Dec. 21, 1948. P. KLOTSCH 2,456,951

COOLING SYSTEM FOR INTERNAL-COMBUSTION ENGINES

Filed May 1, 1946 2 Sheets-Sheet 1

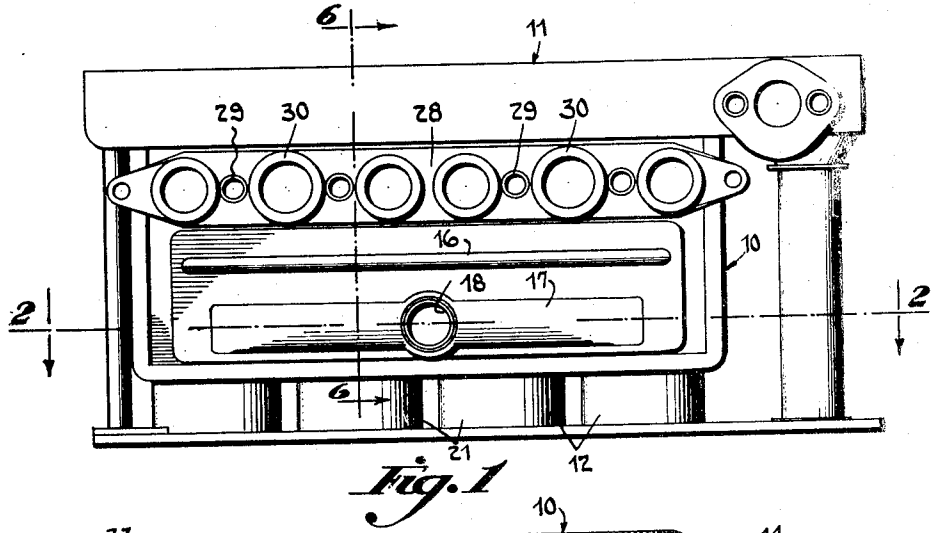


Fig. 1

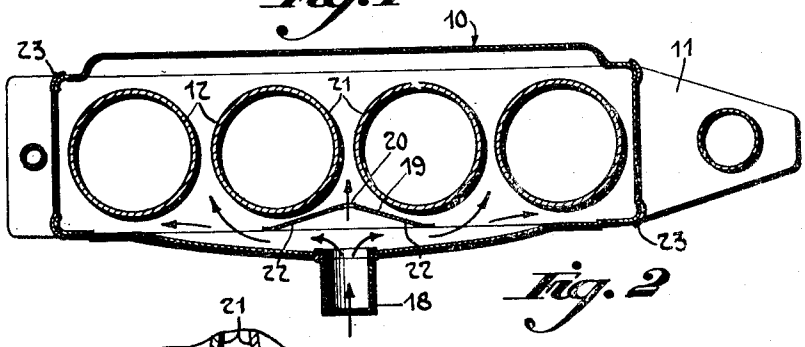


Fig. 2

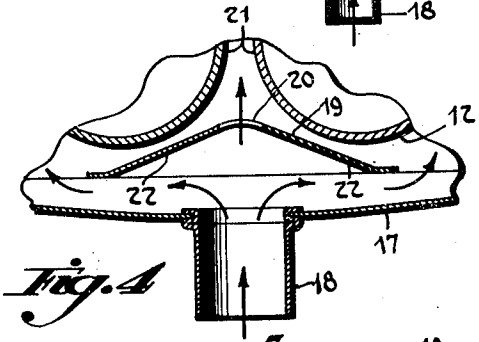


Fig. 4

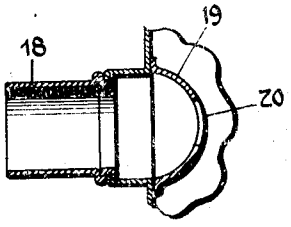


Fig. 5

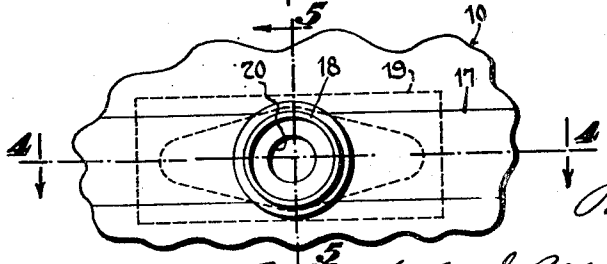


Fig. 3

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COOLING SYSTEM FOR INTERNAL-COMBUSTION ENGINES

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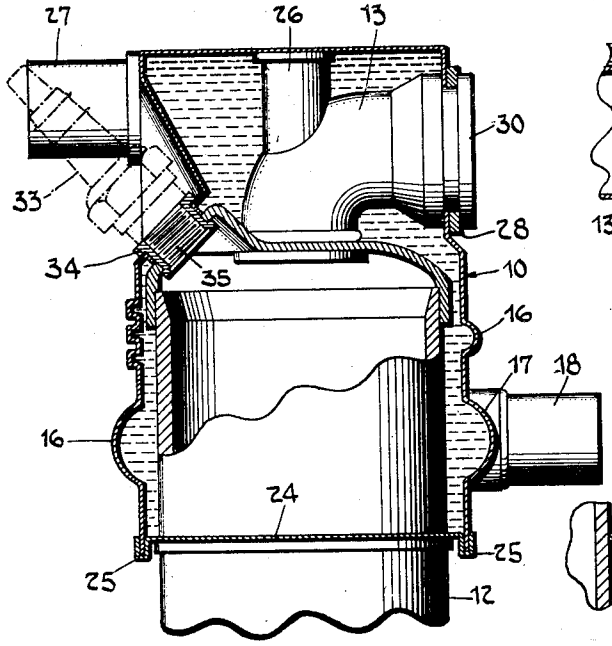


Fig. 6

