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(54) **HEAT PIPE FOR LONG DISTANCE**

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(57) **ABSTRACT**

The present invention relates to a heat pipe for long distance and, in particular, to a heat pipe constituted by an evaporating unit for evaporating working fluid to form vapor, a condensing unit spaced at a long distant from the evaporating unit and discharging heat from a transferred vapor to the outside, and a transferring unit formed as a connecting tube of a general form having a single function connecting the evaporating unit and the condensing unit to transfer only the evaporated fluid vapor, wherein a working fluid supplier is formed in the evaporating unit in order to supplement the evaporated working fluid from the outside and a condensation liquid discharging unit is formed in the condensing unit in order to discharge condensation liquid generated by condensing the vapor to the outside. Accordingly, a recovery pipe formed for a condensation liquid carrying function of a connecting tube in the prior art is removed, making it possible to perform a long distance heat supply irrespectively of a ground landscape feature on which the transferring unit may lie. Also, the pipe connecting tube of a general form having a single function is formed with a heat insulator in order to prevent heat loss during the long distance transfer, whilst making it possible to reduce fabrication and material cost. As such, the heat pipe for long distance of the present invention comprises: an evaporating unit absorbing heat from the outside to evaporate working fluid contained therein; a transferring unit transferring vapor generated from the evaporating unit; and a condensing unit discharging the heat of the vapor transferred through the transferring unit to the outside, wherein the condensation liquid generated from a heat-discharge heat exchanger in the condensing unit is not recovered through a recovery path or a separate recovery pipe.

