United States Patent [19]

Leffert

[11] **3,731,660**

[45] **May 8, 1973**

[54] **VAPOR-COOLED INTERNAL COMBUSTION ENGINE**

[75] Inventor: **Charles B. Leffert**, Troy, Mich.

[73] Assignee: **General Motors Corporation**, Detroit, Mich.

[22] Filed: **Dec. 29, 1971**

[21] Appl. No.: **213,446**

[52] **U.S. Cl.**.....**123/41.42**, 165/105

[51] **Int. Cl.**.....**F01p 3/00**

[58] **Field of Search**.....123/41.42, 41.2, 123/41.21; 165/105

[56] **References Cited**

UNITED STATES PATENTS

1,806,382	5/1931	Barlow	123/41.2
2,413,770	1/1947	Knoy	123/41.42
2,926,641	3/1960	Tacchella et al.	123/41.21
3,448,729	6/1969	Parsons	123/41.2
3,670,495	6/1972	Leffert	165/105

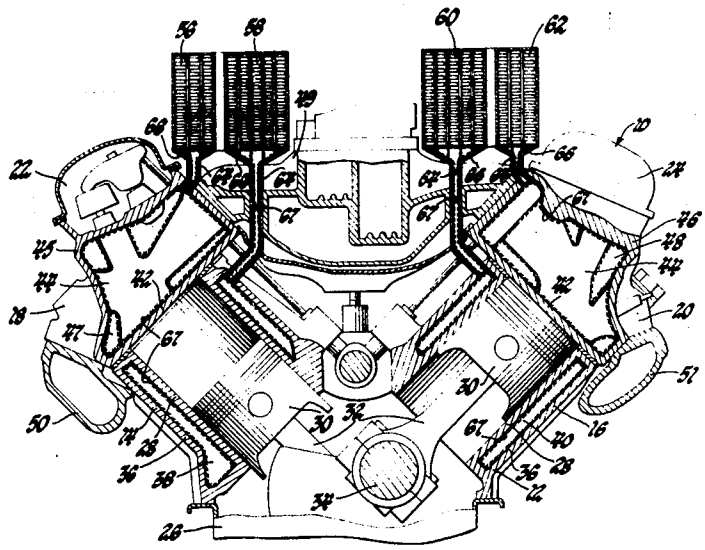
Primary Examiner—C. J. Husar

Attorney—J. L. Carpenter et al.

[57] **ABSTRACT**

An internal combustion engine is provided with separate sealed cooling systems for each of the cylinder block and cylinder head coolant cavities, each system having its own vapor condenser. The condensers are connected with their respective coolant cavities, the connections including wick means to aid the return of liquid coolant to additional wick means within the cavity for vaporization, which occurs on the heated walls, such as the cylinder walls and combustion walls of the cylinder heads. An open flow path is maintained adjacent the wicks for passage of coolant vapor from each coolant cavity to its respective condenser, where it is cooled and returned to liquid form. In a specific embodiment, four rows of condensing means are longitudinally disposed above and between the banks of a V-type engine, forming separate sealed cooling systems for the cylinder block coolant cavity of each bank and the cylinder head coolant cavity of each bank. An engine driven blower directs air through suitable ducts to pass longitudinally through the four condenser rows so as to dissipate heat therefrom.

