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[72] Inventor James Earl Bridegum
12143 Gothic Ave., Granada Hills, Calif. 91344

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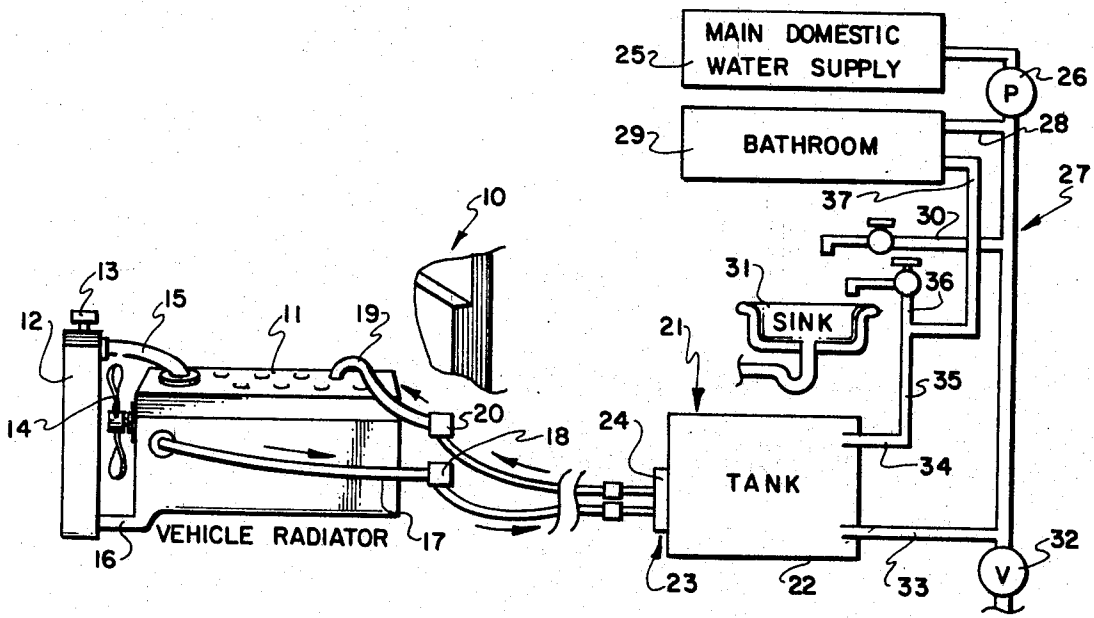
[54] METAL-TO-METAL HEAT EXCHANGER FOR RECREATIONAL VEHICLE
10 Claims, 4 Drawing Figs.

[52] U.S. Cl. 165/70, 165/142
[51] Int. Cl. F28f 11/00
[50] Field of Search 165/70, 142

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Primary Examiner—Martin P. Schwadron
Assistant Examiner—Theophil W. Streule
Attorney—Pastoriza & Kelly

ABSTRACT: A heat exchange unit for circulating vehicle radiator liquid is positioned in a large tank that conducts potable water so that the radiator liquid becomes cooled as the potable water becomes heated. The unit includes a container capable of being mounted to the tank and a conduit inserted in heat exchange relationship within the container. For safety purposes a narrow leakage gap is defined between the container and conduit so that any leakage of radiator liquid from the conduit will automatically flow outwardly of the tank where it will be unable to contaminate the potable water.



