Nov. 13, 1951 A. P. FULKERSON 2,574,823

FLUID FLOW CONTROLLER

Filed Sept. 11, 1947 2 SHEETS—SHEET 1

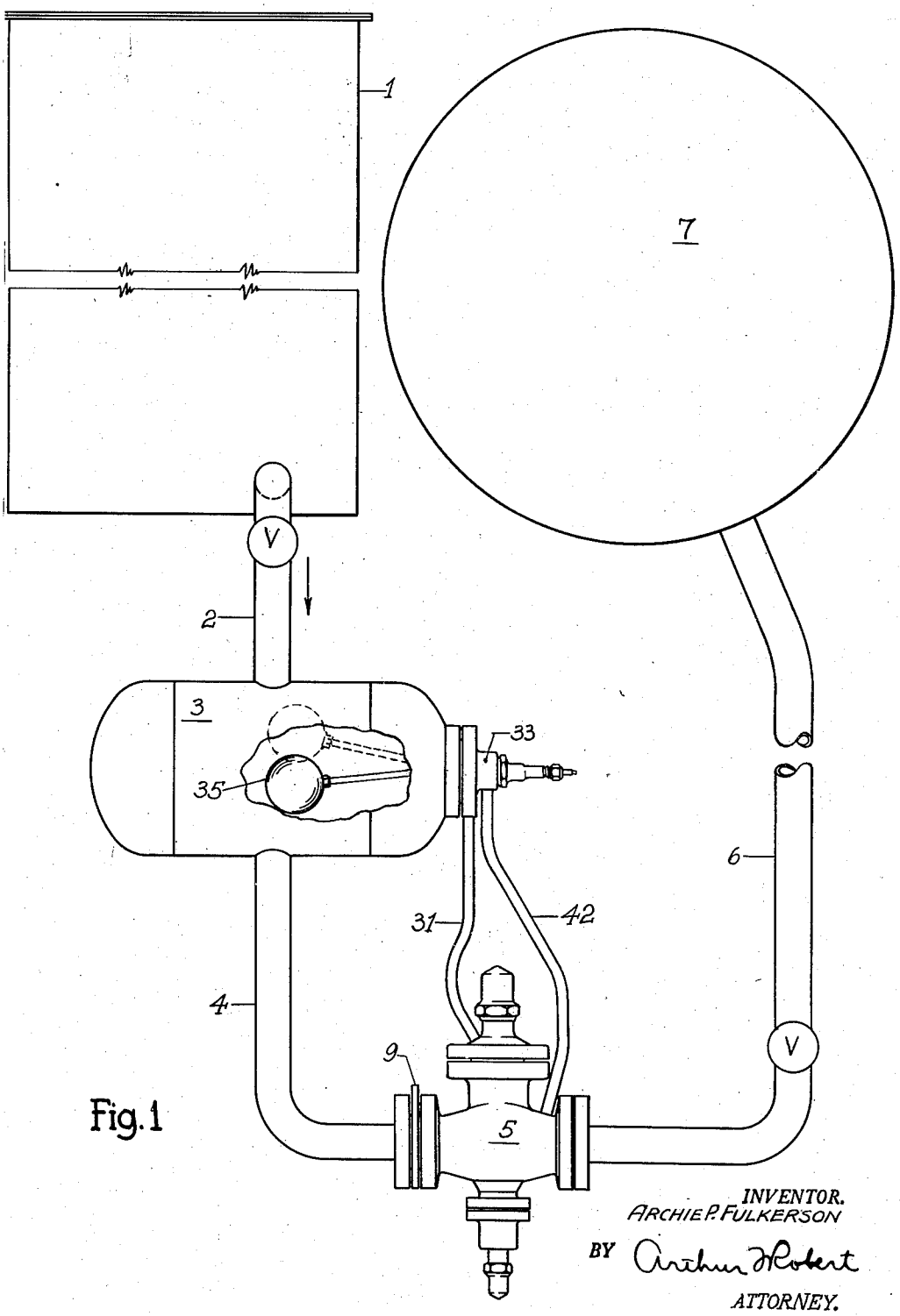


Fig. 1

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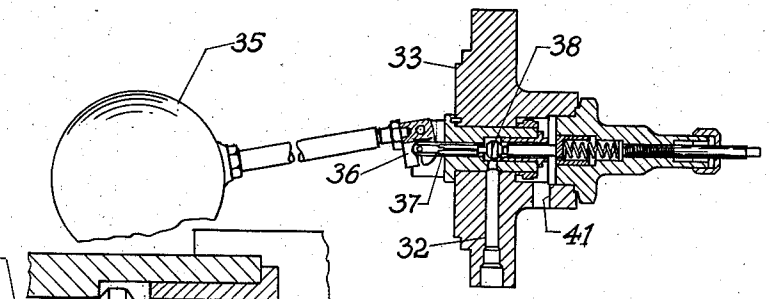


