Sept. 5, 1967 E. M. SCHLUMBERGER 3,339,847

TWO-PHASE SPRAY SYSTEM FOR FILLING TANKS

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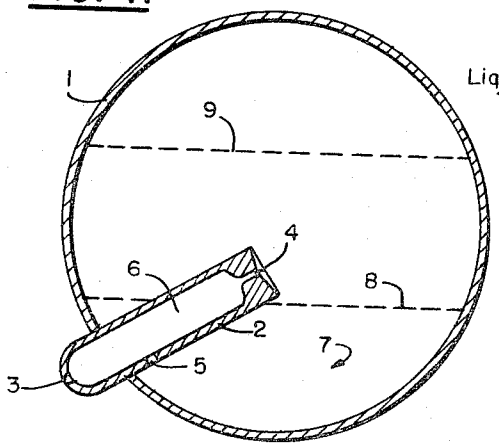
FIG. 1.



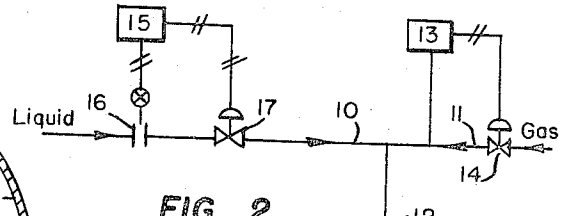


FIG. 2.

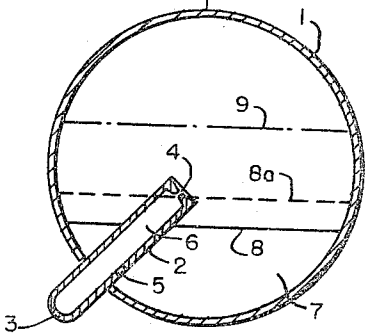


FIG. 3.

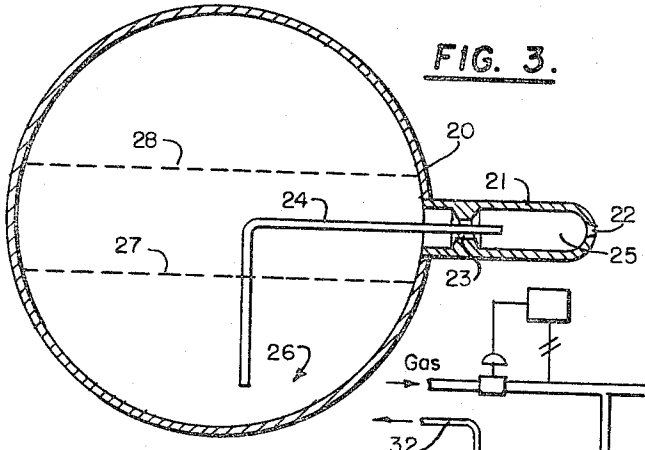
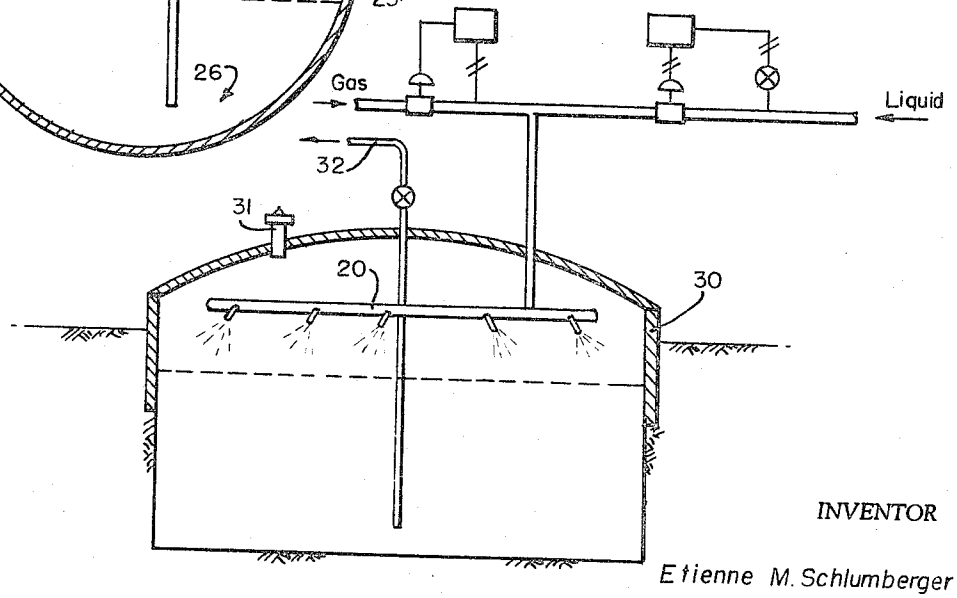


FIG. 4.



