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(71) Applicant (for all designated States except US): **ARCELIK ANONIM SIRKETI** [TR/TR]; E5 Ankara Asfalti Uzeri, Tuzla, 34950 Istanbul (TR).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **SUZEK, Fatih** [TR/TR]; Iban Sokak Akal Sitesi, D Blok Daire 13, Istanbul (TR). **KERPICCI, Husnu** [TR/TR]; Arcelik Anonim Sirketi, E5 Ankara Asfalti Uzeri, Tuzla, 34950 Istanbul (TR). **ESKIN, Nurdil** [TR/TR]; ITU Makine Fakultesi, Inonu Caddesi, Gumussuyu Takim, Istanbul (TR).

(74) Agent: **ANKARA PATENT BUREAU**; Bestekar Sokak No.10, Kavaklidere, 06680 Ankara (TR).

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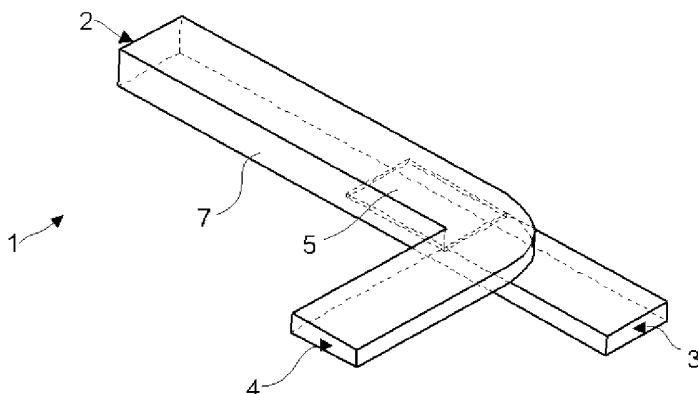
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(54) Title: A COOLING DEVICE AND A PHASE SEPARATOR UTILIZED THEREIN



(57) Abstract: This invention relates to a cooling device (8) and a phase separator utilized therein. The phase separator (1) comprises a movable flap (5).

Description

A COOLING DEVICE AND A PHASE SEPARATOR UTILIZED THEREIN

[001] This invention relates to a phase separator whereby a two-phase flow is separated to a liquid and a gas phase, and a cooling device wherein said phase separator is utilized.

[002] In state-of-the-art cooling devices, the refrigerant circulating inside pipes presents a two-phase flow pattern at some portions. Liquid and gas phases flow either together in such a way that the liquid refrigerant is dispersed in the form of droplets inside the gas fluid or as stratified from each other, where the liquid phase flows below the gas phase. However, the facts that the liquid phase refrigerant enters the compressor and the gas phase refrigerant enters the evaporator are the factors negatively affecting the efficiency of the cooling device. For this purpose, there are phase separators developed in order to separate the liquid and gas phases of the fluids.

[003] In the European Patent Document no. EP 1202003, a phase separator is disclosed wherein the fluid is poured into a chamber having two outlets, one at the upper and one at the lower part. Two phases are separated while the liquid phase leaves the chamber from the lower portion whereas the gas phase leaves from the upper portion. By locating the liquid outlet at some higher position with respect to the floor of the chamber, it is aimed to collect the residues inside the refrigerant at the floor of the chamber. The cross sectional area of the liquid outlet is constant.

[004] In the European Patent Document no. EP 0133549, a description is given of a phase separator incorporating two pipes, one inside the other, having a certain cross sectional area, by means of which the gas phase flowing in the middle is separated in ring type flows.

[005] In the United States Patent Document no. US 6341647, an inclined phase separator is disclosed wherein liquid and gas phases of a two-phase fluid are separated by means of the effect of the gravity. Phase separator has an inlet for the entry of two-phase flow at the upper part and an outlet having a certain cross sectional area providing for the liquid phase to leave at the lower part. Inside the afore-mentioned phase separator, a stationary plate which extends from the inlet to the outlet is positioned preventing the liquid phase from returning to the inlet.

[006] In the International Patent Application no. WO 9206339, a description is given of a phase separator which is horizontally divided into two compartments.

