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Pessolano et al.

[11] **3,880,230**

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[54] **HEAT TRANSFER SYSTEM**

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[73] Assignee: **Isothermics Incorporated**, Clifton, N.J.

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[52] **U.S. Cl.** .... **165/105;** 126/99 R; 126/101; 237/19; 237/53; 165/63; 165/64

[51] **Int. Cl.** **F28d 15/00**

[58] **Field of Search** .... 165/105, 63, 64; 126/101, 126/99 R; 237/19, 53

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Attorney, Agent, or Firm—Mel K. Silverman, Esq.

[57] **ABSTRACT**

The present heat transfer system comprises a heat source; a heat pipe; a thermal transformer in thermal contact with said heat pipe and proximately disposed to said heat source; and a first chamber containing a medium with defined heat transfer characteristics, said chamber thermally coupled to said heat pipe; whereby a uniform heat transfer from said heat source to said medium is obtained.

31 Claims, 5 Drawing Figures

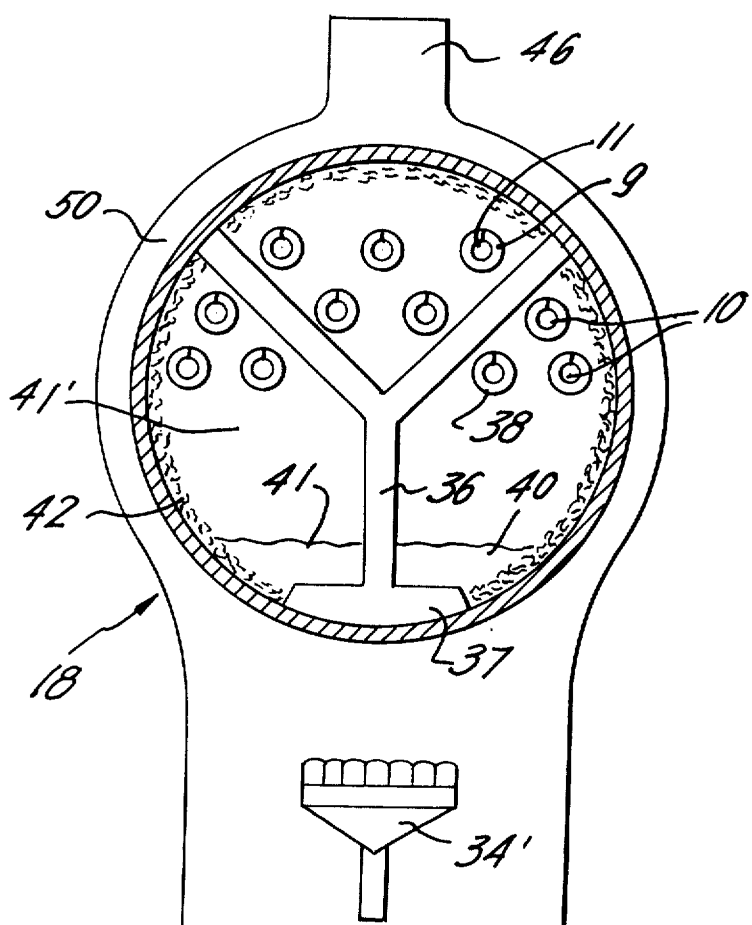
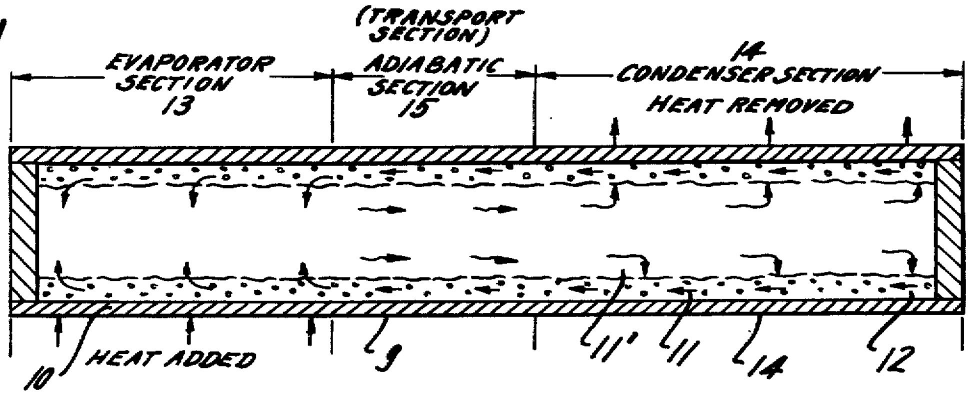


