Sept. 21, 1971 L. ANDERSON 3,606,982

EVAPORATIVE COOLER

Filed Nov. 10, 1969

FIG.1

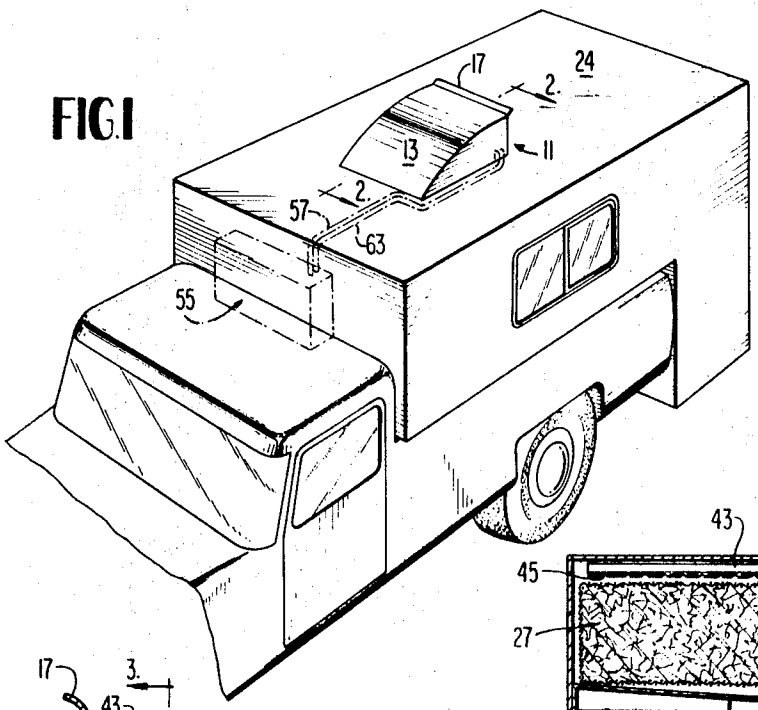


FIG.3

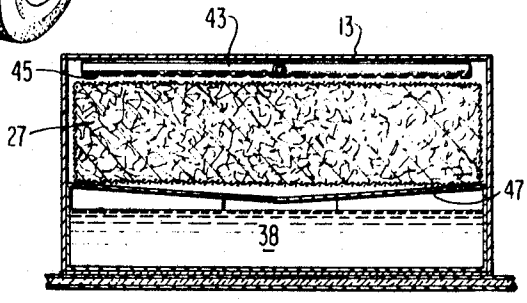


FIG.2

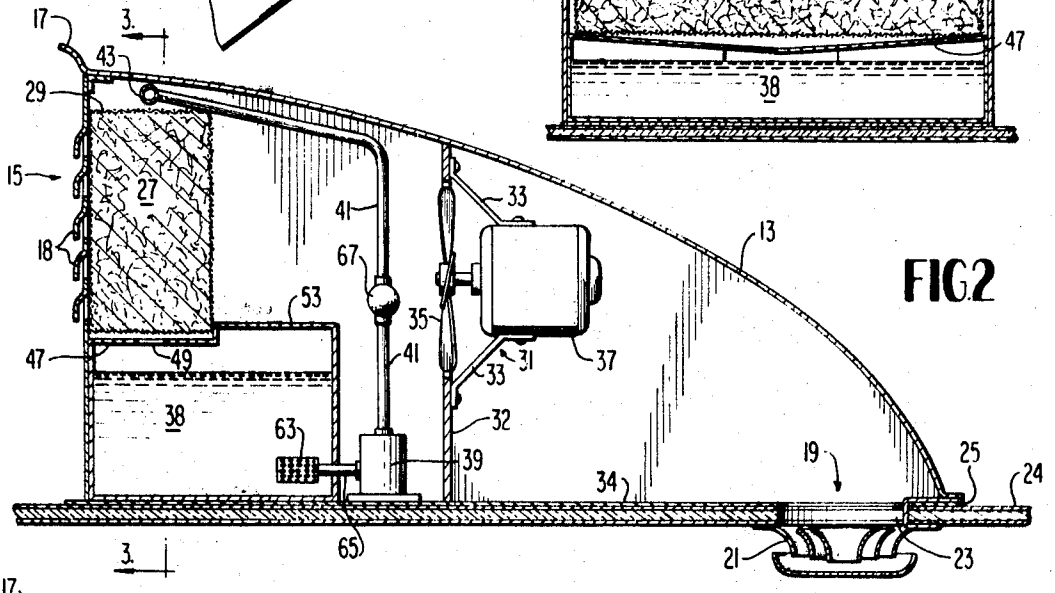
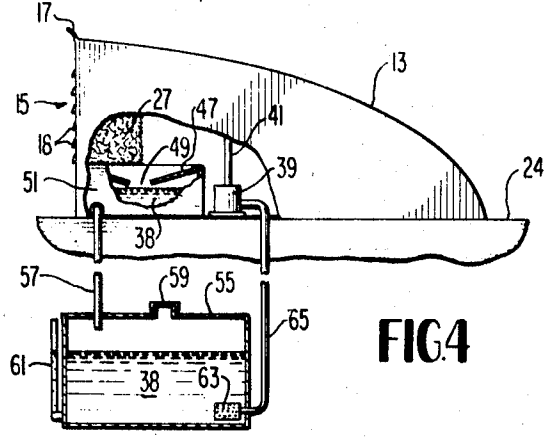


