Aug. 14, 1945. R. W. FERNSTRUM 2,382,218

OUTBOARD MARINE HEAT EXCHANGER

Filed Sept. 18, 1943 2 Sheets-Sheet 1

FIG. 1.

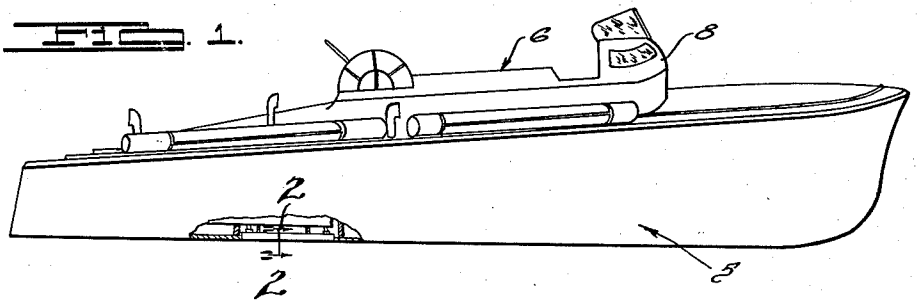
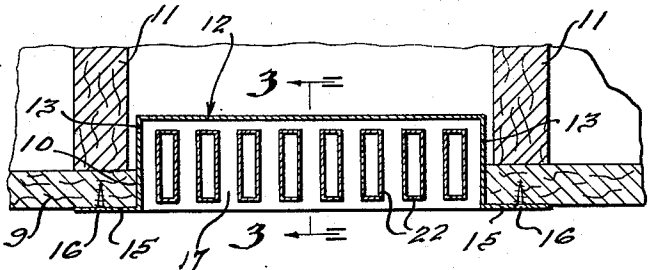


FIG. 2.



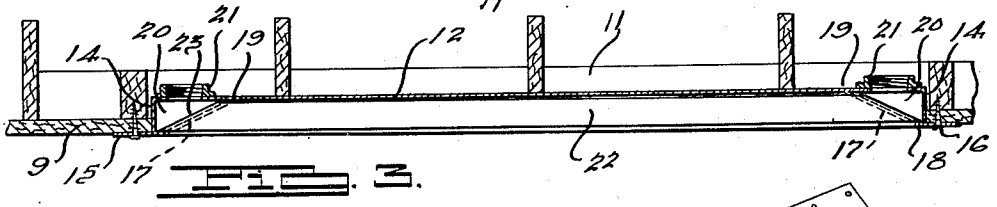


FIG. 3.

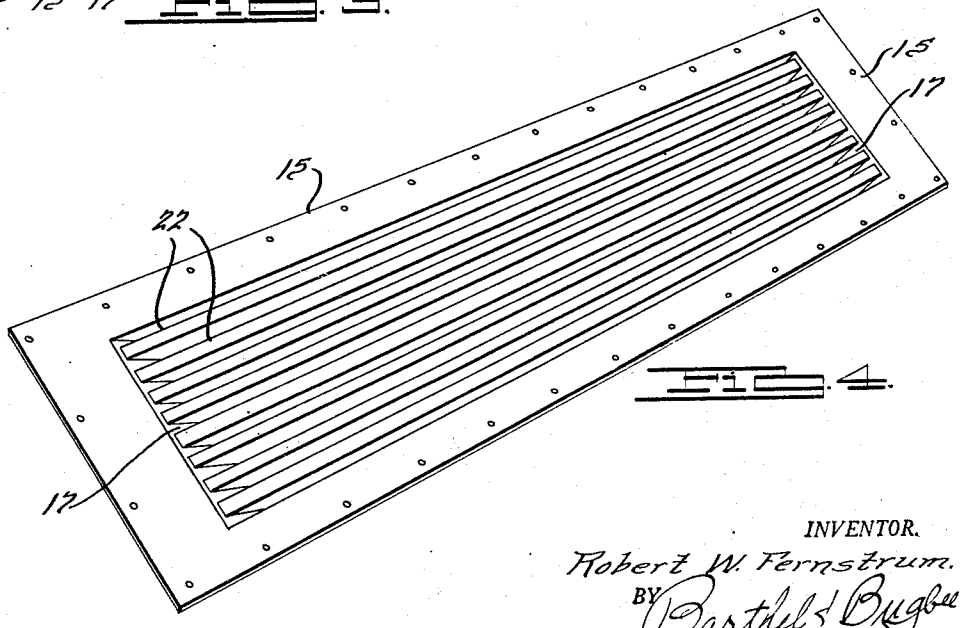


FIG. 4.

