May 30, 1939. E. A. WEAVER 2,160,394

PURGER ASSEMBLY

Filed Oct. 14, 1937

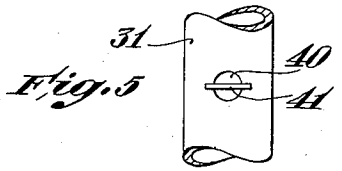


Fig. 5



Fig. 6

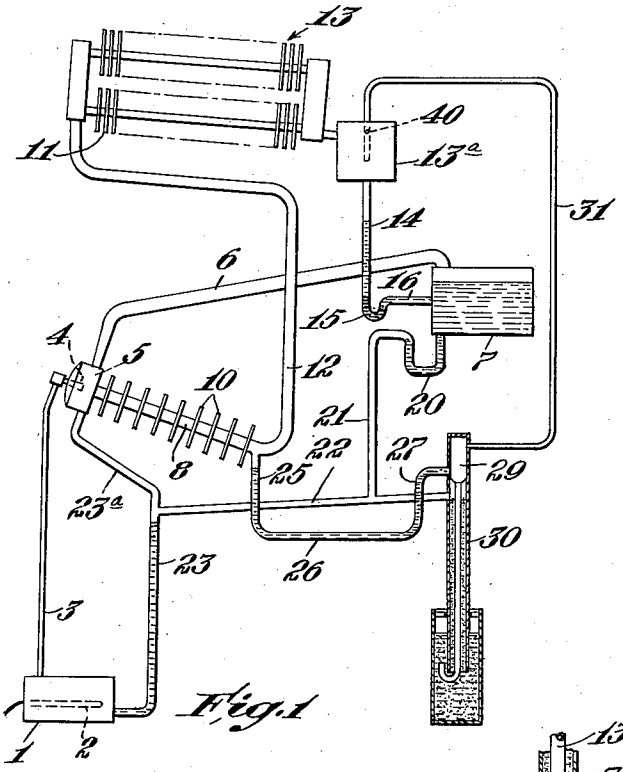
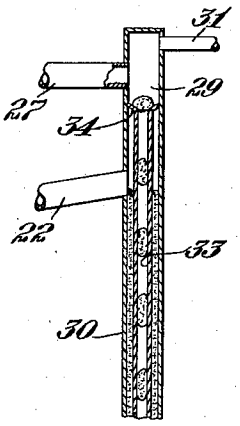


Fig. 1



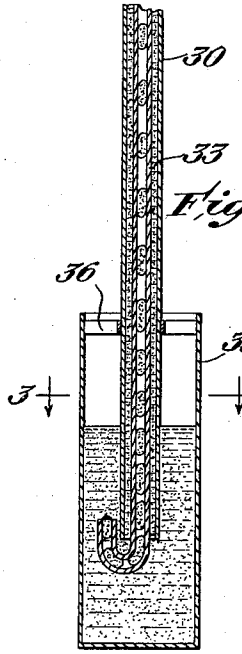


Fig. 2

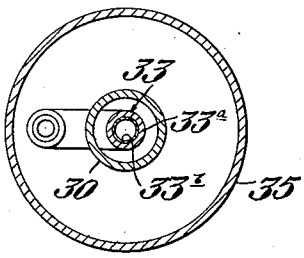


Fig. 3

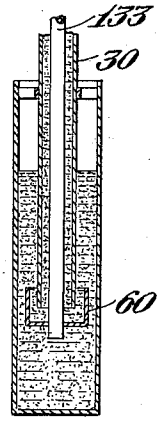


Fig. 4

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PURGER ASSEMBLY

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Application October 14, 1937, Serial No. 168,961

