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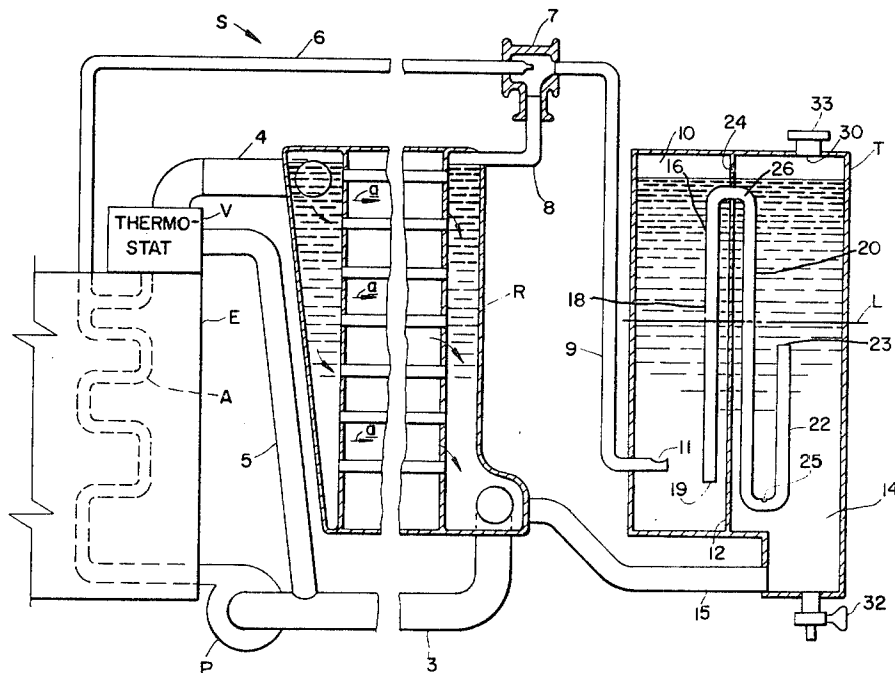
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[54] **APPARATUS FOR DEAERATING AN ENGINE COOLING SYSTEM**
10 Claims, 7 Drawing Figs.

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 [51] Int. Cl..... **F01p 3/20**
 [50] Field of Search..... **123/41.51,**
41.54, 41.27, 41.26, 41.25, 41.24, 41.23, 41.22

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ABSTRACT: In an engine-cooling system, apparatus for deaerating the system including a makeup water tank that can be placed laterally adjacent to the system's radiator, instead of above the radiator. For a vehicular engine, such a placement of the makeup water tank enables one to achieve a low vehicle profile, but if the deaerating apparatus is not properly designed, serious problems arise in keeping air out of the radiator and the engine, both when the engine is running and when it is shut down, and in enabling the system to be properly filled and drained. The invention solves these problems by an aspirator connected to the vent lines from the engine and radiator, and a system of waterlines and ports that permit proper venting of the engine and radiator during filling and draining, yet prevent a backflow of air into the engine and radiator at times other than filling and draining.