FIG.4



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EVAPORATIVE COOLER

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ABSTRACT OF THE DISCLOSURE

This disclosure relates to a roof top evaporative cooler for cooling the interior of vehicles such as campers and trailers, whether the vehicle is moving or stationary. The unit includes a rear facing streamlined housing disposed over a roof top register, with a wind deflector such as a spoiler for directing the air stream passing over the unit into a louvered entrance port. A suction fan is disposed within the housing between the entrance port and the register for pulling air into the housing, through an evaporative pad and for expelling the cooled air, guided by the configuration of the housing, through the register and into the vehicle. The cooling medium is pumped from a supply tank to a distributor over the pad and collected after it passes through the pad for recirculation. The supply tank may be either incorporated within the cooler housing or externally disposed thereto and mounted on the vehicle body. The pad is constructed from a suitable porous material and the cooling medium is typically water.

Evaporative coolers depend upon the well known principle that as a warm air stream passes in intimate contact with a body of water, heat is transferred from the air to the water, and the water evaporates. This principle has found a variety of applications in humidifiers and large scale air conditioning units.

Prior small scale adaptations have encountered design difficulties because the unit must provide for passage of a large volume of air in intimate contact with water over a large surface area. However, this must be accomplished within a small unit for efficient cooling.

Prior interior cooling devices for moving vehicles have utilized an evaporative pad disposed in an air scoop opening in the direction movement. This device, a ram-type, only cools when the vehicle is moving, and has several disadvantages. Insects and debris foul the entrance port reducing the flow of air, and the design inherently creates vehicle drag. This drag requires a strong bracing system connecting the unit and the vehicle, and the drag causes an increase in vehicle gasoline consumption.

Rearwardly opening units have been proposed, but such units have not been feasible. Although such units could be streamlined, the turbulence caused by air rushing over the unit resulted in turbulent low pressure at the rear entrance port. In order to pull warm air into the system, a large suction fan was required. The size of the fan required when the vehicle was moving was grossly disproportionate to the size required when the vehicle was not moving because in the latter instance there was no turbulent low pressure at the entrance port. Therefore, these units were uneconomical and expensive.

Other rearwardly opening evaporative coolers have been of complicated construction or of limited special utility. One such unit is intended to be attached to the rear wall of a truck cab for cooling an interior sleeping area. This device utilizes a falling stream of water against a rising current of air which is filtered, cooled, dried and subsequently blown into the cab adjacent the sleeping area. Such a device is not adaptable for relatively large vehicles such as campers or trailers since most efficient cooling requires air injection at the top while the

prior device is attached at the rear of the vehicle. The device could not practically be top mounted since it requires that warm air enter at the side of an elongated tubular structure and follow an upwardly directed Z-shaped path from the warm air inlet to the cool air outlet and into the cab.

As noted above, a universally adaptable cooling unit for relatively large vehicles wherein the available space is designed for either storage or living area ideally should be mounted on the roof as previously noted. Rear mounting would, in most cases, necessitate a special arrangement of living and sleeping quarters to allow for circulation. Moreover, maximum effective circulation of cool air without rearrangement of the existing living and sleeping areas is achieved with an overhead unit.

