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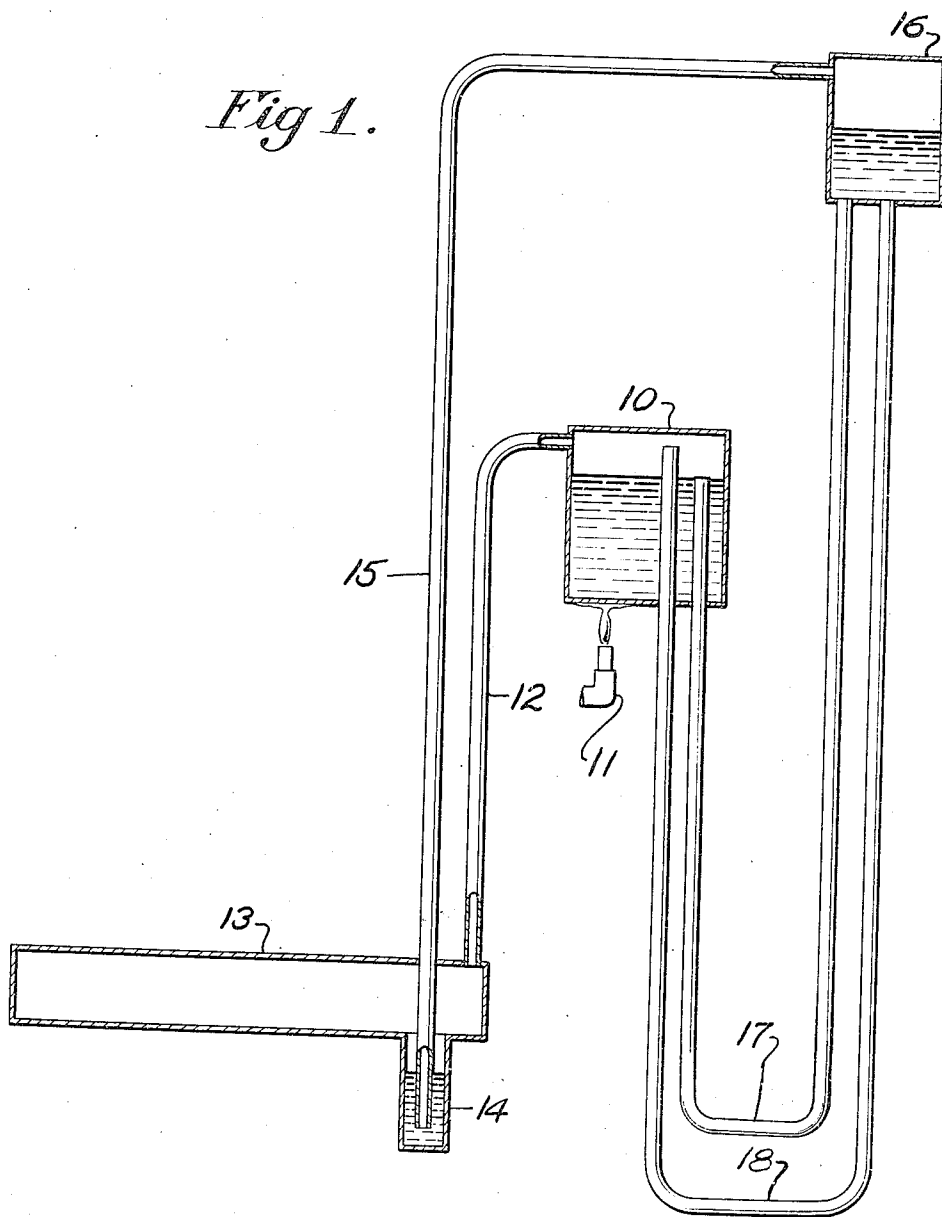
D. B. KNIGHT
HEAT TRANSFER SYSTEM

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2,068,549

2 Sheets-Sheet 1

Fig 1.



