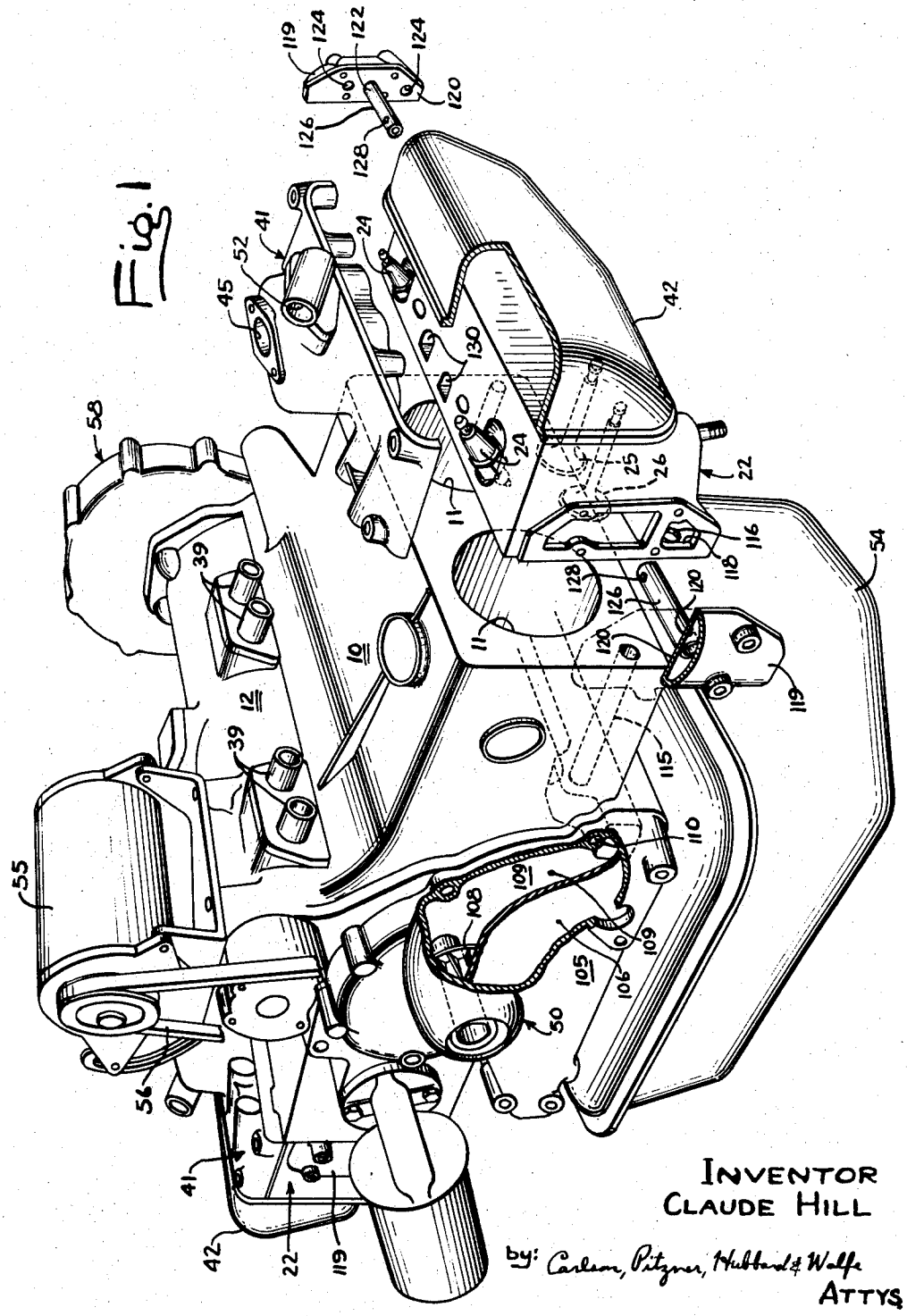
Nov. 24, 1959 C. HILL 2,914,045

INTERNAL COMBUSTION ENGINE

Filed March 8, 1957 5 Sheets-Sheet 1

Fig. 1



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INTERNAL COMBUSTION ENGINE

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Fig. 8

