This invention relates to an air-liquid separator and more particularly to a device for separating entrapped air or gas from a liquid by a simple and efficient device whereby the liquid is subjected to both centrifugal force and pressure to separate the entrained air from the liquid and thereafter expel the separated air or gas from the device and delivering the de-gassed liquid to a desired place of use.

While the device is illustrated as particularly applicable to the separation of air or gas from lubricating oil before this oil is delivered to an engine or other apparatus having mechanism needing lubrication, it will be understood that the invention has other applications as well, for example, as separating air from fuel oil prior to returning it upon delivery to a customer or separating air from gasoline before delivering it to a service station or in any situation where it is desired to expel from a liquid the gases entrained therein.

A number of advantages accrue from such separation of air or gas from fuel. It results in more efficient lubrication when air or gas is removed from lubricating oil. When removed from fuel, the fuel-air-ratio can be more consistently maintained, thereby optimizing the efficiency of the fuel-consuming equipment. When gases normally carried in suspension are removed from a liquid which is to be transported, a greater mass of liquid can be carried in a given size container such as a tanker.

As illustrated, the apparatus comprises an air or gas separator having a helical passage through which the aerated liquid is forced under pressure by a pump to be subjected both to the pressure of the pump and to centrifugal force in its helical passage through the separator and means for receiving the air or gas separated from the liquid for delivering it from the liquid through a separate and restricted exit passage so as to maintain pressure in the separator.

For example, if used in connection with a lubricating system, the oil may be pumped from a tank or other source of supply into a container or chamber within which is a helical baffle carried by a tubular stem. The peripheral edge of the baffle makes close contact with the wall of the chamber or separator body so that the oil which is delivered tangentially to the chamber will be directed in a helical path around the central stem to an outlet from which it is carried to a desired place of delivery.

The central stem is tubular and is provided with openings in its wall so that the air or gas entrained in the liquid which is forced toward the axis of the chamber, the air or gas being forced axially outward by centrifugal force, will pass into the tubular stem and delivered therefrom through a restricted opening. As the liquid is pumped into the chamber, it will be under pressure, and as the opening through which the separated air is delivered is restricted in size, pressure will be maintained in the chamber which, in addition to the centrifugal force, will squeeze the air out of the liquid and thus effect an efficient separation of the gas from the liquid.

One object of the present invention is to provide a new and improved simple and efficient separator or de-aerator for liquids which may carry entrained air or gas.

Still another object of the invention is the provision of a new and improved air separator of the character described wherein the liquid is forced under pressure through a helical passage in a chamber to separate the air or gas from the liquid and through a restricted exit passage separate from that through which the de-aerated liquid is delivered.

Still another object of the invention is to provide a new and improved efficient air-liquid separator comprising a chamber having therein a tubular stem having openings in the wall thereof communicating with the interior of the chamber and a helical baffle secured to the stem, the peripheral edges of which fit closely against the wall of the chamber whereby liquid having entrained gas or air therein may be forced through the chamber under pressure and over a helical path to separate the air or gas therefrom.

To these and other ends the invention consists in the novel features and combinations of parts to be herein described and claimed.

In the accompanying drawings:

FIG. 1 is a diagrammatic view of a lubricating system wherein my improved air-liquid separator is employed;

FIG. 2 is a vertical sectional view of the air-gas separator;

FIG. 3 is a horizontal sectional view on line 3--3 of FIG. 2; and

FIG. 4 is a view partly in elevation and partly in section showing a modified form of air separator.

In the diagrammatic view of FIG. 1 which shows the air separator as used in a lubricating system for an internal combustion engine or other apparatus the air separator is shown at 10 having an inlet pipe 11 through which oil is pumped to the separator by the pump 12 from a tank or other source of supply 13.

After passing through the separator the oil is delivered by a pipe 14 to a cooler 15, if one is desired, and delivered from the cooler by the delivery pipe 16. The pipe 16 has a plurality of branches 17 which lead to various parts of the engine 18 or other device to be lubricated.

After being used the oil returns to a sump 19 and thence through a tube 20 to the tank 13.

