

June 1, 1965

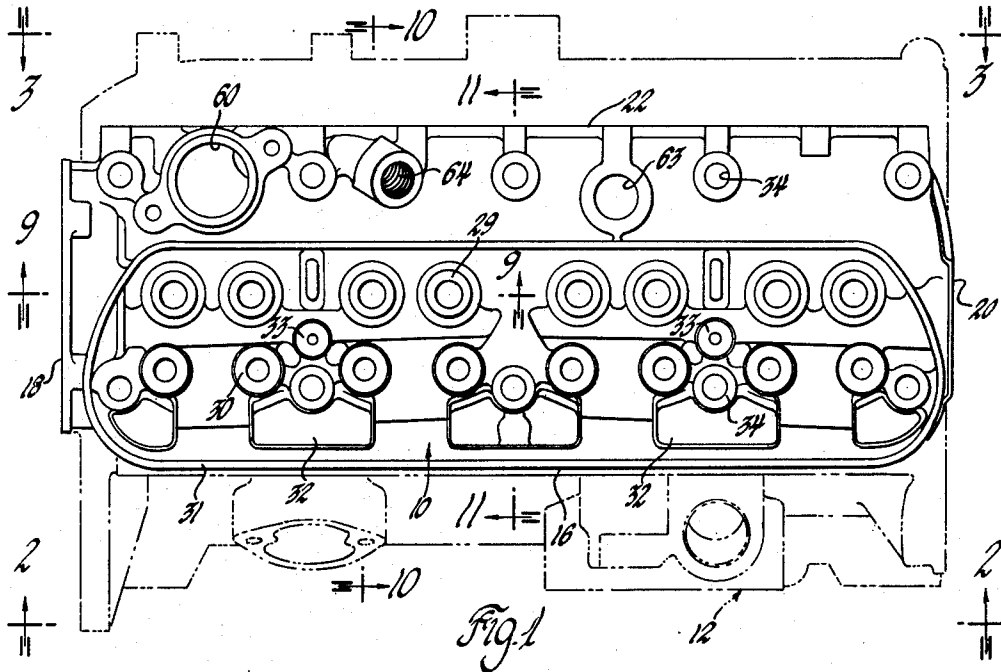
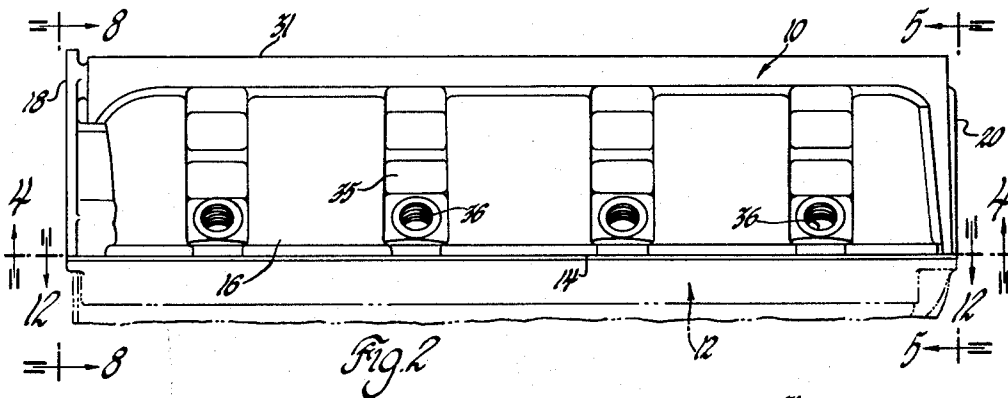
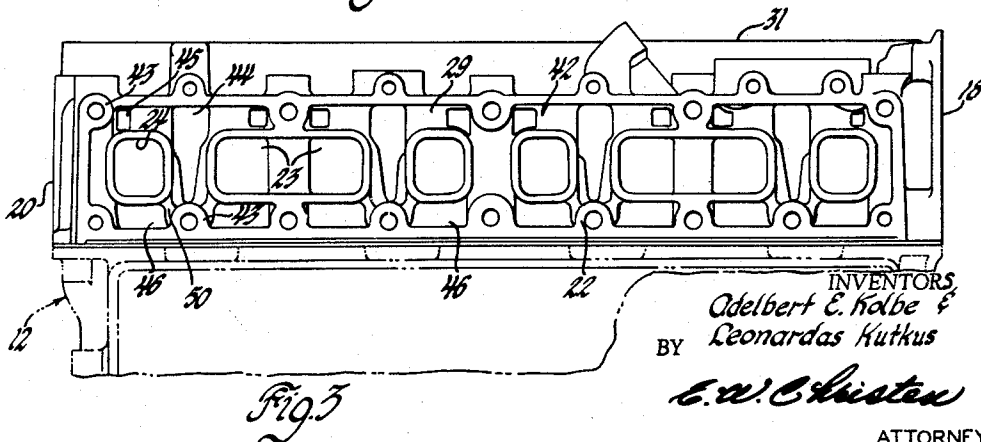
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3,186,387