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TWO-PHASE SPRAY SYSTEM FOR FILLING TANKS

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This invention relates to spraying devices particularly suitable for spraying gas and liquid phase systems.

For various application, for example the filling of a liquefied gas reservoir, it is necessary to spray the liquefied gas either mainly as a liquid or as a mixture of gas and liquid. In the past difficulties have been experienced because for example particles of dirt have blocked the fine spray holes, or the liquefied gas has boiled resulting in pockets of gas in the system leading to difficulties when a mainly liquid stream is required.

Such difficulties can be overcome by the use of the device of this invention comprising a header, at least one spray nozzle connected to the header communicating the interior of the header with the exterior thereof, a constriction inside the nozzle restricting the flow of fluid therethrough, and a passageway communicating the interior of the nozzle downstream of the constriction with the fluid space in the header outside said nozzle.

Provided this header is mounted in the correct position as will be explained later, merely by maintaining a constant pressure on the fluid flowing into the header and by altering the rate of flow of fluid through the header it is possible to arrange for fluid to be sprayed mainly as as a liquid or as a mixture of liquid and gas.

The header, i.e., the pipe or conduit through which the fluid is distributed, is preferably provided with a plurality of nozzles. Thus, if it is desired to spray a large area the header may be a large ring provided with nozzles at intervals along its length. Alternatively of course when it is desired to spray a large area one could use several straight headers which may be arranged in two series of parallel rows, one series being transverse to the other.

The nozzle, which must be longer than its cross-sectional diameter or greatest cross-sectional dimension, may have one spray hole or series of spray holes through which the fluid can be sprayed. The nozzle preferably passes through an aperture in the wall of the header and is sealingly connected to the header. If desired however, the nozzle may be situated externally of the header, one end of the nozzle terminating in an aperture in the wall of the header. Alternatively of course, the nozzle could be housed right inside the header with the spray hole or holes of the nozzle cooperating with a hole or holes in the wall of the header.

The nozzle must be provided with a constriction, so that fluid entering the nozzle will be throttled, and the reduced pressure in the nozzle will cause fluid to be sucked in from the header to the interior of the nozzle through the passageway. The constriction may conveniently be situated at the end of the nozzle, where the fluid from the header first enters the nozzle. It may however be situated some way inside the nozzle, although there must be sufficient distance between the spray hole or holes and the constriction so that there is sufficient throttling for fluid to be sucked into the nozzle through the passageway.

Except when the nozzle is situated externally of the header, the passageway is preferably an aperture in the wall of the nozzle because this is usually the simplest form of passageway. In some cases however, it may be preferable for the passageway to be a small pipe passing through the nozzle and constriction therein, one end of

the pipe terminating in the fluid space in the header outside the nozzle, and the other end terminating inside the nozzle downstream of the constriction. This type of passageway should be used when the nozzle is situated externally of the header. In this case, however, care will have to be taken to ensure that the bore of the pipe is not so small that capilliary effects cause difficulties or that the pipe is so wide that it is difficult to obtain any appreciable constriction in the nozzle.

In order that the device of this invention shall be suitable for spraying a gas and liquid phase system in either a mainly liquid state or as a mixture of liquid and gas, it is necessary for the header to be mounted in the substantially horizontal position. It is also necessary for the nozzle to be arranged so that the inlet from the header into the passageway is below the end of the nozzle which communicates with the fluid space of the header. This latter requirement means that if it is desired to spray fluid upwards, the nozzle must either be bent so that the nozzle is U- or L-shaped, or the passageway must be a separate pipe.

When it is desired to spray a mixture of gas and liquid, after fixing the fluid pressure in the header, the flow of liquid is adjusted so that the liquid level is below that end of the nozzle communicating with the fluid space of the header. This means that when a mixture of liquid and gas is pumped into the header substantially only gas will enter the nozzle, the gas will be throttled and suck in liquid through the passageway. The spray therefore will be a mixture of gas and liquid.

When it is desired to spray mainly liquid, the flow of liquid is increased so that the liquid level in the header is above the end of the nozzle communicating with the fluid space of the header. This means that substantially only liquid will enter the nozzle, and also that only liquid will be sucked in through the passageway. The spray therefore will be mainly liquid.

The device of this invention is particularly suitable for spraying a liquefied gas, that is a liquid which at atmospheric pressure boils below ambient temperature. When spraying very cold liquefied gases such as liquid methane, or liquid ethylene, the components of the spray device, i.e., header and nozzle, should be made of materials which do not become embrittled at low temperatures, e.g., metals such as stainless steel or aluminum. The device may however be used for other gas and liquid phase systems, e.g., boiling liquids such as water and steam, or mixtures of liquid and gas such as water and air.

The invention is now described with reference to the accompanying drawings in which:

FIG. 1 is a cross-sectional elevation of a spray device taken through one of the nozzles;

FIG. 2 shows an arrangement for operating the spray device of FIG. 1;

FIG. 3 shows a cross-sectional elevation taken through one of the nozzles of an alternative spray device to that shown in FIG. 1; and

FIG. 4 shows an arrangement for using the invention to fill a reservoir with liquid natural gas.

