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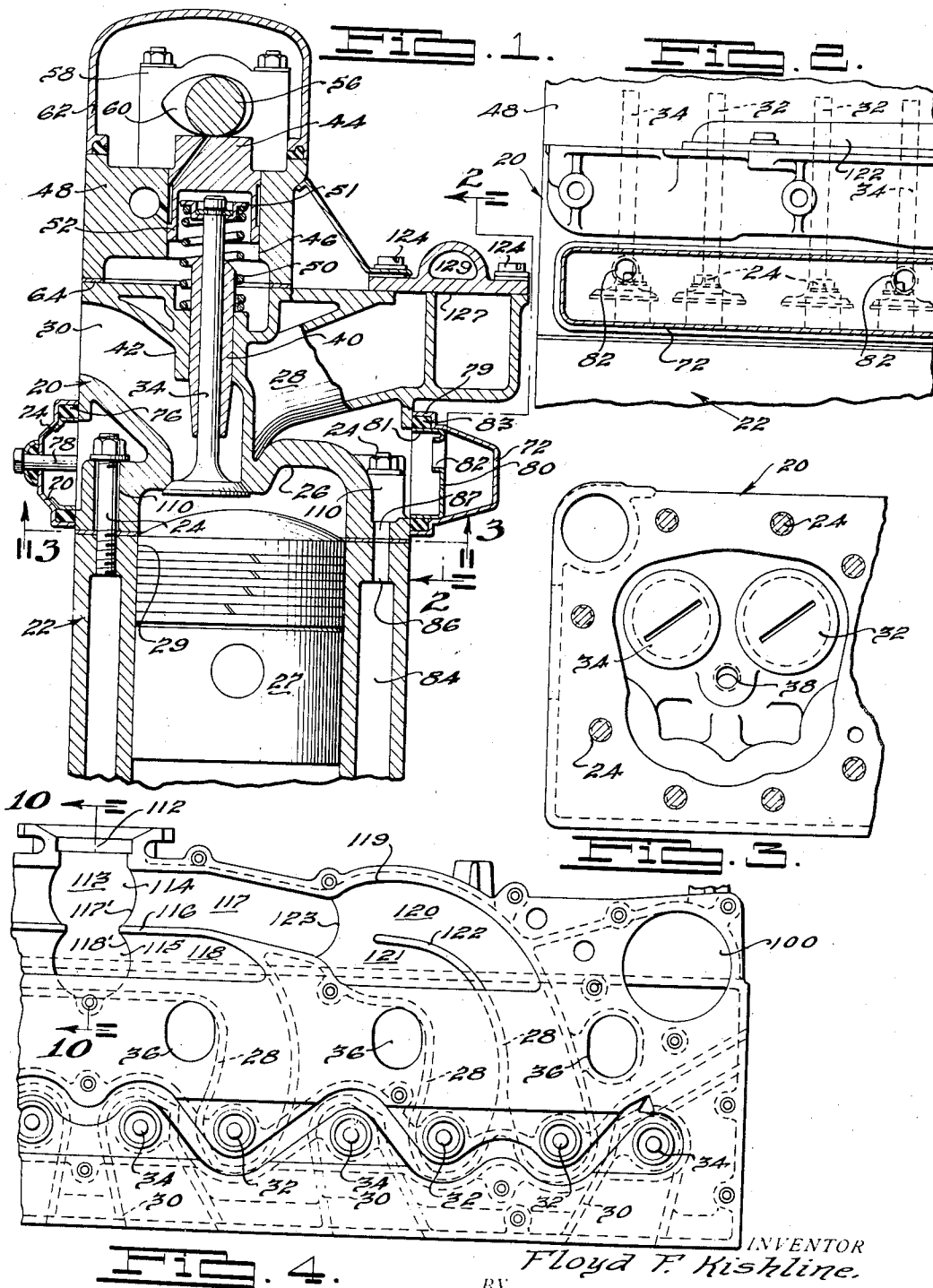
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INTERNAL COMBUSTION ENGINE

