United States Patent [19]

Fish

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[54] LIQUID COOLED ENGINE

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[52] **U.S. Cl.** **165/51,** 165/103
[51] **Int. Cl.** **F28f 27/02**
[58] **Field of Search** 165/50, 51, 103, 165/35, 39, 40

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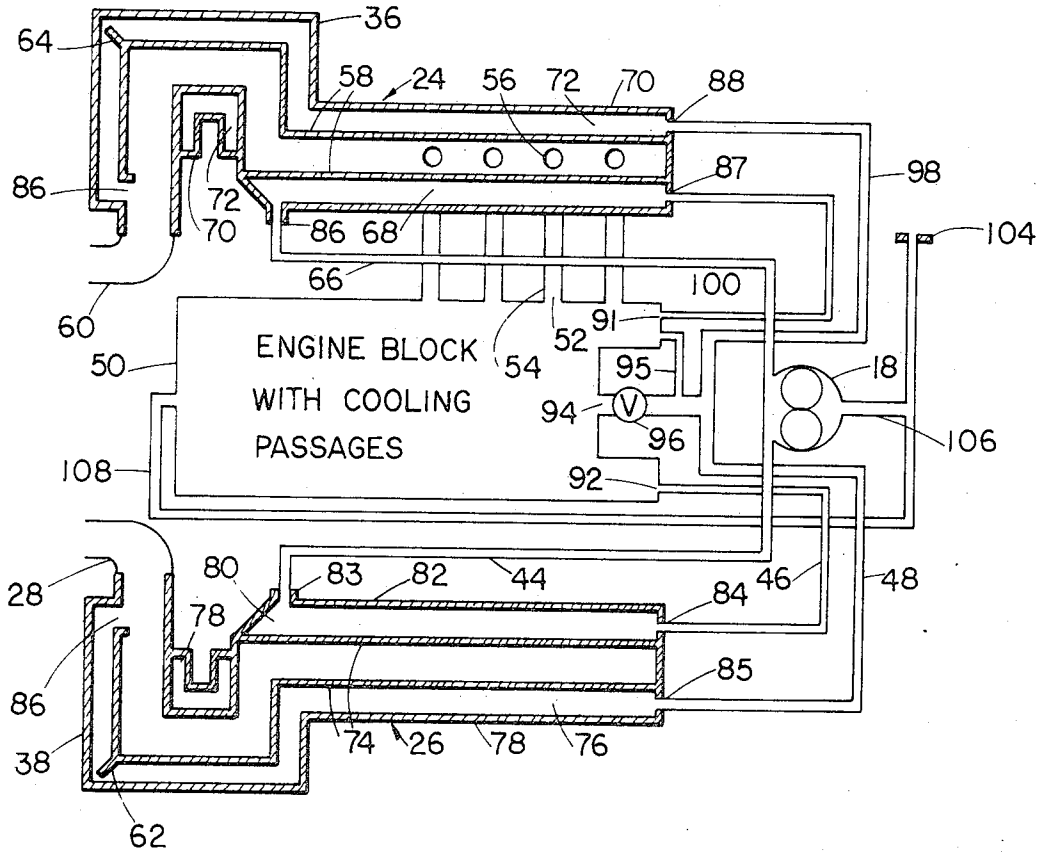
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[57] **ABSTRACT**

A novel engine cooling system which incorporates a special heat exchanger. The heat exchanger replaces the conventional exhaust inlet or inlet manifold of an internal combustion engine. The heat exchanger includes an exhaust conduit having an inlet portion, an intermediate portion and an outlet portion. Encompassing walls define two separate flowpaths for coolant such that the coolant is in thermal communication with the exhaust conduit. A first one of these passages extends only over the inlet portion of the exhaust conduit; the other of the coolant passageways extends over the intermediate and outlet portions of the conduit although it can, and, in the embodiment shown, does extend over the inlet portion as well. The heat exchanger is connected to receive exhaust gases from the engine. Its coolant passageways are connected in a circuit which includes an inlet by which make-up water is introduced into a pump which forces fluid through the first passageway of the heat exchanger into the cooling passages of the engine from whence it is circulated back to the inlet side of the pump when the coolant has a temperature below a selected value. When the coolant temperature rises above that value, it is permitted to flow past a thermostatic valve to the second coolant passageway of the heat exchanger, after which it is exhausted to the exhaust gas stream. The heat exchanger is oriented so that one portion of the second coolant passageway is disposed above other portions and the conduit is arranged so that flow is confined at one point along the length of the exhaust conduit to flow in the region of that uppermost point whereby the second fluid passageway is maintained substantially full of coolant from that point upstream.