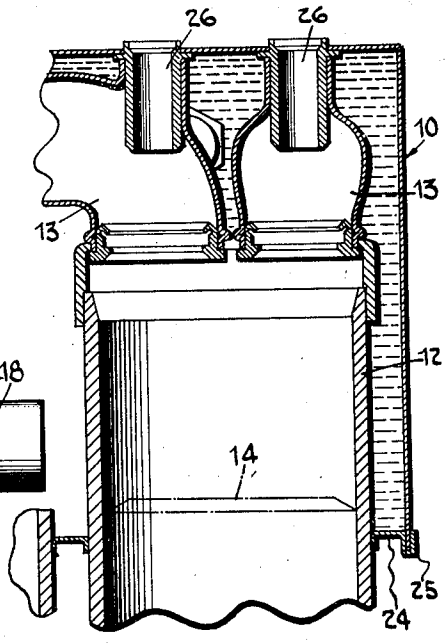


Fig. 7

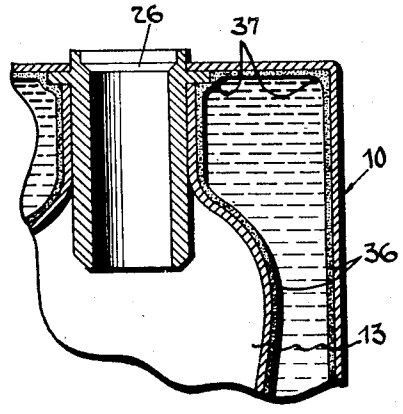


Fig. 8

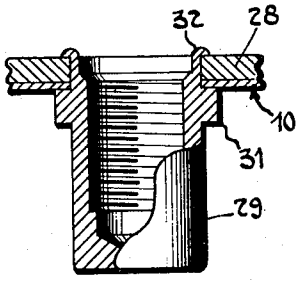


Fig. 9

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2,456,951

COOLING SYSTEM FOR INTERNAL-COMBUSTION ENGINES

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Application May 1, 1946, Serial No. 666,455

7 Claims. (Cl. 123—173)

1

This invention relates to internal combustion engines. It is directed more particularly to the cylinder block of the engine and the fabrication of the water jacket for the cylinder block from thin-walled sheet metal.