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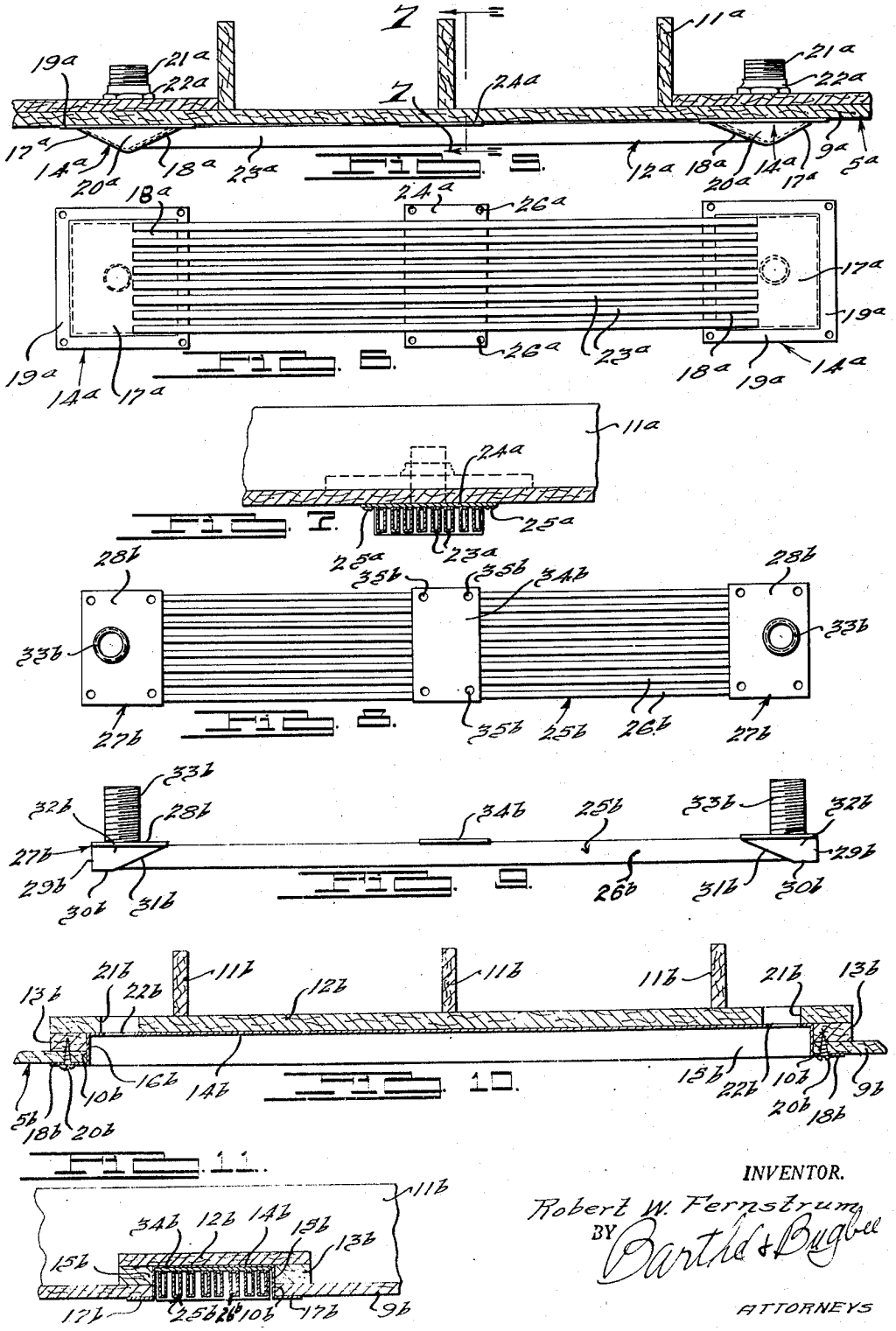

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2,382,218

OUTBOARD MARINE HEAT EXCHANGER

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Application September 18, 1943, Serial No. 502,859

14 Claims. (Cl. 115—0.5)

The present invention relates to improvements in heat exchanges, and more particularly, to a heat exchanger for water craft and vessels.

