Sept. 29, 1953 J. D. WILLIAMS, JR 2,653,453

ICE-MAKING MACHINE

Filed Aug. 5, 1949 3 Sheets-Sheet 1

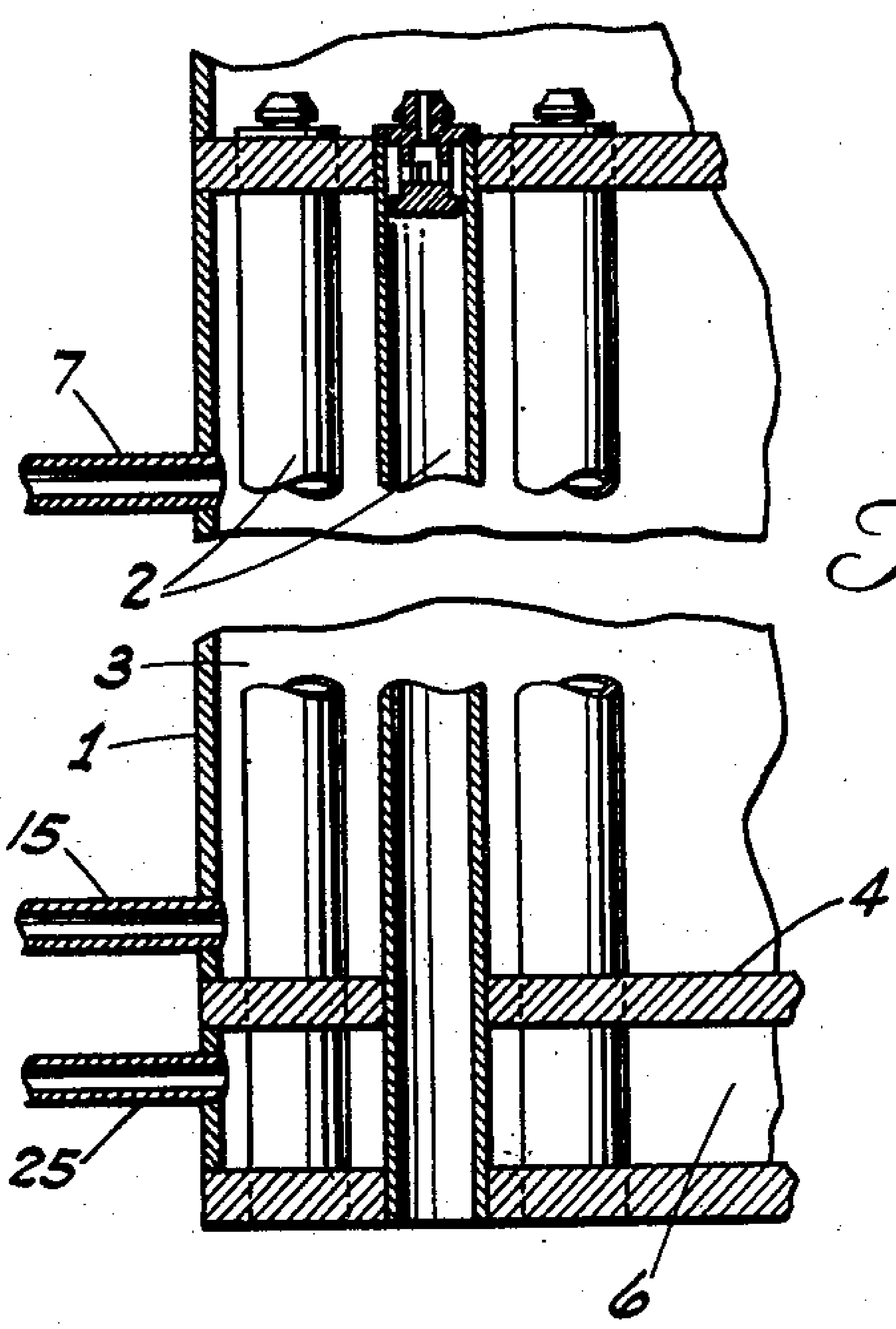

