July 18, 1950 A. W. RUFF 2,516,094

HEAT PUMP WATER HEATER

Filed May 17, 1949 2 Sheets-Sheet 1

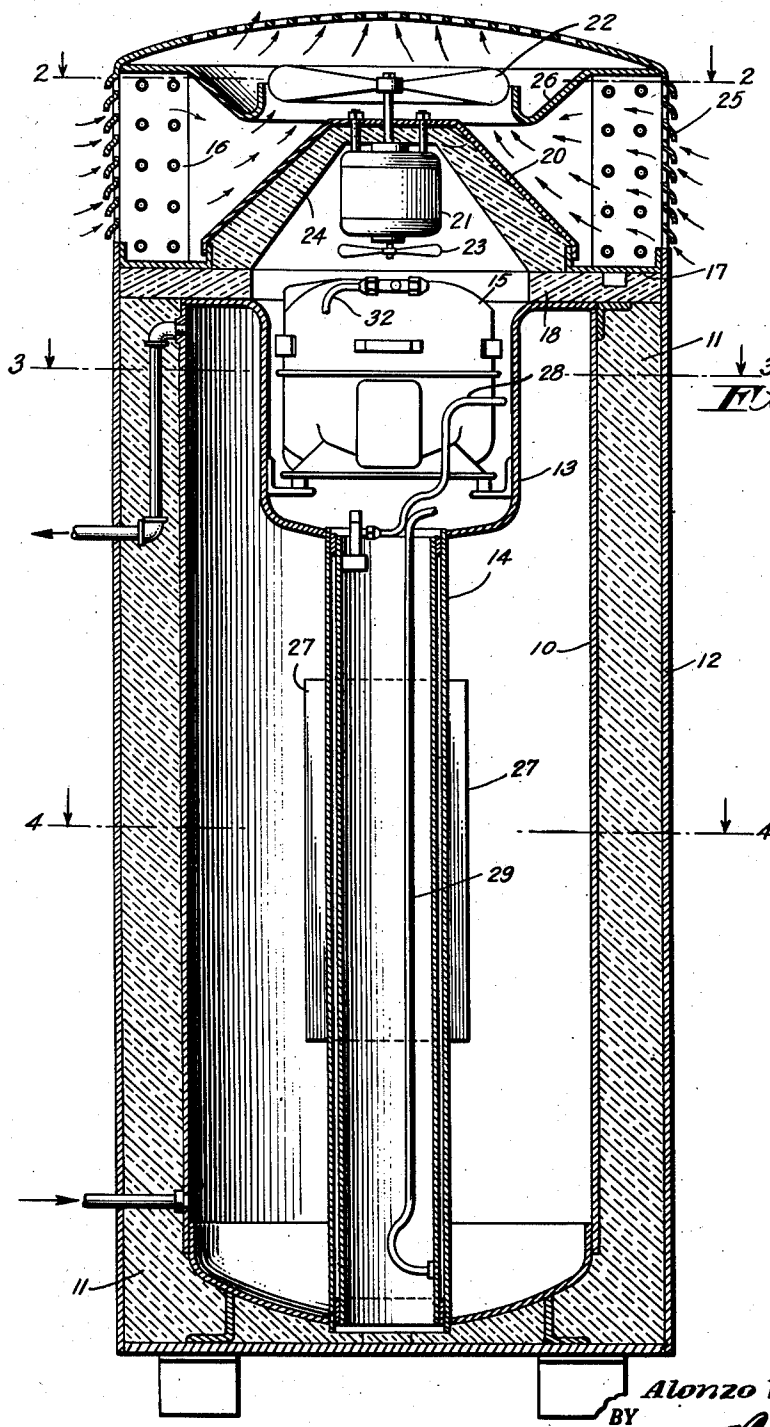


Fig. 1.

INVENTOR.
Alonzo W. Ruff.
BY
ATTORNEY.

July 18, 1950 A. W. RUFF 2,516,094

HEAT PUMP WATER HEATER

Filed May 17, 1949 2 Sheets-Sheet 2

Fig. 2.