In the conventional internal combustion engine a heavy, massive, cast iron block is utilized having core passageways in its interior structure surrounding the cylinder bores. The cast engine head has cooperating passageways, likewise formed in the casting operation, to provide for the circulation of cooling water around the firing chamber, valves and exhaust conduits, and the passageways of the head and block are in communication with one another through a gasket which facilitates attachment of the head to the block in a water-tight seal. Inasmuch as the internal water passages are formed by means of sand cores, the sand subsequently being shaken from the castings, the internal surfaces are very rough and uneven and, since they are inaccessible, it is impossible to make them smooth by machining or otherwise. This surface unevenness greatly increases fluid friction in the system, and local cavitation occurs at many minute points which prevents the efficient heat transfer that might otherwise be expected from the large area provided by the rough surface.

In my copending application, Serial No. 662,323, filed April 15, 1946, an internal combustion engine is disclosed comprising an engine block constructed of sheet metal parts, all of thin wall section brazed together. The engine is characterized by light weight, high speed, efficient operation, and by its inexpensive type of fabrication from light gauge metal parts. The principal objective of the present invention has been to provide an efficient, light weight, sheet metal water jacket which is particularly suitable for use with engines of the type disclosed in the aforesaid patent application.

In pursuing this objective two problems have been encountered. First, the water jacket must be sufficiently strong to resist flexing, vibration, and the tendency toward metal fatigue which are much more pronounced in relatively elastic thin wall metal elements than in cast structures. Second, the problem of providing suitable resistance to rusting and corrosion is much more acute in thin wall structures than in massive iron blocks. Obviously, corrosion of an inconsequential nature in a cast iron block would soon cause a thin piece of sheet metal to become so perforated that the metal would be incapable of serving any water jacket function. The invention

2

in this respect is predicated upon the concept of fabricating cylinder heads and bonnets as integral parts of the cylinder barrels, and of providing a water jacket to embrace and surround this assembly in such manner as to eliminate the need for any gaskets or cement such as conventionally are employed to form a water seal. In other words, the idea has been to build an engine which is devoid of gaskets, upon the premises that the elimination of all gaskets will eliminate the problem of gasket failure and will at the same time prevent local failures of such a nature that engine exhaust gases could escape into the water system to increase the acidity thereof and thereby promote corrosion attack. But even clear hydrant water is corrosive to sheet metal and, to avoid failure from such attack, the invention contemplates the establishment of a uniform, smooth film of corrosion resistant phenol formaldehyde resin on the interior surfaces of the water jacket and the contiguous metal surfaces with which the coolant comes into contact.

The invention is based upon the concept and determination that the high heat transferring capabilities of thin-wall, smooth-surfaced metal parts enables heat to be dissipated by conduction and by radiation, at a rate so good that no area in the surface treated coolant system reaches a temperature approaching the point at which deterioration of the resinous protective surface coating will commence. In other words, I have discovered that by providing a high rate of heat dissipation from the cylinders where intense heat is developed, through the use of thin wall cylinders, bonnets and jacket, a corrosion resistant treatment of the surfaces may be used which would soon decompose and fail in a block of conventional contruction. The coating is continuous and uniform and, in the absence of gaskets, no abutting parts are present at which the coating could be chipped to exposed bare metal.

The conventional engine, because of its thick walls and mass, usually is provided with a number of so-called "freeze out" plugs in the water jacket to protect the block from breaking in case water in it freezes. In a sheet metal cylinder block such freeze out plugs could provide additional foci for rusting. However, the invention contemplates a sheet metal water jacket which is so constructed that it may withstand the bursting effect of freezing coolant independently of the relieving effects of any freeze out plug. For this purpose the water jacket is constructed with longitudinal ribs which permit the water jacket to expand sufficiently to take up the stresses

which may be caused by freezing of water in the jacket.

