March 10, 1925. 1,529,070

J. M. LEA

LIQUID SUPPLY SYSTEM

Filed Nov. 29, 1920 2 Sheets-Sheet 1

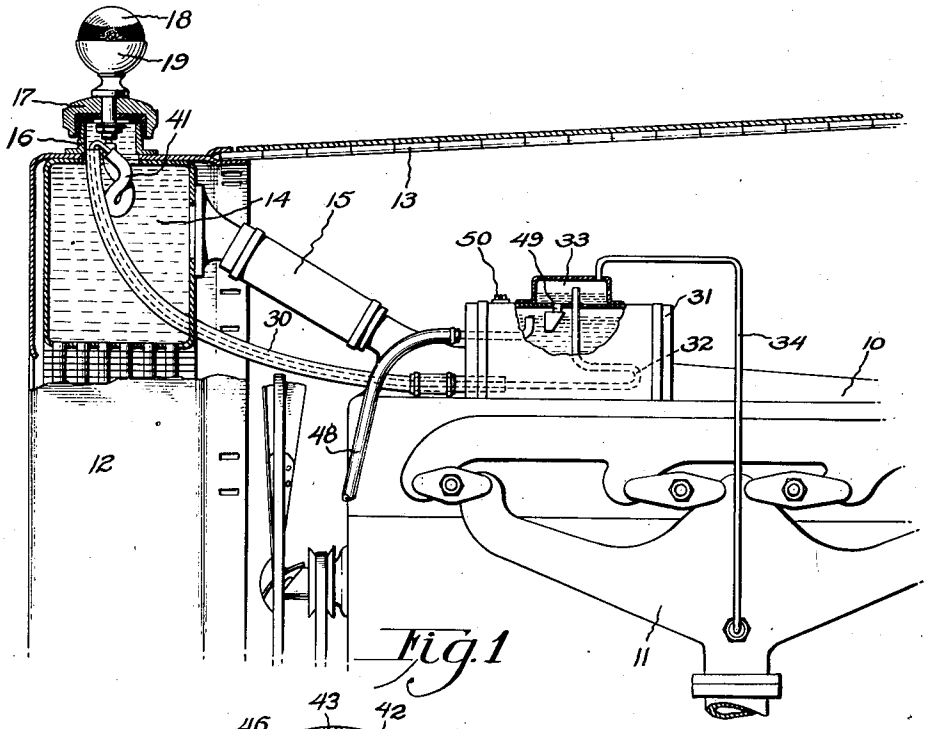


Fig. 1

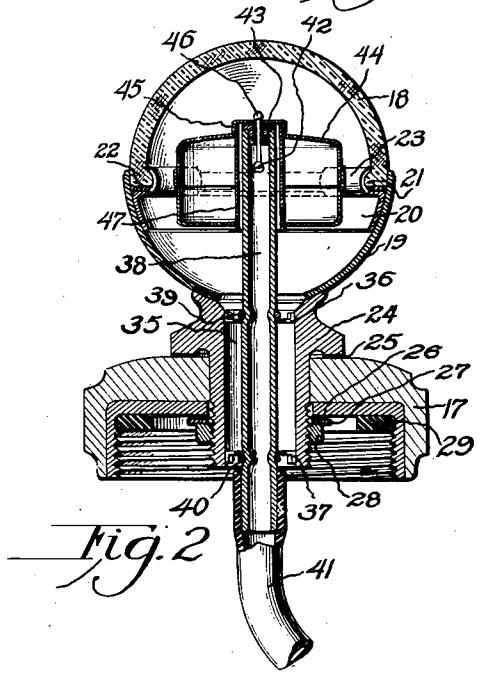


Fig. 2

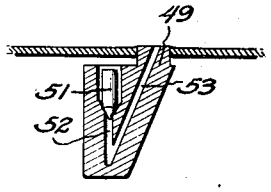


Fig. 5

Witness:
D. Watts.