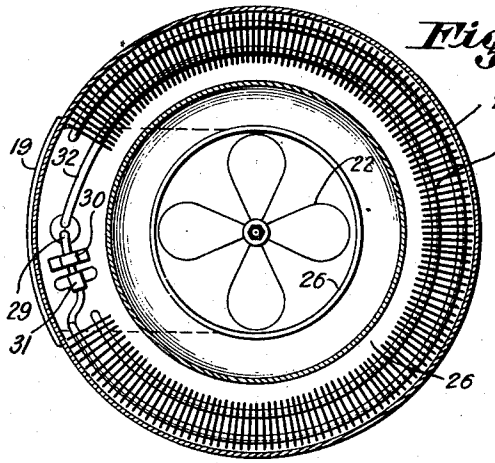
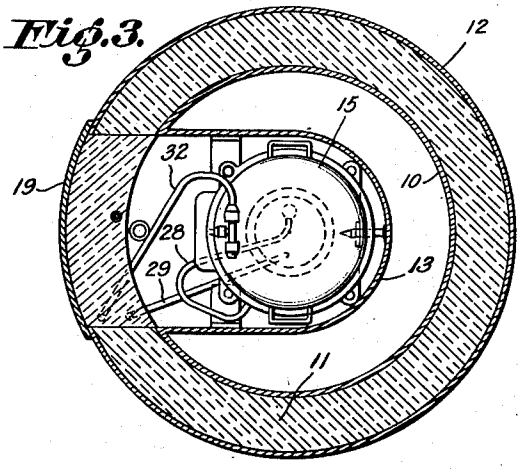


Fig. 3.



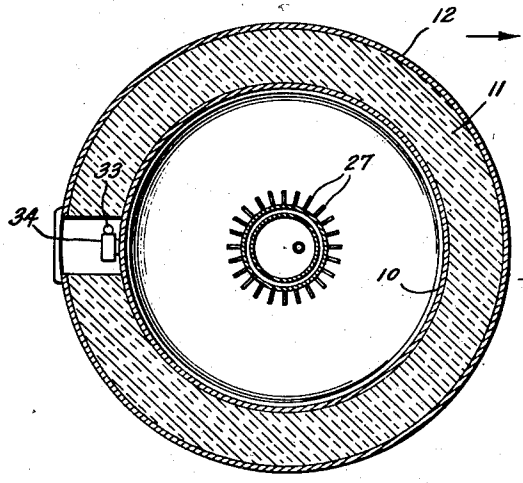
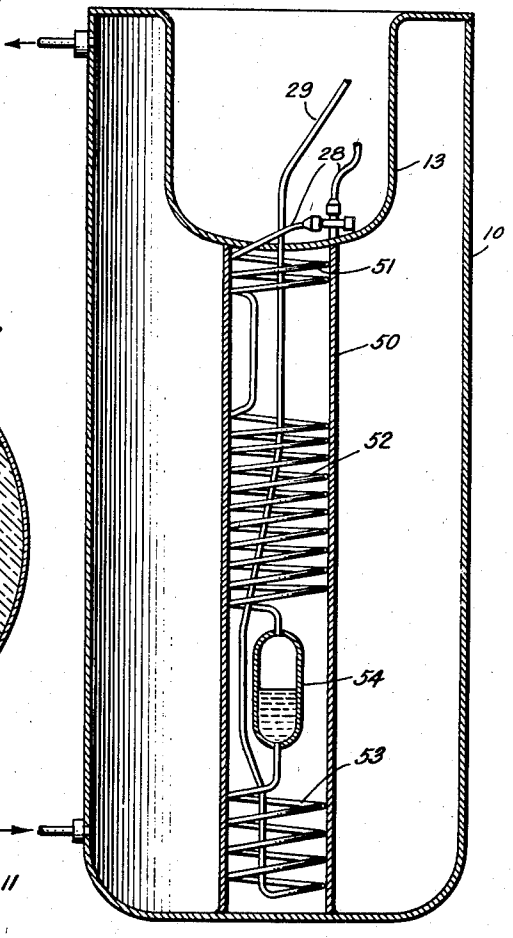


Fig. 4.

Fig. 5.



INVENTOR.
Alonzo W. Ruff.
BY
Attorney.

Patented July 18, 1950 2,516,094

UNITED STATES PATENT OFFICE

2,516,094

HEAT PUMP WATER HEATER

Alonzo W. Ruff, York, Pa., assignor to V. C. Patterson & Associates, Inc., York, Pa., a corporation of Pennsylvania

Application May 17, 1949, Serial No. 93,812

11 Claims. (Cl. 62—129)

1

My invention relates to heat pumps and more particularly to a water heater which operates on the heat pump principle.

My copending application Serial Number 91,595 discloses the particular concepts and principles of heat pump operation which are applicable to the apparatus of this invention.

