May 28, 1968 F. S. BASTER 3,385,273

COOLING SYSTEM FOR INTERNAL COMBUSTION ENGINE

Filed Sept. 10, 1965 3 Sheets-Sheet 1

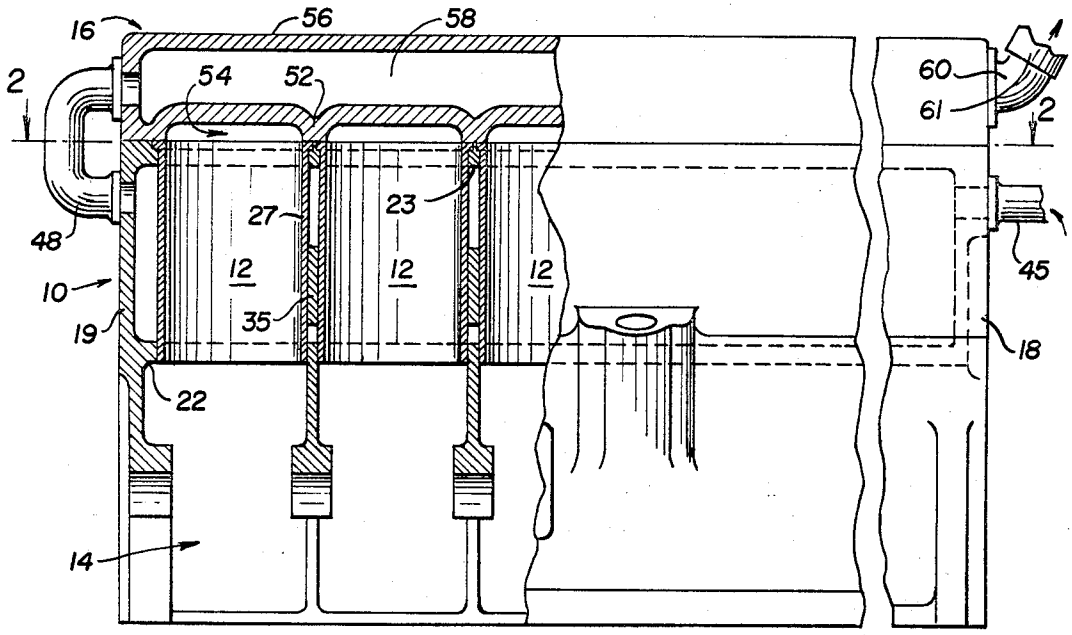


Fig. 1

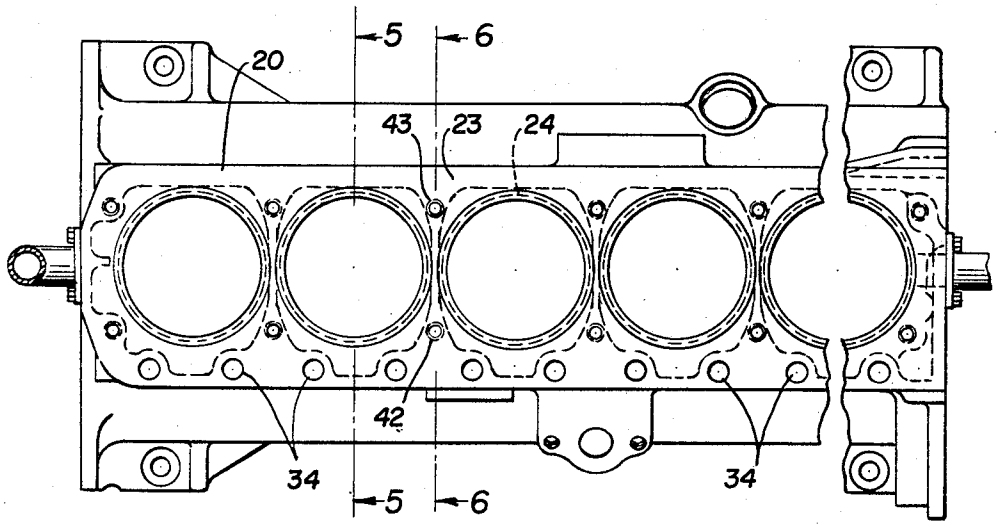


Fig. 2

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COOLING SYSTEM FOR INTERNAL COMBUSTION ENGINE

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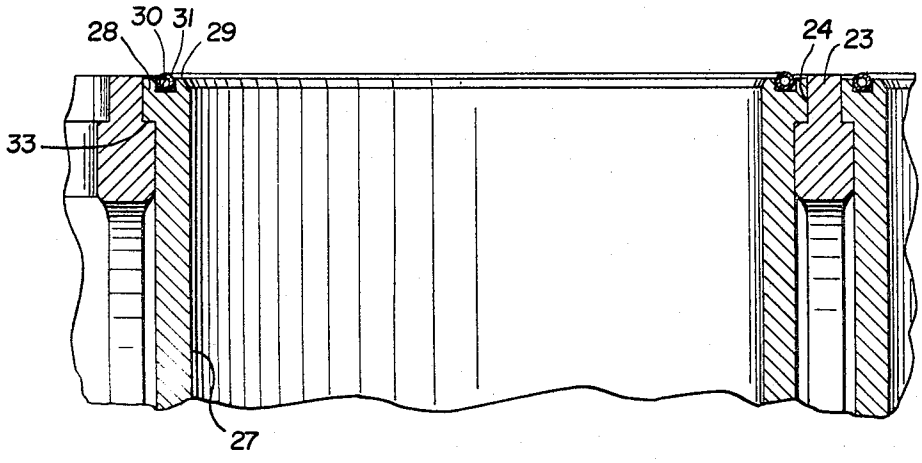