Fig. 1

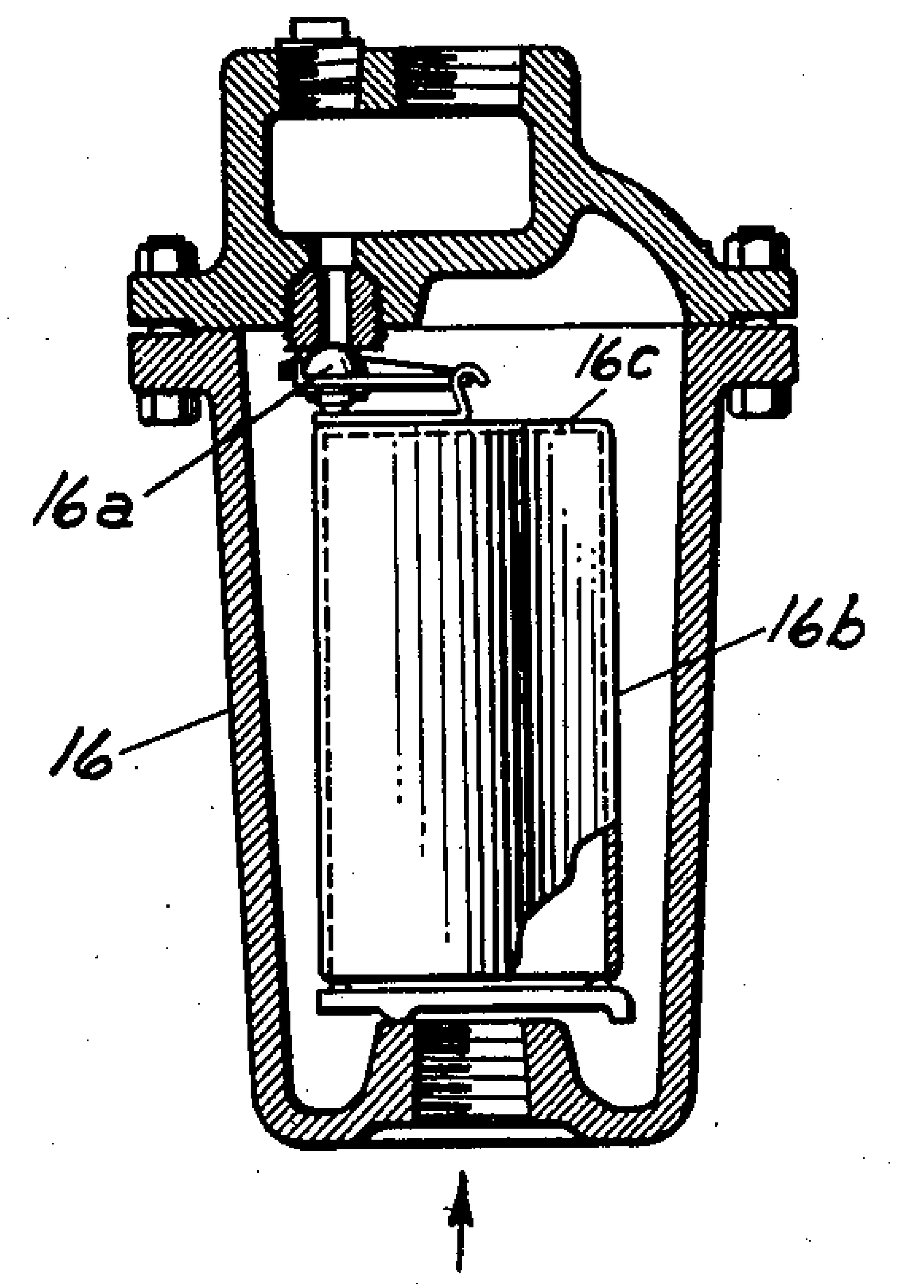

Fig. 2A

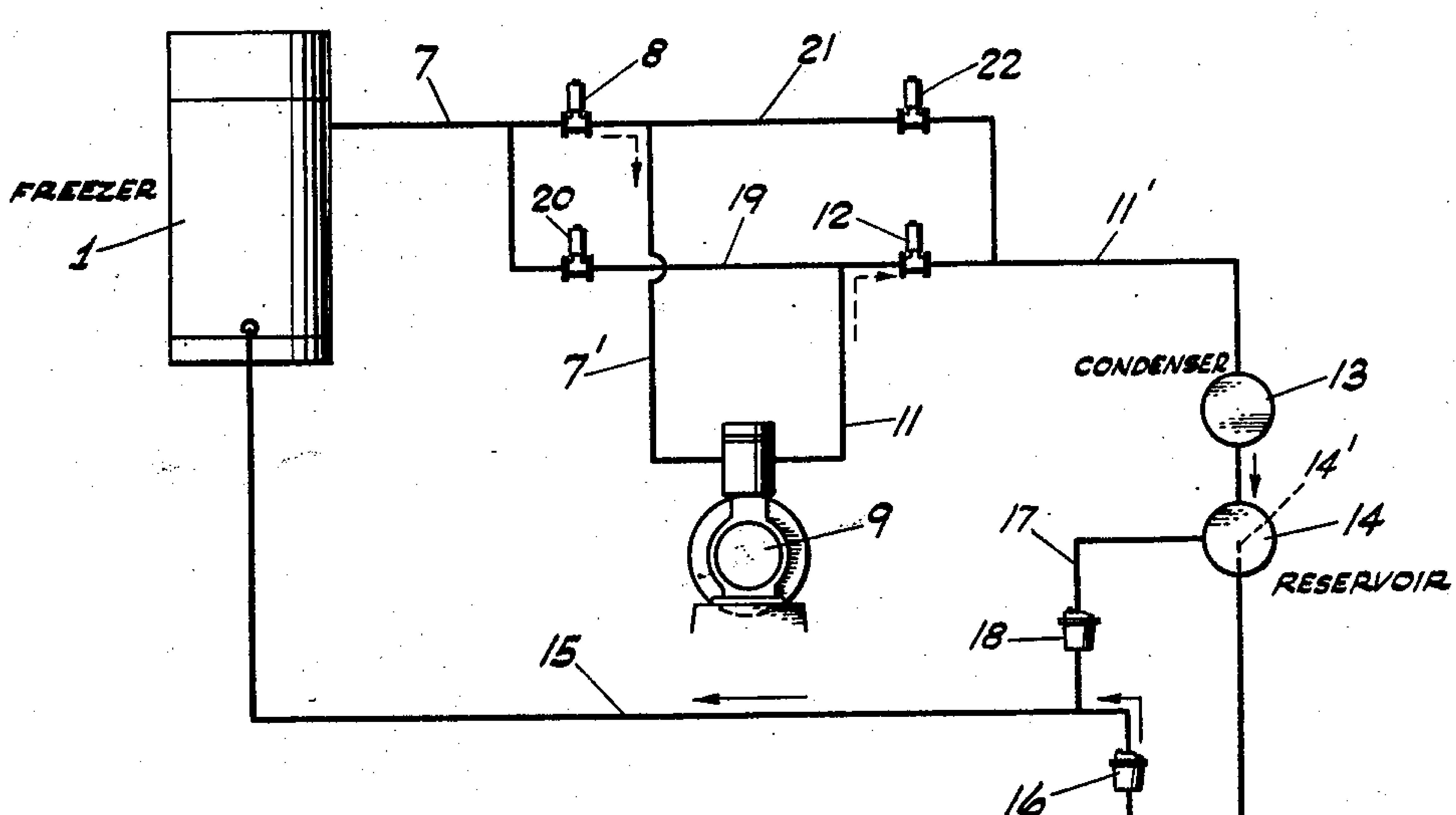

Fig. 2

Inventor
JESSE D. WILLIAMS, JR.