FIG.1



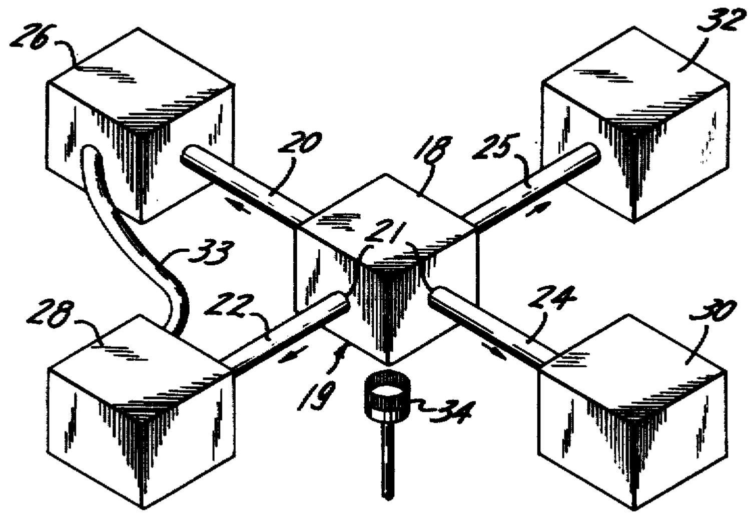
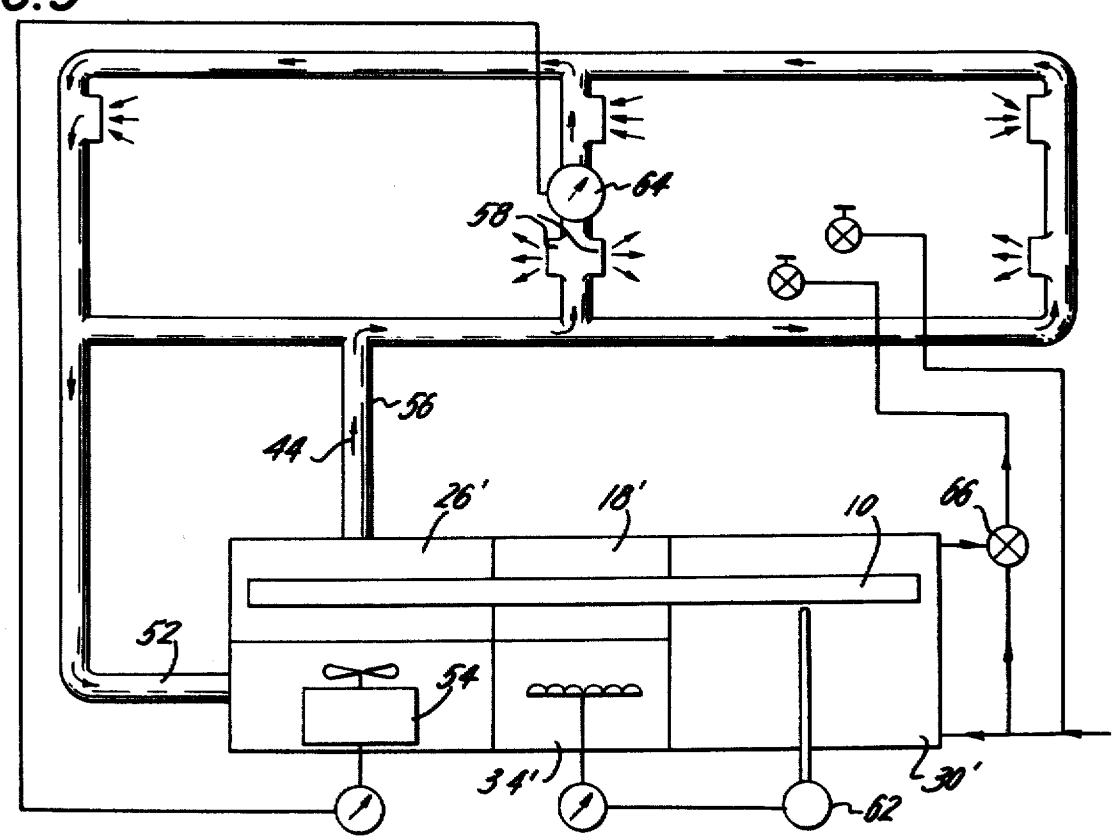