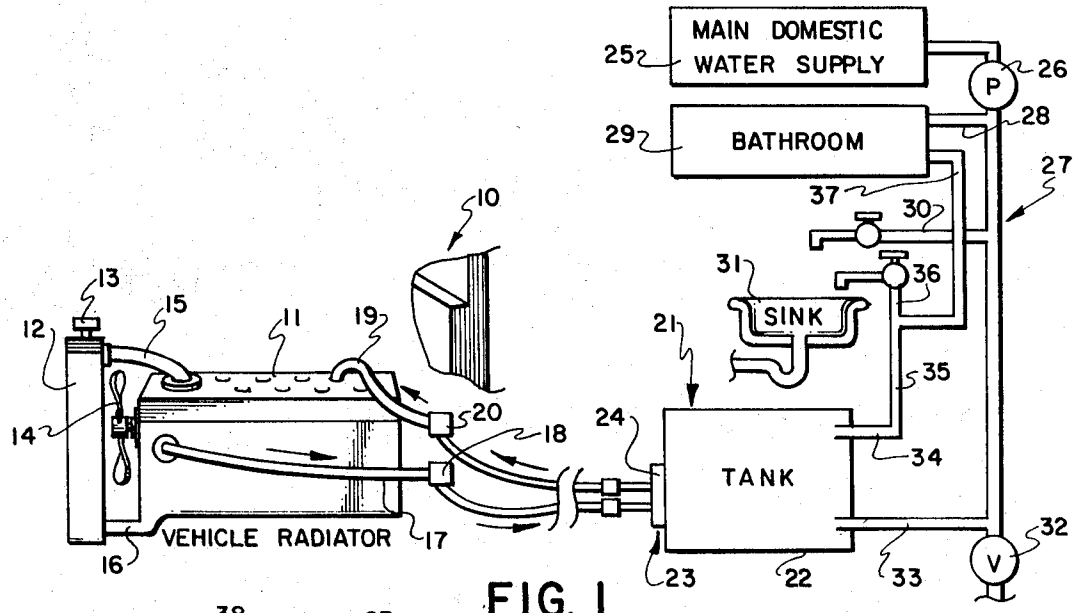


FIG. 1

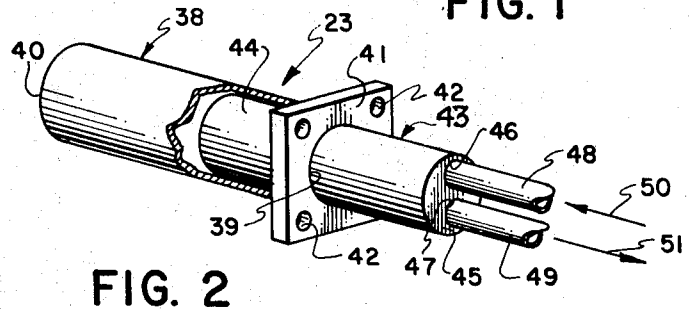


FIG. 2

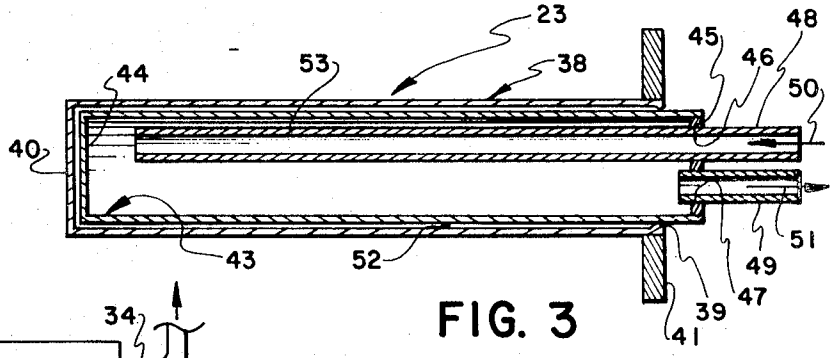


FIG. 3

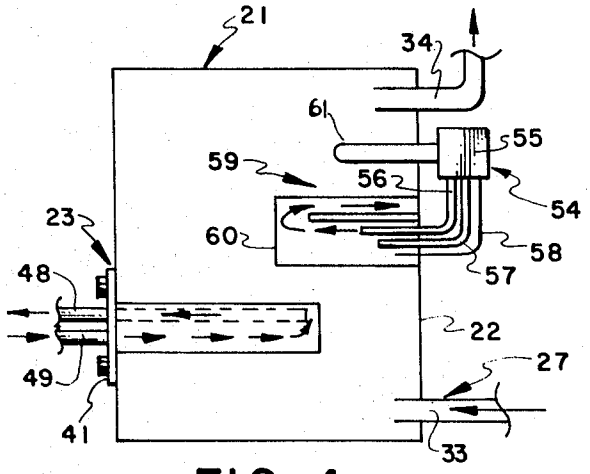


FIG. 4

INVENTOR:
JAMES EARL BRIDEGUM
BY
Elliott & Pastoriza
ATTORNEYS

METAL-TO-METAL HEAT EXCHANGER FOR RECREATIONAL VEHICLE

CROSS REFERENCE TO PENDING APPLICATION

This application is related to a copending U.S. Pat. application Ser. No. 746,448 filed Jul. 22, 1968 now Pat. No. 3,521,704, granted Jul. 28, 1970 and entitled HEAT EXCHANGER FOR RECREATIONAL VEHICLE.

This invention relates to a heat exchange unit and more specifically to a heat exchange unit for simultaneously heating and cooling different liquid circulating around and through the unit.

BACKGROUND OF THE INVENTION

The concept of using the circulating radiator water of a recreational vehicle as a thermal energy source to heat domestic water is known. Some presently operated motor homes and campers link together the radiator water circuit and domestic water circuit so that as the domestic water absorbs heat from the radiator water, then the radiator water automatically becomes cooled.

However, when the radiator water and domestic water circuits are integrated in this manner, a potentially serious health hazard arises. Consumers of the domestic water are constantly exposed to the possibility of having contaminated radiator water seep or leak into the domestic water. Thus far it has been impossible to isolate the domestic water and radiator water circuits and still safely take advantage of the heat exchange relationship.

Various responsible governmental and certifying groups that establish exacting plumbing safety standards routinely refuse to approve presently employed vehicle heat exchange systems because they are inherently incapable of providing adequate safety for the consumer's health. One cause tending to promote the leakage of radiator water into the domestic water is that the customary copper tubing for conducting the radiator water gradually erodes and deteriorates upon prolonged exposure to antifreeze solutions and other radiator water additives. When the tube becomes ruptured, radiator water leaks through the tube and becomes mixed with the domestic water. Safe plumbing practices aimed at guaranteeing wholesome water demand that this type of situation be prevented.