By Arthur Robert

Attorney

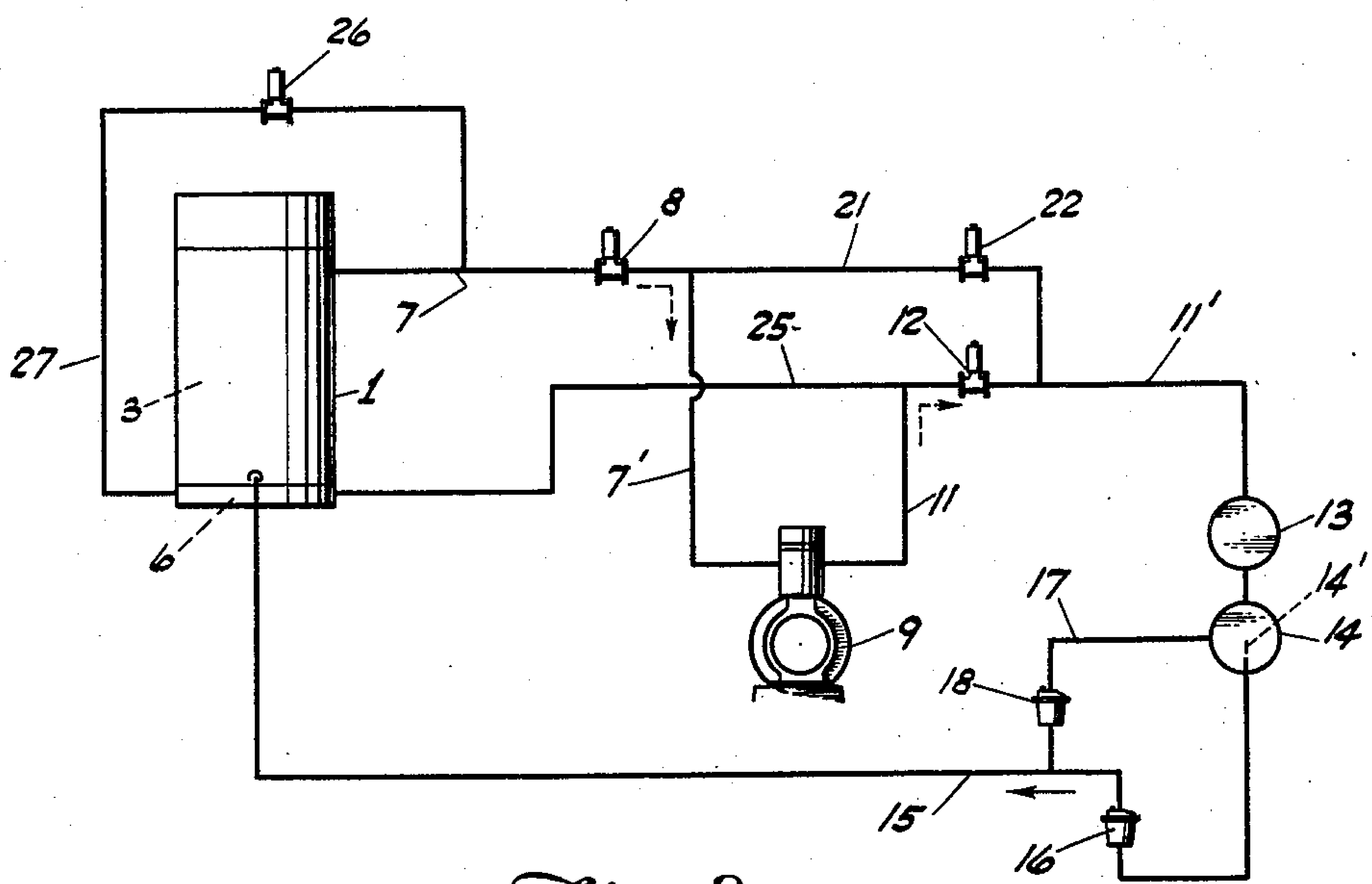

Fig. 3