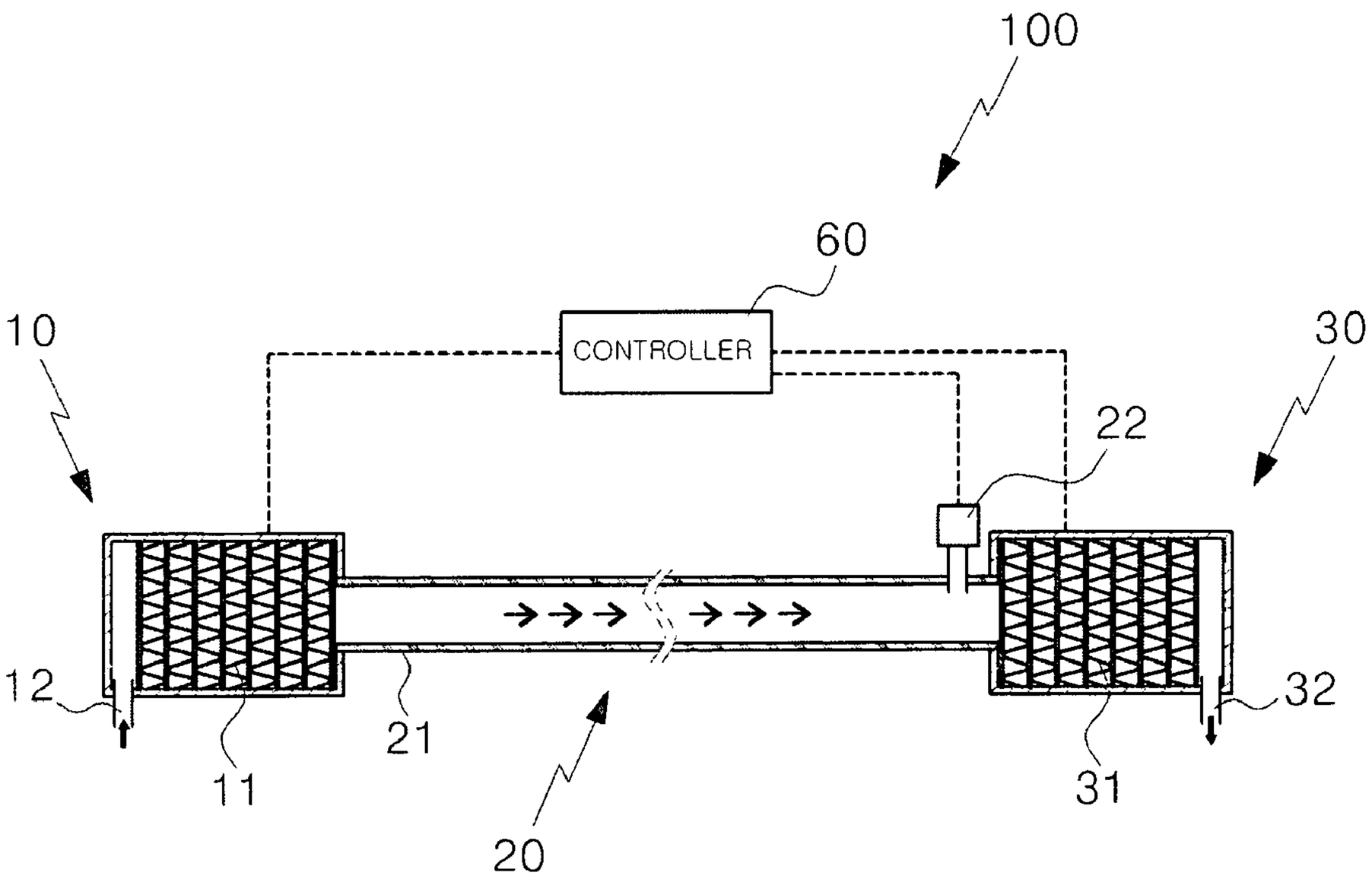


Fig. 1

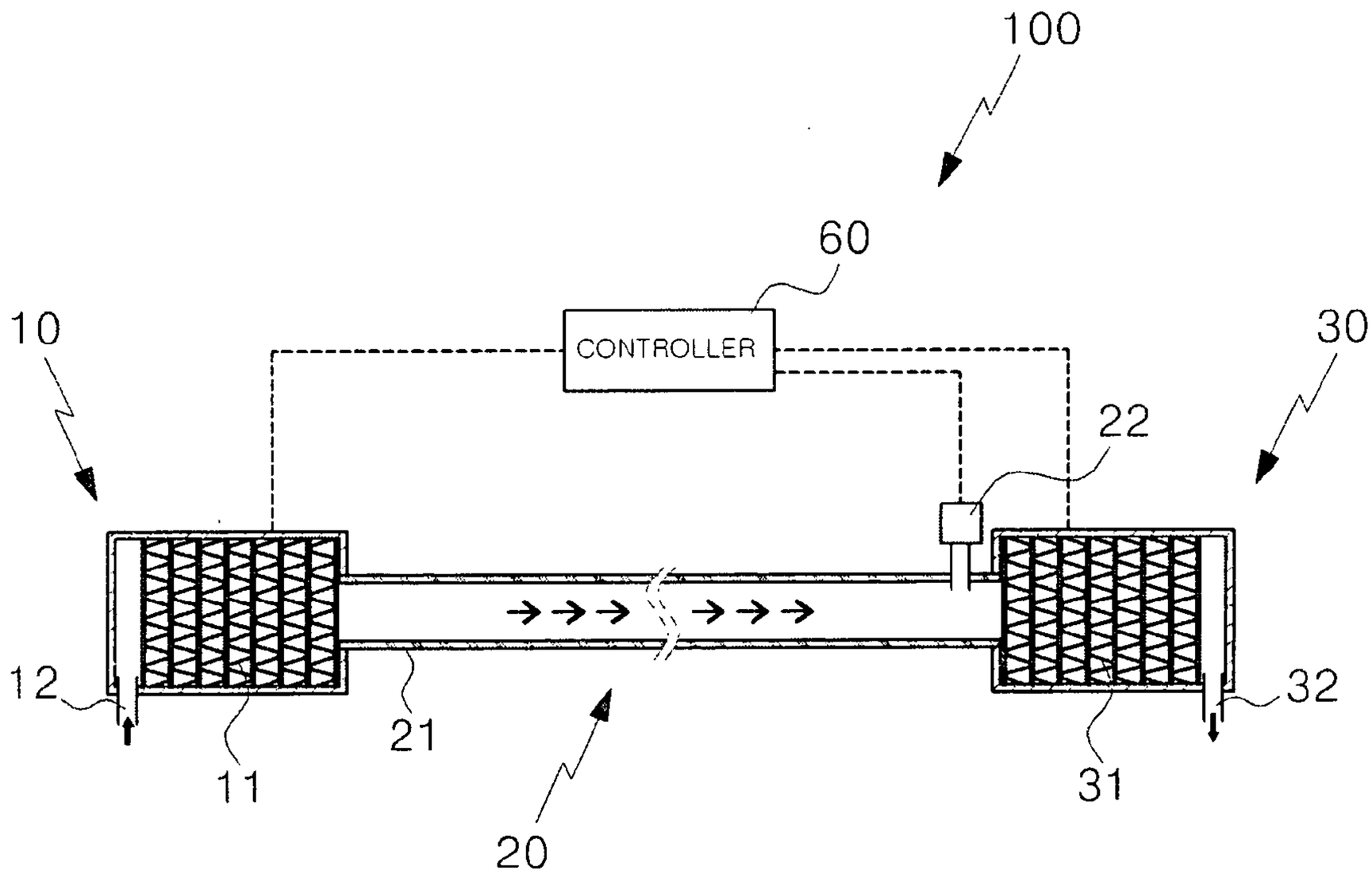


Fig. 2

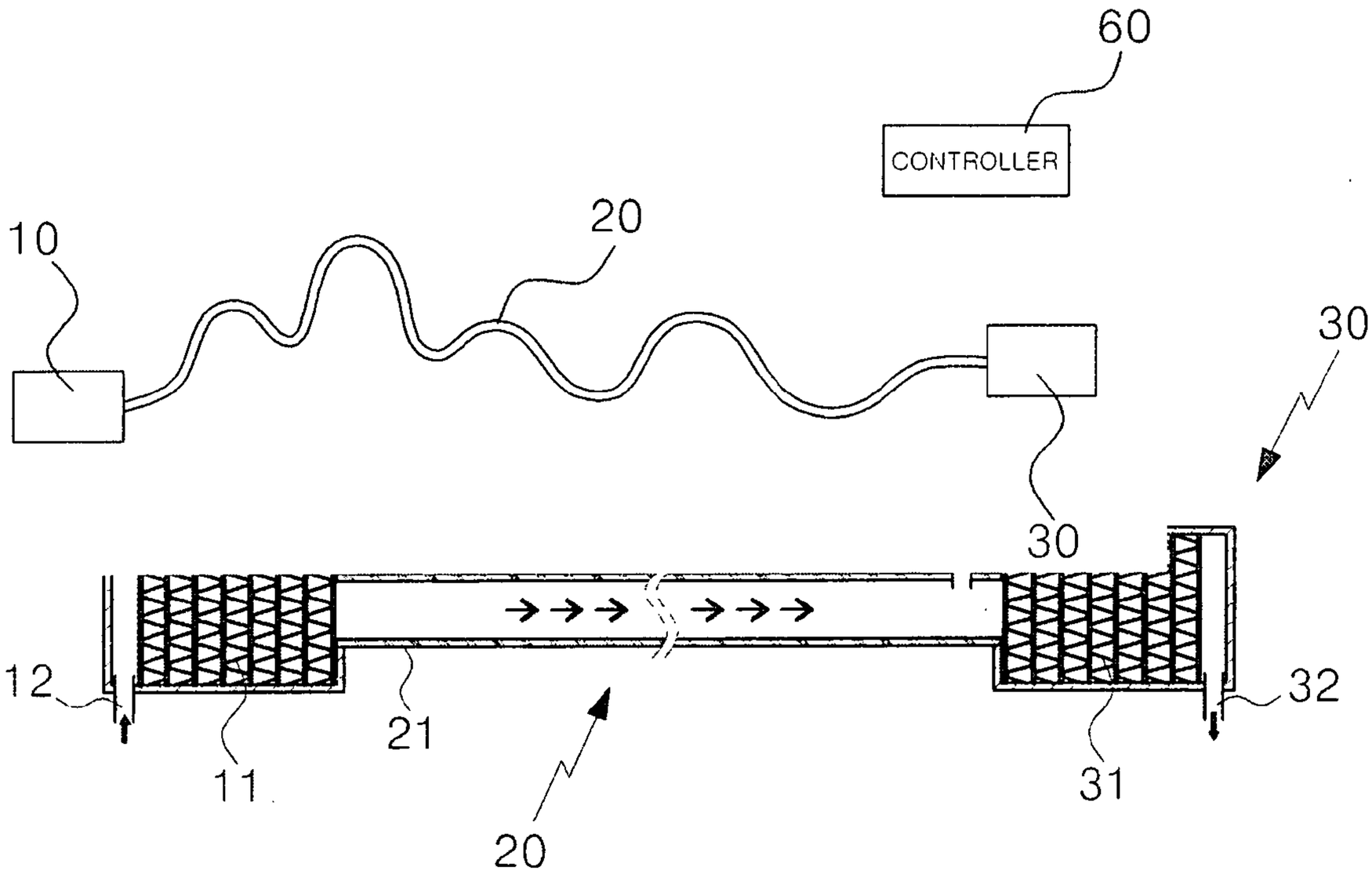
