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2,988,898

COOLING APPARATUS FOR LIQUID BATHS

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Fig. 1.

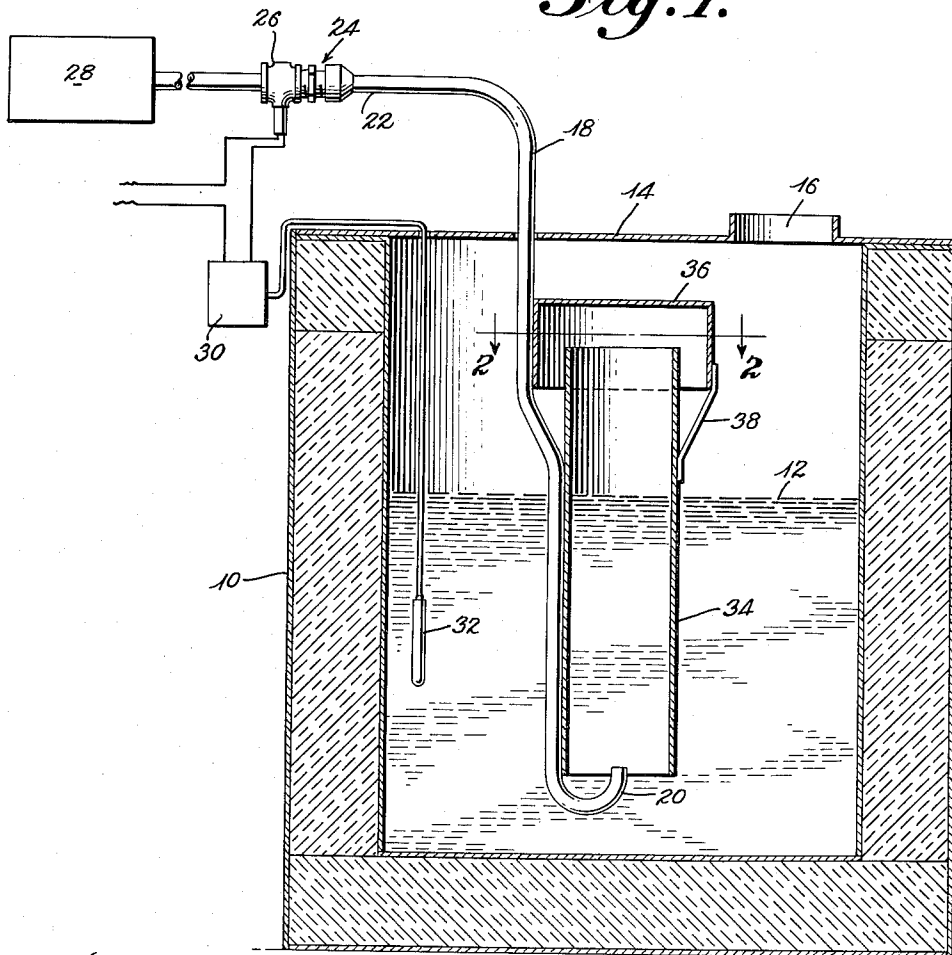


Fig. 2.

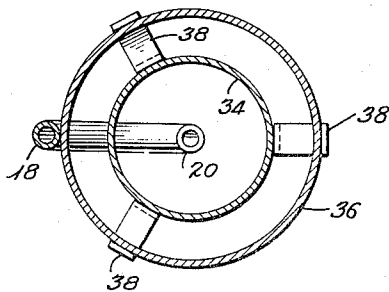
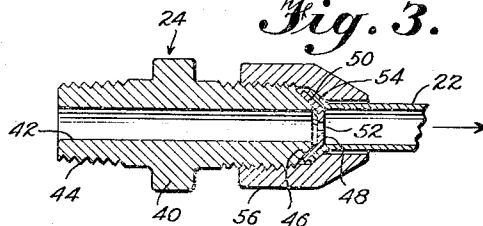


Fig. 3.



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This invention relates to apparatus for cooling a bath of alcohol, or the like, by injecting carbon dioxide into the alcohol from a point located below its surface.

The invention is concerned with systems wherein a fluid such as alcohol to be cooled is placed in an insulated container within which the fluid may be exposed to low temperature and pressure carbon dioxide, usually as snow or a mixture of snow and vapor. In a cooling operation of this type, certain advantages accrue when the carbon dioxide is injected into the fluid from beneath its surface. This operation has the primary advantage that the discharge of carbon dioxide into the bath keeps the fluid stirred up to obtain a more uniform temperature. However, the bubbling and splashing of the fluid being cooled limits the rate at which carbon dioxide may be injected and therefore limits the rate of cooling which may take place. Further, the pipe or conduit through which the carbon dioxide is discharged into the bath becomes cooled, thus tending to cause the carbon dioxide within the conduit to solidify and clog the conduit.

The primary object of the invention is to provide a system for discharging carbon dioxide into a fluid bath for cooling purposes which is so designed as to minimize the possibility of freezing up during use.

Another object of the invention is to provide a system for discharging carbon dioxide into a fluid bath for cooling purposes in which the rate of discharge of the carbon dioxide into the bath may be varied over a fairly wide range.

