Jan. 17, 1967 E. A. WEAVER 3,298,431

HEAT TRANSFER SYSTEM

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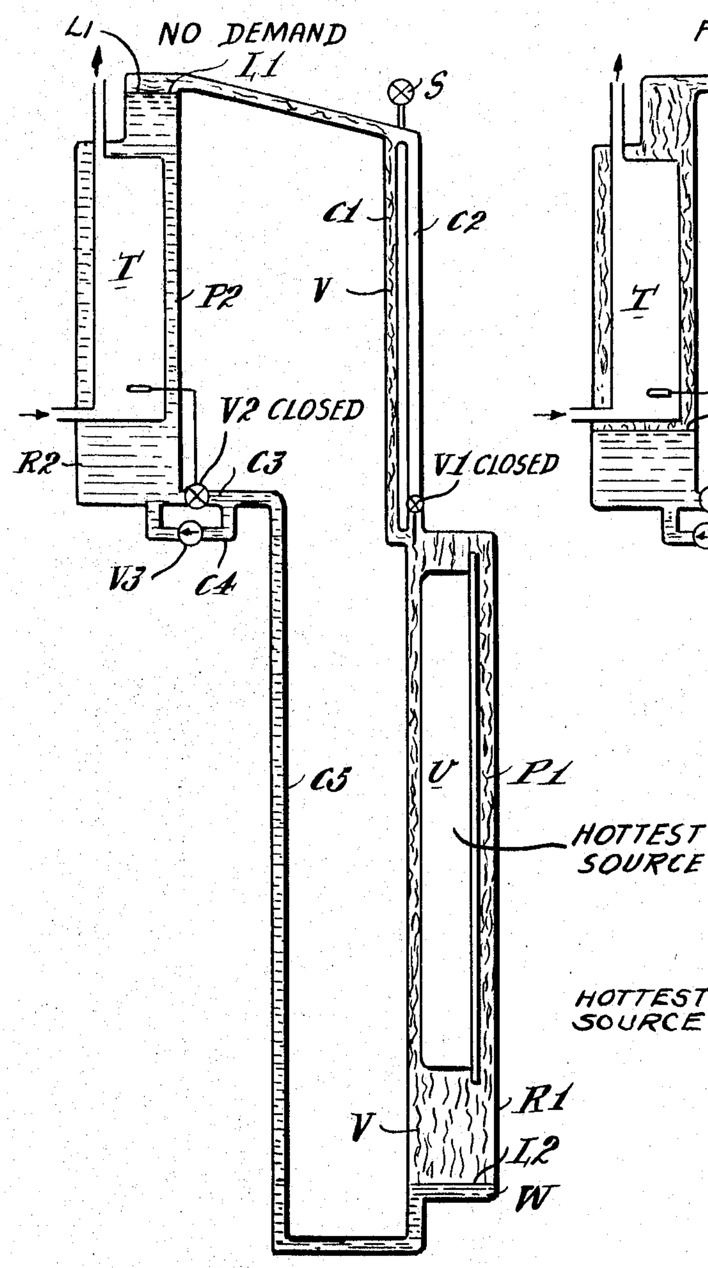