Fig. 3

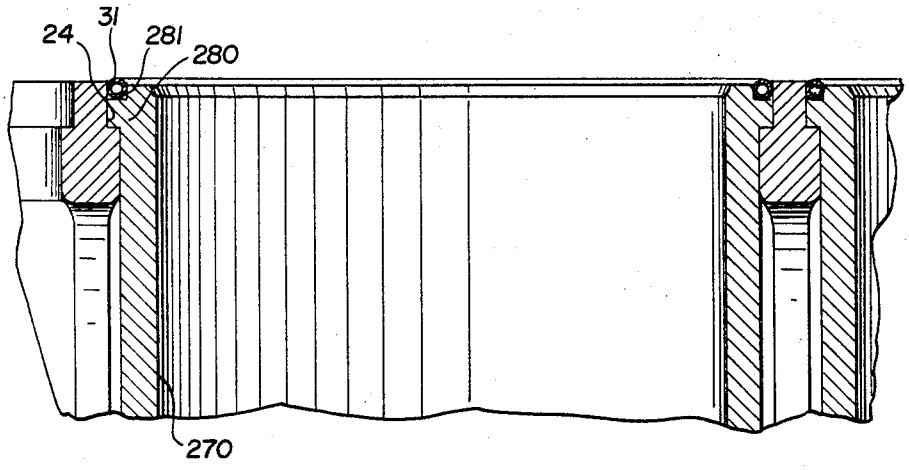


Fig. 4

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COOLING SYSTEM FOR INTERNAL COMBUSTION ENGINE

Filed Sept. 10, 1965 3 Sheets-Sheet 3

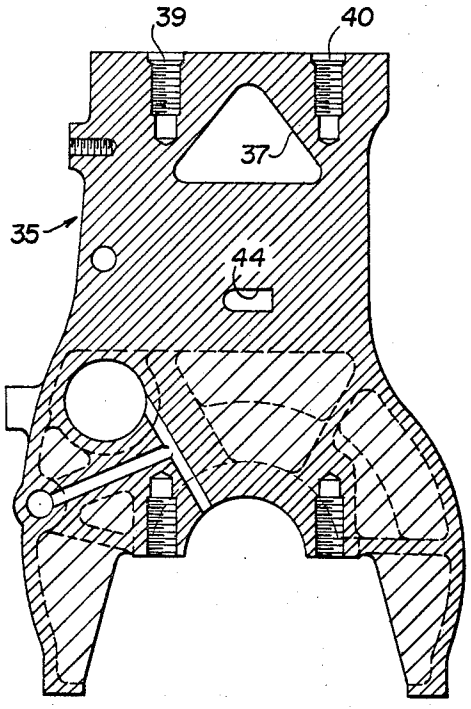


Fig. 6

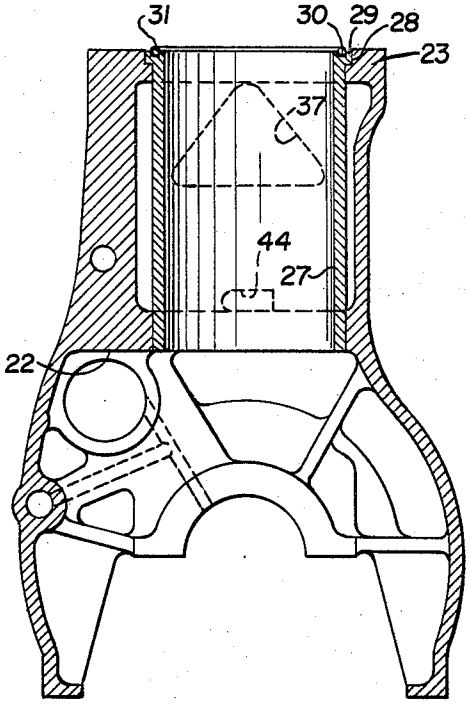


Fig. 5

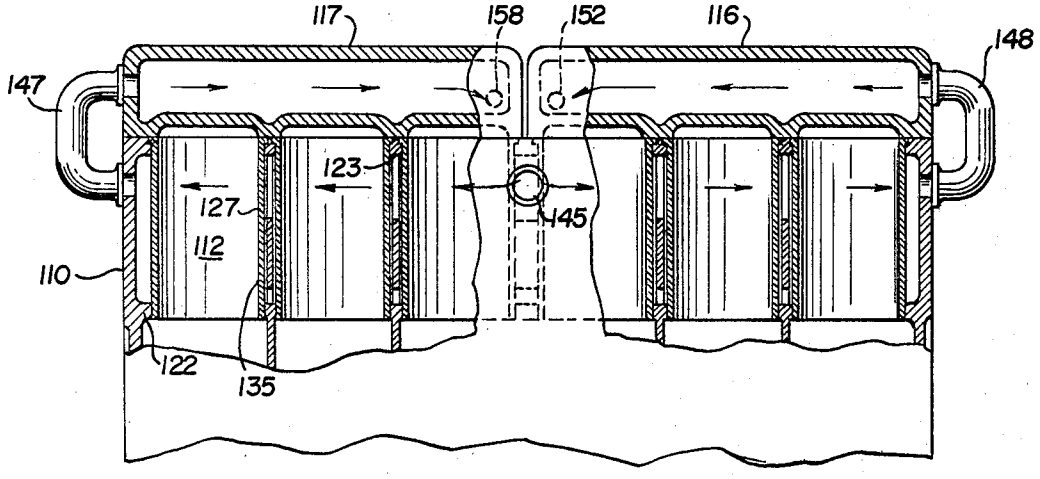


Fig. 7

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United States Patent Office 3,385,273 Patented May 28, 1968

3,385,273

COOLING SYSTEM FOR INTERNAL COMBUSTION ENGINE

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Filed Sept. 10, 1965, Ser. No. 486,408
14 Claims. (Cl. 123—41.74)

ABSTRACT OF THE DISCLOSURE

An internal combustion engine in which the cooling jacket of the cylinder block is connected in series with the cooling jacket of the cylinder head. Transverse baffles are located within the engine block between adjacent cylinder sleeves and are apertured to direct the flow of cooling liquid through the block in essentially a zone surrounding the upper portions of the cylinder sleeves.

This invention relates to an improved cooling system for internal combustion engines and more particularly to an improved arrangement for providing and controlling a desired flow of cooling liquid around the cylinders and through the cylinder head of such combustion engines.

Early attempts at cooling internal combustion engines provided a flow of water through a jacket surrounding the engine cylinders, the water being introduced at one end of the block and removed at the other end. In these early cooling arrangements, it was found that the water had to be either too cool when introduced adjacent the cylinder at the inlet end of the engine or else it was too hot as it reached the last cylinder of the engine adjacent the outlet. In addition because the volume of the liquid flow in some portions of the cooling jacket would be very slow, these portions tended to become excessively hot. As the power of engines was increased the difficiencies in this type of flow became increasingly troublesome.