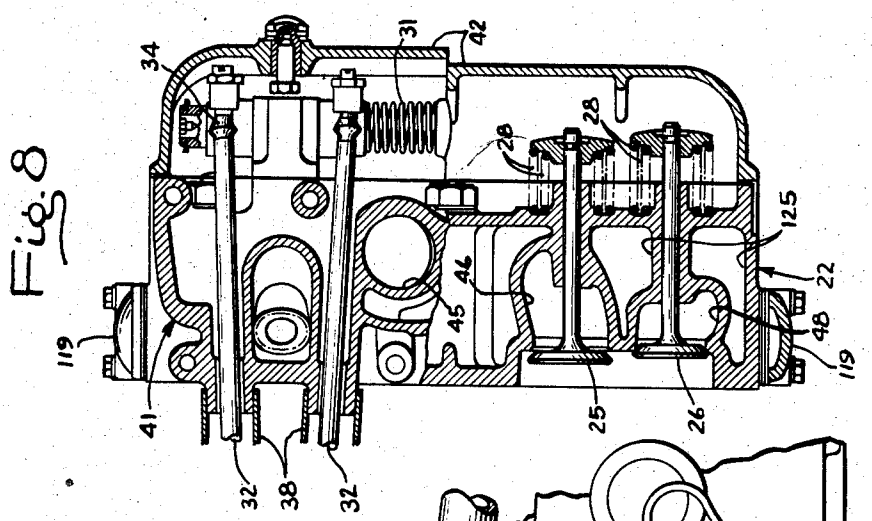
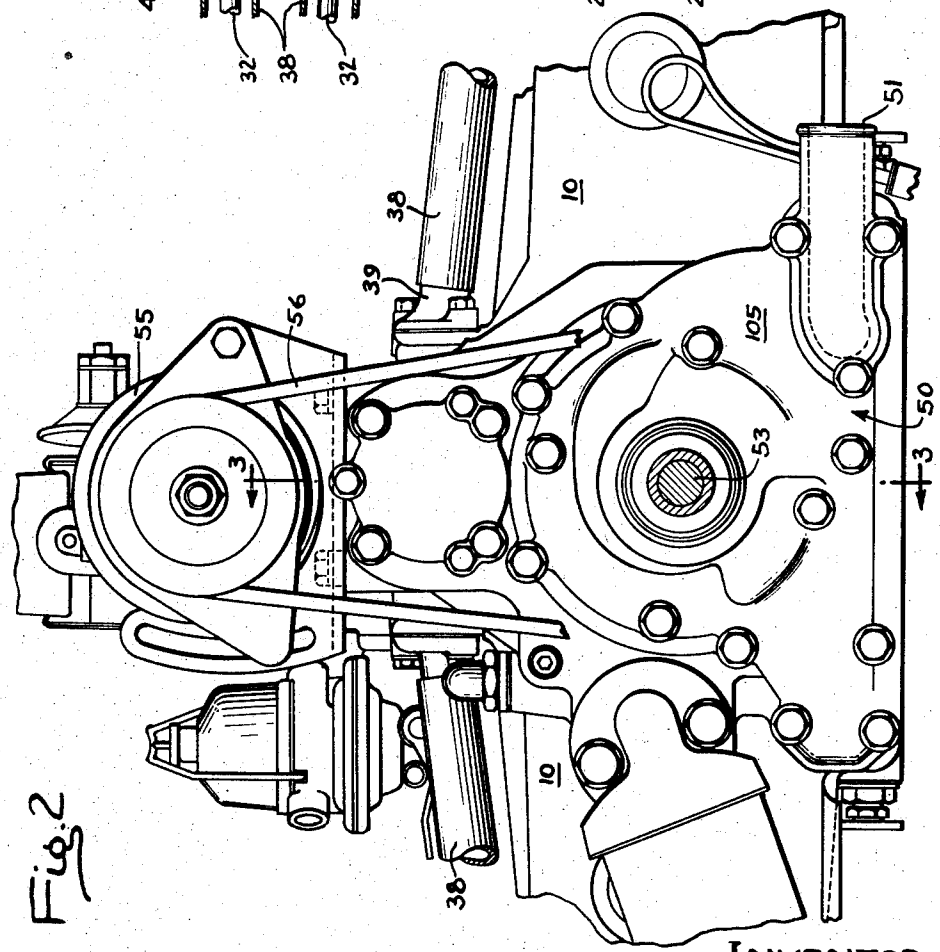


Fig. 2



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Fig. 3

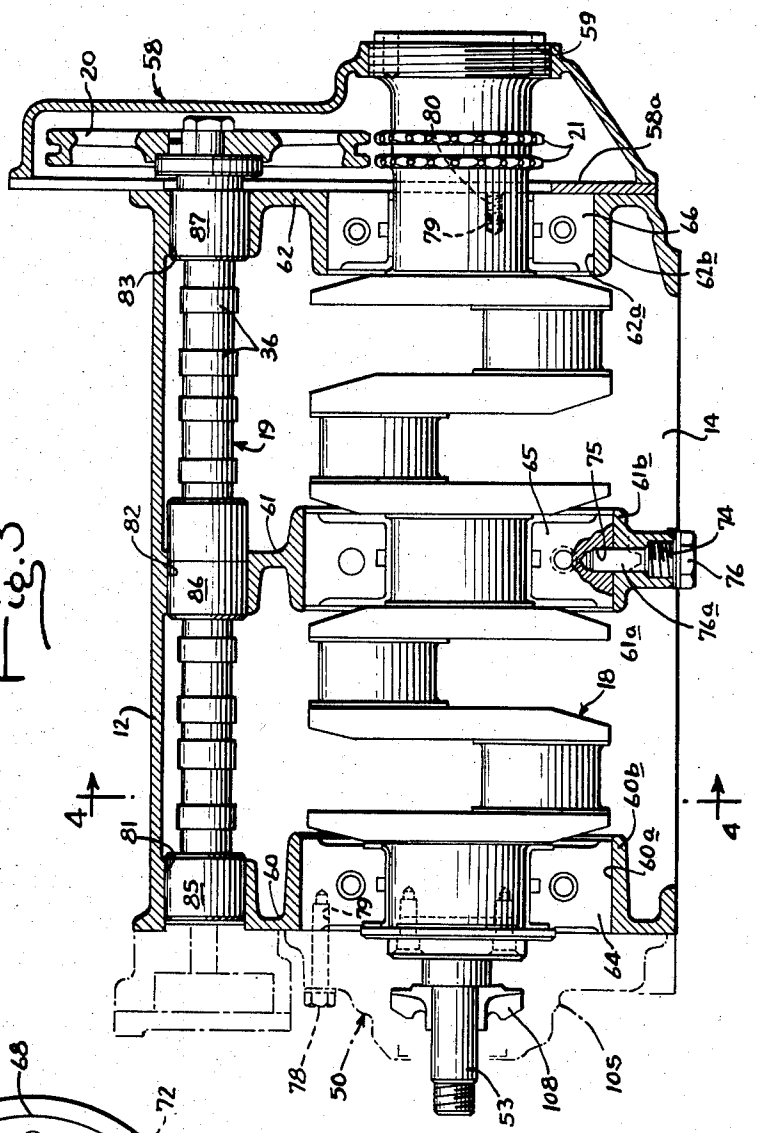
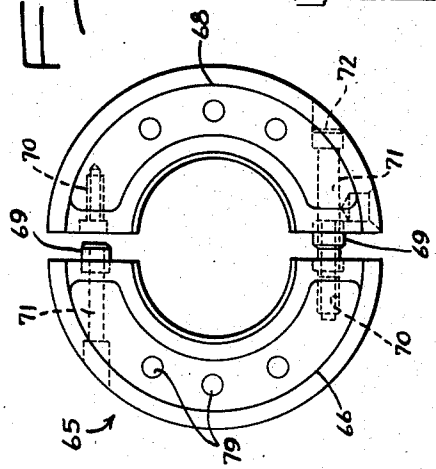