[007] In the French Patent Document no. FR 2644357, a phase separator comprising two compartments next to each other is illustrated. Said compartments are connected to each other via two passages having constant positions and cross sectional areas, one

being located at the upper part, the other at the lower part. The liquid phase of the two-phase fluid entering the first compartment passes to the second compartment through the lower passage while the gas phase passes through the upper passage. Here, liquid phase leaves the phase separator by passing through the lower outlet as the gas phase leaves by passing through the upper outlet.

[008] In the current state of the art, since the cross sectional areas of the liquid phase outlets are constant, if the amount of the liquid is not enough to completely close the mentioned outlet, some portion of this outlet is left open and the gas phase may pass through.

[009] The aim of the present invention is the realization of a phase separator which is able to separate the liquid and gas phases more effectively and a cooling device utilizing the mentioned phase separator.

[010] The phase separator and the cooling device designed to fulfill the objectives of the present invention are illustrated in the annexed drawings where:

[011] Figure 1 – is a perspective view of a phase separator.

[012] Figure 2 – is a perspective view of another embodiment of a phase separator.

[013] Figure 3 – is A-A sectional view of a phase separator.

[014] Figure 4 – is B-B sectional view of a phase separator.

[015] Figure 5 – is a schematic representation of another embodiment of a phase separator.

[016] Figure 6 – is a perspective view of another embodiment of a phase separator.

[017] Figure 7 – is a schematic representation of a cooling device.

[018] Elements shown in figures are numbered as follows:

1. Phase separator
2. Inlet
3. Liquid phase fluid outlet
4. Gas phase fluid outlet
5. Flap
6. Hole
7. Body
8. Cooling device
9. Evaporator
10. Compressor
11. Capillary pipe
12. Condenser
13. Hinge
14. Stopper

[019] In cooling devices, a refrigerant fluid is utilized for the refrigeration cycle. Said re-

frigerant fluid displays a two-phase flow pattern at some portion of the cycle. A phase separator (1) is employed in order to separate the liquid and gas phases of the two-phase fluid.

[020] The phase separator (1) subject to the present invention comprises,

- a body (7),
- an inlet (2) where the two-phase fluid (T) enters, positioned at one side of the body (7),
- a liquid phase fluid outlet (3) where the liquid phase fluid (L) goes out, positioned at the other side of the body (7),
- a gas phase fluid outlet (4) where the gas phase fluid (G) goes out and,
- a flap (5) which
 - has a density such that it can swim on the liquid phase fluid (L),
 - is attached from one edge to a position just before the liquid phase fluid outlet (3),
 - has a free edge able to move upwards and downwards depending on the liquid level,
 - thereby is used to divert the gas phase fluid (G) towards the gas phase fluid outlet (4) and permits only the liquid phase fluid (L) to pass through the liquid phase fluid outlet (3) (Fig. 1).

[021] The flap (5) is mounted at the area where the liquid phase fluid outlet (3) and the gas phase fluid outlet (4) are separated, such that its free edge is closer to the inlet (2). The flap (5) is manufactured from a material having a specific weight so as to float inside the liquid (L). Since having a certain degree of flexibility facilitates the functioning of the material, especially polymers and such which do not react with the refrigerant gas are preferred. Thereby, the free edge of the flap (5) is able to move upwards and downwards, depending on the height of the liquid (L) that reaches the liquid phase fluid outlet (3) (Fig. 3). The flap (5) incorporates a geometry suitable for the structure of the liquid phase fluid outlet (3). The flap (5) may be sized so as to completely or partially close the liquid phase fluid outlet (3).

[022] The flap (5) divides the cross sectional area of the body (7) into two regions as the liquid phase fluid outlet (3) and the gas phase fluid outlet (4). Thanks to the movable free edge of the flap (5), the ratio (A_L/A_G) of the area (A_L) of the liquid phase fluid outlet (3) to the area (A_G) of the gas phase fluid outlet (4) changes in relation to the amount of the liquid coming (Fig. 4).