By about 1920, these disadvantages were overcome with a system for circulating water within the cooling jacket in the manner that is now conventional; that is, by providing a water jacket the length of the engine and causing the flow of cooling water to be in a lateral direction from one side of the engine to the other. This, of course, necessitated a more complex jacket and water manifold construction, but provided more uniform, improved cooling.

In accordance with the present invention, improved engine cooling is obtained while nevertheless circulating a flow of cooling liquid from one end of the engine to the other, an approach previously believed to be disadvantageous. Briefly, the use of this type of circulation is now possible while yet providing adequate and sufficiently uniform cooling by establishing a sufficient, predetermined volume flow of cooling liquid for each unit of rated engine horsepower, and by completely surrounding the cylinders with cooling fluid while restricting the flow of cooling fluid to a zone generally surrounding only the upper portions of each cylinder. Because the flow of cooling liquid is restricted to the upper portions of the cylinders, the circulation and, hence, the effective cooling is applied primarily about the areas of the cylinder that are the hottest and that require efficient cooling. In addition, the velocity of the flow of cooling liquid for a given volume flow through the engine is increased. This higher velocity flow restricted to the hottest portions of the engine removes more heat with a smaller temperature increase in the cooling fluid from inlet to outlet in a given time interval than known cooling systems of this type.