Filed Aug. 4, 1937

2 Sheets-Sheet 1



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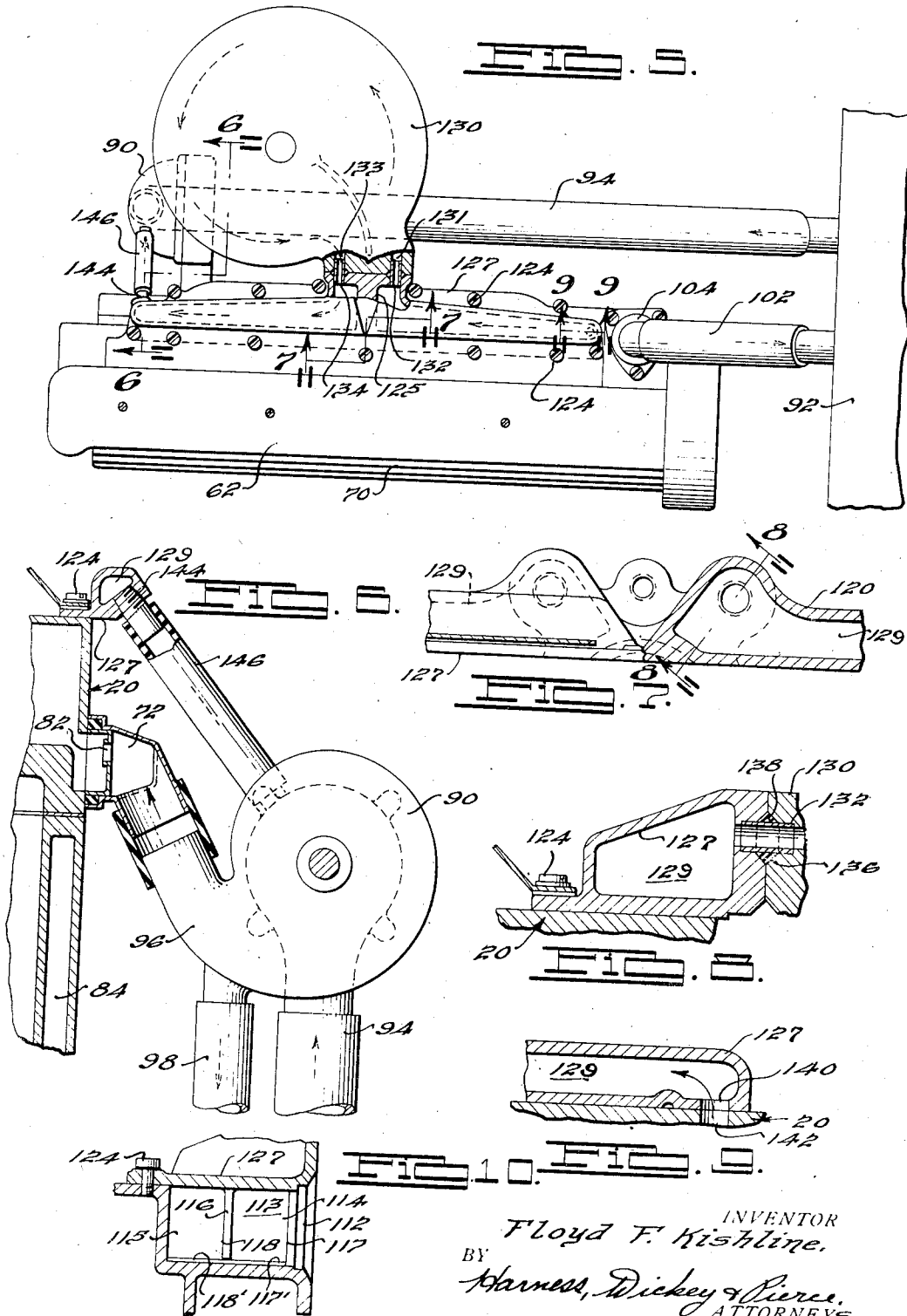
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2 Sheets-Sheet 2



## UNITED STATES PATENT OFFICE

2,182,990

## INTERNAL COMBUSTION ENGINE

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Application August 4, 1937, Serial No. 157,397

13 Claims. (Cl. 123—173)

The present invention relates to internal combustion engines, and in particular is directed to the provision of an improved water cooling system for the cylinder head of an internal combustion engine, as well as to the provision of an improved head and intake manifold construction.