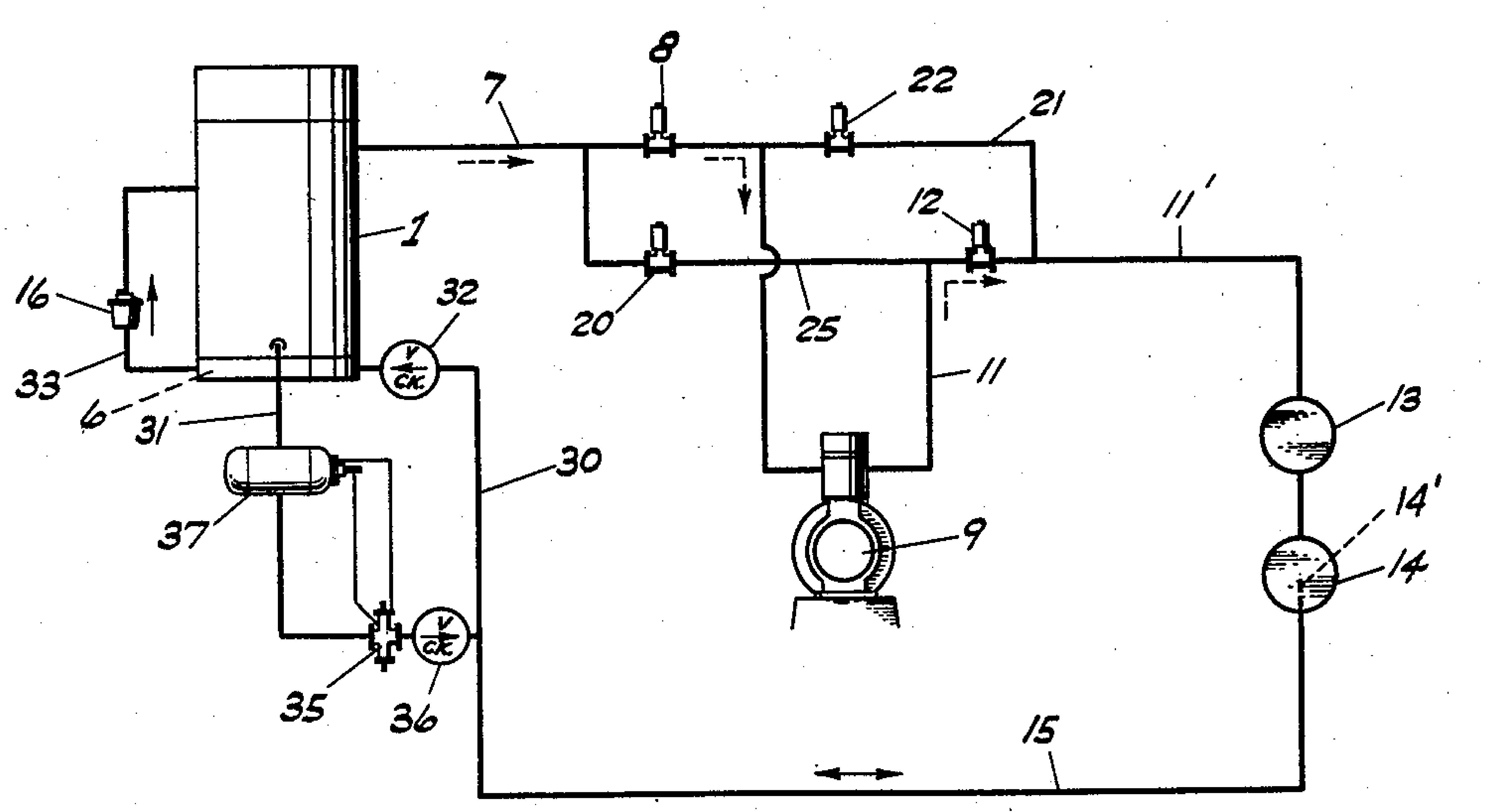

Fig. 4

Inventor
JESSE D. WILLIAMS, JR.

By Arthur Robert

Attorney