7 Claims, 4 Drawing Figures



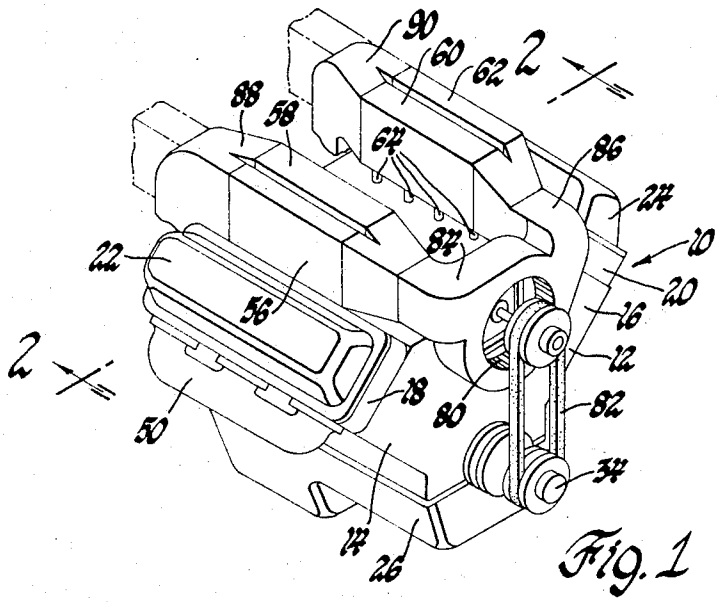


Fig. 1

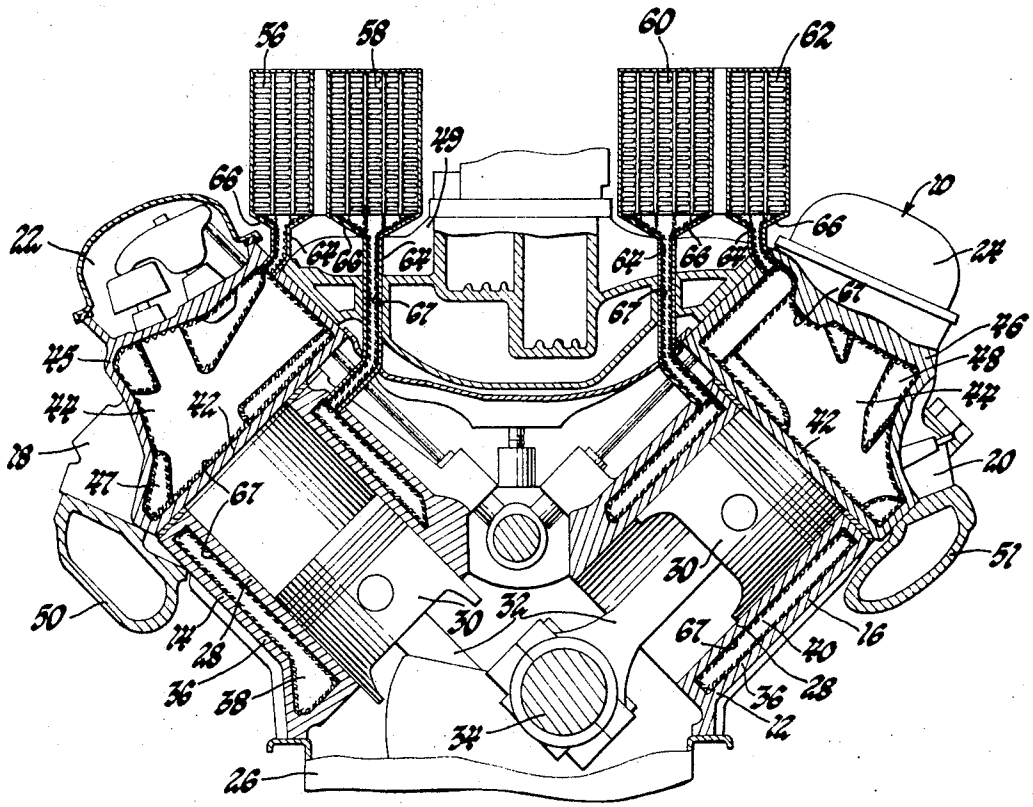


Fig. 2

INVENTOR.
BY Charles B. Leffert
Robert J. Outland
ATTORNEY

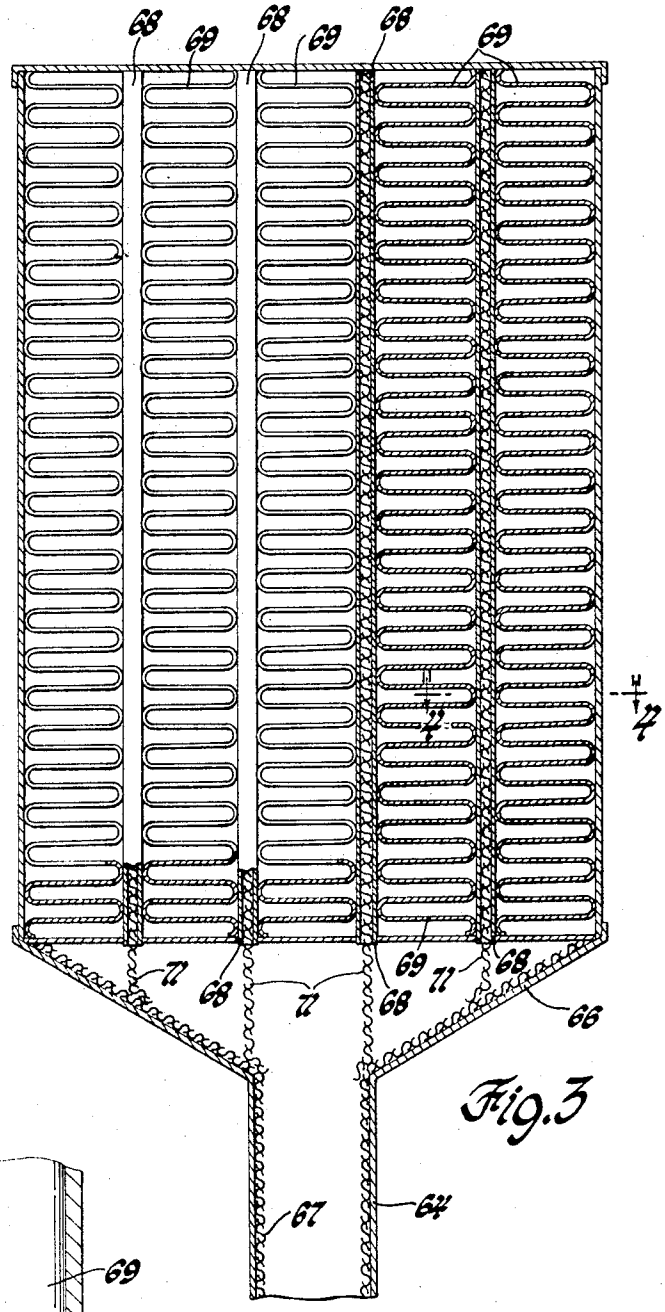


Fig. 3

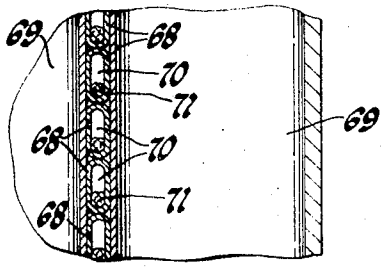


Fig. 4

INVENTOR.
Charles B. Leffert
BY
Robert J. Outland
ATTORNEY

VAPOR-COOLED INTERNAL COMBUSTION ENGINE

FIELD OF THE INVENTION

This invention relates to internal combustion engines and, more particularly, to an engine having separate sealed vapor cooling systems for each of the various cylinder block and cylinder head coolant cavities. In its more particular aspects, it involves cooling systems using wick means to provide capillary coolant flow. It further relates to condenser and air flow arrangements for use with a vehicle engine.

SUMMARY OF THE INVENTION

The present invention provides an internal combustion engine cooling system wherein the various coolant cavities in separate portions or components of the engine, such as the cylinder block and cylinder head, are provided with individual sealed cooling systems utilizing cooling through vaporization of a vaporizable heat transfer fluid with condensation in a remote condenser, with return of the liquid and its vaporization being aided by wick means.

Each of the separate cooling systems borrows from the known technology of heat pipes to provide high capacity heat transfer between the internal engine cavities and the condensers, with the operation and construction of internal wick means being in accordance with known principles. The principles involved are disclosed, for example, in U.S. Pat. Nos. 2,350,348, Gaugler, and 3,287,906, McCormick, assigned to the assignee of the present invention and are further discussed in an article by G. Yale Eastman entitled "The Heat Pipe" and published in the May 1968 issue of Scientific American.