Objects of the present invention are to provide an improved cooling system for the head of an internal combustion engine; to provide such a system in which the opposite sides of the head are provided with removable cover plates which close the head jacket, at least one of the side plates being constructed as a manifold embodying a series of spaced nozzles through which streams of coolant may be directed against selected parts of the head; to provide an internal combustion engine embodying an auxiliary coolant circuit for directing at least a part of the coolant around the cylinder intake passages, to assist in bringing the gas mixture to a desired temperature; to provide such a system in which the just mentioned circuit is independent of the thermostatic control means utilized to prevent a normal circulation through the engine and the vehicle radiator; to provide an internal combustion engine of the overhead valve type, embodying an improved head so constructed that the studs for securing the head to the block are required to pass through only a limited thickness of the head structure; to provide such a construction in which the head is provided with packets on its lateral side, to receive the head securing studs, so that the latter are required to pass only from the base of each pocket through to the underside of the head and are not required to pass entirely through the head; to provide such a construction in which the just mentioned pockets form a part of and are within the head jacket, and are closed by the previously mentioned plates, thereby permitting all studs associated with each cylinder to be positioned immediately adjacent the periphery of the cylinder; to provide an internal combustion engine embodying an improved intake manifold structure, in which the intake passages are formed at least in part as channels in the upper surface of the head, and in which the otherwise open channels are enclosed by a removable plate; to provide such a construction in which the removable plate is jacketed, and the jacket is included in the above mentioned auxiliary cooling circuit; to provide an engine head construction having an improved structural relation between the several intake passages and the passage leading from the carburetor to the passages; to provide such

a construction in which the carburetor passage projects into the head at substantially a right angle to the longitudinal axis of the head, and the several intake passages branch from the carburetor passage at substantially right angles thereto.

Further objects of the present invention are to generally improve the construction of internal combustion engines, and to provide an engine which may be economically manufactured and assembled, and which has improved operating characteristics.

With the above as well as other and more detailed objects in view, which appear in the following description and in the appended claims, a preferred but illustrative embodiment of the invention as shown in the accompanying drawings, throughout the several views of which corresponding reference characters are used to designate corresponding parts, and in which:

Figure 1 is a view in vertical transverse section, of an internal combustion engine embodying the invention;

Fig. 2 is a fragmentary view in side elevation, taken along the line 2—2 of Fig. 1;

Fig. 3 is a fragmentary view in bottom plan, taken along the line 3—3 of Fig. 1;

Fig. 4 is a partial top plan view of the cylinder head, with the hereinafter described removable cover plate removed;

Fig. 5 is a view in top plan of the engine;

Fig. 6 is a view in end elevation, taken along the line 6—6 of Fig. 5;

Fig. 7 is a fragmentary view in section, taken along the line 7—7 of Fig. 5;

Fig. 8 is a fragmentary view in section, taken along the line 8—8 of Fig. 7;

Fig. 9 is a fragmentary view in section taken along the line 9—9 of Fig. 5; and,

Fig. 10 is a fragmentary vertical sectional view taken on the line 10—10 of Fig. 4.

Referring to the drawings, particularly Figs. 1 through 4, the illustrated engine is of the overhead valve type, and the head 20 is secured to the block 22 by a series of studs 24, which pass through slightly enlarged openings provided therefor in the head 20, and the shanks of which are threaded into the block 22.