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LIQUID SUPPLY SYSTEM

Filed Nov. 29, 1920 2 Sheets-Sheet 2

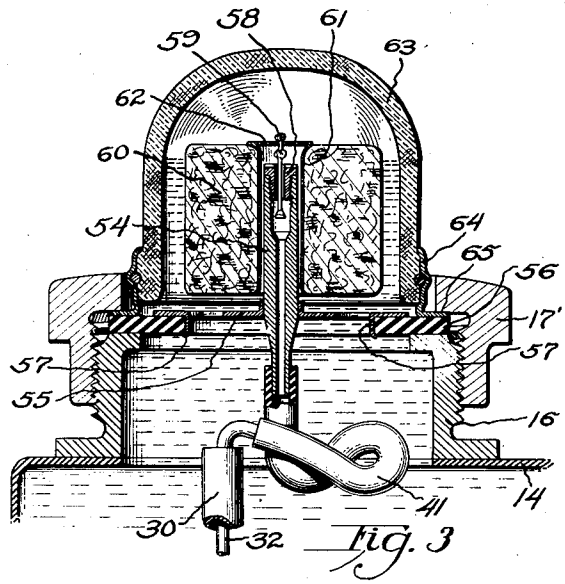


Fig. 3

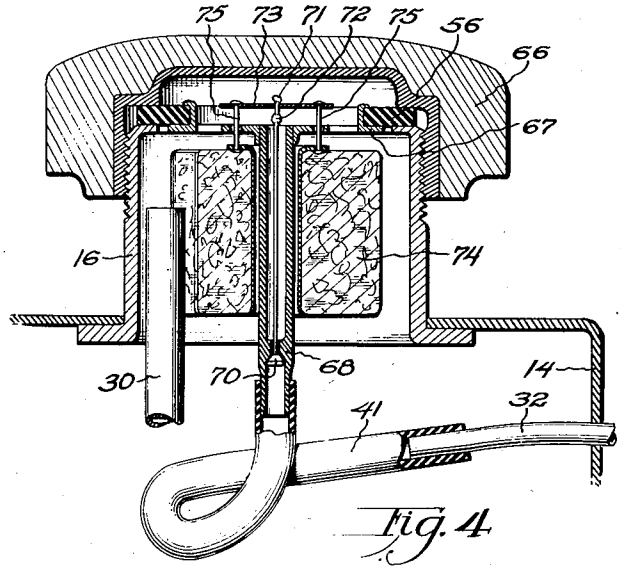


Fig. 4

Witness:

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Patented Mar. 10, 1925. 1,529,070

UNITED STATES PATENT OFFICE.

JOHN M. LEA, OF DETROIT, MICHIGAN.

LIQUID-SUPPLY SYSTEM.

Application filed November 29, 1920. Serial No. 427,345.

To all whom it may concern:

Be it known that I, JOHN M. LEA, a citizen of the United States, and a resident of Detroit, county of Wayne, and State of Michigan, have invented certain new and useful Improvements in Liquid-Supply Systems, of which the following is a full, clear, concise, and exact description, such as will enable others skilled in the art to which the invention relates to make and use the same, reference being made therein to the accompanying drawings, which form a part of this specification.

The invention relates to liquid level maintaining and indicating means and may have especial utility in connection with water-cooled internal combustion engines, and more particularly with those which form a part of the power plant of motor vehicles, such as aeroplanes, tractors, trucks, and passenger automobiles.

The invention has for its principal object the improvement of liquid cooling apparatus of the type above referred to in which sub-atmospheric pressure is utilized within the radiator for filling in one or more of the following respects:

1. By the provision of means for maintaining the level of cooling liquid in the liquid cooling receptacle or heat radiator of the system at a substantially constant point such that the said receptacle is in effect completely filled or the level held at a point even higher than is normally considered full.

2. By the provision of means whereby the level of cooling liquid and the physical effect of abnormal temperature conditions in the radiator may be observed by the operator preferably from the driver's station or seat.

3. By the provision of means attached to the radiator, per se, and preferably applicable to the filling opening or cover thereof, whereby the pressure within the radiator is controlled.

4. By the provision of a relatively inexpensive liquid supply mechanism which may be easily and quickly attached to or removed from existing engine power plants without modification, and, if desired, without necessitating the piercing of the radiator walls.

5. By the provision of means whereby the liquid supply system may be so arranged that the vapors generated in the radiator may be condensed and retained in the cooling system, liquid being fed to the radiator from a reserve supply while the engine is in operation to maintain the level substantially constant.

6. By the provision of means whereby the vapors generated in the radiator may be frequently removed by suction, but by condensation and subsequent trapping of said condensed vapor in an auxiliary vessel, is substantially prevented from entering the suction producing device and means for returning this liquid to the circulating system upon return of atmospheric conditions in said auxiliary tank as a result of stoppage of said device.