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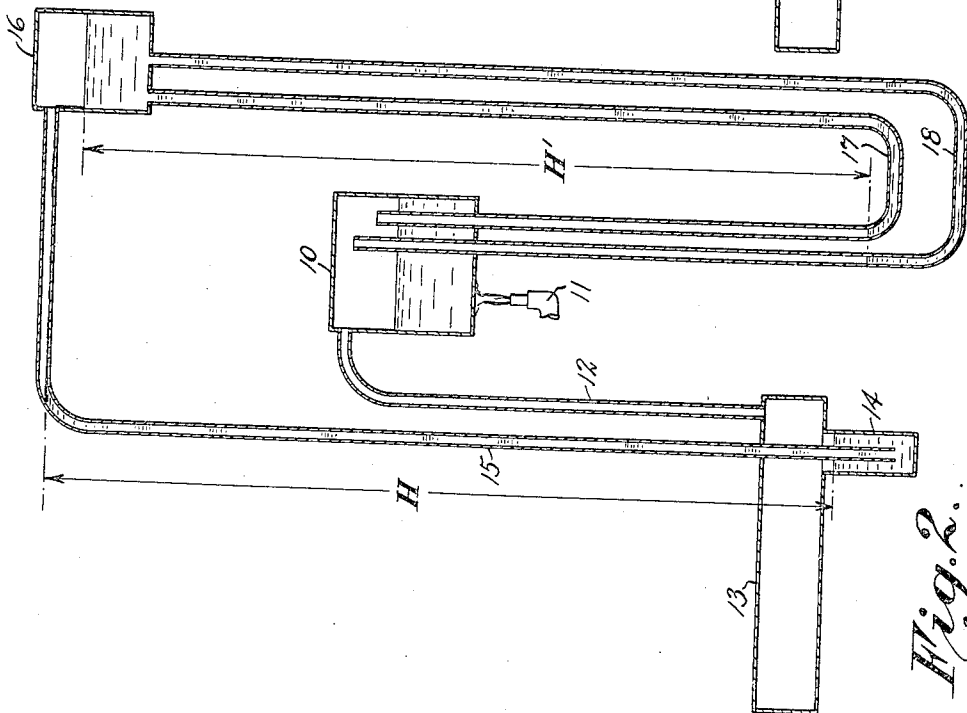
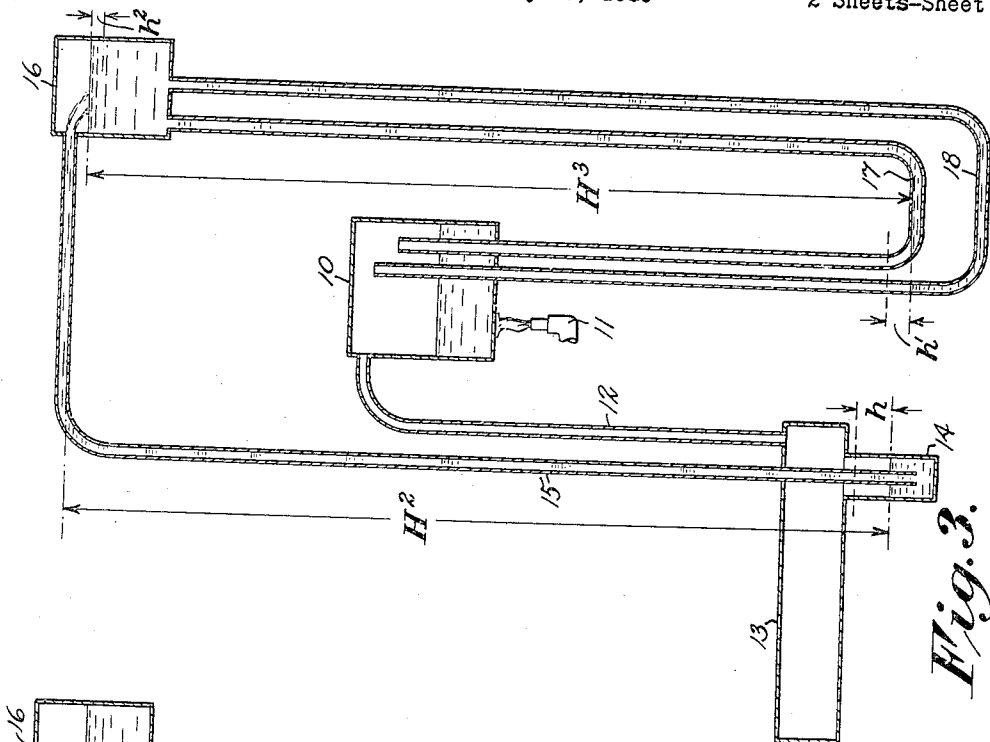
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2 Sheets-Sheet 2



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HEAT TRANSFER SYSTEM

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7 Claims. (Cl. 257-24)

This invention relates to heat transfer systems and more particularly to a system in which heat transfer fluid is circulated by addition of heat at one point in the system and the removal of heat at another point.