Many novel features are embodied in the engine of the present invention, to achieve the improved cooling. One feature of this invention is to provision of transverse

baffles within the engine block between adjacent cylinder sleeves. Each such baffle includes a relatively large aperture located within the upper half of the baffle, adjacent the top of the engine block. A very small aperture, by comparison, is provided in each baffle adjacent the bottom of the cylinder sleeve to permit the engine block to be drained by cooling liquid and to promote a small amount of circulation. The larger apertures are located essentially symmetrically with respect to a longitudinal plane passing through the central longitudinal axes of the cylinder sleeves to allow equal flow around each side of the cylinder sleeves. While baffles restrict the flow of cooling fluid to the upper and middle portions of the cylinder sleeves, so that substantially all and in any event more than half of the volume flow occurs about the upper half and preferably about the upper one-third of the cylinders, the apertures are of sufficient size to allow the desired volume of cooling liquid through the engine without creating an undue pressure drop from inlet to outlet.

A further feature of this invention is that the flow of liquid through the engine block is isolated from the cylinder head so that the water flows through the entire block and thence into the head. Thus, the cooling jacket of the block and head are connected in series, the cooling liquid flowing first, for example, into one end of the engine block, then out the opposite end and into one end of the head, and then out the other end of the head. The cooling jackets of the engine block and the cylinder head do not communicate intermediate the ends. This construction, in combination with seal rings surrounding the top of each cylinder sleeve, eliminates the need of a head gasket between the engine block and the cylinder head, as is customarily required.

The object of the invention, then, is to provide a novel and improved internal combustion engine cooling system and method wherein a high velocity of coolant flow and attendant cooling efficiency is obtained.

Other attendant objects, advantages and features of this invention and various embodiments thereof will be readily appreciated as the same become better understood by reference to the following detailed description when considered in connection with the accompanying drawing in which:

FIGURE 1 is a diagrammatic, longitudinal sectional view of an internal combustion engine constructed in accordance with the present invention;

FIGURE 2 is a plan view taken along the line 2—2 of FIGURE 1, showing the engine block with the cylinder head removed;

FIGURE 3 is an enlarged fragmentary section view of the cylinder sleeves as shown in FIGURE 1, illustrating the construction and arrangement of upper flanges and seal rings associated with each cylinder sleeve;

FIGURE 4 is a view similar to FIGURE 3 showing an alternative embodiment of a cylinder sleeve;

FIGURE 5 is a transverse sectional view of the engine block of FIGURE 2, taken along the line 5—5 and looking in the direction of the arrows;

FIGURE 6 is a sectional view of the engine block of FIGURE 2 taken along the line 6—6 and looking in the direction of the arrows, and showing the construction of one of the transverse flow control baffles; and

FIGURE 7 is a longitudinal sectional view of another embodiment of an internal combustion engine constructed in accordance with the present invention, showing a cooling system for an engine having two logitudinally aligned cylinder heads.

Referring now to the drawings, there is shown in FIGURE 1 the upper portion of an engine block 10, including a plurality of in-line cylinders 12 and the upper portion of a crank case 14. A cylinder head 16 is mounted on top of the engine block 10, enclosing the tops of the

cylinders 12. For clarity, conventional valves, valve operators, manifolds, etc., have been omitted from the drawings.

The engine block 10 includes a front end wall 18, a back end wall 19, two longitudinally extending, spaced, side walls 20 and 21, a lower dividing wall 22 and a top wall 23. Circular openings 24 are provided along the length of the top wall 23 and similar openings are provided in the lower dividing wall 22 to receive cylinder sleeves 27 that define the cylinder cavities 12. The cylinder sleeves 27 and the encompassing side, end, top and lower walls define a water jacket within the engine block 10 in which cooling liquid may be contained around the cylinders 12.

Each cylinder sleeve 27 includes an annular flange 28 extending outwardly about the top of the sleeve. See FIGURE 3. The flange has a flat top surface 29. An annular groove 30 is located within the top surface 29 of the annular flange 28 and contains an annular seal member 31, such as a metal O-ring. Preferably, the metal O-ring is hollow and includes apertures through the wall of the ring so that the pressure within the ring may be equalized with that within the cylinder. A recessed lip 33 formed in the top wall 23 about each circular aperture 24 retains the cylinder sleeve 27 with the top surface 29 of the flange 28 slightly below the top of wall 23. A plurality of openings 34 are provided through the top wall 23 near the side wall 21 of the block for valve operating push rods, and are not connected with the water jacket. With this arrangement, when the cylinder head is in place, a tight seal is provided about each cylinder between the head and block.

As an alternative construction (see FIGURE 4), a cylinder sleeve 270 may be provided having an annular flange 280 about the top of the sleeve. An external annular recess or step 281 is provided about the outer periphery of the flange. The step 281 cooperates with the respective circular aperture 24 in the top wall 23 to form a groove to receive the seal member 31.