An engine manifold, which connects the various cylinder exhaust bonnets together and to the exhaust line is normally connected to one side of the water jacket. In some cases the manifold is connected at such a point that a water tight gasket is necessary where the manifold passes through the water jacket. Moreover, in a conventional engine the water jacket is of such heavy stock that it can easily stand the weight of the mechanical connections which support and hold the manifold in contact with the cylinder bonnets. In a sheet metal water jacket, on the other hand, the metal flexes and the problem has been to provide suitable strength to facilitate manifold attachment without obstructing free circulation of coolant through the jacketing system. Otherwise expressed, it has been the objective to provide a connection between a sheet metal water jacket and a manifold in which there is no necessity for water-tight gaskets and in which the structure of the water jacket is strengthened at the point at which the water jacket and manifold come together. This purpose is accomplished by passing the bonnets entirely through the water jacket, and by attaching the manifold to the bonnets at the outside of the water jacket. Small, threaded, thimble-like inserts are brazed in the water jacket between pairs of bonnets. The bonnets are brazed together and to the cylinders and thus the bonnets serve to strengthen the water jacket at the point at which the manifold and engine are connected. The bonnets are built to pass completely through the water jacket and on the outside of the engine are brazed to the water jacket itself. Thus, no water-tight gaskets are employed in connection with the exhaust manifold.

In the preferred construction the engine jacket is provided only with two openings, the inlet and the outlet, for the coolant, approximately midway between adjacent cylinders for a four-cylinder engine. Due to the circularity of the cylinder barrels, however, a baffle is interposed between the water inlet and these cylinders, in spaced relationship to both, for the purpose of directing an even distribution of coolant to all cylinder barrels. The baffle, directly ahead of the water inlet, contains a metering orifice which controls the flow of water past the cylinders in the central portion of the block, while the portions of the baffle adjacent the orifice channel respective portions of the flow to the other cylinders. The baffle, in the preferred construction, cooperates with a groove in the water jacket which helps desired water distribution to be obtained, and at the same time serves as an expandible rib for protecting the water jacket against freezing.

Other objects and advantages of the invention are described in the following detailed description of the drawings in which typical embodiments of the improvements are illustrated.

In the drawings:

Figure 1 is a side elevational view showing an internal combustion engine having a water jacket constructed in accordance with this invention.

Figure 2 is a sectional view of the water jacket, the section being taken along the line 2—2 in Figure 1.

Figure 3 is an enlarged detailed view showing the construction of the baffle used to distribute water through the water jacket and between the cylinders of the engine illustrated in Figure 1.

Figure 4 is a sectional view of the baffle taken along the line 4—4 in Figure 3.

Figure 5 is a sectional view of the baffle taken along the line 5—5 in Figure 3.

Figure 6 is an enlarged sectional view of a cylinder taken along the line 6—6 in Figure 1.

Figure 7 is an enlarged sectional view of a cylinder, the section being taken on the center line of the cylinder but at right angles to the section shown in Figure 6.

Figure 8 is an enlarged sectional view showing the upper part of a valve assembly enlarged particularly to show the manner in which the resinous coating covers the inside of the water jacket and all parts of the cylinder block with which coolant comes into contact.

Figure 9 is an enlarged view showing details of one of the threaded thimbles which are located between adjacent exhaust bonnets for use in attaching a manifold to the water jacket.