The primary object of the invention is to facilitate circulatory movement of the engine cooling fluid in a closed system to exclude foreign matter from the cooling system of the vessel's power plant or prime mover and to exclude corrosive forming chemicals which would otherwise be pumped through the water cooling jacket of the engine.

Another object of the invention is to provide an outboard heat exchanger for connection with the water jacket of an engine cooling system including a series of tubes, rectangular in cross-section and extending longitudinally of the keel of the vessel to give a greatly increased thermal capacity so as to maintain the coolant in the water jacket at a substantially constant temperature.

Another object of the invention is to provide an outboard heat exchanger adapted to be located in a recess in the key of a hull so as to be removed from the path of obstruction and so as to present little or no resistance to the water path during its motion through the water.

Another object of the invention is to provide an outboard type heat exchanger for water craft and other vessels including a pair of headers mounted in spaced relation along the keel of the boat or vessel with relatively flat heat conduction tubes extending therebetween with their sides of greatest width extending in a vertical plane so as to greatly increase the heat conduction surface and the general efficiency of the heat exchanger.

Another object of the invention is to provide the headers with slightly bevelled surfaces to prevent the water in which the vessel is travelling from becoming pocketed in the space between the longitudinally extending tubes so as to insure proper heat conduction and the resultant continuous cooling of the liquid in the closed circulatory system.

Another object of the invention is to provide an outboard heat exchanger for water craft in which the heat exchanger is received in a longitudinally extending recess in the keel of the boat, and said recess is sealed by means of a sheathing of relatively thin metal to prevent water from finding its way between the joints of the heat exchanger and into the boat.

Another object of the invention is to provide an intermediate support for the longitudinal heat conduction tubes to prevent sagging thereof and distortion when contacting floating objects in the water.

Other objects and advantages of the invention will become apparent during the course of the following description forming a part of the specification, wherein:

Figure 1 is a side elevational view of a small water craft or motor boat illustrating a portion broken away to show the manner in which the heat exchanger is installed;

Figure 2 is a vertical cross sectional view taken on line 2—2 of Figure 1 looking in the direction of the arrows illustrating the structural details of the heat exchanger and the manner of mounting the same;

Figure 3 is a longitudinal cross-sectional view taken on line 3—3 in Figure 2 looking in the direction of the arrows further illustrating the details of construction and the manner of mounting the heat exchanger in a recess formed in the keel of the boat;

Figure 4 is a perspective view of the heat exchanger showing the underside thereof and the longitudinal heat conduction tubes connecting the headers at each end of the frame;

Figure 5 is a longitudinal cross sectional view of a small boat keel illustrating a modified form of the invention in side elevation and showing the same extending longitudinally of the keel;

Figure 6 is a bottom plan view of the modified form of the invention further illustrating the headers at each end of the heat exchanger and the central supporting strut therefor;

Figure 7 is a vertical cross sectional view taken on line 7—7 in Figure 5 looking in the direction of the arrows and illustrating the manner in which the heat exchanger tubes project slightly below the bottom of the boat in the modification;

Figure 8 is a plan view of a still further modified form of the invention showing the arrangement of the longitudinal tubes and illustrating the manner in which they are connected to the headers at each end of the heat exchanger;

Figure 9 is a side elevational view of the modified form of the invention shown in Figure 8 further illustrating the structural details and the general arrangement;

Figure 10 is a longitudinal cross sectional view of a boat hull taken along the keel line illustrating the packing sheathing received in the recess prior to the installation of the heat exchanger shown in Figures 8 and 9; and

Figure 11 is a vertical cross sectional view extending transversely of the keel line, illustrating

the manner in which the heat exchanger is received in the recess shown in Figure 10.

In the drawings, attention is directed to Figures 1 to 4 inclusive wherein there is shown a preferred embodiment, and in Figure 1 the reference character 5 will generally be employed to designate the hull of a small boat or water craft having a power plant such as an internal combustion engine. The boat 5 is provided with a super-structure 6 having a windshield 8 and the hull 5 is provided with a bottom wall 9 which is relatively flat for a portion of its length and tapers to the bow of the boat in a V-shaped formation.

