PRESSURE FLUID RELEASE DEVICE

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2 Sheets-Sheet 1

Fig. 1

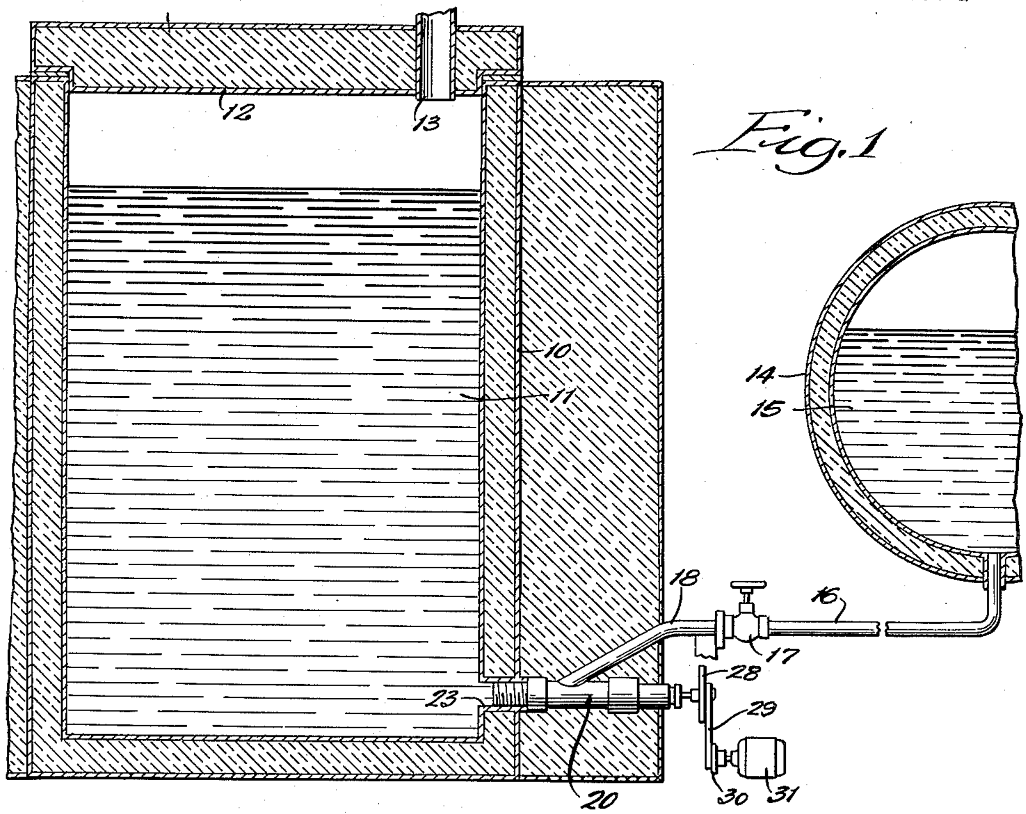

Fig. 2

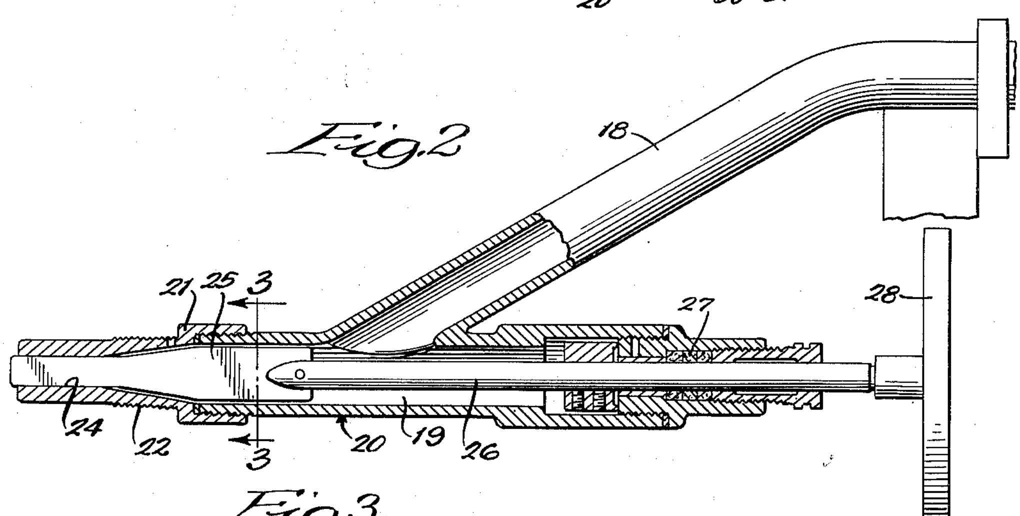

Fig. 3

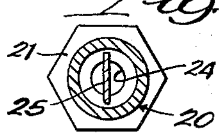

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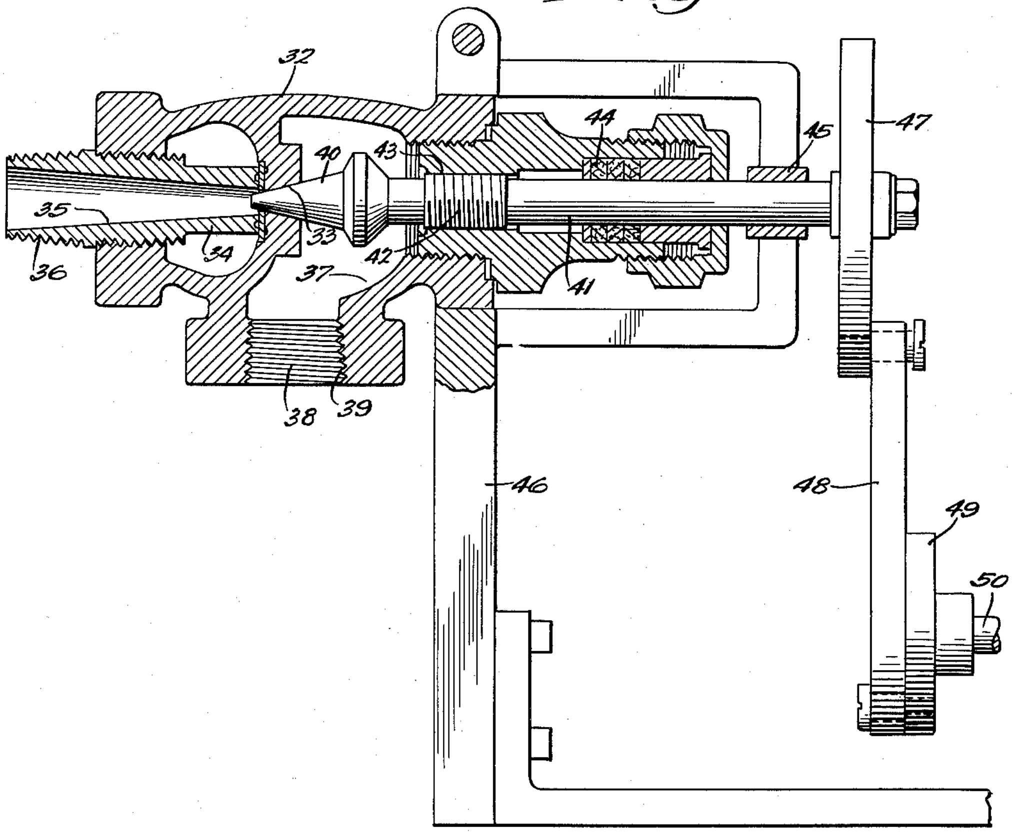
Fig. 4



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PRESSURE FLUID RELEASE DEVICE

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This invention relates to a pressure fluid release device. The invention is particularly useful in the release of CO_2 and the like and in keeping the discharge nozzle or valve orifice substantially free of plugging by CO_2 snow or water crystals, etc. The invention is further useful in refrigerting systems in which the refrigerating liquid is chilled by contact with CO_2, a fluid pressure release being employed for bringing the CO_2 into contact with the refrigerant without blocking or plugging the discharge nozzle or release orifice, etc. The invention is clearly applicable to other uses.

An object of the invention is to provide a discharge nozzle or expansion valve structure in which means are provided for keeping the nozzle or valve seat from being blocked or plugged when CO_2 is being released therethrough. A further object is to provide a pressure fluid release device which is highly effective in the discharge of carbon dioxide and the release of pressure thereon while keeping the discharge port open continuously during the discharge of the carbon dioxide. Yet another object is to provide a refrigerating system in which the refrigerant employed for chilling areas is itself chilled by contact with carbon dioxide which is released from a liquid state to a gaseous state through the employment of a pressure release device equipped with means for keeping the discharge port or orifice clear. A still further object is to provide in such a structure a nozzle equipped with a rotary vane for clearing the nozzle of snow or ice while at the same time providing a valve control conduit for supplying CO_2 to the nozzle discharge port. A still further object is to provide in an expansion valve structure for the release of CO_2 maintained under high pressure, a valve device which is connected to power means for moving the valve to maintain the valve seat or orifice constantly open. Other specific objects and advantages will appear as the specification proceeds.