11 Claims, 7 Drawing Figures

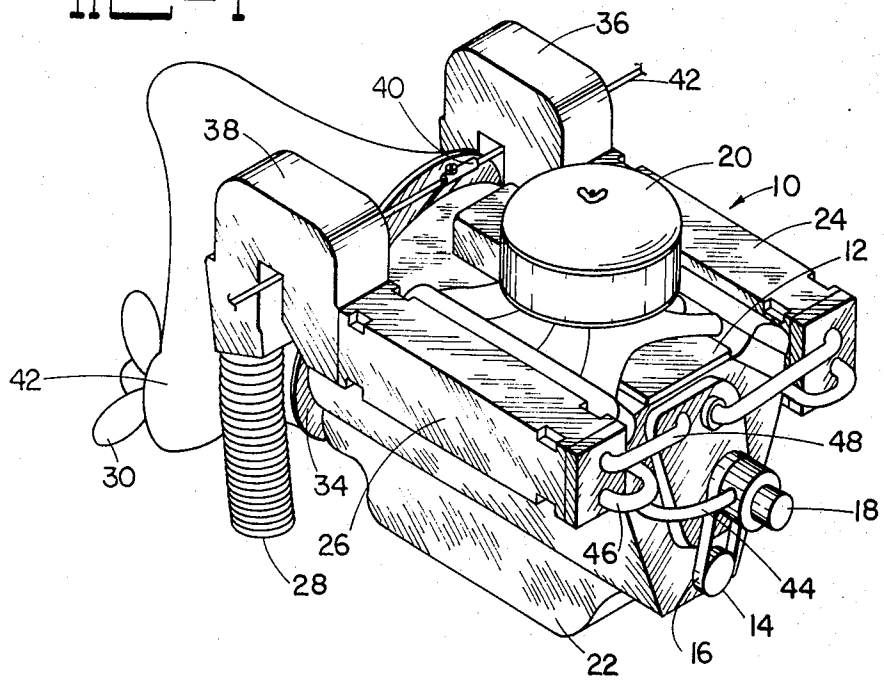


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SHEET 1 OF 3

FIG. 1



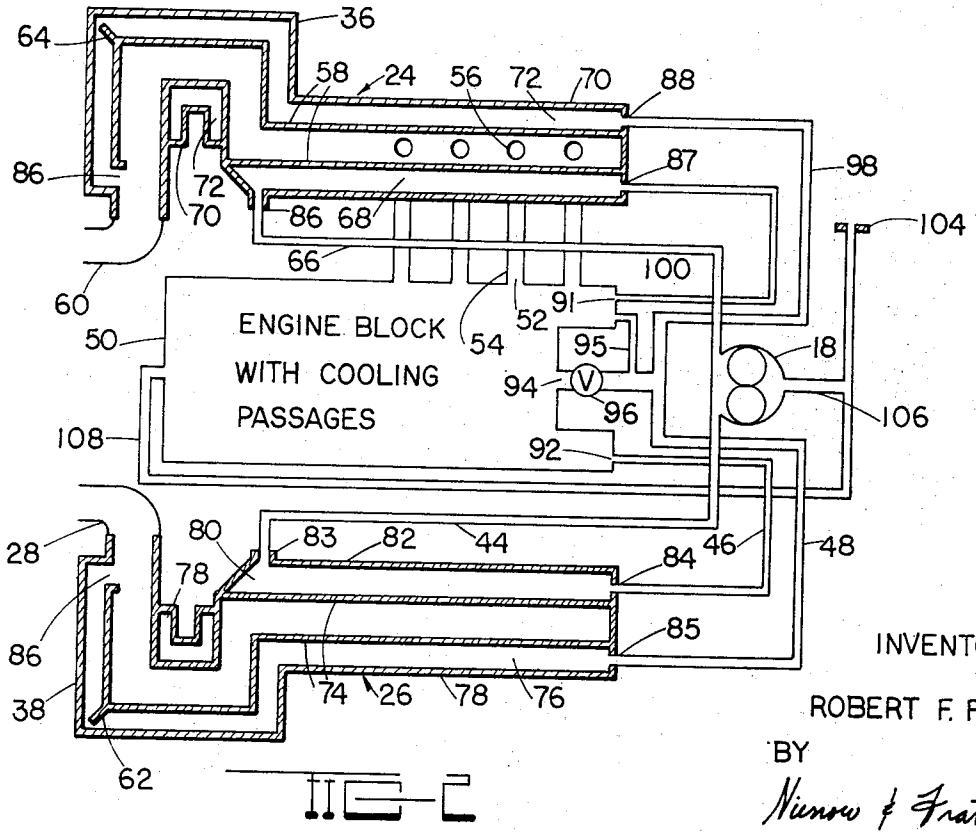


FIG. 2

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FIG. 3