Fig. 7



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Fig. 4

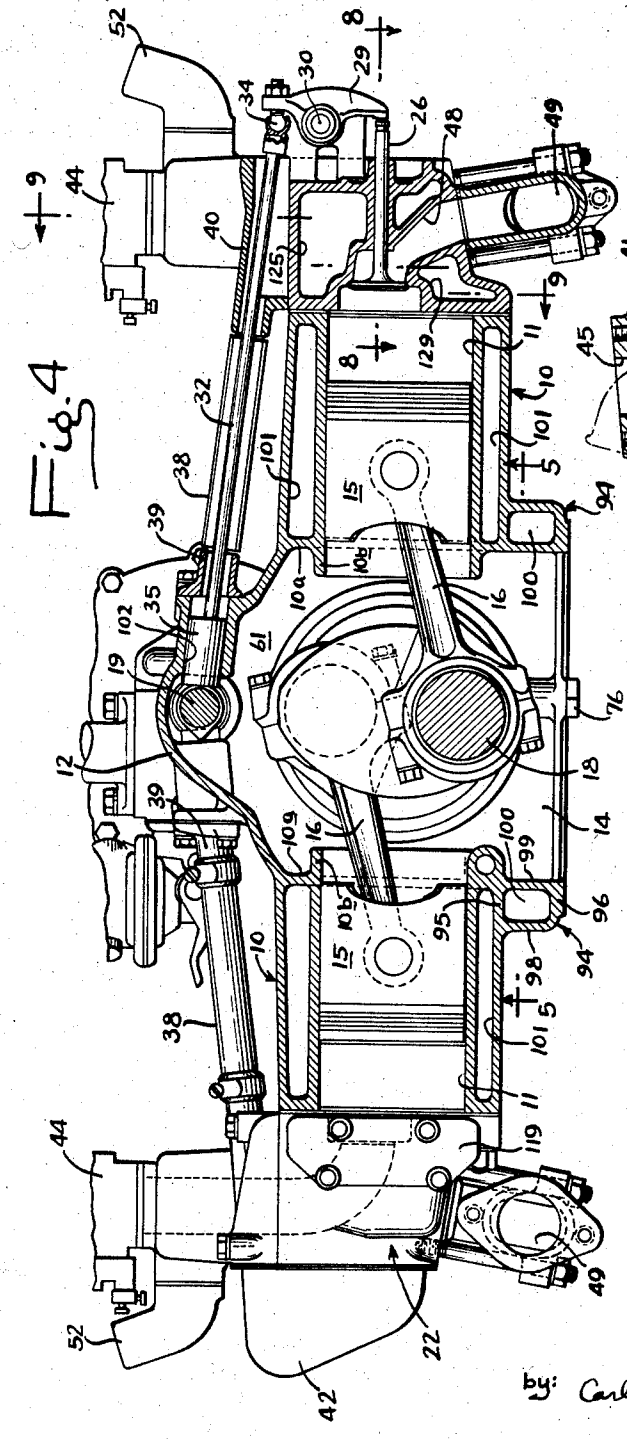


Fig. 9

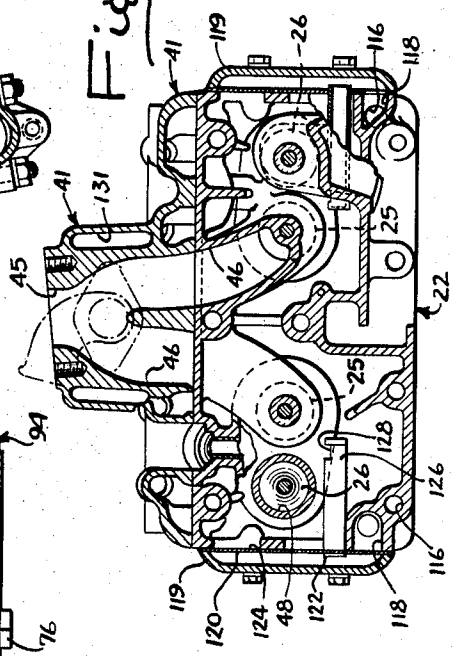
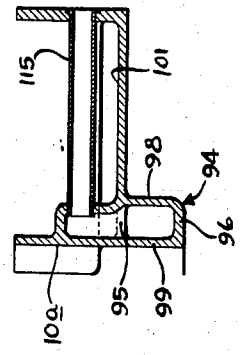


Fig. 6



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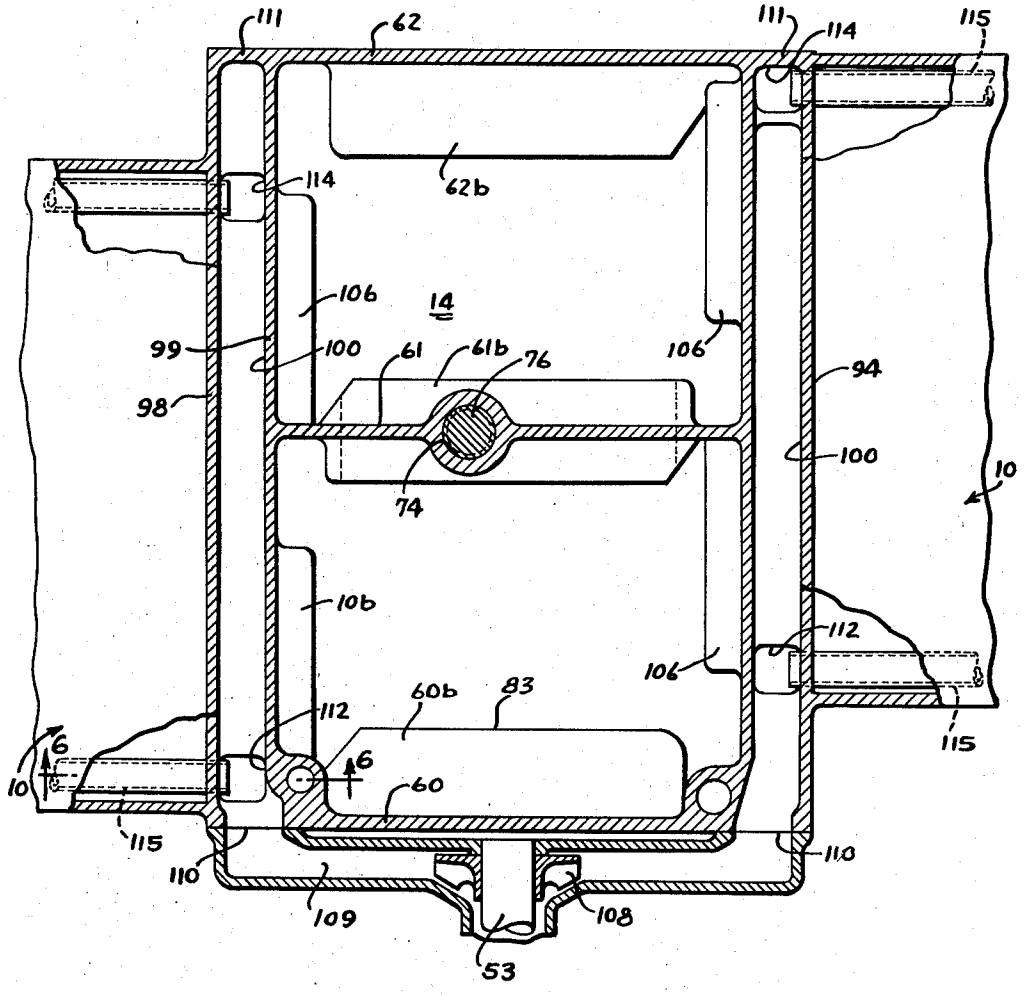
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Fig. 5