[023] In another embodiment of the present invention, to transform the non-stratified two-phase fluid (T) into a stratified fluid and/or to decrease the level of waviness, the cross section of the body (7) enlarges after the inlet (2) and continues with the same width as far as the outlets (3 and 4) (Fig. 2 and Fig. 3). The flap (5) is attached to the portion

where the cross section of the body (7) enlarges and the liquid phase fluid outlet (3) and the gas phase fluid outlet (4) are separated. At that section, as a result of the decrease in the velocity, liquid phase fluid (L) separates from the gas phase fluid (G) and is collected at the bottom portion of the body (7).

[024] If the two-phase fluid (T) entering the phase separator (1) of the present invention displays stratified flow patterns, gas phase fluid (G) flows on top since it is lighter and the liquid phase fluid (L) flows under since it is heavier. When the liquid phase fluid (L) reaches the liquid phase fluid outlet (3), the free edge of the flap (5) having a proper specific weight elevates by floating in the liquid phase fluid (L). Thereby, the flap (5) is able to change the cross sectional area (A_L) of the liquid phase fluid outlet (3) in relation to the amount of the liquid phase fluid (L) coming. The gas phase fluid (G) hits the flap (5) covering the upper portion of the liquid phase fluid outlet (3), and can not pass through the liquid phase fluid outlet (3) since it can not create enough moment to move the flap (5), and leaves the body (7) since it is diverted by the upper surface of the flap (5) towards the gas phase fluid outlet (4). When more amount of liquid phase fluid (L) enters the phase separator (1), the free edge of the flap (5) moves upwards in relation to the liquid level and permits that only liquid phase fluid (L) may pass through the liquid phase fluid outlet (3). By means of the phase separator (1) subject to the present invention, it is achieved to separate the liquid and gas phases in a more effective manner.

[025] In another embodiment of the present invention, because it is not desired that liquid droplets left on the flap (5) reach the gas phase fluid outlet (4), the flap (5) incorporates at least one hole (6) so as the mentioned droplets pass through the liquid phase fluid outlet (3) (Fig. 6). Furthermore, these holes (6) also enable the passing of the liquid phase fluid (L) when the flap (5) blocks the liquid phase fluid outlet (3) for some reason.

[026] In another embodiment of the present invention, the phase separator (1) incorporates a flap (5) the free edge of which is curved upwards (Fig. 5). By means of the mentioned embodiment, it is accomplished that the free side of the flap (5) floats on the surface of the liquid phase fluid (L) more effectively.

[027] In another embodiment of the present invention, in order for the flap (5) to move better, the phase separator (1) incorporates a hinge (13) which is used to attach the flap (5) to the body (7) so that it is able to rotate around its stationary edge (Fig. 5).

[028] In still another embodiment of the present invention, in order to prevent the flap (5) from completely closing the liquid phase fluid outlet (3) and/or the gas phase fluid outlet (4), the phase separator (1) incorporates at least one stopper (14) limiting the upwards and downwards motion of the hinge (13) between some certain angles.

[029] Cooling devices (8) comprise a compressor (10) whereby the refrigerant fluid is

compressed, a condenser (12) whereby the refrigerant fluid that leaves the compressor (10) as hot vapor is condensed to transform into a liquid-gas phase, one or more capillary tubes (11) positioned after the said condenser (12), whereby the refrigerant fluid expands to transform into liquid phase and, an evaporator (9) where the condensed fluid is transferred and whereby cooling is achieved by absorbing heat. The cooling device subject to the present invention additionally comprises a phase separator (1) as described above, positioned between the capillary tube (11) and the evaporator (9). The inlet (2) of the mentioned phase separator (1) is connected to the capillary tube (11) whereas the liquid phase fluid outlet (3) is connected to the evaporator (9) and the gas phase fluid outlet (4) is connected to the compressor (10) (Fig. 7).