Fig. 2

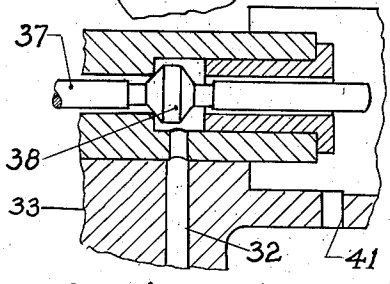


Fig. 4

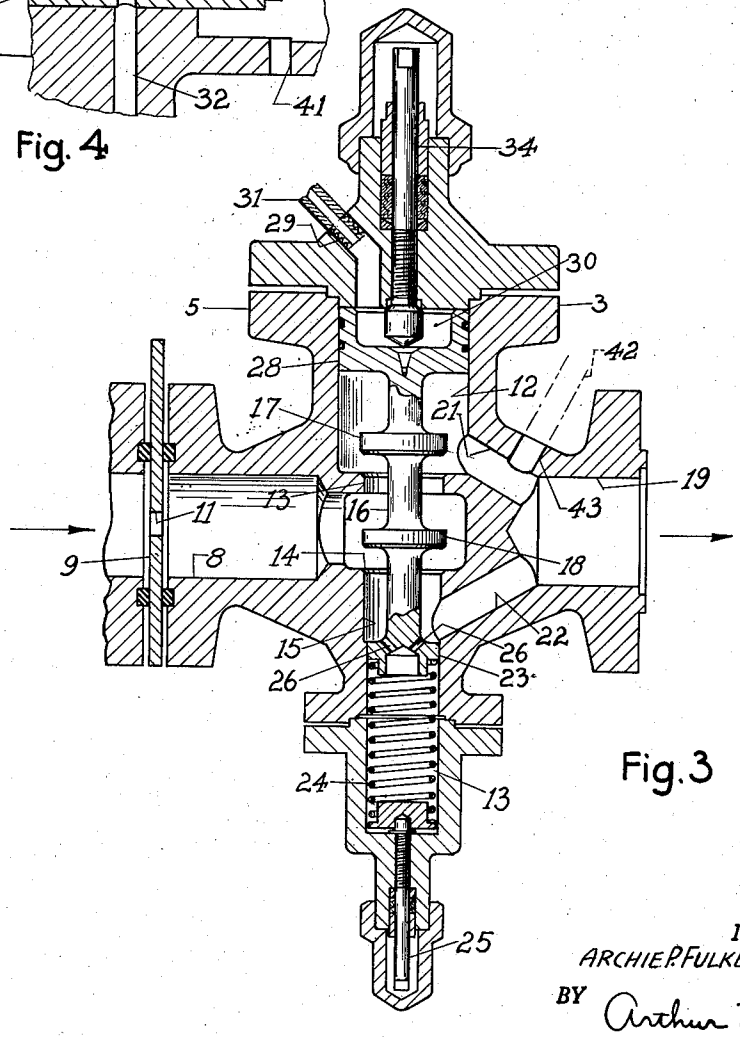


Fig. 3

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UNITED STATES PATENT OFFICE

2,574,823

FLUID FLOW CONTROLLER

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2 Claims. (Cl. 62—2)

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The present invention relates to an automatic refrigerant controller for a tube ice machine to shut off the discharge of refrigerant from the freezing shell and trap heated gas therein in the thawing operation.