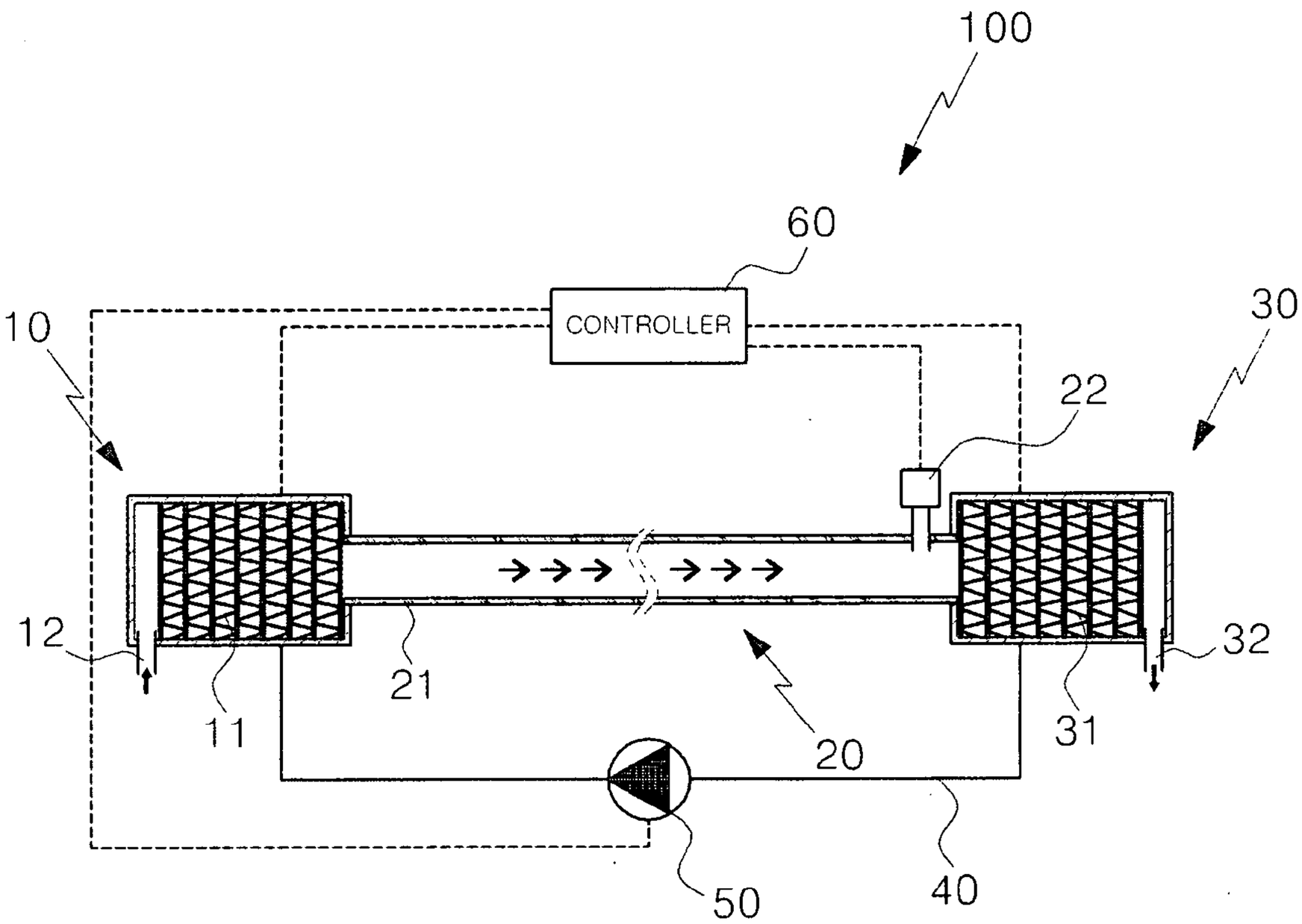


Fig. 3



HEAT PIPE FOR LONG DISTANCE

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of Korean Patent Application No. 2007-0029658, filed Mar. 27, 2007, the disclosure of which is hereby incorporated herein by reference in its entirety.