In the present invention, the cooling cavities of the engine cylinder block and cylinder head are completely separated from one another, thereby avoiding any possibility of leakage through the gasketed connection which is provided between them in conventional engine cooling arrangements. The provision of wick type vaporization and coolant transfer means in sealed systems which are substantially filled with a heat transfer medium in liquid and vaporous form avoids the need for coolant pumps and other devices for transporting or controlling coolant flow and maintaining the desired temperature. The use of a suitable coolant, such as an alcohol-water azeotrope mixture as a heat transfer medium permits trouble-free operation under the varying temperature conditions normally encountered in automotive vehicles. The condensers for the various sealed systems may be conveniently arranged in longitudinal rows alongside or above the cylinder banks and may be cooled by engine driven blower means supplying ambient air through suitable ducts.

These and other advantages of the invention will be more clearly understood by reference to the following description of a preferred embodiment taken together with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 is a pictorial view of an internal combustion engine including vapor cooling means according to the present invention;

FIG. 2 is a transverse cross-sectional view of the engine of FIG. 1 taken generally in the plane indicated by the line 2—2 of FIG. 1;

FIG. 3 is an enlarged cross-sectional view illustrating the internal construction of one of the condenser means of the engine of FIGS. 1 and 2; and

FIG. 4 is a transverse cross-sectional view of a portion of a condenser taken in the plane indicated by the line 4—4 of FIG. 3.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring first to FIG. 1 of the drawings, there is shown an internal combustion engine generally indicated by numeral 10 and having the usual cylinder block 12 with a pair of cylinder banks 14, 16 having cylinder heads 18, 20, respectively, mounted on the two cylinder banks. Valve covers 22 and 24 are conventionally mounted on the cylinder heads 18 and 20, respectively, and an oil pan 26 closes the lower portion of the cylinder block.

As best shown in FIG. 2, the engine cylinder block is provided with a plurality of cylinder walls 28 which define cylinders longitudinally arranged in rows along the length of the cylinder banks 14, 16. Each of the cylinders reciprocably carries a piston 30 connected by a connecting rod 32 with the usual crankshaft 34 for the conversion of the reciprocating motion of the pistons to rotating motion of the crankshaft for the delivery of power from the engine. Surrounding the cylinder walls 28, the cylinder block is provided with external walls 36 which define separate coolant cavities 38 and 40 around the cylinders of the two cylinder banks 14, 16, respectively.

The engine cylinder heads 18, 20 are each provided with combustion walls 42 which are secured against the outer ends of their respective cylinder banks, closing the ends of the cylinders. Within the cylinder heads, there are provided internal walls 44 which define inlet and exhaust gas passages, spark plug openings, valve guides and the like, as needed to accomplish the various purposes of the cylinder head. External walls 45, 46 are also provided, which cooperate with the combustion walls 42 to define coolant cavities 47, 48 adjacent the combustion walls and surrounding the internal walls 44 of the respective cylinder heads.

The engine illustrated is a V-type wherein the cylinder banks are angularly disposed and an inlet manifold 49 is mounted between the banks connecting with the inner sides of the cylinder heads 18, 20. Exhaust manifolds 50, 51 are mounted conventionally on the outer surfaces of the cylinder heads.

Connecting with each of the four separate coolant cavities defined within the cylinder heads and the separate banks of the cylinder block are four rows of vapor condensers 56, 58, 60, 62, each row preferably being made up of a plurality of separate condenser elements, each being connected by a separate tube 64 with its respective coolant cavity at a point in lateral alignment with a respective one of the engine cylinders. In the present instance, engine 10 represents an engine conventionally arranged with eight cylinders, four in each bank. Thus, the condensers of the inner rows 58, 60 are connected through individual tubes 64 with the coolant cavities 38, 40 of their respective banks at

points opposite each of the respective cylinders 38, a separate condenser element being provided for each cylinder. The separate condenser elements of each row are arranged in longitudinal alignment. In like fashion, the outer rows 56, 62 of condenser elements are each made up of four longitudinally arranged condensers which are separately connected through individual tubes 64 with the coolant cavities 47, 48 of their respective cylinder heads 18, 20 at points in alignment with the various engine cylinders 28.