In tube ice machines there is provided a shell adapted to containing a liquid refrigerant surrounding tubes therein through which flows the water to be frozen. At the end of the freezing operation, hot refrigerant gas under pressure is introduced into the freezer shell to drive out the cold liquid refrigerant, and thaw the periphery of the ice in the freezer tubes to free it for discharge from the machine. The expelled cold liquid refrigerant passes to a transfer drum or reservoir. It is necessary to maintain the pressure on the gas in the freezer in order to realize the heat therefrom for thawing the ice, and it is also desirable to prevent entry of the hot refrigerant gas into the transfer drum in which the cold liquid refrigerant is held, as this would unnecessarily heat the liquid refrigerant. Also, as some of the refrigerant gas becomes condensed to a liquid during the thawing cycle in the freezer, it is desirable to allow this condensed cold liquid to escape from the freezer.

It is an object of the present invention to provide a control system for a tube ice machine wherein the orifice for escape of liquid refrigerant from the freezer shell is automatically closed substantially as soon as all the liquid refrigerant is expelled from the freezer by the incoming gas.

Another object is the provision of a control apparatus providing means for insuring against the flow of gaseous refrigerant into the transfer drum during the trawing cycle.

A further object is the provision of a float control system in which the valve for shutting off the escape orifice for the liquid refrigerant from the freezer is pressure operated, and may be maintained in open condition until actuation thereof by a differential pressure timed to act upon discharge of substantially all the liquid refrigerant from the freezer.

A further object is the provision of a control apparatus in which a pressure actuated valve is operated by a pilot valve which is in turn controlled by the discharge of liquid from the freezer shell.

Another object is the provision in a tube ice machine of an apparatus which allows the flow of a current of liquid therethrough, and substantially prevents the flow of gas therethrough.

A further object is the provision in a freezer of

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a control apparatus in which a pressure actuated valve closes upon the discharge of liquid refrigerant from the freezer, and which may be actuated to open position by pressure on the opposite side thereof.

In accordance with the present invention, I provide in the connection between the freezer shell and the transfer drum or reservoir, a main valve with a flow restriction located on one side thereof. The main valve, which may be of the pressure balanced type or any other suitable type, is actuated by a pressure responsive means, the preferred arrangement being one in which the valve is normally biased to open position, and is operated to closed position by said pressure responsive means. The pressure responsive means is connected to be subject to substantially equal pressures under certain conditions, or to the pressure differential across said restriction, and a control member, preferably in the form of a pilot valve, is provided to apply the pressure differential to said pressure responsive means to close the main valve substantially as soon as all the liquid refrigerant is discharged from the freezer shell.

The pilot valve is operated in the preferred embodiment by a float member which is responsive to the level of liquid in a drain tank or chamber below the freezer shell and connected to the bottom thereof. Thus, when liquid is completely discharged from the freezer shell into the drain tank, the change in liquid level in the chamber or drain tank actuates a float therein which in turn actuates the pilot valve to control the application of differential pressure to said pressure responsive means and close the main valve, thus trapping gaseous refrigerant in the freezer shell. If desired, the weight of the float may be partially counterbalanced by a spring or the like. During the thawing operation, some of the refrigerant gas is condensed to a liquid and flows into the float chamber where it causes actuation of the pilot valve long enough to allow the escape of the liquid from the float chamber while trapping the gas in the freezer. Upon completion of the thawing cycle, the liquid in the transfer drum is placed under pressure and the application of the liquid pressure in the connection between the transfer drum and the main valve permits the spring assisted by the pressure responsive means of the main valve to open the valve to readmit liquid refrigerant to the freezer for the next freezing cycle.

In the preferred embodiment, the pressure responsive means comprises a piston suitably

connected to the main valve for actuation thereof, the piston being subject on one side to the pressure of the fluid in the main valve regardless of whether the main valve is in open or closed position and the application of pressure to the other side is controlled by the pilot valve. Any suitable type of flow restricting device may be employed in the connection between the freezer and transfer drum, and in the preferred embodiment, an orifice plate is used for this purpose, as such a plate is compact and may be selected to produce the pressure drop across the two sides thereof required for controlling the main valve.

The invention will be described in greater detail in connection with the accompanying drawings in which there is shown a preferred embodiment of the invention by way of example, and in which:

Figure 1 is a partly diagrammatic view illustrating the invention,

Figure 2 is a view in vertical section of the pilot valve,

Figure 3 is a vertical sectional view of the main shut off valve, and

Figure 4 is a partly diagrammatic view illustrating the operation of the pilot valve.