Formed in the bottom of the hull 9 is a cutaway portion 10 and said cutaway portion is of elongated rectangular shape and extends longitudinally along the keel line of the hull. The elongated opening 10 may be formed between certain pairs of longitudinally extending hull members 11 as is clearly shown in Figure 2.

Mounted within the recess 10 is a box-like casing 12 having side and end walls 13 and 14, and said end walls are provided with a marginal flange 15 held in place by screws or the like as at 16, extending into the hull 9. Each end of the elongated casing is provided with a diagonal wall 17 extending transversely of the casing with its end welded or otherwise secured to the side walls 13. The edges of the diagonal walls 17 are welded or otherwise secured to the end walls 14 and the bottom wall of the casing as at 18 and 19 respectively, thus forming header chambers 20 for the free circulation of liquid. Each header has formed integral therewith or secured thereto a threaded nipple 21 for receiving the circulatory water pipe connected to the engine cooling system, not shown.

Interconnecting the header chambers 20 is a series of conduction tubes 22 having their ends bevelled as at 23 to coincide with the oblique wall 17 and said bevelled ends are welded in place to the oblique wall 17 so that water may circulate therethrough from one end to the other. Openings may be formed in the oblique walls 17 to establish communication between the tubes 22 and the header chambers 20 and said openings are spaced one from the other so that the conduction tubes 22 will be spaced a corresponding distance.

The conduction tubes 22 are preferably formed rectangular in cross-section, as is clearly illustrated in Figure 2 to increase the surface presented to the slipstream of the hull, resulting in a greater efficiency and increased heat conduction. Suitable piping may connect the threaded nipples 21 to the circulatory system of the boat engine and water-cooling jacket thereof.

In the modified form of the invention shown in Figures 5 to 7 inclusive, the boat hull is generally designated by the reference character 5a and likewise includes structural frame members including transverse ribs 11a. As in Figures 1 to 5 inclusive, the heat exchanger generally designated by the reference character 12a extends longitudinally of the hull 5a and is bolted to the bottom wall thereof 9a.

The heat exchanger comprises a pair of header members 14a having angular front and rear walls 17a and 18a conected to a header plate 19a. The diagonal walls 17a and 18a are connected at their ends by triangular-shaped end walls 20a thereby providing a closed header chamber within said diagonal walls. Threaded nipples 21a extend through suitable openings in the hull 5a and said threaded nipples are provided with gland nuts 22a to securely hold the headers in place. A series of longitudinally extending conduction tubes 23a have their ends bevelled similar to the ends 23 of the heat conduction tubes 22 shown in Figures 1 to 4 inclusive and said bevelled ends are welded about suitable openings formed in the oblique plates 18a. The tubes 23a are preferably rectangular in cross-section and have their interiors in communication with the header chambers of the headers 14a. The intermediate portions of said conduction tubes 23a may have welded thereto a plate 24a extending transversely thereof so that screws or the like as at 25a may be passed through openings 26a in the end portions of the anchoring plate 24a. The plate 24a is intended to prevent sagging of the conduction tubes 23a and to prevent vibration thereof when the boat is being propelled through the water.

The screw-threaded nipples 21a are adapted to be connected to the water cooling system or engine water jacket of the power plant so that circulatory movement of water or cooling medium through the conduction tubes will cool said water for being returned to the engine water cooling jacket.

In the further modified form of the invention shown in Figures 8 to 11 inclusive, the bottom wall 9b of the hull 5b (Figure 10) is built up to form a longitudinally extending recess adjacent the opening or cutaway portion 10b. The frame structure of the hull including the ribs 11b, is cut away so as to receive a longitudinal frame member 12b spaced from the hull 9b by suitable frame members 13b. The recess thus formed by the frame structures 12b and 13b is provided with a liner 14b of box-like form having side walls 15b connected by end walls 16b. The side and end walls 15b and 16b are provided with marginal flanges 17b and 18b respectively so that a series of wood screws 20b may be passed therethrough to securely hold the liner in place. The frame structure 12b is provided with a bore 21b at each end thereof and said bores are in alignment with openings 22b formed in the liner 14b.