The invention is shown in illustrative embodiments by the accompanying drawings, in which—

Figure 1 is a vertical sectional view of a refrigerant chilling receptacle, a container for CO_2, and connecting means therebetween, including a pressure fluid release device embodying my invention; Fig. 2, an enlarged broken sectional view showing the fluid pressure release device; Fig. 3, a transverse detail sectional view, the section being taken as indicated at line 3—3 of Fig. 2; and Fig. 4, a broken vertical sectional view of a modified form of the device.

In the illustration given in Figs. 1 to 3, inclusive, **10** designates an insulating refrigerant container adapted to hold therein a body **11** of secondary liquid refrigerant such as methyl alcohol, acetone, etc. The top of the container is closed with an insulated closure **12** having therein a vent pipe **13** for the escape of CO_2 gas, etc. It is common practice to circulate by a pump, the secondary refrigerant **11** through finned heat exchangers. The exchangers are part of a closed insulated duct system in which a blower recirculates air which is chilled as it passes through the exchanger and in turn refrigerates the test

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chamber. For example, such apparatus may be used for maintaining test chambers for various types of devices at very low temperatures, such as, for example, −70° F. Since a temperature differential must exist between the test chamber and the refrigerating fluid, the fluid temperature should be lower than −85° F.

Heretofore it has been common to introduce blocks of solid carbon dioxide into the liquid body **11** as a means for chilling the fluid, but this practice is expensive and it has been desired to use liquid CO_2 as a means for cooling the refrigerant **11**. When, however, liquid CO_2 is employed, it is found that as the pressure upon the discharged CO_2 is released, there is formed in the discharge nozzle or orifice crystalline material which brings about a blocking or plugging of the discharge device. This plugging may be due to the forming of carbon dioxide snow in the nozzle or the forming of water ice crystals, or possibly to a combination of both.

In the structure shown in Figs. 1 to 3, inclusive, I provide an insulated container **14** containing liquid CO_2 **15**, and from the container **14** extends a conduit **16** which is provided with a stop valve **17**. The conduit **16** has a forward portion **18** extending downwardly at an angle and communicating with the bore **19** of the nozzle **20**. The nozzle **20** is threaded at its forward end to receive an attachment member **21** having a threaded portion **22** threadably engaging the inner threaded walls of the opening **23** of container **10**.

Mounted within the bore **19** and the reduced passage **24** in extension **21** is a vane **25** of thin, blade-like cross section, as shown more clearly in Fig. 3, the blade conforming at its rear to the increased diameter of the bore **19** and at its forward end to the reduced passage **24** of the extension **22**.

Any suitable means for rotating the vane **25** may be employed. In the illustration given, a shaft **26** is secured at its forward end to the vane **25** and extends rearwardly through a packing and stuffing box **27** to a drive wheel **28**. A drive arm **29** is eccentrically connected to the wheel **28** at one end and at its other end is eccentrically connected to a small drive wheel **30** mounted on the shaft of motor **31**. With this structure, the wheel **28** is rotated through an arc of approximately 90 degrees as the smaller drive wheel **30** is rotated. If desired, the vane may be rotated continuously by a geared motor.

In the operation of the apparatus, the valve **17** is operated to cause the desired flow of CO_2 downwardly at an angle into the nozzle bore **19**. As the CO_2 passes forwardly through the outlet portion of the nozzle, the crystals formed are engaged by the rotating vane **25** and swept clear from attachment to the inner surface of the nozzle so that such material is swept forward by the pressure of the fluid into the refrigerant **18**. Thus, as the cooling operation starts, it is found that there is no tendency for the material to plug during the cooling period. Intermittent flow is eliminated and a continuous drop in temperature is obtained down to the sublimation temperature of solid carbon dioxide, namely, −110° F.

In the foregoing operation, the CO_2 flows through a rather large conduit **18** into the relatively large bore **19** of the nozzle, and when it reaches the discharge portion of the nozzle where the diameter is substantially reduced, the rotating vane **25** is effective in keeping the ice particles from blocking the passage while at the same time enabling the dislodged crystal material to be carried forwardly through the reduced nozzle opening.

