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DOUBLE-WALLED PIPE FOR LIQUIFIED GAS

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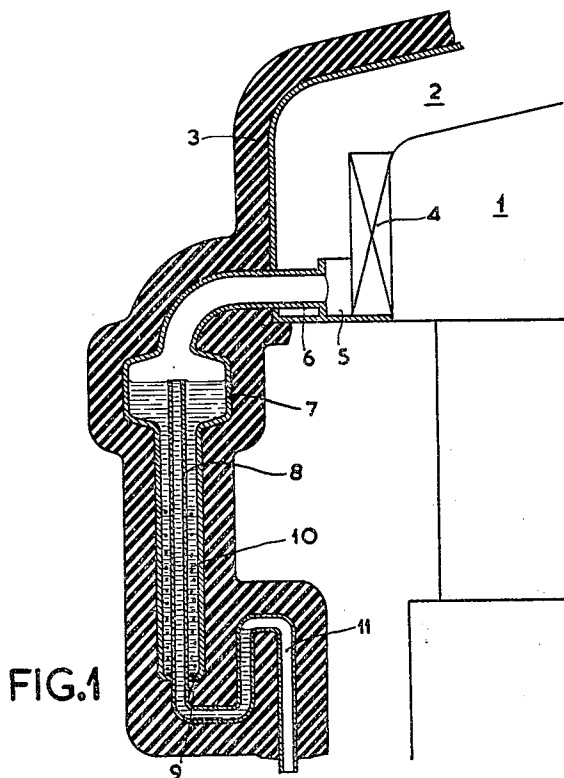


FIG. 1

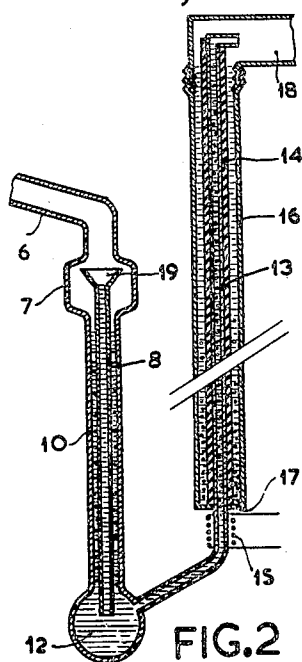


FIG. 2

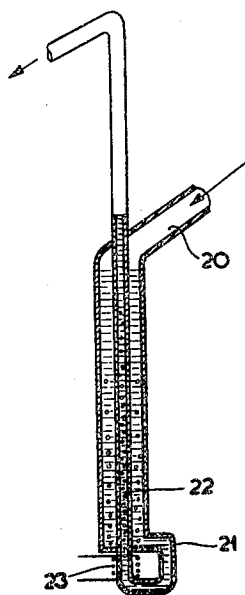


FIG. 3

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DOUBLE-WALLED PIPE FOR LIQUIFIED GAS

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Devices for cooling gases or fractionating gas-mixtures frequently comprise a pipe extending substantially in the vertical direction and containing a certain amount of a liquid boiling below 0° C. In certain installations, the liquid in this pipe flows downwards, while other installations are known in which the liquid is pumped upwards. The pipes in which the liquid flows downwards will be referred to hereinafter as "descension pipes," whereas the pipes in which the liquid is pumped upwards will be referred to as "ascension pipes."

A descension pipe is found, for example, in the condensation space of a cold-gas refrigerator. A cold-gas refrigerator is to be understood, in this case to mean a refrigerator operating on the reverse cooling-gas motor principle as illustrated and described in U.S. Patent No. 2,564,100 to F. K. Dupre. It is known to provide a liquid lock in the outlet pipe of the condensation space in order to avoid the supply of gases via the outlet pipe to the condensation space and to discharge also the liquid produced in the condensation space, while nevertheless a subpressure is maintained in this space. A difference in level must exist between the condensation space and the liquid lock so that a descension pipe is provided. If heat is supplied to the liquid in the descension pipe, vapour bubbles are produced, causing the liquid level in the descension pipe to become higher than would be the case without the supply of heat. Consequently, the difference in level between the liquid lock and the condensation space and hence the length of the descension pipe must be larger than could be expected in connection with the subpressure in the condensation space and the specific weight of the liquid. This is frequently undesirable for structural reasons. One aspect of the invention is to avoid this undesirable phenomenon, or at least to reduce it considerably.

It is also known in a cold-gas refrigerator or in a gas-fractionating column, to pump the liquid upwards by means of a vapour bubble pump. In this case an ascension pipe is provided. This ascension pipe is supplied with heat, resulting in vapour bubbles being produced in the liquid, which bring about the so-called vapour bubble pumping action, so that the liquid is pushed upwards.

