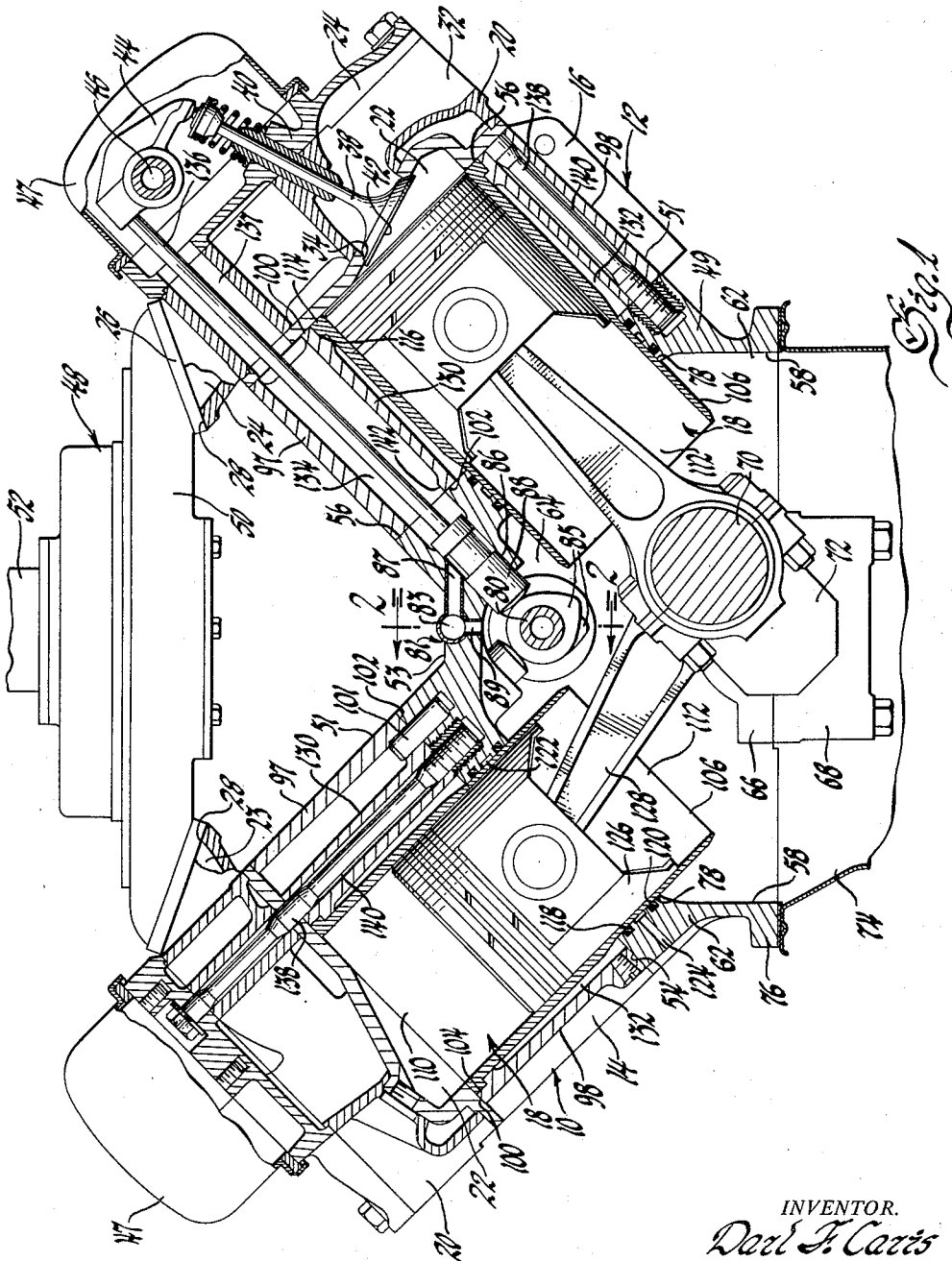


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ENGINE