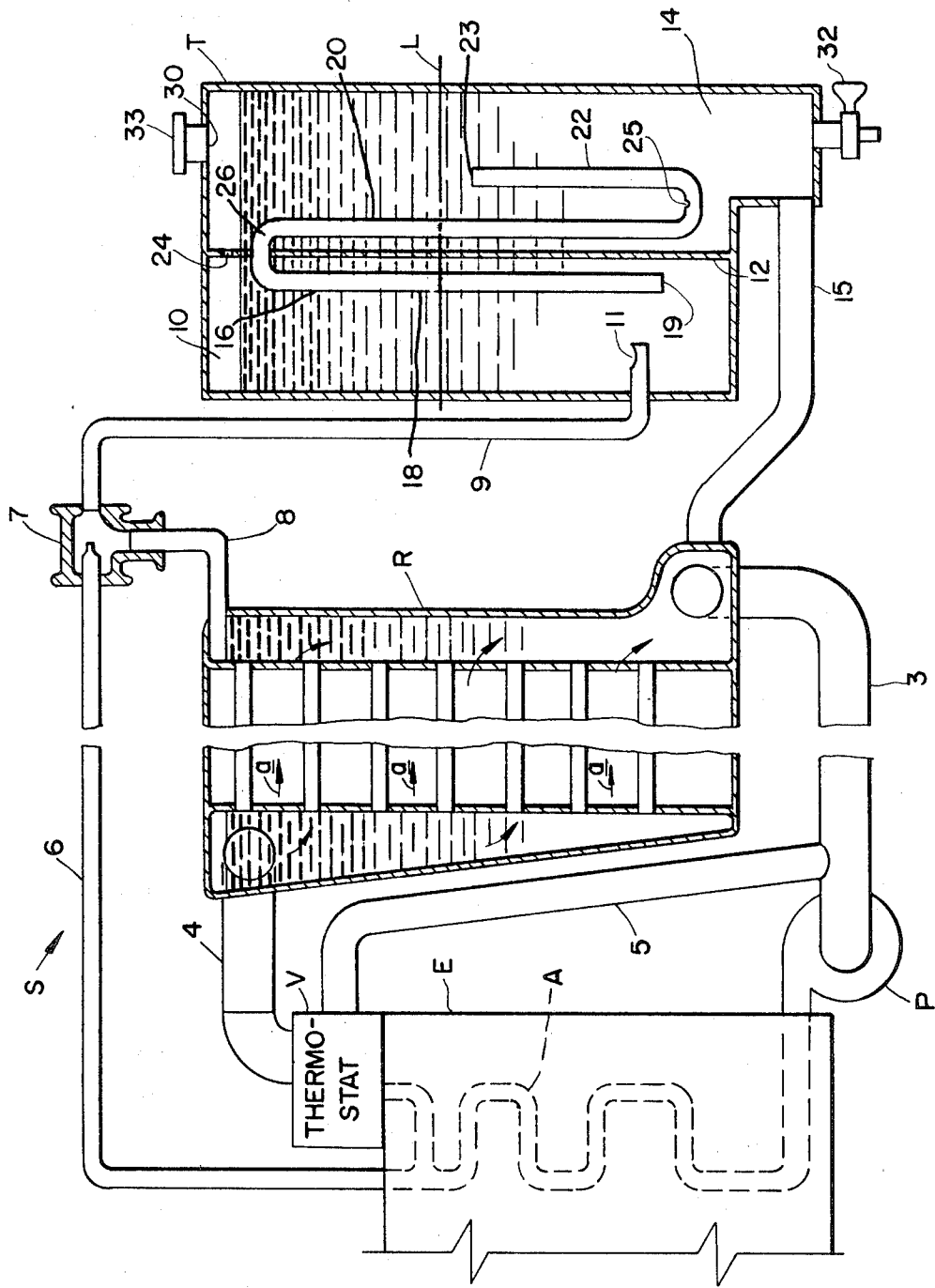


FIG. 1

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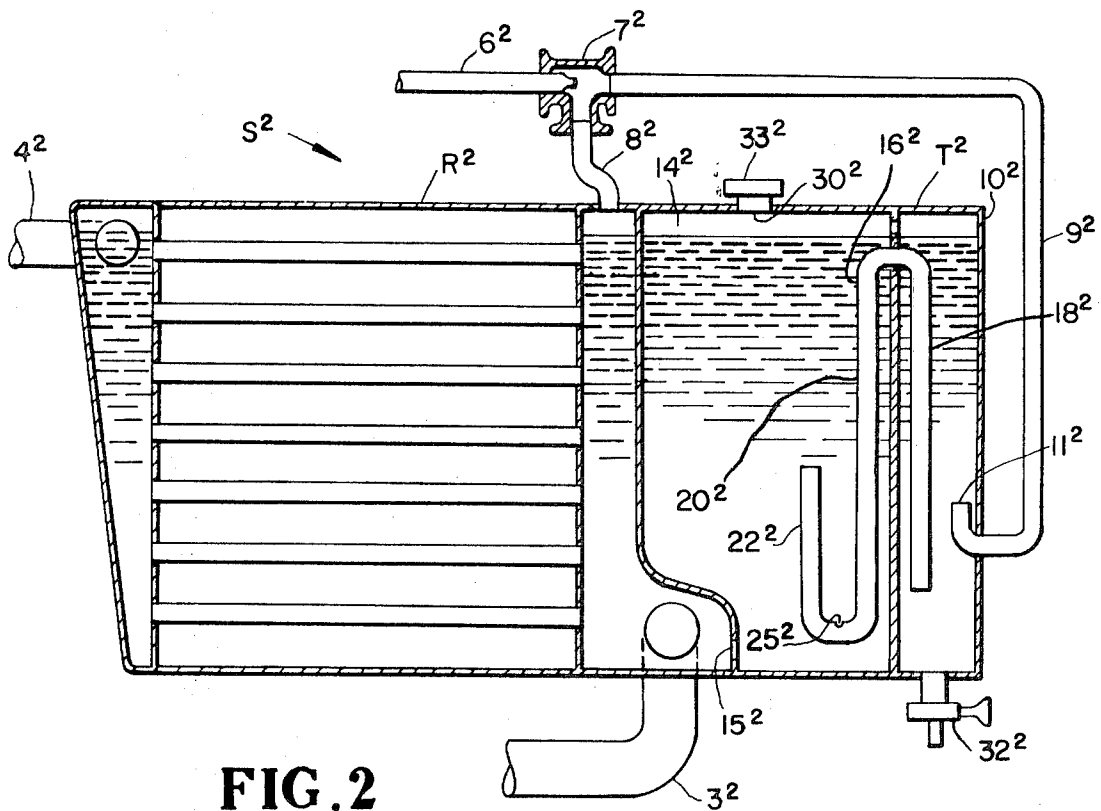