The invention has for a further object the provision of an improved liquid level maintaining device and indicating means especially useful therewith and generally applicable to systems or receptacles wherein it is desirable to maintain a substantially constant level of liquid.

With the above and other objects in view as will appear more fully from the following description, the invention comprises the features of novelty herein described, together with such variations and modifications as fall within the scope of the appended claims.

In the accompanying drawings:

Fig. 1 is an elevation partially in section showing the invention applied to a common form of automobile engine;

Fig. 2 is a sectional elevation taken through the radiator cap shown in Fig. 1;

Figs. 3 and 4 are sectional elevations showing modified forms of the control mechanism mounted in the radiator; and

Fig. 5 is a sectional view showing the construction of the supply tank valve.

Referring to the embodiment of the invention shown in Figs. 1 and 2, 10 indicates an internal combustion engine, which may

be any usual or desired form of engine of the water-cooled type, having an intake conduit or manifold 11 designed to convey explosive mixture to the engine cylinders. The heat radiator 12, which may be of any type adapted to dissipate heat from a cooling liquid, is shown as of a form commonly employed in automobiles and situated in front of the engine at the forward end of the hood 13. The radiator comprises a top header 14 connected to the water jacket of the engine by a pipe 15, similar provision being made at the bottom of the radiator for the return of cooling liquid to the engine, the circulation being induced by thermo-siphonic action or otherwise in the usual manner.

At the top of the cooling receptacle, shown as the radiator casing or header 14, is a reduced portion comprising a neck 16 which provides preferably a filling opening for the radiator and is screw-threaded to receive a cap or closure 17. In order to render visible to the operator the conditions within the cap, I provide the latter with a transparent portion which may take the form of a glass dome 18 arranged to be secured within a recess formed in the semi-spherical member 19 by formed members 20 and sectional ribs 21, formed upon the inner surface of the transparent portion 18, and held in substantially air-tight relation to the member 19 by the resilient gasket 22. The glass dome 18 may be inserted into said recess when the sectional ribs 21 register with the spaces between the curved portions 23 of the members 20. Then by pressing the dome against the gasket 22 and turning the dome relatively to the member 19 the curved portions 23 will engage over the ribs 21 and thereby retain the parts in assembled relation. Attached to or forming part of the member 19 is the hollow threaded member 24 which is inserted into a hole drilled in the radiator cap 17 and secured in practically air-tight relation by gaskets 25 and 26, washer 27, and nut 28, the cap being secured in practically air-tight relation in the usual manner by turning the cap 17 down upon the screw-threaded neck 16 and washer 29. The member 24 has a bore 35 which permits passage of liquids or gases between the dome-shaped enclosure and the radiator Upon the spiders 36 and 37 is mounted the tubular float support 38 which is aligned with the passage 35 by the spiders and is further held in position by wire clamp washers 39 and 40. This arrangement permits the whole valve mechanism to turn freely while screwing down the cap 17 preventing distortion of the flexible connection 41 which is an extension of suction conduit 32 and is preferably of the material commercially known as kerite. As indicated by Fig. 1, this flexible connection is made long enough to permit the removal of cap 17 without disconnection but can readily be disconnected from tubular support 38 if desired. Tubular support 38 communicates at its upper end with the space over the cooling system liquid but such communication is controlled by valve 42 acting upon its seat in plug member 43 which is preferably sealed into support 38. This valve is actuated by float 44 which is guided by the tubular support 38, float 44 being in this case constructed of metal, as is common to the art, having a center sleeve 47 which projects beyond the limits of the float wall and carries a formed member 45 through which the valve stem is loosely inserted and which combination permits ready assembly and alignment of the valve and float.

After this assembly is made and secured by solder or other means the end of the valve stem is flattened into the stop 46 which carries the valve to its seat upon the raising of float 44, the hole in the member 45 being sufficient to provide the desired gas passage between the space adjacent to and within the dome and the suction source.