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United States Patent Office 2,914,045 Patented Nov. 24, 1959

2,914,045

INTERNAL COMBUSTION ENGINE

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Application March 8, 1957, Serial No. 644,795

Claims priority, application Great Britain March 12, 1956

15 Claims. (Cl. 123—41.72)

This invention relates in general to internal combustion engines, and in particular to engines of the opposed cylinder type, for example, the so-called "flat four" engine. While not limited in its use, the invention finds especially advantageous embodiment in fluid cooled engines for automotive vehicles.

The general aim of the invention is to provide an opposed cylinder internal combustion engine which is especially rigid and rugged, and which is simpler and more economical in the construction and machining of its block and crankcase.

An important object of the invention is to make possible a practical and operationally successful one-piece casting constituting the cylinder block portions and crankcase of such an engine.

A related object of the invention is to make quick and convenient the assembly of the crankshaft, camshaft, and connecting rods into an engine of the opposed cylinder type.

Still another object is to provide a one-piece casting forming cylinder block portions and a crankcase with a wide access opening, such casting being strengthened and given additional rigidity by rib-like skirt portions extending along the crankcase opening and which serve also as an important part of coolant circulation paths.

A further object of the invention is to provide an advantageous relationship between an engine block casting and a coolant pump, in which the latter partially closes a crankcase chamber, is driven directly from the crankshaft, and discharges directly into coolant passages formed by strengthening ribs.

It is an additional object to provide, in an opposed cylinder type of engine, an improved cooling arrangement characterized in that relatively cool fluid, supplied for example from a radiator, is circulated first past the regions of exhaust valves and spark plugs, so that maximum cooling effect is exerted on those particular portions of the engine which tend to reach the highest temperatures, and thence past the regions of intake valves which do not require such a great degree of cooling action.

In that connection it is also an object to enhance cooling of an internal combustion engine by causing the coolant to be forced or sprayed against those regions of the engine adjacent exhaust valves, exhaust passages, and spark plugs.

A still further object is to cause, in such an engine, the coolant exiting at the highest coolant temperature in the system to transfer heat to the incoming fuel mixture, thereby increasing the fuel burning efficiency.

Other objects and advantages will become apparent as the following description proceeds, taken in conjunction with the accompanying drawings, in which:

Figure 1 is a perspective view, partially exploded and partially broken away, of an exemplary internal combustion engine embodying the features of this invention;

Fig. 2 is a fragmentary front elevation of an engine shown in Fig. 1;

Fig. 3 is a longitudinal vertical section of the engine, taken substantially along the line 3—3 in Fig. 2;

Fig. 4 is a transverse vertical section of the engine, taken substantially along the line 4—4 in Fig. 3;

Fig. 5 is a sectional view of the engine crankcase, taken substantially along the line 5—5 in Fig. 4;

Fig. 6 is a fragmentary detail view, taken in section substantially along the line 6—6 in Fig. 5;

Fig. 7 is a detail view of one of the crankshaft bearings appearing in Fig. 3;

Fig. 8 is a fragmentary horizontal section taken partly along the line 8—8 in Fig. 4 and partly at the level of the tappet rods above; and

Fig. 9 is a sectional view taken substantially along the offset line 9—9 in Fig. 4.

While the invention has been shown and will be described in some detail with reference to a particular embodiment thereof, there is no intention to thus limit the invention to such details. On the contrary, it is intended here to cover all alterations, modifications and equivalents falling within the spirit and scope of the invention as defined by the appended claims.

Referring now to the drawings, the internal combustion engine here shown as a preferred embodiment of the invention is of the type known in the art as a "flat four." This term is derived from the fact that the engine has four cylinders, two on each side, which extend in a horizontal direction and in generally opposed relation to one another. In order to facilitate an understanding of the invention, it will be appropriate first to briefly describe in general terms the major components of the engine and their relationships to one another.

Referring particularly to Figs. 1–4, the engine here illustrated comprises a pair of horizontally spaced-apart cylinder blocks or block portions 10 each of which has a pair of horizontal cylinder bores 11 therein, the cylinder bores in each block portion being horizontally opposed but offset slightly lengthwise of the engine in relation to those in the other block portion. The inner walls 10*a* of the block portions 10 are joined at their upper edges by a roof portion 12 which defines with those walls a crankcase chamber 14 of generally inverted U-shaped form. Each cylinder terminates in a skirt 10*b* extending inwardly from the walls 10*a*. Pistons 15 disposed for movement within the respective cylinder bores 11 are coupled by suitable connecting rods 16 to a crankshaft 18 extending longitudinally and suitably journaled for rotation within the chamber 14. Journaled in the upper portion of the chamber 14 is a camshaft 19, the latter carrying at its rear end a sprocket 20 (Fig. 3) which is driven by means of a timing chain (not shown) running over a sprocket 21 carried by the rear end of the crankshaft 18.