It is an object of this invention to provide a water heater of the heat pump type which is primarily, though not necessarily, designed for domestic use, i. e. to provide a source of domestic hot water; and, at the same time, serving to cool and dehumidify the air of the room or space in which the water heater is operated.

My invention is best understood by the following description taken in connection with the accompanying drawings, in which

Figure 1 shows, in vertical section, a preferred structural embodiment of my invention,

Figure 2 is a view taken on a line which is at 90° to line 2—2 of Figure 1,

Figure 3 is a view taken on a line which is at 90° to line 3—3 of Figure 1,

Figure 4 is a view taken on a line which is at 90° to line 4—4 of Figure 1,

Figure 5 shows, somewhat diagrammatically, a modification of the structure shown in Figure 1.

Referring now to Figures 1–4, the water storage tank 10 is surrounded on the sides and bottom by insulation 11 and an outer shell or cover 12. The water storage space within the tank is defined by members 10, 13 and 14. The latter functions as the principal heat exchanger and will be hereinafter more fully described. Member 13 comprises an inverted dome-shaped pocket in the top of the tank, as can best be seen from Figures 1 and 5. The motor-compressor unit 15 is mounted within this pocket, for example on the brackets, secured to the side walls, as shown. The evaporator unit 16 is mounted at the top of the tank, and is preferably provided with a drip pan 17. A block of insulation 18 in the form of an annular ring is secured intermediate the drip pan and the top of the tank. As best seen in Figure 2, the evaporator unit is in the shape of an annular ring with about 60° of the circle cut out. Immediately below the said cut-out is a service opening 19 (see Fig. 3) for the motor compressor unit. In the center of the evaporator, mounted on a frusto-conical plate assembly 20, is a motor 21 having fan blades 22 and 23 on opposite ends of its shaft. A hollow insulation block 24, also frusto-conical in shape, completes the chain of insulation which surrounds the water storage tank. The evaporator unit is

2

surrounded by a louvered side panel 25 around its outer periphery, and a fan cowling 26 extends around the top inner periphery so that the surrounding air, as shown by arrows in Fig. 1, is circulated through the evaporator coils by fan blades 22. Fan blades 23 within the insulated space, circulate air, heated by the losses of the fan and compressor, in heat exchange relation to the water in the upper part of the tank.

The heat exchanger 14 of Fig. 1, consists of a double-walled hollow cylindrical member secured to member 13 and extending downwardly therefrom to the bottom of the tank 10. It is secured in watertight relation both to 13 and 10. Refrigerant, circulated by the motor-compressor unit, is passed between the double walls and there gives up its heat to the water in the tank. Fin members 27 (Figures 1 and 4) are attached to the midsection of the heat exchanger to provide an increased area of heat transfer surface.

The path of the refrigerant starting at the high pressure side of the compressor is through line 28 to the top of the heat exchanger 14, out the bottom of the heat exchanger through line 29 to a liquid strainer 30, thence to a thermal expansion valve 31, the said strainer and valve being conveniently located in the cut-out space at the level of the evaporator 16. The refrigerant then passes through the coils of the evaporator unit 16 and back to the low pressure side of the compressor through suction line 32.

The electric power lines 33 may be led down through the insulation surrounding the tank, as shown in Fig. 4 to a suitable plug-in receptacle mounted at the bottom of the tank. A thermostat 34 is placed in the power line in heat exchange relation to the tank wall to control the transfer of heat to the water in the tank.

As hereinbefore stated, the heat cycle of the apparatus of this invention is substantially identical with that shown and described in my copending application Serial Number 91,595, so it need be only briefly described here.

The refrigerant system is charged to a point where the heat exchanger 14 is filled with liquid from the bottom to a point about even with the lower end of the fin structure 27. The refrigerant charge should be such as to maintain this liquid level during operating conditions to take advantage of the liquid subcooling principle disclosed in my copending application mentioned above. Under operating conditions, refrigerant under pressure is allowed to expand in the evaporator coils where it picks up heat from the surrounding atmosphere. Refrigerant gas is then

pumped out of the evaporator at low pressure, compressed to a superheated gaseous condition by the motor compressor unit and led to the top of the heat exchanger where it comes into heat exchange relation with the water in the upper part of the tank. That part of heat exchanger 14 which lies above the fin structure 27 then serves as a desuperheater for the refrigerant, after which condensation takes place in that part of the heat exchanger which is surrounded by the fin structure 27. The condensed refrigerant is then subcooled in the bottom of the heat exchanger and the cycle is repeated.