Extending into the radiator is a conduit 30 serving as a supply conduit through which cooling liquid may enter the radiator. The conduit 30 leads to a reserve tank or auxiliary supply reservoir 31 which may be secured in any convenient position upon or adjacent to the engine but preferably below the top of the radiator so that liquid will not tend to overflow the radiator from the auxiliary tank when the radiator cap is removed. It is not material where the conduit 30 enters the radiator, nor is it essential that it extend to a point within the filler opening as shown. In installing the apparatus in connection with ordinary motor vehicle power plants, however, it is convenient to utilize for the conduit 30 the usual radiator overflow pipe, and I have so illustrated the construction in the drawing, the overflow pipe in this case being merely shortened and connected at its lower end to the tank 31 as, for example, by means of a short length of rubber hose and clamps.

A suction conduit 32 also extends into the radiator and has its end open at a point near the highest portion thereof. It also extends through the supply tank 31 and its other end is sealed into the upper portion thereof but opens into the auxiliary tank 33 at a point adjacent to its upper wall. One end of another suction conduit 34 is sealed into the wall of auxiliary tank 33 preferably adjacent to or in its upper wall and preferably extending to a point where sub-atmospheric pressure is maintained during the operation of the engine by means incident to such operation. In the drawing it is shown communicating with the en-

gine intake manifold 11. In order to avoid piercing the radiator walls the conduit 32 may be inserted through the conduit 30 as indicated in Figs. 1 and 3.

The auxiliary tank 31 may be provided with a suitable removable cap 50 to permit filling of the same independently of the radiator, although, with the arrangement of parts shown in Fig. 1 the tank may be filled by overflow from the radiator through conduit 30. An overflow connection 48 leads from the upper portion of tank 31 to any suitable point of discharge. This connection is open to the atmosphere and insures the maintenance of atmospheric pressure above the liquid in the supply tank.

Connecting the auxiliary tank 33 and supply tank 31, which may be two separate tanks with a check valve of the usual form or a partitioned tank which is the preferred form, as shown, is a valve controlled passage which may be formed in a member 49 as shown on an enlarged scale in Fig. 5. This member is preferably of metal and of such a thickness that it can be stamped out of sheet material in approximately the form shown.

Intersecting drilled holes 52 and 53 form a V-shaped path which will be closed below the intersection, against water leakage, in the position shown, so as to maintain a liquid seal for the valve 51 upon the seat formed by enlarging the hole 52 at its upper end. The upper portion of this member projects through the common wall of tanks 31 and 33 and is sealed therein preferably by soldering. The part of the member 49 through which the passage 52 opens is spaced slightly from the upper wall of tank 31, thus permitting flow from tank 33 to tank 31 so that when atmospheric pressure is restored in tank 33 as by the stoppage of the suction device, any liquid which has been condensed and discharged into tank 33 will flow by gravity into tank 31 which is also at atmospheric pressure. When the pressure in tank 33 is sub-atmospheric the valve 51 prevents air leakage from tank 31, the pressure of which is generally atmospheric by reason of the communication of conduit 48 with the atmosphere. Valve 51 is greater in length than the space between the end opening of passage 52 and the wall common to both tanks which latter therefore acts as a stop for the valve. The opening of passage 52 is preferably close to the upper wall of tank 31 and above the opening in over-flow pipe 48 so that in case valve 51 should fail to close the tank 33 will not be caused to fill with liquid and consequently be discharged into the engine through conduit 34 and the intake manifold 11.

In the form illustrated in Fig. 3 a tubular post 54 is carried by a plate 55 supported by and attached to the gasket 56 as by the struck-up points 57. The lower end of the post is connected by flexible tubing 41 to the upper end of the suction conduit 32 thus permitting the withdrawal of the gasket 56 and the parts supported thereon, when desired, to facilitate the filling of the radiator.

In an interiorly screw-threaded recess in the upper end of the post 54 is mounted a valve body 58 provided at its lower end with a valve seat adapted to cooperate with a valve 59. The stem of the valve 59 extends upwardly through a passage in the valve body 58 and carries two stops formed by flattening the stem, the lower one of which may be omitted if the opening of the valve by the float be regarded as unnecessary. A float 60, which may be of any suitable material commonly employed for this purpose but is shown as of cork, is mounted around the post 54 to be guided vertically thereby. A sleeve or lining 61 may surround the central aperture of the cork, and carried by the float, as by connection to the lining 61, is a valve-actuating member comprising a perforated plate fitting loosely about the stem of valve 59 between the stops shown. The disc may be perforated as at 62 to provide communication between the valve and the upper space, within the cap or dome, which perforations may be so arranged as to permit the insertion of a spanner or slotted screw-driver to engage a slot in the valve body 58 when desired to assemble or disassemble the parts.