Fig. 1

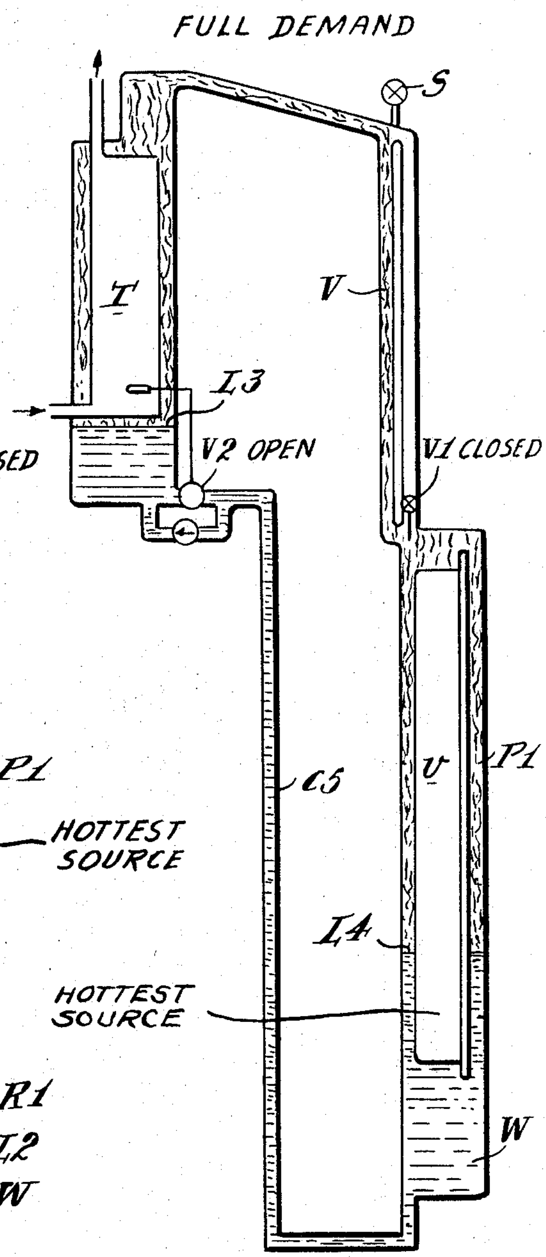

Fig. 2

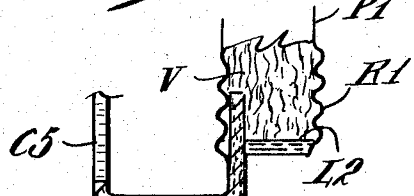

Fig. 5

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HEAT TRANSFER SYSTEM

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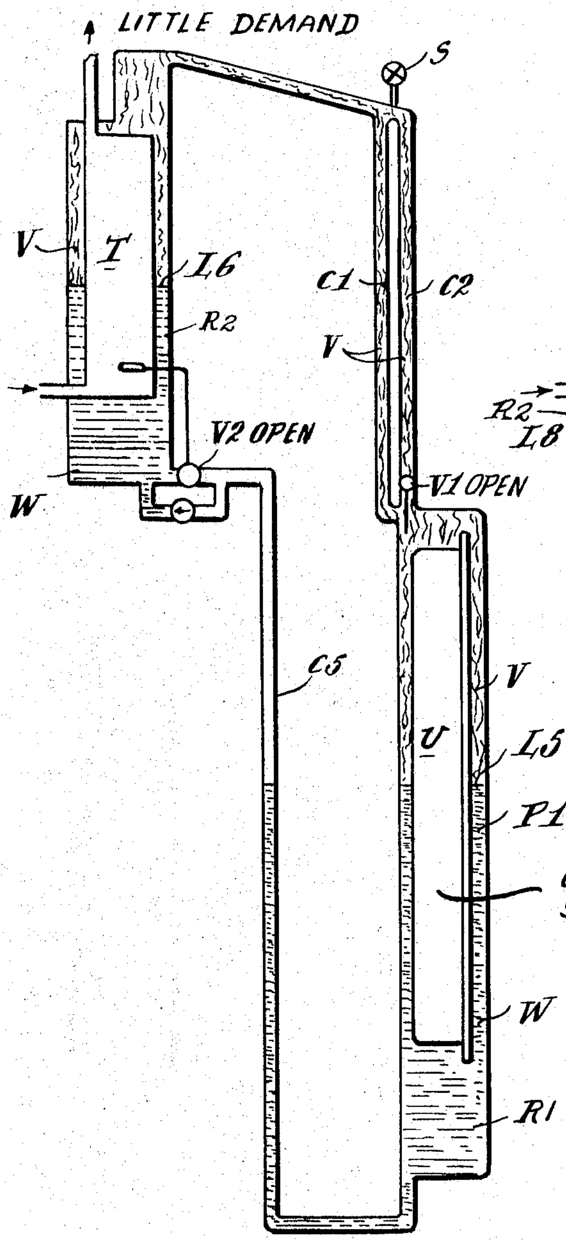