The underside of the head 20 is formed to provide a combustion chamber 26 over each cylinder 28. The illustrated engine embodies six cylinders, although other numbers of cylinders may, of course, be used. Each chamber 26 is provided with an inlet passage 28 and an exhaust passage 30. Each inlet passage 28 is provided

with a valve 32, and each exhaust passage is provided with a valve 34. The head 20 is also provided with a series of pockets which extend downwardly from the top surface thereof at points substantially on the center lines of the respective combustion chambers 26, to receive the usual spark plugs, indicated at 38 in Fig. 3. In the broader aspects of the invention, the combustion chambers 26 may take any of a variety of forms, although it is preferred to follow the disclosure of applicant's co-pending application, Serial No. 138,539, filed April 23, 1937, and assigned to the same assignee as the present application.

As is most clearly shown in Fig. 1, each exhaust valve 34 is provided with a valve guide 40, which is fitted within a boss 42 provided therefor in the head 20, and the upper end of each such valve projects upwardly from the head for cooperation with a tappet 44. Each tappet 44 is slidable within a bore 46 provided therefor in a tappet body 48. Each valve is continuously urged to the upper and closed position by a compression spring 50 which surrounds the stem of the valve and is seated between the previously mentioned boss 42 and a washer 51 secured on the end of the valve stem in a conventional manner. It will be appreciated that each of the inlet valves is similarly constructed and arranged. The cam shaft 56, which is supported above the body 48 by means of two or more pillar blocks 58 is constructed to effect the successive opening and closing of the valves in a conventional manner. An oil tight cover 62 is preferably provided to enclose the cam shaft, its bearings, and the valve tappets 44. The tappet body 48 is suitably and rigidly secured upon the upper surface of the head 20 in any conventional way as by studs (not shown), and a gasket 64 is preferably interposed between the head 20 and the body 48.

With particular respect to the coolant circulation system for these parts of the head which have thus far been described, it will be appreciated that the interior of the head 20 is completely cored out except for the presence of the inlet and exhaust passages 28 and 30, the spark plug pockets 36, and the valve guide bosses 42, and that, due to this cored out relation, a free circulation of coolant is permitted from one end of the head to the other, around and between the just mentioned parts, and over the tops of the individual combustion chambers 26. The upper portions of the opposite lateral sides of the head are enclosed, except for the individual openings associated with the exhaust passages 30, and the single inlet opening 112 associated with the inlet passages 28. The lower portion of each side wall of the head, however, is cut away throughout the length of the head, thus affording access from each side of the head to the interior of the head jacket. These lower portions of the sides of the head are enclosed by members 70 and 72. The member 70 is of generally U shape section or pan-like form, and is provided along its opposite sides with supplemental members 74 which, with the adjacent leg or side wall portions, define channels to receive a sealing gasket 76. The member 70, which is preferably formed of a relatively light metal stamping, is removably secured to the exhaust side of the head, in completely enclosing relation to the associated opening by a plurality of studs 78, which pass through openings formed in the member 70 and are adapted to be threaded into the head 20. The other en-

closing member 72 is also of generally U-shaped section and is provided with an inner U-sectioned member 80. The legs 79 of member 72 and the legs 81 of member 80 define a channel to receive a sealing gasket 83. The members 72 and 80 cooperate to form between them a cooling manifold from which coolant may be directed into the head jacket through a series of nozzles 82, formed in the member 80. Preferably one nozzle opening 82 is provided for each of the cylinders, and is so positioned that the stream of coolant discharged therethrough directly impinges the associated exhaust valve passage 30. A part of the coolant thus discharged also substantially directly impinges the pocket of the associated spark plug, and also flows against and around the top of the associated combustion chamber.

The interior of the head jacket is placed in communication with the interior of the engine block jacket 84, by means of a plurality of passages 86 and 87 which may be distributed along both sides of the block and head, in accordance with conventional practice.