In this form the transparent cap member may be constituted by the glass dome 63 secured to a metal ring 64 having a flange 65 which may be clamped upon the gasket 56 by the filler cap 17', the latter being provided with a central aperture through which the dome projects.

In the embodiment illustrated in Fig. 4 I have shown the conduit 32 as passing through the wall of the header 14 independently of the conduit 30. The cap 66 may be the ordinary radiator filler cap, the transparent portion being dispensed with in this case. The plate 67 in this instance carries the tubular post 68 depending therefrom, since this form of cap may not provide sufficient space for the valve mechanism to be supported above the gasket 56.

A valve 70 is arranged within the post 68, the valve stem extending upwardly and being provided with the stop 71 and, if desired, the stop 72. A bridge 73 supported upon the float 74 by studs 75 fits loosely about the valve step between the stops 71, 72, and serves to seat or unseat the valve as the float rises or falls. Since the valve mechanism is supported upon the gasket 56 it may be removed from the filler opening upon removal of the cap.

The operation of the structure described is as follows:

Supposing that the radiator and reserve tank have been filled with cooling liquid, for example water, through the radiator filling opening alone or through said opening and the opening in the top of the reserve tank, and the filler cap has been applied in substantially air-tight relation to the system, the cooling liquid will stand in the radiator at the level of the top or end opening of the overflow pipe 30. The float will rest in its lowermost position and the float-operated valve will therefore be open. If now the engine be started the partial vacuum produced in the engine intake conduit or manifold will be communicated through pipes 34 and 32 to the upper portion of the radiator thereby causing liquid to flow from the reserve tank through pipe 30 until the float rises and closes the valve, at which time, if the transparent cap or dome is employed as indicated, the liquid may be seen from the driver's seat. At this time the level of liquid will be above the outlet of the overflow or supply conduit 30 and the pressure in the dome will be sufficiently below atmospheric pressure to balance a column of liquid of a height equal to the difference between the levels in the radiator and the reserve tank.

When the cooling liquid becomes sufficiently warm to begin to vaporize, the evolution of vapor will relieve the vacuum to a certain extent thereby permitting the level of liquid to fall until the float operates to open the valve and thus re-establish communication with the engine intake.

Vapor drawn off through the suction conduit 32 will be condensed therein due to its large superficial area relatively to its volume and to the cooling effect of the medium in tank 31 and conduit 30 through which the conduit 32 passes. If desired, the suction conduit may be given greater condensing area by increasing its length by bends or coils either in the air or, as indicated in the drawing, in tank 31. Any vapor thus condensed will be trapped in tank or chamber 33, and upon its accumulation in sufficient amount to counterbalance the existing suction or upon the reduction of suction as by stoppage of the engine or opening the throttle, the liquid will flow through the communicating passages to tank 31, the valve 51 opening under hydraulic pressure and permitting the return of the condensate to the reserve tank or supply reservoir.

Since the float valve opens toward the intake, it will tend to be opened both under the influence of the suction and of the pressure of the vapors present in the radiator, that is due to the differential pressure into the area of the valve seat, hence the opening movement will take place, when the engine is running, somewhat before it would be effected by the loss of buoyant effort or the weight of the float due to the lowering of the liquid. The fluctuations in level are therefore even less than those provided for by the normal range of movement of the float.

When the cooling medium is sufficiently heated, ebullition will occur to such an extent that the vapor cannot be entirely drawn off through the comparatively restricted passage 32, in which case the liquid may fall to a level at or somewhat below that of the end opening of the overflow or supply pipe 30, and any excess vapor may escape freely through said pipe to the reserve tank, in which it will normally condense, or, under extraordinary conditions, it may escape to the atmosphere through the overflow pipe 48. A moderate amount of ebullition may occur without lowering the level of liquid below the transparent dome, when the latter is employed, the formation of bubbles being plainly visible through the dome and thereby giving notice to the operator of the physical condition of his cooling system. This notice will be considerably in advance of actual dangerous conditions due to bubbles forming with greater and greater frequency as the boiling point is approached. There is considerable vaporization at temperatures considerably below the boiling point and this effect is further accelerated by the reduced pressure in the radiator. This feature is particularly valuable when use is made of anti-freezing mixtures, such as alcohol mixtures, where the boiling point is much lower than that of water, the cooling fluid generally employed. Such low-boiling constituents will be distilled off and lost to the ordinary liquid circulating system during the normal operating temperatures of an engine as indicated by a thermometer or other temperature responsive element, as the temperature at which serious loss of the liquid will take place is usually unknown to the engine operator and indeterminate, due to material used and its concentration which again is usually indeterminate. Ebullition and vaporization also take place at greater or less speed depending upon temperature and pressure. A sight indication, therefore, of the action of the liquid itself is the only convenient and true criterion which will permit the driver to adjust the radiation conditions of his engine so as to be able to operate at the highest profitable temperature, taking into account the loss of so-called anti-freezing compounds such as alcohol which is expensive as compared with water. In case the boiling becomes so rapid as to be indicative of dangerous conditions, or should the system become inoperative through leakage or other cause, or should the reserve supply of liquid become exhausted, the lowering of the level of liquid in the cooling system below the