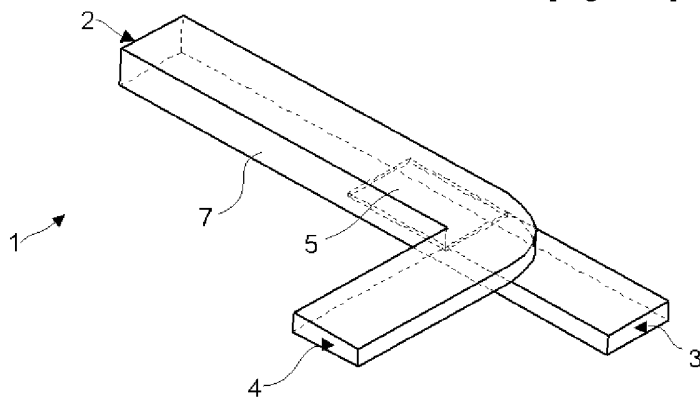
[030] In the cooling device (8) which is the object of the present invention, the phase separator (1) enables the evaporator (9) to operate more effectively by separating the liquid and gas phases of the refrigerant, and decreases the possibility of the transfer of the liquid phase refrigerant (L) from the evaporator (9) to the compressor (10).

Claims

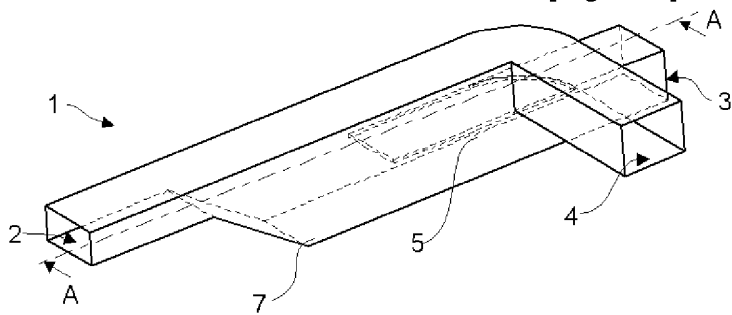
- [001] A phase separator (1) used to separate two-phase fluids (T) into liquid (L) and gas (G) phases, comprising; a body (7); an inlet (2) through which the two-phase fluid (T) enters, positioned at one side of the mentioned body (7); a liquid phase fluid outlet (3) through which the liquid phase fluid (L) goes out, positioned at the other side of the body (7) and; a gas phase fluid outlet (4) which is positioned above the liquid phase fluid outlet (3) and through which the gas phase fluid (G) goes out and **characterized by** a flap (5); having a density such that it can float inside the liquid phase fluid (L); attached from one edge to a position just before the liquid phase fluid outlet (3); having a free edge being able to move upwards and downwards depending on the liquid level; used to divert the gas phase fluid (G) towards the gas phase fluid outlet (4) and permitting only liquid phase fluid (L) to pass through the liquid phase fluid outlet (3).
- [002] A phase separator (1) according to Claim 1, **characterized in that** the flap (5) extends towards the inlet (2) and is attached at the portion where the liquid phase fluid outlet (3) and the gas phase fluid outlet (4) are separated.
- [003] A phase separator (1) according to any one of the preceding Claims, **characterized in that** the flap (5) is manufactured from a flexible material.
- [004] A phase separator (1) according to any one of the preceding Claims, **characterized in that** the flap (5) is sized so as to completely or partially close the liquid phase fluid outlet (3).
- [005] A phase separator (1) according to any of the preceding Claims, **characterized in that** the flap (5) comprises at least one hole (6) in order for the liquid phase droplets left on it to pass through the liquid phase fluid outlet (3).
- [006] A phase separator (1) according to any one of the preceding Claims, **characterized by** a flap (5) the free edge of which is curved upwards.
- [007] A phase separator (1) according to any one of the above Claims, **characterized by** a hinge (13) which is used to attach the flap (5) to the body (7) in such a way that it is able to rotate around its stationary edge, in order to improve the movement of the flap (5).
- [008] A phase separator (1) according to Claim 7, **characterized by** at least one stopper (14) limiting the upwards and downwards motion of the hinge (13) within a certain angle, in order to prevent the flap (5) from completely closing the liquid phase fluid outlet (3) and/or the gas phase fluid outlet (4).
- [009] A cooling device (8) comprising a phase separator (1) according to any one of the preceding Claims.
- [010] A cooling device (8) according to Claim 9, **characterized by** a capillary tube

(11) where the inlet (2) is connected, an evaporator (9) where the liquid phase fluid outlet (3) of the phase separator (1) is connected and a compressor (10) where the gas phase fluid outlet (4) of the phase separator (1) is connected.