It should be noted that marked stratification of the water in the tank takes place so that the desuperheating, condensing and subcooling functions of the heat exchanger occur at substantially the same temperatures in each cycle. The hottest water accumulates in the top of the tank and is subjected to the heat of the superheated refrigerant. Also the heated air from the motor-compressor and fan units acts by convection and conduction to transfer heat to the water in the upper reaches of the tank. The greatest heat transfer takes place in the water surrounding the condenser section of the heat exchanger, and, during normal operation of the heater, there will be a second stratum of water in the tank at that point which is at a somewhat lower temperature than that in the uppermost portion. A third strata of water surrounds the subcooling section of the heat exchanger and will be only a few degrees warmer than the source of supply or make-up water.

Figure 5 shows a modification of the structure of Figure 1 which will qualify this apparatus for use in certain localities of the United States, which require two thicknesses of metal between refrigerant and water to be used in homes or public buildings. Since the only changes necessary are those to the heat exchanger, only so much of the apparatus is shown in this drawing as will make those changes apparent.

The double-walled heat exchanger 14 of Figure 1 is replaced by a single-walled member 50. Heat exchange coils 51, 52 and 53 are fitted to the inner wall of this member, in heat exchange relation thereto. These coils are series-connected and function in exactly the same way as does member 14 of Figure 1. A liquid receiver 54 is placed between coils 52 and 53 in order to insure that refrigerant passing to the subcooling coil 53 is in liquid form. All other refrigerant connections are the same as described with reference to Figure 1 and this apparatus will perform substantially as well.

From the above, it will be apparent that I have shown and described a hot water heater which is compact in design and capable of easy installation, since only the water pipe connections need be made. The power requirements are small so that the power line can be merely plugged in to the nearest convenience outlet. In operation, this unit is found, by test, to have a coefficient of performance of better than 4.5. Economy of operation therefor combines with the other salient advantages such as no flame (and hence no flue connections), which renders the apparatus capable of installation in almost any desired location, to produce a new and novel type of water heater which will have widespread adaptation and use. Among the many other advantages afforded by this apparatus, that of cooling and dehumidfying the air in the room or space in which the apparatus is located, is worthy of

mention. When located, for example, in a kitchen where there is generally a substantial amount of waste heat, the cooling effected on the air in the kitchen by the apparatus of my invention is highly desirable. It is also possible to achieve this same effect in a room or space remote from the apparatus by means of air duct connections. When located in a basement or cellar, waste heat from the furnace is sufficient for normal operation and the dehumidifying action of the apparatus is effective to reduce dampness.

I claim:

1. A water heater of the heat pump type, in which a refrigerant is used as the working fluid, comprising in combination: a hot water storage tank; a refrigerant evaporator unit mounted on said tank and adapted to absorb heat from the air at the prevailing room temperature; heat transfer means of the type in which refrigerant is circulated, said means being mounted in heat conducting relation with a wall of said tank and extending substantially from top to bottom thereof; a motor compressor unit mounted in heat exchange relation to the water in said tank; closed fluid conduits extending between said compressor and the evaporator and heat exchanger to enable the compressor to pump gaseous refrigerant at low pressure from said evaporator and deliver said refrigerant at high pressure to the top of said heat exchanger; a closed conduit for the refrigerant connecting the bottom of said heat transfer means to said evaporator; and means responsive to the temperature of the water in said tank to control the transfer of heat thereto.

2. A water heater of the heat pump type, in which a refrigerant is used as the working fluid, comprising in combination: a hot water storage tank; a refrigerant evaporator unit mounted on said tank and adapted to absorb heat from the air at the prevailing room temperature; an enclosed flue-like member centrally and vertically disposed in said tank; heat transfer means, of the type in which refrigerant is circulated, disposed in heat conducting relationship with said member and extending substantially from top to bottom thereof; a motor compressor unit mounted in heat exchange relation to the water in said tank; closed fluid conduits extending between said compressor and the evaporator and heat exchanger to enable the compressor to pump gaseous refrigerant at low pressure from said evaporator and deliver said refrigerant at high pressure to the top of said heat exchanger; a closed conduit for the refrigerant connecting the bottom of said heat transfer means and said evaporator; and means responsive to the temperature of the water in said tank to control the transfer of heat thereto.

