Sept. 14, 1965 E. W. FRANTTI 3,205,667

SUBMARINE AIR CONDITIONING MODULE

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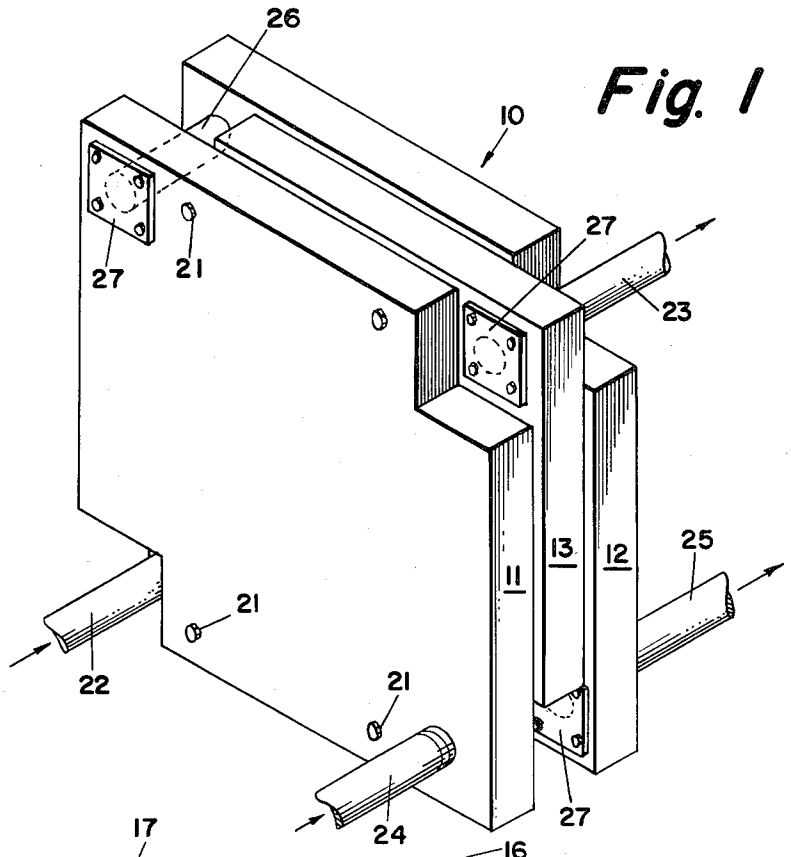