FIG.2

FIG.5



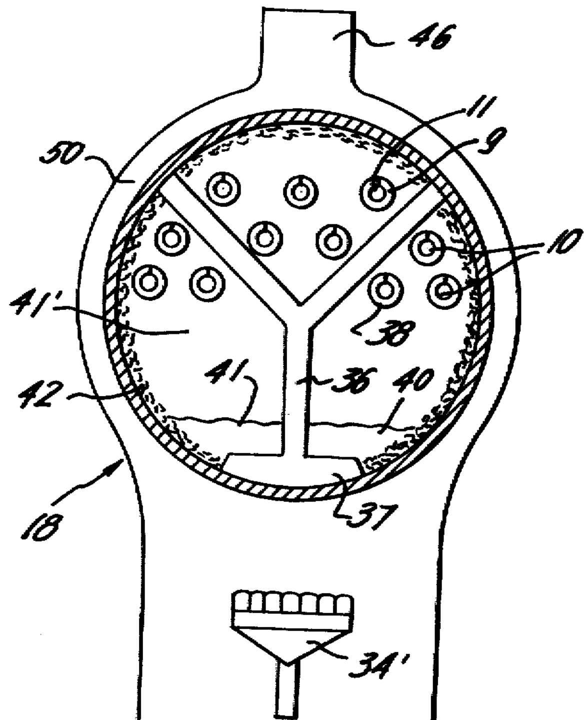
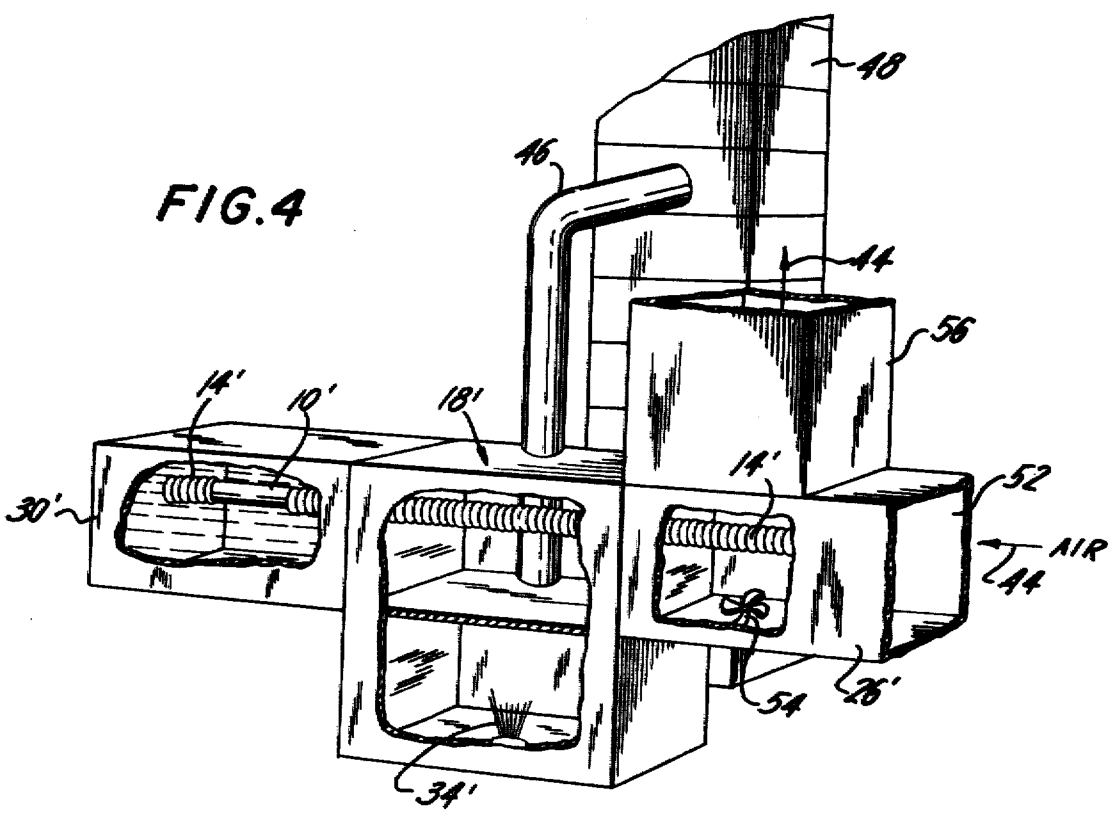

46
11
9
50
10
41'
38
41
36
40
42
18
37
34'

FIG.3

FIG.4


48
46
44
56
14'
10'
18'
14'
52
30'
AIR
44
54
26'
34'

HEAT TRANSFER SYSTEM

BACKGROUND OF INVENTION

In recent years, a major effort has been mounted in an attempt to find more efficient methods for the transport of thermal energy. This effort derives from the fact that the problem of heat loss or waste has become one of the major areas of concern in our highly technological society.

A promising new device has evolved from these studies which has the potential to revolutionize the heat transfer industry. This new device, termed the heat pipe, can be utilized to significantly increase the efficiency of heat transfer, thereby obtaining a resultant minimization of undesired heat dissipation. The heat pipe can transmit thermal energy at rates that are several hundred times greater than that of the best solid conductors, i.e., silver, copper and gold. Additionally, a much lower power to weight ratio is attained in the use of the heat pipe.

This device is simple, has no moving parts, is inexpensive to manufacture, has a long if not indefinite life, and can be operated over an extended range of temperatures.

The basic principles of the heat pipe were developed by Richard S. Gaugler of General Motors Corporation some 30 years ago. However, no effort was made to put these principles to work until 1963 when the National Aeronautics and Space Administration was faced with the need for a superconductor of thermal energy. The device now known in the art as the heat pipe was developed at the University of California by a team of research scientists headed by Dr. George L. Grover.

Sometimes compared to a steam heating system, the device is more accurately described as a miniaturized, hermetically sealed evaporating and condensing system.

Until recently, only exotic applications such as NASA's use of the device as a cooling means for electronic components in space, have been considered for the heat pipe. Accordingly, the primary object of the present invention is to define at least one significant commercial application for this promising device.

The heat pipe consists essentially of a sealed container, a capillary wick structure which is secured to the interior surface of the container, and a quantity of working fluid sufficient to saturate the wick structure. The container is sealed while under a vacuum.

Because the container is sealed under a vacuum, the working fluid is in equilibrium with its own vapor. Thus, any application of heat to any external surface of the heat pipe will cause an instantaneous evaporation of the working fluid near the heated surface. In the vaporization process, the latent heat of vaporization is absorbed by the vapor.