3. A water heater of the heat pump type, in which a refrigerant is used as the working fluid, comprising in combination: a hot water storage tank; a flue like member centrally and vertically disposed in said tank and extending substantially from top to bottom thereof; a second flue like member concentrically disposed within said first named member and coextensive in length therewith; means closing the space between said members at each end thereof, said means and said members thus defining a heat exchanger through which refrigerant may be circulated in heat-conducting relation to the water in said tank; a refrigerant evaporator unit mounted on said tank and adapted to absorb heat from the air at the prevailing room temperature; a motor compressor unit mounted in heat exchange relation

to the water in said tank; closed fluid conduits extending between said compressor and the evaporator and heat exchanger to enable the compressor to pump gaseous refrigerant at low pressure from said evaporator and deliver said refrigerant at high pressure to the top of said heat exchanger; a closed conduit for said refrigerant connecting the bottom of said heat exchanger and said evaporator; and means responsive to the temperature of the water in said tank to control the transfer of heat thereto.

4. A water heater of the heat pump type, in which a refrigerant is used as the working fluid, comprising in combination: a hot water storage tank; a heat exchanger of the type in which refrigerant may be circulated, comprising a pair of spaced concentric cylindrical members closed at opposite ends, said heat exchanger being centrally and vertically disposed in said tank and extending substantially from top to bottom thereof; a refrigerant evaporator mounted on said tank and adapted to absorb heat from the air at the prevailing room temperature; a motor compressor unit mounted in heat exchange relation to the water in said tank; closed fluid conduits extending between said compressor and the evaporator and heat exchanger to enable the compressor to pump gaseous refrigerant at low pressure from said evaporator and deliver said refrigerant at high pressure to the top of said heat exchanger; a closed conduit for said refrigerant connecting the bottom of said heat exchanger and said evaporator; and means responsive to the temperature of the water in said tank to control the transfer of heat thereto.

5. A water heater of the heat pump type, in which a refrigerant is used as the working fluid, comprising in combination: a hot water storage tank having a depression in the top thereof; a refrigerant evaporator unit mounted on said tank and adapted to absorb heat from the air at the prevailing room temperature; a heat exchanger of the type in which refrigerant is circulated comprising a pair of spaced concentric cylindrical members closed at their opposite ends, said heat exchanger being centrally and vertically disposed in said tank and extending from the bottom of said depression to the bottom of said tank, a motor compressor unit mounted within said depression in heat exchange relation to the water in said tank; closed fluid conduits extending between said compressor and the evaporator and heat exchanger to enable the compressor to pump gaseous refrigerant at low pressure from said evaporator and deliver said refrigerant at high pressure to the top of said heat exchanger; a closed conduit for said refrigerant connecting the bottom of said heat exchanger and said evaporator; and means responsive to the temperature of the water in said tank to control the transfer of heat thereto.

6. A water heater of the heat pump type, in which a refrigerant is used as the working fluid, comprising in combination: a hot water storage tank having a dome-shaped depression in the top thereof; a refrigerant evaporator mounted on said tank and adapted to absorb heat from the air at the prevailing room temperature; a heat exchanger of the type in which refrigerant is circulated comprising a pair of spaced concentric cylindrical members closed at their opposite ends, said heat exchanger being centrally and vertically disposed within said tank and extending from the bottom wall of said depression to the bottom of said tank; a motor compressor unit mounted

within said depression in heat exchange relation to the water in said tank; closed fluid conduits extending between said compressor and the evaporator and heat exchanger to enable the compressor to pump gaseous refrigerant at low pressure from said evaporator and deliver said refrigerant at high pressure to the top of said heat exchanger; a closed conduit for said refrigerant connecting the bottom of said heat exchanger and said evaporator; an inverted, cup shaped member, thermally insulated and mounted on said tank above said motor compressor unit; an electric motor mounted within said member in heat exchange relation to the water in said tank, said motor having a first fan within said cup shaped member adapted to circulate air heated by the losses of said motor and said motor compressor unit in heat exchange relation to the water in said tank, and a second fan above said cup shaped member, operated by said motor, and adapted to circulate air at the prevailing room temperature through said evaporator unit; and means responsive to the temperature of the water in said tank to control the transfer of heat thereto.