Fig. 3

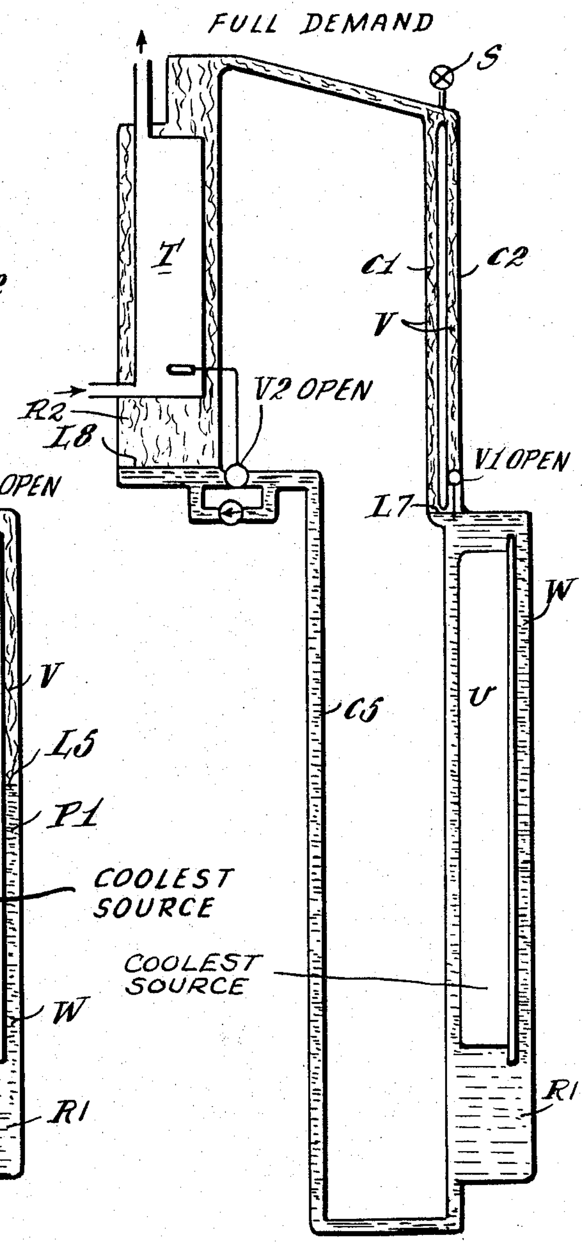

Fig. 4

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HEAT TRANSFER SYSTEM

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5 Claims. (Cl. 165—105)

This invention relates to the transfer of heat from a heat source to a heat sink and more particularly to heat transfer from a heat-storage unit to a water heater. While any storage unit may be employed in the system, the unit is preferably of the kind disclosed in the application of Richard E. Rice and William E. Whitney, Ser., No. 391,-676, filed August 24, 1964. Irrespective of the type of unit employed the temperature of the unit varies through wide limits from a maximum when the unit is freshly charged with heat to a minimum when the unit cools to its lowest effective temperature. Also the rate at which heat should be transferred to the water heater varies widely depending on the rate at which that water is drawn from the heater.

Objects of the present invention are to provide a self-regulatory system which is simple and economical to produce, which may be sealed from the atmosphere, which varies the rate of heat-transfer automatically in response to demand, from maximum to minimum temperature of the storage unit, and which is durable and reliable in use.

In one aspect the present invention involves a heat sink, a variable heat source, an endless conduit circuit in heat-transfer relation to the source and sink for transferring heat from the source to the sink, the circuit containing liquid vaporizable by the source and condensible by the sink, the circuit including a sink-portion for holding fluid (liquid and/or condensing vapor in heat-transfer relation to the sink, and a source-portion for holding a quantity of said liquid in varying heat-transfer relation to the source, the sink being located above the source so that the condensed liquid may drain back to or toward the source by gravity through a return part of said circuit, a thermal valve in said return part of the circuit, and means responsive to the temperature of the sink for substantially closing the valve when the temperature of the sink reaches a predetermined maximum, said sink-portion being large enough to contain substantially all of said quantity, whereby when the sink reaches said maximum, substantially all of said quantity has been transferred to the sink-portion, thereby substantially stopping heat-transfer from source to sink.