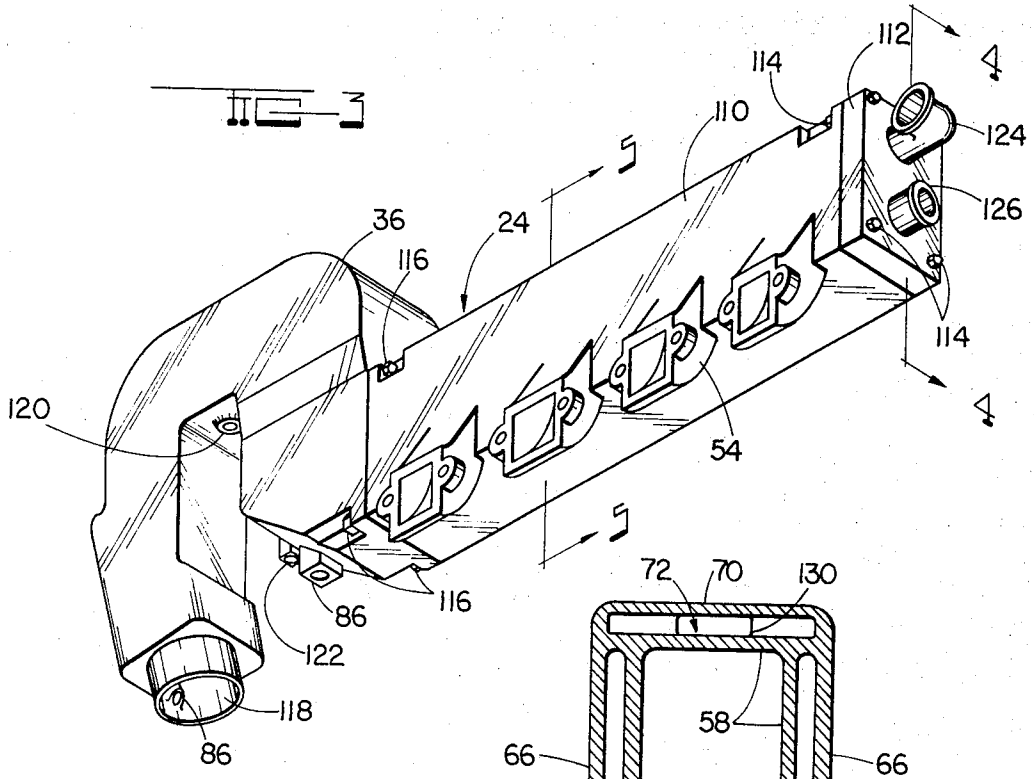


FIG. 5

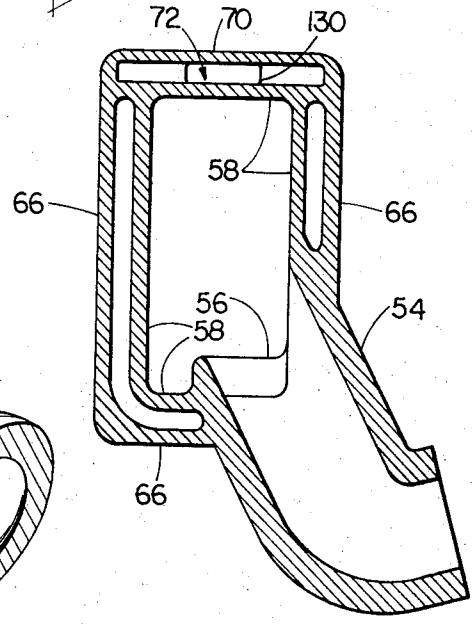
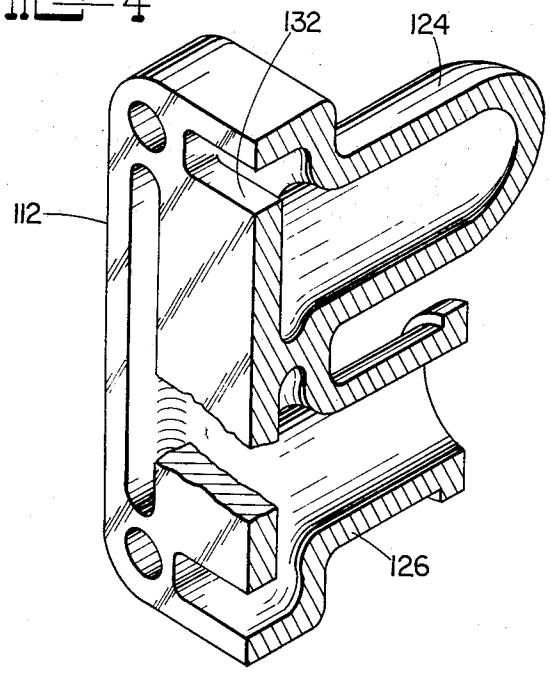


FIG. 4



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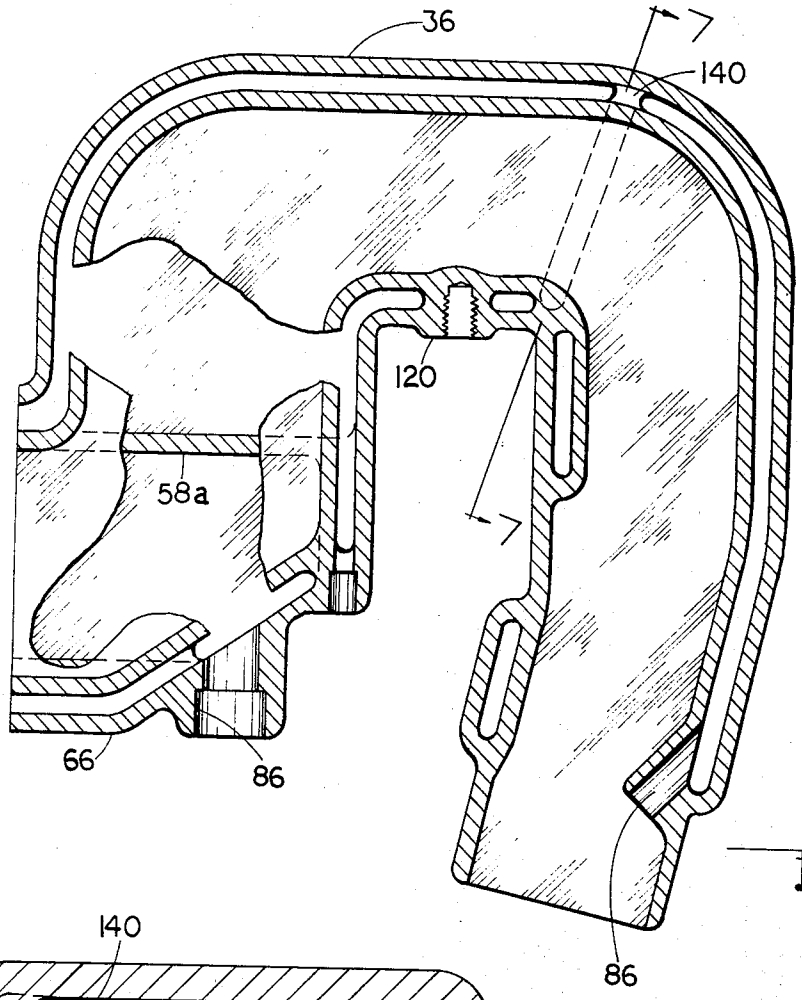


