The present invention provides a heat exchange structure of a loop type heat pipe, which has a closed loop formed by connecting an evaporation portion, a vapor passageway, a condensation portion, and a fluid return passageway in series in this order. Appropriate amount of liquid is filled in the loop. The flow resistance of the vapor passageway is smaller than that of the fluid return passageway. When the evaporation portion is heated and the condensation portion radiates heat, all the fluids in the loop will stably flow toward the same direction, and pass through any position of the loop. Therefore, non-condensing gas existing in the loop will have little influence to the loop and flow along the loop, thereby letting the loop have good uniformity of temperature and large amount of heat transfer rate.
HEAT EXCHANGE STRUCTURE OF LOOP TYPE HEAT PIPE

FIELD OF THE INVENTION

[0001] The present invention relates to a heat exchange structure of a loop type heat pipe and, more particularly, to a heat exchange structure of large heat transfer rate and better uniformity of temperature, whereby non-condensing gas existing in the heat pipe has little influence to the characteristic of the loop system.

BACKGROUND OF THE INVENTION

[0002] Because the thermal performance of conventional heat pipes is very good, they have been widely applied to heat radiating parts of electronic devices. Usually, a heat pipe type heat radiating apparatus has a heat pipe 1. A heat spreader 11 is disposed at an electronic device end that needs to be cooled. The heat spreader 11 is connected with one end of the heat pipe 1. The other end of the heat pipe 1 can be connected to a heat radiator via another heat spreader, or the other end of the heat pipe 1 can directly clip a plurality of heat radiating fins 12. FIG. 1 shows a radiating fin type heat pipe.

[0003] For the manufacture of heat pipe, a pretty high part of cost is spent in the procedure of cleaning and degassing the pipeline. The higher class of cleanliness and degassing, the better effect of thermal performance, and the stability of thermal performance can be better ensured. However, there still exists a trace of non-condensing gas in the pipeline, and it is very difficult to degas completely. Because the non-condensing gas in the heat pipe will accumulate, and the difference of temperature between the accumulation region and the heated end is very large, the operational function of the heat pipe is affected. The non-condensing gas easily accumulates at the distal end of the condenser pipeline, greatly reducing its uniformity of temperature and thermal performance.

[0004] In the conventional heat pipe 1, the evaporation end of the heating region of the heat spreader 11 generates the vapor and provides vapor flow, which flows along the pipeline toward the condensation end of the cooling region at the other end, and then the vapor condenses into condensed liquid in the pipeline at the cooling region. A capillary tissue 13 is then used to quickly guide the condensed liquid to flow from the cooling region toward the heating region, thereby replenishing liquid for the evaporation end that reduced by evaporation to accomplish circulatory flow.

[0005] When one end of the heat pipe 1 is heated to evaporate liquid in the heat pipe 1, vapor will flow toward the condensation end and condense into liquid, which then flows back to the evaporation portion via the capillary tissue. Because the structure of vapor flow and liquid flow in the conventional heat pipe is disposed in the same pipeline, the flowing directions of vapor flow and liquid flow in the pipeline will be impacted to each other, reducing the amount of heat transfer rate. Moreover, non-condensing gas remaining in the pipeline will accumulate at the condensation end to form a region with large difference of temperature, reducing uniformity of temperature and greatly decreasing thermal performance. Therefore, the requirement of manufacturing conditions and maintenance for conventional heat pipes is stringent, hence greatly increasing the cost and not conforming to economy.

SUMMARY OF THE INVENTION

[0006] The primary object of the present invention is to provide a heat exchange structure of a loop type heat pipe, which forms a multiple-pipe type structure connecting an evaporation portion, a vapor passageway, a condensing portion, a fluid return passageway in series in this order. The vapor passageway can be a single pipeline or more than two pipelines connected in parallel. The fluid return passageway can also be a single pipeline or more than two pipelines connected in parallel. A series- and parallel-connected architecture of single loop is thus formed to apply to heat exchange of higher efficiency. The operational theory is using a guidance effect of flow resistance of pipeline to let the loop automatically generate circulative and stable unidirectional flow. The phenomenon of dry-out of the loop type heat pipe will hardly occur so that very good thermal performance can be achieved to acquire quite large amount of heat transfer rate.