Preferably, the system has a by-pass around the aforesaid valve, and in the by-pass a check-valve which permits flow only from the source-portion to the sink-portion, and the system is sealed so that, when the thermal valve is closed, the vapor-pressure in the source-portion forces substantially all the liquid in the source-portion through the check-valve to the sink-portion.

In another aspect the system comprises a heat sink, a variable heat source, an endless conduit circuit in heat-transfer relation to the source and sink for transferring heat from the source to the sink, the circuit containing liquid vaporizable by the source and condensible by the sink, the circuit including a sink-portion for holding fluid in heat-transfer relation to the sink and a source-portion for holding a quantity of said liquid in variable heat-transfer relation to the source, the sink being located above the source so that condensed liquid may drain back to the source by gravity through a return part of said circuit, the circuit including a conduit for vapor flow from the source-portion to the sink-portion, and thermostatic means in the conduit responsive to the temperature of the source for imposing resistance to the aforesaid vapor flow when the source is hot. Preferably, the aforesaid conduit comprises two branches in parrallel and the thermostatic means comprises a valve for closing one branch.

The vaporizable liquid must not decompose in contact with the aforesaid circuit wall when the source is at maximum temperature, e.g., 900° F. and neither the liquid nor its vapors should corrode the walls of the circuit. Preferably the circuit is formed of stainless steel and the liquid comprises water containing an anticorrosive such as a chromate.

For the purpose of illustration a typical embodiment is shown in the accompanying drawings in which the figures are diagrams showing the conditions in the system under different conditions of operation as follows:

FIG. 1—source at maximum temperature and no demand for hot water;

FIG. 2—source at maximum temperature and maximum demand for hot water;

FIG. 3—source at minimum temperature and little demand for hot water;

FIG. 4—source at minimum temperature and maximum demand for hot water, and

FIG. 5 shows a modified construction.

The particular embodiment chosen for the purpose of illustration comprises a heat-storage unit U, a water tank T and a sealed conduit circuit containing water W and water vapor V. The circuit comprises a source-portion P1 surrounding the unit U, a sink-portion P2 surrounding the tank T, a branched conduit C1 and C2 interconnecting the upper ends of the portions P1 and P2 and a branched conduit C3 and C4 interconnecting the lower ends of the portions P1 and P2. Below the unit U is a reservoir R1 and below the tank T is a reservoir R2, these reservoirs being large enough to hold much of the liquid out of heat-transfer relation to the tank and unit respectively. As illustrated the reservoirs may constitute continuations of the portions P1 and P2 respectively.

The system is sealed from the outside atmosphere but at the top of the circuit is a safety-valve S to vent the system in case of excessive pressure.

In the conduit C2 is a thermostatic valve V1 controlled by the temperature of the heat unit U the valve being closed when the heat unit is freshly charged and gradually opening as the temperature of the unit decreases from maximum to minimum. Thus when the unit is at maximum temperature, vapor can flow only through conduit C1 but as the temperature of the unit decreases an increasing amount of vapor can flow through conduit C2 in parallel with C1. Thus the flow of vapor is automatically controlled by the temperature of the unit U so that the flow corresponds to the need irrespective of the temperature of the unit U. In the illustration valve V1 is closed in FIGS. 1 and 2 and open in FIGS. 3 and 4.

In the conduit C3 is a thermostatic valve V2 controlled by the temperature of the water in tank T. When the water is at maximum temperature the valve is closed so that the liquid in P2 may rise to the level L1 (FIG. 1) thereby obstructing vapor from reaching tank T and stopping heat transfer to the tank. When the tank begins to cool valve V2 gradually opens, permitting the level L1 to fall and thereby exposing the tank to condensing vapor.