Referring particularly to Figs. 5 and 6, the external circulating system for the head and engine block cooling system includes the pump 90 and a conventional radiator 92. Coolant is drawn from the base of the radiator, by the pump 90, through the line 94, thence through the pump, and thence through the two branching lines 96 and 98 into the manifold 72 and the block jacket 84, respectively. The coolant flowing through the line 98 enters the block adjacent the base thereof, at the rear end of the engine, circulates around the several cylinders, and from there flows into the head jacket through the previously mentioned connecting passages 86 and 87. The coolant which flows through the line 96, enters the manifold 72 and is discharged into the head jacket on a plurality of streams, through the nozzle openings 82 and mingles with the coolant introduced into the head through the passages 86. The thus commingled supplies of coolant pass forwardly through the head, are discharged therefrom through the outlet passage 100 (Fig. 4), and are returned to the upper part of the radiator through the line 102, the fitting 104 associated with which is removably secured over the opening 100. It will be appreciated that the relative sizes of the supply lines 96 and 98 (Fig. 6) depend upon the relative quantities of coolant which it is desired to direct individually into the block jacket and into the head jacket. The parts immediately associated with the head may normally be expected to require substantially greater cooling than is required by the cylinders themselves. Accordingly, it is preferred to construct the line 96 to have a substantially greater capacity than the capacity of the line 98.

The above described construction of the head in addition to providing an extremely satisfactory coolant circulation arrangement, also results in several very important structural advantages. The advantages of aluminum cylinder heads for internal combustion engines are well understood. Due to the substantially greater coefficient of expansion of aluminum than that of iron or steel, however, aluminum cylinder heads have not come into commercial use in engines of the overhead valve type. This is for the reason that an overhead valve head is of substantially greater thickness than a so-called L-head type, and, in the absence of an arrangement of the type about to be described, the head studs are required to be of correspondingly greater

length. Due to the difference in co-efficient of expansion of the head and of the studs, it is found that the head cannot be maintained in a tight relation to the block. In other words, if the studs are tightened down when the engine is cold, as soon as the engine and consequently the cylinder head become heated, the studs are stretched beyond their elastic limit and when the engine again cools down the studs are often loose enough to permit the gasket between the cylinder block and head to be blown out. To overcome this difficulty, it has been proposed to utilize specially constructed head studs, which proposal is objectionable as being expensive and unreliable. It has also been proposed to so construct the head that the studs which project into the cylinder block are not required to pass entirely through the head, and this, in a broad sense, is the present arrangement. So far as the present applicant is aware, however, it has not heretofore been proposed to take advantage of a pocket formed within the head for water jacket purposes as a means of permitting the use of shorter head studs.

In the present instance it will be observed that the head studs 24 are provided with bosses 110 formed in the base of the head within the previously mentioned water jacket. The bosses 110 are relatively short, and permit the use of studs which are commensurate in length with and in most cases shorter than those which are conventionally utilized in engines of the L-head type. With the present construction, accordingly, it is possible to make use of an aluminum head with its attendant advantages without at the same time introducing any of the aforementioned difficulties encountered in the application of aluminum heads to engines of the valve-in-head type. A further important advantage of enclosing the head studs within the head water jacket resides in the fact that in this way all of the studs immediately associated with any particular cylinder may be positioned immediately adjacent the side walls of such cylinder with a complete water jacketing of the head. As is clearly shown in Fig. 3, the studs 24 associated with each cylinder are arranged in the general form of a circle surrounding such cylinder. This is of real and material advantage because it eliminates the possibility of blowing out the gasket between the head and block due to yielding of the head under high explosion pressures. Ready access to the studs 24 is afforded by removing the members 70 and 72.