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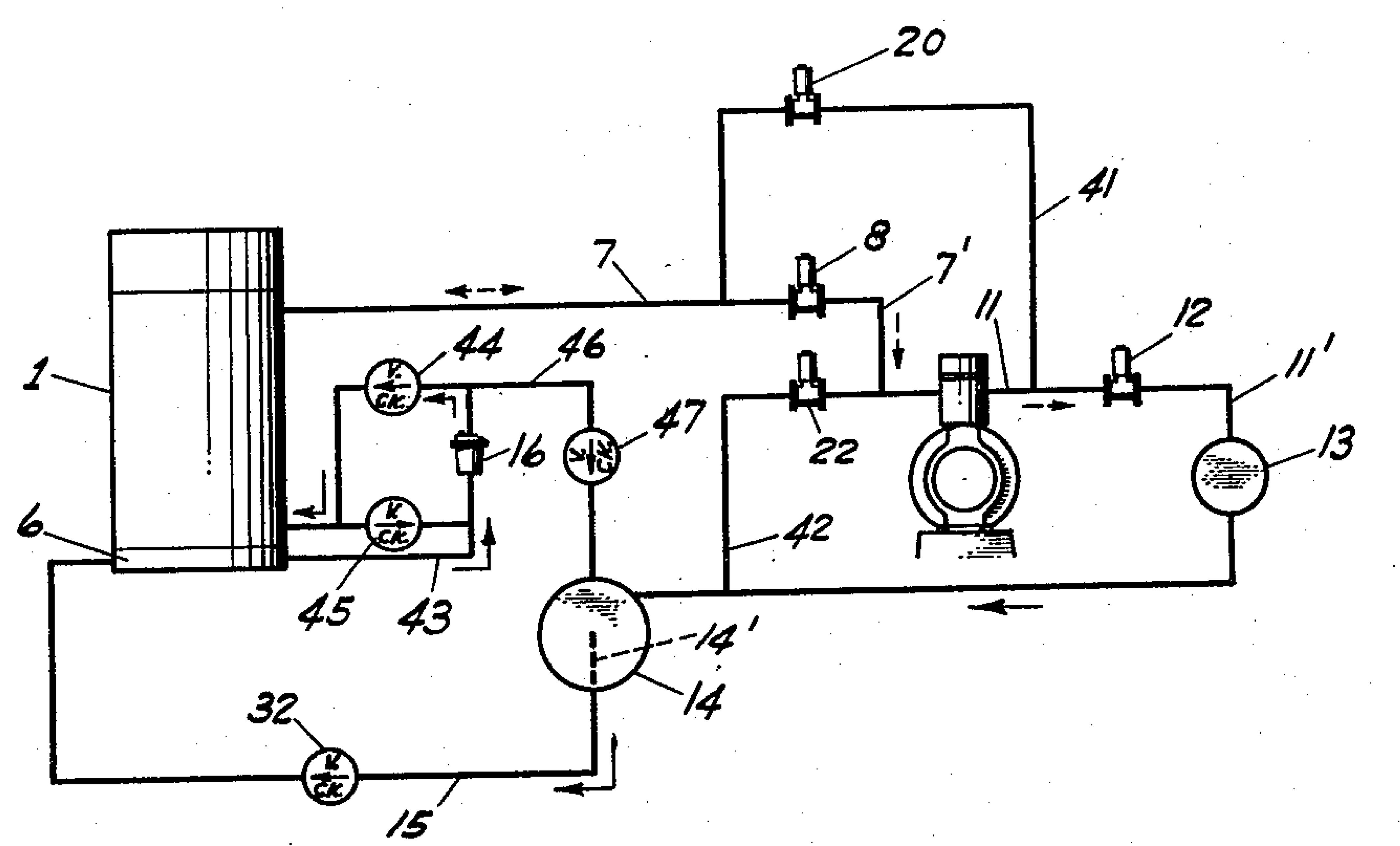