BACKGROUND OF THE INVENTION

[0002] 1. Technical Field

[0003] The present invention relates to a heat pipe for long distance and, particularly, to a heat pipe constituted by an evaporating unit for evaporating working fluid to form vapor, a condensing unit spaced at a long distance from the evaporating unit and discharging heat from a transferred vapor to the outside, and a vapor transferring unit connecting the evaporating unit and the condensing unit to transfer the vapor, wherein a condensation liquid recovery path or a condensation liquid recovery pipe is formed in the condensing unit in order to recover condensation liquid generated by condensing the vapor upon dissipating heat to outside and thus cooling vapor. Whereat, in order to improve upon a disadvantage of a conventional heat pipe totally constituted in a closed form to be limited to a short distance application, a recovery pipe or a recovery path formed for carrying the condensate back to the evaporating unit in the prior art is removed, making it possible to perform long-distance heat transmittal irrespectively of a ground landscape feature on which the vapor transferring unit may lie, whilst reducing the material cost.

[0004] 2. Discussion of Related Art

[0005] In general, added heat performs a role of raising temperature of an object, a liquid in the present case in particular, and further heat addition causes a phase variation in the liquid. When the phase change is to occur in the liquid, the latent heat of the liquid at the state must be additionally needed and vice versa. In general and as a rule, the latent heat required in the liquid during the phase change from liquid to vapor is far greater than the regular temperature raising, in case of water some 1,550 times, compared to the heat amount needed to raise one (1) degree centigrade, at 100 degrees centigrade liquid water to 100 degrees vapor steam at one (1) atmospheric pressure.

[0006] Heat transmittal may take a form by means of a direct material contact, a chemical variation process, an electromagnetic conversion and the above mentioned liquid-vapor phase change with vapor transport. A heat pipe is an efficient means of transmitting the heat, and is also referred to as an electric heat pipe. The heat pipe was first made in General Motors Corporation, in 1942 for heat-discharge, but has been put to practical use since 1963, primarily for spacecraft. The heat pipe widely used today employs a pipe whose inside is evacuated to promote the evaporation of liquid at lower temperature, wherein the inside having a plurality of small holes perforated therethrough is filled with a liquid to be evaporated. When applying the heat to one end of the pipe, the liquid temperature there is raised and further addition of heat to this end the liquid is evaporated to have heat energy and at the same time, the vapor moves to the other end at a speed of air pressure transmission provided the condensation at the other end removes the vapor fast enough to condensation. The heat is discharged at the heat removal and condensing unit in the other end of the pipe, and the evaporated vapor is again condensed to the liquid so that it returns to original position along a separate pipe or a condensation liquid recovery path by means of capillary effect, gravity effect and the like. Whence the vapor inside the heat pipe is transferred at a high speed thus high speed heat transmittal, but the recovery condensate return is necessarily slow and thus the limit to the total system, even with efficient vaporizing units and condensing units.

[0007] Although the heat pipe is a single pipe in appearance, it is a duplex circuit having a vapor path and a condensation liquid recovery path within the pipe. A heat pipe having a single connecting tube or a single function indicates a pipe having an ordinary cross section, as compared to the duplex circuit, and a pipe not having a porous fiber, etc. for a condensation liquid recovery path. In the case of the heat pipe having the single connecting tube, although partial condensation liquid is formed, the condensation liquid path is not formed, except that the partial condensation liquid is collected from a high place to a low place by means of gravity action.

[0008] Ordinarily copper, stainless steal, ceramic, tungsten, etc. are used as material of a body of the heat pipe, and the porous fiber, wicks, etc. is used as material of the inner wall thereof in order to raise movement efficiency in a recovery path for condensation recovery liquid by the help of the osmotic pressure.