FIG. 2

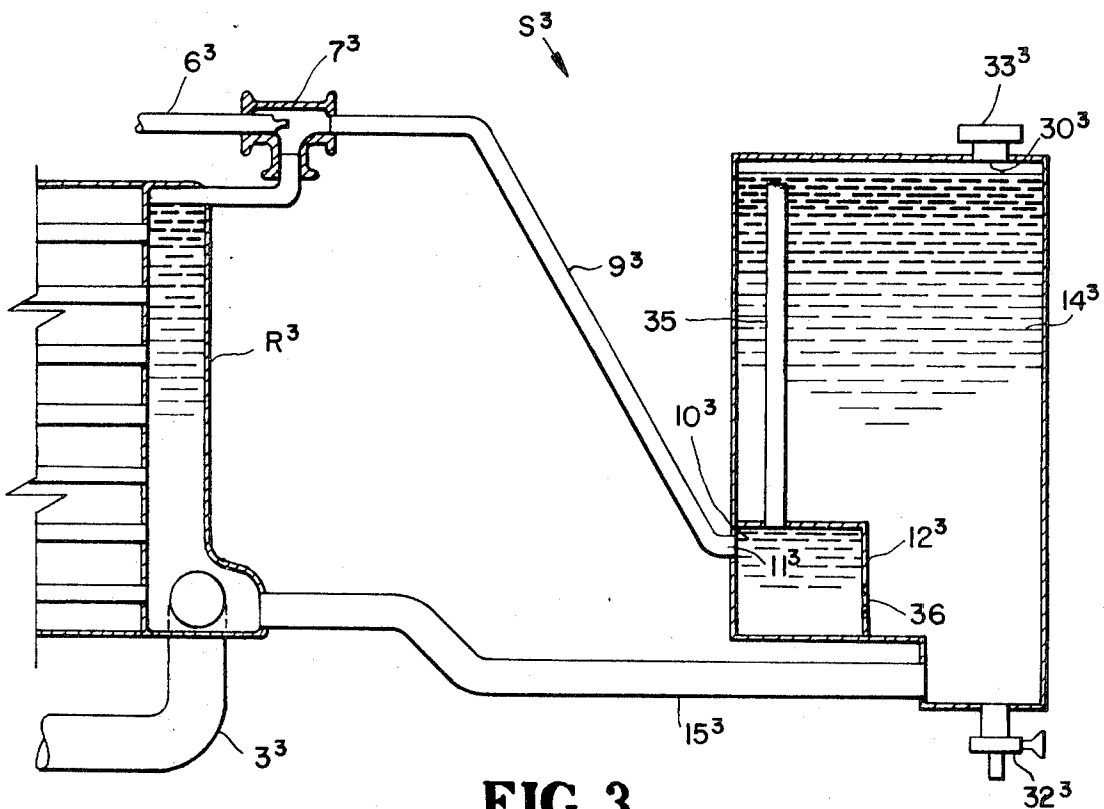
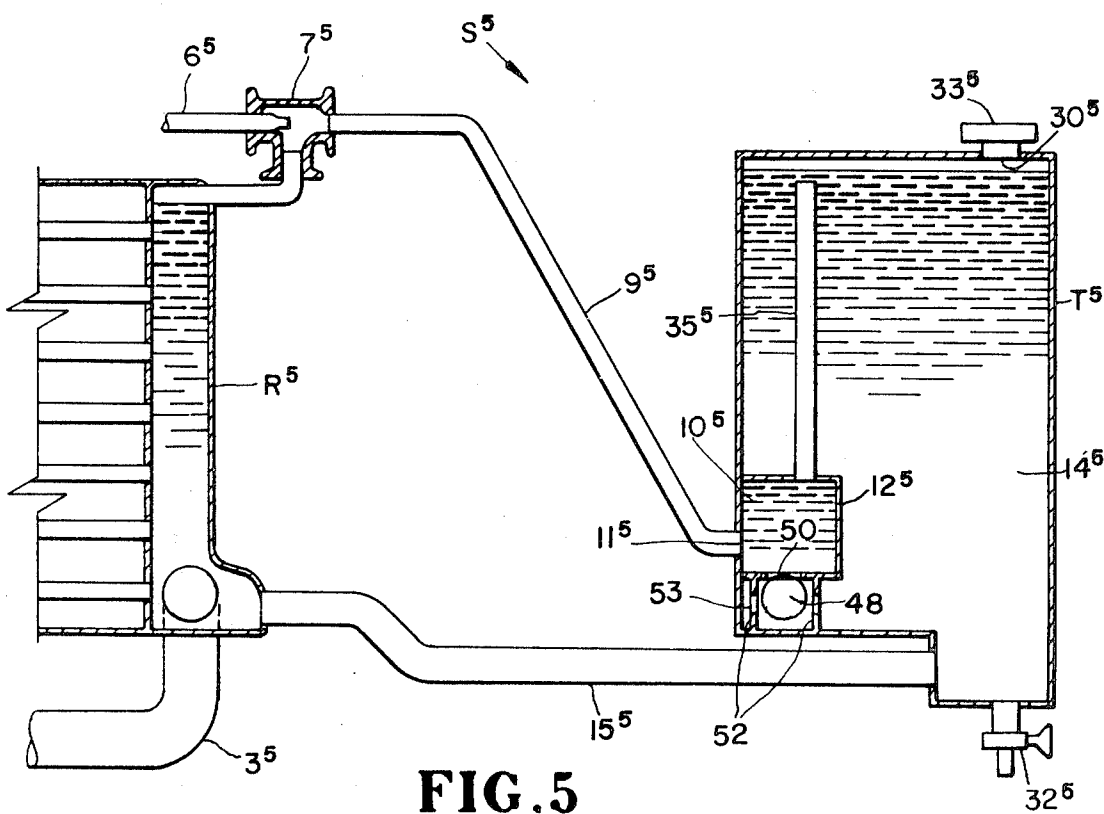
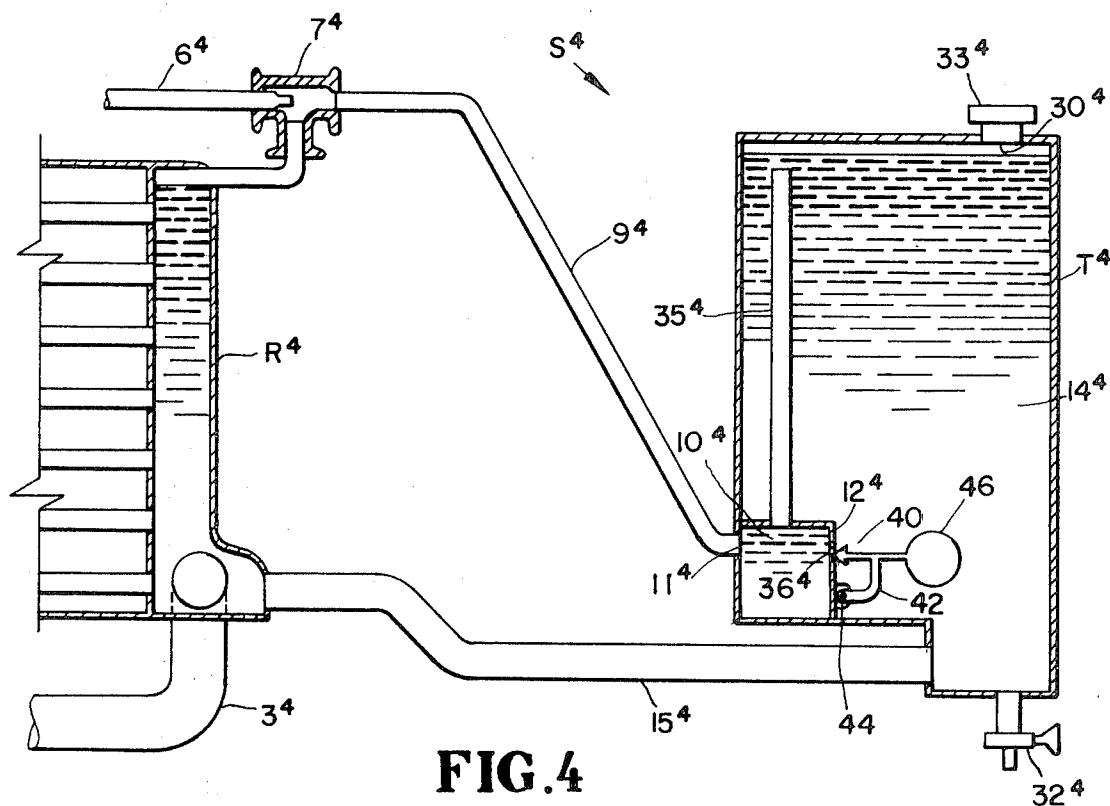