Referring to the drawings, there is shown a freezer shell 1, containing a suitable liquid refrigerant, such as ammonia, which surrounds a plurality of water tubes extending therethrough (not shown). A conduit 2 connects the bottom of the shell 1 to a float tank 3, and a conduit 4 leads to the inlet side of valve 5, which valve is preferably of the balanced type, the outlet side thereof being connected by a conduit 6 with a transfer storage drum or tank 7.

Referring to Figure 3, the valve 5 has an inlet passageway 8 in advance of which is suitably located a plate 9 having a suitable orifice 11 therein. Passageway 8 connects with the transverse bore 12 having dividing walls providing valve seats 13 and 14, the latter being at the end of reduced bore 15. A valve stem 16 is longitudinally movable in the bore and carries suitable valve closure members 17 and 18 adapted to seat upon the seats 13 and 14. The plural valve closure members 17 and 18 provide a pressure balanced assembly, and it will be understood that if desired, a single valve may be employed. The outlet passageway 19 communicates with bore 12 by a port 21, and communicates with bore 15 by a port 22, so that ports 21 and 22 and bore 12 serve to carry flow from inlet passageway 8 past the seats 13 and 14 to the outlet 19.

The lower end of valve stem 16 carries a piston 23 fitting into bore 15, and the weight of the valve stem is counter-balanced by a spring 24, the compression of which may be suitably adjusted by a threaded stem 25, so as to normally maintain the valve in open position. The pressure on the opposite sides of piston 23 is balanced by the provision of small ports 26 therethrough, so that piston 23 serves to cushion the operation of the valve.

The upper end of valve stem 16 carries a suitable pressure responsive means, which in the preferred form comprises a piston 28 operating in bore 12, and the passageway 21 thus subjects the underside of piston 28 to the pressure of fluid in the outlet 19 of valve. A passageway 29 connects to the opposite chamber 30 of piston 28, this passageway being connected by a conduit 31 to passageway 32 in the float controlled valve 33. A threaded stem 34 may be provided which

may be manually operated to engage stem 16 to close the valve when desired.

From the description so far pursued, it will be apparent that the fluid pressure on piston 23 is balanced by reason of the orifices or ports 26, the valves 17 and 18 being normally held open by spring 24, and the pressure on valve closures 17 and 18 also is balanced. The pressure on the lower side of piston 28 is substantially that in the outlet passageway 19 (or inlet 8, neglecting the small pressure drop through the valve). The pressure on the upper side of piston 28 may be varied as will be now explained.

Referring to Figures 1 and 2, when the float chamber 3 contains liquid substantially above the middle thereof, the float 35, shown in the dotted line position in Figure 1, through lever 36 holds the valve stem 37 and double valve member 38 of the float controlled pilot valve, to the left seat as shown in Figure 4, to close off communication between the float chamber 3 and the passageway 32 leading to chamber 30 on the upper side of piston 28. A passageway 41 in the pilot valve is connected by a conduit 42 (Figs. 1 and 3) to passageway 43 on the outlet side of the main valve 5. In this position chamber 30 is connected by conduit 31 through the pilot valve and the open right seat of the pilot valve, and through the conduit 42 and bores 43, 21 to the downstream passageway 19, while the underside of piston 28 is connected by passage 21 to outlet 19, so that in this position liquid pressure is balanced on opposite sides of piston 28. When the liquid level in chamber 3 drops sufficiently, the float 35 drops to the full line position shown in Figs. 1 and 2, and causes the double valve 38 to assume the right hand position shown in Figure 2, in which position the left seat thereof is open. The pressure of gas in the float chamber is transmitted through passage 32, conduit 31, and passage 29 to chamber 30. At the same time, a small flow may occur along the pilot valve stem, passage 41, conduit 42, and passageways 43, 21 to the outlet passageway 19 of the valve, but by reason of the small clearance area around the pilot valve stem, this flow is small enough so as not to materially affect the operation. The pressure in chamber 30 therefore will be substantially that of the gas in the float chamber 3, and the pressure on the underside of piston 28 is substantially the outlet pressure in the main valve.