Another drawback of conventional vehicle heat exchange systems in campers for example, is that when the camper is replenishing its depleted domestic water supply and an undetected leak has occurred then the mixed liquid may backflow into the community water supply. Those who administer the plumbing codes are especially vigilant of this danger source and disapprove such proposed vehicle heat exchange systems. Otherwise the serious deficiencies might eventually harm numerous people.

BRIEF SUMMARY OF THE INVENTION

Briefly described the present invention comprehends a compact, inexpensive heat exchange unit that has no moving parts and can be easily assembled, for example, to a recreational vehicle tank that conducts potable water.

The heat exchange unit includes a metal container with a closed end and an open end, and a metal conduit having an inlet port for admitting a liquid and an exit port for discharging the liquid. The conduit is positioned in heat exchange relationship within the container and a closed conduit end is arranged adjacent a closed container end. A leakage gap is defined between the container inner wall and conduit outer wall in order to conduct any liquid outwardly of the container that leaks from the conduit into the leakage gap. The escape through the leakage gap of liquid, which may be vehicle radiator water, prevents the liquid from mingling with and contaminating potable water in the tank.

Preferably the leakage gap clearance between the container inner wall and conduit outer wall is between 0.002 inches and 0.005 inches. A flow tube extends through one of the conduit ports and into the interior portion of the conduit in order to increase the circulation path of the relatively hot radiator liquid through the conduit so that the heat transfer capacity between the conduit and container can be improved.

Preferably the flow tube extends into the conduit by a distance equivalent over 90 percent of the end-to-end length of the conduit. A mounting flange is joined to the conduit so that the heat exchange unit can be mounted to the tank.