FIG. 3



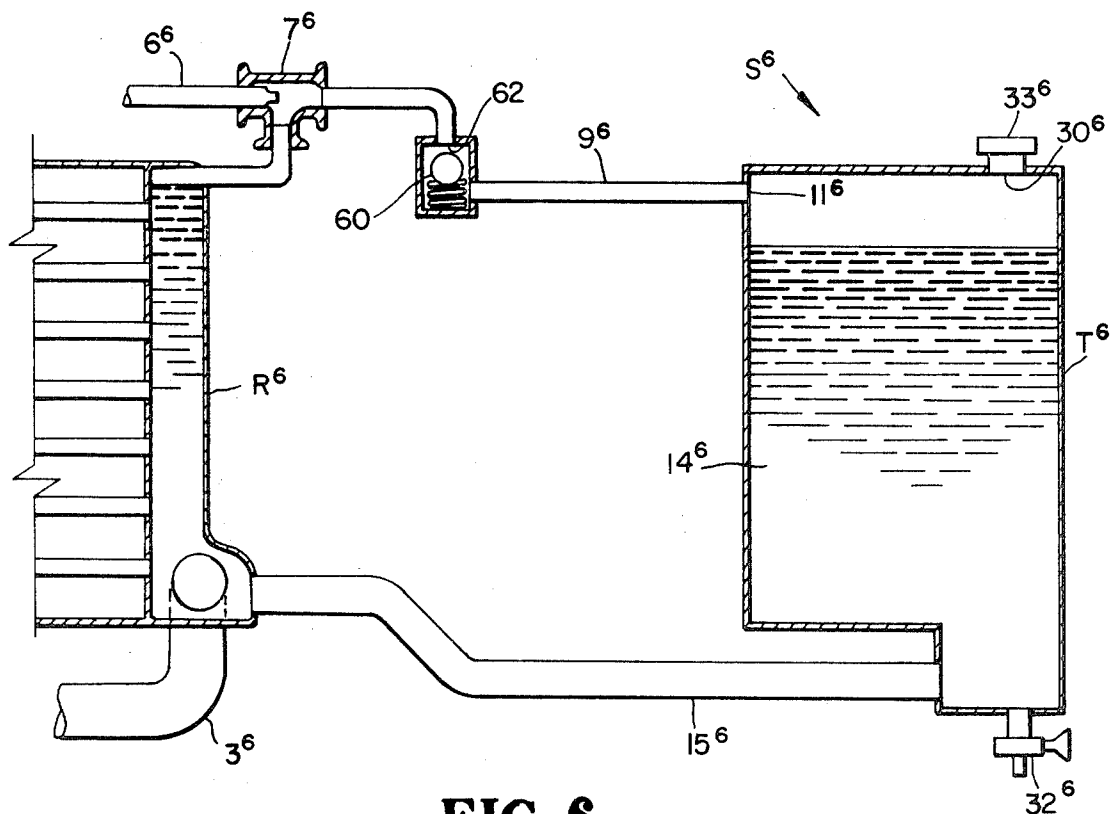


FIG. 6

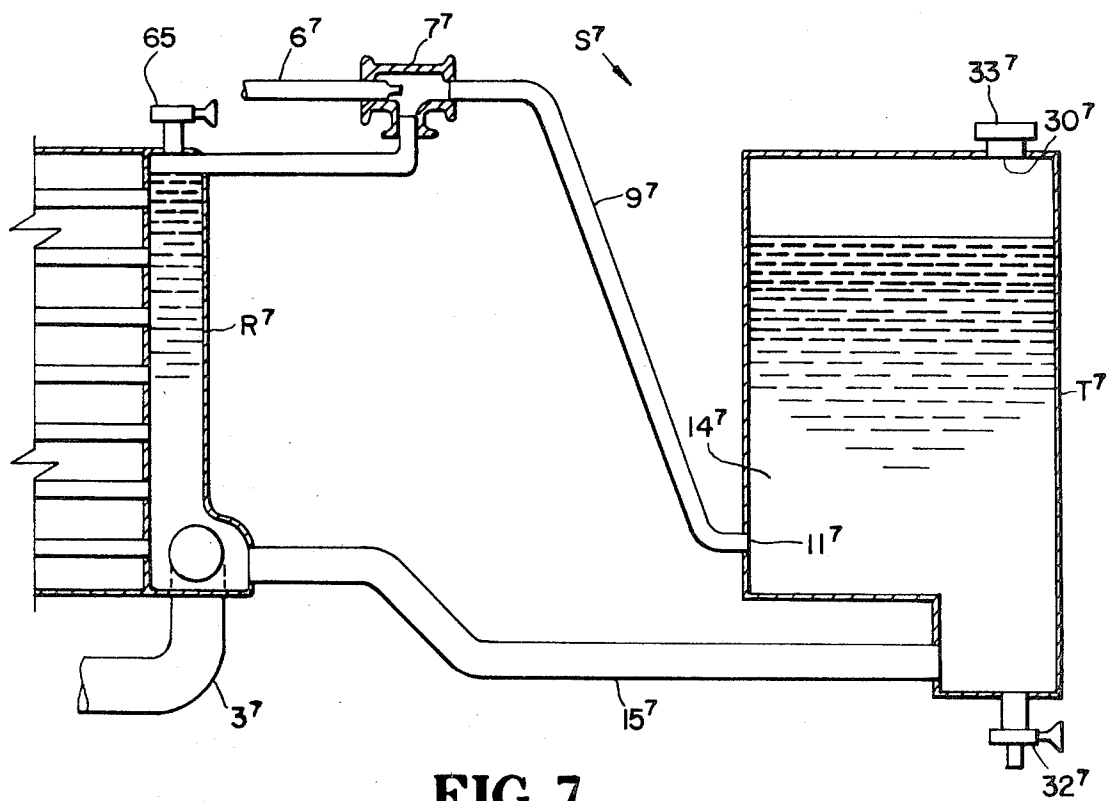


FIG. 7

APPARATUS FOR DEAERATING AN ENGINE COOLING SYSTEM

This invention relates to apparatus for deaerating an engine-cooling system, particularly a cooling system for an engine mounted on a vehicle. The apparatus forms a part of the cooling system and includes a makeup water tank that can be placed laterally adjacent the radiator, rather than above it.

Designers of trucks and related types of vehicles are constantly trying to achieve more attractive profiles for their vehicles. If the vehicle has a diesel engine with a cooling system requiring a makeup water tank, this tank can cause problems when attempting to "streamline" the vehicle profile. This is because the makeup water tank must usually be placed above the radiator, and the top of the radiator is usually at fairly high elevation. The radiator can be placed on its side for the sake of a low vehicle profile, but there still remains the problem of having to place the makeup water tank on top of the radiator, in order for the cooling system to operate properly.

In a conventional cooling system for diesel engines, a waterline is connected to the bottom of the makeup water tank and communicates with the bottom portions of both the radiator and the engine water passages. Vent lines lead from the top portions of the engine water passages and the radiator to the air space above the water in the makeup water tank. With this arrangement, the makeup water tank provides a head of water that always extends above the top portions of the radiator and the engine cooling passages, thereby keeping these lower units filled with water. Also, water laden with air bubbles travels through the vent lines from the engine and radiator to the air space above the water in the makeup water tank, and the water in the system is thereby deaerated.

If the top of the foregoing makeup water tank is lowered to the same elevation as the top of the radiator for the sake of a low vehicle profile, then the system will not work properly as described above. The water levels in the engine and in the radiator will tend to fall to the same level as the water in the makeup water tank, particularly when the engine is idling or is shut down. This tendency causes an airflow from the top of the makeup water tank back into the engine and the radiator through the cooling system vent lines. Such air causes accelerated erosion and corrosion in the cooling system, and often causes an "air lock" on the system's centrifugal water pump.