The latent heat of vaporization is essentially the ratio of (a) the heat absorbed during the change of phase from liquid to vapor to (b) the mass of the system undergoing the change of phase. More technically speaking, the heat of vaporization is defined as the difference between the enthalpies of the system before and after the change of phase from liquid to vapor at constant temperature.

The vapor generated as a result of any heat addition creates a pressure gradient within the heat pipe which forces the excess vapor to an area of the heat pipe having a lower pressure and temperature. The lower temperature causes the condensation of some vapor, thereby causing the latent heat of vaporization to be absorbed by the condenser surfaces of the heat pipe. The heat may be removed from the condenser surfaces by conduction, convection or radiation to the surrounding environment.

The condensate is retuned to the evaporator region (area of heat addition) by the capillary pumping forces within the circumferential interior wick structure. This return may occur either with or without the aid of gravity.

There are, as aforestated, only three basic components to any heat pipe: the container, the wick and the fluid. This extreme simplicity, taken in complement with the fact of the absence of any moving mechanical parts, has demanded that the heating and refrigeration industries pay far greater heed to heat pipe technology. The high efficiency of the heat pipe derives from the fact that the quantity of heat absorbed in the vaporization of a fluid is enormous compared to that absorbed during an increase in temperature of a fluid. For example, the amount of heat absorbed by 1 pound of water while being heated from 164° to 165° F. is 1 Btu. However, if the same pound of water were first vaporized at 164° F, and then the vapor heated to 165°F., the amount of heat absorbed would be 1,000 Btu. Hence the same mass of water offers 1,000 times the heat transfer capability over the same temperature gradient, when latent heat transfer is utilized.

Heat pipes can be designed to handle virtually any heat load and can be designed to operate over any temperature range, from below −300°F. to above 3,630°F., by proper selection of the working fluid. Heat pipe fluids have ranged from cryogenics such as nitrogen and helium, to liquid metals such as potassium and silver. One of the most common fluids is water which has a useful operating range from 40° to 450° F.

A standard line of copper-water heat pipes is now commercially available. These heat pipes range in diameter from 3/16 inch to 1 inch, and in length from 6 inches to 72 inches. The range of axial power ratings is from 60 watts to 1400 watts.

SUMMARY OF THE INVENTION

The present invention can be viewed as one of the first of what is believed will be virtually innumerable applications of the heat pipe concept. More particularly, the present invention constitutes an attempt to (a) reduce heat losses, (b) increase heating efficiency in domestic heating systems, and (c) at the same time, to eliminate the duplication of system components such as now exists in gas, oil, or coal systems with separate hot water heaters, and separate air-conditioning systems.

The present invention in its application to domestic heating systems, comprises a heat transfer system having three basic sections: a primary heat transformer, a hot water chamber, and a hot air chamber. In addition to these three basic sections, there is an additional fundamental system component, that of a plurality of heat pipes which thermally connect said hot water chamber and said hot air chamber to said primary heat transformer.

The terms "heat transformer, thermal transformer, and transformer" shall be hereafter applied to any chamber of the system which acts primarily as a thermal link between any heat source external to the system and the system, and in which the principal means of heat transfer shall be the evaporation or boiling of a working fluid contained within said chamber followed by the condensation of said working fluid upon the exterior surfaces of a plurality of heat pipes, which thermally connect said chamber with another chamber of the system.

The term "chamber" shall be hereafter applied to any distinct and separate region of the system into or through which pass a plurality of heat pipes, which thermally connect said region with another region of the system, and the primary purpose of said region is to permit heat to be transferred to or from said plurality of heat pipes, from or to some medium with defined heat transfer properties which may reside within or pass through said region.

The transformer can be powered by any type of heat source. From the transformer, heat enters the heat pipes which in turn direct the thermal energy toward both the water and air chambers. In a typical system the water tank serves three functions: first, as a source of domestic hot water; second, as a thermal capacitor; and third, as a burner control. In a characteristic mode of operation, the burner will shut down when the water tank reaches a predetermined temperature. Since the hot water section is connected by heat pipes to the hot air section, the water tank will serve as an additional source of heat for the hot air section when the burner is off. This represents an efficiency in heat use that does not exist in prior art systems. When the temperature of the tank water drops below a second predetermined temperature, the burner will reignite.

The hot air flow is regulated by a room thermostat which controls a two-speed fan. The fan has a low speed to supply a constant trickle of warm air, and a high speed to provide additional heat when required. The fan controls are completely independent from the burner.

This mode of operation eliminates the type of large temperature variations that are common in present systems. By using the water tank as a thermal capacitor, it is possible to reduce overall burner running time and to change the burning cycle from many short runs to fewer, longer runs per day. Fewer starts and stops reduce burner exhaust pollution as well as system maintenance costs, as compared to the higher frequency conventional burner cycles.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross-sectional schematic view of a heat pipe.

FIG. 2 is a systems view of one embodiment of the present invention.

FIG. 3 is a cross-sectional radial schematic view of the transformer.

FIG. 4 is a cut-away perspective view of a domestic heating system utilizing the principles of the present invention.

FIG. 5 is a schematic view of a residential climate control system embodying the present invention.