A rear mounted unit has another disadvantage similar to prior rear opening top mounted units. A large enough fan is required while the vehicle is moving to suck in warm air from the turbulent low pressure trough following the vehicle. However, when the vehicle is at rest, and the unit is in use, a smaller fan would be adequate. Therefore the use of the large fan would be unduly expensive if a cooler could be designed to use a smaller fan even when the vehicle is in motion.

The device of the preesnt invention broadly includes a streamlined housing with a rearwardly opening louvered entrance port, a vertical evaporative pad fed by recirculating flow of an evaporative coolant such as water, and a suction fan. The fan sucks air into the housing through the entrance port and through the evaporative pad wherein it is cooled. The cooled air stream is then directed downward into the vehicle through a register in the roof of the vehicle, by shape of inner surface of the streamlined housing. The inner surface of the housing aids the fan by acting as a slightly converging nozzle to further speed the air flow through the housing and into the vehicle. Expansion of the air flow as it passes through the register and into the vehicle gives an additional cooling effect to the flow of air.

Accordingly, it is an object of this invention to provide a rear opening roof top evaporative cooler for vehicles such as campers or house trailers.

Another object is to provide such a device with a spoiler to direct the flow of air into the cooler and fan to propel the cooled air from the cooler, into the vehicle.

It is another object to provide a roof top cooler which is equally efficient for moving or parked vehicles.

It is also an object to provide such a device which will exert a minimum drag on the vehicle when moving and require a relatively small fan for effective cooling.

It is another object to provide a compact and efficient roof top cooler for vehicles having a recirculating coolant supply, the cooler being small, streamlined, and effective to cool either a moving or stationary vehicle.

It is yet another object to provide an evaporative roof top cooler for moving or stationary vehicles using a falling stream of water in a porous pad, the pad being disposed across the stream of warm air entering the cooler, a portion of the falling water evaporating to humidify and cool the air and the remaining water being collected for recirculation for additional evaporative cooling.

It is a further object to provide an evaporative cooler wherein warm air is sucked through a moisture laden evaporative pad wherein it is cooled, humidified and directed into the area to be cooled, the pad having a recirculating source of evaporative coolant from a storage area easily accessible for refilling.

The exact nature of the invention, as well as other objects and advantages will become readily apparent with reference to the following drawings and description wherein:

FIG. 1 is a perspective view of a vehicle with the

evaporative cooler of this invention mounted on the roof and an optional, separate coolant storage tank in phantom;

FIG. 2 is a cross sectional view of the cooler of FIG. 1 taken along lines 2—2;

FIG. 3 is a cross sectional view of the cooler of FIG. 2 taken along lines 3—3 of FIG. 2;

FIG. 4 is a side view of the cooler of this invention in partial section and showing an alternative coolant storage tank placement and coolant recovery configuration.

As seen in FIG. 1, the evaporative cooler of this invention **11** is mounted on the roof of a vehicle such as a camper. The cooler **11** is comprised of an outside housing **12** formed of sheet metal, reinforced plastic or other suitable material. Housing is formed with a streamlined leading surface **13** and a rear facing entrance port **15** through which the warm air is drawn into the device. Disposed above entrance port **15** is a wind deflector or spoiler **17** for directing air rushing over the surface **13** into the port **15**, thereby defeating the formation of a vacuum at entrance port **15**. The port **15** may additionally have louvers **18** (see FIG. 2) to shelter the interior of the cooler from the weather and insects and other foreign matter which might be sucked in through the entrance port **15**.

Cooled, humidified air from cooler **11** enters the space to be cooled through an exhaust port **19**. As illustrated in FIG. 2, port **19** includes a stepdown deflector **21** extending through a hole **23** in the roof **24** of the vehicle to be cooled. Alternatively, stepdown deflector **21** may be replaced with a conventional flat register (not shown) if desired.

Cooler **11** is secured to the roof of the vehicle in any conventional manner such as with a roof jack or bracket **25** as shown in FIG. 2, connecting the cooler **11** at the exhaust port **19** with the roof **24** of the vehicle at hole **23**. Other means of attachment such as by welding, or directly with rivets or bolts could also be employed.