The intake manifold for the combustible mixture is for the most part formed integrally with the cylinder head 20. It is best illustrated in Figs. 1 and 4, Fig. 4 showing substantially only half of the same and one-half only will be described as it will be understood that both halves are identical except reversed in direction. The inlet 112 for the intake manifold opens laterally and centrally of the cylinder head 20 into a distributing chamber illustrated generally at 113 and comprises a first chamber or portion 114 of generally cylindrical formation positioned with its axis vertical and a second chamber or portion 115 likewise of generally cylindrical formation with its axis vertical and intersecting the portion 114 so as to provide open communication between them. From the chamber 113 the combustible mixture is directed forwardly toward one end of the engine to supply the cylinders at such end and rearwardly of the engine to supply the cylinders at the opposite end. The mixture flow-

ing toward one end of the engine from the chamber 113 is initially divided into two streams of equal volume by a central vertical wall 116 the plane of which lies in the direction of the flow from the chamber 113, namely in approximately parallel relation with respect to the longitudinal axis of the engine. The forward or upstream end of the wall 116 coincides with the line of junction between the portions 114 and 115 at the corresponding side of the chamber 113. In other words this wall 116 provides a pair of independent passages 117 and 118 which open into the portions 114 and 115 respectively. The passage 118 opens into the passage 23 leading to that one of the two center cylinders on the corresponding side of the mid-point of the engine length and consequently feeds only the corresponding cylinder.

The passage 117 extends for a short distance longitudinally of the engine and is then laterally enlarged as at 119 and shortly after the point of enlargement in the direction of flow of the combustible mixture therethrough is, in turn, divided into two passages 120 and 121 of equal volume by means of a vertical central wall 122, the upstream end of which lies in a plane substantially parallel to the direction of flow through the passage 117 and centrally thereof. The passage 120 communicates with the passage 23 leading to the intake port of the endmost cylinder on the corresponding end of the engine, and the passage 121 communicates with the passage 23 leading to the intake port of that cylinder next to the end cylinder on the corresponding end of the engine. It will thus be apparent that the intake port of each cylinder is fed by a separate branch of the manifold, this aiding in eliminating the difficulties experienced in connection with the proper distribution of liquid fuel particles between the different intake ports of the engine and also aids in eliminating the phenomena of breathing of the fuel mixture in the manifold between the various ports thereof.

To further aid in the proper distribution of the liquid fuel particles between the branches 120 and 121 the floor of the passage 117 in advance of the upstream end of the wall 122 is provided with an upward step or dam 123, curved in plan view, which causes the liquid fuel particles clinging to the bottom wall of the passage 117 to be equally distributed over the width of the bottom wall before it is picked up and carried on into the passages 120 and 121, thus assuring that equal distribution of these liquid fuel particles to both passages 120 and 121 will occur.

It has been found that the provision of the two intersecting cylindrical chambers 114 and 115, one of which is preferably smaller than the other, aids in effecting not only an equal distribution of the gaseous combustible mixture entering the inlet port 112 from whatever type of carbureting means is employed, but also is very effective in causing an equal distribution of unvaporized fuel particles to both the passages 117 and 118 on the same side of the manifold. This last effect is particularly obtained by extending the flat bottom ends of the chambers 114 and 115 slightly below the floors of the chambers 117 and 118 so as to effect an upward step from the floor of the chambers 114 and 115 to the floors of the passages 117 and 118, this upward step affording dams 117' and 118' respectively for the particles of liquid fuel tending to collect in the distributing chamber 113 and having the same general effects in the distribution of the liquid fuel

particles to the passages 117 and 118 as the dam 123 previously described in distributing the liquid fuel particles on the floor of the passage 117 to the passages 120 and 121.

The cross-sectional configuration of the various passages and branches of the manifold may be either round, square, or any other desirable shape, or combination of shapes, but particularly in order to enable full advantages to be taken of the dams 123 and the corresponding dams formed at the outlet to the chambers 114 and 115 it is preferably of rectangular section particularly adjacent the locations of these dams.

It will be noted from an inspection of Figs. 1 and 4 that a portion of the intake manifold projects laterally outwardly beyond the side walls of the head 20 and such portion is formed with an open upper face closed by a cover element or closure plate 122. This construction is followed preferably to enhance the ease of the molding operations in the formation of the head and also to permit greater facility in inspection of the interior walls of the intake manifold and removing rough spots or other obstructions that might occur therein during the casting operation. The closure plate 122 overlaps the upper face of the cylinder head 20 at its inner edge, and its outer edge is preferably formed to a contour such as to bring it flush with the outer edge of the main body portion of the manifold, and it is secured in place by means of screws 124.