As illustrated in Figures 1 and 2, a sheet metal water jacket 10 is shown attached to a sheet metal motor 11. The jacket forms a shell surrounding the cylinders 12 of the motor and the water jacket is brazed to and supported by the cylinders 12. The jacket extends from above the bonnets 13 down along the cylinders to a point just below the lower portions of the cylinders, preferably, just below the lowest point to which pistons 14 descend as illustrated in Figure 7. Thus, all that part of the cylinders exposed to hot gases of combustion are jacketed and in addition the exhaust bonnets on top of each of the cylinders are also enclosed.

As shown in Figures 1 and 6, each side of the water jacket 10 is provided with one or more longitudinal ribs 16 which extend along the length of each side. The ribs 16 strengthen the water jacket longitudinally and additionally serve to permit the water jacket to be deformed without tearing. Thus, the walls of the water jacket are provided with sufficient flexibility that the contents of the water jacket can be frozen solid without any rupture of the jacket. This permits construction of a water jacket without any freeze-out plugs such as are usual in the conventional cast cylinder block.

Below the ribs 16 (Figure 1) is a wide, water-distributing rib 17. The rib 17 serves to permit expansion of the water jacket in a manner similar to the ribs 16, but in addition the rib 17 is built around a water inlet 18 and acts to channel the flow of water into the water jacket. The water inlet 18 leads into the water jacket 10 and a baffle 19 is provided in association with the water inlet 18 and the distributing rib 17, which baffle guides the flow of water so that all of the cylinders are cooled equally.

Details of the baffle construction are shown in Figures 3 to 5. The baffle 19 is attached to the sides of the water jacket above and below the distributing rib 17, by spot welding or other appropriate means. The baffle has a small orifice 20 through which water is metered between the innermost cylinders 21 of the engine, and a pair of wings 22 which guide water away from the innermost cylinders and into the water distributing rib 17. Water guided by the baffle flows along the distributing rib 17 as shown by arrows in Figure 2 to surround all of the cylinders 12, cooling them all evenly.

The water jacket, as illustrated in Figures 1 and 2, is constructed from sheet metal. As shown in Figure 2, four sheets, one on each side, may

be used to construct the jacket proper. These are pressed into shape and then are brazed together in a hydrogen brazing furnace. The brazing of the water jacket is done at the same time as the brazing of the other parts of the engine as described in my aforementioned application. Serial No. 662,323. At these points at which the sheets come together at the corners, overlaps 23 are provided to form brazing connections and to strengthen the corners of the water jacket. Alternately, the jacket proper may be made from a single sheet of metal having a series of openings in the center to permit valve stems and bonnets to pass through and having side sections bent with a box-like structure to provide sides for the water jacket. The overlaps 23 preferably are constructed as a part of the side sections; thus, a part of one side section overlaps the adjacent side section to strengthen the joint. As shown in Figures 6 and 7, a bottom panel 24 is brazed to the cylinder and to the water jacket to support the water jacket and hold it in spaced relationship with the cylinders. The outer edge of the panel 24 is crimped as at 25 to fit around the edge of the water jacket and form a firm contact suitable for brazing, while the upper part of the water jacket fits around and is brazed to valve followers 26. After brazing, the assembly forms a single unitary structure with the cylinders having no openings other than the water inlet 18 and a water outlet 27.