Fig. 5

Inventor
JESSE D. WILLIAMS, JR.

By Arthur Robert
Attorney

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2,653,453

ICE-MAKING MACHINE

Jesse D. Williams, Jr., Shively, Ky., assignor to Henry Vogt Machine Company, Louisville, Ky., a corporation of Kentucky

Application August 5, 1949, Serial No. 108,783

6 Claims. (Cl. 62—3)

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In reverse cycle ice making machines of the type exemplified by Kubaugh Patent 2,444,514 issued July 6, 1948, during the freezing cycle the refrigerant gas drawn by the pump from the evaporator is condensed and stored in a reservoir, from which reservoir it is fed as required to the freezer or evaporator. In the thawing cycle the liquid refrigerant is rapidly evacuated from the evaporator and is stored in a separate transfer drum or displacement vessel until completion of the thawing cycle, whereupon the liquid refrigerant is rapidly returned therefrom to the evaporator for the freezing cycle. During the freezing cycle, as refrigerant boils off in the evaporator, it is replaced at a relatively slow rate by liquid refrigerant from the condenser.

It is an object of the present invention to simplify the construction and operation of this type of machine, by having a single vessel serve as a receiver or reservoir for liquefied refrigerant from the condenser, and as a receiver for liquid refrigerant expelled from the evaporator during the thawing cycle, and as the gas supply to the compressor during the thawing cycle, thereby eliminating the stand-by transfer drum or displacement vessel.

In accordance with the present invention, the reservoir which receives liquefied refrigerant from the condenser, is utilized to receive the reverse flow of liquefied refrigerant from the freezer and to supply gas to the compressor during the thawing cycle, thus eliminating the transfer drum or displacement vessel. Any suitable cycle control valve and piping is employed to allow the freezer and reservoir to be interchangeable connected with the compressor inlet and outlet to maintain suction on the freezer and pressure on the reservoir during the freezing cycle, and to maintain suction on the reservoir and pressure on the freezer during the thawing cycle. The liquid flow connecting means between the reservoir and freezer also allows flow of liquid refrigerant from the reservoir to the freezer during the freezing cycle while pressure is maintained in the reservoir and suction is maintained in the freezer, and allows reverse flow of liquid refrigerant during the thawing cycle while pressure is maintained in the freezer and suction is maintained in the reservoir. Any known device or devices may be employed in the gas and liquid flow connecting means to carry out these functions.

In one preferred embodiment of the invention the liquid flow connecting means between the reservoir and freezer includes a vapor trap that

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allows flow of liquid and closes to prevent flow of gas therethrough. By the provision of two such traps oppositely arranged in parallel in the liquid flow line, the liquid can flow in either direction from the high pressure side to the low pressure side, and the flow of gas therethrough is effectively prevented. There is thus provided an effective pressure lock which allows liquid to flow therethrough and which maintains the required pressure difference on opposite sides thereof during each cycle of operation. However, in place of vapor traps, especially where flow of gas through the liquid flow line is restricted or prevented by other means, other forms of pressure locks or restrictions may be provided, such as, for example, loaded check valves, expansion valves, capillary tubes, time or temperature controlled valves, and the like.

The invention is applicable to systems which employ water for thawing the lower ends of the ice tubes, or to systems wherein heat is supplied to the bottoms of the ice tubes by warm refrigerant in liquid or gaseous state, as disclosed and claimed in my application Serial No. 95,557 filed May 26, 1949, for Ice Making Apparatus, now Patent No. 2,618,129, granted November 18, 1952.