Within each of the sealed systems comprising the separate coolant cavities and their respective connecting condenser means, porous wick means 67 are provided which preferably coat the internal surfaces of each of the coolant cavities, their respective connecting tubes 64 and at least the lower portions 66 of the condenser elements so as to provide a continuous flow path for liquid coolant. Preferably the condensers also include vertical cooling tubes 68 in heat exchange contact with suitable fins 69. The cooling tubes 68 include internal open portions 70 for the passage of vapor therethrough and preferably also include wick means 71 at one edge thereof extending longitudinally of the tubes and downwardly into contact with the wick means 69 in the lower portions of the condensers.

Upon assembly, each of the separate cooling systems is evacuated of air and filled with a suitable vaporizable coolant (heat exchange medium). While water has desirable heat transfer qualities for this purpose, the desirability of avoiding freezing at low ambient temperatures makes preferable the use of another fluid, such as methanol or an azeotropic mixture of alcohol and water. Each system is filled with at least a sufficient volume of coolant so that the wicks are completely saturated with coolant in the liquid state and the remainder of the system contains coolant in the vapor state.

While the use of wick means in the vertical condenser tubes is deemed preferable, it is recognized that satisfactory operation would be possible if suitably sized condenser tubes are provided to permit the flow of vapor and condensed liquid in opposite directions therethrough without blockage by capillary action, in which case the use of wick means in the tubes would not be a requirement of the present invention. In addition, the coolant cavities of the cylinder block and cylinder heads would not necessarily require wick means on all their surfaces but might alternatively be arranged so that wick means are used only on such surfaces as the cylinder walls of the various cylinder banks and the combustion walls and possibly the exhaust passage walls of the cylinder heads which are the primary surfaces from which heat must be dissipated in the operation of the engine. In each case, however, it is necessary that the wick means provided in the coolant cavities be connected in a continuous path with the wick means in the tubes 64 leading to the respective condensers.

While it is possible that the arrangement of condenser elements so far described could be cooled by the longitudinal passage of air through the condensers caused by the forward motion of a vehicle in which the engine may be installed, it is believed preferable that a suitable fan or blower be employed. In the present arrangement, a drum type blower 80 is mounted along the forward portion of the engine cylinder block and driven by suitable belt means 82 from the forward end of the engine crankshaft 34. Blower 80 distributes air through ducts 84, 86 to the forward ends of the condenser rows 56, 58, 60, 62 so that it passes longitudinally through the condensers, dissipating heat therefrom. Suitable ducts 88, 90 are provided to receive the air passing from the condenser elements and direct it either downwardly toward the ground or through suitable ducting, not shown, into the passenger compartment of an associated vehicle for heating purposes.

While the arrangement disclosed is considered suitable for installation in the under-hood compartments of current vehicles, it is recognized that the condenser elements might be located in numerous other convenient positions with equally acceptable results. The arrangement as pictured requires that the inlet manifold 49 be built up in separable sections so as to provide for installation of the manifold around the tubes 64 of the inner rows 58, 60 of condensers. It would, however, be within the scope of the invention to provide other arrangements of the condensers or to relocate the connecting tubes 64 so that the use of a multipiece manifold would be avoided.

While the invention has been disclosed by reference to a preferred embodiment chosen for purposes of illustration, it is intended that the invention not be so limited but that it include all possible arrangements which may follow from the inventive concepts disclosed and are within the scope of the following claims.

I claim:

1. In combination:

an internal combustion engine including a cylinder block having a cylinder wall defining a cylinder and outer walls forming an enclosed coolant jacket around said cylinder wall and a cylinder head having a combustion wall secured against said cylinder block and closing one end of said cylinder, said cylinder head also having external walls forming an enclosed coolant jacket adjacent said combustion wall,

a first sealed cooling system comprising a first fluid condenser having internal fluid passages and connected with said cylinder block coolant jacket, first liquid carrying wick means covering the coolant jacket side of said cylinder wall and extending into said condenser while leaving an open passage therebetween and a vaporizable fluid coolant substantially filling said first sealed system, a portion of said coolant being in the liquid state and saturating said first wick means and the remainder of said coolant being in the vapor state, and

a second sealed cooling system comprising a second fluid condenser having internal fluid passages and connected with said cylinder head coolant jacket, second liquid carrying wick means covering the coolant jacket side of said combustion wall and extending into said second condenser while leaving an open passage therebetween and a vaporizable fluid coolant substantially filling said second sealed system, a portion of said coolant being in the liquid state and saturating said second wick means and the remainder of said coolant being in the vapor state.

