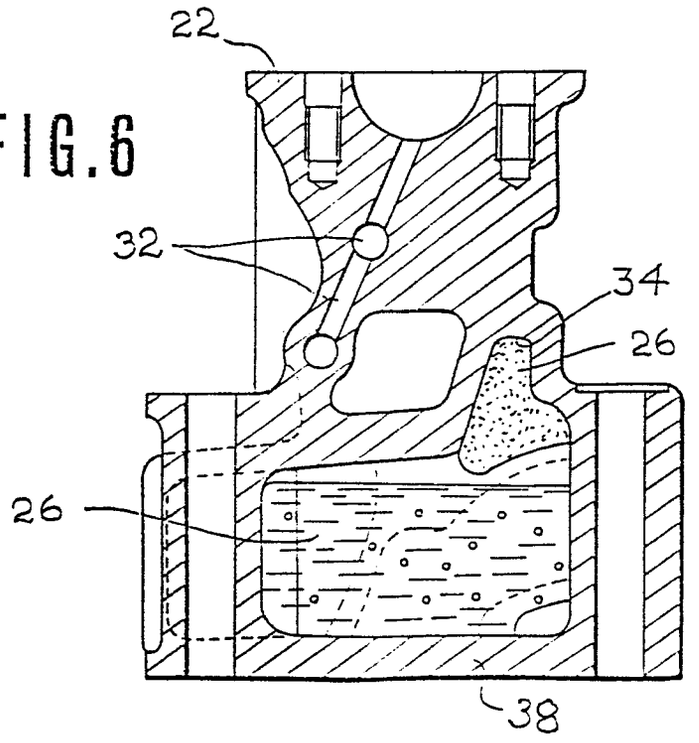


FIG.7

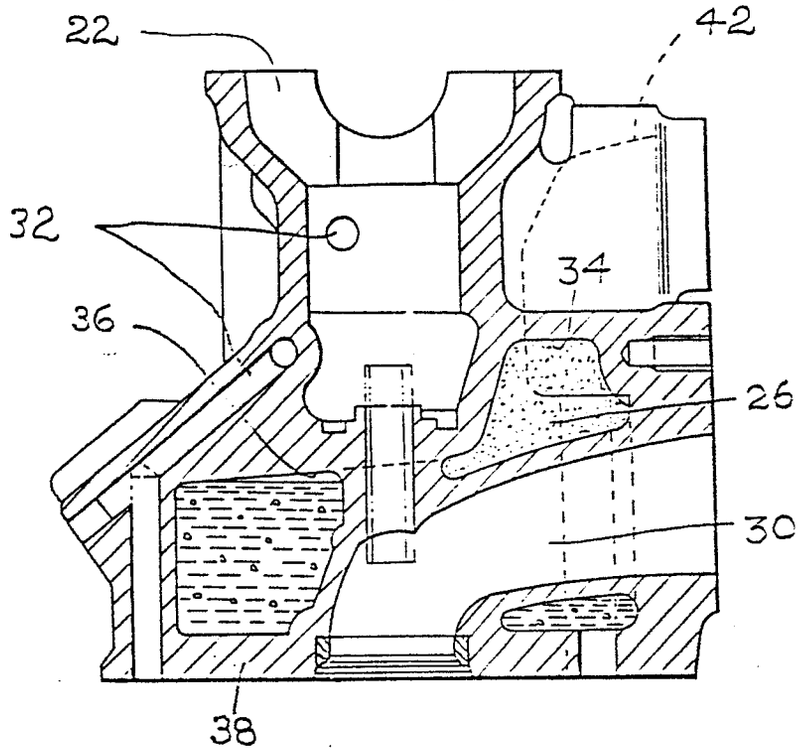


FIG.8

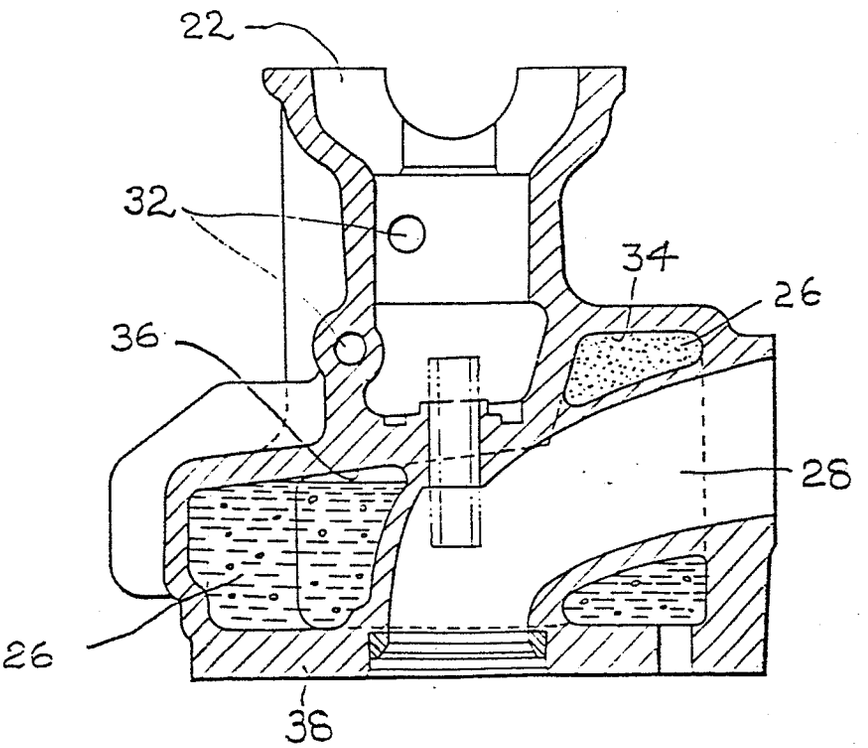


FIG.9

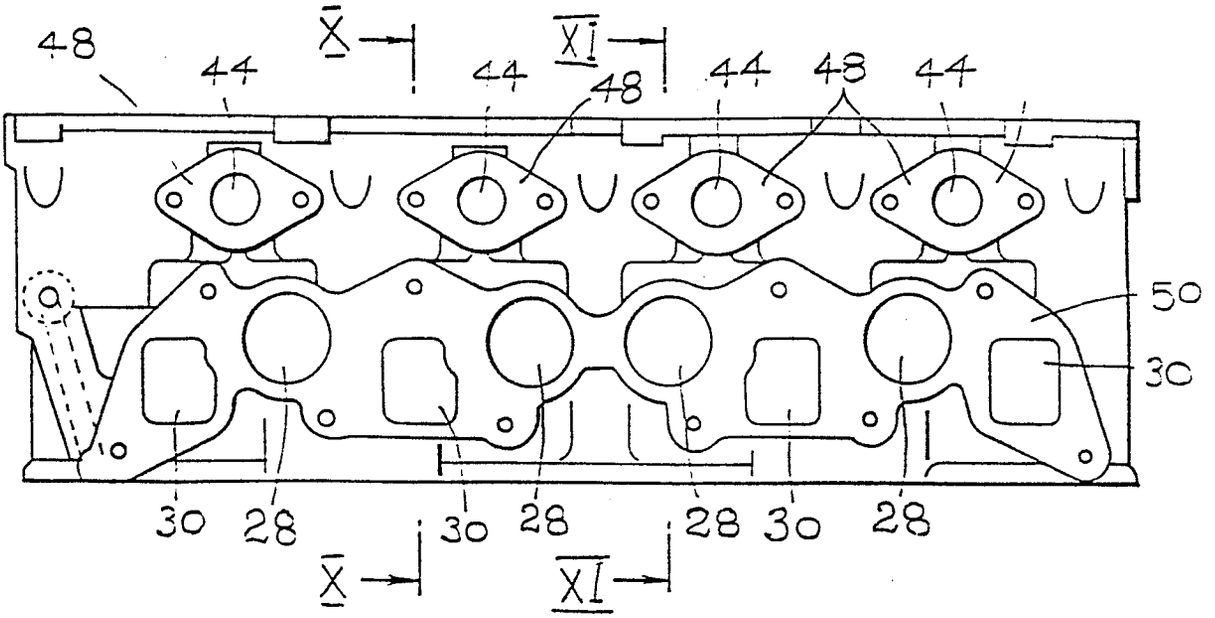

48
X
XI
44
44
48
44
48
44
50
30
30
28
30
28
28
30
28
X
XI

FIG.10

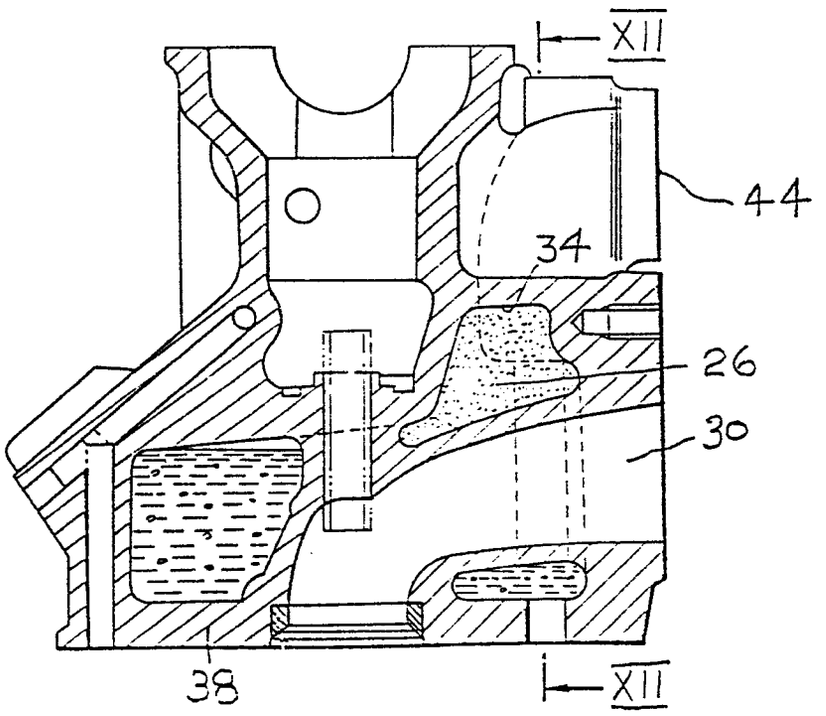

XII
44
34
26
30
38
XII

FIG. 11

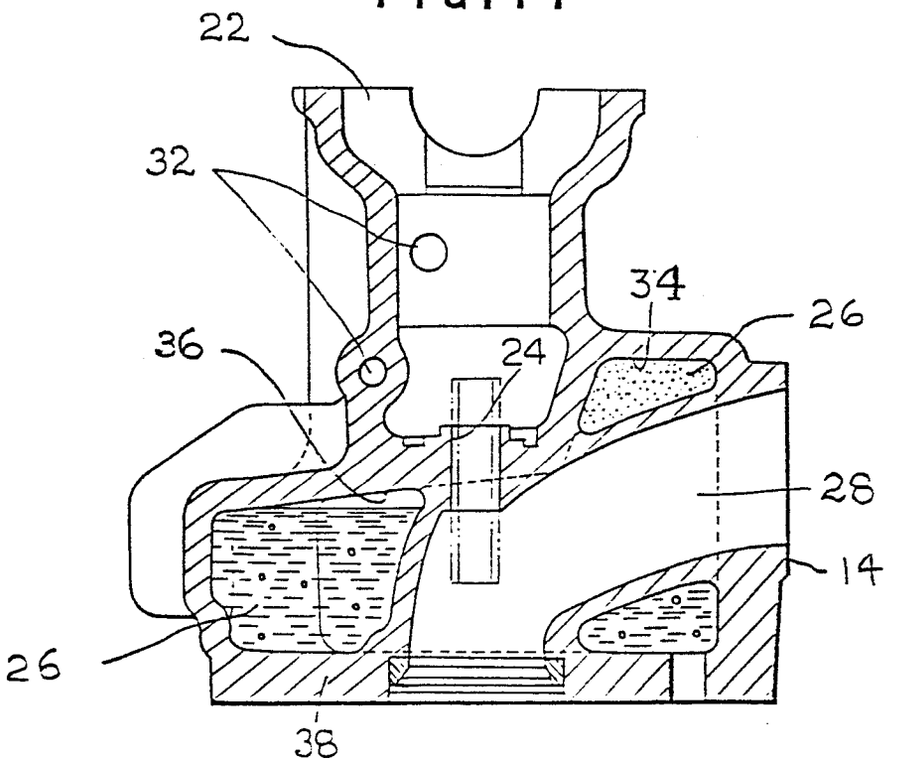
