Jan. 13, 1959 J. MAKOWSKI 2,867,991

INVERTIBLE EVAPORATOR

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FIG.1.

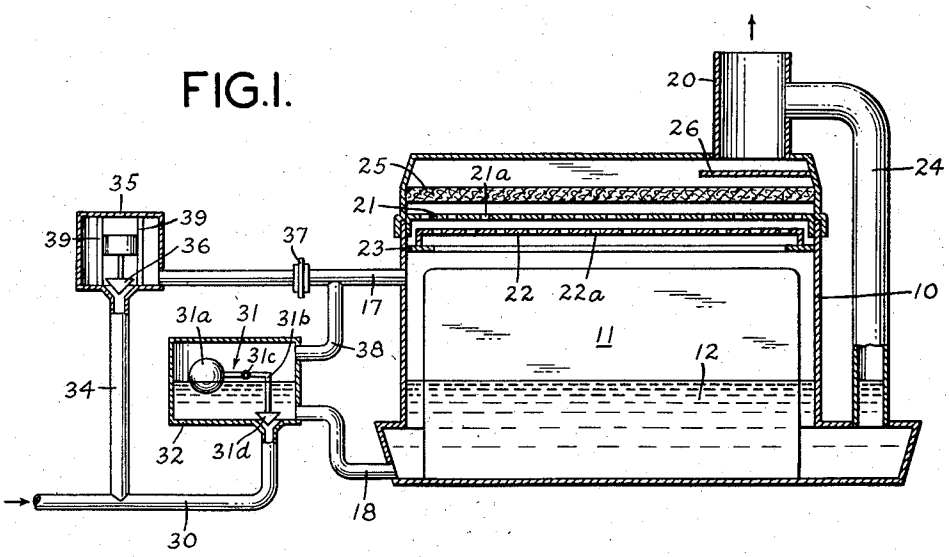
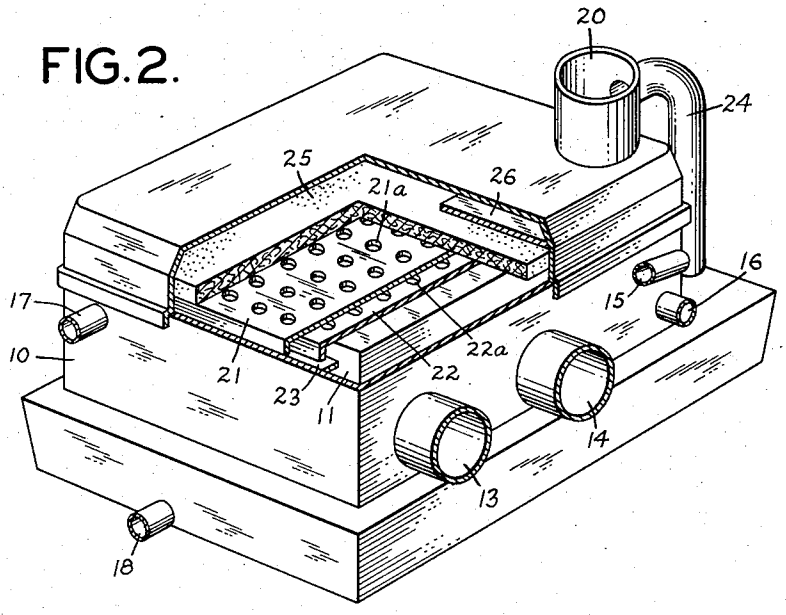


FIG.2.



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INVERTIBLE EVAPORATOR

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6 Claims. (Cl. 62—169)

This invention relates to an apparatus in which vapor is evolved from a liquid and which is capable of operating in either an upright or an inverted position.

In evaporative cooling systems installed in aircraft, the cooler is capable of functioning satisfactorily in an upright position, during which the vapor formed by the evaporation of the coolant passes from the evaporator through a discharge passage at the top thereof. When, however, a cooler of this type is inverted, as sometimes happens when an airplane is maneuvering, the coolant is free to escape through the discharge passage, with the result that a valuable supply of the coolant is lost. This not only imposes a weight penalty on the aircraft by necessitating that it carry a greater reserve of coolant, but, even more important, it may interrupt the operation of the cooler, causing overheating of certain equipment, or necessitating its shutdown for a time.

The principal object of the present invention is to provide an apparatus from which vapor is readily withdrawn when operating in either an upright or an inverted position, but without substantial loss of the liquid.