A plurality of transversely extending baffles 35 are each located between adjacent cylinder sleeves 27 and extend transversely between the side walls 20 and 21. The baffles also extend from the top wall 23 through the lower dividing wall 22 into the crank case 14 and in part surround the crank shaft and bearings, not shown. Each baffle 35 is narrow with respect to its width so as to fit between the closely adjacent cylinder sleeves 27. An aperture, such as a triangular opening 37, is provided through the upper portion of each baffle 35, located symmetrically with respect to a longitudinally extending plane of the block through the central longitudinal axes of the cylinder sleeves 27. As best shown in FIGURES 5 and 6, the triangular opening 37 is oriented with its apex adjacent the top portion of baffle 35, just beneath the top wall 23 of the engine block 10. The base of the triangular opening 37 is located above the mid-point between the top and bottom of the cylinder sleeve 27 so that the opening 37 is adjacent only the upper portion of an adjacent cylinder sleeve. Two vertically extending threaded bores 39 and 40 extend from the top of the baffle 35 downwardly through the body or web portion of the baffle. It will be seen that the triangular shaped opening 37 provides a relatively large open area through the upper portion of the baffle 35 while yet providing structurally strong web portions adjacent the top of the baffle to accommodate the threaded bores 39 and 40 which receive threaded fasteners, not shown, for securing the head and block together.

A second aperture 44 is provided through each baffle 35, spaced below the triangular opening 37. The aperture 44 is much smaller than the opening 37 and is positioned just above the lower dividing wall 22, between adjacent cylinders sleeves 27.

In the embodiment shown in FIGURES 1 and 2, an inlet pipe 45 is connected to the front wall 18 of the engine block 10 just beneath the top wall 23. The pipe 45 communicates between the water jacket surrounding the cylinder sleeves 27 and a supply of cooling fluid e.g., a radiator or water pump. A second pipe 48 is located at the back wall 19 of the engine block 10 just beneath the top wall 23 and communicates between the water jacket of the block and the cylinder head 16.

As best shown in FIGURE 1, the cylinder head 16 includes a bottom wall 52 in which are formed combustion chamber cavities 54 adapted to overlie the cylinders 12. An outer, surrounding, spaced wall 56 contiguous with the perimeter of the bottom wall 52 forms an elongated cavity or water jacket 58 within the cylinder head 16. The pipe 43 from the engine block communicates with this cavity. An outlet pipe 60 is provided through the outer wall 56 of the cylinder head 16 at the front of the engine, generally above the inlet pipe 45 of the cylinder block 10. The outlet pipe 60 is connected by hose 61 with the source of cooling liquid to provide for recirculation.

The flat bottom surface 52 of the cylinder head 16 fits substantially flush with and directly upon the top wall 23 of the engine block 10. Seal members 31 abut the lower surface of the wall 52 and are compressed somewhat between the lower surface and the annular groove 30 encircling the flange 28 of each cylinder sleeve 27. This provides a pressure-tight seal between the cylinder head and the flange of each cylinder sleeve. These seals, plus the absence of communication between the cooling jackets of the block and head intermediate the ends of the engine, eliminate the need for a conventional head gasket. Obviously, this same arrangement may be used where the cylinder head is formed with a completely flat bottom wall, as where the combustion chamber is formed in the pistons.

A modification of the embodiment above described is shown in FIGURE 7 of the drawings. This embodiment is comprised of an engine block 110 having six in-line cylinders 112 extending along the length thereof. There are two cylinder heads 116 and 117 extending along the length of the engine block 10. The cylinder head 116 overlies the first three cylinders of the engine and the cylinder head 117 overlies the last three. The general construction and arrangement of the cylinder sleeves and baffles is identical to the embodiment already described. Thus, each cylinder 112 is formed of a cylinder sleeve 127 supported between a top wall 123 and a lower dividing wall 122 of the engine block, and the engine block walls and the sleeves 127 form a continuous water jacket around the cylinder 112. Baffles 135 extend transversely of the engine block 110 between the adjacent cylinder sleeves 127. Each baffle includes apertures as described in the previous embodiment. In this embodiment an inlet pipe 145 for introducing cooling liquid into the water jacket surrounding the cylinders 112 is provided at a central location in the outer wall of the engine block 110, i.e., between the third and fourth cylinders. The inlet pipe 145 is located near the top wall 123 of the engine block and is connected to a source of cooling fluid.