The heat exchanger is generally designated by the reference character 25b and is constructed similar to the heat exchangers shown in Figures 1 to 7 inclusive in that it includes a series of longitudinally extending conduction tubes 26b the ends of which are connected to headers generally designated by the reference character 27b. The headers 27b include a top wall 28b having end walls 29b and relatively short bottom walls 30b. Interconnecting the top wall 28b and relatively short bottom wall 30b is an oblique wall 31b having a series of spaced openings for the reception of the bevelled ends of the heat conduction tubes 26b. Said bevelled ends may be welded or otherwise secured in place and are shaped similar to the ends 23 of the heat conduction tubes 22. End walls 32b complete the structure and form an enclosed header chamber in communication with each end of the conduction tubes 26b. Secured to the top walls 28b of the headers 27b is a threaded nipple 33b and said threaded nipples are adapted to extend through the openings 21b and 22b in the frame structure 12b and sheathing liner 14b respectively. Gland packing nuts may be threaded on the nipples 33b above the frame structure 12b to securely clamp the headers 27b in position and suitable pipes may be connected with the threaded nipples 33b for communication

with the cooling system of the engine or power plant.

The intermediate portions of the heat conduction tubes 26b may be provided with an anchor plate 34b having openings at the corner portions thereof as at 35b to facilitate anchoring the tubes against vibration when the heat exchanger is in the position shown in Fig. 11. In this position, the heat conduction tubes 26b are partially concealed so that the lower walls thereof are flush with the bottom wall 9b of the hull 5b. Obviously, the heat conduction tubes will be out of the path of floating obstructions and will be completely protected from striking floating objects and other debris.

While the invention is particularly applicable to small water craft, such as motor boats, it is to be understood that the same may be applied to larger vessels for cooling circulatory liquid or fluid for various purposes.

It is to be understood that the forms of the invention herewith shown and described are to be taken as preferred embodiments of the same and that various changes in the shape, size and arrangement of parts may be resorted to without departing from the spirit of the invention or the scope of the subjoined claims.

What I claim is:

1. In combination with a marine hull structure having a keel line, a heat exchanger extending longitudinally of said keel line, said heat exchanger comprising spaced headers secured to the hull and a plurality of flat heat conduction tubes rectangular in cross-section connecting and in communication with said headers said conduction tubes being located within the confines of said spaced headers.

2. In combination with a marine hull structure having a keel line, a heat exchanger extending longitudinally of said keel line, said heat exchanger comprising spaced headers secured to the hull in longitudinal alignment with the keel line, a threaded pipe connection on each of said headers for connection with a liquid circulatory system, and a series of flat heat conduction tubes extending between said headers and in communication therewith along said keel line, said tubes being located within the confines of the headers out of the path of obstructions.

3. In combination with a marine hull structure having a keel line and a recess extending longitudinally thereof, a heat exchanger mounted in said recess comprising spaced headers having chambers therein and arranged in longitudinal alignment with said hull keel line, a plurality of heat conduction tubes connecting said headers and in fluid communication with said chambers, said heat conduction tubes being arranged and confined in the space between said headers, and means for fastening said heat exchanger in said recess.

4. In combination with a marine hull structure having a keel line and a recess extending longitudinally thereof, a heat exchanger mounted in said recess comprising spaced headers having chambers therein and arranged in longitudinal alignment with the keel line of said hull, a series of relatively flat heat conduction tubes connecting said headers in fluid communication with said chambers, threaded pipe couplings on each header extending through opening in said hull, and means for securing said heat exchanger in said recess, said heat conduction tubes being arranged so as to lie within the confines of the headers so as to be removed from the path of obstructions.

5. In combination with a marine hull structure having a keel line and a recess extending longitudinally thereof, a heat exchanger mounted in said recess comprising spaced headers having chambers therein, a plurality of heat conduction tubes connecting said headers and in fluid communication therewith, and means for fastening said heat exchanger in said recess, said conduction tubes being rectangular in cross-section with their side walls extending in a plane perpendicular to the bottom of said hull structure and being positioned between said headers to be removed from the path of obstructions.