The foregoing problem cannot be solved simply by connecting the vent lines from the radiator and engine water passages to the bottom of the makeup water tank, rather than to the top of the tank. It is true that collect connections would create a "water lock" that would allow air from the engine and the radiator to pass through the vent lines and bubble up through the water in the makeup water tank, and this "water lock" would also keep the air in the top of the makeup water tank from backing into the engine and the radiator. However, when the engine is cool and most of the water from the engine bypasses the radiator, the foregoing vent connections would still permit air bubbles generated by combustion leaks and other air leaks in the cooling system to collect in the top of the radiator. Such air would not be forced out, because of the relatively static conditions in the radiator while the cooling water bypasses it. Also, a "water lock" created by so venting the engine water passages and the radiator would prevent the system from being properly refilled after it had been drained. During filling, it is necessary that the air initially in the radiator and engine passages have a way to escape to the air space above the water in the makeup water tank. The "water lock" on the vent lines connected to the bottom of the makeup water tank blocks the only available escape path for this air.

One object of our invention is to provide in an engine-cooling system an apparatus for deaerating the system which apparatus will draw air out of the system's radiator even when the makeup water tank included in the apparatus is placed laterally adjacent the radiator and the cooling system thermostat is set so that all or most of the water from the engine water passages bypasses the radiator.

Another object of our invention is to provide in an engine-cooling system, apparatus for deaerating the system and maintaining the engine water passages and radiator of the system filled with water, said apparatus having a makeup water tank that can be placed laterally adjacent the system's radiator while maintaining adequate means for deaerating, filling and draining the cooling system.

To accomplish the foregoing objects, our invention includes an aspirator or an equivalent means that is connected to the vent line of the engine and uses the velocity of the fluid in this vent line to draw air and water from the radiator. Also, our invention provides a fluid communicating means between the aspirator and the makeup water tank, which is designed with a "water lock" means or a valve means that prevent fluid in the fluid communicating means from flowing from the makeup water tank to the engine and radiator, but permits flow in the opposite direction. Additionally, in the case of the "water lock" means, our invention contemplates a means for releasing this "water lock" when the engine-cooling system is filled or drained.

The foregoing objects, as well as other objects accomplished by our invention, will be apparent from the following detailed description of our invention and the attached drawings in which:

FIG. 1 is a schematic drawing of an engine-cooling system, incorporating a preferred embodiment of our invention;

FIG. 2 is a schematic drawing showing a rearrangement of the components of the cooling system of FIG. 1;

FIG. 3 is a schematic drawing of a modified form of a portion of the engine-cooling system of FIG. 1;

FIG. 4 is a schematic drawing of a further modification of the engine-cooling system of FIG. 3;

FIG. 5 is a schematic drawing of another further modification of the engine-cooling system of FIG. 3;

FIG. 6 is a schematic drawing of another modified form of a portion of the engine-cooling system of FIG. 1; and

FIG. 7 is a schematic drawing of yet another modified form of a portion of the engine-cooling system of FIG. 1.

In the preferred embodiment of FIG. 1 engine E is provided with a cooling system S, comprising water passages A in the engine block, a radiator R, and a makeup water tank T. The water in tank T insures that the radiator R and passages A in engine E remain full of water, in spite of loss of water from the cooling system. The tank T also serves as a deaerating chamber to free the air bubbles trapped in the engine passages A and radiator R. These air bubbles result from such sources as gas leaks around the cylinder water jackets, and air leaks at the water pump.

In order to obtain a low vehicle profile, the radiator R has been placed on its side, and water flows crosswise in the radiator from left to right, as indicated by arrows a. Also, for the sake of a low vehicle profile the makeup water tank T is placed laterally adjacent the radiator R, rather than in its usual position above the radiator.

The connections between the radiator R and the water passages A in engine E are conventional. Pump P pumps water from the radiator through line 3 and into the passages A. After circulating through passages A, most of the water flows through thermostatic valve V where, depending on its temperature, it flows either into line 4 leading to the inlet of radiator R, or into bypass line 5 leading back to pump P, or is divided in some proportion between lines 4 and 5.

Air bubbles that are trapped in the water passages A eventually rise into engine vent line 6. These bubbles are carried away by diverting about 2 and 5 percent of the water in the passages A through the vent line 6. The desired percentage of water diverted is obtained by the proper sizing of the vent line 6 relative to the sizes of lines 4 and 5.

An aspirator 7 has inlets connected to vent line 6 and to a vent line 8 leading from the top of radiator R. In the aspirator 7, the water from vent line 6 forms a jet which draws water and air from radiator R up through vent line 8. Thus, except when thermostatic valve V diverts all of the water through bypass line 5, the water in the top of radiator R is maintained at a slight negative pressure.

Of course, the aspirator 7 may be substituted by a turbine-driven pump or other equivalent suction means for using the velocity of the water in vent line 6 to draw water and air from radiator R. The advantage of the aspirator is that it has no moving parts.

The outlet of aspirator 7 is connected to a combined vent line 9, which leads into the lower portion of a vent chamber 10 of tank T. The combined vent line 9 communicates with the vent chamber 10 by means of an upwardly facing port 11, which is designed to direct air bubbles from the vent line 9 upwardly through water in vent chamber 10. The port 11 is located in tank T below the level of line L, which is assumed to be the minimum operating level of the water in tank T.

The tank T has a central wall 12 which divides the tank into two chambers of substantially equal size, namely the vent chamber 10 and a fill chamber 14. Waterline 15 extends between the bottom of fill chamber 14 and the bottom of radiator R.

A siphon 16 is mounted in the central wall 12 and communicates between the vent chamber 10 and the fill chamber 14. The siphon 16 has a leg 18 with a bottom port 19 that is below the elevation of port 11 of combined vent line 9. Leg 20 of the siphon 16 is located in the fill chamber 14 of tank T, and has at its bottom end a U-shaped section 22 with an upwardly facing opening 23. A small upwardly facing port 25 is located at the bottom of leg 20, in the U portion of U-shaped section 22. Like port 19 of leg 18, the port 25 in leg 20 is below the elevation of port 11 of combined vent line 9. The section 22 with its upwardly facing opening 23 is provided to insure that air bubbles flowing from leg 20 into fill water chamber 14 are directed upwardly toward the top of tank T. Preferably, the section 22 extends about 6 inches above the port 25.