In the invertible type vapor evolving apparatus of the present invention, a pair of relatively movable perforated plates is interposed between the upper level of the liquid and the vapor discharge passage. The perforations in one of the plates are laterally offset with respect to the perforations in the other of the plates, but in the upright position of the apparatus the plates are spaced apart so that the vapor is free to pass through the perforations in the plates in passing to the vapor discharge passage. When the apparatus is inverted, however, the plates come together and, due to the laterally offset perforations in the two plates, the liquid is prevented from flowing, at least in substantial quantities, through the plates toward the discharge passage.

The apparatus also includes an auxiliary passage which connects the lower portion of the apparatus with the vapor discharge passage. In the upright position of the apparatus, the entrance to this passage is blocked by the liquid coolant. In the inverted position, however, the auxiliary passage permits vapor which is evolved from the liquid coolant to be discharged through the vapor discharge passage.

Additional features of the present invention are concerned with the means for supplying the liquid coolant to the apparatus in both the upright and inverted positions.

For a complete understanding of the present invention, reference may be made to the detailed description which follows and to the accompanying drawings in which:

Figure 1 is an elevation view showing the invertible vapor evolving apparatus of the present invention in cross-section; and

Figure 2 is a perspective view of the evaporator housing, with a portion thereof broken away.

Referring to the drawings, an evaporative cooler embodying the present invention is shown as comprising a

housing **10** containing a heat exchanger, generally designated **11**, through which one or more fluids can be circulated in out-of-contact heat exchange relationship with a liquid coolant **12** which, for present purposes, will be assumed to be water. In the type of evaporator cooler illustrated, the heat exchanger **11** is divided into two parts—one for cooling the cabin air and the other for cooling a lubricant. The cabin air is admitted into the heat exchanger through an inlet conduit **13** and discharged from the heat exchanger through a conduit **14**. The lubricant is admitted into the heat exchanger through a conduit **15** and discharged therefrom through a conduit **16**. It is, of course, understood that the air and lubricant are not intermingled with each other within the heat exchanger **11**.

The liquid coolant or water is admitted into the housing **10** through a conduit **18** when the evaporator is in upright position, or through a passage **17** when the evaporator is in inverted position.

Steam or vapor evolved from the water or liquid coolant **12** passes upwardly through the housing **10** and is exhausted therefrom through a vapor discharge vent **20** in the upper portion of the housing. Two perforated baffle plates **21** and **22** are accommodated in the upper region of the housing **10** intermediate the liquid level of the coolant **12** and the entrance to the discharge vent **20**. The perforations **21***a* in the upper baffle plate **21** are staggered or offset in relation to the perforations **22***a* in the lower baffle plate **22**. The upper baffle plate is fixedly mounted to the walls forming the interior of the housing, and the lower baffle plate **22** is movable relatively thereto. When the housing is in upright position, the lower perforated plate **22** is supported on a ledge **23** which projects inwardly from the walls forming the interior of the housing. When the perforated baffle plate **22** is supported on the ledge **23**, the baffle plates **21** and **22** are spaced apart, so that, notwithstanding the fact that the perforations in each are staggered or offset laterally in relation to each other, the vapor evolved from the liquid coolant **12** is free to pass through the perforations to the discharge vent **20**. However, when the housing **10** is inverted, the perforated plate **22** falls by gravity against the upper perforated plate **21**, bringing the plates into face-to-face contact, and when this takes place the perforations in each baffle plate are closed by the other plate. As a consequence, the liquid coolant will be prevented from flowing, at least in substantial quantities, from the housing through the discharge vent **20**.

The effectiveness of the seal may be increased by various means such as by affixing flexible gaskets to the adjacent sides of the baffle plates around each of the perforations therein.

When the housing **10** is in inverted position, the vapor evolved from the liquid coolant is still free to be withdrawn from the housing **10** through the discharge vent **20** by flowing through an auxiliary passage within a conduit **24**. The lower end of the conduit **24** communicates with the lower portion of the housing **10**, and the upper end thereof communicates with the vent **20**. When the housing is in upright position, as shown in the drawings, the liquid level of the coolant is at a level higher than the entrance to the conduit **24**, so that the entrance is closed to vapor evolved from the surface of the liquid coolant.

To prevent unnecessary loss of the liquid, a filter or gauze layer **25** may be accommodated within the housing above the baffle plate **21**. In addition, a baffle plate **26** may be placed at the entrance end of the discharge vent **20**. The gauze layer **25** and the baffle plate **26** prevent moisture particles or drops from being discharged with the vapor through the vent **20**, thereby preventing un-

necessary dissipation of the liquid coolant. The gauze layer **25** also absorbs moisture which seeps through the perforated baffle plates **21** and **22** when the housing is inverted. The vapor, however, is free to pass readily through the gauze layer **25**.