position of visibility will give immediate indication of the existence of abnormal conditions.

While the transparent portion of the liquid receptacle might be varied widely in character, the dome-shaped form is preferred, since, by reason of the refractive effect of the curved body, it reduces the apparent size of the gas bubble, or space unoccupied by liquid, and causes the level of liquid to appear higher than it really is. The difference in refraction and reflection of light which occur when the dome is partially filled with liquid, render the height of liquid readily apparent even with the imperfect illumination usually available at night.

The suction conduits 32 and 34 are formed preferably from quite small tubing, or otherwise restricted in cross-section, whereby the condensation in conduit 32 is facilitated and whereby the production of vacuum in the conduits and associated chambers is rendered relatively uniform notwithstanding the fluctuations in pressure conditions occurring in the source of suction as in the engine intake. The constriction especially of conduit 34 prevents the occurrence in chamber 33 of abnormally high vacuum corresponding to sudden increases in suction in the engine intake, thereby eliminating the probability of inducing further ebullition in the said chamber. Since the operation of the mechanism requires only the removal from the system on starting of sufficient air to produce the required sub-atmospheric pressure, any vapor which is drawn off being condensed in the system, there will be no continuous flow to the engine intake but merely an ebb and flow as suction conditions vary due to varying conditions of engine operation.

It will be seen from the foregoing description that the liquid supply system which I have devised may be readily installed either as original equipment or as an accessory for vehicles already in service. The working parts are simple and easily and cheaply constructed and applied, the manner of mounting and assembling the parts being such that they are readily accessible for removal, inspection, cleaning, or repair. Since the valve mechanism is mounted within the radiator casing or within the indicator extension, no special fabricated housing is required, and its location in the upper part of the radiator permits sand, rust particles, or other sediment to be removed by gravity from the vicinity of the valve.

The indication is undisturbed by the ordinary interflow between the liquid cooling system and the reservoir due to expansion and contraction of the liquid caused by changes in temperature.

The indication given by the device under normal conditions presents the appearance represented in Fig. 1, comprising a bubble in the upper portion of the dome below which appears a band formed by the liquid, the color and character of which band will depend somewhat upon the nature and color of the float and the presence of which may be rendered even more apparent by a contrasting color on the lower portion or cup of the indicator. The liquid itself may be colored, if desired, to further accentuate the contrasting features of the indicator. The distinctive appearance is such as to afford a clear indication at some distance from the device and in any direction, as from the station or seat of the operator or driver.

While I have described the invention in the foregoing embodiments as applied to the radiator of a motor vehicle engine, it will be understood that it may be applied in other relationships wherever the novel features herein disclosed may be useful or desirable.

Many variations and modifications in details of construction may also be made in addition to those herein described without departing from the spirit or sacrificing the advantages of the invention, and therefore I do not wish to be limited to the specific structure herein set forth except as required by the language of the appended claims.

I claim:

1. In a cooling system for internal combustion engines for motor vehicles, the combination of a heat radiator having a transparent portion visible from the driver's station and means for supplying cooling liquid to said radiator to maintain the level of liquid within said radiator normally within said transparent portion during the operation of the engine.

2. In a radiator construction for motor vehicles, the combination of a radiator having a filling opening, a cap adapted to cooperate with said opening, said cap having a transparent dome, and means for normally maintaining the level of cooling liquid in said radiator within said dome during the operation of the engine.