The construction of the separator indicated generally by the numeral 10 is shown more particularly in FIGS. 2 and 3. This apparatus comprises a chamber having a wall 21 which may be of any suitable shape such as cylindrical, which chamber is closed by a cap 22 to which may be secured a tubular stem 23, the interior of which connects with the interior of the chamber by openings 24. The tubular stem 23 is closed at its lower end, as shown at 25, and at its upper end is provided with a restricted vent or bleed 26 through which the separated air together with some of the liquid may exit.

The outlet of the pump 12 communicates with the interior of the chamber through the inlet passage 27, which, as shown in FIG. 4, is arranged tangentially to the chamber wall so that the oil or other liquid will be given a swirling motion when introduced into the chamber under pressure of the pump. The oil is delivered from the chamber through the outlet 28 remote from the inlet 27, which outlet communicates with the pipe 14 shown in FIG. 1. If desired a pipe 29 (FIG. 1) may connect the restricted or vent opening 26 with the tank 13 so that, if any oil is discharged with the separated air, it will be returned to the tank to be used again. The restricted outlet 26 may be provided in a hollow fitting 25 threaded into the cap 22, and it may be noted that the opening 26 is a sharp-edged orifice which tends to restrict the passage of liquid through the opening and maintains pressure in the spiral chamber.

A helical baffle 31 is provided in the chamber of the separator 10 which may be secured in any desired manner and supported by the hollow stem 23. The outer peripheral edge of the baffle fits closely against the wall 21 of the chamber so that there will be no space through...
which the coil may creep along the chamber wall without following the helical path. It has been found, for example, that the greatest portion of the separation of the air from the oil occurs at a point in the chamber remote from the inlet. Hence, if the oil or other liquid were allowed to creep along the wall of the chamber, the efficiency of the device would be reduced.

The helical baffle may be made of such a size to have a similar effect in the chamber of the separator to enable its removal, if desired, for cleaning or other purposes. In order to insure tight contact between the periphery of the baffle and the chamber wall, the latter may be shrunk upon the baffle to prevent any chance of the liquid passing axially along the wall of the chamber. The helical baffle 31, together with wall 21 (FIG. 2) or wall 21a (FIG. 4) defines and provides a continuous helical passage between the inlet and outlet openings of the separator.

A somewhat modified form of my invention is shown in FIG. 4 wherein the wall 21a of the separator 10 is provided with a helical groove 33 within which the peripheral edge of the baffle 31 extends. This will provide a tight fit between these two elements and at the same time permit removal of the hollow stem 23 and baffle 31 by rotating it with respect to the wall 21a. In this embodiment of the invention a liquid or oil filter 34 may be provided at one end of the separator, the filter receiving the oil or other liquid through the inlet 35. The chamber or container 26 of the filter communicates with the separator 10 through an opening 37. Otherwise the construction shown in FIG. 2 is like that shown in FIG. 3, and it will be understood that the liquid is forced into the inlet 35 in the usual manner as by a pump so that it is propelled through the separator under pressure and in a helical path. While I have shown and described some preferred embodiments of my invention, it will be understood that it is not to be limited to all of the details shown, but is capable of modification and variation within the spirit of the invention and within the scope of the claims.

What I claim is:

1. A gas-liquid separator comprising means providing a closed chamber having inlet and outlet openings, means defining a continuous helical passage for the liquid from the inlet to the outlet opening, a hollow stem extending along the axis of the helical passage and having openings therein communicating with the passage to admit gas separated from the liquid into said stem, a pump having its high pressure side connected to the inlet opening for forcing liquids into the inlet opening and through the helical passage under pressure and causing the liquid to be subjected to centrifugal forces in passing through the helical passage to separate gas therefrom, said stem being closed at one end thereof and having an opening at the other end thereof venting said stem externally of the chamber, and means on said stem for maintaining the pressure in said stem and said chamber greater than atmospheric when said pump is in operation.

2. A gas-liquid separator as in claim 1 wherein the means providing a chamber is of substantially cylindrical shape and the inlet and outlet openings in said chamber are generally tangential to the continuous helical passage.

3. A gas-liquid separator as in claim 1 wherein the means for maintaining the pressure greater than atmospheric comprises an orifice restriction venting said hollow stem.

4. A gas-liquid separator as in claim 1 wherein a filter is interposed between said inlet opening and said pump adjacent said inlet opening.