DETAILED DESCRIPTION OF THE INVENTION

In FIG. 1 is illustrated a single heat pipe **10** in schematic form. The pipe, in the illustrated embodiment, comprises a closed elongated cylindrical container **9** containing a working fluid **11** and a capillary wick structure **12** which is cirumferentially secured to the interior surface of the pipe **10**. Region **13** is termed the evaporator end of the pipe. It is at this end that heat is added to the present system, thereby causing evaporation of the fluid **11** or the formation of vapor **11'** and movement of said vapor axially to the right and toward a cooler area **14** of the pipe having a lower pressure. Area **14** comprises the condenser end of the pipe. It is at this end that the vapor **11'** is condensed, thus releasing its latent heat. On condensation, the fluid **11** is absorbed into the wick structure **12** and is returned, by capillary forces, to the evaporator end **13** where the above cycle can be repeated indefinitely.

Section **15** is variously termèd as a transport and an adiabutic section. In essence, this terminology means that section **15** functions to effect an efficient transfer of the vaporized fluid from sections **13** to **14**, and the condensed vapor from sections **14** to **13**.

FIG. 2 presents a systems illustration of one embodiment of the present invention. Shown is a multi-chambered heat transfer system which utilizies heat pipes to thermally connect several separate chambers. The number, size, shape, construction and relative orientation of the separate chambers may be varied in any manner whatsoever to accommodate virtually any type of heating or cooling problem. Similarly, the heat pipes, their number, shape, size, orientation, construction and internal working mechanisms can be varied wherever necessary to achieve a solution to a particular heating or cooling problem. The present invention is similarly intended to be readily adaptable to use with any source of heat and with virtually any heating load.

The primary mode of heat transfer is through the evaporation and condensation of a working fluid in a thermal transformer **18**, and in one or more of the heat pipes **20, 22, 24** and **25**. The transformer **18** functions to convert or transform the high and non-uniform heat fluxes typical on the exterior of said transformer, into lower and more uniform heat fluxes. Said heat pipes serve as thermal connectors and as heat transfer mediums to the several chambers **26, 28, 30** and **32**. Secondary heat transfer can be obtained by ancillary heat pipes **33** disposed within or between said chambers **26,** 28, 30 and **32.**

It is to be noted that the working fluid utilized within the transformer **18** need not necessarily be the same as the working fluid utilized within said heat pipes in said chambers.

All containment materials, and other materials in the invention's construction, may be varied in any manner and are limited only with regard to their chemical compatability with each other and with the different materials with which they may come into contact. This constraint pertains to the working fluids employed in the invention and its component parts. In addition, both the working fluids, and their respective containment materials, have a common limitation in that the structural integrity of said containments must withstand the operating temperatures and resultant operating pressures of the respective fluids.

Heat may be transferred through and/or from the transformer **18,** to one or more of several chambers **26** through **32.** These several chambers are intended to be sealed from each other in a suitable manner with, under the worst design and external conditions, no mass transfer occurring from one chamber to any other chamber, except where a mass transfer is intended as a part of a heat transfer process.

An ultimate heat source **34**, whether this source be a gas flame, an oil burner fire box, an electric heater, or any other source of thermal energy, is intended to supply the primary heat in required amounts to the invention. In the embodiment illustrated in FIG. **2**, the heat source **34** is applied to the transformer **18**. It is, however, to be emphasized that alternate arrangements could be equally suitable in any given application. For example, the system of FIG. **2** could, with minor adaptations, have the heat source **34** applied to one of the chambers **26** through **32**.

The chamber to which the heat source **34** is applied should contain, in addition to its enclosing walls, a working fluid (which may from time to time be frozen) and its vapor, as well as evaporation surfaces, condensation surfaces, a pressure release safety valve, and any temperature and/or pressure sensitive control devices that may be required in the solving of a particular heating problem.

The primary purpose in the use of a transformer as opposed to the direct application of the heat source **34** to the evaporator ends of the heat pipes **20** through **26**, is to create a uniformity in the heat flux (noted by the four arrows in FIG. **2**) from the heat source **34** to the chambers (**26** through **32**). In addition to providing the present system with a uniformity in its heat gradient, the transformer **18** also serves to reduce the possibility of a phenomenon which is known as heat pipe burnout. Heat pipe burnout occurs when the rate of evaporation in the evaporator section exceeds the rate of condensate return to the evaporator section, and the evaporator becomes dried out. In such a condition, a heat pipe cannot function.

In theory, the system shown in FIG. **2** need comprise only a single heat pipe. However, experimentation has shown that a more efficient operation can be obtained where a plurality of heat pipes are enclosed within the transformer **18**. A representative configuration of such multiple heat pipes, enclosed with the transformer, is illustrated in FIG. **3**.

A Y-shaped channel **36** (see FIG. **3**) is termed a percolation channel. A collector **37** serves to collect vapor bubbles which provide the means to pump working fluid via the percolation channel to the upper extremities of the wick structure. In doing so, the burnout heat flux of the transfomer evaporation surface is greatly increased because of this added condensate return mechanism.