In accordance with a further phase of the present invention the closure plate 127 is provided on its upper surface with a water passage 129 formed integrally therewith. This is for the purpose of imparting a relatively small amount of heat to the combustible mixture flowing through the intake manifold but without adding sufficient heat to the mixture to materially adversely effect the volumetric efficiency of the engine. In this respect it will also be understood that inasmuch as the intake manifold is formed mainly within the cylinder head 20 and a material proportion of its exterior walls is bathed by the cooling water circulated through the head, a considerably greater amount of heat than that provided only by the passages 129 will be transmitted to the combustible mixture during engine operation.

In accordance with the broader phases of the present invention the passage 123 may be connected into the engine cooling system in any suitable manner so as to effect a circulation of the cooling water heated by the engine therethrough. However, in some cases it will be desirable to employ a supercharger in connection with the engine and which supercharger may be of the type shown and claimed in my co-pending application for Letters Patent of the United States Serial No. 35,022, filed August 7, 1935, now Patent No. 2,157,761, May 9, 1939, and in such case the supercharger is preferably water jacketed. This combination is illustrated in Fig. 5 and in such case the supply of heated liquid for the water jacketed supercharger may be readily provided by connecting the water jacket of the supercharger in series with the passage 123. To this end the passage 123 is interrupted at 125 midway of its length and immediately over the inlet port 112 to which the supercharger 130 is suitably secured, it being understood that a suitable or conventional carburetor (not shown) is provided for feeding the combustible mixture to the supercharger 130.

The water jacket inlet 131 for the supercharger 130 is communicated with the interior

of the passage 123 on the forward side of the interruption 125 by means of a suitable nipple 132 extending therebetween and aiding in locating the supercharger 130 with respect to the cylinder head. The outlet 133 for the supercharger water jacket is similarly placed in communication with the passage 123 on the rear side of the interruption 125 by means of a corresponding nipple 134. This construction is clearly brought out in Fig. 8 in which it will be noted that the contacting faces of the closure plate 122 and supercharger 130 about the corresponding nipple 132 or 134 are beveled as at 136 in opposed relation to form a chamber in which a suitable packing such as 138 is received in order to render the connection water tight.

As clearly appears in Fig. 9, the inlet 140 for the passage 123 is connected into the interior of the cylinder head jacket adjacent the front end thereof by a short connecting passage 142. Similarly, the outlet 144 associated at the left hand end of the passage 123 is connected to the inlet side of the pump 90 by means of a short hose connection 146 (Figs. 5 and 6). With this arrangement it will be observed that a portion of the coolant which would otherwise be discharged at the front end of the head 20 through the previously mentioned hose connection 102, is discharged through the passage 142 into the closure passage 123. Such portion of the coolant flows to the left, as viewed in Fig. 5 through the right-hand portion of the passage 123, thence circulates through the water jacket of the supercharger 130, through the lefthand portion of the jacket of the passage 123, and is then returned to the inlet side of the pump through the short connection 146.

The just mentioned coolant circulating circuit by-passes the previously mentioned radiator 92. With this arrangement, a thermostat or other heat responsive element may be interposed in the line 102, or in the fitting 104, in accordance with conventional practice, to prevent a circulation through the radiator 92, except upon the attainment of a predetermined operating temperature of the water or other coolant in the water jackets of the engine cylinder block and cylinder head. The closing off of the line 102, however, does not interfere with the circulation of coolant from the pump through the block and head jackets, and through the just mentioned by-pass coolant circuit.

From the foregoing description, it will be appreciated that the present invention provides an effective and efficient coolant circulating system for an internal combustion engine, and also affords improved features of construction of the cylinder head and intake manifold of internal combustion engines. It will be understood that the foregoing description is to be regarded as an illustrative, and not in a limiting sense.