5. A gas-liquid separator as in claim 1 wherein said chamber is of substantially cylindrical form and said inlet opening is directed substantially tangentially of said chamber.

6. A gas-liquid separator comprising means defining a closed chamber, a helical baffle in said chamber providing a continuous helical passage between an inlet opening at one end of said chamber and an outlet opening at the other end of said chamber, a tubular stem extending through the axis of the helical baffle, means for delivering liquid to be degassed under pressure to said chamber, said said chamber having openings therein providing communication between the inlet passage and the helical passage and the hollow stem, wherein the stem is to permit passage of gas separated from the liquid into said stem, said orifice restriction being effective to maintain the pressure in said stem and said chamber above atmospheric pressure when liquid is delivered into the helical passage under pressure.

7. A gas-liquid separator comprising means providing a chamber having inlet and outlet openings, means defining a helical passage for liquid from the inlet to the outlet opening, a hollow stem extending along the axis of the helical passage and having openings therein communicating with the passage to admit gas separated from the liquid into said stem, means for delivering liquid under greater than atmospheric pressure to and through such helical passage and subjecting the liquid to centrifugal forces in passing through the helical passage to separate gas therefrom, said stem being closed at one end thereof, the other end of said stem venting said chamber externally of said chamber, and means on said stem for maintaining the pressure in said stem and said chamber greater than atmospheric when liquid is forced through the helical passage under pressure.

8. A gas-liquid separator comprising means defining a closed chamber substantially circular in cross section, a hollow stem extending along the axis of the chamber, said stem being closed at one end and the other end being provided with an orifice restriction venting said stem externally of said chamber, said stem having a plurality of openings in its side wall communicating with the chamber to permit passage of gas from the latter into the stem, a baffle in said chamber between said said stem and the wall of said chamber providing a helical passage through the chamber, said chamber having an inlet opening at one end of the passage and an outlet opening at the other end thereof and means for delivering liquid to be degassed under pressure to the inlet opening of said chamber, said chamber having its high pressure outlet connected to the inlet opening, said orifice restriction venting the stem being effective to maintain the pressure in the stem and said chamber in excess of atmospheric pressure when liquid is delivered to the helical passage under pressure.

9. For use in a lubrication system including a lubricant reservoir, a lubricant consuming means and a pump for drawing lubricant from the reservoir and supplying lubricant to the consuming means; a gas-liquid separator comprising means providing a closed chamber, means defining a helical passage through said chamber, inlet and outlet openings defined in said chamber providing means at opposite ends of the helical passage, a hollow stem extending along the axis of the passage and having openings therein providing communication between the interior of the stem and the helical passage, said stem being closed at one end thereof and having an opening at the other end thereof venting the interior of said stem to the ambient atmosphere, the inlet opening of said chamber being adapted to be connected to the pressure side of the pump and the outlet opening being adapted to be connected to the consuming means so that when the pump is operated liquid is forced under pressure into said chamber and through the helical passage and subjected to centrifugal forces in passing through the helical passage to separate gas therefrom, the restrictive orifice being effective to maintain the pressure in the stem and chamber at a value
greater than the pressure of the atmosphere ambient to
the chamber.

10. For use in a lubrication system including a lubricant reservoir, a lubricant consuming means and a pump for drawing lubricant from the reservoir and supplying lubricant to the consuming means; a gas-liquid separator comprising means providing a closed chamber, means defining a helical passage through said chamber, inlet and outlet openings defined in said chamber-providing means at opposite ends of the helical passage, a hollow stem extending along the axis of the passage and having openings therein providing communication between the interior of the stem and the helical passage, said stem being closed at one end thereof and having a restrictive orifice at the other end thereof venting the interior of said stem to the ambient atmosphere, the inlet opening of said chamber being adapted to be connected to the pressure side of the pump and the outlet opening being adapted to be connected to the consuming means so that when the pump is operated liquid is formed under pressure into said chamber and through the helical passage and subjected to centrifugal forces in passing through the helical passage to separate gas therefrom, the restrictive orifice being effective to maintain the pressure in the stem and chamber at a value greater than the pressure of the atmosphere ambient to the chamber, and conduit means connecting the venting end of said stem to the reservoir.

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