FIG. 6

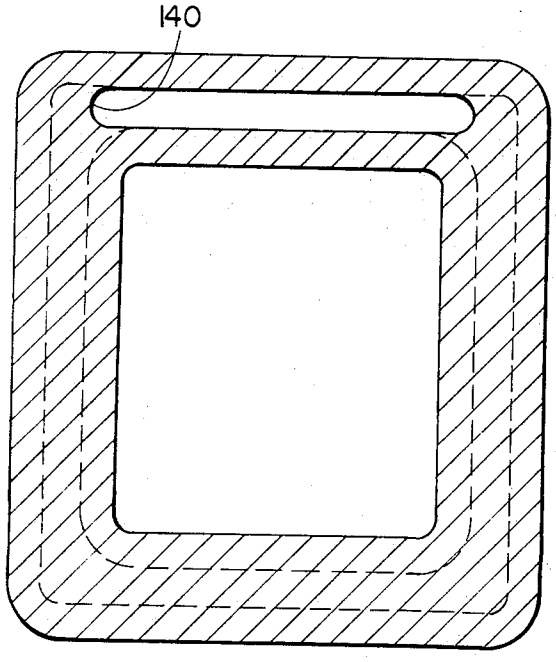


FIG. 7

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LIQUID COOLED ENGINE

This invention relates to improvements in liquid cooled engines and it relates particularly to an improved engine for marine application.

One of the objects of the invention is to provide an improved liquid cooling system for engines which combines the engine and its coolant passageways with conduits, pumps, valves and a heat exchange structure arranged for preheating liquid coolant before introduction into the engine passages and for cooling the conduit by which exhaust gases are lead from the engine. Provision of that novel structure, and provision of the novel cooling system made possible by its combination with an engine, are both objects of the invention.

It will be apparent that the invention is not limited to use in connection with inboard marine engines. However, the invention is especially well-adapted for that application. Accordingly, it is one of the objects to provide an improved cooling system circuit and structure for that application. In certain classes of boats, it is advantageous to mount the propulsion engine back adjacent to the transom for direct connection to a steerable propeller drive and propeller. Locating the engine in that fashion introduces a number of problems. Special design is ordinarily required to ensure that the engine structure imposes no serious limitation on the steering system. In addition, space limitations ordinarily require that the engine enclosure be as small as possible and that boat occupants be seated and that gear be placed immediately adjacent to the engine. That spatial limitation gives rise to the requirement that engine heat be minimized by use of an effective and efficient cooling arrangement. The exhaust gases, in the case of most engines, are exhausted from a series of space ports. Consequently, the manifold in which they are collected for explusion outside the boat extends substantially over the whole length of the engine and is exposed at the interior of the engine. In the case of V–8 engines two such manifolds are employed. One of the objects of the invention is to make it more feasible to employ an engine of conventional design which requires large, exposed exhaust gas collection manifolds. A related object is to provide an engine and engine cooling system for limiting the maximum engine temperature and for greatly reducing exhaust conduit temperature.

These and other objects and advantages of the invention are realized by the combination with an engine of the kind that has exhaust ports and internal passageways for fluid coolant of a heat exchanger means comprising an exhaust gas conduit formed by an inner wall and extending from the region of the engine exhaust ports to an intermediate gas flow conducting portion and then to an outlet section for discharging that exhaust gas and, which further comprises a jacket formed by said inner wall and an overlying outer wall, the outer wall being arranged to define two separate passageways capable of conducting fluid coolant. One of the passageways extends over that portion of the exhaust conduit at which exhaust gas is received. The other passageway extends over the intermediate and outlet sections of the exhaust conduit. The exhaust conduit and jacket combination is arranged so that the coolant passageways adjacent the intermediate section of the exhaust conduit must remain full of coolant regardless of boat motion.