[0009] Herein, the heat pipe, which is a super heat conductor, is a heat conductor transmitting the heat to both ends thereof using phase variation caused by evaporation and condensation generated in working fluid injected into a closed container in a vacuum state to ease evaporation at the time of heat-absorption and heat-discharge of the working fluid.

SUMMARY OF THE INVENTION

[0010] Therefore, the present invention has been proposed in order to solve the above problem in the prior art. It is objective of the present invention to provide a heat pipe for long distance constituted by an evaporating unit for evaporating working fluid to form vapor, a condensing unit spaced at a long distance from the evaporating unit and discharging heat form a transferred vapor to the outside at the condensing unit, and a transferring unit formed as a connecting tube of a general form having a single function connecting the evaporating unit and the condensing unit to transfer only evaporated vapor, wherein a working fluid supplier is formed in the evaporating unit in order to supplement the evaporated working fluid from the outside and a condensation liquid discharging unit is formed in the condensing unit in order to discharge to the outside condensation liquid generated by condensed vapor after discharging heat. Accordingly, a recovery pipe formed for a condensation liquid carrying function of a connecting tube in the prior art is removed, making it possible to perform long-distance heat supply irrespectively of a ground landscape feature. Also, the pipe connecting tube of a general form having a single function is formed of a heat insulator in order to prevent heat loss, due to in particular because of the long-distance vapor transfer, whilst making it possible to reduce fabrication and material cost.

[0011] In order to accomplish the above object, there is provided a heat pipe for long distance according to the present invention, comprising:

[0012] an evaporating unit absorbing heat from the outside to evaporate working fluid contained therein and be provided with continuous working fluid supplying unit(s);

[0013] a transferring unit transferring vapor generated from the evaporating unit insulated so as to prevent heat loss during the transfer; and

[0014] a condensing unit discharging the heat of the vapor to the outside transferred through the transferring unit and be provided with continuous working liquid discharging unit(s);

[0015] Also, the evaporating unit is formed with an efficient heat-absorption heat exchanger in order to increase efficiency of heat exchange, the condensing unit is formed with a heat-discharge heat exchanger in order to increase efficiency of heat exchange, and the transferring unit is formed with a single connecting tube connecting the evaporating unit and the condensing unit for transfer of the vapor.

[0016] The present invention having such a feature will be described in detail with reference to exemplary embodiments thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] The above and other features and advantages of the present invention will become more apparent to those of ordinary skill in the art by describing in detail preferred embodiments thereof with reference to the attached drawings in which:

[0018] FIG. **1** is a cross-sectional view showing a heat pipe according to one embodiment of the present invention;

[0019] FIG. **2** is a schematic view showing the heat pipe according to one embodiment of the present invention; and

[0020] FIG. **3** is a cross-sectional view showing a heat pipe according to another embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0021] The present invention will now be described more fully hereinafter with reference to the accompanying drawings, in which preferred embodiments of the invention are shown. This invention may, however, be embodied in different forms and should not be construed as limited to the embodiments set forth herein. Rather, these embodiments are provided as teaching examples of the invention. Like numbers refer to like element.

[0022] FIG. **1** is a cross-sectional view showing a heat pipe according to one embodiment of the present invention, and FIG. **2** is a schematic view showing the heat pipe according to one embodiment of the present invention.

[0023] As shown in FIGS. **1** and **2**, the heat pipe for long distance according to the present invention is constituted by an evaporating unit **10**, a transferring unit **20**, a condensing unit **30**, and a controller **60**.

[0024] The heat pipe **100** is made of a metal material superior in heat-absorption, heat-discharge, and heat-transmission in order to absorb heat in one side thereof having heat source and rapidly transmit and discharge the heat to the other side thereof. By lowering inner pressure of the pipe, evaporation of used liquid absorbing the heat is facilitated and pressure transmitting speed of vapor increases through heat-transfer. Herein, the used liquid is water, methane, alcohol, etc, wherein the water is generally best easy to use and relatively good in efficiency.

[0025] At this time, heat exchangers formed of a metal material are used on a heat-absorption unit and a heat-discharge unit (i.e. the evaporating unit **10** and the condensing unit **30**), which are both ends of the heat pipe **100**. The transmitting unit (i.e. transferring unit **20**) is formed of a heat insulator made of a non-metal material to be long in order to transmit the heat over a long distance.