3 Sheets-Sheet 1



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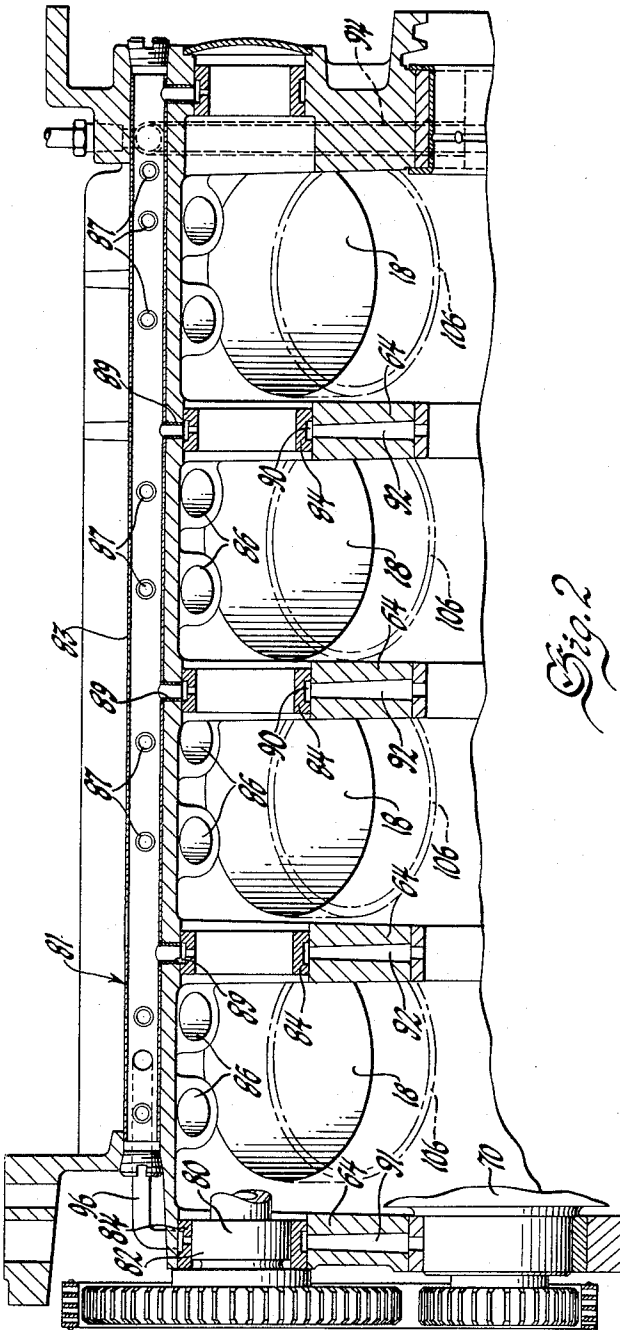