In the drawings:

FIG. 1 is a pictorial view of a marine engine which is fitted with the cooling circuit of the invention including the novel heat exchanger structure that it provides;

FIG. 2 is a diagram of the cooling system circuit employed in the engine of FIG. 1;

FIG. 3 is a pictorial view of the novel heat exchanger employed in the invention;

FIG. 4 is a cross-sectional view taken on line 4—4 of FIG. 3;

FIG. 5 is a cross-sectional view taken on line 5—5 of FIG. 3;

FIG. 6 is a cross-sectional view taken on the vertical, longitudinal midplane of the U-shaped portion of the heat exchanger of FIG. 3, except that portions have been cut away to expose the nature of the double walled construction; and

FIG. 7 is a cross-sectional view taken on line 7—7 of FIG. 6.

The engine selected for illustration in FIG. 1 is an internal combustion unit which uses gasoline as fuel and is generally of the same type and style as the engines used in passenger automobiles. The engine is generally designated **10.** Its block **12** is provided with internal passageways by which a coolant may flow. A pulley **14** at the lower, forward end of the engine is driven by the engine's crankshaft. A belt **16** transmits power from that pulley to a cam driven pump **18** by which coolant is pumped through the system. The numeral **20** designates an air filter; the element **22** is the oil pan.

Thus far described the unit does not differ materially from an ordinary automobile engine. The exhaust manifolds do differ, however. They are heat exchangers. In this case it has been assumed that the engine is of the V—8 variety with four exhaust ports at the right and four at the left. The right exhaust manifold - heat exchanger structure is designated by the numeral **24** and the left one is designated **26.** In this embodiment the exhaust gas is expelled from the heat exchanger through a flexible conduit **28** through an opening in the boat's transom.

The boat's transom was omitted from FIG. 1 so that the propeller **30** and the propeller drive housing **32** would be visible. A part **34** of the transmission's system is mounted forward to the transom and the remainder is mounted behind it. Thus, the transom is placed just rearward of the U-shaped portions **36** and **38** of the two heat exchangers.

The boat may be steered by pivoting the propeller drive housing **32** about a pivot axis rearward of the transom. The force by which it is made to pivot is applied to a tiller arm **40** which is arranged to extend through or over the transom. Steering cables **42** extend in opposite directions from a connection to the end of the tiller bar **40** through the spaces defined by the U-shaped rear sections **36** and **38** of the two heat exchangers. Guides for those cables are attached to the housing within those spaces. This arrangement is particularly advantageous. The U-shape of the heat exchanger structure is doubly functional in that it ensures a generally uniform high degree of exhaust gas cooling, as well as providing protection for, and against, the tiller bar while providing a high order of stability for the steering cable system in the region of tiller bar movement.

The heat exchangers both include a passageway or conduit for exhaust gases and two liquid coolant passageways. The inner exhaust conduit is jacketed to

form a double walled arrangement. Exhaust gases flow in the conduit defined by the inner wall and the cooling liquid flows in the space between the double walls. That space is divided by blocking walls into two flowpaths. The exhaust conduit is connected to the exhaust ports of the engine by laterally and downwardly extending connecting conduits that are not visible in FIG. 1. They can be seen in FIG. 3 and one of them is shown in cross-section in FIG. 5. The exhaust conduit extends over the length of the engine and through the U-shaped section of the heat exchanger housing to an exit point at its junction with the flexible conduit **28.** One of the liquid passageways, in this embodiment, extends only part way over the length of the exhaust conduit. It extends over that part, called the inlet region, where the exhaust gases are collected. Flow lines connected to the exchanger structure at both ends of that passage are connected at thier opposite ends to fittings at the forward end of the engine block. The two conduits associated with heat exchanger **26** are identified in FIG. 1 by the reference numerals **44** and **46.** Another conduit **48** interconnects the inner passages of the engine block with the other liquid flow passage in exchanger **26.** That passageway has an outlet near the outlet of the exchanger at the point of its connection with flexible conduit **28.**

The interconnection of the engine pump, control valve, and the several conduits with the passageways of the manifold structure is illustrated in FIG. **2.** In that figure, the engine block and its cooling passages are illustrated by a block **50.** The engine block is provided with four exhaust gas outlet ports on each side. For identification, one of those outlet ports has been designated **52** in FIG. **2.** The lateral, connecting conduit **54** leads from that exhaust port opening to a port **56** which opens to the interior of the heat exchange structure **24.** The preferred arrangement is illustrated in detail in FIG. **5.**

Pump **18** of FIG. **2** is the same one designated **18** in FIG. **1.** The exhaust gases are collected in the exhaust conduit which is formed by an inner wall generally designated **58** in FIG. **2.** Those gases pass through the conduit moving rearwardly through the U-shaped section **36** of the structure and then emerge at the junction with the flexible conduit **60.** The latter is like the flexible conduit **28** with the exception that it is connected to the other of the two heat exchangers.

The exhaust conduit portion of the exchanger is conveniently considered to comprise three portions. The first is called an inlet portion and is that portion of the conduit in which the exhaust gases are collected. In general, that part extends from the forward end of the exhaust conduit to a point just downstream of the rearmost of the exhaust inlet openings. The numeral **62** in the case of U-shaped member **38,** and the numeral **64** in the case of U-shaped member **36,** identify a dam in one of the two liquid flow passageways. The portion of the exhaust conduit which lies upstream from the vicinity of that dam, and downstream from the inlet portion is called the intermediate portion. That portion of the exhaust conduit which lies downstream from the vicinity of the dam is called the exhaust or outlet portion.