BRIEF DESCRIPTION OF THE DRAWINGS

The numerous benefits and unique aspects of the present invention will be fully understood when the following detailed description is studied in conjunction with the drawings in which:

FIG. 1 is a schematic view showing a vehicle radiator circuit interconnected by way of the heat exchanger of the present invention with a typical recreational vehicle plumbing system;

FIG. 2 is a perspective partially sectional view showing the conduit component partially inserted into the container component of the heat exchange unit;

FIG. 3 is a longitudinal cross-sectional view of the container and conduit components fully assembled; and

FIG. 4 is a schematic view showing the simultaneous flow of vehicle radiator water through the heat exchange unit and potable water through the tank.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1, there is shown a fire wall **10** or other support partition incorporated in a recreational vehicle such as a motor home, camper or pleasure boat. The vehicle includes a customary engine block **11** and radiator **12** that may be filled with water and various chemical compounds such as antifreeze not fit for human consumption when a radiator cap **13** is removed. A conventional fan **14** is mounted to the forward wall of engine block **11**. A supply hose **15** conducts radiator water into a manifold within engine block **11** and a return hose **16** returns heated water from block **11** to radiator **12**.

A flow line for circulating radiator water includes a radiator exit flow line **17** having sections that may be disconnected by an intermediate coupling **18**, and, a radiator inlet flow line **19** having a similar intermediate coupling **20** for disconnecting segments of line **19**. Lines **17** and **19** are arranged to circulate radiator liquid through a portion of a heat exchange system **21**. Heat exchange system **21** includes a tank **22** which mounts a heat exchange unit **23** coupled to a mounting member **24**.

Heat exchange system **21**, as shall be fully explained interconnects the radiator water circuit with the vehicle plumbing circuit which conducts domestic or potable water suitable for cleansing and human consumption. Potable water from a main supply domestic water tank **25** is channeled by a pump or compressor **26** through a main flow line **27**. Extending from main flow line **27** is a first cold water branch line **28** leading to a bathroom **29** and a second cold water branch line **30** leading to a sink **31** which may be located in the vehicle kitchen, bathroom or any other convenient location. Potable water flowing downstream of line **30** may be discharged through a drain valve **32** or through a flow line **33** to tank **22**. Extending from the top part of tank **22** is a tank exit flow line **34** for supplying heated water to a riser **35**. From riser **35** heated water may be supplied to sink **31** through line **36** and/or bathroom **29** through another line **37**.

FIG. 2 illustrates important details of heat exchange unit **23** which is constructed of two main components. A metal container **38** is of tubular shape and has an open end **39** and a closed end **40**. Open end **39** is joined to a mounting flange **41** formed with a series of mounting openings **42** can be used to mount heat exchange unit **23** to a tank, such as tank **22** shown in FIG. **1**.

A tubular shaped metal conduit **43** has an inwardly disposed closed end **44** and an outwardly disposed closed end **45**. A pair of ports **46** and **47** for conducting fluid are formed in closed end **45**. Coupled in fluid communication with ports **46** and **47** are flow tubes **48** and **49** respectively. When conduit **43** is fully slid into container **38** and heat exchange unit **23** is in operation then radiator water may flow inwardly through flow tube **48**, as indicated by directional arrow **50**, and outwardly through flow tube **49**, as indicated by directional arrow **51**.

FIG. **3** shows heat exchange unit **23** fully assembled and ready for use. Conduit closed end **44** is arranged adjacent container closed end **40** and conduit closed end **45** is arranged adjacent container open end **39**. Container **38** and conduit **43** are relatively sized so that the interior wall of container **38** and exterior wall of conduit **43** are positioned in heat exchange relationship and define a leakage gap **52**. Both conduit **43** and **38** are constructed of metal with outstanding heat transfer characteristics such as copper, aluminum or brass.