Fig. 2

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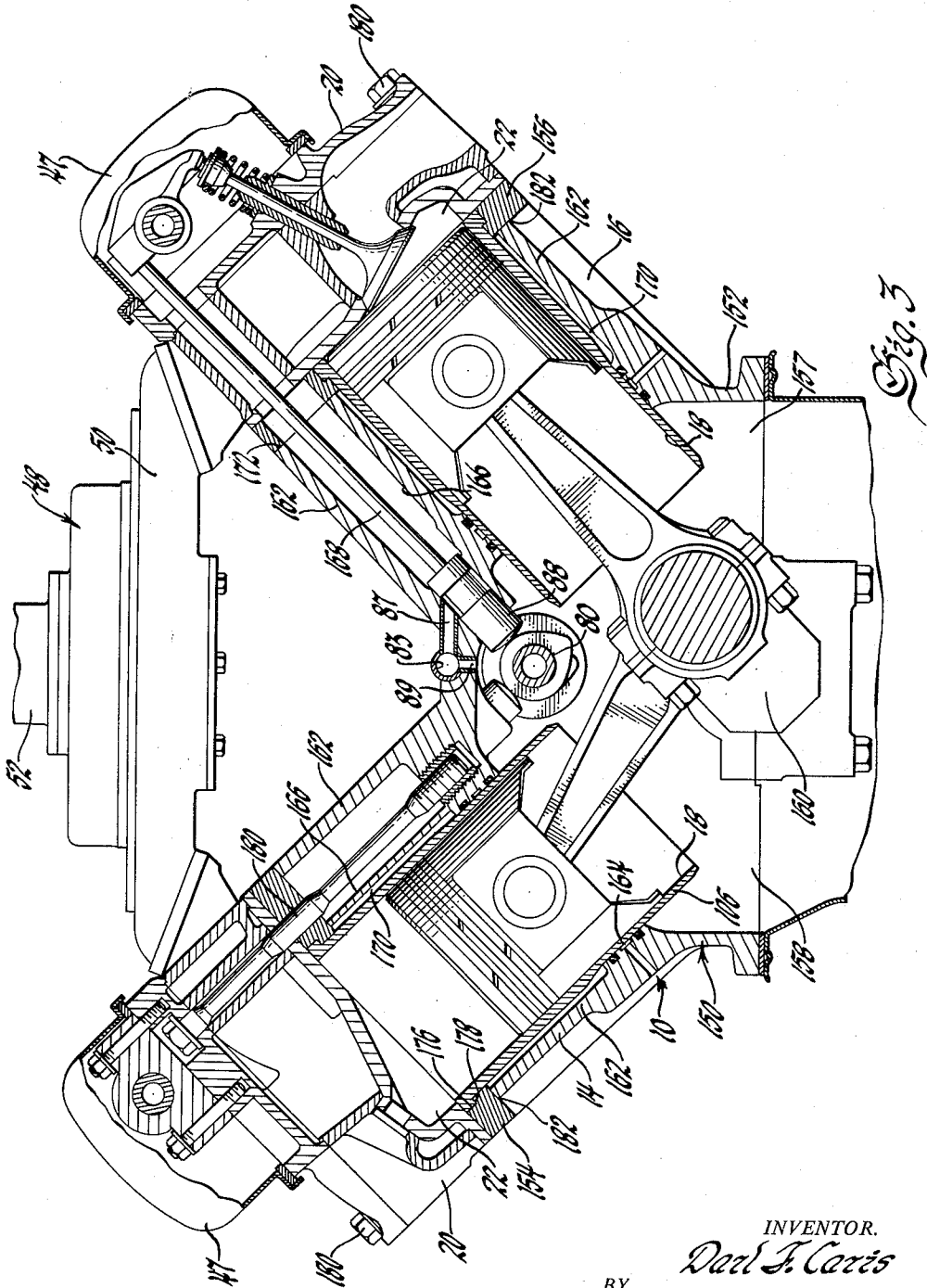
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7 Claims. (Cl. 123-41.72)

The present invention relates to internal combustion engines and more particularly to a novel cylinder block structure therefor which is particularly adapted to be die cast out of a lightweight material such as an alloy of magnesium or aluminum.

At the present time the most common method of producing internal combustion engines is to employ sand casting for the various members thereof, particularly the cylinder blocks. Such castings are made by pouring cast iron into a mold having sand cores arranged to form the numerous passages required for the cooling jacket, cylinders, oil galleries, etc. These sand cores can only be used once and are complicated and expensive to assemble. Since these sand cores must be destructible to facilitate their removal from the finished casting, they frequently become damaged prior to or during the casting operation, thereby resulting in defective castings. To compensate for the frailties of the sand cores and the inaccuracies of such casting methods, many of the wall sections and passages in the finished cylinder block must be larger than is necessary for proper operation of the engine. This results in unnecessarily heavy and expensive engines. In an effort to overcome these objections numerous attempts have been made to employ more accurate and/or economical casting methods. For example, a considerable amount of work has been done toward die casting the cylinder block. However, to be a desirable process, the die casting must have permanent cores. Prior attempts at die casting cylinder blocks have either employed complex, collapsible cores or have die cast several separate parts and secured them into a single integral structure by soldering, brazing or welding. However, such attempts have not been satisfactory for numerous reasons. Thus, in spite of all the objections to sand casting of cylinder blocks, heretofore no methods have been devised which are better suited to mass producing internal combustion engines such as employed in automotive vehicles.

It is now proposed to provide a new means for mass producing a novel cylinder block structure for internal combustion engines. The cylinder block structure is fabricated from a plurality of separate members having the various cavities and passages therein arranged to permit a permanent core to be used. More particularly, the cored internal passage is free from any reverse taper therein to allow the cores to be pulled in a straight line therefrom. As a result of being able to employ permanent cores, the members may be die cast out of a lightweight material such as aluminum or magnesium to greatly reduce the weight of the finished structure and also permit easier machining thereof. In order to permanently secure the various members together, an adhesive bonding material is employed that will set up at comparatively low temperatures. For example, a thermal setting plastic such as an epoxy resin may be employed. This will permit the members to be secured together without the necessity of subjecting them to elevated temperatures that might adversely affect the characteristics of the material in the members or cause thermal distortions in the final structure.