11 Claims. (Cl. 62—115)

This invention relates to a drop tube assembly or purger arrangement wherein globules or bodies of a liquid pump lighter fluid bodies. More particularly such an arrangement may be employed in conjunction with refrigerating systems of the type disclosed in my United States Patent No. 1,761,551, issued June 3, 1930, and United States Patent No. 1,892,869, issued January 3, 1933, to Daniel F. Comstock. These patents disclose refrigerating systems wherein a heavy propellant having a relatively high boiling point pumps a refrigerant vapor from an evaporator or cooler to a condenser by aspiration. Preferably such systems may operate at a low pressure, the pressure in the cooler, for example, being a fraction of an atmosphere, so that air tends to leak into the system. Furthermore, under certain operating conditions, particularly when an aqueous refrigerant is employed, such as water or water mixed with an anti-freeze ingredient, there is a tendency for certain gases to develop within the system even if the same is perfectly sealed against the leakage of air.

Accordingly, as set forth in the above-identified Comstock patent, it is desirable to provide a purger which is effective in compressing non-condensable gases and exhausting the same to the atmosphere. Such a purger, as taught in that above-identified patent, may conveniently comprise a drop tube in which successive bodies or globules of the propellant liquid, e. g., mercury, entrain bodies of the non-condensable gases, compressing the same and venting the same into a liquid-containing well or vat. The body of liquid in this vat has its upper surface exposed to the atmosphere and the non-condensable gases may rise through the mercury to the atmosphere, thus being exhausted.

The above-identified Comstock patent discloses an arrangement of the tubes and ducts associated with the purger assembly which is satisfactory and operative for the indicated purposes, but in an actual commercial refrigerating system it is desirable to afford a more compact assembly which may be more easily supported. For this purpose, the drop tube may be arranged concentrically within the return duct through which the liquid propellant rises from the lower part of the purger assembly to a spill-over connected to the duct which feeds the mercury back to the boiler. Thus the drop tube is disposed within the outer duct and it is only necessary to afford exterior supporting means for one tube or duct rather than two spaced ducts. Such an arrangement also protects the relatively small drop tube against injury from accidental blows or the like. The arrangement of the return duct about the drop tube also permits the former to be non-capillary while having a small capacity, thus reducing the quantity of mercury required in the system. It is also desirable to arrange the vat or well which contains the liquid body of mercury that is exposed to the atmosphere so that this well is disposed concentrically about the lower end of the drop tube and the lower end of the return duct.

Such an assembly, while having distinct advantages from the point of view of manufacture and assembly, provides an arrangement which, without further qualification, results in a tendency of the compressed gases to return to the low pressure portion of the system by rising in the return duct rather than being exhausted to the atmosphere.

In order to avoid such an objectionable result, the lower end of the drop tube may be bent upwardly so that it extends past the lower end of the surrounding duct. Thus the lower end of the tube is provided with a generally U-shaped or J-shaped portion.

Ordinary steel drop tubes have proved in practice to have certain practical disadvantages, since in the manufacture of conventional steel tubing certain irregularities and imperfections are likely to appear on the inner surface of the tubing. Such irregularities result in imperfect sealing of the fluid bodies by the piston-like liquid globules. Accordingly, if steel tubing is used for a purger of this type, the bore of the drop tube must be substantially smaller than would appear to be theoretically necessary in order to avoid objectionable leakage. Materials which afford smooth, continuous surfaces permit substantially larger drop tubes to be employed, thus increasing the effective capacity of the purger. For example, glass may be employed satisfactorily to avoid the difficulties due to irregularities in the surface of the tubing. However, in practical operation, glass is objectionable due to its frangibility and brittleness, and I have also found that glass will sometimes fracture, apparently due to some electrical action of the operating fluids.

A tube lined with cellulosic material may provide a smooth surface, but such material is likely to be attached by the anti-freeze ingredients which are employed in systems of this character. Such systems, for example, may employ an aqueous refrigerant including anti-freeze agents such as "methyl cellosolve" (the mono methyl ether of ethylene glycol) and/or ethylene diamine.