It is often desirable to transfer heat from a higher to a lower level, as in the case of a steam heating plant in which it is necessary to locate a radiator below the level of the boiler. Ordinarily it is not possible to thus locate a radiator without provision of a pump or other similar device for returning the condensate from the radiator to the boiler against the force of gravity. Other examples are numerous; for instance, it is often desirable to convey heat from a heat rejecting portion of a refrigeration apparatus, such as the condenser or the absorber of an absorption type refrigeration apparatus, to a cooling medium therebelow, as indicated in my Patent No. 1,846,006. Such examples are merely illustrative of the fields of utility of my present invention which, however, is not limited thereto, but resides in a system which operates without the use of mechanical pumps, valves, or other moving parts and which may be employed to transfer heat from an object or area to be cooled to a cooling medium at a level lower than the object or area, or, broadly, the circulation of a heat transfer fluid by the addition of heat at one level and the removal of heat at a lower level.

It is an object of my invention to provide a system by which heat may be transferred a greater distance below the source thereof through the agency of a fluid which is circulated due to a force within the system produced only by the heating and cooling of the fluid therein.

It is a further object to provide such a system having a liquid column forming loop or other like apparatus which extends only slightly below the heat rejecting portion of the system.

I attain these objects by providing a main condenser or heat radiator and a small condenser located at a higher level, these condensers being connected by a rising liquid conduit, the connection of this conduit to the main condenser being made through a liquid trap so that condensate in the main condenser is raised therethrough into the upper condenser due to a difference in pressure between the condensers. A boiler or vaporizer is connected for delivery of vapor to the lower main condenser and is located sufficiently below the upper condenser for delivery of liquid from the latter by gravity through a liquid trap when the pressures in the boiler and upper condenser are equalized. Intermittent equalization of pressure

is accomplished by a liquid seal which creates a liquid column sufficient to balance a pressure great enough to raise liquid from the lower main condenser to the upper condenser, but which is intermittently displaced when this pressure is exceeded.

The full nature of my invention together with the objects and advantages thereof will be apparent from the following description taken in connection with the accompanying drawings in which Fig. 1 shows schematically one embodiment of this invention, and Figs. 2 and 3 are views similar to Fig. 1 with all parts in vertical section and showing liquid columns under different conditions during operation of the system.

Referring to Fig. 1 of the drawings, the heat input portion of the system is represented by a boiler 10 and the supply of heat thereto is represented by a burner 11. The upper part of the boiler is connected through conduit 12 to a condenser or radiator 13 located at a level below the boiler. The condenser is constructed with a liquid trap or collecting chamber 14 from the lower part of which a riser or pump pipe 15 extends upwardly to a second condenser 16 located above the boiler 10. The lower part of condenser 16 communicates with the boiler 10 through a trap shown as a U-tube 17 having one leg extending into the upper part of the boiler. A second U-tube trap 18 is also provided between the condenser 16 and the boiler 10. As shown, the first trap 17 extends downwardly to a level slightly above the opening of the riser or pump pipe 15 in the collecting chamber 14 and the second trap 18 extends downwardly further than the trap 17 and has one leg opening into the boiler slightly above the corresponding opening of trap 17.

Assuming that liquid stands in the system to a level above the bottom of the boiler 10, heat applied to the boiler causes the liquid therein to vaporize, the vapor passing through conduit 12 to the condenser 13. Here the vapor is condensed and the liquid drains into the trap 14 where it seals the end of the riser or pump pipe 15. Since the pressure in the condenser 13 is substantially the same as the pressure in the boiler 10 the condensate collected in trap 14 rises in the pipe 15. At the same time, the liquid in the right hand leg of the U-tube traps 17 and 18 rises to a level which balances the liquid column in pipe 15. When the liquid level in the left hand leg of U-tube trap 17 is depressed until it reaches the bottom of said trap this trap blows, that is, the liquid in the right hand leg is forced upwardly into condenser 16 permitting vapor from

boiler 10 to pass directly to the condenser 16 thus equalizing the pressures in the system.