DIE CASTABLE CYLINDER HEAD CONSTRUCTION

Filed Oct. 9, 1963

4 Sheets-Sheet 1



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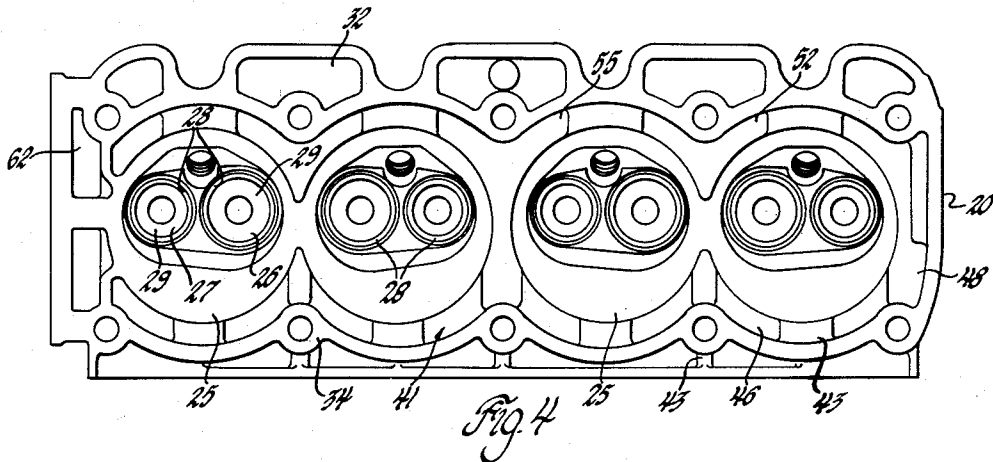
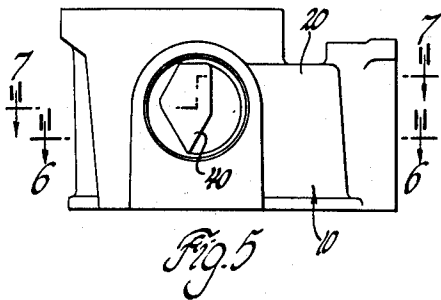
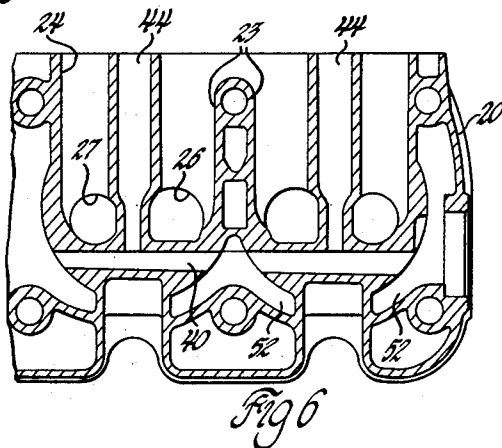
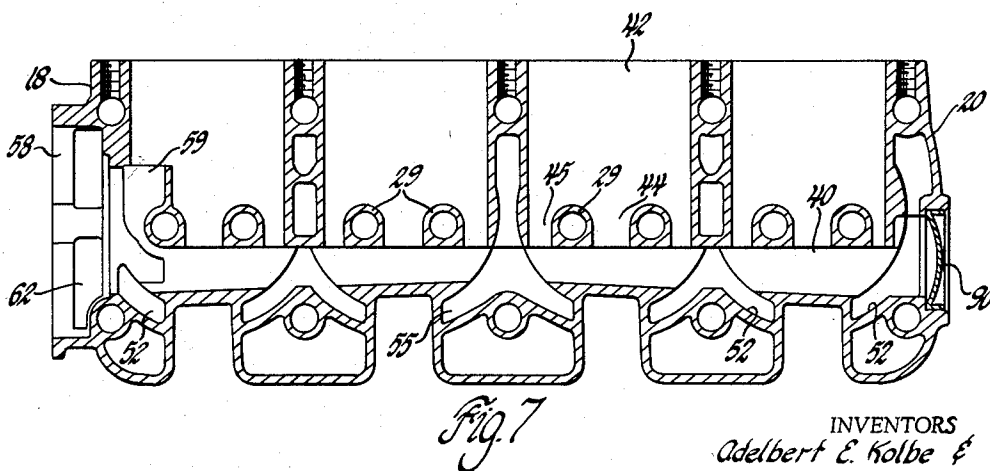