Referring to FIG. 1 of the drawings, the horizontally-mounted header **1** is provided with a number of nozzles, one of which is shown at **2**. This nozzle has a spray hole **3**, and at the other end a constriction **4**. In the lower portion of the nozzle there is an aperture **5** providing direct communication between the interior **6** of the nozzle and the fluid space **7** in the header outside the nozzle. When it is desired to spray a mixture of gas and liquid, the liquid level is set below the constriction **4** in the nozzle, say at level **8**. When however it is desired to spray mainly liquid, the liquid level is set higher above the constriction **4**, say at level **9**.

Referring to FIG. 2 of the drawings, liquefied gas in

the liquid condition is pumped along line **10** whilst liquefied gas in the gaseous condition is pumped along line **11**. The mixture of liquid and gas then enters the header **1** via line **12**.

The gas pressure in line **11** is controlled by a pressure controller **13** which automatically controls valve **14**. The liquid flow rate in line **10** is controlled by the flow rate controller **15**. This controller **15** can be set to the desired rate of flow and by means of the differential orifice **16** automatically controls the flow of liquid through the valve **17** according to the predetermined rate. Thus, when liquid is pumped along line **10** and gas along line **11**, the mixture enters line **12**. If the relative rates of flow of liquid and gas are such that the liquid level in the header **1** is below the end of the nozzle, say level **8**, then the spray will be a mixture of liquid and gas, and will continue to be a two-phase mixture so long as the liquid level in the header is below the end of the nozzle, i.e., below level **8***a*. If however relatively more liquid is pumped along line **10** so that the liquid level in the header **1** rises above the level **8***a*, up to level **9** for example, then only liquid passes through the constriction in the nozzle, and the spray is mainly liquid.

Thus the device automatically adjusts itself and sprays either a mixture of liquid and gas, or mainly only liquid according to the level of liquid in the header. If it is desired to change the composition of the spray then the rate of flow of the liquid is altered, and the flow rate controller **15** adjusted to a new setting.

Referring to FIG. 3 of the drawings, the nozzle **21** is connected externally to the header **20**. The nozzle has a spray hole **22** and a constriction **23**. A small pipe **24** passing through the constriction **23** connects the interior of the nozzle **25** with the fluid zone **26** in the header **20**. Two suitable liquid levels are shown at **27** and **28** providing a spray of gas and liquid, and the one at **28** providing a mainly liquid spray.

FIG. 4 shows the invention used to fill an in-ground storage reservoir **30** provided with the customary automatically controlled venting outlet **31** and means for withdrawing liquid gas, indicated as a pipe **32**, the other elements being indicated by the same reference characters as before.

It will be apparent that the embodiments shown are only exemplary and that various modifications can be made in construction and arrangement within the scope of the invention as defined in the appended claims.

I claim:

1. A device suitable for spraying a single phase or two phase fluid, comprising a header, means for maintaining liquid at a substantially constant controlled level in said header, at least one spray nozzle having an inlet end and an outlet end connected to the header communicating the interior of the header with the exterior thereof, a constriction within the nozzle upstream of said outlet end restricting the flow of fluid therethrough and a passageway communicating the interior of the nozzle downstream of the constriction with the liquid in the header outside said nozzle, and means for adjusting the constant liquid level in the header from a level below the inlet end of said spray nozzle to a level above the inlet end to thereby control the type of spray emitted by the nozzle.

2. A device as claimed in claim **1** in which the header is provided with a plurality of nozzles.

3. A device as claimed in claim **1** in which the passageway is a small pipe passing through the nozzle and constriction therein, one end of the pipe terminating in the liquid in the header outside the nozzle, and the other end terminating inside the nozzle downstream of the constriction.

4. Means for filling a liquefied gas reservoir comprising

(a) a generally horizontal header within the reservoir,

(b) means for supplying pressure gas to the header at a constant pressure,

(c) means for supplying liquid to the header at a predetermined rate of flow to maintain a constant liquid level in the header,

(d) at least one spray nozzle exterior of the header and communicating with the interior of the header by a tubular member,

(e) a restricted passageway in said tubular member providing a region of reduced pressure within the tubular member during fluid flow through said passageway,

(f) and a second passageway in said tubular member leading from below the liquid level in the header to said region of reduced pressure for drawing liquid from the header into the tubular member and through the spray nozzle, said spray nozzle being below the liquid level in the header.

5. A device as claimed in claim **4**, said restricted passageway being located above the level of liquid in the header, so that the pressure gas passes through the restricted passageway.

6. A device as claimed in claim **5**, there being a plurality of such spray nozzles and tubular members, all similarly arranged with respect to the liquid level in the header.

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