The invention will be described in greater detail in connection with the accompanying drawings illustrating preferred embodiments of the invention by way of example, and wherein:

Figure 1 is a fragmentary sectional view through a freezer,

Figure 2 is a diagram illustrating the operation of one embodiment of the invention,

Figure 2a is a view in vertical section of a vapor lock feed valve,

Figure 3 is a view similar to Figure 2, of a modification,

Figure 4 is another view similar to Figure 2 of a further modification, and

Figure 5 is a diagrammatic view of another modification.

Referring to the drawing (Figure 1), the freezer is of conventional construction and comprises a shell or housing 1 through which extend vertically arranged tubes 2. Water, or other liquid to be chilled or frozen, flows downwardly in a thin film through tubes 2 and is chilled or frozen by the evaporation of liquefied refrigerant from evaporator chamber 3 surrounding the tubes. A partition 4 may be provided at the bottom to separate off a chamber 6 around the lower ends of the ice tubes, and thus prevent ice formation on the bottom.

The evaporator chamber 3 is connected by conduits 7, 7′ (Figure 2) having a solenoid operated valve 8 therein, to the inlet side of a compressor 9; and conduits 11, 11′ having a solenoid operated valve 12 therein connect the compressor outlet to the condenser 13. During the freezing cycle, the compressor draws gas from the evaporator by conduits 7, 7′, compresses it, and the compressed gas is conducted by conduits 11, 11′ to condenser 13 where it is liquefied, the liquid flowing into reservoir 14. The conduit 15 having a vapor trap feed valve 16 therein connects the reservoir to the bottom of evaporator chamber 3 to supply liquid to the evaporator, and a standpipe 14′ in the reservoir provides a residual or minimum level of liquid refrigerant in the reservoir.

Vapor trap valve 16 is of known construction, and the embodiment illustrated in Figure 2*a* comprises a housing having a valve 16*a*, controlling the outlet, which is connected to a bell type float 16*b* having a small vent 16*c* therein. Should the liquid level in the reservoir fall so low that gas passes into trap 16, the gas buoys up the float 16*b* to close valve 16*a*. The gas bleeds through vent 16*c* and condenses in the chamber. The float drops to reopen the valve when the liquid in the trap is replenished. This valve thus acts as an expansion valve to relieve the pressure on the liquid on the outlet side, to allow it to evaporate.

A bypass pipe 17 connected around vapor trap valve 16 has a suitable vapor locking device 18 therein. The device 18 may be a vapor trap like member 16 connected to allow liquid flow in the opposite direction, that is, from the evaporator to the reservoir. Or it may be a spring loaded check valve, or any other suitable device.

A bypass conduit 19 is connected between conduit 7 on the freezer side of valve 8, and conduit 11 on the compressor side of valve 12, this conduit having a solenoid valve 20 therein. Another bypass conduit 21 is connected between conduit 11′ on the reservoir side of valve 12, and conduit 7′ on the compressor side of valve 8, this conduit having a solenoid operated valve 22 therein.

The operation of the invention now will be described. During the freezing cycle valves 8 and 12 are open, and valves 20 and 22 are closed. The compressor draws gas from evaporator chamber 3 thereby lowering the pressure in the evaporator; the gas withdrawn is compressed by the compressor and is incidentally heated; and the warm gas is discharged therefrom into the condenser reservoir system where the refrigerant is liquefied and kept under pressure. Float operated valve 16 remains open as long as liquid is supplied by reservoir 14, and because of the higher pressure in the reservoir, liquefied refrigerant is supplied to evaporator chamber 3 through conduit 15. The flow of gas is indicated by dotted arrows, and the flow of liquid by full arrows in the freezing cycle.

During the thawing cycle valves 8 and 12 are closed and valves 20 and 22 are opened. Vapor thus is drawn by compressor 9 through conduits 11′, 21 and 7′ from reservoir 14 to reduce the pressure thereon, cause evaporation from the residual pool of liquefied refrigerant therein, and cool the liquid refrigerant in the reservoir; the vapor is compressed and heated by the compressor; and the warm gas is introduced under pressure into evaporating compartment 3 by way of conduits 11, 19 and 7. The liquefied refrigerant in evaporator chamber 3 is thus expelled by the pressure of the gas supplied to chamber 3, and flows through conduits 15 and 17 back to the reservoir 14. Gas cannot flow back through vapor trap valve 16 into reservoir 14 because upon introduction of vapor into housing 16, the vapor bleeds through vent 16*c* into the bell 16*b* until the level of liquid inside and outside the bell are equal, thus buoying up the bell and closing the valve 16*a*. Gas cannot flow through trap valve 18 as previously explained in connection with member 16. The warm compressed gas in the freezer thaws the ice free from the tube walls and the ice thereupon falls out. The thawing of the lower ends of the tubes may be expedited by supplying warm water by means not shown to chamber 6 during the thawing cycle. The apparatus then reverts again to the freezing cycle by the closing of valves 20 and 22 and opening of valves 8 and 12, which causes the cooled liquid refrigerant in the reservoir to flow to the evaporator chamber while suction is applied to the evaporator chamber. It will be understood that valves 8, 12, 20 and 22 may be of any suitable type, and may be operated manually or may be operated automatically by suitable timing or cycle control mechanism.