As previously noted, cooling is effected by passing a stream of air through a moisture laden medium. According to this invention, this medium is comprised of porous pad **27** disposed within the cooler **11** adjacent entrance port **13**. The pad **27** may be made of several layers of cloth, of foam molded plastic, shredded wood fibers retained in an open mesh screen or other suitable material. Preferably, a metal or molded plastic frame **29** is provided to hold pad **27** and to simplify pad replacement when necessary. This may be done, e.g., by removal of the louvers **18** thereby providing convenient access to the interior of cooler **11** through port **15**.

Warm air is sucked into cooler **11** through entrance port **15** and through pad **27** by fan **31**. The fan **31** is surrounded by a shroud **32**, and is mounted by bracket **33** to the said shroud as shown in FIG. 2. The fan may also be secured to the inner surface of the front portion **13**, if desired, or it may be mounted at the floor portion **34** of cooler **11** with a suitable bracket. The fan may have either two blades **35** as pictured in FIG. 2, or four, or the fan may be of the squirrel cage type depending on the volume of air to be moved. The fan blades **35**, normally disposed in the same plane as the shroud **32**, are preferably driven by a 6 or 12 volt electric motor. The fan should be capable of moving between 250 and 1000 cubic feet of air per minute (c.f.m.) through the cooler, depending on the size of the vehicle to be cooled. However, a fan capable of moving from 300 to 500 c.f.m. is preferred for most applications. The motor for such a fan should draw less than 1.0 ampere, e.g., about 0.8 ampere for most satisfactory operation.

A coolant **38**, such as water, is fed by pump **39** through a pipe **41** to a seepage tube **43** which is disposed over pad **27** as shown in FIGS. 2 and 3. Tube **43** is perforated by holes **45** as shown in FIG. 3 to allow the coolant to fall on the upper surface of pad **28**. The pad is maintained in a saturated condition so that as warm air is drawn through port **15** and pad **27** by fan **31**, it will cause

the liquid water in the pad **27** to evaporate, cooling and humidifying the air with the vaporized water. A pump, driven by an electric motor which draws about .5 ampere and achieves a flow of 0.5 to 1.0 gallan per minute should be provided to keep the pad **27** sufficiently saturated.

As will be understood, a portion of coolant **38** evaporates in the process of cooling the incoming air, but a substantial volume of coolant seeps down through pad **27**, and is caught by a splash pan **47**. Pan **47** is formed of plastic or sheet metal and is in the form of an inverted four-sided pyramid with a drain opening **49** at the lowest point as illustrated in FIGS. 3 and 4. As illustrated in FIG. 2, pan **47** extends the width of pad **27**.

In an alternative and preferred embodiment, pan **47** extends behind pad **27** as shown in FIG. 4 to catch any coolant drawn out of the pad with the cooled air.

In the embodiment of FIG. 4, seepage from outlet **49** in pan **47** falls into an intermediate storage tank **51**, or it may fall directly into the main storage tank **53** as in the embodiment of FIG. 2.

In the embodiment of FIG. 4, the main storage tank **55** is disposed externally to cooler **11** and conventionally mounted on the front or side of the vehicle as indicated in phantom in FIG. 1. Coolant **38** flows by gravity through pipe **57** from intermediate tank **53** to main tank **55**. Tank **55** is provided with an accessible filling port **59** and a sight tube **61** for convenient gauging of the amount of coolant **38** in the system.

In the embodiment of FIG. 2, tank **53** also is provided with a filling port and gauge (not shown) which are located in an accessible manner for convenient use.

During recirculation, pump **39** draws water from main tank **53** or **55** through a filter **63** and a line **65** for transmission through line **41** to seepage tube **43**. The coolant **38** saturates pad **27**, and flows by gravity through pad **27** for collection in the splash pan **47**. The return flow from pan **47** is directly into storage tank **53** (in the embodiment of FIG. 2) or through intermediate tank **51**, and thence to the main tank **55** in the embodiment of FIG. 4.

As shown in FIG. 2, a check valve **67** is inserted in line **41** above pump **39** to act as a trap for the pump primer if a centrifugal pump is used. A submergicle pump can also be used, but this requires that the pump be situated within the storage tank where it is not readily accessible for servicing. Tanks **51**, **53** and **55** are preferably completely sealed to prevent spillage when the vehicle is moving and to minimize evaporative water loss.