[0026] Herein, the evaporating unit **10** is formed with a heat-absorption heat exchanger **11** made of the metal material in order to increase efficiency of heat exchange, and the condensing unit **30** is formed with a heat-discharge heat exchanger **31** made of the metal material in order to increase efficiency of heat exchange, like the evaporating unit **10**.

[0027] The inside of the heat exchangers **11** and **31** of the evaporating unit **10** and the condensing unit **30** may be inserted with a wick in order to increase the efficiency of the heat exchange in evaporation and condensation. At this time, the wick, which is a structure form or a substance formed in the inside of the heat exchangers **11** and **31** of the evaporating unit **10** and the condensing unit **30** in order to increase the evaporation and condensation efficiencies of the used liquid, has a large effect on characteristics of the heat pipe **100** together with an injected fluid.

[0028] Also, the evaporating unit **10** is installed with an evaporation working fluid supplier **12** in order to be able to supply evaporation liquid of amount reduced by means of the evaporation to be continuously required in the heat exchanger **11**, and the condensing unit **30** is installed with a condensation working fluid discharging unit **32** in order to prevent overflow caused by allowing the condensation liquid continuously generated in the heat exchanger **31** not to be recovered through a recovery pipe.

[0029] And, the transferring unit **20** is formed with a connecting tube **21** having a single function connecting the evaporating unit **10** and the condensing unit **30** to transfer vapor, wherein the connecting tube **21** is made of a general material such as polyvinyl chloride (PVC), which is a non-metal material or can be a general pipe having a structure of a simple form with a heat insulator, in order to transfer the vapor over the long distance and reduce material cost.

[0030] At this time, kinds of the wick include grooves, a screen, felt, sintered powder, etc. wherein a wick structure is to be less influenced by gravity and is to be able to convert more amount of the heat, as compared to other structures.

[0031] In addition, one end of the connecting tube **21** is installed with a decompression vacuum device **22** to maintain the inside of the connecting tube in a decompression vacuum state in order to maintain the transferred vapor and to counter the loss in effect due to heat loss.

[0032] As such, the connecting tube **21** is formed as a single pipe and a plurality of connecting tubes **21** formed as the single pipe are provided so that the vapor for transmitting the heat is branched in one evaporating unit **10** to be supplied to a plurality of heat-source requiring places, or one single connecting tube **21** is attached to each of a plurality of evaporating units **10** so that the vapor for transmitting the heat are combined in one place to transmit a large amount of the vapor to one heat-source requiring place.

[0033] At this time, the ends of the plurality of single connecting tubes **21** are formed with the condensing units **30**, respectively, so that the vapor for transmitting the heat can be supplied to the heat-source requiring place, thereby allowing the heat pipe to be used in a plurality of long-distance positions.

[0034] The evaporating unit **10** is formed with the evaporation working fluid supplier **12** in order to supplement the evaporation working fluid evaporated through the heat-absorption heat exchanger **11** from the outside, and the condensing unit **30** is formed with the condensation working fluid

discharging unit **32** in order to discharge the condensation working fluid formed by the heat discharged to the outside through the heat-discharge heat exchanger **31** to the outside.

[0035] The condensation working fluid discharging unit **32** of the connecting tube **21** is installed on the connecting tube **21** of the condensing unit **30** side. Also, as shown in FIG. **2**, since the connecting tube **21** of the transferring unit **20** is formed to be long over the long distance, a plurality of condensation working fluid discharging units **32** is installed to be spaced at intervals in order to prevent the connecting tube **21** from being blocked due to formation of the condensation liquid in a low position.

[0036] FIG. **3** is a cross-sectional view showing a heat pipe according to another embodiment of the present invention.

[0037] The structure, constitutions, and reference numbers of the heat pipe described below will be the same as those of the above-mentioned heat pipe **100**.

[0038] As shown in FIG. **3**, a recovery pipe **40** is installed between the evaporating unit **10** and the condensing unit **30** in order to be able to recover condensation liquid generated from the condensing unit **30** to the evaporating unit **10**, and a pump **50** is attached to one end of the recovery pipe **40** in order to be able to transfer the condensation liquid through the recovery pipe **40**.