6. In combination with a marine hull structure having a keel line and a recess extending longitudinally thereof, a heat exchanger mounted in said recess comprising spaced headers having chambers therein and arranged at each end of said recess, a plurality of flat heat conduction tubes rectangular in cross section connecting said headers and in fluid communication therewith, said heat conduction tubes being arranged between said headers in said recess to be removed from the path of obstructions, and means for fastening said heat exchanger in said recess, said headers each having a wall inclined oppositely to that of the other to create a flow action around and between said heat conduction tubes when the marine hull is propelled through the water.

7. In combination with a marine hull structure having a keel line and a recess extending longitudnally thereof, a heat exchanger mounted in said recess comprising spaced headers having chambers therein arranged at each end of said recess, a series of relatively flat heat conduction tubes rectangular in cross section connecting said headers in fluid communication with said chambers, threaded pipe couplings on each header extending through openings in said hull, and threaded gland nuts on said pipe couplings to clamp said heat exchanger in said recess, said heat conduction tubes being arranged in said recesses and within the confines of said headers to be removed from the path of obstructions.

8. In combination with a marine hull structure having a keel line and a recess extending longitudinally thereof, a heat exchanger mounted in said recess comprising spaced headers having chambers therein located at each end of said recess, a plurality of flat heat conduction tubes connecting said headers and in fluid communication therewith, and means for fastening said heat exchanger in said recess, said heat exchanger being provided with a marginal flange portion for attachment to said hull structure and said flat conduction tubes being arranged within the confines of said recess to be removed from the path of obstructions.

9. In combination with a marine hull structure having a recess formed longitudinally of its keel line, a heat exchanger mounted in said recess substantially flush with the bottom of said hull, said heat exchanger comprising spaced header members in longitudinal alignment with the keel of said hull having chambers therein at each end of said recess, flat heat conduction tubes connecting and in fluid communication with said header chambers, and a sealing sheathing member located in said recess between the hull and said heat exchanger, said heat conduction tubes being rectangular in cross section and arranged within the confines of said recess.

10. In combination with a marine hull struc-

ture having a recess formed longitudinally of its keel line, a heat exchanger mounted in said recess substantially flush with the bottom of said hull, said heat exchanger comprising spaced header members having chambers therein at each end of said recess, heat conduction tubes connecting and in communication with said header chambers, and a sealing sheathing member located in said recess between the hull and said heat exchanger, said heat conduction tubes being substantially flat and rectangular in cross-section.

11. In combination with a marine hull structure having a recess formed longitudinally of its keel line, a heat exchanger mounted in said recess substantially flush with the bottom of said hull, said heat exchanger comprising spaced header members having chambers therein at each end of said recess, heat conduction tubes connecting and in communication with said header chambers, and a sealing sheathing member located in said recess between the hull and said heat exchanger, said heat conduction tubes being substantially flat and rectangular in cross-section and being spaced a distance equal to their thickness.

12. In combination with a marine hull structure having a recess formed longitudinally of its keel line, a heat exchanger mounted in said recess substantially flush with the bottom of said hull, said heat exchanger comprising spaced header members having chambers therein at each end of said recess, heat conduction tubes connecting and in communication with said header chambers, and a sealing sheathing member located in said recess between the hull and said heat exchange, each of said headers having a threaded coupling member adapted to extend through an opening in said hull to anchor said heat-exchanger within said recess.

13. In combination with a marine hull structure having a recess formed longitudinally of its keel line, a heat exchanger mounted in said recess substantially flush with the bottom of said hull, said heat exchanger comprising spaced header members having chambers therein at each end of said recess, heat conduction tubes connecting and in communication with said header chambers, and a sealing sheathing member located in said recess between the hull and said heat exchanger, said heat exchanger having a marginal flange adapted to overlie the edge of said recess for securing said heat exchanger in position.

14. In a marine craft, a heat exchanger comprising header members spaced along the keel line of said marine craft, relatively flat heat conduction tubes connecting said headers, threaded coupling nipples on each header for connection with a fluid circulatory system of said marine craft, and inclined front and back walls on said headers extending forwardly and rearwardly so that the slip stream of said marine craft will be uninterrupted, said heat conduction tubes being rectangular in cross-section with their sides of greatest width extending perpendicular to the bottom of said marine craft and arranged within the confines of said headers so as to be removed from the path of obstructions.

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