7. A water heater of the heat pump type, in which a refrigerant is used as the working fluid, comprising in combination: a hot water storage tank; a flue like member centrally and vertically disposed within said tank; a heat exchanger of the type in which refrigerant may be circulated, said heat exchanger being disposed in said flue in heat conducting relation to the wall thereof, and extending substantially from top to bottom thereof; a refrigerant evaporator mounted on said tank and adapted to absorb heat from the air at the prevailing room temperature; a motor compressor unit mounted in heat exchange relation to the water in said tank; closed fluid conduits extending between said compressor and the evaporator and heat exchanger to enable the compressor to pump gaseous refrigerant at low pressure from said evaporator and deliver said refrigerant at high pressure to the top of said heat exchanger; a closed conduit for refrigerant, connecting the bottom of said heat exchanger to said evaporator; and means responsive to the temperature of the water in said tank to control the transfer of heat thereto.

8. A water heater of the heat pump type, in which a refrigerant is used as the working fluid, comprising in combination: a hot water storage tank; a flue like member centrally and vertically disposed in said tank; a heat exchanger of the type in which refrigerant may be circulated comprising, a first coil located in the upper section of said flue, a second coil located in the midsection of said flue, a third coil located in the bottom section of said flue, the said coils being connected in series and each disposed in heat conducting relation with the wall of said flue; a liquid receiver serving as a liquid seal and connected between said second and third coils; a refrigerant evaporator mounted on said tank and adapted to absorb heat from the air at the prevailing room temperature; a motor compressor unit mounted in heat exchange relation to the water in said tank; closed fluid conduits extending between said compressor and the evaporator and heat exchanger to enable the compressor to pump gaseous refrigerant at low pressure from said evaporator and deliver said refrigerant at high pressure to the top of said heat exchanger; a closed conduit for refrigerant connecting said third coil to said evaporator; and means respon-

sive to the temperature of the water in said tank to control the transfer of heat thereto.

9. A water heater of the heat pump type, in which a refrigerant is used as the working fluid, comprising in combination: a hot water storage tank having a dome-shaped depression in the top thereof; a flue like member centrally and vertically disposed within said tank and connected at its upper end to the bottom wall of said depression, the said member extending therefrom to the bottom of said tank; a heat exchanger of the type in which refrigerant may be circulated, said heat exchanger being disposed in said flue in heat conducting relation with the wall thereof and extending substantially from top to bottom thereof; a refrigerant evaporator mounted on said tank and adapted to absorb heat from the air at the prevailing room temperature; a motor compressor unit mounted within said depression in heat exchange relation to the water in said tank; closed fluid conduits extending between said compressor and the evaporator and heat exchanger to enable the compressor to pump gaseous refrigerant at low pressure from said evaporator and deliver said refrigerant at high pressure to the top of said heat exchanger; a closed conduit for refrigerant connecting the bottom of said heat exchanger to said evaporator; and means responsive to the temperature of the water in said tank to control the transfer of heat thereto.

10. A water heater of the heat pump type, in which a refrigerant is used as the working fluid, comprising in combination: a hot water storage tank having a dome-shaped depression in the top thereof; a flue like member centrally and vertically disposed within said tank and connected at its upper end to the bottom wall of said depression, the said member extending to the bottom of said tank; a heat exchanger of the type in which refrigerant may be circulated comprising, a first coil located in the upper section of said flue, a second coil located in the midsection of said flue, a third coil located in the bottom section of said flue, the said coils being connected in series and each being disposed in heat conducting relation with the wall of said flue; a liquid receiver serving as a liquid seal and connected between said second and third coils; a refrigerant evaporator mounted on said tank and adapted to absorb heat from the air at the prevailing room temperature; a motor compressor unit mounted within said depression in heat exchange relation to the water in said tank; closed fluid conduits extending between said compressor and the evaporator and heat exchanger to enable the compressor to pump gaseous refrigerant at low pressure from said evaporator and deliver said refrigerant at high pressure to the top of said heat exchanger; a closed conduit for refrigerant connecting said third coil to said evaporator; and means responsive to the temperature of the water in said tank to control the transfer of heat thereto.

11. A water heater as defined in claim 10 and including: an inverted cup-shaped thermal insulating member mounted on said tank above said motor compressor; an electric motor mounted within said member in heat exchange relation to the water in said tank; a first fan blade mounted within said member driven by said motor, and adapted to circulate air heated by the losses of said motor and said motor compressor unit in heat exchange relation to the water in said tank; and a second fan blade mounted outside said member driven by said motor, and adapted to circulate air at the prevailing room temperature through said evaporator unit.

ALONZO W. RUFF.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,937,288	McGraw	Nov. 28, 1933
2,066,161	Roessler	Dec. 29, 1936
2,095,017	Wilkes	Oct. 5, 1937
2,162,245	Comstock	June 13, 1939