I have found that a satisfactory solution of this problem is afforded by coating the inner surface of a metal drop tube with a thin layer of a resinoid such as a phenol aldehyde resin. Thus the material known commercially as "Bakelite" lacquer may be employed for this purpose. However, in order to eliminate deterioration of the coating by the preferred anti-freeze ingredients, such a lacquer preferably is of the non-plasticized type, since lacquers including a plasticizer are somewhat subject to attack, for example, by "methyl cellosolve".

Such materials permit the interior of the drop tube to have a smooth, continuous surface so that the diameter of the same may be at least fifty per cent larger than when an uncoated steel tube is used under similar conditions. Even without a plasticizer, the tubing may be bent substantially without cracking of the lacquer, thus facilitating installation and replacement if repairs for any reason should be necessary. Other materials may also be employed for this purpose, such materials preferably being acid and alkali resistant. An example of such a material is a lacquer in the form of a chlorinated rubber derivative obtained by the interaction of rubber in a hydrocarbon solution with tin tetrachloride and by subsequent removal of the tin.

While a drop tube arrangement of the character disclosed herein is particularly useful and advantageous in purger arrangements of the character described, it may also be used in other somewhat similar environments as, for example, in refrigerant or propellant lifter tubes of the type shown in United States Patent No. 1,892,823.

A further aspect of this invention relates to the arrangement of the purger supply pipe and its connection to the refrigerant condenser in a manner to prevent the feeding of a liquid refrigerant to the purger and the consequent exhaustion of such liquid from the system. When freezing occurs in a system of this character, a substantial body of liquid refrigerant may collect in the condenser about the inlet of the tube through which gas is supplied to the purger. Under these conditions, when the inlet opening of the tube is closed by the body of collected liquid, a vent in the tube may automatically become effective in receiving the gases so that gas and vapor rather than liquid is pumped from the condenser.

In the accompanying drawing:

Fig. 1 is a diagrammatic view of a refrigerating system including my preferred purger arrangement;

Fig. 2 is a broken vertical sectional view of the purger assembly;

Fig. 3 is an enlarged section on line 3—3 of Fig. 2;

Fig. 4 is a vertical sectional detail of an optional arrangement which may be employed at the lower end of the assembly;

Fig. 5 is an elevational detail of a portion of the purger supply tube; and

Fig. 6 is a horizontal section of the same.

The accompanying drawing, for purposes of illustration, show a simple type of refrigerating system with which my purger arrangement may be associated, it being understood that in practice this arrangement may be employed in more highly developed systems of the same general character, such, for example, as disclosed in the copending application of Lyman F. Whitney, Serial No. 171,325, filed October 27, 1937.

Such a system may comprise a boiler 1 which contains a body of liquid mercury and is provided with a heating element 2 such as an electrical resistance factor. A vapor duct or riser 3 extends upwardly from the boiler 1 to the aspirator nozzle 4 which is arranged to emit mercury vapor at high velocity into a mixing chamber 5. The latter is connected by a vapor duct 6 to the upper part of an evaporator or cooler 7. This cooler contains a body of liquid refrigerant such as water or a suitable mixture of water and an anti-freeze agent. A funnel 8 is aligned with the nozzle 4 and is provided with suitable cooling means such as fins 10.

The mercury vapor issuing from the nozzle 4 is effective in drawing refrigerant vapor from the cooler 7 through the duct 6, the mixed vapors passing into the funnel 8 where the refrigerant vapor is compressed and the major portion of the propellant vapor is condensed. The refrigerant vapor rises through the duct 12 to the condenser 13. The latter may be provided with a gas collecting drum 13a of the general type disclosed in the copending application of Lyman F. Whitney, Serial No. 171,647, filed October 29, 1937. The liquid refrigerant passes to the bottom of the drum 13a and from the latter into the drain 14 which communicates with a mercury containing trap 15 connected by a duct 16 to the cooler 7. Thus as liquid refrigerant piles up in the pipe 14, the pressure on the trap 15 is sufficient to cause some of the refrigerant to pass through the trap and the pipe 16 back to the cooler.