In the event there are some intricate passages such as in portions of the lubricating system, these passages are formed by a tubular harness that is placed in the mold prior to the casting operation. As a result simple, perma-

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nent molds and cores may be used in a die casting process for producing the cylinder block structure.

In the drawings:

FIGURE 1 is a transverse cross-sectional view of an internal combustion engine embodying the present invention.

FIGURE 2 is a longitudinal cross-sectional view of the crankcase member employed in the engine of FIGURE 1.

FIGURE 3 is a transverse cross-sectional view of an engine similar to that in FIGURE 1, but showing a modified form of the present invention.

Referring to the drawings in more detail, although this invention may be embodied in any type of engine, in the present instance it is particularly adapted for use in an internal combustion engine 10 of the so-called V-type wherein the cylinder block structure 12 includes a pair of angularly disposed banks 14 and 16 of aligned cylinders 18. A cylinder head 20 is secured to each bank of cylinders to close the outer ends thereof and form combustion chambers 22. Although these cylinder heads 20 may be fabricated in any suitable manner, in the present instance they comprise a single casting having intake and exhaust passages 23 and 24 extending transversely there-through. The outer ends of the intake passage 23 form intake ports 26 on the sides 28 of the cylinder heads 20 while the inner ends open into the combustion chamber to form intake valve seats. The outer ends of the exhaust passages 24 form exhaust ports 32 for discharging the exhaust gases into the exhaust manifolds while the inner ends form exhaust valve seats 34 communicating with the combustion chambers 22. Intake and exhaust valves 38 are reciprocally disposed in the valve guides 40 so that the heads 42 thereof will open and close the valve seats and thereby regulate the charging and exhausting of the combustion chambers 22. The movements of these valves 38 are controlled by rocker arms 44 mounted on a rocker arm shaft 46 and enclosed by rocker arm covers 47 secured onto the cylinder heads 20.

In order to supply the combustible charge of air and fuel to the combustion chambers 22, an induction system 48 is provided in the space between the two banks of cylinders. This system 48 comprises an intake manifold 50 having a carburetor 52 mounted thereon. The opposite sides of the manifold 50 form angularly disposed plane faces that fit against the plane sides of the cylinder heads 20. A plurality of distribution passages are provided in the manifold 50 for interconnecting the carburetor 52 with the intake ports 26 for thereby supplying a combustible charge of air and fuel to the various combustion chambers 22.

The cylinder block structure 12 comprises a crankcase member 49 and at least one cylinder bank member 51 adhesively bonded thereto to form a single integral structure 12. The crankcase member 49 includes a center web section 53, a pair of inclined faces 54 and 56 and downwardly extending side walls 58 arranged to form a downwardly opening chamber or crankcase 62. A plurality of bulkheads 64 extend transversely across said crankcase 62 to form end walls for the crankcase 62 and also divide it into separate compartments. Main bearing inserts 66 and bearing caps 68 are secured onto the bottom of these bulkheads 64 to rotatably support a crankshaft 70 with the throws 72 thereof being disposed in the compartments on the opposite sides of the bulkheads 64. An oil pan 74 is secured to a flange 76 on the side walls 58 to enclose the crankcase 62 and to form a sump for the lubricant.

The faces 54 and 56 have a plane surface thereon disposed at approximately 45 degrees to the horizontal or at right angles to each other. Each of these faces 54 and 56 has a row of enlarged cylindrical passages 78 extending therethrough and opening into the crankcase 62.

A separate passage 78 is provided in each face 54 and 56 for each compartment and the axes thereof are substantially normal to the crankshaft axis.

The camshaft gallery is formed in the apex of the crankcase 62 so that the camshaft 80 will be above and parallel to the crankshaft 70. This camshaft 80 includes cylindrical journals that ride in bearing inserts 84 on the bulkheads 64 and a separate intake and exhaust cam 85 for each cylinder. The camshaft 80 is rotatably driven from the crankshaft 70 by any suitable means such as a timing gear or timing chain. A plurality of smaller passages 86 extend through the faces 54 and 56 with the axes thereof substantially normal to the axis of the camshaft 80. These passages 86 form tappet guides adapted to reciprocally receive tappets 88 that ride on the various cams 85. In the present instance these tappets 88 are of the so-called hydraulic slack adjuster type wherein hydraulic pressure is employed to eliminate any lost motion in the valve train.