A small port 24 near the top of wall 12 provides air communication between the vent chamber 10 and the fill chamber 14. Also, a crossover section 26 extends through the central wall 12, and between legs 18 and 20 of siphon 16. The crossover section 26 is preferably above the level of the top portions of engine passages A and radiator R, but in any event, the section 26 should be no lower than slightly below the elevations of the top portions of the engine passages A and radiator R. As will be seen later when the operation of the system is described, the level of the crossover section 26 is important for insuring that the water passages A and radiator R receive an adequate amount of water during the filling of cooling system S.

The fill chamber 14 is provided with a fill port 30 and a drain petcock 32. Cap 33 covers the fill port 30, and contains a pressure relief valve that controls the pressure in the top of tank T.

In operation, to fill the cooling system S, water is poured into the fill chamber 14 through open fill port 30. This water flows from tank T through lines 15 and 3 to the radiator R and engine passages A. The water forces the air initially in the passages A and radiator R to flow out through vent lines 6 and 8 respectively. This air then flows through the aspirator 7 and combined vent line 9 into the vent chamber 10 of tank T. From the chamber 10, the air flows through port 24 in the top of wall 12, into fill chamber 14, and then to the atmosphere through fill port 30. With this vent path for the air, the incoming water from fill chamber 14 quickly fills radiator R and the passages A in engine E.

When the fill chamber 14 is filled to the level of crossover section 26 of siphon 16, the leg 20 and section 22 of the siphon will also be filled with water entering through opening 23 and port 25. In addition, the engine passages A and radiator R will be filled to approximately the same level as the level of crossover section 26 of siphon 16. If the crossover section 26 is at the same elevation as or is above the top portions of engine passages A and radiator R, then the passages A and radiator R will be substantially filled with water.

As more water is poured into the fill water chamber 14, the water in the siphon 16 flows through the crossover section 26

and down the leg 18, thus beginning the siphoning action. Water will then siphon from the fill chamber 14 into the vent chamber 10 until the levels of the water in the two chambers are equal. When the water in vent chamber 10 rises past the port 11 in combined vent line 9, it creates a "water lock" on the engine passages A and radiator R. This "water lock" prevents water from flowing back from the engine passages A and radiator R into the fill chamber 14 of tank T. Even if the water level in tank T drops to the level of line L, the water in engine passages A and radiator R will not tend to equalize with that level, because no air to replace that water can flow past the port 11, which is below the water level at line L. The water in chamber 14 may drop to the level of line L due to the continued siphoning of water from chamber 14 to chamber 10 after the "water lock" is established during filling of the cooling system S. Also, water in the cooling system may be lost during the running of engine E, and when the engine is stopped or idled, the water in tank T may drop to the level L.

Before the engine E is started there will be some air trapped in the vent lines 6, 8, and 9 by the "water lock" described above. Also, some air may be trapped in the top of engine passages A and in the top portion of radiator R, if the crossover section 26 at the tip of siphon 16 is slightly below the tops of engine E and radiator R. All the air so trapped will be quickly forced out when the engine is started and the pressure generated by pump P begins to force water upwardly through the radiator R and vent lines 6 and 9. This water draws the air out of the top of engine passages A by means of the aspirator 7, and all of the trapped air then travels through vent line 9 and bubbles up through the vent chamber 10. The air then passes through port 24 in wall 12 to the top of fill chamber 14, from where it gradually leaks out through the cap 33 covering fill port 30.

There is a limit to how much air can be forced out of the radiator R and passages A during the initial startup of the engine. If there is too much air in the engine passages A and radiator R, large air bubbles will be drawn down into the pump P through line 3, and these bubbles can cause an air lock on the pump P making it inoperative. It is for this reason that the crossover section 26 of siphon 16 should be at least an elevation slightly below the level of the top portions of engine passages A and radiator R.

During the operation of the engine E, water and trapped air bubbles continuously flow through the vent line 6 to form a jet in the aspirator 7. This jet draws water and air bubbles from radiator R through line 8. Thus, the radiator R will remain substantially filled with water, even when most of the water from engine passages A is being diverted by the thermostatic valve V through bypass line 5.

Air bubbles trapped in the engine passages A and radiator R flow through vent line 9, through upwardly facing port 11, and bubble upwardly through the water in vent chamber 10 to the air space in the top of the chamber. Port 4 in wall 12 provides air communication between the vent chamber 10 and fill chamber 14.

The water flowing out of the engine passages A and radiator R through the vent lines 6 and 8 is continuously replaced by water flowing from fill chamber 14 through waterline 15 to the radiator R. As the vent chamber 10 receives water from combined vent line 9 and fill chamber 14 loses water to line 15, water is siphoned from the vent chamber 10 to the fill chamber 14 through siphon 16. The water in the two chambers of tank T thus remains at substantially equal levels.

To drain the cooling system S, the petcock 32 in the bottom of fill chamber 14 is opened, and cap 33 is removed from fill port 30 to allow a free flow of air to the top of fill chamber 14. While the fill chamber 14 is draining, water siphons from the vent chamber 10 to the fill chamber 14, and the water levels in both chambers fall at approximately the same rate. However, no water initially flows from the passages A in engine E or from radiator R, due to the "water lock" established by the water in vent chamber 10 covering port 11 of vent line 9.

As tank T is drained, water continues to siphon from the vent chamber 10 to the fill chamber 14 until the water level in both chambers reaches the level of small port 25 at the bottom of U-shaped section 22. Since the small port 25 is positioned below the port 11 in combined vent line 9, the water level in vent chamber 10 will then be below the port 11 in vent line 9, thus breaking the "water lock" on radiator R and engine passages A. Then the engine water passages A and radiator R will drain freely through lines 3 and 15, the bottom of fill chamber 14, and the drain petcock 32.

FIG. 2 shows a cooling system S², which is almost the same as the system S of FIG. 1, except that the makeup water tank T² and the radiator R² are physically combined in one unit. In order to facilitate the plumbing, the vent chamber 10² is on the right side of tank T² and the fill chamber 14² is on the left side of tank T² (FIG. 2), which is the reverse of the arrangement in FIG. 1. These structural changes have no effect on the operation of the cooling system, and FIG. 2 is provided simply to show how the radiator and makeup tank may be combined in one compact unit.

Cooling system S³ of FIG. 3 is a more extensive modification of the system S of FIG. 1. The makeup water tank T³ includes a small vent chamber 10³ and a fill chamber 14³, separated by a wall 12³. Combined vent line 9³ from the aspirator 7³ communicates with vent chamber 10³ at port 11³. A standpipe 35 extends upwardly from vent chamber 10³. The top of standpipe 35 should be at the same elevation as one would place the crossover section 26 of the siphon 16 of FIG. 1.