Removably and rigidly fastened to the block portions 10 in closing relation to the cylinder bores 11 are cylinder heads 22 which are of hollow construction to define fuel intake and exhaust passages, as well as coolant circulating passageways as hereinafter described. Each cylinder head 22 is provided with a tapped opening for the reception of two spark plugs 24, the electrodes of which are thus located in the upper portions of the respective cylinders. For introducing fuel mixtures into each cylinder, and for permitting removal of the products of combustion from each cylinder, the heads 22 mount movable intake and exhaust valves 25 and 26, these valves being biased to closed positions by concentric compression springs 28 (Fig. 8). The valves are opened and closed in properly timed relation to the movement of the corresponding pistons 15 by rockers 29 journaled on a rockshaft 30 mounted on the outer face of the heads 22. The rockers themselves are biased

in a direction to release the valves by torsion springs 31 (Fig. 8) and are actuated by individual tappet rods 32 connected by universal joints 34. The rods 32 carry at their opposite ends tappets 35 which ride upon cams 36 integrally formed on and spaced axially along the camshaft 19. The tappet rods 32 (Fig. 4) extend through protective sleeves 38 connected at their opposite ends to collars 39 attached to the roof portion 12 and guides 40 formed in castings 41 rigidly and removably fixed to the upper surface of each of the heads 22. The valve springs 28, rockshaft 30 and rockers 29 are all enclosed and protected by suitable removable cylinder head covers 42.

For introducing a mixture of air and fuel through the intake valves 25 to the cylinders 11, carburetors 44 are connected to intake ducts 45 opening downwardly through each of the upper head castings 41. The fuel intake ducts 45 diverge as shown in Fig. 9 to communicate with fuel inlet passages 46 leading to each of the intake valves 25. As shown best in Fig. 9, the two intake valves 25 are disposed medially of the head 22, while the two exhaust valves 26 are located at the opposite end portions of the heads 22. The products of combustion are removed from each of the cylinders when the exhaust valves 26 open by passing through exhaust passages 48 leading downwardly to an exhaust manifold 49 held by studs to the lower side of the heads 22 and leading rearwardly to an exhaust pipe and muffler (not shown). It will thus be seen that fuel and air mixtures are introduced into the engine at the upper, medial portion of each of the heads 22, while products of combustion are exhausted downwardly from opposite end portions of the heads.

The cooling system for the present engine will be described in greater detail below. For the present it will suffice to note that a pump 50 for cooling fluid, such as water, is mounted at the front of the engine to close the forward end of the crankshaft chamber 14, the pump having an inlet conduit 51 (Fig. 2) adapted for connection to any suitable radiator or heat exchanger (not shown). The pump forcibly circulates the cooling fluid through the various parts of the engine, after which such fluid passes through an outlet 52 for return to the heat exchanger or radiator. The downwardly opening mouth of the crankshaft chamber 14 may be closed by a removable oil pan 54 which serves as a sump for the lubricant. Any suitable lubricating system (not shown) may be provided to distribute lubricating oil from the pan 54 to the various moving parts and bearings of the engine. If desired, a fan may be connected at the forward end of the shaft 53 for the pump 50 to draw air over an associated radiator, and a pulley (not shown) on that shaft may serve to drive a generator 55 mounted on the top of the engine through a belt 56. As shown in Fig. 3, the pump 50 may be driven directly from the forward end of the crankshaft 18, while the output of the engine may be taken by a suitable connection from the rear end of the crankshaft. The timing sprockets 20 and 21 may be protectively enclosed in a suitable casing 58 bolted or otherwise fastened to the rear of the engine block, an inner partition 58*a* for this casing closing the rear end of the U-shaped crankshaft chamber 14. An oil seal 59 may be provided between the crankshaft 18 and the casing 58 at the point where the former projects through the latter.

In accordance with the present invention, the cylinder block portions 10 and the crankcase or chamber 14 are all formed and defined by a single one-piece casting, with the inner, opposed sides 10*a* of the block portions 10 forming the inner side walls of that chamber. The roof portion 12 which completes the inverted U-shaped chamber 14 is integrally joined to the spaced-apart block portions 10. This leaves a wide, open mouth at the bottom which is as wide as the widest part of the chamber 14, and which makes it easy to couple the bearings of the connecting rods 16 to the crankshaft 18.

The one-piece casting, besides including the spaced-apart block portions 10 and the integral roof portion 12 joining them, is also formed with a plurality of partitions spaced lengthwise of the chamber 14 and extending transversely thereacross. These partitions 60, 61 and 62 (Fig. 3) are integrally joined to the side walls 10*a*, as well as to the roof portion 12, extending downwardly substantially the full depth of the chamber 14 so as to make the entire casting rigid, especially against flexure of the roof portion. The partitions 60, 61 and 62 also support the crankshaft 18 and camshaft 19, and to make convenient the assembly of the crankshaft into the engine.

As shown best in Fig. 3, the partitions 60, 61, 62 are formed with coaxially alined bores 60*a*, 61*a* and 62*a* which are surrounded and partially defined by axially extending, stiffening flanges 60*b*, 61*b*, 62*b*. Because these bores are coaxial and of the same diameter, it is a relatively simple matter to machine them in the rough casting, one feeding pass of a boring tool being sufficient. The crankshaft 18 is supported for rotation by three bearings 64, 65 and 66. These bearings are substantially identical, and as shown in Fig. 7, may comprise two half rings 66, 68 which may be fixed in surrounding relation to the three journals of the crankshaft 18. The half rings 66, 68 (Fig. 7) have ferrules 69 and counterbored tapped holes 70, together with bolt holes 71. After the half rings have been placed around the crankshaft journals, bolts 72 are inserted into the holes 71 and tightened into threaded engagement with the opposite tapped holes 70. The ferrules 69 enter the counterbores of the tapped holes 70 to positively position the two half rings 66, 68 relative to one another.

After the bearings 64, 65, 66 are thus assembled on the journals of the crankshaft 18, the latter is assembled into the crankcase simply by sliding it axially through the bores 60*a*, 61*a*, 62*a*. The outside diameter of the bearings 64, 65, 66 is only slightly less than the diameter of the bores 60*a*—62*a*. And the diameter of those bores is greater than the effective diameter or "swing" of the crank portions on the crankshaft 18, so that such assembly of the crankshaft and its bearings into the casting is accomplished in a minute or two. To lock the bearings and the crankshaft axially in place, the partition 61 is formed with a tapped, counterbored hole 74 in its lower edge, and the center bearing 65 formed with a radial hole 75. A machine bolt 76 is threaded into the hole 74 and has a dowel portion 76*a* which projects into the bearing hole 75, thus holding the bearing 65 in the desired axial location. The front bearing 64 is locked axially in place by one or more long machine screws 78 passed through the housing of the pump 50 and into tapped axial openings 79 in the face of the bearing. Similarly, the rear bearing 66 is locked axially by one or more machine screws 80 passed through the wall 58*a* of the timing sprocket casing 58 and into threaded engagement with the tapped holes 79.