Some of the propellant vapor may stray into the refrigerant condenser, there being condensed and draining back to the trap 15 which is thus kept suitably filled with mercury. Excess mercury from the trap 15 passes through pipe 16 into the cooler 7. A trap 20 is connected to the lower part of this cooler, receiving mercury therefrom so that when mercury fills the trap it may overflow into the duct 21. The lower end of this duct is connected to a downwardly inclined pipe or tube 22 which is joined to a standpipe 23. A continuation 23a of the latter affords a drain to receive any condensed mercury which may appear in the mixing chamber 5. Condensed propellant from the lower end of the funnel 8 is received by a drain 25 which forms one leg of a trap 26, the opposite leg 27 of which is arranged to emit liquid propellant into the chamber 29 at the upper part of the tubular member 30 (Fig. 2).

A purger supply tube 31 is connected to the condenser chamber 13a to receive non-condensable gases therefrom and to direct the same into the chamber 29. The tube 31 extends downwardly into the lower part of the drum and has an open end to receive non-condensable gases therefrom. As more fully explained in the above-identified copending Whitney application, the mixture of vapor and non-condensable gas which collects in this portion of the drum is comparatively rich in gas due to the action of gravity. Accordingly, while some vapor may be exhausted from the system, a substantial portion of the fluid exhausted by the purger may be in the form of non-condensable gases. The wall of tube 31 preferably is provided with a small opening or vent 40 in the upper part of the chamber 13a and a wire 41 may be welded to the tube and extend diametrically across this opening. Thus the opening 40 affords a vent for purposes which will be more fully described.

A drop tube 33 of restricted internal diameter is disposed within the tubular member 30, having its upper end flared outwardly, as designated

by numeral 34, substantially to close the lower end of chamber 29 except for the opening provided by the upper end of the bore of the tube.

The drop tube 33 receives globules of mercury between which successive bodies of non-condensable gas are entrained. The restricted internal diameter of the tube 33 permits the globules to act as liquid pistons so that the successive bodies of gas are compressed as they approach the lower end of the tube.

A well or vat 35 is disposed about the lower end of the drop tube 33 and contains a body of liquid mercury in which the lower end of the tube and the lower end of the tubular member 30 are immersed. The upper part of the vat 35 may be open to the atmosphere, being, for example, connected to the tubular member 30 by radial struts 36.

In accordance with this invention the drop tube 33 may extend downwardly past the end of the tubular duct 30 to afford a U-shaped portion so that the lower part of the tube is J-shaped, the shorter leg of the tube extending upwardly past the open lower end of the duct 30. Thus bodies of gas may be entrained between successive liquid globules entering the upper part of the tube 33, being compressed as the fluid moves downwardly in the tube. Since the shorter leg of the tube extends upwardly past the end of duct 30, the gases will rise from the same to the surface of the mercury body in the well 35, while the mercury from the tube will be added to the liquid body, tending to cause the level of the same to rise. Since, however, the surface of this mercury body is exposed to atmospheric pressure, mercury is forced upwardly into the return duct 30, so that the liquid fills this duct until it reaches a level even with the connection of pipe 22, whereupon the mercury spills over into this pipe, being received by the standpipe 23. The latter contains a column of liquid mercury which balances the boiler pressure and it serves as a boiler feed pipe. It is evident that the arrangement which has been described permits the gas bubbles to pass upwardly in well 35 without entering the return duct 30 so that the gas is exhausted to the atmosphere rather than returning to the interior of the system.

In accordance with this invention, the inner surface of the drop tube is smooth and continuous. For this purpose the tube preferably may be provided with a steel body portion 33a and with an inner coating 33b (Fig. 3) of suitable material immune to the electric action which evidently occurs under some operating conditions, and providing an intimate bond with the metal tube 33a. For this purpose I prefer to employ a polymerized phenol resinoid such as a Bakelite lacquer, or some other acid and base resisting lacquer. If anti-freeze ingredients such as "methyl cellosolve" and/or ethylene diamine are employed in the aqueous refrigerant, the lacquer preferably is employed without any plasticizer.