The width of leakage gap **52** is sufficiently small so that the heat transfer capacity and efficiency between container **38** and conduit **43** is adequate and is sufficiently large so that the leakage of any liquid such as contaminated vehicle radiator water from conduit **43** must enter gap **52** and then pass outwardly of unit **23**. The aim is to prevent contaminated or offensive liquid circulating through conduit **43** from mixing with potable water surrounding container **38**. The width of leakage gap **52** which is sufficiently small for heat transfer purposes and sufficiently large to permit the leakage or escape of offensive liquid is between 0.002 inches and 0.005 inches.

Flow tube **49** is coupled in fluid communication with port **47** and does not extend into conduit **43**. In comparison flow tube **48** extends through port **46** and has an extension **53** that projects into the interior of conduit **43**. The purpose of extending only one flow tube into the interior of conduit **43** is to increase the circulation path of liquid flowing through conduit **43** in order to increase the overall heat transfer capacity between conduit **43** and container **38**.

The length of extension **53** is preferably between 85 percent and 97 percent of the end-to-end length of conduit **43**. By this arrangement a greater quantity of thermal energy has an opportunity to be transferred across the metal-to-metal interface defined by container **38** and conduit **43**.

If extension **53** were eliminated then, it will be appreciated, a sharp heat transfer gradient would result across the end-to-end length of the metal-to-metal interface between conduit **43** and container **38**. Maximum heat transfer would occur adjacent conduit outer end **45** and the heat transfer efficiency would gradually diminish to a minimum heat transfer value adjacent conduit inner end **44**. The use of extension **53** causes more heat to be liberated from liquid circulating through conduit **38** to liquid surrounding container **38**. It should be noted that the liquid circulating through heat exchanger **23** may be either hotter or colder than the liquid surrounding heat exchange unit **23**, and, liquid may enter flow tube **49** and exit through flow tube **48** or vice versa.

Referring now to FIG. **4**, tank **22** has a space which together with tank inlet line **33** and tank exit line **34** constitutes a part of the main domestic flow line **27** shown in FIG. **1**.

Heat exchange unit **23** is mounted by its flange **41** and bolts to a wall of tank **22**. Installed on one side of tank **22** is a gas water heater **54** which may be operated to heat the potable liquid circulating through tank **22** when the vehicle engine is not running. Heater **54** which may be a conventional propane heater includes the usual controls **55**, main gas supply tube **56**, pilot gas tube **57** and thermocouple **58** for sensing the presence of a pilot light. A flue box **59** defines a flue passageway **60** through which heated gas is forced in order to heat surrounding domestic water. A heat sensitive sensor **61** is inserted in the domestic water so that when the water is heated to a predetermined temperature sensor **61** can cause operation of gas heater **54** to be discontinued.

OPERATION

Keeping the above construction in mind it can be understood how many disadvantages of conventional vehicle heat exchange systems are overcome or substantially eliminated by the present invention.

In order to prepare heat exchange unit **23** for actual use in its intended environment, metal conduit **43** is slid into metal container **38**, mounting flange **41** is fixed to an appropriate wall portion of tank **22**, and, then flow tubes **48** and **49** are coupled to different flow segments of the radiator water circuit as indicated in FIG. **1**.

When the recreational vehicle motor is running circulating radiator water passes through flow tube **49**, (referring to FIG. **4**), travels approximately the end-to-end length of metal conduit **43**, reverses its path and travels through extension **53**, and, eventually exits through flow tube **48**. As the radiator water progresses through heat exchange unit **23** thermal energy is liberated by the radiator water and is absorbed by the domestic water passing through tank **22**. Domestic water enters tank **22** through flow line **33**, and, after circulating around heat exchange unit **23**, departs through exit flow line **34**. As the domestic water acquires thermal energy from the radiator water, due to the metal-to-metal contact between container **38** and conduit **43**, the radiator water automatically becomes cooled in order to improve the operating efficiency of the vehicle engine.