Two connecting pipes 147, 148 are provided, one at each end of the engine block 110 adjacent the top wall 123. The pipe 147 connects between the water jacket of the engine block 110 and the outer end of the water jacket of the head 117. The pipe 148 similarly connects with the water jacket of the cylinder head 116. Each cylinder head 116, 117 has an outlet pipe 152, 158, respectively, at the opposite end of the water jacket from the connecting pipe 147, 148. The two outlet pipes 152, 158 are located centrally of the engine, above the inlet pipe 145 and both are connected to the source of cooling liquid.

The operation will be first described with respect to the embodiment of FIGURES 1 and 2.

Cooling liquid, such as water, is introduced under positive pressure in a conventional manner through the inlet pipe 45 and into the water jacket surrounding the cylinders 12, as defined by the end walls 18 and 19, the

top wall 23, the bottom wall 22 and the cylinder sleeves 27. Cooling liquid flows from the inlet pipe 45 through the length of the engine block 10 and into one end of the water jacket 58 of cylinder head 16 via the connecting pipe 48. The cooling liquid then flows the length of the cylinder head 16 from the connecting pipe 48 to the outlet pipe 60 at the front of the engine, near pipe 45 where it entered. The top wall 23 of the engine block 10 and the bottom wall 52 of the cylinder head 16 confine the flow of cooling liquid to a series flow through the engine block and cylinder head, there being no lateral or parallel flow between the two, intermediate the ends. The flow of cooling liquid within the engine block 10 between the inlet pipe 45 and the pipe 48 is controlled by the transverse baffles 35. The relatively large triangular openings 37 adjacent the top portions of the baffles 35 readily permit the flow of cooling liquid along the upper portion of the engine block 10 from one end to the other. Because the openings 37 are located symmetrically with respect to a longitudinal plane through the central longitudinal axes of each cylinder 12, a substantially equal flow of liquid is provided about each side of the cylinders. Very little flow passes through the lower apertures 44 in each baffle 35 because they are much smaller than the triangular openings 37 (being no more than 1/5 as large and preferably about 1/10 as large) and, in addition, they are substantially blocked off by the cylindrical sleeves 27 of each adjacent cylinder. These openings are sufficient merely to provide very restricted flow around the lower end of cylinders plus complete drainage of the cooling liquid from the engine when it is desired to do so.

The area of each triangular opening 37 is selected, along with the size of the inlet and outlet openings in the engine block and cylinder head, to permit a flow rate of cooling liquid through the engine block and cylinder head of at least .5 gallon per minute and preferably at least .7 gallon per minute per rated engine horsepower, while producing a pressure drop from the cooling liquid inlet of the engine to the cooling liquid outlet of less than 25 pounds per square inch and preferably less than 10 pounds per square inch. Because the restricted passageways provided by the apertures 37 limit the flow circulating water to the zone about the top of the cylinders, the velocity at which the liquid flows through the engine block and cylinder head is greatly increased for a given volume flow as compared with the velocity in the absence of the baffles 35. As a result of this higher velocity, heat from the upper portions of the cylinders 12 is rapidly removed and the temperature differential of the water between the inlet pipe 45 and the outlet pipe 60 is maintained relatively small. The circulation of cooling liquid adjacent the lower portions of the cylinders 12 beneath the openings 37 in the baffles 35 is extremely small. This is quite satisfactory, however, because the lower portion of the cylinders 12 do not get as hot as the top portions and therefore do not need as much cooling.

In the operation of the embodiment shown in FIGURE 7 of the drawings, cooling liquid is introduced through the inlet 145 adjacent the central portion of the engine block 110. The flow of cooling liquid essentially divides, half flowing toward the front of the engine block and half flowing toward the rear, surrounding each cylinder 112 and flowing through the openings in the baffles 135 in the manner described above. At each end of the engine block 110 the cooling liquid exits through pipes 147 and 148 and is then introduced to the respective cylinder head 116 or 117 adjacent the end of the cylinder block 110. The cooling liquid then flows through both cylinder heads 116 and 117 from the front and back ends of the engine toward the central portion where it is discharged through the outlet pipes 152 and 158.

It will be seen that, in both embodiments, the flow of cooling liquid passes through the engine block and the cylinder head or heads in series, there being no transverse flow between the engine block and cylinder head intermediate the ends.

It will be apparent to those skilled in the art that the present invention, while shown in conjunction with straight or in-line engines, is equally applicable to a V-type engine where the cooling arrangement of each bank of the V-block is constructed in accordance with either embodiment above. In addition, it is contemplated that the triangular-shaped openings in the baffles of the engine block between the cylinders may be of a modified configuration. For example, they may be semi-circular or semi-elliptical, as long as the openings are restricted to the upper portion of the baffle and are shaped with narrow upper areas to properly control the flow of coolant. Thus, while in the foregoing disclosure certain preferred embodiments of the invention have been disclosed, numerous modifications or alterations may be made therein without departing from the spirit and scope of the invention as set forth in the appended claims.