An additional condensate return mechanism, that of the gravity return of condensate from the condenser surface, is aided by the use of parallel radial fins **38** on the heat pipes. Said parallel radial fins, when spaced properly, aid the condensate return as a result of a miniscus which forms between adjacent fins, and on the lower surfaces, with respect to gravity. As droplets fall from said lower surfaces, surface tension forces resultant from said miniscus serve to draw condensate in the form of a falling film from the upper surfaces of said parallel fins. It is believed that this phenomenon can increase the heat transfer due to condensation on the underside of a horizontal surface by as much as five fold as compared to condensation without formation of said miniscus and its resultant surface tension forces. The primary reason for increased heat transfer is the reduction of the film thickness as a result of this falling film phenomenon.

It has also been found that the design of FIG. **3** will operate at maximum efficiency where each pipe **10** is aligned in its own vertical plane. Such alignment provides each pipe with its own dripping path to the region **40**. Hence, the fluid transport process within the transformer **18** is further assisted.

Heat may enter the transformer by means of conduction through one or more of its walls, and then through evaporator surface **42**. See FIG. **3**. Since the working fluid and its vapor are in a state of equilibrium at a reduced pressure, the addition of any heat to chamber **18** will cause a shift in the equilibrium state, favoring the evaporation of the working fluid. When this occurs, the latent heat of vaporization of the working fluid is transferred to the heat pipes by the condensation of vapor on said heat pipes' exterior surfaces. The heat is then transferred axially away from the transformer by the internal dynamics of said heat pipes.

Thus, heat transferred through the evaporator surface **42** as a result of a finite temperature difference across the surface **42**, will cause portions of the working fluid **41** to vaporize or boil immediately, absorbing the latent heat of vaporization of fluid **41** in doing so. As a result of the pressure gradient induced by said vapor formation, the vapor **41** is forced into regions of lower pressure, and consequently lower temperature. Within the transformer **18**, these regions of lower pressure and temperature are in the vicinity of the heat pipes **10** which pass through said transformer. Because the heat pipes **10** are at an equilibrium temperature which is lower than that of the newly created vapor **41'**, said newly created vapor **41'** will condense on the exterior finned surfaces **38** of said heat pipes **10**, and in doing so, deposit the latent heat of vaporization of said working fluid **41** on said finned surfaces **38**.

Thus the heat transferred to the finned surfaces **38** as a result of a finite temperature difference across evaporator surface **42**, will conduct through the heat pipe wall **9** and cause portions of the working fluid **11** contained within heat pipes **10** to vaporize or boil immediately, absorbing the latent heat of vaporization of fluid **11** in doing so. As a result of the pressure gradient induced by said vapor formation, the vapor **11'** is forced into regions, within said heat pipes **10**, of lower pressure and consequently lower temperature. These regions of lower pressure and temperature coresponding to condenser section **14** of FIG. **1**, are disposed within the chambers **26, 28, 30** and **32** of FIG. **2**. Because these condenser sections **14'** disposed within the chambers **26, 28, 30** and **32** are at an equilibrium temperature which is less than that of the newly created vapor **11'** said newly created vapor **11'**, will condense on the interior surfaces of heat pipes **10** in regions denoted by **14'** of FIG. **4**, and in doing so deposit the latent heat of vaporization of said working fluid **11** in said condenser regions **14'**.

The heat deposited in regions **14'** of said heat pipes **10** will conduct through the wall of said heat pipes **10** in regions **14'** disposed within chambers **26, 28, 30** and **32**, and then transfer from the exterior surfaces of the heat pipes **10** to the mediums contained within chambers **26, 28, 30** and **32**, in a manner which is extremely efficient and uniform.

In the event that source **34** is inactive, and that one or more of the media contained within chambers **26**, 28, 30 and **32** reside at a temperature which is different from the temperature at which one medium within one of the chambers resides at, said temperature gradient is sufficient to promote heat transfer from a medium residing at higher temperature to a medium residing at lower temperature.

Heat transfer to the media contained within chambers **26** to **32** of the system of FIG. **2** from the thermally connective heat pipes may be effected by any transfer means, that is, by conduction, convection, radiation, or the evaporation and condensation of a working fluid, or any combination of these. In attaining said various heat transfer modes, the thermally connective heat pipes **10** may be variously smooth, rough, or finned in any manner so as to regulate the heat transfer to or from a heat pipe surface and from or to the medium in contact with said surface.

It is to be noted that certain thermal sources, such as electrical heat, could be applied to transformer **18** by the placement of heating elements inside of said transformer. This design would be in distinction from the illustrated embodiment wherein the ultimate heat source **34** is applied externally.

It is to be understood that the transfomer **18** and its associated plurality of heat pipes may serve as a means of thermally linking, and thereby thermally powering, any heating or cooling system. Viewed in this light, it can be appreciated that the hereinafter described embodiment represents but one of a multiplicity of systems to which the present concept may be readily adapted.

Turning now to FIG. **4**, we see that one or more of the several chambers may be in the form of an air duct **26**′ designed so as to allow the passage of various quantities of air **44** or any other suitable gas, through the duct **26**′. Said air **44** is in thermal contact with the exterior surface of the heat pipes **10** which extend into chamber **26**′. The intent of such a chamber is to raise or lower the temperature of the air **44** flowing through it. In conjunction with chamber **26**′ the system will be equipped with air moving equipment, air flow controls, with temperature controls, and with any other control deemed necessary for the solution of a particular heat transfer problem.