3. In radiator construction, a radiator casing having a reduced upper portion provided with an opening, a cap for said opening, supply and suction conduits and float valve mechanism removable through said opening upon the removal of said cap and arranged to control flow through said conduits.

4. In a liquid cooling system for internal combustion engines, a heat radiator having a filling tube and a cap therefor, a suction conduit having a float valve controlled orifice and supported between said filling tube and said cap.

5. In a cooling system for internal combustion engines, a radiator, an auxiliary supply tank, a conduit leading from said tank and having an end opening in said radiator, and suction means for causing flow

through said conduit for maintaining the level of cooling liquid within said radiator normally during the operation of the engine above the end opening of said conduit.

6. In a liquid cooling system for internal combustion engines, a heat radiator an auxiliary supply tank, a supply conduit leading from the radiator to said tank, and a suction conduit located within said supply conduit and arranged to communicate with the upper portion of said radiator.

7. In a liquid cooling system for internal combustion engines, a radiator having the usual overflow pipe leading from the upper portion thereof, a reserve tank to which said pipe is connected, a suction conduit extending through said pipe to the upper portion of the radiator, and means for controlling flow through said conduit.

8. In a cooling system for internal combustion engines, a heat radiator, a reserve tank, a combined supply and overflow conduit connecting the tank to the radiator, a suction conduit leading from the upper part of the radiator, and float-operated valve mechanism for controlling flow through said suction conduit, said valve mechanism being so constructed and arranged that the valve tends to open under the influence of the suction in the suction conduit and the vapor pressure in the radiator, and close due to the buoyant effort of the float.

9. In a cooling system for internal combustion engines, a radiator having a filler opening and a gasket and a cap therefor, a reserve tank, a conduit connecting the tank to the radiator, a suction conduit extending to the upper part of said radiator within said filler opening, and float valve mechanism supported upon said gasket and housed within said cap for controlling flow through said conduit.

10. In a cooling system for internal combustion engines, a radiator having a filler opening and a gasket and a cap therefor, a reserve tank, a conduit connecting said tank to said radiator, a suction conduit extending to the upper part of said radiator, a valve arranged to close the extremity of said conduit and opening in the direction of flow therein, and a float arranged to close said valve at its upper limit of movement, the valve mechanism being mounted upon said gasket and depending therefrom in the filler opening.

11. A liquid level indicator for liquid cooling systems applicable to motor vehicles comprising a base adapted to be applied to a radiator filling opening, a transparent dome supported upon said base, and means for controlling supply of cooling liquid to said radiator comprising float valve mechanism mounted within the enclosure formed by said base and dome.

12. A liquid level indicator for liquid cooling systems applicable to motor vehicles comprising a base adapted to be applied to a radiator filling opening, a transparent dome supported upon said base and means for controlling supply of cooling liquid to said radiator comprising float valve mechanism mounted within the enclosure formed by said base and dome and in swivelled relation thereto.

13. The combination of a cooling system for internal combustion engines, a liquid supply reservoir having an overflow outlet, means for applying suction to reduce the gas pressure in the cooling system, means for condensing vapor withdrawn by such suction means, means for trapping the condensate and returning it to the reservoir, and means for preventing flow from said reservoir to said suction means, comprising a liquid-sealed valve having its exit at a higher point in said reservoir than said overflow outlet.

14. In a cooling system for liquid cooled internal combustion engines, a radiator, a chamber having a sight opening, a liquid reservoir auxiliary to the radiator, means incident to the operation of the engine for supplying liquid from said reservoir to said radiator to maintain normally the upper level of liquid in said radiator within predetermined limits with reference to said sight device, whereby said upper level may be observed through said sight device.

15. In combination with a liqud cooled internal combustion engine and a sight device connected to the cooling system thereof, means associated with said sight device and system for normally maintaining the level of the liquid in said system with its upper level in predetermined relation to said sight device and for directing ebullition bubbles from said system out through said portion of liquid.

16. The combination with the liquid cooling system of an internal combustion engine, a liquid supply reservoir open to atmospheric pressure, and means permitting liquid communication between them, of means for reducing the pressure within the system below atmospheric by the extraction of the surplus quantity of gas from a measured volume of gas confined and maintained therein during the normal operation of the engine whereby liquid is caused to flow from said reservoir to said system by atmospheric pressure, and means for condensing the vapor of said extracted gas during the operation of the engine.