Fig. 1

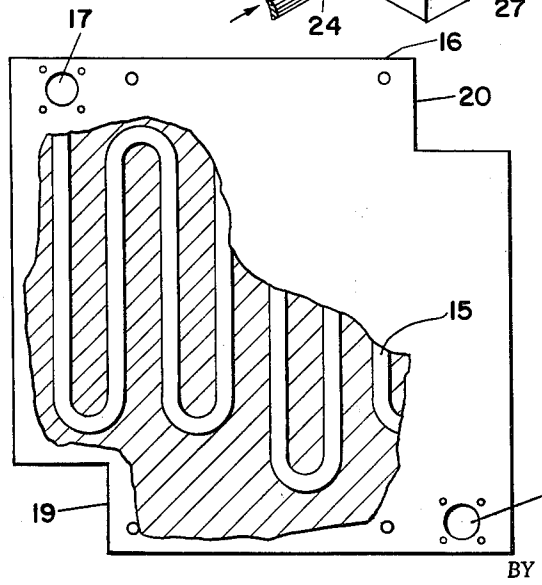


Fig. 2

INVENTOR.
EDSEL W. FRANTTI
BY
J. F. Shelton
ATTORNEY

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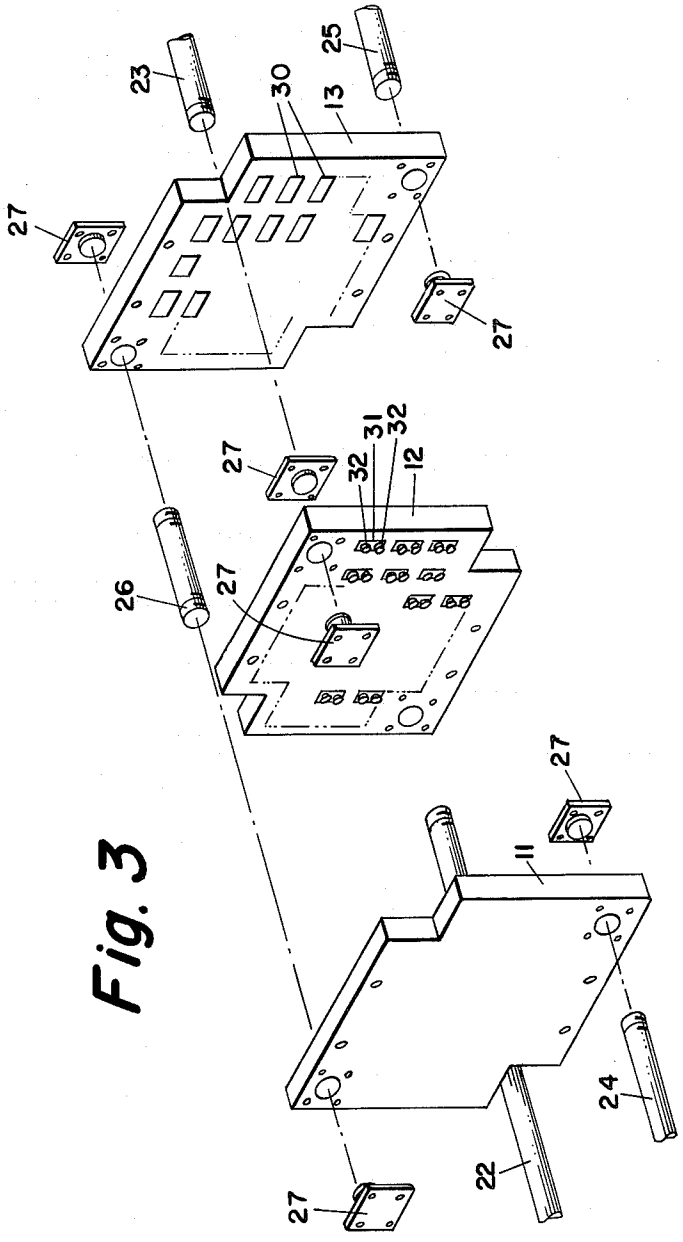


Fig. 3

INVENTOR.
EDSEL W. FRANTTI
BY
ATTORNEY

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SUBMARINE AIR CONDITIONING MODULE

Edsel W. Frantti, Pittsburgh, Pa., assignor, by mesne assignments, to the United States of America as represented by the Secretary of the Navy

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The invention relates to theremoelectric heating and cooling apparatus and in particular involves Peltier thermocouple apparatus for heating and cooling separate bodies of liquids utilized in heat transfer.

Two dissimilar thermoelectric materials, which have different thermoelectric powers, may be joined together to form a Peltier couple which function when current is passed therethrough to provide a hot junction and a cold junction. When a plurality of such couples are arranged in an array in which the hot junctions and cold junctions are segregated into separate groups, a heat pumping device known as a thermopile is produced. Heat will be absorbed by the cold junctions of the thermopile and liberated by the hot junctions and consequently liquid circulated in heat exchange relation with the cold junctions will give up heat thereto and when circulated in heat exchange relation with the hot junctions will absorb heat therefrom.

In accordance with the present invention, the appartus consists of a unit which is formed of a group of compactly arranged and cooperating thermoelectric heat exchangers. A unit consists of three such heat exchangers which are arranged for the circulation of one fluid through certain of the heat exchangers and the circulation of another fluid simultaneously through certain other of the heat exchangers. The heat exchangers are generally similarly designed in that each is formed with a passageway through which a fluid may be circulated and each is provided with flat faces permitting assembly in face to face relation. Thermoelectric elements forming thermocouples are arranged between adjacent faces of the assembled housings for effecting heat transfer between circulated fluids.

Additionally, each housing is provided with a pair of openings in communication with the passageways for connecting the passageways with inlet and outlet manifolding conduits and each housing is also provided with a pair of notches or cutout areas for receiving the fluid inlet and outlet manifolding conduits. This arrangement permits the convenient assembly of the unit by stacking the heat exchangers with the apertures and notches positioned in alternation, that is, with an aperture and a notched area aligned with each other. The apertures and notches will be diametrically opposed and preferably the heat exchangers will be of rectangular shape with the apertures located at one pair of opposite corners and the notches located at the other pair of opposite corners.

Such an arangement permits varying the capacity of an apparatus by assembling a number of the units since the heat exchangers of each unit are readily manifolded and similarly the units are readily manifolded. In order to effect heat transfer, the dissimilar thermocouple elements will be located between adjacent faces of the heat exchangers preferably by mounting the dissimilar elements on one face of one heat exchanger and a cooperating element on the adjacent surface of an adjacent heat exchanger and heat exchangers so arranged as to locate the cold junctions for absorbing heat from one liquid and the hot junctions located for supplying heat to another liquid.

The broad object of the present invention is to provide a thermoelectric heat exchanger unit for use as a heat pump.

Another object is to provide a thermoelectric heat exchanger unit which is particularly useful in air conditioning.

And another object is to provide a compact thermoelectric heat exchanger unit which is readily arranged for multiple operations for varying cooling capacities.

Other objects, advantages and novel features of the invention will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawings, wherein:

FIGURE 1 is a view in perspective of the heat exchanger unit or module of the invention.

FIGURE 2 is a cutaway view showing the interior construction of one of the heat exchanger elements of FIGURE 1.

FIGURE 3 is an exploded view of FIGURE 1 to show additional details of construction.