The liquid passageways are formed by the double walls of the exchanger structure. In the case of manifold **24** the inner walls are generally designated **58.** Together with a portion of the outer wall that is identified by the reference numeral **66,** the inner wall **58** defines a passageway in which cooling liquid is preheated. This passageway, numbered **68,** is called the "preheating passageway." Another portion **70** of the outer wall cooperates with wall **58** to define a second passageway for liquid coolant which is called the "exhaust conduit cooling passageway" or cooling passageway **72.** In this embodiment the preheating passageway extends approximately the length of the inlet portion of the exhaust conduit. The cooling passageway extends over the intermediate portion of the exhaust conduit and over at least part of the exhaust portion of that conduit. It may, and in this embodiment it does, extend over the inlet portion of the exhaust conduit as well. In the intermediate portion of the exhaust conduit, the cooling passageway **72** extends substantially entirely around the exhaust conduit and the passageway has been extended in the diagram to the inner region of the U-shaped section **76** to illustrate that this is so.

The arrangement of the other exhaust manifold structure **26** is similar. For identification, walls that define the exhaust conduit are generally designated **74.** The wall that cooperates with that inner conduit to form the exhaust conduit cooling passage **76** is designated **78.** The wall that cooperates with inner wall **74** to form the precooling passageway **80** is designated by reference numeral **82.** The inlet to that passage is designated **83** and the outlet is numbered **84.** The inlet **85** of the exhaust conduit cooling passageway is at the forward end of the structure and the outlet **86** is at the rearward end adjacent the connection with the flexible conduit **28.** In the lower part of FIG. **2** the precooling passageway has an inlet **86** and an outlet **87.** The exhaust conduit cooling passageway has an inlet **88** and an outlet **89.** The engine block cooling passage system includes inlets **91** and **92.** It includes a recirculation outlet **90,** a primary outlet **94** and a safety bypass passageway **95.** That outlet bypasses the thermostatic valve **96.** That valve is connected in series between outlets **94** and the inlets **85** and **88** of the two exhaust conduit passageways. Valve **96** and inlet **85** are interconnected by the conduit **48** which was visible in FIG. **1.** The valve **96** and inlet **88** are connected by a conduit **98.** Outlet **84** and engine block unit **92** are interconnected by the conduit **46.** On the other side of the engine, engine block inlet **91** and precooling passage outlet **87** are interconnected by a conduit **100.** The outlet side of pump **18** is connected to precooling passageway **80** by the conduit **44** and is connected to the inlet opening **86** of the other precooling passageway by a conduit **102.** Cooling water, either sea water or fresh water, enters the system at an inlet **104** and is conducted by a passageway **106** to the inlet side of pump **108.** The recirculation outlet is connected by a conduit **108** back to the inlet side of the pump.

Make-up water enters in at inlet **104** and proceeds by conduit **106** to the inlet side of pump **18** where it is forced through conduits **44** and **102** to enter into the precooling passageways **80** and **68.** The water flows through those passageways and emerges at outlets **84** and **87.** It then proceeds by conduits **46** and **100** to engine block inlets **92** and **91,** respectively. Until that cooling water has reached a temperature sufficiently high to open the thermostatic valve **96,** it exits the engine at outlet **90** and travels by conduit **108** to the junction with conduit **106.** Thereafter, it again flows to the inlet section of pump **18** to be recirculated through the preheating passageways **80** and **68.** When this circulat-

ing water has reached a temperature sufficiently high to open the thermostatic valve **96,** then the water is free to flow from the engine to conduits **48** and **98** to inlets **85** and **88** of the two exhaust conduit cooling passageways **76** and **72.** Those passageways must become entirely filled with water downstream of their respective dams **62** and **64,** before any of the water they contain can be expelled to that portion of the passageway that surrounds the outlet section of the exhaust conduit. This result is achieved by providing the heat exchange structure with a downstream section that is placed generally above and higher than any other section of the exhaust system. That section could be U-shaped, V-shaped, or otherwise shaped to accomplish that result. In the preferred embodiment, the U-shape is employed because it provides a number of advantages. It removes the cooling function to the very rear of the boat, or at least to the rear of the engine; it provides a very effective and efficient means for protecting the tiller linkage and for guiding the steering cables; and it has certain manufacturing advantages.

The cooling circuit arrangement offers a number of advantages. It is desirable to have the heat rise in the engine block occur as uniformly as possible following engine start-up. The invention helps to achieve that result by precirculating the water contained in the engine block past the hottest portion, the inlet portion, of the exhaust conduit. In the preferred form, that passageway is limited substantially to the inlet portion of the exhaust conduit as illustrated in FIG. **2.** It will be shown subsequently, in examination of FIG. **5,** that the preheating passageway encompasses a larger portion of the inlet portion of the exhaust conduit than does the cooling passageway. The result is rapid preheating of the cooling water. During initial operation that feature helps raise engine block temperature uniformly and rapidly. Subsequently, it minimizes extreme thermal differences by preventing direct introduction into the heated block of very much colder sea water. A further advantage is that the coolant that flows through the preheated passageway derives its heat from the hottest part of the exhaust conduit so that excessive heat rise is avoided.