[0007] Another object of the present invention is to provide a heat exchange structure of a loop type heat pipe, whereby the manufacture of a heat pipe can be performed at a low cost in consideration of economy, the effect of thermal performance of the heat pipe can be maintained, and quicker heat transfer can be achieved simultaneously. Asymmetric phenomenon of heat flow in the loop to cause a guidance in the loop structure are exploited to let the heat exchange loop form a circulative pipeline so that non-condensing gas existing in the pipeline cannot stay and accumulate at the condensation portion of the pipeline. The non-condensing gas will continually circulate along the pipeline to greatly enhance the uniformity of temperature and reduce the difference of temperature of the heat pipe. Therefore, even though the non-condensing gas in the heat pipe appears after manufacture, the function and characteristic of the heat pipe will be hardly affected. Moreover, the lifetime of use of the heat pipe can be extended.

[0008] To achieve the above objects, the structure of the present invention has a closed loop, which is formed by connecting an evaporation portion, a vapor passageway, a condensation portion, a fluid return passageway in series in this order. Appropriate amount of liquid is filled in the loop. The fluid return passageway and the vapor passageway are not at the same pipeline. The flow resistance in the fluid return passageway is larger than that in the vapor passageway so that vapor forming at the evaporation portion will naturally flow toward the condensation portion. Under the effect of pressure difference of asymmetry of heat flow intentionally formed in the loop to cause the guidance in the pipeline structure, the condensed liquid and the non-condensing gas along with the left vapor without condensing will flow stably and unidirectionally toward the fluid return passageway, flow back to the evaporation portion, and then flow into the vapor passageway, forming a circulative flow and obtaining a heat exchange device of good uniformity of temperature and quite large amount of heat transfer rate.

[0009] The various objects and advantages of the present invention will be more readily understood from the following detailed description when read in conjunction with the appended drawing, in which:
BRIEF DESCRIPTION OF THE DRAWINGS

[0010] FIG. 1 is a cross-sectional view of a prior art heat pipe;

[0011] FIG. 2 is a cross-sectional view of the present invention;

[0012] FIG. 2A is an enlarged view of the part a shown in FIG. 2; and

[0013] FIG. 3 is a side cross-sectional view of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0014] As shown in FIGS. 2 to 3, a heat exchange structure of a loop type heat pipe has a closed loop 2, which is formed by connecting an evaporation portion 21, a vapor passageway 22, an condensation portion 23, a fluid return passageway 24 in series in this order. Appropriate amount of liquid 20 is filled in the loop 2. The amount of liquid will fill a capillary tissue and up to 90% of the volume of the loop.

[0015] The fluid return passageway 24 and the vapor passageway 22 are not at the same pipeline. That is, the vapor passageway 22 is an independent pipeline, and the fluid return passageway 24 is also an independent pipeline. This is different from a conventional heat pipe, wherein the vapor passageway and the fluid return passageway are at the same pipeline.

[0016] In the present invention, the flow resistance in the fluid return passageway 24 is larger than that in the vapor passageway. This is intentional to build imbalance of heat flow in the pipeline to form an asymmetric structure in the pipeline, causing a pressure difference. Therefore, vapor forming at the evaporation portion 21 will stably and unidirectionally flow toward the condensation portion 23 and condense at the condensation portion 23 to form condensed liquid flow. Under the effect of pressure difference of the loop to cause the guidance of the pipeline structure, the condensed liquid and the non-condensing gas along with the left vapor without condensing will flow stably and unidirectionally toward the fluid return passageway 24, and then flow back to the evaporation portion 21 via the fluid return passageway 24.

[0017] The evaporation portion 21 in the present invention is the heated portion of the loop 2. In order to have a better thermal performance, in addition that the vapor passageway 22 and the fluid return passageway 24 are directly connected, a heat spreader 3 can be joined between them. The heat spreader 3 has a connected passageway 31 therein to connect the vapor passageway 22 and the fluid return passageway 24. The pipeline of the evaporation portion 21 can be thermally connected with a heat conductor (not shown), or the heat spreader 3 can be thermally connected with a heat source via a heat conductor. The heat source can be the hot surface of an electronic device, usually being a central processing unit, but is not limited to the electronic device. Therefore, the evaporation portion is thermally connected with a heat exchange device to be cooled. The heat exchange device to be cooled can be the heat spreader of a heat source, a fin sets, a water sleeve, or an evaporation portion of another loop, which means that a loop type heat pipe of the present invention is connected with another independent loop type heat pipe in series.