In the modification illustrated in Fig. 4, there is provided a valve casing **32** providing an inner valve seat **33**. A threaded member **34** provides an outwardly-flaring passage **35** communicating with the valve orifice. The member **34** also has an outer threaded portion **36** which is adapted to engage the threaded wall of the opening **23** in the container **10**. The valve casing **32** provides an inner chamber **37** to which liquid carbon dioxide is fed through the opening **38**. A conduit (not shown) from the source of supply and preferably equipped with a stop valve, is adapted to threadably engage the threaded boss **39** about opening **38**. The valve seat **33** is tapered and a tapered or needle valve **40** is supported for engagement with the seat upon the valve stem **41**. The valve stem **41** is threaded at **42** and engages threads in the valve casing **43** so that upon rotation of the valve stem the valve **40** is moved toward or away from the valve seat **33**. The valve stem **41** passes through a packing and stuffing box **44** and thence through a bearing **45** provided by a support **46**. To the end of stem **41** is secured a wheel **47** and eccentrically connected to the wheel is an arm **48**. The arm **48** is eccentrically connected at its other end to a drive disc **49** mounted upon a motor shaft **50**. The loose connections between the parts enable the wheel **47** to be oscillated through a short arc as the motor shaft **50** is rotated, and the valve **40** thus has a partly rotating movement and a partly longitudinal movement toward and away from the valve seat **33**.

In order to change the quantity of gas flowing through the orifice it is necessary to first remove the connecting rod **48** stud in disc **47** and then turn the valve stem **41** counterclockwise to enlarge the valve opening after which the stud and connecting rod are again assembled.

In the operation of the expansion valve structure shown in Fig. 4, it is probable that the solid carbon dioxide is not formed until the liquid has expanded into the divergent cone **35** of the discharge nozzle, and it seems likely that the plugging of the annular conical space between the needle and the orifice or valve seat may be caused by water ice crystals. In any event, the oscillating needle of the valve apparently crushes the minute crystals and keeps the orifice clear for flow. Thus, the valve **40**, which rotates as well as moves longitudinally, is effective in causing the flow of the CO_2 into the expanding cone **35** of the discharge nozzle and a continuous drop in temperature is obtained in the operation of the device for cooling the refrigerating fluid in vessel **10**. The stem **41** may be oscillated through an angle of approximately 40 degrees, or through any other desired angle, using any suitable linkage to a gear motor shaft and the motor shaft may rotate at approximately 10 R. P. M., the gear motor output not being critical.

While I have shown two specific modifications in which the CO_2 passes through an orifice or through a restricted discharge passage, the orifice or restricted passage being kept free of clogging through the employment of an oscillating, rotating or longitudinally-movable member, it will be understood that various other forms of fluid pressure release devices may be used having different forms of crystal breakers or movable members for eliminating the formed crystals. Such movable members may be rotated continuously or oscillated or moved back and forth or moved in other ways to break the crystal formations and prevent them from building up in the reduced diameter area to cause plugging of the apparatus. The freezing difficulties or plugging are aggravated in the smaller size of nozzles, and the moving or oscillating

crystal breakers are of great value in connection with such nozzles to permit a continuous drop in temperature down to the sublimation temperature of solid carbon dioxide without any break in the flow of the carbon dioxide.

In the drawing, as shown in Fig. 1, the insulation extends about the valve structure **20** and the inclined portion of pipe **18**. If desired, the thickness of insulation shown may extend about the entire chamber containing the chilled liquid **11**.

While in the foregoing specification I have set forth specific embodiments of the invention in considerable detail for the purpose of illustrating the invention, it will be understood that such details of structure may be varied widely by those skilled in the art without departing from the spirit of my invention.

I claim:

1. In a refrigeration system in which a liquid refrigerant is chilled by contact with expanded CO_2 and in which the refrigerant is contained within an insulated vessel, a nozzle secured within an opening in the side wall of said vessel and having its discharge port communicating with the refrigerant in said vessel, a conduit leading from a source of liquid CO_2 to the bore of said nozzle, means for controlling the flow of CO_2 in said bore, a movable member adjacent the discharge portion of said nozzle, and power means for moving said member to break crystals forming within the bore of said nozzle adjacent said discharge portion.

2. In combination with a vessel containing liquid refrigerant, a nozzle having an enlarged bore portion and a reduced bore portion secured to a wall of said vessel and communicating with the refrigerant therein, a conduit leading from a source of CO_2 to the enlarged bore portion of said nozzle, a member rotatably mounted in said nozzle adjacent the discharge portion thereof and being substantially enclosed within said nozzle, and power means for continuously oscillating said rotatably mounted member.

3. In a nozzle structure for use in combination with a vessel containing liquid refrigerant, a nozzle having an enlarged bore portion and a reduced bore portion for securance to such a vessel with the reduced portion thereof in communication with the refrigerant within that vessel, a conduit leading from a source of CO_2 to the enlarged bore portion of said nozzle, a member rotatably mounted in said nozzle adjacent the discharge portion thereof and being substantially enclosed within the nozzle, and power means for continuously oscillating said rotatably mounted member.

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