2. The combination of claim 1 wherein said first and second wick means extend over substantially all the interior surfaces of said cylinder block coolant jacket and said cylinder head coolant jacket, respectively.

3. The combination of claim 1 and further comprising blower means connected with said first and second fluid condensers to deliver cooling air to said condensers for carrying heat therefrom.

4. In combination:

an internal combustion engine including a cylinder block having a plurality of cylinder walls defining an equal number of longitudinally aligned cylinders and outer walls forming an enclosed coolant jacket around said cylinder walls, and a cylinder head having a combustion wall secured against said cylinder block and closing one end of said cylinders, said cylinder head also having external walls forming an enclosed coolant jacket adjacent said combustion wall,

a first sealed cooling system comprising a first plurality of longitudinally aligned fluid condensers, one for each of said cylinders, each said condenser having internal fluid passages and being connected with said cylinder block coolant jacket adjacent its respective cylinder, first liquid carrying wick means covering the coolant jacket side of each said cylinder wall and extending into its respective condenser while leaving an open passage therebetween and a vaporizable fluid coolant substantially filling said first sealed system, a portion of said coolant being in the liquid state and saturating said first wick means and the remainder of said coolant being in the vapor state, and

a second sealed cooling system comprising a second plurality of longitudinally aligned fluid condensers, one associated with each of said cylinders, said condensers having internal fluid passages and connected with said cylinder head coolant jacket adjacent their associated cylinders, second liquid carrying wick means covering the coolant jacket side of the combustion wall portion at the end of each cylinder, said wick means extending into the respective second fluid condenser associated therewith while leaving an open passage therebetween and a vaporizable fluid coolant substantially filling said second sealed system, a portion of said coolant being in the liquid state and saturating said first wick means and the remainder of said coolant being in the vapor state, and

blower means connected with said first and second fluid condensers to deliver cooling air to said condensers for carrying heat therefrom.

5. The combination of claim 4 wherein said first and second wick means extend over substantially all the interior surfaces of said cylinder block coolant jacket and said cylinder head coolant jacket, respectively.

6. In combination:

a V-type internal combustion engine including a cylinder block having two angularly disposed cylinder banks with a plurality of cylinder walls defining an equal number of longitudinally aligned cylinders in each cylinder bank and outer walls forming an enclosed coolant jacket around the cylinder walls of each bank, and a cylinder head for each bank, each head having a combustion wall secured against its respective cylinder bank and closing one end of the cylinders thereof, each said cylinder head also having external walls forming an enclosed coolant jacket adjacent said combustion wall, and

inner and outer longitudinally extending pairs of fluid condenser means disposed above and intermediate said cylinder banks, said inner pairs being connected with the cylinder block coolant jackets of their respective banks and said outer pairs being connected with the cylinder head coolant jackets of their respective banks to form four separate sealed cooling systems,

first liquid carrying wick means covering the coolant jacket sides of cylinder walls of the respective cylinder banks and extending into their respective condenser means while leaving open passages therebetween,

second liquid carrying wick means covering the coolant jacket side of said cylinder head combustion wall portions adjacent said cylinder ends, said second wick means extending into their respective condenser means while leaving open passages therebetween, and

vaporizable fluid coolant substantially filling all four of said sealed cooling systems, portions of said coolant being in the liquid state and saturating all of said first and second wick means and the remainder of said coolant being in the vapor state.

7. The combination of claim 6 and further comprising an air blower drivable by said engine and direct means connecting said air blower with each of said fluid condenser means and directing air delivered by said blower longitudinally through said condenser means.

* * * * *