[0018] Additionally, the condensation portion 23 of the present invention is the heat-radiating position of the loop, i.e., the primary heat-radiating region. Of course, the loop itself is also a good heat-radiating structure. Similarly, like the evaporation portion, a connection block 4 is provided. The connection block 4 has a connected passageway 41 to connect the vapor passageway 22 and the fluid return passageway 24. It is also feasible that the pipeline of the condensation portion or a more bigger connection block 4 is connected with a set of integral heat radiators or heat-radiating sheets 25. In the appended drawings of the present invention, a set of heat-radiating sheets are embodied, and the connection block 4 can be a pipeline type. In other words, the condensation portion is thermally connected with a heat exchange device. The heat exchange device can be the heat spreader of a heat source, a set of heated fins, a cooling water sleeve, or an evaporation portion of another loop.

[0019] The vapor passageway 22 shown in FIG. 2 is a pair of pipelines. That is, the vapor passageway 22 be a single pipeline or more than two pipelines connected in parallel so that the total sum of the flow resistances of all the pipelines of the vapor passageway is smaller than the flow resistance of the fluid return passageway. The flow resistance is controlled by the cross-section, the length, and the shape of the pipeline. The vapor passageway has a small flow resistance at a high flow speed, while the fluid return passageway has a large flow resistance at a low flow speed, hence generating asymmetric heat flow intentionally formed in the loop to ensure a unidirectional flowing direction. Moreover, the fluid return passageway 24 in the figures is a single pipeline, but it also can be more than two pipelines connected in parallel. It is only necessary that the fluid return passageway 24 has a larger flow resistance than the vapor passageway, and the condensed fluid will only passes through the fluid return passageway to return to the evaporation portion, naturally forming guided flow of the loop. This kind of flow is stable and unidirectional, and is intentionally limited to flowing along the desired direction to ensure the thermal performance.

[0020] It is also feasible that liquid occupies completely the fluid return passageway to form liquid shuttling phenomenon, which can be accomplished by placing a capillary tissue to fill up the fluid return passageway, or shrinking the gas passing space of the fluid return passageway. Therefore, asymmetry of flow resistance can be enhanced to let circulation of fluid flow more stably toward the designed direction. However, because the fluid return passageway will affect passage of non-condensing gas in this case, uniformity of temperature will be inferior. Degassing procedure to the loop can be exploited to remove the non-condensing gas to enhance uniformity of temperature.

[0021] Because the pipeline of the loop 2 has been arranged in serial, and the flow follows unidirectional circulation, non-condensing gas existing in the loop will not stay, but can only flow with the vapor flow or the condensed liquid flow in the loop. Therefore, in the present invention, the vapor passageway has large part of vapor flow and small part of condensed liquid flow and non-condensing gas therein, and the fluid return passageway has large part of condensed liquid flow and small part of vapor flow and
non-condensing gas therein, hence forming quick and unidirectional circulation of flow. All the fluids in the heat pipe will flow toward the same direction and pass through any pipeline in the system. This is different from the conventional heat pipe. Good thermal performance, large amount of heat transfer rate, and small difference of temperature can thus be achieved.

[0022] The pipelines adopted in the present invention have the same outer diameters, but can have different inner diameters when being manufactured. In one method, a capillary tissue 26 is placed in the fluid return passageway to shrink the inner diameter, hence increasing the flow resistance. The capillary tissue 26 is only of the length of the fluid return passageway where condensed liquid flow passes through, or extends to the evaporation portion alone, or extends to the condensation portion alone, or extends to the evaporation portion and the condensation portion simultaneously. A capillary tissue can also be further disposed in the vapor passageway to let the distribution of liquid be more uniform, but the flow resistance of the vapor passageway still must be smaller than that of the fluid return passageway. The capillary tissue can be ceramic, sintered powder, foaming metal, a knitted net, a sintered net, a grooved plate, a fiber bundle, or a spiral wire. The fluid return passageway must have space to let vapor and non-condensing gas pass through.