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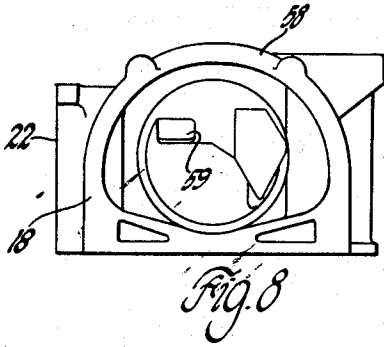
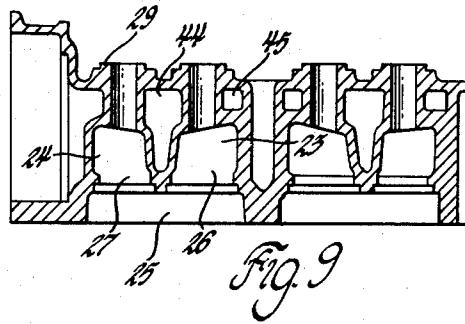
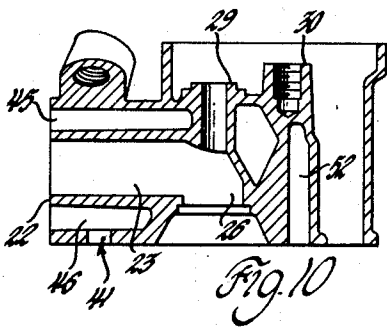
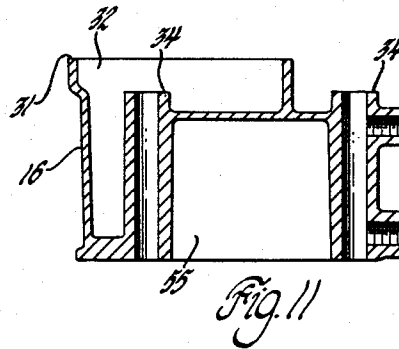
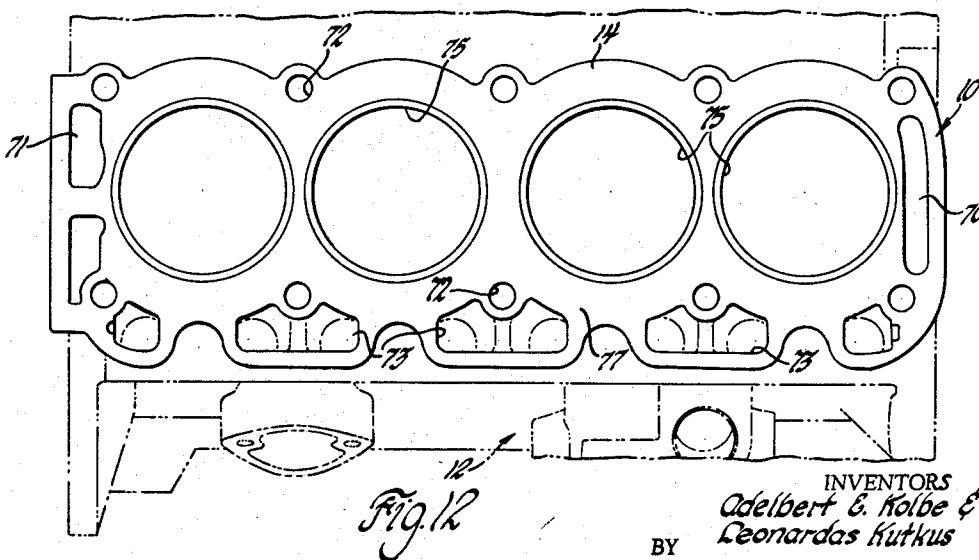
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4 Sheets-Sheet 3