What is claimed is:

1. In an internal combustion engine of predetermined rated horsepower, said engine including a cylinder block, a cylinder head, means to introduce cooling liquid to the engine and means to remove the cooling liquid from the engine so that the liquid flow moves along a path of aligned cylinders: a cylinder block having top and bottom walls, side walls and end walls; a plurality of in-line cylinder sleeves in the block, the sleeves being spaced from each other in the direction of alignment of the in-line cylinders and spaced from the side walls of the block to provide a zone for the flow of cooling fluid around each cylinder sleeve; baffles within the cylinder block between adjacent cylinder sleeves, which baffles extend between the top and bottom walls along the height of adjacent cylinder sleeves in planes that extend parallel to the axes of the cylinders and transversely of the block between the side walls, said baffles each having a top portion adjacent an upper end of an adjacent cylinder sleeve and a lower portion adjacent a lower end of the adjacent cylinder sleeve; aperture means in each baffle adjacent the top portion thereof providing a path for the flow of fluid within the cylinder block through the baffle, said aperture means being constructed and arranged to permit a flow of liquid therethrough at a rate of at least 0.5 gallon per minute per rated engine horsepower with a pressure drop from the cooling liquid inlet means of the engine to the cooling liquid outlet means of less than 25 pounds per square inch, said aperture means being located essentially symmetrically about a plane containing the central axes of the cylinders; and an additional aperture means in each baffle adjacent the bottom portion of the baffle, said additional aperture means being small with respect to the first said aperture means of each baffle, both said first aperture means and said additional aperture means being located in the baffle with respect to the adjacent cylinder sleeves so that more than one-half of a volume flow of cooling liquid introduced to the engine flows around the upper half of the cylinder casing sleeve as the cooling liquid travels from the cooling inlet means to the cooling outlet means of the engine.

2. The engine of claim 1 wherein the first said aperture means is triangular in shape.

3. The engine of claim 1 wherein the baffles include spaced threaded apertures in the top extending in a direction parallel to the central axis of the cylinder sleeves and wherein part of the first aperture means extends between the spaced threaded apertures.

4. The engine of claim 1 wherein the said first aperture means is at least five times the cross sectional area of the said additional aperture means adjacent the bottom of the web.

5. The engine of claim 1 wherein the said first aperture means is at least ten times the cross sectional area of the

said additional aperture means adjacent the bottom of the baffle.

6. An engine block for an internal combustion engine which comprises spaced side walls and end walls, a top wall and a bottom wall, the top wall and bottom wall each having aligned openings for cylinder sleeves, a plurality of cylinder sleeves spaced from each other and in-line within the walls of the engine block, means to supply cooling liquid under pressure to the engine, and around the cylinder sleeves within the walls of the engine block, at a flow rate of at least 0.7 gallon per minute of liquid for each unit of rated horsepower of the engine, and means between the cylinder sleeves to control the flow of cooling liquid along the engine block, said means to control the flow being constructed and arranged to provide equal flow about each side of the adjacent sleeves, to essentially restrict the flow of liquid about the cylinder sleeves to the upper one-third of the sleeves, and to produce a pressure drop of the cooling liquid in its flow through the engine of not more than 25 pounds per square inch.

7. The engine block of claim 6 wherein said means to control the flow produce a pressure drop in the cooling liquid in its flow through the engine of not more than 10 pounds per square inch.

8. An engine block and head, the block having a plurality of aligned cylinder sleeves along the length of the block and a cooling jacket for containing a liquid around the sleeves, and the head having a passageway extending along the length of the head for containing a liquid around the top of the cylinder sleeves; a liquid inlet in the block; a liquid outlet in the head; and conduit means directly connecting the head passageway and block cooling jacket in series only; the block, head and conduit means being so constructed and arranged to provide essentially a continuous path of flow of cooling liquid from the inlet of the block to an end of the block, thence to an end of the head, and through the head to the outlet; and baffle means within the block for controlling the flow of liquid through block so that the flow is essentially limited to a zone surrounding the upper one-half of the cylinder sleeves while permitting a volume flow of cooling liquid of at least 0.7 gallon per minute for each unit of rated horsepower of the engine and while producing a drop in pressure of the cooling liquid flowing through the block and head from inlet to outlet of not more than 10 pounds per square inch.

9. In an engine block and head, a plurality of aligned cylinder sleeves along the length of the block, an enclosure about the cylinder sleeves for containing cooling liquid, a passageway within and along the entire length of the head for containing cooling liquid, liquid inlet means in the block adjacent an end thereof, liquid outlet means in the head adjacent an end thereof corresponding to the end of the block in which the inlet means is located, a passageway communicating between the block and the head through ends of each opposite the ends in which the said inlet and outlet means are located, whereby all the flow of cooling liquid passes through the block and the head in series, and a baffle between adjacent cylinder sleeves having aperture means, said baffle and aperture means directing the flow of cooling liquid through the block in essentially a zone surrounding the upper portions of the cylinder sleeves, thereby increasing the velocity of liquid flow around the upper portions of the cylinder sleeves for a given liquid volume throughput.