The lubricating system is formed by a tubular harness 81 which is preassembled and inserted into the mold prior to the casting operation so that the material in the crankcase member will be cast around the tubular harness, thereby making it an integral part of the cylinder block structure 12. The tubular harness 81 comprises a substantially straight tube 83 and a plurality of branch tubes 87 and 89. The straight tube 83 forms a main oil gallery disposed in the web portion of the crankcase member and extending longitudinally of the engine. The branch tubes 87 and 89 project laterally from the main tube 83 so as to supply lubricant to the various working portions of the engine. The horizontal branches 87 terminate in the tappet guides 86 so as to supply lubricant under pressure to the slack adjusters 88. The vertical branches 89 communicate directly with an annular groove 90 extending around the exterior of the camshaft bearing inserts 84. These inserts 84 are perforated so that a lubricant may flow onto the bearing surface and lubricate the camshaft journals. In addition, a vertical passage 92 extends downwardly through the bulkhead 64 to interconnect the annular groove 90 with one or more perforations in the main bearing inserts 66 for supplying metered quantities of lubricant to the various journals on the crankshaft 70. In addition, the tubular harness 81 includes an inlet tube 94 which extends downwardly through one of the bulkheads into the crankcase 62 so as to be interconnected with a source of lubricant under pressure such as the lubricating pump. The front end of the tubular harness 81 includes an additional branch passage 96 which extends forwardly through the web and into the forward bulkhead for not only supplying lubricant to the front slack adjuster but also the front camshaft and main crankshaft bearings. It will be noted that by employing this tubular lubricating harness 81 the entire lubricating system is contained within the cylinder block structure. However, in spite of all of the intricate passages in the system, they are formed by the tubular harness and not by any complicated permanent cores or machining operations that might otherwise detract from the advantages of the die casting operation.

Each of the cylinder bank members 51 comprises a pair of lateral side walls 97 and 98, a pair of end walls, a top face 100 and a bottom face 102 arranged to form a box-like structure. The top face 100 is adapted to have the cylinder head 20 disposed thereon while the bottom face 102 is complementary to the face 54 or 56 on the crankcase member 49. Each of the cylinder bank members 51 is permanently secured to the face 54 or 56 on the crankcase member 49. A plurality of positioning dowels 101 may be employed to insure exact alignment of the various members. Although it has been customary in fabricating an engine structure to braze, weld, etc. the various members together, in the present instance the members are adhesively bonded together by any suitable thermal setting plastic such as an epoxy or buna-phenolic

resin. The temperatures at which such resins set up and/or cure is not critical and, moreover, they are comparatively low. As a result the members forming the block structure may be adhesively bonded together to form an integral structure without adversely affecting the characteristics of the materials therein or causing thermal distortions thereof. In addition, it is not necessary to employ expensive baking ovens, etc. having precisely controlled temperatures, the failure of which will result in a defective block structure. It has been found that these resins have sufficient strength to retain the members permanently bonded together and will also insure an impervious joint between the members that is free of any leaks. Thus the lubricating system, cooling system, etc. will be separated from each other without the necessity of relying on any fragile gaskets.

The top face 100 of the cylinder bank member 51 includes separate openings 104 that register with each of the passages 78 in the faces 54 and 56 on the crankcase members 49. The cylinders are formed by cylinder liners 106 provided in the apertures 104 and passages 78 so that the outer ends 110 thereof register with the combustion chambers 22 and the inner ends 112 open into the crankcase. These cylinder liners 106 are substantially the same as those disclosed and claimed in copending application Serial No. 667,654, filed June 24, 1957 in the name of Darl F. Caris. The liners 106 may be of a material similar to that of the crankcase and bank members. The upper end 110 of the liner 106 includes a radially outwardly projecting flange 114 that rests on a seat 116 extending around the inside of the aperture 104. The seat 116 is recessed sufficiently to permit the end 110 of the liner 106 to be flush with the face 100. The lower ends 112 of the liners 106 extend through the passages 78 and into the crankcase 62 and are floatingly retained in position by resilient seals or O rings 118, 120. These O rings 118, 120 are seated in grooves machined into the surfaces of the passages 78 and are separated by annular chambers 122 therebetween vented to the atmosphere by passages 124 extending through the side walls 58 of the crankcase member 49. Thus if either seal 118 or 120 fails the lubricant from the crankcase 62 and/or the coolant from the cooling jacket will collect in the chamber 122 and will flow through the passage 124 and become apparent on the exterior of the block structure 12. Pistons 126 are reciprocally disposed in the liners 106 and drivingly connected to the throws 72 of the crankshaft 70 by suitable connecting rods 128.