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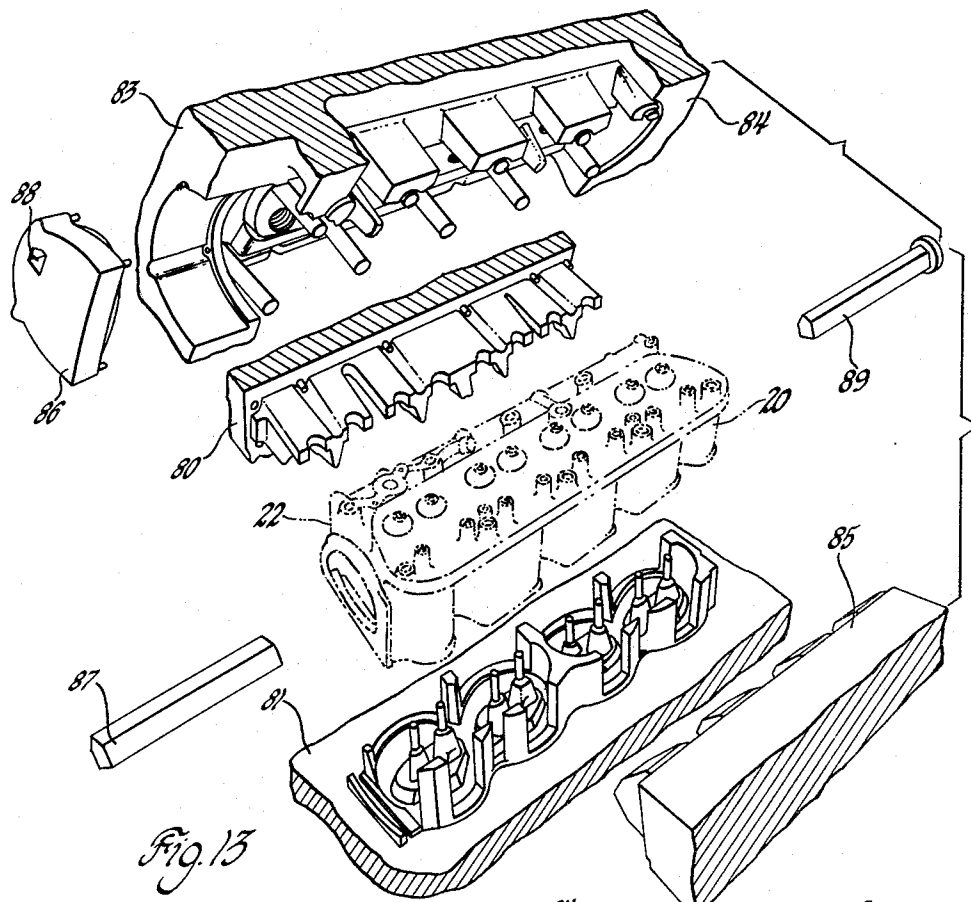
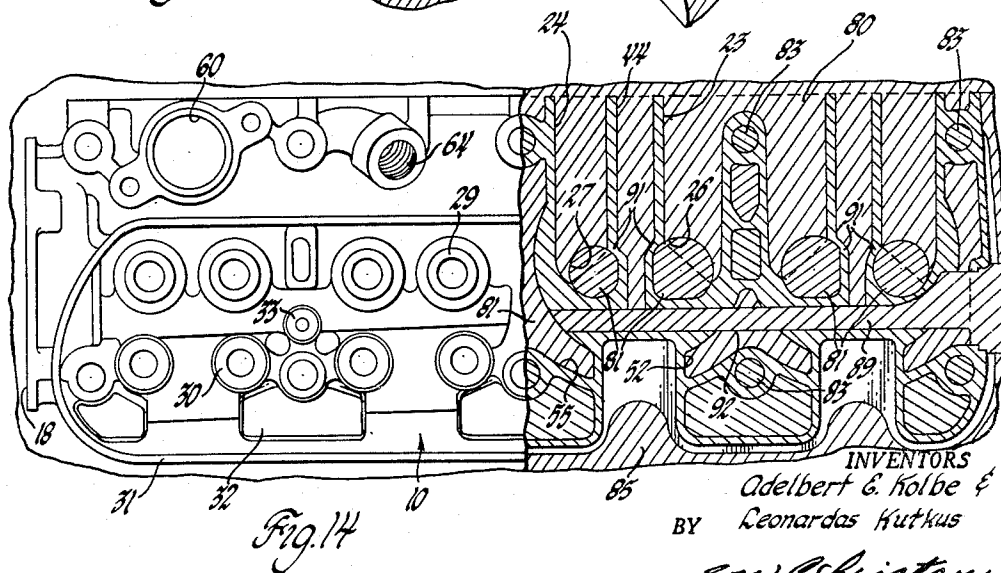
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DIE CASTABLE CYLINDER HEAD CONSTRUCTION

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4 Sheets-Sheet 4



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3,186,387 DIE CASTABLE CYLINDER HEAD CONSTRUCTION

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5 Claims. (Cl. 123—41.74)

This invention relates to cylinder heads for water cooled internal combustion engines, and more particularly to a die castable light metal head formable in one piece.