The bonnets 13 at the top of each cylinder lead completely through the jacket side wall, as shown in Figures 1, 6 and 7. All bonnets are brazed to the cylinder heads and are held firmly in spaced relationship, so as to strengthen the upper portion of the jacket structure. However, no watertight gaskets are required in connection with the bonnets because they lead through the water jacket to the outside where the bonnets can be attached directly to a manifold. In addition, a strengthening plate 28 is firmly attached to the outer surface of the water jacket where the bonnets 13 pass through the jacket. A series of thimbles 29 is provided in the water jacket for use in attaching a manifold to the bonnets. Each of the thimbles 29 is located between a pair of bonnets, and passes through the jacket wall and through strengthening plate 28. Only a narrow and, therefore, rigid portion of sheet metal wall exists between a thimble and the adjoining bonnet and the metal is thickened by the plate 28 at this point to hold the thimbles 29 firmly in place. An annular collar 30 is brazed to the outside of each bonnet and serves to hold the plate 28 in place and as a surface for attachment of manifolds. After brazing, all collars are surfaced in alignment to facilitate the seating of the manifolds upon the structure. Thus, the bonnets, thimbles, and strengthening plate form a single structure, self-strengthening, to support a manifold; and the manifold may be attached tightly to the sheet metal water jacket and held firmly in place thereon without causing deformation of the jacket metal. Details of the thimble construction are shown in Figure 9. The thimble 29 has a blind, threaded hole and is firmly brazed to the water jacket 10. The manifold bolts engaging the threaded bores can be tightened in the thimble 29 to hold the manifold in place against the bonnets. The thimble has a shoulder 31 and an outer crimped edge 32 which cooperate to hold the thimble in place and to hold the strengthening plate to the wall of the water jacket 10.

In the upper portion of the cylinder, as shown in Figure 6, water flows around and cools each of the bonnets 13. In addition each spark plug 33, as shown in dotted lines, is constructed to pass through a socket 34 in the water jacket whereby the lower portion 35 of the spark plug 33 is cooled by water in the water jacket. As a result the operational, lower portion of the spark is maintained at a relatively cool temperature. The details of construction and operation of this portion of the engine are described and claimed in copending application Serial No. 662,323.

The problem of rusting is particularly serious in a sheet metal water jacket because the walls of the jacket are thin and can rust through easily and quickly once corrosion starts. Corrosion inhibitors such as sodium chromate or the like are effective rust preventives so long as they are maintained in adequate concentration in the coolant system, but the necessity of vigilance in this respect makes their use undesirable. Various resins, paints and varnishes also are effective as rust proofers but, being of organic nature, they are subject to decomposition and carbonization at high temperature. Upon explosion of the fuel air mixture in an internal combustion engine an exceedingly high temperature is attained, at least momentarily, yet in the high speed engine these explosions occur with great rapidity. As previously indicated, I have discovered that notwithstanding these exceptionally high temperatures occurring in the cylinders at one side of their wall still a resinous corrosion and moisture resistant coating may be maintained without decomposition upon the surface at the other side of the wall by virtue of the high heat conductivity of the wall and the high heat dissipating action of the thin wall block and jacket structure.

While various film forming, organic, resinous materials may be used for this purpose one which has been found to be suitable is disclosed in Hempel Patent No. 2,198,939, comprising a thermo setting oil-free pigmented formulation containing a volatile solvent as the diluent. It is not necessary, as contemplated by the Hempel patent to apply three or four coats of this material. One coat is adequate followed by the application of a second coat of the clear lacquer. In the application of film of this type it is preferable to introduce the liquid resin material into the jacket and, with the inlet and the outlet openings being closed, to flush or circulate the liquid through the jacket in such manner that all surfaces are wetted thoroughly. If desirable, for mass production operations, a stream of the liquid material may be pumped through the jacket preferably while the jacket is being rocked or turned so as to insure the treatment of all internal surfaces. After the application of this liquid the excess is permitted to drain and the block is then heated sufficiently to evaporate the volatile solvent, but not so hot as to set the resin. Then the clear coat is applied and after the excess of clear coat has been drained both films simultaneously are baked so that the resin becomes set and hard. Pretreatment of the gasket surfaces by bonderizing or the like promotes adhesion of the coating to the metal surfaces. In this manner a continuous film is established devoid of pin point cavities or cracks. The resin is flexible enabling the jacket walls to expand and contract and vibrate as they do during engine operation without rupture of the coating.