To support and journal the camshaft 19, the partitions 60, 61, 62 are also formed with coaxially alined bores or passages 81, 82 and 83 disposed just beneath the roof portion 12 and surrounded by axially extending stiffening flanges. Again, the passages 81, 82, 83 may be machined in the one-piece casting by one pass of a boring tool, since they are coaxially alined and of the same diameter. The camshaft 19 has three journals 85, 86, 87 spaced therealong and of greater radius than the maximum radius of the cams 36. The camshaft 19 may be slipped axially into the casting, so that the journals 85—87 are received and rotatably supported by simple bearings in the passages 81, 82, 83 as shown in Fig. 3. The camshaft is prevented from shifting axially by suitable means (not shown).

From the foregoing, it will be seen that a single one-piece casting is made to provide the spaced-apart cylinder

block portions 10 and to define partially by the opposed walls of those block portions a crankshaft chamber 14 of inverted U-shaped form. Such one-piece casting makes the entire engine rigid and eliminates the necessity of precisely positioning and bolting together two or more castings to make up the cylinder blocks and crankcase. Yet, the one-piece casting here described requires but very simple machining operations to convert it from a rough casting into finished form. Only a few minutes are required to assemble the crankshaft 18 and camshaft 19 with their bearings in place. Because of the wide open mouth at the bottom of the chamber 14, it is a quick and convenient operation to couple the bearings for the connecting rods 16 to the camshaft.

To further achieve the objective of a rigid engine, the wide mouth at the bottom of the crankcase chamber 14 is reinforced by enlarged ribs or skirts formed as a part of the one-piece casting. It is contemplated, however, that such stiffening skirts serve a second function in providing a part of the coolant circulating path for the engine. As best shown in Figs. 4 and 5, the one-piece casting includes integral hollow skirts 94 running lengthwise along the lower edges of the walls 10*a*. The skirts include upper and lower walls 95, 96 and side walls 98, 99 defining a passage 100. Such hollow cross section skirts have a marked stiffening effect for the weight and material which they add to the one-piece casting, reinforcing the casting against distortion under stress at what otherwise would be its weakest location owing to the open mouth at the bottom of the chamber 14. And, as will be made clear, the longitudinal passages 100 defined by the skirts make possible an advantageous symmetrical coolant flow path, being properly located to receive fluid from dual outlets of the pump 50.

In addition to the structure of the one-piece casting previously described, such casting is also formed with coolant jackets or pockets 101 substantially surrounding each cylinder 11. Rather than incorporating these jackets into a forced flow coolant path, cooling fluid may be allowed to circulate sluggishly therethrough by thermosyphonic action. Also, the roof portion 12 is cast to define a plurality of laterally-opening guideways 102 which slidably support the tappets 35 riding against the cams of the camshaft 19.

In accordance with another feature of the invention, advantage is taken of the one-piece casting with the hollow skirts 94 to provide a simple and highly efficient cooling system or coolant flow path for the engine. In general, the cooling system causes coolant to flow from the lowest regions of the engine toward the highest, so that natural convection aids the pump. Moreover, the coolant is caused to pass the hottest portions of the engine first, so that maximum cooling action is created where it is most needed. Finally, the cooling system utilizes the heat of the coolant at its warmest point to preheat the incoming fuel mixture for increased efficiency.

Referring to Figs. 1, 2 and 5, the pump 50 includes a housing 105 which is rigidly bolted to the front of the one-piece casting, forming the front vertical wall of the chamber 14. The housing 105 has an intake chamber 106, connectable through the inlet 51 by suitable means such as a hose (not shown) to the lower outlet of a radiator or other heat exchanger which may be of conventional construction and which is thus not illustrated. An impeller 108, driven directly from the crankshaft 18, pressurizes cooling fluid in an outlet chamber 109 and forces it through dual outlet ports 110 into the two passages 100 formed by the skirts 94, and in a direction transverse to the axes of the cylinders 11.

The skirt passages 100 are closed off at their rear ends by walls 111, and means are provided for conveying the cooling fluid from the passages at a low level to the opposite end portions of the two cylinder heads 22. For this purpose, each passage 100 is formed with front and rear openings 112, 114 communicating with conduits 115 which extend outwardly, in a direction substantially parallel to the cylinders 11, through the block portions 10 (Figs. 1, 5 and 6). The cylinder heads 22 have ports 116 (Fig. 1) registering with the conduits 115 and opening into pockets 118, so that coolant can flow into the lower portions of the heads 22 at either end thereof.

In accordance with the invention, the heads 22 are formed to define means for directing coolant inwardly toward the middle and upwardly toward the top after it passes through the conduits 115, thus aiding the forced flow by convection and causing the coolant to circulate first past the regions of the exhaust valves 26 (which require more cooling action) and then past the regions of the intake valves 25 (which do not require such great cooling action). For this purpose, hollow headers 119 are bolted to the opposite ends of the heads 22, with interposed plates 120 having inlet ports 121 communicating with the pockets 118, and two outlet ports 122, 124. As shown in Figs. 1 and 9, coolant flows upwardly through the headers 119 and the uppermost ports 124 into passageways 125 formed in the interior of the heads 22. Coolant is thus directed inwardly over the top surfaces of the walls forming the exhaust passages 48 (Fig. 4).

Additionally, means are provided to positively force or spray coolant against the regions of the exhaust passages 48 and the seats for the adjacent spark plugs. As shown in Figs. 1 and 9, an inwardly extending nozzle 126 is fixed within the header outlet port 122, and has an upwardly directed opening 128 at its inner end which sprays or ejects currents of the coolant upwardly within a coolant passage 129 so that it strikes the walls of the exhaust passage 48 in the region of the exhaust valves 26 and also the seats for the spark plugs. After that, the coolant flows laterally inward toward the medial portion of the heads 22, passing over the outer walls defining the fuel intake passages and cooling the intake valves 25. From the region of the intake valves, the cooling fluid then flows inwardly and upwardly to ports 130 opening from the upper surface of the heads 22.