One problem in connection with the use of a die casting process for making light metal engine parts of intricate design is due to the rapid solidification of die casting metals. It is difficult to flow such metals into the mold cavity in such a manner that defects due to regions of imperfect filling are not formed when freezing metal blocks passages of the mold cavity. Furthermore, die casting complicated structures which have metal sections of different thicknesses and internal pockets is a problem from the standpoint of pulling the cores used to form the interior of the part.

Attempts to solve some of these problems have occupied the time of skilled foundry people, but the designer of the part to be cast also has an important duty. A designer with some knowledge of foundry practice can suggest ways of modifying the construction of the part so that it can be made by a particular casting process otherwise wholly unable to form the shape required. For example, cylinder heads have been successfully die cast when made in two pieces. The usual two-part head comprises a cover section and a main section. The main section may include the combustion chambers; portions of the intake and exhaust ports which open into the combustion chambers; the valve recesses; and portions of the water jacket. The cover section usually contains the remaining structure which includes the valve stem column and complementary portions of the intake and exhaust ports and water jacket. It is principally because of the intricate passage configurations of the water jacket that die casting cylinder heads has been found difficult. Simplifying the water jacket passage arrangement to facilitate casting often results in a loss of cooling efficiency, but when the water jacket is formed partly in the main section and partly in the cover section of a two-part head, the internal structure is made more amenable for casting purposes without losing the required heat transfer efficiency. For example, complicated interior wall sections can be provided with the proper draft so that die projections may be withdrawn from the top of the main section and bottom of the cover section; these sections being later assembled to form the cylinder head.

What is now needed is a cylinder head design that can be cast as one piece instead of two. As might be expected, die casting equipment represents a huge expense and any development tending to cut these costs has a material effect on the feasibility of an item for production. Die casting two separate parts requires a prohibitive outlay in equipment with the result that other casting methods are more competitive.

It is a purpose of the present invention to provide a one piece cylinder head construction for water cooled engines which may be formed by a die casting method at a cost that compares favorably with other casting methods. It

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is a further purpose to provide a cylinder head construction that retains the cooling efficiency required for light metal heads. And still another purpose is to provide a cylinder head design in which all of the internal spaces are formed by mating die projections relatively movable with respect to each other and withdrawable through exterior surfaces of the head.

We have accomplished these purposes by providing a cylinder head wherein the water jacket therefor includes rectilinear water passages which open at exterior surfaces of the cylinder head and which join interiorly in interconnecting relationship, these passages being formed in cast structure characterized by the absence of re-entrant angles or pockets which would otherwise inhibit core drawing through the exterior surfaces of the head.

A more detailed understanding of the invention may be had by reference to the following description and drawings wherein:

FIGURE 1 is a plan view of a cylinder head embodying the invention and adapted for use with a four cylinder engine;

FIGURE 2 is a side elevation view along the line 2—2 of FIGURE 1;

FIGURE 3 is a side elevation view along the line 3—3 of FIGURE 1;

FIGURE 4 is a bottom view taken along the line 4—4 of FIGURE 2;

FIGURE 5 is a rear end view along the line 5—5 of FIGURE 2;

FIGURE 6 is a partial horizontal sectional view along the line 6—6 of FIGURE 5;

FIGURE 7 is an off-set horizontal sectional view along the line 7—7 of FIGURE 5;

FIGURE 8 is a front end view along the line 8—8 of FIGURE 2;

FIGURE 9 is a partial vertical sectional view along the line 9—9 of FIGURE 1;

FIGURE 10 is an off-set cross sectional view along the line 10—10 of FIGURE 1;

FIGURE 11 is a cross-sectional view taken through the center of the head along the line 11—11 of FIGURE 1;

FIGURE 12 is a plan view of the engine block showing the head gasket with the cylinder head removed;

FIGURE 13 depicts the mold open position showing the relative arrangement of die blocks for a die casting process; and

FIGURE 14 is a broken away horizontal sectional view showing the core positioning with the mold closed.