In a typical procedure after the excess resin of the first coat has been drained from the jacket

the first coat may be air dried for fifteen minutes and then baked in an oven for about thirty minutes, during which time low pressure air at 150° F. is circulated through the block. The block may then be baked for about twenty minutes more at a temperature of about 250° to 275° F. and cooled at room temperature for application of the second coat. The second coat is slushed through the block and, as previously described, the excess is drained and the block is then baked for thirty minutes at 150° F. and for twenty minutes at 250° to 275° F. as just described. Finally, the temperature is raised to 375° to 385° F. for twenty minutes to give a completed, durable, non-soluble coat of hard but flexible resin.

The coating is shown in detail in Figure 8. The film 36 adheres to all the walls of the water jacket 10 and also the walls of the bonnets 13. The resin builds up at all sharp corners to form rounded fillets 37 at the sharp corners. Thus, the finished interior resinous coating presents a smooth somewhat glossy surface to the flow of water, and the surface is free of any sharp corners at which cavitation would tend to occur during flow of the coolant. Moreover, it is to be noted that the most usual foci for rusting and corrosion, those points at which there is a sharp bend in metal or at which two or more sheets of metal come together, are absent in the present structure because the fillets 37 provide protection at such points.

The jacket of this invention has been described with particular reference to the use of water as the cooling medium. However, other cooling liquids such as diethylene glycol or water-alcohol mixtures may be used.

Having described my invention, I claim:

1. A sheet metal water jacket which comprises a shell surrounding cylinders of an engine, bonnets on the cylinders which pass completely through the shell, and a series of threaded thimbles inserted in the shell, each of said thimbles being inserted between adjacent bonnets and constructed and arranged to hold a manifold in abutting relation with said bonnets.

2. A sheet metal jacket for an engine comprising sheets of metal brazed together and to the cylinders of the engine to form a unitary structure, a plurality of spaced bonnets attached to the cylinders and to the jacket, and a plurality of threaded thimbles brazed to the jacket, each of said thimbles being attached to the jacket between adjacent bonnets, said thimbles being constructed and arranged to hold a manifold in abutting relation to the bonnets.

3. A sheet metal coolant jacket for an engine comprising a shell surrounding cylinders of the engine, said shell comprising sheets of metal brazed together and to the cylinders to form a unitary structure having openings only to admit and remove cooling liquid, and a baffle placed in spaced relation with the water inlet, said baffle having an orifice adapted to channel the flow of water about the innermost cylinders and having a pair of wings adapted to channel the flow of water about the other cylinders.

4. A water jacket which comprises a sheet metal shell, said shell having longitudinal ribs, a water inlet associated with one of said ribs, and a baffle in spaced relation with said inlet, said baffle having an orifice and a plurality of wings adapted to channel the flow of water about the cylinders of an engine.

5. A sheet metal water jacket which comprises a shell surrounding cylinders of an engine, bonnets from the cylinders which pass completely through the shell, and a series of internally threaded thimbles extending into said jacket from said shell, each of said thimbles having a threaded blind hole therein and being inserted between a pair of bonnets whereby said thimbles are adapted to hold a manifold in abutting relation with said bonnets.

6. A sheet metal water jacket which comprises a shell surrounding cylinders of an engine, said shell having a plurality of longitudinal ribs constructed and arranged longitudinally to strengthen the water jacket and to permit expansion of the water jacket, a water inlet pipe associated with one of said ribs, and a baffle in spaced relationship with the water inlet, said baffle having an orifice adapted to channel part of the cooling water about the cylinders in front of the baffle, and said baffle having a pair of wings adapted to channel the rest of the cooling water into the rib associated with the water inlet to flow about the rest of the cylinders of the engine.

7. A sheet metal water jacket which comprises a shell surrounding cylinders of an engine, said shell having a plurality of longitudinal ribs constructed and arranged longitudinally to strengthen the shell, bonnets from the cylinders which pass completely through the shell, a strengthening plate fixed to the shell and to the bonnets, and a series of blind-hole, threaded thimbles inserted in said plate and shell, each of said thimbles being inserted between a pair of bonnets and constructed and arranged to hold a manifold in abutting relation with the bonnets.

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