A partition 130 extends longitudinally of the interior of the cylinder bank member 51 to divide it into two separate portions. The partition 130 and the side wall 98 are disposed immediately adjacent the exterior of the liner 106 to form a cooling jacket 132 containing a liquid coolant in intimate heat exchanging relation with the liner 106. By die casting the cylinder bank members and employing removable cylindrical liners, the location of the partition relative to the exterior of the liner will be sufficiently accurate to permit a minimum spacing around the exterior of the liners. This will insure proper circulation of the coolant and also reduce the amount of coolant in the system.

The other side of the partition forms enclosures 134 for the push rods 136 and passage means for returning lubricant to the crankcase 62. The lower ends of these enclosures register with the tappet guides 86. The upper ends of these enclosures register with openings 137 extending through the cylinder heads 20. Thus the push rods 136 may be disposed in the enclosures 134 with one end thereof seated in the slack adjusters 88 while the opposite ends bear on the rocker arms 44. It may thus be seen that rotation of the camshaft 80 will reciprocate the slack adjusters 88 so as to drive the push rods 136 and rocker arms 44 to thereby open and close the valves 38. The openings 137 and the enclosures 134 preferably have a sufficiently large internal diameter to permit the push rods 136 and slack adjusters 88 to pass therethrough.

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Thus if it is desirable to service the slack adjusters 88, they may be removed through the openings 137 without removing the heads.

The cylinder heads 20, the structure of which has been previously described, may be secured onto the block structure 12 by any suitable means such as bolts or studs 138. In the present instance a plurality of bolts are staggered around the cylinder heads 20 and extend downwardly therethrough into passages 140 in the cylinder bank members 51. It has been found preferable for the lower ends of bolts 138 to be threaded into the crankcase member 49. These bolts 138 will then be loaded in tension and the cylinder bank member 51 will be compressed between the crankcase member 49 and the cylinder head member 20. As a result the adhesively bonded joint between the crankcase and cylinder bank members 49 and 51 will be relieved of excessive tension loads.

It may be seen that by arranging the cylinder block structure 12 so that it is formed by separately cast crankcase and bank members 49 and 51 all of the major passages extending into and through each of the members may be designed to be free of any reverse taper on the opposite sides of a central parting surface. For example, the cooling jacket 132 is formed by surfaces free from any taper between the seat 116 and the face 100. The apertures 104 in the face 100 and the seat 116 formed thereby are of a similar nature. As a result the water jacket 132 is defined by a surface that may be molded around a two piece permanent core that separates in the plane of the seat 116 and pulls in straight lines parallel to the axis of the cylinder liners 106. The enclosures 134 for the push rods 136 are of a similar nature in that the core may part in the area of the shoulder 142 adjacent the face 102. Since these cores are pulled on straight lines parallel to the cylinder liner axis, they may be a portion of the same structure containing the cores for the water jacket 132.

The crankcase member 49 is also arranged to be cast around non-collapsible permanent cores. The crankcase 62 and transverse bulkheads 64 are defined by a core that is extracted by pulling straight down. The passages 78 and tappet guides 86 are defined by separate cores that are arranged to be pulled outwardly in straight lines normal to the faces 54 and 56. These cores are temporarily joined to the crankcase core at some point inside of the crankcase 62.

It can be seen that the foregoing block structure can readily be fabricated by die casting the various portions thereof. This method of casting will permit the use of the so-called lightweight alloys such as aluminum and magnesium. Although the present price of such alloys may be somewhat higher than the cast iron presently employed, by employing a die casting process, the surfaces on the various members may be cast sufficiently accurate to drastically reduce the amount of machining required on the cylinder block structure. This not only reduces the amount of scrap but also since there is less machining and the metal is easier to machine, the cutting tools last longer. As a result, by employing applicant's invention, a lightweight engine with its inherent advantages can be produced at costs competitive with cast iron.

In addition, by adhesively bonding the cylinder bank members to the crankcase member by a thermal setting plastic that sets up at a relatively low temperature, it is not necessary to bake the cylinder bank structure at precisely controlled temperatures in expensive ovens, etc.