Referring to FIGURES 1—4, the illustrated cylinder head 10 is of the type used with four cylinder engines having a block 12 shown outlined below the head. A head gasket 14 normally seals between the head and block, and in the present case, additionally serves as a bottom wall for the water jacket in the head as will be hereinafter described.

The head generally includes a left side wall 16 joined by a front end wall 18, a rear end wall 20, and a right side wall 22. Opening at the right side wall 22 are intake and exhaust ports 23 and 24 respectively which communicate on the interior of the head with combustion chambers 25. Combustion chambers 25 are provided with intake and exhaust valve recesses 26 and 27 having valve seats 28 which may receive intake and exhaust valves having stems that project through the valve stem columns 29, being actuated in a conventional manner by a valve mechanism

adapted for controlling the intake and exhaust cycles of the engine. The top of the head has posts 30 projecting upwardly within the peripheral wall 31 which are adapted for carrying rocker arm shaft brackets which may receive the rocker arm and shaft assembly of the valve mechanism, actuation of the valves being in timed sequence for admitting the fuel mixture and exhausting the combustion products of the engine in accordance with the operation of push rods which may project through openings 32. The wall 31 may seal with a valve cover attachable by screws threadably received in bosses 33. Bolt bosses 34 are adapted to receive head bolts for securing the head to the block 12 and spaced pockets 35 along the left side of the head are adapted to receive spark plugs in threaded openings 36 which open into the combustion chambers. The bolt bosses and other openings may be more conveniently drilled after the head has been cast, otherwise, the cast structure shown is virtually complete when taken from the mold cavity.

In the past, cylinder heads have been cast as one piece constructions using sand molds and complicated baked sand cores to form the water jacket and other interior spaces. Attempts to convert to die casting have led to considerable difficulty; for example, the problem of withdrawing core projections from interior spaces deep within the casting while providing the proper draft had no practical solution, to our knowledge, until the present invention.

The cylinder head of the present invention is a one piece die castable part. The unitized head design is accomplished without sacrificing the water jacket cooling efficiency required for light metal heads and at the same time permits cores to be pulled from interior spaces by relatively movable die blocks cooperating to form the sides, top and bottom of the head.

We may consider the water jacket essentially as having two main flow paths, one behind the valve columns 29, running longitudinally above the combustion chambers; and the other being in intimate heat transfer relationship with the intake and exhaust ports 23 and 24 and running along the bottom of the head on opposite sides of the combustion chambers, these two flow paths being interconnected by a plurality of transverse cooling passages.

Referring to FIGURES 3-10, the first mentioned flow path is represented by the water manifold 40 and the second by the scallop-shaped spaces indicated generally at 41 shown in FIGURE 4 partially surrounding the combustion chambers. The transverse cooling passages 42 connecting these two paths of flow open at the side 22 as shown in FIGURE 3. This side may be closed by a gasket and plate arrangement (not shown) which could be bolted to bosses 43 and have openings therein for the intake and exhaust ports 23 and 24 to communicate with intake and exhaust manifolds. The transverse cooling passages 42 fully surround the intake and exhaust port structure and extend inwardly to connect with the water manifold 40. The passages 42 include a main channel 44 between adjacent intake and exhaust ports spreading out at the top and bottom to form branch cooling fingers 45 and 46. Cooling fingers 45 run parallel to the passages 44 communicating with the water manifold 40 on the other side of the valve columns 29 as shown in FIGURE 7. Cooling fingers 46 form a part of the scallop-shaped spaces 41 along the right side and extend inwardly below the intake and exhaust structure to the outer perimeter of the combustion chamber walls as best seen in FIGURE 4. The cooling fingers 46 all interconnect with each other throughout the length of the head to eliminate dead spaces around the combustion chambers and intake and exhaust structure and extend below the intake and exhaust ports 23 and 24 joining behind bolt bosses 43 between the combustion chambers, connecting with the passages 44 across a web structure 50 cast integrally with the exhaust and intake ports. The cooling fingers 45 connect with passages 44 above the exhaust and intake ports and

around the cast structure of the valve columns 29. The scallop-shaped spaces 41 along the left side of the head are joined by vertical cooling passages 52 between adjacent combustion chambers which communicate directly with water manifold 40 as shown in FIGURES 6 and 7.

Cooling water enters from the block 12 at port 48 at the rear of the head and is diverted around the rearmost combustion chamber to run through manifold 40 and along both sides of the head in the scallop-shaped spaces 41, interconnecting on one side through passages 44, 45 and 46, and on the other side through vertical cooling passages 52. A cross over passage 55 running transversely between the two sets of the combustion chambers in the center of the head provides a central mixing chamber for the cooling water.