Such vapour bubble pumps have been found to be very sensitive, since even a small additional supply of heat may bring about a comparatively great increase in output. Consequently, the control of the pumps may cause difficulties, if no particular steps are taken to keep the supply of heat within the desired limits. In these vapour bubble pumps, it has been found desirable to supply heat only at an area at which this supply may be completely controlled. At other areas, the ascension tube must thus be insulated as well as possible.

A second aspect of the invention is substantially to avoid unwanted supply of heat to an ascension tube.

According to the invention, at least part of the pipe containing the liquid boiling below 0° C., is surrounded by a second pipe, so that a space exists between the two pipes, which space likewise contains a certain amount of the liquid, so that the second amount of liquid serves as an insulation for the first amount of liquid. The space surrounding the inner pipe thus contains a liquid

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serving as an insulation, which may locally boil as a result of any supply of heat from the exterior, so that the flow of the liquid in the inner tube is substantially not affected.

In one embodiment of the invention, the inner pipe serves as an ascension pipe, heat being supplied to this pipe at its lower end, which does not contain the second amount of liquid, so that a vapour bubble pumping action is maintained in the inner pipe.

Since a small difference in temperature may prevail between the boiling liquid in the outer pipe and the liquid in the inner pipe, it may be desirable also substantially to avoid the transmission of heat resulting from this difference in temperature. In another embodiment of the invention, the ascension pipe is provided with an insulating layer reducing the transmission of heat from the outer amount of liquid to the inner amount of liquid.

In certain cases, a great difference in level may accidentally exist between the lower end of an ascension pipe and the area, at which the liquid is produced; this may be, for example, the condensation space of a cold-gas refrigerator. Consequently, a comparatively long descension pipe is then provided between the cold-gas refrigerator and the lower end of the ascension pipe. Since in this case there is a smaller risk of the liquid in the descension pipe being pushed upwards, but additional supply of heat in the ascension pipe must certainly be avoided in another embodiment of the invention, the ascension tube is arranged inside a descension pipe associated with the ascension pipe, so that the liquid in the descension pipe serves as an insulation for the ascension pipe.

In another embodiment of the invention, the inner pipe, which serves as a descension pipe, and the second pipe surrounding it each open at the lower end and at the upper end into the same space, resulting in a simple embodiment in structural respect.

In another embodiment of the invention, it is in this case desirable that the outer pipe should have a widened part at its upper end at the level of the debouchment of the inner pipe, so that at this area sufficient space exists for discharging the vapour bubbles produced.

In order that the invention may be readily carried into effect, several embodiments thereof will now be described, by way of example, with reference to the accompanying drawing.

FIG. 1 shows a condensation space of a cold-gas refrigerator, in which a descension pipe, connected to a liquid lock, is insulated.

FIG. 2 show an ascension pipe in which a liquid is pumped upwards by means of a vapour bubble pumping action, and

FIG. 3 shows a similar ascension pipe arranged inside a descension pipe.

The installation shown in FIG. 1 comprises a cold-gas refrigerator 1 (shown only in part) having a space 2, in which a gas, for example air, is condensed (the condensation space). This space is surrounded by an insulating wall 3. Air supplied to the space is condensed on fins 4, associated with the freezer of the cold-gas refrigerator, the condensate being collected in an annular channel 5. Connected to the annular channel is a pipe 6, which has a widened portion 7 and tightly surrounds an inner pipe 8. The pipe 6 is closed at its lower end 9, so that around the inner pipe 8 is a space 10, which may contain a certain amount of liquid. The inner pipe 8, in its turn, is connected to a liquid lock 11.

During operation, the liquid produced in the condensation space 2 flows via the pipe 6 to the space 10, which contain only little liquid; when this space is filled, the liquid flows through the inner pipe 8, leaving the installation via the liquid lock 11. The liquid in the space 10

serves as an insulation, so that vapour bubbles are not produced in the liquid flowing through the inner pipe 8, the liquid thus being prevented from being pushed upwards in this pipe.

The vapour bubbles ascending in the space 10 reach the widened portion 7 without bringing about there any substantial pushing-up effect as a result of the large surface of the liquid.

In the construction shown in FIG. 2, parts identical with those of FIG. 1 are indicated with the same reference numerals. As before the discharge pipe 6 is connected to a space (not shown), which contains the liquid having a boiling point below 0° C. The space 10, instead of being closed at its lower side, is connected in this figure to a container 12. Connected to the container 12 is also an ascension pipe 13, which is covered with a thin insulating layer 14 and to the lower end of which heat is supplied, for example, by means of an electric spiral 15. The ascension pipe 13 is substantially surrounded by a pipe 16, which is closed at its lower end 17 and is connected at its upper end, similarly as the pipe 13, to a line 18. The upper end of the inner pipe 8 has a funnel-like aperture 19 for collecting the liquid flowing out of the pipe 6.