As an alternative the engine may be built as shown in FIGURE 3. This engine is similar to the embodiment of FIGURE 1 in that it is of the so-called V-type having a pair of angularly disposed banks 14 and 16 of aligned cylinders 18. Cylinder heads 20 are secured to each of these banks 14 and 16 to close the outer ends of the cylinders and form combustion chambers 22. The charge for these cylinders is provided by an induction system 48 disposed in the space between the two banks 14 and 16 and

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including an intake manifold 50 having a carburetor 52 mounted thereon.

The cylinder block structure 150 comprises a crankcase member 152 and a pair of cover members 154 and 156. The crankcase member 152 is die cast with a crankcase chamber 157 divided into a plurality of separate compartments by transverse bulkheads 158 that rotatably support a crankshaft 160. The cylinder banks 14 and 16 are formed by side and end walls 162 that project upwardly from the crankcase at substantially 45 degrees to the horizontal or with the cylinder banks at right angles to each other. These walls 162 are arranged to form a box-like structure similar to the cylinder bank members 51 in the first embodiment. Passages 164 extend through these banks to open into the crankcase 157 at substantially right angles to the crankshaft 160. A partition 166 extends longitudinally of the cylinder bank to divide it into separate portions. One portion is adapted to enclose the push rods 168, etc. for the valve gear train. The other portion is adapted to receive the cylinder liners 106 and form a cooling jacket 170 therearound.

The outer faces 172 of the cylinder banks 14 and 16 have a cover plate 154 or 156 adhesively bonded thereto. The cover members 154 or 156 not only close and seal the various interior portions of the cylinder banks but also have apertures 176 therein to form seats 178 for the outer ends of the cylinder liners 106.

The cylinder heads 20 are placed on the cover plates 154 and 156 and are secured in place by suitable fastening means such as studs or bolts 180. In this instance bolts 180 are employed that extend through the heads 20 and cover plates 154 and 156 downwardly into the center portion of the crankcase member. Thus tightening of the bolts 180 will cause the adhesively bonded joint 182 between the cover plate 154 or 156 and crankcase member 152 to be loaded in compression.

The passages 164 for the cooling jacket 170 and cylinder liners 106 as well as the passages for the tappet guides and push rods have the smallest diameter adjacent the crankcase. In addition, there is no reverse taper in these passages. As a result a single permanent non-collapsible core may be used that is pulled in a straight line parallel to the axis of the cylinders. The parting line for the crankcase core and the bank core will be in or adjacent the crankcase. The cover member may be die cast or a machined plate.

It is to be understood that, although the invention has been described with specific reference to particular embodiments thereof, it is not to be so limited since changes and alterations therein may be made which are within the full intended scope of this invention as defined by the appended claims.

What is claimed is:

1. In a liquid cooled engine of the type having a cast cylinder block with a crankcase on one side and a plane surface on the opposite side adapted to mount a cylinder head, a passage extending through said block to form openings in said plane surface and crankcase, a cylinder liner disposed inside of said passage and extending from said plane surface to said crankcase, said passage having inwardly extending flanges at the ends thereof engaging the outside of said liner and being spaced from said liner between said flanges to form a liquid cooling jacket around said liner, the improvement comprising said cylinder block including first and second members secured together along a mating surface located between said flanges to facilitate separate die casting of the passage portions of each member.

2. Apparatus in accordance with claim 1 wherein said mating surface is adjacent said flange at the crankcase end of said passage.

3. Apparatus in accordance with claim 1 wherein said mating surface is adjacent said flange at the cylinder head end of said passage.

4. Apparatus in accordance with claim 1 wherein said first and second members are adhesively bonded together along said mating surface by a thermally setting plastic.

5. Apparatus in accordance with claim 1 wherein said liner includes an outwardly extending flange at the cylinder head end of said passage and said cylinder block includes a complementary seat for said liner flange and wherein said liner is slidably engaged with said flange at said crankcase end of said passage.

6. Apparatus in accordance with claim 1 wherein said mating surface is adjacent said flange at the crankcase end of said passage and wherein said first and second members are adhesively bonded together along said mating surface by a thermally setting plastic.

7. Apparatus in accordance with claim 1 wherein said mating surface is adjacent said flange at the cylinder head end of said passage and wherein said first and second members are adhesively bonded together along said mating surface by a thermally setting plastic.

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