Still another object of the invention is to provide a system for discharging carbon dioxide into a fluid bath for cooling purposes and in which regulating apparatus for controlling the rate of flow of the carbon dioxide in the system may be located at points remote from the bath itself.

A still further object of the invention is to provide a cooling system of the above mentioned type which is especially designed to minimize bubbling and splashing of the fluid within the bath even though the carbon dioxide is discharged below the surface of the fluid.

Other objects and advantages of the invention will be apparent during the course of the following description.

In the accompanying drawing forming a part of this specification and in which like numerals are employed to designate like parts throughout the same,

FIGURE 1 is a side elevational view, partially in cross section, of a system embodying the present invention;

FIGURE 2 is a cross sectional view of the apparatus taken on line 2-2 of FIG. 1; and

FIGURE 3 is a longitudinal sectional view of an orifice plate assembly employed in the apparatus of FIG. 1.

In FIG. 1, a typical system embodying the invention is disclosed as including an insulated tank or container 10 within which is disposed the bath of fluid 12, such as alcohol. The constructional details of the container 10 may vary widely, depending upon the particular application and hence its structure will not be described in detail other than to state that it is suitably insulated to reduce the transfer of heat between the outside of the container and the bath 12. The container 10 is provided with a cover plate 14 which in the usual case is provided with an opening such as 16 to permit the escape of carbon dioxide vapor.

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An elongated conduit 18 of relatively small diameter projects through the cover plate 14 and extends downwardly into the bath to terminate at an open discharge end 20 located well below the surface of the bath 12. The conduit 18 extends to an inlet end 22 which includes an orifice plate assembly 24. For reasons which will be developed, the inlet end 22 of the conduit 18 may be located at a point which is quite remote from the bath 12. Thus, the physical location of the inlet end 22 of the conduit 18 is not limited to the precise relationship suggested in FIG. 1.

The orifice plate assembly 24 is connected to a valve 26 which preferably is electrically controlled in accordance with the temperature of the bath 12. The valve 26 is in turn connected to a schematically illustrated supply 28 of refrigerated liquid carbon dioxide under low temperature and its corresponding low vapor pressure. The valve 26 may be controlled by suitable electrical connections to a thermostatically operated switch 30 which in turn is controlled by a temperature-sensitive element 32 which may be suspended within the bath 12.

As best seen in FIG. 1, the discharge end 20 of the conduit 18 is bent upwardly and projects slightly within one end of an open-ended riser tube 34 located partially within the bath 12. As suggested in FIG. 1, the conduit 18 may be secured along the outer side of the tube 34, as by welding. The tube 34 projects upwardly from the discharge end 20 of the conduit 18 to an open upper end which is located well above the surface of the bath 12. Due to the fact that both the upper and lower ends of the tube 34 are completely open, the interior of the tube 34 is filled with bath liquid to a depth corresponding to the surface of the liquid of the bath. An annular cap 36 is mounted upon and in spaced overlying relationship to the upper end of the tube 34. The cap 36 may be secured in position by a plurality of braces such as 38 which may be welded to the cap and to the walls of the tube 34.

In FIG. 3, a longitudinal sectional view of the orifice plate assembly 24 shows the same as including a coupling 40 having a bore 42 extending therethrough. The coupling 40 is externally threaded at each end, the threads 44 being employed in securing the coupling 40 to the outlet of the valve 26. The opposite end of the coupling 40 is provided with a conical surface 46 upon which is seated an orifice plate 48 having a conical skirt 50 which is complementary to the surface 46 on the coupling 40. The plate 48 is provided with a centrally located orifice 52 through which carbon dioxide is discharged from the bore 42 into the conduit 22. As shown in FIG. 3, the inlet end of the conduit 22 is flared as at 54 to snugly seat upon the conical skirt 50 of the orifice plate so that the plate 48 and the conduit 22 are firmly clamped to the coupling 40 by the nut 56 which is threaded upon the adjacent end of the coupling.

In operation, liquid carbon dioxide under low temperature and pressure from the source 28 may be admitted to the bore 42 by the opening of the valve 26. As stated above, the valve 26 may be suitably connected to the switch 30 to be opened and closed depending upon the temperature within the bath 12 as sensed by the element 32. Assuming that the valve 26 is open, the liquid carbon dioxide is forced through the orifice 52 in the plate 48 and thence into the interior of the conduit 18. Because of the relatively restricted size of the orifice 52, the carbon dioxide changes from a liquid state into a mixture of vapor and snow by virtue of its passage through the orifice 52. This mixture is discharged from the end 20 of the conduit 18 into the interior of the riser tube 34 and thus into the bath 12. The riser tube 34 and the cap 36 prevent violent bubbling and splashing of the

entire surface of the bath 12 and thus permit a relatively high rate of discharge of carbon dioxide into the bath.

By regulating the size or diameter of the orifice 52, the length of the conduit 18 between its discharge end 20 and the location of the orifice plate assembly 24 may be varied within wide limits. Previously, it was thought to be desirable to maintain the pressure within the conduit 18 at a value well above the triple point (sixty pounds per square inch gauge pressure) in order to prevent the formation of carbon dioxide snow within the conduit 18. Also, that the orifice should be located at a point quite close to the bath and the conduit 18 should be made large and straight and without internal projections in order that the pressure existing between the orifice and the discharge end of the conduit would be maintained at substantially atmospheric pressure.