In most small boat designs, the engine occupies a premium space. The engines themselves are available in compact form. However, the space that must be devoted to the engine is function not only of engine size but is also a function of engine temperature. If the temperature can be minimized, the size of the engine compartment **0**r enclosure can be reduced. In large measure, the size of that compartment is determined by maximum engine temperature rather than by average temperature. Accordingly, it is desirable to provide an engine cooling system which minimizes peak temperature as well as average temperature. Efficiency demands that the cooling system contribute to engine warm-up. Within the engine itself, these antithetical requirements are dealt with by the thermostatic valve. In this case, it is desired not only to control block temperature but also to control exhaust conduit temperature. Here, too, the requirements are different during the start-up and the run condition. In this case, the invention solves the problem by the special arrangement of its exhaust manifold and heat exchange structure and by the combination with that structure of the thermostatic valve and the flow circuit arrangement. During the start-up period, the short but large area preheating passageway provides the heat input necessary to ensure the requisite degree of block temperature uniformity. The preheating passageway is assisted in its function by the thermostatic valve which ensures recirculation of the coolant with minimum introduction of cold water. After the engine is heated, the coolant is expelled from the system and new coolant is introduced. That new coolant has a much lower temperature and serves to carry away large quantities of heat from the hottest, inlet section of the exhaust conduit. The cooling passage of the exchanger is supplied with coolant only after the engine is heated. It completely surrounds the intermediate portion of the exhaust conduit to ensure that a maximum volume of water is exposed, through a maximum heat exchange surface, to the heat of the exhaust gases. The cooling passage is extended forwardly adjacent the inlet portion of the exhaust passage to the extent that the surface area of the exhaust conduit does not need to be encompassed by the preheating conduit. In this embodiment, approximately one-fourth of the conduit wall in the inlet portion forms a part of the cooling passageway while three-fourths of that wall forms a part of the preheating passageway. The heat exchange structure is oriented so that dams **62** and **64** are at an uppermost point thereby to ensure that the passageway is completely filled with coolant upstream from that point. Below the dam, the coolant is finally expelled into the stream of exhaust gases, cooling those gases sufficiently so that flexible conduit of conventional material can withstand their temperatures.

A preferred heat exchange structure is shown in FIGS. **3** through **7.** The whole structure **24** is shown in FIG. **3.** It comprises a straight section **110,** having an end closure **112** at its forward end, and the U-shaped section **36** at its rearmost end. The three sections are cast separately and are bolted together. Bolts **114** connect the forward closure to the straight section **112** and the bolts **116** connect the U-shaped section to the straight section. There are four inlet conduits that afford communication for exhaust gases from the exit ports of the engine to the inlet section of the exhaust conduit. The conduit **54** is the one that was identified in connection with the description of FIG. **2** and is the one shown in cross-section in FIG. **5.** The exit opening for the exhaust conduit is designated **118** and it is on this element that the flexible conduit **60** is fitted. The flexible conduit has been omitted from the figure so that the outlet opening **86** of the coolant passage is made visible. The threaded boss **120,** which can be seen on the upper inner surface of the U-shaped section **36,** accommodates a fitting through which the steering cable is run. Just below that, the numeral **122** identifies a drain port for the cooling passageway. At the front closure **112,** elbow **124** is connected to the inlet opening **85** and forms part of conduit **48.** Just below, the nipple **126** forms part of the coolant passage outlet opening **84.**

In this embodiment, the cooling passage extends over the length of the straight section **112** and it continues into the lower forward portion of the U-shaped section **36.** Except in the region of the four passageways by which exhaust gases are admitted into the exchanger, the preheating passageway extends between the double walls of the structure at its sides and at its bottom. Thus, in FIG. **5** the exhaust conduit is defined by the inner walls **58.** The cooling passageway is defined by

the lower one and the side ones of those inner walls and by the outer walls **66** at the sides and the bottom of the structure. The coolant passage is the upper one in FIG. **5** and is defined by the upper wall **58** at its inside and the wall **70** at its outside. The passageway is necked down at **130** because the outer wall is indented to accommodate the bolts **114.**

That the two passageways are separated is illustrated by the cross-sectional, pictorial view of end member **112** in FIG. **4.** The slot **132** communicates only with the upper coolant passage of the straight section **110** and with the elbow **124.** On the other hand, nipple **126** communicates with the bottom and the side openings that comprise the precooling passageways **68.**

The rearmost region of the precooling passage is shown at the lower left in FIG. **6.** The cross-sectional view in that figure is taken on the vertical, longitudinal midplane of the U-shaped section **36.** The far wall of this structure is double; part of it has been broken away to make it clear that the upper section of wall **58** extends throughout the length of the precooling passageway with respect to the coolant passageway even though the exhaust conduit turns upwardly and continues through portion **58a** of that wall. The inner wall has been broken away above the webb **58*a*** to show that from that point on downstream all of the space between the inner and outer walls is part of the cooling passageway. A dam is formed transversely across that flow passage on the plane **7—7** of FIG. **6.** The dam is formed by a webb that interconnects the inner and outer walls except at the upper portion of the space between them. The edge of the dam visible in FIG. **6** is designated **140.** FIG. **7** is a cross-sectional view taken on line **7—7** which illustrates this construction. Below the dam the cooling passageway encompasses the exhaust conduit over most of its area so that additional cooling is accomplished.