In this embodiment, liquid also flows through the descension pipe 8 into the container 12, while liquid from this container ascends into the space 10.

As a result of the supply of heat to space 10, the liquid in this space starts to boil, so that the liquid is pushed upwards and serves as an insulation for the liquid in the inner pipe. The liquid pumped upwards flows through the pipe 8 downwards again, while liquid is supplied to the space 10 from the container 12.

In the ascension pipe 13, a vapour bubble pumping action is obtained as a result of the heat supplied to the liquid by means of the heating spiral 15. The tube 16 contains liquid, which serves as an insulation for the ascension pipe. Since a temperature difference, though small, prevails between the boiling liquid in the pipe 16 and the liquid in the ascension pipe 13, a small amount of heat is still supplied to the last-mentioned liquid. In order to avoid this as far as possible, the pipe 13 is surrounded by an insulating layer 14.

In the construction shown in FIG. 3, a descension pipe partly surrounds an ascension pipe. The device comprises a descension pipe 20, the upper end of which is connected to a space (not shown) containing a liquid boiling below 0° C., as described with reference to FIGS. 1 and 2. The lower end of descension pipe 20 has a channel 21, which is connected to an ascension pipe 22. The ascension pipe 22 is heated at its lower end by an electric heating spiral 23, so that heat is supplied to the ascension pipe and a vapour bubble pumping action is obtained in the pipe. The liquid in the descension pipe serves as an insulation for the liquid in the ascension pipe. If desired, the descension pipe itself may also be surrounded by liquid, as shown in FIG. 1. As a further alternative, the upper part of the ascension tube, which is not insulated by the liquid in the descension pipe, may be provided with an insulation space as shown in FIG. 2.

What is claimed is:

1. A cooled conduit for use with a cold-gas refrigerator provided with a condenser for condensing gas to form a condensation liquid comprising; a first pipe operatively connected to said condenser and extending downwardly for a substantial portion of its length, said first pipe having a widened portion adjacent to the end thereof closest to said condenser, a second pipe within said first pipe and having the upper end thereof terminating in the widened portion of said first pipe, said condensation liquid forming on said condenser and being conducted to

said first pipe whereby when said condensation liquid in said first pipe rises to a predetermined level in the widened portion of said first pipe it overflows into the upper end of said second pipe, the condensation liquid in said first pipe acting as an insulation for the condensation liquid in said second pipe, and an insulating wall surrounding said first and second pipes.

2. A cooled conduit for use with a cold-gas refrigerator as claimed in claim 1 wherein said second pipe is an outlet pipe and is provided with a liquid lock.

3. A cooled conduit for use with a cold-gas refrigerator as claimed in claim 2 wherein said first pipe is closed at its lower end.

4. A cooled conduit for use with a cold-gas refrigerator provided with a condenser for condensing gas to form a condensation liquid comprising; a first pipe operatively connected to said condenser and extending downwardly for a substantial portion of its length, said first pipe having a widened portion adjacent to the end thereof closest to said condenser, a second pipe within said first pipe and having the upper end thereof terminating in the widened portion of said first pipe, said condensation liquid forming on said condenser and being conducted to said first pipe whereby when said condensation liquid in said first pipe rises to a predetermined level in the widened portion of said first pipe it overflows into the upper end of said second pipe, the condensation liquid in said first pipe acting as an insulation for the condensation liquid in said second pipe, an insulating wall surrounding said first and second pipes, said first pipe provided with an extension forming an ascension pipe, and a heat source adjacent to said ascension pipe for assisting in the ascension of said condensation liquid in said ascension pipe.

5. A cooled conduit for use with a cold-gas refrigerator as claimed in claim 3 further comprising an insulating layer at least substantially covering said ascension pipe, and a third pipe having said condensation liquid therein surrounding said ascension pipe and insulating layer.

6. A cooled conduit for use with a cold-gas refrigerator provided with a condenser for condensing gas to form a condensation liquid comprising; a first pipe operatively connected to said condenser and extending downwardly for a substantial portion of its length, said first pipe having a widened portion adjacent to the end thereof closest to said condenser, a second pipe within said first pipe and having the upper end thereof terminating in the widened portion of said first pipe, said condensation liquid forming on said condenser and being conducted to said first pipe whereby when said condensation liquid in said first pipe rises to a predetermined level in the widened portion of said first pipe it overflows into the upper end of said second pipe, the condensation liquid in said first pipe acting as an insulation for the condensation liquid in said second pipe, an insulating wall surrounding said first and second pipes, said first pipe having widened portions adjacent to the top and at the bottom thereof, a second pipe within said first pipe having the top end thereof terminating in the top widened portion of said first pipe and the bottom end thereof terminating in the bottom widened portion thereof.

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