Before the lacquer is applied to the tube, its surface may receive a commercial rustproofing treatment which, for example, converts the surface of the steel tube to form iron and manganese phosphates. Such a treatment permits a firmer bond between the lacquer and the steel tube.

A tube of this character may have its bore provided with the resinoid lacquer coating by first drawing a slug of liquid lacquer upwardly through the tube by gentle suction, then releasing the suction and letting the slug drop back through the tube. The surface of the tube is thus coated with a thin liquid lacquer layer. The tube is then gradually heated while a current of air is directed through the bore, so that the lacquer dries evenly and does not plug the tube. After the tube has been heated to the proper baking or polymerizing temperature, the air current may be interrupted. Thus a continuous, smooth coating of the baked lacquer is provided upon the inner surface of the tube.

Under some operating conditions the refrigeant returning from the condenser to the cooler 7 may freeze in the duct 16. Accordingly liquid refrigerant collects in the pipe 14 and the chamber 13a. This liquid refrigerant may close the inlet end of tube 31, thus precluding the movement of gas to the purger in the normal manner, but under these conditions the gas may enter the tube through the opening 40, thus being received from the upper part of the drum 13a rather than from the lower portion thereof. Under normal operating conditions, however, the small opening or vent 40 with its diametrically disposed wire 41 becomes closed by a liquid film or bubble of the condensed refrigerant, due to the wetting action and surface tension of the liquid, and the gas enters the tube through its lower inlet opening rather than through the vent 40. Thus an arrangement is provided which permits the normal exhaustion of a mixture which is comparatively rich in non-condensable gas and which permits the purger to continue to operate to exhaust gases when the normally operative inlet is closed. Accordingly, when freezing occurs and the lower part of the drum 13a is filled with condensed refrigerant, the vent 40 automatically becomes effective in permitting the purger to pump gas from the drum 13a rather than condensed refrigerant.

The present invention affords a drop tube which may have a relatively large diameter and yet which permits effective pumping of the non-condensable gases without objectionable leakage. While the present invention is particularly effective in permitting a satisfactory purger arrangement, the same general principles may also be employed with other pumping means or drop tube assemblies wherein successive bodies of liquid pump another fluid, as, for example, in the lifter arrangements disclosed in United States Patent No. 1,892,823.

It is furthermore to be noted that this drop tube arrangement may be employed in conjunction with an air deflector such as disclosed in the copending application of Raymond W. Tibbetts, Serial No. 168,958, filed on even date herewith. Fig. 4 illustrates such an arrangement, the tube 133 being similar to the tube 33 but terminating somewhat below the outer duct 30 and being provided with an air deflector 60 of the shape shown in Fig. 4 and of the type fully described in the above-identified copending application.

It should be understood that the present disclosure is for the purpose of illustration only and that this invention includes all modifications and equivalents which fall within the scope of the appended claims.

I claim:

1. A system of the class described including a purger for exhausting non-condensable gases from the system, said purger comprising a drop tube of small diameter, the system being arranged to supply successive liquid globules to the upper end of said tube to pump and compress bodies

of gases, the lower end of the tube providing an outlet opening, a receptacle surrounding the lower end of the tube and containing a body of liquid with its surface exposed to the atmosphere, and a duct having an inlet communicating with the receptacle to receive liquid therefrom, said tube having a smooth surface provided by a heat-resistant, phenol aldehyde composition.

2. A system of the class described including a purger for exhausting non-condensable gases from the system, said purger comprising a drop tube of small diameter, the system being arranged to supply successive mercury globules to the upper end of said tube to pump and compress bodies of gases, the lower end of the tube providing an outlet opening, a receptacle surrounding the lower end of the tube and containing a body of liquid with its surface exposed to the atmosphere, and a duct having an inlet communicating with the receptacle to receive liquid therefrom, said tube being formed of metal but having its inner surface coated with phenol aldehyde resinoid composition free from plasticizer, said coating providing a smooth continuous surface and being intimately bonded to the metal of the tube.