In FIGURE 1 the thermoelectric unit or module is indicated at **10** and is formed of outer heat exchangers **11** and **12** and an inner or central heat exchanger indicated at **13**. In appearance and construction the heat exchangers are generally similar and preferably are formed of rectangular shape and are of confined thickness in relation to their length and width. For example, a unit constructed as shown in the figure and capable of producing one-quarter ton of air conditioning was square having the measurements of twelve inches in length and width and three inches in thickness.

FIGURE 2 shows the preferred heat exchanger construction wherein **15** indicates a tubing of copper nickel alloy, for example, which is embedded in a casting **16** and provides a sinuous passageway. The castings for each of the exchangers **11**, **12** and **13** are approximately three-quarters of an inch in thickness allowing one-quarter inch between their adjacent surfaces for locating the thermoelectric elements.

In FIGURE 2 the apertures are indicated at **17** and **18** and formed in alternate corners in communication with the tubing and the notched areas indicated at **19** and **20** are formed at the other alternate corners as shown. The thermoelectric elements are not shown in FIGURES 1 and 2 but will be mounted on the adjacent inner face of the central heat exchanger housing and the inner faces of the outer heat exchangers will be described in connection with FIGURE 3.

The heat exchangers or elements **11**, **12** and **13** are further formed as an integral unit by means of bolt connections **21** as shown in FIGURE 1. Conduits **22** and **23** represent the inlet and outlet conduits, respectively, for one liquid which is circulated through the inner or central heat exchanger **13**. At **24** and **25** are represented the inlet and outlet conduits for another liquid which is circulated through the outer heat exchangers **11** and **12** which are interconnected by a communicating connector **26**. Similar fittings **27** are provided in association with the respective heat exchangers **11**, **12** and **13**, as shown, to direct the fluids through the tubing passageways **15** in the respective heat exchangers for desired circulation of the liquids between conduits **22** and **23** and between conduits **24** and **25**.

The various elements in FIGURES 1 and 2 are similarly identified in the exploded view of FIGURE 3 which shows adequately the relationship between the various elements.

In FIGURE 3 the thermocouples are formed, for example, by copper plasma straps **30** sprayed on the inner face of heat exchanger **13** and extending horizontally between its side walls and copper straps **31** soldered to the face of the inner heat exchanger **12** and extending vertically between its upper and lower edges as shown and having suitable pellets **32—32** of dissimilar materials.

Similar straps are provided on the other face of the inner heat exchanger and straps similar to **30** are provided on the inner face of heat exchanger **12**. The thermocouples are assembled and a thermopile is formed when the heat exchangers **11**, **12** and **13** are united and the straps **30** interconnect pellets **32** of adjacent straps **31** in a manner to form a continuous circuit providing the cold junctions on the inner heat exchanger **12** and the hot junctions on the outer heat exchangers **11** and **13**.

Although this invention has various applications, the thermoelectric unit **10** has particular application in air conditioning a submarine since it involves no moving parts and is practically free of noise providing characteristics requisite for submarine operation, especially under war conditions. In using the unit for such an operation the fresh water which is used in room heat exchangers of the submarine would be directed by conduit **22** to the central or inner heat exchanger **13** for removal of the heat extracted from the rooms and this heat would be dissipated in sea water admitted by conduit **24** to the outer heat exchangers **11** and **13**.

It will be understood that current flow through the unit or module **10** is in the direction requisite for establishing the hot junction at the elements **30** and the cold junctions at the elements **31**. The unit or module **10** may be used as a heat pump by current flow in the opposite direction which reverses the locations of the hot and cold junctions to extract heat from the sea water and disperse it through the submarine air heat exchangers by means of the fresh water.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

I claim:

1. Apparatus for simultaneously heating one body of fluid and cooling another body of fluid which comprises:

(a) a unit formed of similar rectangular central and end housings having opposed flat front and rear faces,

(b) a sinuous passageway between the opposed flat faces having an inlet conduit and an outlet conduit communicating therewith for the circulation of fluid,

(c) said conduits being located at one pair of diametrically opposed corners of a housing with one conduit extending normal to one face and the other conduit extending normal to the other face,

(d) a pair of notches in each housing located at the other pair of diametrically opposed corners,

(e) said housings being assembled in face to face relation and positioning the conduits extending from one housing in the notches of an adjacent housing and

(f) a first set of thermocouples located between the central housing and one end housing and a second set of thermocouples located between the central housing and the other end housing.

2. Apparatus as in claim **1**, further characterized by the housings being formed of a casting having a sinuous passageway between the front and rear faces and a pair of diametrically opposed transverse passageways in communication with the sinuous passageway for receiving the inlet and outlet conduits and wherein one transverse passageway communicates through one face of the housing and the other transverse passageway communicates through the other face of the housing.

3. Apparatus as in claim **1**, further characterized by the housings being formed of a casting having a sinuous passageway extending between the front and rear faces and a pair of diametrically opposed transverse passageways extending through both faces of the housing in communication with the sinuous passageway and wherein closure means is provided for each transverse passageway opposite the conduits.

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WILLIAM J. WYE, *Primary Examiner.*