Instead of simply returning the coolant to the radiator or heat exchanger after it leaves the heads 22, provision is made to utilize some of the heat that it has absorbed to precondition the incoming fuel and air mixture. For this purpose, the castings 41, which are fastened to the upper surface of the heads 22, are formed with a hollow jacket or cavity 131 (Fig. 9) substantially surrounding the fuel inlet ducts 45 leading downwardly from the carburetors to the intake passages and valves. The jacket 131 communicates with the ports 130 in the upper surface of the heads 22. As cooling fluid exits from the heads, it passes through that jacket before emerging from the fluid outlet 52 (Fig. 1). Thus, the cooling fluid at its warmest point in the circulation path is caused to transfer some of the heat which it has absorbed to the incoming air and fuel mixture, preheating the latter so that it burns with greater efficiency as it is introduced into the cylinders 11.

By locating the fuel intake passages and valves in the medial portion of the heads 22 and introducing fuel-air mixtures downwardly through the central inlet duct 45, and by causing the coolant to circulate inwardly from the ends of the heads 22 toward the center and upwardly through the centralized ports 130, the cooling fluid at its maximum temperature within the system is brought into heat-exchanging relation with the entering fuel-air mixture. Moreover, because the exhaust valves 26 are located at opposite end portions of each head, and the cooling fluid is introduced first to those end portions before being circulated toward the middle of the head, the exhaust valves and seats receive the maximum degree of cooling action which they require. By virtue of the stiffening skirts 94 formed as integral parts of the one-piece casting which makes up the cylinder block portions and crankcase of the engine, a single inlet pump (and a single outlet radiator) may be employed, the pump serving the structural function of closing the front end of the crank

case, and readily discharging cooling fluid from dual outlets into the two skirt passages 100 which form parts of two symmetrical coolant flow paths for the two halves of the engine.

There has thus been provided a very compact and structurally rigid opposed cylinder engine in which the block portions and crankcase are all formed by a single one-piece casting, yet in which the machining of that casting is quickly and economically effected. The one-piece casting is formed to cooperate with a crankshaft, camshaft and bearings therefor so as to afford a very simple and rapid procedure for assembling the latter in place. The one-piece casting, in addition, presents a crankcase or chamber of inverted U-shaped form which is wide open at its bottom and partially defined by the inner walls of the block portions themselves, so that the entire assembly is extremely compact and the connecting rods are conveniently connectable to the crankshaft.

I claim as my invention:

1. In an internal combustion engine of the opposed cylinder type, a one-piece casting which includes spaced-apart cylinder block portions having opposed cylinder bores therein, the opposed sides of said block portions constituting walls defining a crankcase chamber, said casting further including a portion integrally joining two respective edges of the opposed sides of said block portions and making said crankcase chamber generally of U-shape form with an open mouth and integral transverse partitions extending from said block portions across said chamber, and extending from said joining portion substantially the full depth of said chamber.

2. In an internal combustion engine of the opposed cylinder type, a one-piece casting which includes horizontally spaced-apart cylinder block portions having opposed horizontal cylinder bores therein, the inner sides of said block portions constituting vertical walls defining a crankcase chamber, said casting further including a roof portion integrally joining the upper edges of the opposed sides of said block portions and making said crankcase chamber generally of inverted U-shape, said walls extending to define an open mouth at the bottom of said chamber which is substantially as wide as the widest part of the chamber, and stiffening partitions integrally joined to said walls and said roof portion, said partitions spanning said chamber transversely and being spaced apart longitudinally thereof.

3. For use in an internal combustion engine of the opposed cylinder type, a one-piece casting which includes spaced-apart block portions having opposed cylinders bored therein, a portion integrally joining two respective edges of the opposed sides of said block portions and defining therewith a crankcase chamber of generally U-shape form with an open mouth, a plurality of partitions spaced lengthwise along and transversely spanning said chamber between said block portions and integrally joining the latter, said partitions being formed with coaxially alined circular bores therethrough for receiving mounting bearings of a crankshaft.

4. For use in an internal combustion engine of the opposed cylinder type, the combination with a one-piece casting which includes horizontally spaced-apart block portions having horizontal cylinders bored therein, a roof portion integrally connecting the upper edges of the opposed sides of said block portions and defining therewith a crankcase chamber of generally inverted U-shape form with an open mouth at its bottom, a plurality of partitions spaced lengthwise along and transversely spanning said chamber between said block portions and integrally joining the latter, said partitions being formed with coaxially alined bores therethrough surrounded by axial flanges; of a crankshaft having crank portions and a plurality of journals spaced correspondingly with said partitions, a plurality of bearings surrounding said journals and having an outside diameter slightly less than the diameter of said bores but greater than the effective diameter of said crank portions, so that the crankshaft and its bearings can be inserted as a unit axially into said bores, and means for axially locking said bearings in respective ones of said bores.

5. For use in an internal combustion engine of the opposed cylinder type, a one-piece casting which includes two spaced-apart block portions having opposed cylinders bored therein, a connecting portion integrally joining two respective edges of the opposed sides of said block portions and defining with such sides a crankcase chamber of generally U-shape form with an open mouth, a plurality of partitions spaced lengthwise along and transversely spanning said chamber and integrally joined to said block and roof portions, said partitions being formed with coaxially alined passages beneath said connecting portion for receiving and supporting the bearings of a camshaft, and said partitions also being formed with coaxially alined bores for receiving and supporting the bearings of a crankshaft.

6. For use in an internal combustion engine of the opposed cylinder type, a one-piece casting which includes two horizontally spaced-apart block portions having opposed cylinders bored therein, a roof portion integrally joining the upper edges of the opposed sides of said block portions and defining therewith a crankcase chamber of generally inverted U-shape form with an open mouth at its bottom, a plurality of partitions spaced lengthwise along and transversely spanning said chamber and integrally joined to said block and roof portions, said partitions being formed with coaxially alined passages bordered by axial flanges beneath said roof portion for receiving and supporting the bearings of a camshaft, and said partitions also being formed with coaxially alined bores bordered by axial flanges beneath said passages for receiving and supporting the bearings of a crankshaft.