With the pressure thus equalized, liquid flows from condenser 16 through the U-tube trap 18 into the boiler 10 until the seal in trap 17 is reformed, and liquid is again pumped through pipe 15 from the trap 14 by the difference in pressures in condensers 13 and 16.

Thus, the pressures in the boiler 10 and the upper condenser 16 are intermittently equalized. During the time that the pressures are equalized, that is when trap 17 is open, liquid flows by gravity from the upper condenser 16 to the boiler 10 through the trap 18. When the trap 17 is again filled with liquid, as previously described, a pressure differential again builds up between the boiler 10 and the upper condenser 16, since no more vapor is delivered to the condenser 16 and the residue vapor therein condenses to liquid. As the pressure differential builds up, liquid rises in conduit 15 and is correspondingly depressed in the left hand legs of the traps 17 and 18, as previously described, the liquid columns in traps 17 and 18 and in conduit 15 balancing each other. It will be understood from the above description that the depth of the trap 17 must be sufficient to permit the liquid column in conduit 15 to rise high enough to overflow into the upper condenser 16 before the trap 17 blows. That is, liquid should reach the upper end of the conduit 15 just as vapor from the boiler approaches the bottom of the trap 17, so that liquid is intermittently spilled into the upper condenser 16 just prior to the intermittent blowing of the trap 17, whereby liquid is intermittently pumped from the lower condenser or radiator 13 to the upper condenser 16, as previously described.

An important result of the above described double trap arrangement is that liquid will flow from condenser 16 through trap 18 into the boiler 10 until the trap 17 is reformed and the liquid columns in traps 17 and 18 balance the column in riser pipe 15. Also by terminating one leg of the trap 17 in the bottom of condenser 16 if any vapor should be pocketed when the seal in trap 17 is re-formed this vapor condenses and is replaced by liquid from condenser 16 thereby insuring a liquid column which will counterbalance the column of liquid in riser 15 during the pumping cycle.

It will be understood that the above described heat transfer system may be utilized for either heating or cooling purposes. For instance, the boiler 10 may be the boiler of a steam heating plant and the main condenser 13, a radiator which it is desired should be located in a basement or other locality below the level of the boiler. In such case the system would be supplied with water as the heat transfer fluid which is vaporized in the boiler 10 and condensed in the radiator 13 in the manner previously described, the heat of condensation being radiated to increase or maintain the temperature of the locality to be heated. It may be that it is desired to transfer heat from a heat rejecting element represented in the drawings by the burner 11, for instance, the condenser of a refrigeration apparatus located in the upper part of a refrigerator cabinet where it is inaccessible for cooling by direct contact with air. In such instance the heat transfer system may be supplied with a suitable fluid such as methyl chloride, and the boiler or vaporizer 10 arranged in thermal exchange relation with the condenser to be cooled. In accordance with this invention the condenser or

radiator 13 may be located at the bottom of the refrigerator cabinet.

Figs. 2 and 3 show the above described liquid columns under two conditions in operation of the system. Referring to Fig. 2, liquid has just reached the upper end of the riser conduit 15 and has started to flow toward the upper condenser 16. Since the pressures in the boiler 10 and condenser 13 are substantially the same, liquid has been depressed in the traps 17 and 18. H indicates the height of the column of liquid in conduit 15, and H' indicates the height of the liquid columns in the traps 17 and 18. The liquid columns H and H' are equal and balance each other. Under these conditions, liquid has started to flow from the upper end of conduit 15 toward the upper condenser 16, and liquid has not yet reached the bottom of the shorter trap 17.

The liquid which flows into the upper condenser 16 from the upper end of conduit 15 is replaced by liquid from the sump 14. The liquid level thus goes down in the sump 14. When the liquid level in the sump 14 has decreased an amount h , indicated in Fig. 3, the liquid column in conduit 15 has increased to a height H^2 . During this time, liquid has been added to that in the upper condenser 16 from the conduit 15. Also, liquid has been forced upwardly in the right hand legs of the traps 17 and 18 due to depression of liquid in the left hand legs of these traps a distance h^1 . The liquid level in the upper condenser 16 therefore increases by a height h^2 . This results in a new height of the liquid columns in the traps 17 and 18. This new height is indicated by H^3 in Fig. 3. Again, the liquid columns H^2 and H^3 must be equal to each other. The liquid column H^2 in Fig. 3 is higher than the liquid column H in Fig. 2 by the distance h in Fig. 3. The liquid columns H^3 in Fig. 3 are higher than the liquid columns H^1 in Fig. 2 by the sum of the distances h^1 and h^2 indicated in Fig. 3. The sum of the distances h^1 and h^2 is equal to the distance h .