The extent to which that passage is filled with water, and therefore the extent to which cooling is accomplished in that portion, depends upon the size of opening **86** and the rate at which **18** forces coolant to flow. The pump **18** is driven at a speed that varies with engine speed. In a marine engine, engine load is rather directly related to engine speed and heating is rather directly related to engine load. As a consequence, if the outlet opening **86** is not unduly large, the amount of water in the final section of the cooling passage will vary with load and the quantity of heat that must be removed from the exhaust gases.

Advantageously, the dam is located at the highest point in the coolant flowpath so that the flowpath must be completely filled upstream from that point. Removal of the dam from that high point does not destroy the value of the invention although efficiency would be lowered somewhat. The dam may have any convenient form. Thus, it could comprise any kind of structural division of the coolant passageway into upstream and downstream sections interconnected at an elevated point.

Although I have shown and described certain specific embodiments of my invention, I am fully aware that many modifications thereof are possible. My invention, therefore, is not to be restricted except insofar as is necessitated by the prior art.

I claim:

1. For use in cooling an engine which has an exhaust gas exit port and has an inlet opening and an outlet opening for receiving and discharging fluid, respectively:

a heat exchanger comprising an exhaust conduit formed by an encompassing wall and defining an inlet portion for receiving exhaust gas from the engine exit port, an intermediate portion, and an outlet end portion for discharging exhaust gas that has traversed said intermediate portion after entering at the inlet portion;

a jacket comprising said encompassing wall and an overlying outer wall, said jacket being formed to define two passageways capable of conducting liquid coolant, one of said passageways extending over the inlet portion of said exhaust conduit, the other one of said passageways extending over the intermediate portion of said exhaust conduit; and

means interconnecting said heat exchanger and said engine such that exhaust gas is permitted to flow to said exhaust conduit, coolant is permitted to flow from said one passageway to said engine inlet, and fluid from said engine outlet is permitted to flow to said other one of said passageways.

2. The invention defined in claim **1** in which said other one of said passageways is formed with an outlet opening which opens at the interior of said exhaust conduit.

3. The invention defined in claim **2** in which said jacket further comprises means for insuring that said other one of said passageways is substantially completely filled with coolant along an initial portion of its length before fluid can be discharged from said outlet opening.

4. The invention defined in claim **1** in which said jacket comprises means for insuring that said other one of said passageways is substantially completely filled with coolant along an upstream portion of its length, said means comprising mounting means for mounting said conduit with one portion of said other one of said passageways uppermost and of dam means in the form of a dam interconnecting said inner and outer walls except in the region of said one portion of said other of said passageways for confining flow to that one portion.

5. In combination:

an elongate exhaust conduit comprising an inlet section, an intermediate section and an outlet section, said conduit being formed with openings in its inlet section by which exhaust gases may be admitted thereto so that they will traverse the conduit from its inlet section through its intermediate section to be expelled at said outlet section;

means comprising a first enclosing wall overlying portions of said exhaust conduit at its inlet section and defining a first passageway for coolant having inlet and outlet openings;

means comprising a second enclosing wall overlying portions of said conduit at its intermediate section and at its outlet section and defining inlet and outlet openings; and

means for orienting said conduit and enclosing walls such that one portion of the flowpath formed by said conduit and said second enclosing wall is uppermost in the vicinity of the juncture of said intermediate section and said outlet section of said conduit and for confining flow of fluid along said second passageway to flow substantially at said uppermost region.

6. The invention defined in claim 5 together with an engine comprising a plurality of spaced exhaust gas outlet ports, an inlet opening for coolant, an outlet opening for coolant, and internal passageways interconnecting said inlet and said outlet;

means interconnecting the outlet ports of the engine with the openings in the inlet section of said exhaust conduit;

means for connecting said first passageway and the passageways through said engine and said second passageway in series, in that order, comprising a first conduit extending from said first passageway defined by said first overlying wall to the inlet of said engine, and comprising a second interconnecting conduit extending from the outlet of said engine to said second passageway defined by said second overlying wall.

7. The invention defined in claim 6 together with means for forcing a flow of coolant into said first passageway and for permitting flow of coolant from said passageways of the engine to said second passageway when said coolant has a temperature exceeding a selected value.

8. The invention defined in claim 7 in which said first passageway is confined to the inlet area of said exhaust conduit and in which said second passageway extends throughout the length of said exhaust conduit.

9. The invention defined in claim 6 in which said conduit comprises a horizontal section and an inverted U-shaped section, said first enclosing wall overlying the horizontal section and said second enclosing wall overlying the inverted U-shaped section.

10. The invention defined in claim 9 in which said U-shaped section comprises a double-walled jacket and said means for confining the flow to said one portion of said second passageway comprises a dam disposed between the walls of the conduit and the second overlying wall except at an upper region of said U-shaped section.

11. The invention defined in claim 9 which further comprises an inlet conduit for make-up water connected to the inlet side of said pump, means interconnecting the passageways of the engine with the inlet side of said pump, said means for permitting flow of coolant from the engine passageways to said second conduit comprising a thermostatic valve.

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