It may be seen that the possibility of any dead water spaces which would tend to create hot spots in the head has been eliminated. Water flowing along the bottom of the head around the combustion chambers in the scallop-shaped spaces 41 travels on one side within the cooling fingers 46 which in turn feed into the passages 44 and the water manifold 40; and on the other side through passages 52 also connecting with the manifold 40. The cooling passages 44 cross over the top of each combustion chamber, as seen in FIGURE 9, to bring cooling water directly to one of the hottest parts of the head. Each exhaust and intake port 23 and 24 is surrounded on all four sides by cooling water in the interconnecting transverse spaces 42. The possibility of a dead space at the front of the cylinder head around the bell housing 58 is eliminated by the provision of a port 59, as shown in FIGURE 7, communicating with the end transverse passage 42. Water traversing along the other side of the head is collected in passages 52 and returned to the water manifold 40 which empties directly into the bell housing 58.

The front flange of the bell housing 58 is adapted to mount a water pump for circulating the water back to a radiator through a water outlet 60 in the top of the head as controlled by a conventional thermostatic device. When the thermostat is closed, the water pump will circulate the water back into the block through openings 62 at the bottom of the bell housing. A temperature indicator may be installed in the connection 63 and provision for a heater hose coupling is made through a threaded connection 64 as shown in FIGURE 1.

Referring to FIGURE 12, the gasket 14 is shown in position on the block 12 and has openings 70 and 71 registering with water jacket ports 48 and 62 in the head; head bolt openings 72, push rod opening 73 and cylinder bore openings 75 also are aligned with the appropriate opening in the block and head. The gasket functions as a bottom wall for the water jacket in the head closing the scallop-shaped spaces 41 in addition to sealing the combustion chambers. If desired however, ports may be provided in the portions 77 to permit water circulation directly from the block into the head from around the cylinder bores.

It is important to recognize that the water jacket design allows die projections to be withdrawn from interior spaces in any direction. Core placement may be visualized by reference to FIGURES 13 and 14. A five-die block mold is used, each block having core projections for the formation of interior spaces and being relatively movable between a closed cavity position and an open position to form the sides, bottom, and top of the cylinder head.

As seen by inspection, the right side 22 of the head is formed by a die block 80 having cavities and core projections for the intake and exhaust ports 23 and 24, cooling fingers 45 and 46, and transverse cooling passages 44; similarly, the bottom of the head is formed in a bottom die block 81 having core projections for forming combustion chambers 25, portions of the intake and exhaust re-

cesses 26 and 27, and the plurality of cooling spaces 41, 52, and 55. The top of the head and the rear wall 20 of the head are formed by a vertically movable top die block 83 having an end plate 84 for the rear wall, additionally, downwardly extending core projections for forming the push rod openings 32, and the cavity within the peripheral wall 31 are provided; further, a left side die block 85 forms the side of the head 16 and includes projections for coring out the recesses 35 which will later be drilled and threaded to receive the spark plugs; and finally, a front die block 86 forms the bell housing 58. A long core projection 87 for forming the front half of the water manifold 40 is adapted to be inserted in the front die block 86 through opening 88 which is aligned with the manifold passage, the core projection 87 may be fixed to the die block and pulled with it if desired. Naturally a single core projection for the water manifold extending the full length of the head would be difficult to draw at any reasonable drafting angle for a four cylinder engine, and for this reason, the water manifold is cored in two parts. The front core 87 projects half the length of the head and is withdrawable from a parting line at the center in chamber 55 while the rear half of the head is cored out by a core projection 89. The end plate 84 of the top die block 83 which also forms the rear wall 20, has an opening therein aligned with the axis for water manifold passage 40 through which the separately movable core 89 is inserted, this core being withdrawn prior to opening the mold. The hole in the rear wall of the finished casting through which core 89 is pulled will be later closed by some means, for example by a sheet metal plug 90 as shown in FIGURE 7.