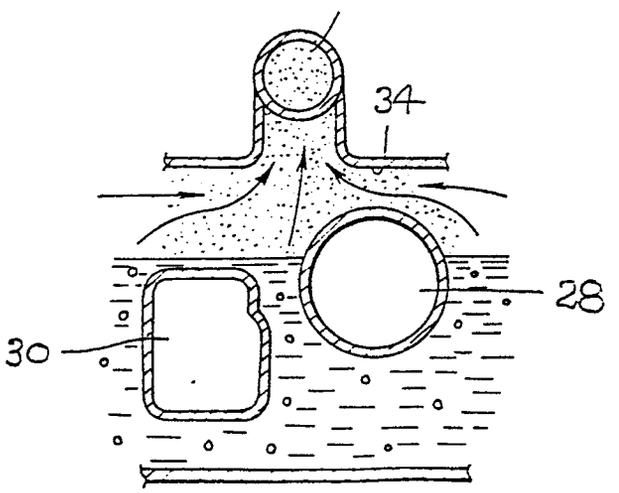


FIG. 12



European Patent Office

EUROPEAN SEARCH REPORT

0134579 Application number

EP 84 11 0578

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int Cl 4)
X	DE-C- 412 531 (MALLORY) * Page 1, lines 31-38; figures 1,2 *	1,2	F 01 P 3/22 F 02 F 1/40
Y		3-5	
Y	US-A-1 330 436 (FEKETE) * Page 1, lines 25-65; page 1, line 86 - page 2, line 21; figures 1-3 *		
A	US-A-1 632 586 (BARLOW)		
A,D	EP-A-0 059 423 (NISSAN)		TECHNICAL FIELDS SEARCHED (Int Cl 4) F 01 P F 02 F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	08-11-1984	KOOIJMAN F.G.M.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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