One or more of the several chambers may contain a medium, with defined thermodynamic properties, which has the ability to store heat energy, either by virtue of increasing the temperature of said medium (sensible energy storage) or by virtue of changing the phase of said medium, either from solid to liquid, or from liquid to vapor (latent energy storage), or by virtue of a combination of these two (sensible and latent energy storage). Said chamber can be termed a thermal battery, or a thermal capacitor.

Such a chamber may be in the form of a water tank **30**′, as is illustrated in FIG. **4**. The intent of the tank **30**′ (in addition to its obvious use as a tank for supplying hot water for domestic use) is to absorb and store thermal energy, from the transformer **18**, that is not immediately being utilized by the domestic hot water and hot air system. Energy absorbed by the tank **30**′, is available for immediate use, either as instantaneous domestic hot water, or by virtue of the thermally connective heat pipes, as instantaneous hot air for domestic heat, regardless of whether the ultimate heat source is functioning or not.

One or more of the several chambers may comprise a geometric configuration similar to interchangeable with, or in place of the generator of an absorption refrigeration system of suitable size to be powered by the energy which could be provided by said chamber. It is not intended that an absorption refrigeration system is a part of this invention; however, it is intended that an appropriately sized absorption refrigeration system can be powered by a suitably designed chamber of said invention.

Such a suitably designed chamber **28** or **32** of said invention, when serving to power such an appropriately sized absorption system can be considered to provide a means for removing heat energy from a second chamber, which may be an integral part of the invention, by virtue of the direct application of the absorption refrigeration system evaporating coil to that chamber. Said chamber could provide means for cooling air, water or any other medium used within the present system.

The residential heating system shown in FIGS. **4** and **5** includes a stack **46** for venting products of combustion from the heat source **34**′. Also shown is a chimney **48.**

The stack **46** receives the products combustion through the circumferential channel **50** (shown in FIG. **3**). Hot water for household use is, as above noted, supplied from the tank **30**′ (shown in FIG. **4**). An air exchange system and duct network for conditioning residential air comprises the duct for supplying air and an air return **52.** The air is circulated, by a fan **54,** past a portion of the hot air chamber **26**′. The heated air is thereby supplied through air supply **56** and to the individual room heat vents **58.**

A typical operation cycle would be as follows: The water in tank **30**′ will be initially heated to 200°F. A blower **54** will run at a low speed, sufficient to transfer an amount of heat from the transformer **18**′ through the air supply duct **56** and into the individual room vents **58,** thereby compensating for heat losses through the domestic structure. With the heat source **34**′ off, heat is supplied to the air supply **44** via heat pipe **10** from **30**′ of the system. That is, the hot air chamber **26**′ will draw upon the thermal energy stored within the hot water chamber **30**′. This illustrates, in one form, the above-described thermal battery properties of the chamber **30**′.

When the temperature within the chamber **30**′ is reduced to 140° F., an aquastat **62** will reactivate heat source **34**′. Said heat source will supply heat through the transformer **18**′ for both the air and water supplied to the present domestic system. (The source **34**′ will operate until the water in tank **30**′ reaches 200° F, at which point the aquastat **62** will turn off the heat source.) In order to compensate for what is often a variable demand for heat within the rooms, a room thermostat **64** is provided which will control the speed of the fan **54,** thereby regulating the rate at which heat is drawn from the chamber **26**′ for delivery to the rooms. In order to compensate for the varying temperature of the water stored in tank **30**′, which from time to time will range between 140° and 200 ° F., a tempering valve **66** may be employed to provide domestic hot water at one specified temperature, perhaps 140° F. Such a valve contains a thermal sensor which regulates the mixing ratio of hot water and cold water input to obtain a constant temperature output.

It would be apparent to one having ordinary skill in the art that a suitable air filtration system could be provided within air return **52.** In like manner, a humidifier could be provided within air supply duct **56.** Additionally, it can be readily appreciated that the theoretical system of FIG. 2 could easily serve as thermal transfer means for a centralized air conditioning unit, utilizing the absorption refrigeration system aforementioned.

While there have been herein shown and described the preferred embodiments of the present invention, it will be understood that the invention may be embodied otherwise than is herein specifically illustrated or described and that in the illustrated embodiments certain changes in the detail of construction and in the form and arrangement of parts may be made without departing from the underlying idea or principles of this invention within the scope of the appended claims.

Having thus described our invention, what we claim as new, useful and non-obvious and accordingly secure by Letters Patent of the United States is:

1. A heat transfer system, comprising:
 a. a heat source;
 b. a plurality of heat pipes:
 c. a thermal transformer thermally linked to both said heat pipes and said heat source, said transformer comprising:
  i. a container,
  ii. a working fluid and its vapor, said fluid and said vapor being essentially in equilibrium,
  iii. evaporating surfaces depending from the internal surfaces of said transformer that are wetted by said working fluid and that are proximate to said heat source, and
  iv. condensing surfaces depending from the exterior of those areas of said heat pipes that are in thermal contact with said transformer; and
 d. a first chamber containing a medium with defined heat transfer characteristics, said chamber thermally coupled to said heat pipes,

whereby a uniform heat transfer from said heat source to said medium is obtained.