Those having skill in the die casting industry will appreciate that due to the novel passage arrangement, the head may be formed entirely by a die casting or similar process without the necessity of casting two head pieces. The dies are withdrawable from the top, bottom, sides and ends to form such internal spaces as are required by virtue of the fact that the inner surfaces are free of any re-entrant angles or pockets which would otherwise inhibit the pulling of cores. That is, the interior passage walls incline outwardly with respect to the axes of core movement and toward the exterior surface through which the core is withdrawn. For example, the right side die block 80 has core projections for forming the intake and exhaust ports 23 and 24 which also form a small portion of the intake and exhaust valve recesses 26 and 27 as may be visualized by referring to FIGURE 14. These core projections extend interiorly to form a parting line with the core projections on the die block 81 coming up from the bottom which form the remaining portions of the valve recesses, such parting line being in a diagonal plane passing generally through the converging portions 91 of the intake and exhaust port walls. The core projections for forming water passages 52 and 55 may have V-shaped cut-outs in the areas 92 below the water manifold cores 87 and 89 to provide intermediate support for these elements.

Having now described our invention as it relates to a four cylinder head, it will be obvious that the invention could be adapted for use with a head for a V-8 engine for example. Accordingly, we do not wish to be limited by the specific embodiments shown and it should be understood that obvious modifications are intended to be included within the scope of the appended claims, except insofar as limited by the prior art.

What is claimed is:

1. A cylinder head having a combustion chamber, intake and exhaust means communicating with the combustion chamber and including valve recess means having a valve seat in the combustion chamber and a valve stem column opening at an exterior surface of the head, water jacket means formed within the head in heat transfer relationship with the combustion chamber and intake and

exhaust means, said water jacket means comprising; water manifold passage means formed in the head immediately adjacent said valve recess means and having rectilinear portions opening at opposite sides of the head, said portions being formed in cast structure of the head characterized by having inner passage wall surfaces which open outwardly with respect to the respective axes of said portions and toward the respective opposite sides whereby a pair of cores are made withdrawable in opposite directions through said opposite sides.

2. A one piece die castable cylinder head having combustion chamber means, intake and exhaust means communicating with the combustion chamber means and including valve recesses having valve seats in the combustion chamber means and valve stem columns opening at an exterior surface of the head, water jacket means in heat transfer relationship with the combustion chamber means and intake and exhaust means and comprising;

rectilinear water manifold passage means formed longitudinally in the head above said combustion chamber means immediately adjacent said valve recesses and opening at an end of the head,

rectilinear transverse cooling passage means opening at a side of the head and having portions thereof intersecting the manifold passage means passing between said valve recesses above the combustion chamber means; and

each said passage means being formed in cast structure of the head the surfaces of which open outwardly with respect to the axes of said passage means and toward said one end and side respectively whereby cores are made withdrawable from the end and side of the head.

3. A one piece die castable cylinder head for a water cooled internal combustion engine having a cylinder bore adapted to be closed by the head to form a combustion chamber, intake and exhaust means communicating with the combustion chamber and including valve recesses formed in the head having valve seats in the combustion chamber and valve stem columns opening at an exterior surface of the head, water jacket means connectable with the cooling passages of the engine being formed in heat transfer relationship with the combustion chamber and intake and exhaust means and comprising;

water manifold passage means having rectilinear portions immediately adjacent said valve recesses and opening at opposite ends of the head, said portions being formed in cast structure of the head having inner passage wall surfaces which incline outwardly with respect to the respective axes of said portions from substantially the middle of the head and toward the respective opposite ends so that cores may be pulled from said opposite ends; and

separate closure means for the openings in said opposite ends through which the cores were withdrawn.

4. A one piece die castable cylinder head according to claim 3 wherein one of said closure means comprises a sheet metal plug sealably closing the opening in one of the ends.

5. A one piece die castable cylinder head for a water cooled internal combustion engine having a cylinder bore adapted to be closed by the head to form a combustion chamber, intake and exhaust valve recesses formed in the head having valve seats in the combustion chamber and valve stem columns opening at an exterior surface of the head, intake and exhaust ports connecting with the respective valve recesses at one end and opening at another exterior surface of the head at the other end, water jacket means in heat transfer relationship with the combustion chamber, valve recesses, and intake and exhaust ports being connectable with the cooling passages of the engine and comprising;

a rectilinear water manifold passage formed in the head above the combustion chamber in heat transfer

relationship with said valve recesses and opening at opposite ends of the head; and
rectilinear transverse cooling passages joining the water manifold passage on the interior of the head arranged in heat transfer relationship with the intake and exhaust ports and opening at the same exterior surface as said ports, said manifold and transverse passages being formed in cast structure of the head characterized by the absence of re-entrant angles or pockets which would otherwise inhibit core drawing from the opposite ends of the head for the mani-

fold passage and from said other exterior surface for the transverse passages.

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