A small drain port 36 is positioned in the wall 12³ at a level below port 11³. The drain port 36 is designed to drain the vent chamber 10³ during draining of the cooling system S³. However, since the vent chamber 10³ must not fill up too quickly during filling of the cooling system, the drain port 36 permits only a very slow waterflow between the chambers 14³ and 10³.

Unlike the port 11 of FIG. 1, the port 11³ need not be below any minimum water level in tank T. This port must, however, be at an elevation such that water flowing into vent chamber 10³ through drain port 36 during the filling of fill chamber 14³ does not block the port 11³ before the cooling system S³ is substantially filled with water.

As in the embodiment of FIG. 1, the fill chamber 14³ is provided with a fill port 30³ and a drain petcock 32³. Cap 33³ covers the fill port 30³. The bottom of fill chamber 14³ communicates with radiator R through waterline 15³.

In operation, water is poured into fill chamber 14³ of tank T³ through fill port 30³. This water flows into the engine water passages A and radiator R and forces out the air initially in these units, in the same manner as in the embodiment of FIG. 1.

As the water level rises in fill chamber 14³, water flows slowly into the vent chamber 10³ through drain port 36. Since the waterflow is slow, it is easy to fill the fill chamber 14³ to the top of standpipe 35, before the water level in vent chamber 10³ covers the port 11³.

When the level of water in fill chamber 14³ reaches the top of standpipe 35, water flows down through the standpipe and fills the vent chamber 10³. By this time, the engine water passages A³ and the radiator R³ will be filled or nearly filled with water. The filling of vent chamber 10³ blocks the port 11³, creating a "water lock" that prevent the water from flowing back to tank T³ from the engine water passages and the radiator R³.

During operation of the engine, water and trapped air bubbles flow from the engine passages and the radiator R³ through aspirator 7³ and down combined vent line 9³ to the vent chamber 10³. The air bubbles then escape through standpipe 35 to the top of fill chamber 14³.

When the petcock 32³ is opened to drain the cooling system S³, the water in fill chamber 14³ drains quickly. At the same time, water in standpipe 35 and vent chamber 10³ flows through drain port 36 into the draining fill chamber 14³. When the port 11³ in vent chamber 10³ is uncovered, air bubbles

travel quickly up the combined vent line 9³ and destroy the "water lock" on the engine passages A³ and radiator R³. Water then drains from the radiator R³ and engine passages A³ by way of lines 3³ and 15³, fill chamber 14³, and drain petcock 32³.

A disadvantage of the embodiment shown in FIG. 3 is that once the operator begins to fill the chamber 14³ by pouring water through fill port 30³, he must continue to pour until the water overflows into standpipe 35. If he interrupts this pouring for any length of time the water flowing through drain port 36 will fill up vent chamber 10³. This will block the port 11³ and create a "water lock" on the system before the engine water passages and radiator R have received enough water to prevent an air lock on the water pump when the engine is started.

The foregoing disadvantage may be eliminated by providing a float-ball-type valve for the drain port 36. FIGS. 4 and 5 show cooling systems S⁴ and S⁵ with two different types of float-ball valves that will solve the problem. In FIG. 4, a valve 40 is mounted on an arm 42 that is pivotally connected to the wall 12⁴ at pivot pin 44. Float-ball 46 connected to the pivot arm 42 causes the valve 40 to seat in the drain port 36⁴ whenever the water level in fill chamber 14⁴ is above the drain port 36⁴. Thus, the port 36⁴ need not be small and there will be no concern about the vent chamber 10⁴ filling up before the fill chamber 14⁴ is filled above the top of standpipe 35⁴. When the fill chamber 14⁴ is empty, the float-ball 46 drops, thus opening the drain port 36⁴. Water then drains out of standpipe 35⁴ and vent chamber 10⁴, breaking the "water lock."

With float-ball valve 48 in FIG. 5, the operation of the system S⁵ is very much the same as in FIG. 4. When the water level in chamber 14⁵ is above the drain port 50 in the bottom of vent chamber 10⁵, the float-ball valve 48 rises and closes the port 50. When the water level in chamber 14⁵ is below the drain port 50, as when the cooling system is drained, the ball 48 drops and opens the port 50. The float-ball 48 is constrained laterally by walls 52 which have openings 53 that permit the passage of water.

An objection that may be raised in using the float-ball-type valves of FIGS. 4 or 5 is that these valves are subject to leakage due to the building up of solid deposits around the drain port 36⁴ (FIG. 4) or drain port 50 (FIG. 5).

FIG. 6 shows still another modification of our invention. In cooling system S⁶, makeup water tank T⁶ has a single chamber, namely fill chamber 14⁶. Combined vent line 9⁶ feeds into the top of fill chamber 14⁶ at the same elevation as one would place crossover section 26 of siphon 16 of FIG. 1. As with the other embodiments, waterline 15 feeds from the bottom of fill chamber 14⁶ back to the radiator R⁶.

A spring-loaded check-ball 60 is located in the vent line 9⁶. Whenever the pressure on the engine and radiator side of check-ball 60 is less than the pressure on the side of the check-ball feeding into the tank T⁶, the check-ball 60 seats against the seat 62 and prevents air from flowing from the fill chamber 14⁶ back into the radiator R⁶ or the engine water passages. Thus, even though there is no "water lock" on the engine passages and the radiator R⁶, water will not drain backward out of these units into the fill chamber 14⁶, even when the engine is shut down. Whenever there is a tendency for such a flow of water, the check-ball 60 closes against its seat 62 thereby creating a "water lock" on the engine passages in radiator R⁶. There is no problem in filling the cooling system or in evacuating the air bubbles while the engine is operating, because air and water are free to flow from the aspirator 7⁶ through the open check-ball 60 and vent line 9⁶ into the fill chamber 14⁶.

However, the system S⁶ will not drain as fast as the previous systems S through S⁵. In draining, the fill chamber 14⁶ will first drain completely through the open petcock 32⁶ until waterline 15⁶ is exposed to air, thereby breaking the "water lock." Then the engine water passages and radiator R⁶ will begin to drain through the waterline 15 and petcock 32, but only as fast as air bubbles travel through the waterlines 3⁶ and 15⁶ to replace the water that is flowing out.

Still another embodiment is shown in the form of cooling system S⁷ of FIG. 7. Makeup water tank T⁷ has a single chamber namely fill chamber 14⁷. A combined vent line 9⁷ is connected to the bottom portion of fill chamber 14⁷ at the same elevation as one would connect vent line 9 to vent chamber 10 in FIG. 1. A valve or petcock 65 is provided in the top of radiator R⁷ and is open while the cooling system S⁷ is filled with water. The petcock 65 thus allows the air in the engine passages and radiator R⁷ to escape while water is filling these units. When the filling is completed, the petcock 65 is closed, thereby establishing the "water lock" which prevents the water from draining back out of the engine passages and radiator R⁷.