What is claimed is:

1. The combination with a water jacketed cylinder head of a multi-cylinder internal combustion engine, formed to provide a series of individual combustion chambers, of a plurality of means associated with each chamber and arranged around and adjacent the periphery thereof, for securing the head to an associated engine block, said means being removably accessible from within the head jacket.

2. In an internal combustion engine, the combination of a water jacketed cylinder head, one wall of the jacket being adapted to close a cylinder of the engine, and a plurality of means ar-

5 ranged around and closely adjacent the wall of the cylinder for securing the head to the block, said means being passed through the wall of the head and being removably accessible from within the head jacket.

10 3. In an internal combustion engine, the combination of a head having a water jacket formed therein and having an opening in at least one lateral wall of the jacket affording access to the interior thereof, means accessible within the jacket through said opening for securing the head to an associated cylinder, and a plate removably secured to the said lateral side for closing said opening.

15 4. In an internal combustion engine, the combination of a head having a water jacket formed therein and having an opening in at least one lateral wall of the jacket affording access to the interior thereof, means accessible within the jacket through said opening for securing the head to an associated cylinder and a removable coolant manifold secured to the said lateral side of the head for closing said opening and through which coolant may be directed into the head jacket.

20 5. In an internal combustion engine, the combination of a head having a water jacket formed therein and having an opening in at least one lateral wall of the jacket affording access to the interior thereof, means accessible within the jacket through said opening for securing the head to associated engine cylinders, and a removable coolant manifold having a plurality of nozzles associated therewith for closing said opening and through which coolant may be directed into the head jacket.

25 6. In an internal combustion engine, the combination of a head having a water jacket formed therein and having an opening in at least one lateral wall of the jacket affording access to the interior thereof, means accessible within the jacket through said opening for securing the head to an associated cylinder, means for circulating coolant past the cylinder and to the head, and additional means including a coolant manifold secured to the said side of the head for closing said opening and through which coolant may be directed into the head jacket.

30 7. In an internal combustion engine, the combination of a cylinder head formed to provide a coolant jacket therein, and having the lateral sides thereof provided with openings leading into the interior of the jacket, means extending into and accessible from within the jacket for securing the head to an associated cylinder, and removable plates secured to the opposite sides of the head for closing said openings.

8. In an internal combustion engine, the combination of a cylinder head formed to provide a coolant jacket therein, and having the lateral sides thereof provided with openings leading into the interior of the jacket, means extending into and accessible from within the jacket for securing the head to an associated cylinder, and removable plates secured to the opposite sides of the head for closing said openings, at least one of said members being formed as a coolant manifold through which the coolant may be introduced into the head.

9. In a removable coolant manifold adapted to be secured to the side of an internal combustion engine, the combination of a pair of generally U-shaped members secured together in telescoped relation, the base of the inner member having a plurality of nozzles formed therein, and the legs of the members defining a channel between them to receive a sealing jacket.

10. In an internal combustion engine, the combination of a cylinder head having a plurality of cylinder intake passages integrally formed therein, a portion of which are exposed upon a surface of the head as channels, and a closure member removably secured to the head for closing said channel-like portions.

11. In an internal combustion engine, the combination of a cylinder head having a plurality of cylinder intake passages integrally formed therein, a portion of which are exposed upon a surface of the head as channels, and a water jacketed closure member removably secured to the head for enclosing said channel-like portions.

12. In an internal combustion engine, the combination of a cylinder head having a plurality of cylinder intake passages integrally formed therein, a portion of which are exposed upon a surface of the head as channels, a jacketed supercharger associated with said engine, a closure member for said channel-like portions of said passages having a pair of separate jackets formed therein, and means connecting said separate portions and said supercharger jacket in series relation in a coolant circuit.

13. In an internal combustion engine, the combination of a cylinder head having a plurality of cylinder intake passages integrally formed therein, a portion of which are exposed upon a surface of the head as channels, a jacketed supercharger associated with said engine, a closure member for said channel-like portions of said passages having a pair of separate jackets formed therein, and means connecting said supercharger jacket between said separate portions in a series coolant circuit.

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