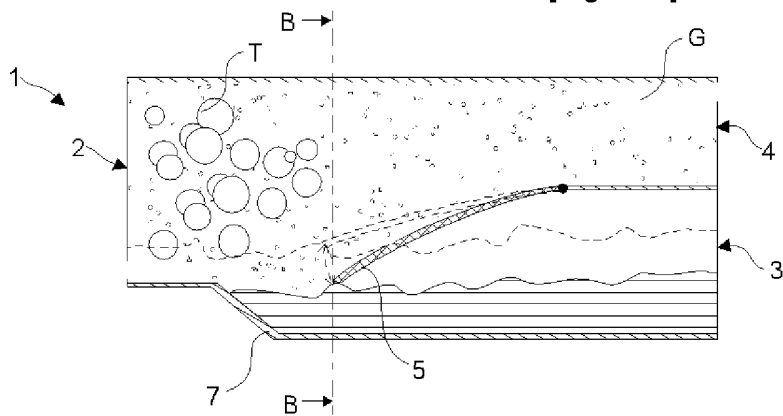
[Fig. 001]



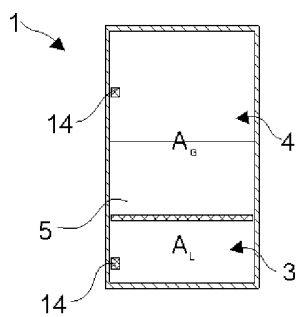
[Fig. 002]



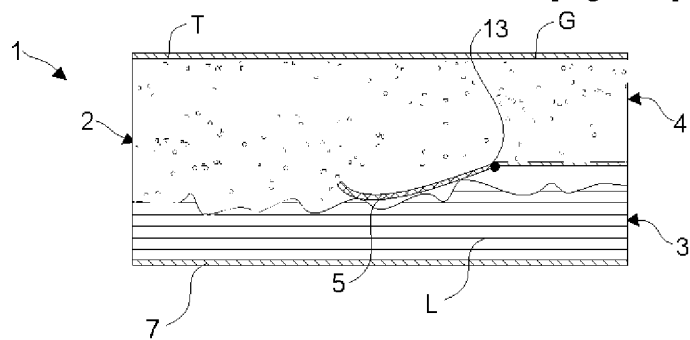
[Fig. 003]



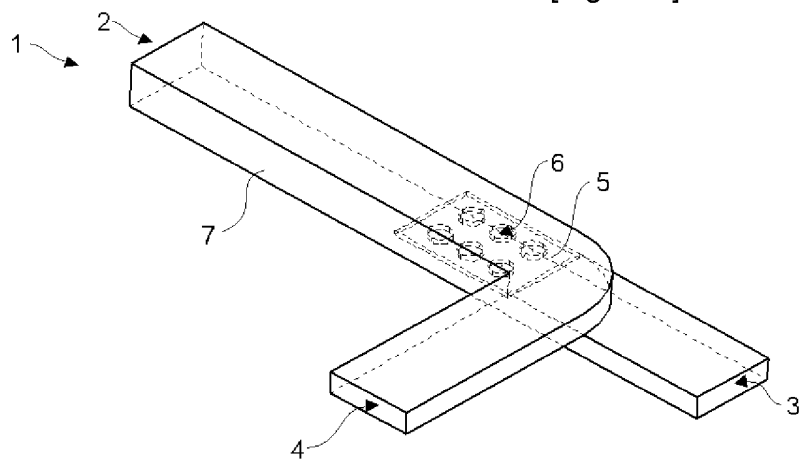
[Fig. 004]



[Fig. 005]



[Fig. 006]



[Fig. 007]