7. An internal combustion engine comprising, in combination, a one-piece metal casting including two laterally spaced-apart block portions having horizontal, opposed cylinders bored therein, a roof portion integral with and joining said block portions and defining therewith a crankcase chamber of generally inverted U-shape cross section, said casting further including a plurality of partitions spaced apart lengthwise of and extending transversely across said chamber and joined integrally to said block and roof portions, said partitions having coaxially alined passages therethrough, a camshaft supported and journaled in said passages, said partitions also having coaxially alined bores beneath said passages, a plurality of crankshaft bearings each fixed in one of said bores, a crankshaft supported and journaled by said crankshaft bearings, and said casting further including integral enlarged skirts extending lengthwise along said block portions at the lower mouth of said chamber to impart rigidity to the casting notwithstanding the open chamber therein.

8. In an internal combustion engine having a block portion with two horizontal cylinder bores therein, the combination comprising means defining a coolant flow passage lengthwise of the block portion along the lower inner edge thereof, means defining coolant conduits opening from said passage through said block portion at the lower edge of either end thereof and in a direction substantially parallel to said cylinder bores, a cylinder head fastened to said block portion, an exhaust valve structure for each bore located in opposite ends of said head, a fuel intake valve structure for each bore located medially in said head between said exhaust valve structures, means defining coolant passages in said head which include ports registering with said conduits, means defining passageways directing coolant flow from said ports upwardly toward the said exhaust valve structures and thence laterally inward toward the region of said intake valve structures, and a coolant outlet extending upwardly from said passageways in the region of said intake valve structures.

9. The combination set forth in claim 8 further characterized in that said cylinder head is formed with a fuel intake passage opening downwardly and leading to said intake valve structures, and in that said coolant outlet partially surrounds said intake passage, so that outgoing coolant preheats incoming fuel.

10. In an internal combustion engine having a block portion with horizontal cylinder bores therein, the combination comprising means defining a coolant flow passage lengthwise along one edge of said block portion in a direction transverse to said cylinder bores, means defining coolant conduits at either end of said block portion communicating with said passage and extending through said block portion in a direction substantially parallel to said cylinder bores, a cylinder head fastened to said block portion, said head having walls defining intake and exhaust passages and having valves in such passages, said head having ports registering with said conduits, nozzles communicating with said ports and directed to discharge coolant upwardly against the walls of said exhaust passages, and means defining in said head coolant passageways leading from the region of the walls of said exhaust passages past the walls of said intake passages and thence to an outlet.

11. In an internal combustion engine of the opposed cylinder type, the combination with a one-piece casting which includes two laterally spaced-apart block portions having horizontally opposed cylinder bores therein, a roof portion integrally joining the upper edges of said block portions and defining therewith a crankcase chamber of generally inverted U-shape form with an open mouth at the bottom, integral ribs formed on the lower edges of said block portions and running lengthwise along opposite sides of the mouth of said chamber, said ribs being formed with hollow passages therein for the flow of cooling fluid to each of said block portions.

12. In an internal combustion engine, the combination of a one-piece casting which includes two spaced-apart block portions with cylinder bores therein, a roof portion integrally joining said block portions and defining therewith a U-shaped crankshaft chamber, strengthening ribs integral with the edges of said block portions and extending lengthwise along the mouth of said chamber, said ribs being hollow to define coolant paths therethrough; and a pump mounted at one end of said casting to close one end of said chamber, said pump having two outlets communicating with respective ones of said hollow ribs to circulate coolant fluid to the two block portions.

13. In an internal combustion engine of the opposed cylinder type, the combination of a casting which includes spaced-apart cylinder block portions having opposed cylinder bores therein, the opposed sides of said block portions constituting walls defining a crankcase chamber, said casting further including a portion integrally joining two respective edges of the opposed sides of said block portions and making said crankcase chamber generally of U-shape form with an open mouth, strengthening ribs integral with edges of said block portions bordering said mouth, said ribs being hollow to also define coolant flow paths therethrough, a crankshaft within and journaled for rotation about an axis extending longitudinally of said chamber, a pump having a hollow housing rigidly fixed to said casting in closing relation to one end of said chamber, said pump housing having two ports spaced to register and communicate with said hollow ribs, said pump further including an impeller journaled in said housing and drivingly connected to one end of said crankshaft.

14. In an internal combustion engine of the opposed cylinder type, the combination comprising a one-piece casting which includes spaced-apart block portions having opposed cylinders bored therein, a portion integrally joining two respective edges of the opposed sides of said block portions and defining therewith a crankcase chamber of generally U-shape form with an open mouth, a plurality of partitions spaced lengthwise along and transversely spanning said chamber between said block portions and integrally joining the latter, said partitions having coaxially alined bores therein, bearings removably fixed in said bores, a crankshaft journaled in said bearings, said casting further having integral, hollow ribs running lengthwise along the edges of said block portions and forming part of a coolant circulation path, a pump having a hollow housing and an impeller journaled therein, means fixing said housing to said casting in closing relationship to one end of said chamber, said housing having ports which register and communicate with said hollow ribs, and means connecting said impeller to the adjacent end of said crankshaft to be driven thereby.

15. In an internal combustion engine of the opposed cylinder type, a one-piece casting which includes two spaced-apart block portions having opposed cylinders bored therein, a connecting portion integrally joining two respective edges of the opposed sides of said block portions and defining with such sides a crankcase chamber of generally U-shape form with an open mouth, a plurality of partitions spaced lengthwise along and transversely spanning said chamber and integrally joined to said block and roof portions, said partitions being formed with coaxially alined bores bordered by axial flanges, a crankshaft having a plurality of journals spaced correspondingly with said partitions and removably supported in the bores thereof, integral stiffening ribs running lengthwise along the edges of said block portions which border said mouth, said ribs being hollow to form a part of coolant flow paths and being open at one end thereof, a pump having a hollow housing removably fixed to one end of said casting to close one end of said chamber, said housing having ports registered and communicating with the open ends of said ribs, said pump further having an impeller journaled in said housing and drivingly connected to one end of said crankshaft.

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