[0023] To sum up, the present invention utilizes an independent pipe mechanism and forms an arrangement of unequal flow resistance between the vapor passageway and the fluid return passageway. The generated pressure difference, imbalanced heat flow, and capillary phenomenon are matched to form a serial, orderly, and unidirectional circulation structure of fluid. The vapor passageway and the fluid return passageway can also form pipeline structures connected in parallel, respectively. It is only necessary that the flow resistance in the fluid return passageway 24 is larger than that in the vapor passageway 22. Matched with the disposition of the heat spreader and the connection block, a connected annular loop can be obtained. Therefore, during the manufacture of pipelines of the present invention, heat can be conducted even without the degassing procedure. Better thermal performance and wider range of operational temperature can be achieved with the degassing procedure. As compared to a prior art heat pipe in practical use, the present invention has better uniformity of temperature, better thermal performance, and larger amount of heat transfer rate and quicker heat transfer. Because the degassing process is not required and the cleaning process is not important, the present invention has a simple manufacturing process to lower the cost and conform to economy.

[0024] Although the present invention has been described with reference to the preferred embodiment thereof, it will be understood that the invention is not limited to the details thereof. Various substitutions and modifications have been suggested in the foregoing description, and other will occur to those of ordinary skill in the art. Therefore, all such substitutions and modifications are intended to be embraced within the scope of the invention as defined in the appended claims.

I claim:
1. A heat exchange structure of a loop type heat pipe having a closed loop, said loop being formed by connecting an evaporation portion, a vapor passageway, a condensation portion, and a fluid return passageway in series in this order, liquid being filled in said loop, said fluid return passageway and said vapor passageway being independent passageways, the flow resistance in said fluid return passageway being larger than that in said vapor passageway; whereby when fluid is heated in said evaporation portion to form vapor flow, which flows to said condensation portion to condense into liquid, the condensed liquid, left vapor without condensing, and non-condensing gas in said loop will flow unidirectionally toward said fluid return passageway, return to said evaporation portion, and then flow into said vapor passageway under asymmetric guidance of heat flow in said loop, hence forming circulative flow in said loop.
2. The heat exchange structure of a loop type heat pipe as claimed in claim 1, wherein said evaporation portion is a pipeline and/or said condensation portion is a pipeline.
3. The heat exchange structure of a loop type heat pipe as claimed in claim 1, wherein said evaporation portion is formed of a heat spreader, said heat spreader being connected to said vapor passageway and said fluid return passageway, said heat spreader having a connected passageway connected with said vapor passageway and said fluid return passageway.
4. The heat exchange structure of a loop type heat pipe as claimed in claim 1, wherein said evaporation portion is thermally connected with a heat exchange device to be cooled, said heat exchange device to be cooled being a heat spreader of a heat source, a set of fins, a water sleeve, or an condensation portion of another loop.
5. The heat exchange structure of a loop type heat pipe as claimed in claim 1, wherein said vapor passageway is composed of more than two pipelines connected in parallel.
6. The heat exchange structure of a loop type heat pipe as claimed in claim 1, wherein said condensation portion is formed of a connection block, said connection block being connected to said vapor passageway and said fluid return passageway, said connection block having a connected passageway connected with said vapor passageway and said fluid return passageway.
7. The heat exchange structure of a loop type heat pipe as claimed in claim 1, wherein said condensation portion is connected with a heat exchange device, said heat exchange device being a set of heat-radiating fins, a heat radiator, a cooling water sleeve, or an evaporation portion of another loop.
8. The heat exchange structure of a loop type heat pipe as claimed in claim 1, wherein liquid-shutting phenomenon is formed in said fluid return passageway with liquid.
9. The heat exchange structure of a loop type heat pipe as claimed in claim 1, wherein said fluid return passageway is composed of more than two pipelines connected in parallel.
10. The heat exchange structure of a loop type heat pipe as claimed in claim 1, wherein the requirement that the flow resistance of said fluid return passageway be larger than that of said vapor passageway is accomplished by reducing the cross-sectional area of said fluid return passageway or lengthening the length thereof or both.
11. The heat exchange structure of a loop type heat pipe as claimed in claim 1, wherein a capillary tissue is disposed in said fluid return passageway to obtain a larger flow resistance and to simultaneously guide the condensed liquid by capillarity to return to said evaporation portion.
12. The heat exchange structure of a loop type heat pipe as claimed in claim 11, wherein the amount of fluid can fill the whole said capillary tissue and up to 90% of the volume of said loop.

13. The heat exchange structure of a loop type heat pipe as claimed in claim 11, wherein said capillary tissue can further extend to said evaporation portion and/or said condensation portion, and said capillary tissue is ceramic, sintered powder, foaming metal, a knitted net, a sintered net, a grooved plate, a fiber bundle, or a spiral wire.

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