2. The system as recited in claim 1 in which said transformer further comprises: a wick structure affixed to the interior surface of said transformer and in contact with said evaporating surfaces.

3. The system as recited in claim 1 in which said heat source comprises an electric heating element disposed externally proximate said transformer.

4. The system as recited in claim 2 in which said transformer is sealed while under a partial vacuum, said vacuum being measured exclusively of partial pressures contributed by said working fluid.

5. The system as recited in claim 1 in which said system further comprises: a second chamber containing a second medium with defined heat transfer characteristics, said second chamber being thermally connected to said first chamber by said heat pipe.

6. The system as recited in claim 1 in which said system further comprises:
 a. an ancillary heat pipe;
 b. a second chamber containing a second medium with defined thermodynamic properties, said second medium thermally connected to said first chamber by said ancillary heat pipe.

7. The system as defined in claim 5 in which said second medium may reside at a lower temperature than said first medium, thus creating a temperature gradient between said first and second chambers, thereby causing a heat transfer through said heat pipe between said chambers, said heat transfer occurring regardless of the degree of activity of said heat source.

8. The system as recited in claim 7 in which heat removed from said first chamber may be removed by either sensible or latent heat transfer.

9. The system as recited in claim 8 in which said system further includes:
 a. a heat sensor disposed in one of said chambers; and
 b. means for heat source control, associated with said sensor.

10. The system as recited in claim 9 in which said first medium comprises water and said second medium comprises air.

11. The system as recited in claim 7 in which said heat pipe comprises a plurality of heat pipes, each of said heat pipes being disposed in a vertical plane that does not intersect the vertical plane of any other of said heat pipes.

12. The system as recited in claim 7 in which said heat source comprises: an exothermic chemical heat source.

13. The system as recited in claim 12 in which said system further comprises: a flue structure peripherally surrounding said thermal transformer and said heat source.

14. The system as recited in claim 11 in which said condensing surface of said heat pipes comprises a multiplicity of fins, projecting radially from said heat pipes.

15. The system as recited in claim 10 in which the working fluid of the transformer is water and the working fluid of said heat pipe is also water.

16. The system as recited in claim 10 in which the working fluid of said transformer is different from the working fluid of said heat pipe.

17. A heat transfer system, comprising:
 a. a heat source;
 b. a heat pipe having a first end and a second end;
 c. a thermal transformer thermally linked to both said heat pipe and said heat source, said thermal transformer comprising:
  i. a container,
  ii. a working fluid and its vapor, said fluid and said vapor being essentially in equilibrium,
  iii. evaporating surfaces depending from the internal surfaces of said transformer that are wetted by said working fluid and that are proximate to said heat source, and
  iv. condensing surfaces depending from the exterior of those areas of said heat pipe that are in thermal contact with said transformer;
 d. a first chamber containing a first medium with defined heat transfer characteristics and residing at a first temperature, said first chamber thermally coupled to said first end of said heat pipe; and
 e. a second chamber containing a second medium with defined heat transfer characteristics and residing at a second temperature, said second chamber chamber thermally coupled to said second end of said heat pipe,

whereby both a first and a second heat transfer from said heat source to said first and second media respectively are obtained, said first and second heat transfers being a function of the respective thermal gradient between said heat source and each of said respective media, wherein each of said heat transfers is proportional to its respective thermal gradient.

18. The system as recited in claim 17 is which said transformer further comprises: a wick structure affixed

to the interior surface of said transformer and in contact with said evaporating surfaces.

19. The system as recited in claim **17** in which heat source comprises an electric heating element disposed externally proximate said transformer.

20. The system as recited in claim **18** in which said transformer is sealed while under a partial vacuum, said vacuum being measured exclusively of partial pressures contributed by said working fluid.

21. The system as recited in claim **20** in which said heat pipe comprises a plurality of heat pipes.

22. The system as defined in claim **17** in which said second medium may reside at a lower temperature than said first medium, thus creating a temperature gradient between said first and second chambers, thereby causing a heat transfer thru said heat pipe between said chambers, said heat transfer occurring regardless of the degree of activity of said heat source.

23. The system as recited in claim **22** in which heat removed from said first chamber may be removed by either sensible or latent heat transfer.

24. The system as recited in claim **23** in which said system further includes:

a. a heat sensor disposed in one of said chambers; and

b. means for heat source control, associated with said sensor.

25. The system as recited in claim **24** in which said first medium comprises water and said second medium comprises air.

26. The system as recited in claim **22** in which said heat pipe comprises a plurality of heat pipes, each of said heat pipes being disposed in a vertical plane that does not intersect the vertical plane of any other of said heat pipes.

27. The system as recited in claim **22** in which said heat source comprises: an exothermic chemical heat source.

28. The system as recited in claim **27** in which said system further comprises: a flue structure peripherally surrounding said thermal transformer and said heat source.

29. The system as recited in claim **26** in which said condensing surface of said heat pipes comprises a multiplicity of fins, projecting radially from said heat pipes.

30. The system as recited in claim **25** in which the working fluid of the transformer is water and the working fluid of said heat pipe is also water.

31. The system as recited in claim **25** in which the working fluid of said transformer is different from the working fluid of said heat pipe.

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