10. An engine block and head as set forth in claim 9 in which the liquid inlet means in the block and the passageway communicating between the block and the head open into the block at locations adjacent an upper portion of the block.

11. In an engine block and head in which the engine block contains a plurality of cylinder sleeves and forms a jacket about the cylinder sleeves for containing a cooling liquid and in which there are two separate cylinder heads covering different ones of a plurality of in-line cylinders formed by the cylinder sleeves in the engine block and extending along the length of the block: a passageway within and along the entire length of each cylinder head for containing cooling liquid, liquid inlet means in the block adjacent a central portion thereof, liquid outlet means in each of the two aligned heads at adjacent ends thereof, liquid inlet means in each of the heads at opposite ends thereof, a passageway at each end of the block communicating between the jacket and the inlet means of the adjacent head whereby a flow of cooling liquid first passes through a portion of the block and then through the entire length of only one of the two cylinder heads, and a baffle between adjacent cylinder sleeves having aperture means, said baffle and aperture means directing the flow of cooling liquid through the block in a zone surrounding the upper portions of the cylinder sleeves, thereby increasing the velocity of the liquid flow about said zone for a given volume throughput of cooling liquid.

12. An internal combustion engine comprising

(a) an engine block having spaced side walls and end walls, and a top wall and bottom wall each apertured to locate a plurality of spaced, in-line cylinder sleeves,
(b) annular recesses in the apertures of the top wall,
(c) a plurality of cylinder sleeves each located in the apertures in the top and bottom walls of the engine block and each having an outwardly extending flange about the top of the sleeve, each said flange fitting within the annular recess about the respective aperture in the top wall and having a flat upper surface,
(d) an annular groove at the top of each of the cylinder sleeves and opening upward,
(e) a sealing element within the annular groove,
(f) said side, end, top, and bottom walls and said cylinder sleeves defining an enclosed path for circulating cooling fluid around the cylinder sleeves,
(g) an inlet opening in the engine block adjacent the top thereof for introducing cooling fluid into the block,
(h) a cooling fluid outlet opening adjacent an end and the top wall of the engine block,
(i) an elongated cylinder head mounted directly on the engine block in sealing relationship with a plurality of the sealing elements in the annular grooves at the top of the cylinder sleeves,
(j) a passageway within the cylinder head extending along the length thereof for carrying cooling liquid,
(k) an inlet opening in the cylinder head for introducing cooling fluid into the head, said inlet opening being located at an end of the cylinder head adjacent the said outlet opening of the engine block and in communication with the said outlet opening to provide for the passage of cooling fluid between the block and head,
(l) a cooling fluid outlet opening in the cylinder head located at an opposite end of the head from the inlet opening, and
(m) a plurality of baffles within the engine block and aperture means in each baffle, said baffles essentially restricting the flow of cooling liquid through the engine block to upper portions thereof.

13. The engine of claim 12 wherein the baffle and aperture means are so constructed and arranged to permit a volume flow of liquid of at least 0.7 gallon per minute per unit of rated horsepower of the engine with a pressure drop through the engine of not more than 10 pounds per square inch.

14. The engine of claim 12 wherein there are two longitudinally aligned cylinder heads on the engine block and the cooling fluid inlet opening is located adjacent a central portion of the cylinder block, and wherein there are two cooling fluid outlet openings in the cylinder block, one adjacent each end thereof and there is one cooling fluid inlet opening in each of the cylinder heads, the inlet

opening of each head being located adjacent an end of the cylinder block and the outlet opening of each head being located adjacent a central portion of the cylinder block.

References Cited

UNITED STATES PATENTS

943,408	12/1909	Heinze	123—41.74
1,643,645	9/1927	Strand.	
2,037,354	4/1936	Treiber	123—41.74 X
2,152,594	3/1939	Klotsch	123—41.74 X
2,175,448	10/1939	Schlagintweit	123—41.74

2,734,497	2/1956	Chayne.	
2,972,341	2/1961	Forst	123—193 X
2,976,859	3/1961	Bentz	123—41.74 X
3,203,408	8/1965	Winkelman	123—41.74
3,315,651	4/1967	Dangauthier	123—41.28

FOREIGN PATENTS

1,067,637	10/1959	Germany.
965	5/1914	Great Britain.

AL LAWRENCE SMITH, *Primary Examiner.*