[0039] As another example, as shown in FIG. **1**, in order to save material cost, it is possible to omit the recovery pipe **40** and the pump **50** required for recovering the condensation liquid, supply liquid through the evaporation working fluid supplier **12** in the evaporating unit **10** and remove the condensation liquid through the condensation working fluid discharging unit **32** in the condensing unit **30**.

[0040] The above-mentioned heat pipe **100** is formed with the evaporation working fluid supplier in the evaporating unit, the condensation working fluid discharging unit in the condensing unit, and a controller **60** sensing temperature, pressure, vapor amount, condensation liquid amount, etc. corresponding to heat loss of the transferring unit to be able to electrically and automatically control them, wherein the controller **60** can control the evaporating unit **10**, the transferring unit **20**, the condensing unit **30**, the decompression vacuum device **22**, and the pump **50**.

[0041] As described above, the heat pipe for long distance according to the present invention is constituted by an evaporating unit for evaporating working fluid to form vapor, a condensing unit spaced at a long distance from the evaporating unit and discharging heat from transferred vapor to the outside, and a transferring unit formed as a connecting pipe of a general form having a single function connecting the evaporating unit and the condensing unit to transfer only the evaporated fluid vapor, wherein a working fluid supplier is formed in the evaporating unit in order to supplement the evaporated working fluid from the outside and a condensation liquid discharging unit is formed in the condensing unit in order to discharge condensation liquid generated by condensing the vapor to the outside. Accordingly, a recovery pipe formed for a condensation liquid carrying function of a connecting tube in the prior art is removed, making it possible to perform a long distance heat supply irrespectively of a ground landscape feature. Also, the pipe connecting tube of a general form having a single function is formed suitably with a heat insulator in order to prevent heat loss due to the long distance transfer, whilst also making it possible to reduce fabrication and material cost.

[0042] The invention has been described using preferred exemplary embodiments. However, it is to be understood that the scope of the invention is not limited to the disclosed embodiments. On the contrary, the scope of the invention is intended to include various modifications and alternative arrangements within the capabilities of persons skilled in the art using presently known or future technologies and equivalents. The scope of the claims, therefore, should be accorded the broadest interpretation so as to encompass all such modifications and similar arrangements.

What is claimed is:

1. A heat pipe (**100**) for long distance comprising:

an evaporating unit (**10**) absorbing heat from the outside to evaporate working fluid contained therein, and having a heat-absorption heat exchanger (**11**) formed for heat exchange;

a transferring unit (**20**) transferring vapor generated from the evaporating unit (**10**); and

a condensing unit discharging the heat of the vapor transferred through the transferring unit (**20**) to the outside, and having a heat-discharge heat exchanger (**31**) formed for heat exchange,

wherein the transferring unit (**20**) is formed as a connecting tube (**21**) having a single function connecting the evaporating unit (**10**) and the condensing unit (**30**) to transfer the vapor in order to allow the vapor to be transferred in only one direction and allow condensation liquid generated from the condensing unit not to be recovered, the evaporating unit (**10**) is formed with an evaporation working fluid supplier (**12**) in order to supplement an evaporation working fluid evaporated through the heat-absorption heat exchanger (**11**) from the outside, and the condensing unit (**30**) is formed with a condensation working fluid discharging unit (**32**) in order to discharge condensation working liquid formed by the heat discharged to the outside through the heat-discharge heat exchanger (**31**) to the outside.

2. The heat pipe (**100**) for long distance of claim **1**, wherein one end of the connecting tube (**21**) is installed with a decompression vacuum device (**22**) to maintain the inside of the connecting tube in a decompression vacuum state in order to maintain the transferred vapor from condensing.

3. The heat pipe (**100**) for long distance of claim **1**, wherein a recovery pipe (**40**) and a pump (**50**) are further installed between the evaporating unit (**10**) and the condensing unit (**30**) in order to be able to support recovering the condensation liquid generated from the condensing unit (**30**) to the evaporating unit (**10**).

4. The heat pipe (**100**) for long distance of claim **1**, wherein the heat pipe (**100**) is installed with a controller (**60**) electrically and automatically controlling so as to attain the best working condition of the heat pipe (**100**).

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