If intense pressure, metal deterioration, inherent defects or the like cause an inner wall portion of conduit **43** to rupture and develop a leakage passage then, in accordance with safety aspects of this invention, the risk of toxic radiator water contaminating the domestic water is prevented. Radiator water flows into the narrow leakage gap **52** and, due to the radiator water pressure, is driven through leakage gap **52** outwardly of heat exchange unit **23**. The vehicle driver will be notified of the leakage condition by a conventional vehicle dashboard gauge that is responsive to engine overheating or reduced pressure.

From the foregoing it will be evident that the present invention has provided a metal-to-metal heat exchange unit for recreational vehicles in which all of the various advantages are fully realized.

I claim:

1. A vehicle heat exchange system for simultaneously heating potable liquid from a potable liquid source and cooling radiator water circulating through the vehicle radiator circuit, the system comprising:

a. a tank having inlet and exit lines for admitting and discharging potable liquid;

b. a metal container mounted to and projecting into the tank, the container being arranged in heat exchange relationship with the tank;

c. a vehicle radiator flow line segment;

d. a metal conduit coupled to the radiator vehicle flow line segment and having an inlet port for admitting radiator water and an exit port for discharging radiator water, the conduit being positioned within the container and in metal-to-metal heat exchange relationship therewith throughout the major portion of its length; and

e. means defining a leakage gap between the container and conduit for conducting any radiator water that might leak from a portion of the conduit position within a container to a location outwardly of the container.

2. The structure according to claim **1**, wherein; the average clearance between the container inner wall and conduit outer wall is between 0.002 inches and 0.005 inches.

3. The structure according to claim **1**, including; a flow tube extending through one conduit port and into the interior of the conduit, the flow tube being arranged to increase the circulation path of radiator water through the conduit in order to increase the heat transfer capacity between the conduit and container.

4. The structure according to claim 3, wherein; the flow tube extends over 90 percent of the end-to-end distance of the conduit.

5. The structure according to claim 4, including; a second flow tube coupled in fluid communication to the other conduit port.

6. The structure according to claim 1, wherein:

the container has a closed end and an open end for receiving the conduit; and

the conduit has a closed end arranged adjacent the container closed end and a second end that forms the fluid inlet and exit ports.

7. The structure according to claim 6, wherein:

the container is of tubular cross section;

a mounting flange is joined to the container open end;

the conduit is of tubular cross section and has a length substantially equivalent with that of the container, and

the leakage gap is of annular configuration.

8. A vehicle heat exchange system for simultaneously heating potable liquid from a potable liquid source and cooling radiator water circulating through the vehicle radiator circuit, the system comprising:

a. a tank having inlet and exit lines for admitting and discharging potable liquid;

b. a metal container having a closed end and an open end, the container being mounted to and projecting into the tank and arranged in heat exchange relationship with the tank;

c. a vehicle radiator flow line segment;

d. a metal conduit coupled to the radiator vehicle flow line segment and having an inlet port for admitting radiator water and an exit port for discharging radiator water, the conduit being positioned within the container and in metal-to-metal heat exchange relationship therewith throughout the major portion of its length;

e. a flow tube extending through one conduit port and into the interior of the conduit, the flow tube being arranged to increase the circulation path of radiator water through the conduit in order to increase the heat transfer capacity between the conduit and container; and

f. means defining a leakage gap between the container and conduit for conducting any radiator water that might leak from a portion of the conduit positioned within the container to a location outwardly of the container, the average width of the leakage gap being between 0.002 inches and 0.005 inches.

9. The structure according to claim 8, wherein; the flow tube extends over 90 percent of the end-to-end distance of the conduit.

10. The structure according to claim 9, including:

a tank for conducting potable liquid, the metal container being mounted to the tank so that the major portion of the conduit projects into the tank and the leakage gap terminates outwardly of the tank; and

wherein, when relatively high vehicle radiator water is circulated through the conduit and relatively cool potable is circulated through the tank the heat exchange relationship between the conduit and container simultaneously causes the potable water to become heated while the radiator liquid becomes cooled.