17. The combination with the liquid cooling system of an internal combustion engine, a liquid supply reservoir open to atmospheric pressure, and means permitting liquid communication between them, of means for reducing the pressure within the system below atmospheric by the extraction of

the surplus quantity of gas from a measured volume of gas confined and maintained therein during the normal operation of the engine whereby liquid is caused to flow from said reservoir to said system by atmospheric pressure, and means for condensing the vapor of said extracted gas and retaining the condensation liquid in said cooling system during the operation of the engine.

18. The combination with the liquid cooling system of an internal combustion engine, a liquid supply reservoir open to atmospheric pressure, and means permitting liquid communication between them, of means for reducing the pressure within the system below atmospheric by the extraction of the surplus quantity of gas from a measured volume of gas confined and maintained therein during the normal operation of the engine whereby liquid is caused to flow from said reservoir to said system by atmospheric pressure, means for condensing the vapor of said extracted gas, during the operation of the engine, means for retaining the condensation liquid and means for discharging said condensation liquid into said reservoir upon the restoration of atmospheric pressure in said retaining means.

19. The combination with the liquid cooling system of an internal combustion engine, a liquid supply reservoir open to atmospheric pressure, and means permitting liquid communication between them, of means for reducing the pressure within the system below atmospheric by the extraction of the surplus quantity of gas from a measured volume of gas confined and maintained therein during the normal operation of the engine whereby liquid is caused to flow from said reservoir to said system by atmospheric pressure, means for condensing the vapor of said extracted gas, means for discharging said condensation liquid into said reservoir upon the restoration of atmospheric pressure in said retaining means, a chamber having a transparent portion, in communication with said system and so located in respect to the liquid in the system, that a portion of the gas, maintained in the system, will be confined therein, and means for controlling the volume of the gas in said chamber during the normal operation of the engine.

20. The combination with the liquid cooling system of an internal combustion engine, a liquid supply reservoir and a conduit permitting liquid communication between them, of a chamber comprising a space above the outlet of said conduit in communication with said system and so located in respect to the liquid in the system that a portion of the gas which may be in or generated in the system will be contained therein and means for maintaining the volume of the gas contained in said chamber less than the total volume of said chamber, during the normal operation of the engine.

21. The combination with the liquid cooling system of an internal combustion engine, a liquid supply reservoir and means permitting liquid communication between them, of a chamber in communication with said system and so located in respect to the liquid in the system that a portion of the gas which may be in or generated in the system will be contained therein and means for maintaining the volume of the gas contained in said chamber less than the total volume of said chamber, said chamber having a transparent portion so arranged that changes in the volume of the gas may be observed and indicate the conditions in the liquid cooling system during the operation of the engine.

22. The combination with the liquid cooling system of an internal combustion engine, a liquid supply reservoir and means permitting liquid communication between them, of a chamber in communication with said system and so located in respect to the liquid in the system that a portion of the gas which may be in or generated in the system will be contained therein and means for maintatining the volume of the gas contained in said chamber less than the total volume of said chamber, said chamber having a transparent portion so arranged that changes in the volume of the gas may be observed and indicate the conditions in the liquid cooling system during the operation of the engine, said transparent portion being dome-shaped and confining said gas in its upper portion.

23. The combination with the liquid cooling system of an internal combustion engine, a liquid supply reservoir and means permitting liquid communication between them, of a chamber in communication with said system and so located in respect to the liquid in the system that a portion of the gas which may be in or generated in the system will be contained therein and means for maintaining the volume of the gas contained in said chamber less than the total volume of said chamber, said chamber having a transparent, dome-shaped portion filled partially with liquid and partially with gas during the normal operation of the engine.

24. The combination with the liquid cooling system of an internal combustion engine, a liquid supply reservoir open to atmospheric pressure, and means permitting liquid communication between them, of means for reducing the pressure within the system below atmospheric by the extraction of gas, means for condensing the vapor of said extracted gas, and means for retaining the condensate during the operation of the engine.

25. The combination with the liquid cool-

ing system of an internal combustion engine, a liquid supply reservoir open to atmospheric pressure, and means permitting liquid communication between them, of means for reducing the pressure within the system below atmospheric by the extraction of gas, means for condensing the vapor of said extracted gas, means for retaining the condensation liquid, and means for discharging said condensate into said reservoir upon the restoration of atmospheric pressure in said retaining means.

In testimony whereof I affix my signature.

JOHN M. LEA.