In the upright position of the housing **10**, the liquid coolant is admitted thereto through a conduit **30**, a float valve **31** accommodated within a chamber **32**, and the conduit **18** which connects the interior of the chamber **32** with the interior of the housing. The float valve **31** comprises a float **31***a* connected to one end of a lever **31***b* pivoted at **31***c*, and a valve head **31***d* connected to the lever **31***b* on the opposite side of the pivot. The chamber **32** is supported beside the housing at a height which is determined by the level at which it is desired to maintain the liquid within the housing **10**. The weight of the float **31***a* will lift the valve head **31***d* to open position, thereby admitting liquid into the housing **10** through the conduit **18** until the level of the liquid lifts the float to a height which permits the valve head **31***d* to close. Thereafter, liquid will be admitted into the housing **10** as needed to maintain the desired level of the liquid within the housing.

In the inverted position of the housing, the liquid coolant is admitted thereto through a conduit **34** which communicates with the supply line **30**, a weighted valve **36** within the chamber **35**, and the conduit **17** which connects the interior of the chamber **35** with the interior of the housing **10**. The conduit **17** has interposed therein a calibrated orifice **37** which regulates the rate of flow through the conduit **17**. In the upright position of the housing, gravity maintains the weighted valve **36** closed, so that the level of the liquid within the housing is regulated by the float valve **31**. However, in the inverted position of the housing, the valve **36** opens and permits the flow of liquid into the housing **10** at a rate which is determined by the calibrated orifice **37**. The longitudinal movement of the valve **36** within the chamber **35** is guided by a group of parallel members **39** surrounding the valve.

A connection **38** between the conduit **17** on the downstream side of the orifice **37** and the chamber **32** permits the liquid entrapped within the chamber **32** to flow into the housing when the housing is inverted. However, as soon as this entrapped liquid is withdrawn from the chamber, the weight of the float **31***a* will hold the valve head **31***d* closed. Since it is not expected that the cooler will be operating in inverted position for a substantial period of time, it is not likely that a sufficient quantity of the liquid will be admitted into the housing **10** via the conduit **17** such that the level of the liquid therein would be raised high enough to lift the float **31***a* and thereby open the valve **31***d*. This, however, can be prevented even in the event of prolonged operation in the inverted position by limiting the size of the restricted orifice **37**.

The invention has been shown in preferred form and by way of example only, and obviously many variations and modifications may be made therein without departing from the spirit of the invention. The invention, therefore, is not to be limited to any specified form or embodiment, except in so far as such limitations are set forth in the claims.

I claim:

1. An apparatus in which vapor is evolved from a liquid comprising a housing for the liquid, a vapor discharge passage, and a pair of relatively movable perforated plates separating the liquid in the housing and the vapor discharge passage, each perforation in one of the plates being offset with respect to each perforation in the other of the plates, said perforated plates being spaced apart in one position of the evaporator to permit the evolved vapor to pass through both of said perforated plates and to be discharged from the housing through the vapor discharge passage, and said perforated plates being movable together when the evaporator is inverted to stop the flow of the liquid through said perforated plates.

2. An apparatus as set forth in claim 1 including means forming an auxiliary passage between the vapor discharge passage and the interior of the housing on the opposite side of the perforated plates, said auxiliary passage permitting vapor to be discharged from the housing when the housing is inverted, the entrance to the auxiliary passage being below the usual level of the vapor evolving liquid when the housing is in upright position, thereby preventing the flow of vapor through said auxiliary passage in the upright position of the housing.

3. An apparatus as set forth in claim 1 including a passage for admitting liquid into the housing in the upright position of the housing, a passage for admitting liquid into the housing in the inverted position of the housing, means for closing one passage in the upright position of the housing, and means for closing the other passage in the inverted position of the housing.

4. An apparatus as set forth in claim 1 including means for maintaining a predetermined level of the liquid in the housing when the housing is in one position and means for feeding a regulated quantity of the liquid to the housing when the housing is in inverted position.

5. An invertible apparatus in which vapor is evolved from a liquid comprising a housing for the liquid, a discharge passage communicating with the upper region of the housing when the housing is in upright position, a pair of perforated plates accommodated in the housing separating the liquid and the discharge passage, the perforations in one plate being offset laterally in relation to the perforations in the other plate, and means for supporting the lower of the plates spacially separated from the upper plate in the upright position of the housing, permitting the vapor evolved from the liquid to pass through the perforations of both plates to the discharge passage, said lower plate falling by gravity into contact with the upper plate when the housing is inverted to stop the flow of the liquid through said perforated plates.

6. An invertible apparatus as set forth in claim 5 including means forming an auxiliary passage, the upper end of which communicates with the region above the perforated plates and the lower end of which communicates with the region below the perforated plates and below the usual level of the liquid in the housing, said auxiliary passage permitting the vapor to be removed from the housing when the housing is inverted.

No references cited.