When draining the cooling system S⁷, the petcock 65 is again opened to break the "water lock," so that the water in the engine passages and radiator drains freely.

The disadvantage of the embodiment of FIG. 7 is that one can easily forget to open or close the petcock 65. An operator forgetting to open the petcock 65 could think he had filled the entire cooling system when he had only filled the fill chamber 14⁷. On the other hand, if the operator forgets to close the petcock 65 after filling the cooling system, he will lose large amounts of water through the open petcock while the engine is operating. In both instances, the engine could be seriously damaged by inadequate cooling.

It should be noted that in all the cooling systems S through S⁷, it is necessary to have an aspirator 7 or some equivalent means of using the velocity of the water in engine vent line 6 to draw air and water from the top of radiator R. Without such a means, air will collect in the top of radiator R when some or all of the water from the engine water passages is being bypassed through line 5 (FIG. 1). In addition, all the embodiments provide some means for preventing fluid from flowing from makeup water tank T and through the vent lines 6, 8, and 9 to the radiator R and engine passages A, while the cooling system is operating or the engine is shut down. Thus, water does not undesirably drain out of the engine and radiator and through the waterline 15 into the makeup water tank T.

While several embodiments of our invention have been shown and described herein, other embodiments and modifications may, of course, be designed which are within the scope of the appended claims.

We claim:

1. In a cooling system for an engine that includes water passages in said engine, a radiator in communication with said water passages, and vent lines connected respectively to said water passages and said radiator, apparatus for deaerating said cooling system during all conditions while said engine is operating comprising:

a makeup water tank having a fill chamber for storing water;
a waterline connected to said fill chamber and communicating with said engine water passages and said radiator;

suction means having fluid inlets connected to said vent lines and operable by means of the water moving in the vent line connected to said water passages to draw air and water through the vent line connected to said radiator; and

fluid communicating means connected between the outlet of said suction means and said fill chamber.

2. Apparatus of claim 1 wherein said fluid communicating means includes a "water lock" means preventing fluid from flowing from said fill chamber through said fluid communicating means to said engine water passages and said radiator, said "water lock" means permitting said fluid to flow in the opposite direction.

3. Apparatus of claim 1 wherein said fluid communicating means includes:

a combined vent line connected to the outlet of said suction means;

a vent chamber;

said combined vent line connected to said vent chamber and having a port communicating therewith at an

elevation below the minimum operating level of the water in said chamber;

a siphon communicating between said vent chamber and said fill chamber, said siphon having one leg located in said vent chamber and another leg located in said fill chamber, said siphon also having a crossover section connecting said legs at at least an elevation slightly below the elevations of the top portions of said engine water passages and said radiator; and

an air passage communicating between said chambers at at least an elevation substantially equal to said crossover section of said siphon;

whereby water introduced into said fill chamber to the level of said crossover section of said siphon starts a siphoning action which causes water to flow into said vent chamber, eventually covering said combined vent line port and providing a water lock on said vent lines, engine water passages, and radiator.

4. Apparatus of claim 3 wherein said fill chamber has a fill port through which water may be poured into the fill chamber, and a drain opening through which the water in said fill chamber may drain; and wherein:

each of said legs of said siphon has an opening to its respective chamber located below said combined vent line port in said vent chamber;

whereby said siphon operates during the draining of said fill chamber to siphon water from said vent chamber into said fill chamber until said combined vent line port is uncovered to destroy said "water lock" on said vent lines, engine water passages, and radiator.

5. Apparatus of claim 4 wherein:

said combined vent line extends laterally into said vent chamber, and said combined vent line port faces upwardly in said chamber so as to direct upwardly air bubbles flowing from said combined vent line into the water in said vent chamber; and

said siphon has a U-shaped section connected to the bottom of its leg in said fill chamber, said U-shaped section having an upwardly facing opening in said fill chamber, whereby air bubbles flowing from said siphon leg into said fill chamber are directed upwardly.

6. Apparatus of claim 1 wherein said fluid communicating means includes:

a combined vent line connected to the outlet of said suction means;

a vent chamber;

said combined vent line connected to said vent chamber and having a port communicating therewith;

a fluid passage connected between said vent chamber and said fill chamber, said fluid passage having a port communicating with said fill chamber at at least an elevation slightly below the elevations of the top portions of said engine water passages and said radiator, whereby the water in said fill chamber reaching the level of said fluid passage port spills into said vent chamber, fills the vent chamber above the level of said combined vent line port, and provides a "water lock" on said vent lines, engine water passages, and radiator; and

a drain port in said vent chamber located at a level below said combined vent line port, said drain port thereby enabling water to flow out of said vent chamber and break said "water lock."

7. Apparatus of claim 6 wherein:

said vent chamber is an integral part of said makeup water tank;

said fluid passage includes a standpipe extending upwardly from said vent chamber and within said fill chamber; said fluid passage port is an upwardly facing hole in the top of said standpipe;

said drain port communicates between said vent chamber and said fill chamber; and

said fill chamber has a fill port through which water may be poured into the fill chamber, and a drain opening through which the water in said fill chamber may drain.

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8. Apparatus of claim 7 including a valve for opening and closing said drain port between said vent chamber and fill chamber, said valve having a float member in said fill chamber which is positioned to rise and seat the valve against said drain port whenever the water in said fill chamber is above the level of said drain port, said float member also positioned to drop and open said drain port when the water in said fill chamber is below the drain port.

9. Apparatus of claim 1 wherein said fluid communicating means includes:

- a combined vent line connected between the outlet of said suction means and said fill chamber, said combined vent line having a port communicating with said fill chamber that is located at at least an elevation slightly below the elevations of the top portions of said engine water passages and said radiator;
- a check valve in said combined vent line that is normally

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open, but is loaded so as to close whenever the pressure on the engine and radiator side of the check valve is less than the pressure on the fill chamber side of the check valve, thereby preventing fluid from flowing from said fill chamber through said combined vent line to said engine and said radiator.

10. Apparatus of claim 1, wherein:

said fluid communicating means includes a combined vent line connected to the outlet of said suction means, said combined vent line connected to said fill chamber at an elevation below the minimum operating level of the water in said fill chamber; and

said apparatus includes a valve in the top of said radiator which can be opened to vent the top portion of the radiator during the filling and draining of said cooling system.

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