The operation of the apparatus now will be described. When the freezing operation in freezer shell 1 is completed, the system is full of liquid refrigerant, and hot refrigerant gas under pressure is introduced into the shell 1 through a suitable opening (not shown), to expel the cold liquid refrigerant therein and thaw the ice in the tubes so that it can be discharged. At the same time suction is applied to the transfer drum. The pilot valve 38 will be in the position shown in Figure 4 closing the left seat, because the float 35 is held elevated by the liquid in chamber 3, as shown in dotted lines in Figure 1. The liquid refrigerant thus is forced by the pressure of the hot gaseous refrigerant through conduit 2, float chamber 3, conduit 4, orifice 11, valve 5 and conduit 6 to the transfer drum 7.

When the liquid refrigerant is completely expelled from shell 1, the level of liquid in float chamber 3 drops until the float 35 moves downwardly sufficiently to unseat the valve member 38 from the left hand seat and close it against the right hand seat. In this position of the pilot valve, the gas pressure in the upper part of chamber 3 will be transmitted through passageway 32,

conduit 31 and passageway 29 to the chamber 30 above the piston 28, while the pressure below piston 28 will be substantially that in outlet 19. However, by reason of the flow through the orifice 11 and the resulting pressure differential produced thereby on the approach and discharge sides, the pressure in outlet passageway 19 and the pressure under piston 28 will be materially lower than the pressure in chamber 3, so that a substantial differential in pressure will be developed across the piston 28, with the result that the piston 28 moves the stem 16 downwardly against the bias of spring 24 to close the valve members 17 and 18 and stop flow of liquid refrigerant therethrough.

After the main valve closes, it is maintained closed by the pressure of the gaseous refrigerant applied to the top side of piston 28. Suction preferably is maintained on the liquid refrigerant in the transfer drum to keep the refrigerant cool by evaporation and this also serves to prevent building up of pressure on the outlet side 19 of the valve. Any gaseous refrigerant in the freezer condensed to liquid flows into chamber 3 and if sufficient condensate is formed to raise float 35, the pilot valve opens the right seat and closes the left seat, thus allowing the pressures on the opposite sides of piston 28 to equalize through conduits 31 and 42, whereupon spring 24 opens the valve. This causes flow of liquid refrigerant from conduit 4 through the valve to conduit 5 and allows the liquid level in chamber 3 to again fall and again actuate float 35 to move valve 38 against the right hand seat to impose a differential pressure on piston 28 to close the main valve, as previously described.

Upon completion of the thawing cycle and discharge of ice from the freezer shell, suction is applied to the freezer shell by any suitable automatic or manual arrangement and pressure is applied to the transfer drum, so that the pressure above the piston 28 drops while the pressure below the piston increases until it is sufficient to allow spring 24 to open the main valve and thus allow liquid refrigerant to return to the freezer shell for the next freezing cycle. This causes filling of the chamber 3 and raises the float therein to move the pilot valve to the left hand seat, so that the pressures on piston 28 become balanced and valve 5 is held open. The application of suction to the transfer drum and to the freezer as herein described ordinarily will be accomplished automatically by suitable solenoid controlled valves or the like, which suitably

connect the pressure and suction sides of the refrigerant compressor to accomplish this result.

The apparatus herein illustrated and described automatically stops the flow of liquid refrigerant from the freezer shell to the storage reservoir before there is any opportunity for a substantial quantity of the heated refrigerant gas to enter the storage reservoir, and traps the gaseous refrigerant in the freezer shell, where it serves to release the ice for discharge from the freezer. The orifice 11 provides a pressure differential, and the float controlled pilot valve automatically applies the higher gas pressure to the upper side of the piston, so as to actuate the piston to close the main valve, before any substantial quantity of the gas can blow into the transfer drum.

Various modifications may be made in the invention without departing from the spirit or scope thereof.

Having described my invention, I claim:

1. A fluid control apparatus for a freezer comprising: a conduit connected to said freezer for reversible flow of refrigerant; a valve in said conduit; pressure responsive means for operating said valve; a chamber connected to said conduit on one side of said valve; flow restricting means in the conduit between the chamber and said valve; a passageway connecting said chamber to one side of the pressure responsive means, the other side of the pressure responsive means being connected to the other side of said restriction; a pilot valve in said passageway; a duct connecting the pilot valve with said other side of the pressure responsive means, whereby movement of the pilot valve in one direction disconnects said chamber from said pressure responsive means and interconnects the two sides of the pressure responsive means; and means operated by the level of liquid in said chamber for operating said pilot valve.

2. A fluid control apparatus as specified in claim 1 wherein said pressure responsive means is a piston.

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