It has been determined that by regulating the size of the orifice 52 so that the pressure at a point within the conduit 18 just downstream of the orifice, i.e. within, but adjacent to the inlet end 22, is maintained between five pounds and sixty pounds per square inch gauge, the carbon dioxide within the conduit 18 will consist of a mixture of snow suspended in vapor. So long as the pressure adjacent the inlet end of the conduit 18 is maintained above five pounds per square inch gauge pressure, the carbon dioxide vapor within the conduit will flow at a velocity which is sufficient to keep the carbon dioxide snow in suspension and thus permit it to be carried along with the vapor and discharged into the bath 12. Should the pressure at the inlet end of the conduit 18 fall below five pounds per square inch gauge pressure, the velocity of flow becomes too low for the snow to remain in suspension and it settles out and blocks the tube, especially at bends or irregularities.

In one system, the conduit 18 consisted of a length of approximately twenty feet of copper tubing having a .30 inch inside diameter. Several loops and bends existed in the conduit. The source of supply 28 furnished liquid carbon dioxide at 2° F. to the valve 26 at approximately 300 pounds per square inch gauge pressure. In this system, it was found that successful operation could be achieved where the diameter of the orifice 52 ranged between .021 inch and .042 inch. An attempt to operate the system with an orifice of .07 inch was unsuccessful since the pressure just downstream of the orifice rose above the triple point and the tube became clogged.

While we have described but one embodiment of our invention, it will be apparent to those skilled in the art that the disclosed embodiment may be modified. Therefore, the foregoing description is to be considered exemplary rather than limiting and the true scope of our invention is that defined in the following claims.

Having thus described the invention, we claim:

1. Means for cooling an alcohol bath, or the like, by the injection of carbon dioxide at low temperature and pressure, comprising a conduit having its discharge end located below the surface of said bath and having its inlet end located at a point remote from said bath, means for supplying liquid carbon dioxide under pressure to the inlet end of said conduit, means responsive to changes in the temperature of the alcohol bath for varying the supply of the carbon dioxide to said conduit, and means mounted at the inlet end of said conduit providing a flow restriction for transforming liquid carbon dioxide from said supply means into a mixture of snow suspended in vapor within said conduit, said flow restriction being of such size as to maintain a velocity of flow in the conduit sufficient to keep the snow in suspension until it reaches said discharge end.

2. Means for cooling an alcohol bath, or the like, by the injection of carbon dioxide at low temperature and pressure, comprising a conduit of relatively small internal diameter extending into the body of said bath with its discharge end located below the surface of said bath and with its inlet end located at a point remote from said bath, means for supplying liquid carbon dioxide to the inlet end of said conduit, and means defining an orifice through which the carbon dioxide passes into said conduit, said orifice having a diameter selected to maintain the pressure adjacent said inlet end at a value of between 5 and 60 pounds per square inch gauge pressure during normal flow of carbon dioxide through said conduit.

3. Means for cooling an alcohol bath or the like by injecting carbon dioxide at low temperature and pressure, into said bath comprising a conduit of relatively small internal diameter having its discharge end located below the surface of said bath and having its inlet end located at a point remote from said bath, means for supplying liquid carbon dioxide to the inlet end of said conduit, and flow restriction means mounted in the inlet end of said conduit, said flow restriction having an effective flow area selected to maintain the pressure adjacent said inlet end at a value of between five and sixty pounds per square inch gauge pressure during normal flow of carbon dioxide through said conduit.

4. Means for cooling an alcohol bath, or the like, by the injection of carbon dioxide, comprising a conduit extending a substantial distance through the bath having an unobstructed discharge opening located within said bath and having an inlet opening located outside the bath, means for supplying liquid carbon dioxide under pressure to the inlet opening of said conduit, and flow restriction means positioned in the path of flow of the liquid carbon dioxide to said inlet opening for transforming the liquid carbon dioxide from said supply means into a mixture of snow suspended in vapor within said conduit, said flow restriction means having an effective flow area selected to maintain the pressure adjacent said inlet opening at a value of between five and sixty pounds per square inch gauge for maintaining a velocity of flow in the conduit which is sufficient to retain the snow in suspension until it reaches said discharge opening.

5. Means for cooling an alcohol bath, or the like, by the injection of carbon dioxide, comprising a conduit having a discharge opening adjacent the bottom of said bath and having an inlet opening located outside the bath, means for supplying liquid carbon dioxide under pressure to the inlet opening of said conduit, and means positioned in the path of flow of the liquid carbon dioxide to said inlet opening for providing a restriction orifice of a size ranging between .021 inches and .042 inches for transforming the liquid carbon dioxide from said supply means into a mixture of snow suspended in vapor within said conduit, said restriction means so controlling the forming of the snow and vapor mixture as to maintain a velocity of flow in the conduit sufficient to retain the snow in suspension until it reaches said discharge opening.

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