It has been found that various engineering changes may be made within the scope of this invention, such as varying the type of fan and the type of pump employed as previously explained. The type of fan and pump selected will depend upon the volume of air to be cooled which in turn will depend in part on the size of the vehicle.

The structural design may also be modified according to the nature of the vehicle to be cooled. Of the two embodiments, one with the storage tank disposed within the cooler, and the other with the tank external to the cooler, attached to the vehicle, the former embodiment may be preferred because as shown in FIG. 2, the cooler is self-contained and easily installed. However, the embodiment of FIG. 4 is easily filled and the sight gauge **61** is conveniently accessible for visual inspection of the coolant level, which makes this embodiment advantageous under certain conditions. In this regard, it should be noted that the coolant level should not be permitted to drop to the point of exposing the normally submerged pump inlet because in the event a centrifugal pump is used, it would have to be primed to restart the cooler.

A practical and commercially satisfactory roof top evaporative cooler for trailers, campers and other vehicles has herein been described. Broadly described, the cooler operates by drawing arm air into the cooler through a liquid saturated pad, and expelling the evaporation cooled air downward through a register into the vehicle.

A pump draws the liquid coolant from a storage tank and feeds it through a seepage tube over the pad to keep the pad saturated. Coolant from the pad falls into a splash pan where it is collected for return to the storage tank by gravity flow. The cooler enclosure has a rear facing opening and streamline design to minimize drag and a spoiler device to eliminate a low pressure area that would develop at the rear opening entrance port.

What is claimed and desired to be secured by United States Letters Patent is:

1. A roof top evaporative cooler for a vehicle comprising: a streamlined hollow enclosure having a forward sloping surface, a rear opening entrance port, and a downwardly opening exit port; said enclosure designed to be mounted on the roof of a vehicle; a liquid saturable medium disposed within said enclosure adjacent the entrance port; fan means mounted within the said enclosure for pulling warm air into the enclosure through the entrance port and said saturable medium and for expelling cooled air from said exit port into said vehicle; and recirculating means for continuously introducing evaporative coolant liquid into said medium to saturate the same and for recovering unevaporated liquid coolant from said medium for recirculation.

2. The cooler of claim **1** wherein said enclosure further comprises deflector means projecting upwardly of said enclosure, said deflecting means being disposed adjacent said forward sloping surface and above said entrance port, whereby warm air passing over said streamlined enclosure flows downwardly to said entrance port.

3. The cooler of claim **1** wherein the said fan means is disposed between the entrance and exit ports, said exit port being adjacent the forward edge of said sloping surface so that said fan means cooperates with the internal surface of said streamline enclosure to direct cooled air downwardly through said exit port.

4. The evaporative cooler of claim **1** wherein the evaporative coolant liquid is water and the warm air entering the entrance port is cooled and humidified as it passes through the saturated medium and a portion of the liquid vaporizes.

5. The cooler of claim **1** wherein the circulating means comprises: distributing means disposed over said medium for distributing coolant liquid over the upper surface of said medium so that said liquid will seep downwardly therethrough; collecting means disposed under said medium for collecting coolant liquid draining from said medium; and pump means connecting said collecting and distributing means for recirculating said coolant liquid.

6. The cooler of claim **5** wherein said distributing means is a foraminous seepage tube.

7. The cooler of claim **5** wherein said medium is a body of liquid saturable material permitting free flow of air therethrough.

8. The cooler of claim **7** wherein said body of material is a cloth pad mounted in a removable frame.

9. The cooler of claim **7** wherein said body of material is comprised of porous molded plastic.

10. The cooler of claim **7** wherein said body of material is comprised of wood fibers retained in a removable open mesh screen.

11. The cooler of claim **5** further comprising a splash plate disposed under the said medium, said plate collecting the coolant liquid as it drains from the bottom of said medium; and a storage means communicating with said splash plate for receiving the liquid as it collects in said plate.

12. The storage means of claim **11** including a sealed storage tank having a filling opening and a liquid level gauge, said tank being disposed within said cooler in communication with said splash plate.

13. The storage means of claim **11** comprising a sealed storage tank having a filling opening and a liquid level gauge in communication with said splash plate for collecting the drainage from said splash plate; said tank being located externally to said cooler and attached to the vehicle.

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TIM R. MILES, Primary Examiner

U.S. Cl. X.R.

261—96, 97, Dig. 4; 62—241, Dig. 16; 98—2G