3. A pumping assembly of the class described comprising a tube of restricted diameter through which a succession of mercury globules pass with bodies of another fluid therebetween, said tube having a metal body portion and a lining of non-metallic material bonded to the metal, said material providing a smooth continuous surface for the bore of the tube with which the liquid globules may contact to afford sealing means between successive fluid bodies.

4. A pumping assembly of the class described comprising a tube of restricted diameter through which a succession of mercury globules pass with bodies of another fluid therebetween, said tube having a metal body portion and a lining of lacquer bonded to the metal, said lacquer providing a smooth continuous surface for the bore of the tube with which the liquid globules may contact to afford sealing means between successive fluid bodies.

5. A pumping assembly of the class described comprising a tube of restricted diameter through which a succession of mercury globules pass with bodies of another fluid therebetween, said tube having a metal body portion and a lining of phenol aldehyde composition free from plasticizer, said composition being bonded to the metal, said composition providing a smooth continuous surface for the bore of the tube with which the liquid globules may contact to afford sealing means between successive fluid bodies.

6. A pumping assembly of the class described comprising a tube of restricted diameter through which successive liquid globules pass with bodies of another fluid therebetween, said tube having a metal body portion and a lining in the form of a synthetic resinoid composition bonded to the metal body portion by being deposited from a solution, said composition providing a smooth, continuous surface for the bore of the tube with which the liquid globules may contact to afford sealing means between successive fluid bodies.

7. A system of the class described comprising a pumping assembly including a drop tube wherein successive liquid globules pump bodies of a lighter fluid, a receptacle surrounding the lower end of the tube and containing a body of the liquid, a return duct surrounding the tube and having a lower inlet opening immersed in said body of liquid within the receptacle, said tube having an upturned lower end in said receptacle terminating in an outlet opening disposed laterally at one side of the inlet opening of the duct, whereby the fluid bodies pass from the upturned lower end of the tube into the liquid body and rise in the same without being received by the return duct.

8. A system of the class described including a condenser and a purger for exhausting non-condensable gas from the condenser, said condenser being provided with a chamber in which a mixture of vapor and gas may collect, a supply tube connecting the chamber and purger, said tube having an open inlet end in the lower part of the chamber, and providing a small vent in the upper part of the chamber, said vent under normal operating conditions being closed by liquid condensate but permitting gas to enter the tube when a body of liquid collects in the lower part of the chamber and closes the open inlet end of the tube.

9. A system of the class described including a condenser and a purger for exhausting non-condensable gas from the condenser, said condenser being provided with a chamber in which a mixture of vapor and gas may collect, a supply tube connecting the chamber and purger, said tube having an open inlet end in the lower part of the chamber, and providing a small vent in the upper part of the chamber, an element extending across said vent to aid the closing of the same with liquid condensate, said vent under normal operating conditions being closed by liquid condensate but permitting gas to enter the tube when a body of liquid collects in the lower part of the chamber and closes the open inlet end of the tube.

10. A system of the class described comprising a refrigerant circuit including a cooler and a condenser which operate at sub-atmospheric pressure, a purger for pumping non-condensable gas from the condenser, a supply tube for directing gas from the condenser to the purger, said tube having an inlet opening communicating with the condenser, and means to prevent the purger from pumping liquid condensate from the condenser when a body of said condensate collects at said inlet opening.

11. A system of the class described comprising a refrigerant circuit including a cooler and a condenser which operate at sub-atmospheric pressure, a purger for pumping non-condensable gas from the condenser, a supply tube to direct gas from the condenser to the purger, said tube having an inlet communicating with the condenser, said condenser being arranged to collect a body of liquid refrigerant when the refrigerant freezes between the condenser and cooler to prevent normal refrigerant circulation, said tube being provided with a small vent above said inlet which is normally closed by liquid condensate but which is automatically opened when said inlet is closed by liquid refrigerant thus collecting in the condenser.

EASTMAN A. WEAVER.