It will be seen in Fig. 3 that liquid has reached the bottom of the equalizing trap 17, but has not yet reached the bottom of either the permanent trap 18 or the bottom of the riser conduit 15 in the sump 14. At this point, as well known, the equalizing trap 17 blows, that is, vapor forces liquid up the right hand leg of this trap and opens communication between the vapor spaces of the boiler 10 and the upper condenser 16.

When the pressures are equalized, as described, liquid drops back through conduit 15 into the sump 14 and liquid flows by gravity from the upper condenser 16 through the permanent trap 18 into the boiler 10, until the liquid seal in trap 17 is reformed, and the process is repeated as long as heat is applied to the boiler 10.

It will be obvious to those skilled in the art that various other changes may be made in the construction and arrangement without departing from the spirit of the invention and therefore the invention is not limited to what is shown in the drawings and described in the specification but only as indicated in the following claims.

I claim:

1. In a fluid heat transfer system, a boiler, a condenser below said boiler having a liquid collecting chamber, a condenser above said boiler, a conduit from the upper part of said boiler to the lower condenser, a liquid lift conduit from the collecting chamber in said lower condenser to said upper condenser, a U-tube liquid trap having one leg connected to the bottom of said

upper condenser and the other leg open into the upper part of said boiler, and a second U-tube liquid trap having one leg connected to the bottom of said upper condenser and the other leg open into the upper part of said boiler above the opening of said first trap, said second trap extending below said first trap.

2. In a fluid heat transfer system, an upper condenser, a lower condenser having a liquid collecting chamber, a boiler, a conduit from the vapor space in said boiler to said lower condenser, a liquid lift conduit from said collecting chamber to said upper condenser, means for intermittently relieving the boiler pressure into said upper condenser, and means for delivering liquid from said upper condenser to said boiler responsive to the pressure in the latter.

3. In a fluid heat transfer system, a lower condenser, an upper condenser, a liquid lift conduit between said condensers, a boiler connected from its vapor space to said lower condenser, means for intermittently relieving the pressure in the boiler, and means for re-filling the boiler with liquid during the period that the pressure therein is relieved.

4. In a fluid heat transfer system, a lower condenser, an upper condenser, a liquid lift conduit between said condensers, a boiler connected from its vapor space to said lower condenser, and means for intermittently relieving the boiler pressure into said upper condenser and simultaneously delivering liquid from said upper condenser into said boiler.

5. In a fluid heat transfer system, an upper condenser, a lower condenser, a liquid lift conduit between said condensers, a boiler connected from its vapor space to said lower condenser, and valve means comprising a liquid column seal between

said boiler and said upper condenser adapted to be opened responsive to a predetermined pressure rise in the boiler and closed responsive to a predetermined rise of liquid level in the boiler.

6. The method of circulating heat-conducting fluid in a closed heat transfer circuit comprising applying heat to one portion of the system to vaporize a liquid, condensing the resulting vapor by the removal of heat in a first condenser, removing heat from the circuit in a second condenser at a higher level than said first condenser, utilizing the difference in pressures in said condensers to raise condensed fluid from the lower to the upper condenser, balancing the pressure difference by a liquid column between the upper condenser and said heated portion of the system, displacing said column to equalize the pressures responsive to a predetermined pressure difference, conducting liquid from the upper condenser to the heated portion of the system while the pressures are equalized, and again establishing said liquid column.

7. In a closed fluid heat transfer system, the method of circulation which comprises vaporizing liquid by the addition of heat, condensing the resulting vapor in one portion of the system, removing heat from a higher portion of the system, utilizing the pressure difference between the upper and lower portions to lift the fluid condensed in the lower portion to the upper portion, balancing the pressure difference with a liquid column between said upper portion and the heated portion, and intermittently displacing said liquid column to allow liquid to flow from said upper portion to the heated portion by gravity.

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