In conduit C4 is a check-valve V3 which permits flow only in the direction of the arrow. Thus when tank T reaches maximum temperature and no water is being drawn from the tank the vapor pressure forces liquid from the reservoir R1 upwardly through conduit C5 to reservoir R2 and P2, causing the liquid in P1 and R1 to fall to a level L2 (FIG. 1) practically out of heat-transfer relation to the unit U and thereby substantially stopping vaporization.

When water is drawn from tank T the temperature of the water at the bottom of the tank drops and the valve V2 opens, thereby permitting water to flow downwardly through conduit C5, lowering level L1 to L3 and raising level L2 to L4 (FIG. 2). When the unit U is relatively cool and little water is being drawn from tank T the liquid in P1 stands at a level L5 in heat-transfer relation to only a part of the unit U, and the liquid in reservoir R2 stands at a corresponding level L6 (FIG. 3). As demand increases valve V2 opens to permit liquid to flow from reservoir R2 to R1 and P1, thereby producing levels L7 and L8 such as illustrated in FIG. 4 where the liquid is in heat-transfer relation to the entire unit U.

As shown in FIG. 5 the outlet from conduit C5 to reservoir R1 may be above the bottom of the reservoir and a wick K may be anchored in the conduit to minimize pressure surges. Also the walls of reservoir R1 may be corrugated to increase the length of the conductive path from the bottom of the unit U to the level L2, thereby to minimize vaporization when the liquid is at this low level as in FIG. 1.

It should be understood that the present disclosure is for the purpose of illustration only and that this invention includes all modifications and equivalents which fall within the scope of the appended claims.

I claim:

1. A heat-transfer system comprising a heat sink, a variable heat source the temperature of which varies throughout a wide range, an endless conduit circuit in heat-transfer relation to the source and sink for transferring heat from the source to the sink, the circuit containing liquid vaporizable by the source and condensible by the sink, the circuit including a sink-portion for holding liquid in heat-transfer relation to the sink and a source-portion for holding a quantity of said liquid in heat-transfer relation to the source and a return-portion leading from the lower end of the source-portion, the sink being located above the source so that the condensed liquid may drain back to the source by gravity through said return portion of said circuit, a thermal valve in said return-portion of the circuit, means responsive to the temperature of the sink for substantially closing the valve when the temperature of the sink reaches a predetermined maximum, said sink-portion being large enough to contain substantially all of said quantity, whereby when the sink reaches said maximum substantially all of said quantity is transferred to the sink-portion thereby substantially stopping heat-transfer from source to sink, a by-pass around said valve and in the by-pass a check-valve which permits flow only from said source-

portion to said sink-portion, and the system being sealed so that, when said thermal valve is closed, the vapor pressure in the source-portion produced by said source may force substantially all the liquid in the source-portion through the check-valve to the sink-portion.

2. A heat-transfer system comprising a heat sink, a variable heat source the temperature of which varies throughout a wide range, an endless conduit circuit in heat-transfer relation to the source and sink for transferring heat from the source to the sink, the circuit containing liquid vaporizable by the source and condensible by the sink, the circuit including a sink-portion for holding liquid in heat-transfer relation to the sink and a source-portion for holding a quantity of said liquid in heat-transfer relation to the source, the sink being located above the source so that the condensed liquid may drain back to the source by gravity through a return part of said circuit, the circuit including a conduit for vapor flow from the source-portion to the sink-portion, and means in said conduit responsive to the temperature of the source for gradually increasing resistance to said vapor flow as the temperature of the source rises.

3. A heat-transfer system according to claim 2 wherein said conduit comprises two branches in parallel and said means comprises a valve for closing one branch.

4. A heat-transfer system according to claim 1 further characterized by a conduit for vapor flow from the source-portion to the sink-portion, and means in said conduit responsive to the temperature of the source for imposing resistance to said vapor flow as the temperature of the source rises.

5. A heat-transfer system according to claim 4 wherein said conduit comprises two branches in parallel and said means comprises a valve for closing one branch.

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