In the modification shown in Figure 3, wherein like parts are indicated by like reference numerals, the lower ends of the freezer tubes are heated during the thawing cycle by hot compressed refrigerant gas introduced into chamber 6. The bypass conduit 25 is connected between conduit 11 on the compressor side of valve 12, and the chamber 6 of the freezer. A conduit 27 connects the heating chamber 6 with the evaporator chamber 3 by its connection to conduit 7 on the freezer side of valve 8, and may have a solenoid operated valve 26 therein. If desired, the valve 26 may be in conduit 25 between conduit 11 and the chamber 6. In this modification, during the freezing cycle valves 8 and 12 are open and valves 22 and 26 are closed, so that the apparatus operates as described in connection with Figure 2.

During the thawing cycle valves 8 and 12 are closed and valves 22 and 26 are open so that gas is drawn from the reservoir by the conduit 11′ through conduits 21 and 7′ to the compressor, and heated compressed gas flows through conduits 11 and 25 to chamber 6, and thence by conduits 27 and 7 to the evaporator chamber to expel liquefied refrigerant therefrom. The expelled liquefied refrigerant returns to reservoir 14 by way of conduits 15 and 17 as above described. The warm refrigerant gas introduced into chambers 6 and 3 thaws loose the ice rods which fall out of the freezer, and thereafter the system is returned to the freezing cycle by the closing of valves 22, 26 and opening of valves 8, and 12. Now, while gas is being withdrawn from freezer 1 by the compressor, liquid refrigerant enters freezer 1 from the reservoir through conduit 15 and feed valve 16.

The embodiment illustrated in Figure 4 is designed for operation in an arrangement wherein the bottoms of the tubes are prevented from freezing during the freezing cycle by the application of heat thereto from the warm liquefied refrigerant, this feature being described and claimed in my application previously referred to. In this embodiment wherein like parts are indicated by like reference numerals, the conduit 15 connects with a conduit 30 having a one-way valve 32 therein which in turn is connected to the bottom thawing chamber 6 of the freezer. A conduit 33 having the vapor trap 16 therein is connected from the thawing chamber 6 to a point above the bottom of the evaporating chamber 3. By this arrangement, during the freezing cycle, warm liquefied refrigerant from the receiver 14 slowly flows through check valve 32 into the thawing chamber 6 and thence through conduit 33 and valve 16 to the evaporator chamber 3, the warm refrigerant preventing freezing in the lower ends of the tubes in chamber 6.

In the thawing cycle valves 8 and 12 are closed and valves 20 and 22 are opened, so that when warm refrigerant gas under pressure is introduced into evaporator chamber 3 the liquid refrigerant is expelled rapidly by conduit 31 and flows through the float tank 37, liquid transfer valve 35, and one-way valve 36, into conduit 15 back to the reservoir. Valve 35 is controlled by a float in tank 37 to allow liquid to pass therethrough and to close to prevent flow of gas. This valve is described and claimed in the application of Archie P. Fulkerson, Serial No. 773,421, filed September 11, 1947, now Patent No. 2,574,823, granted November 13 ,1951, for Fluid Flow Controller. The warm refrigerant gas in chamber 3 thaws the ice rods loose, after which the apparatus reverts, to the freezing cycle. Now, when ga sis withdrawn from evaporator chamber 3 by the compressor, liquid refrigerant enters chamber 3 from the reservoir through conduits 15, 38, check valve 32, chamber 6 and conduit 33, the check valve 36 preventing flow of liquid refrigerant through transfer valve 35 directly to chamber 3.

In the modification shown in Figure 5 a conduit 41 having the valve 20 therein connects the compressor outlet to conduit 7 between valve 8 and the evaporator, and a conduit 42 having the valve 22 therein leads from the reservoir above the liquid pool to the compressor inlet. Liquid from the reservoir flows by conduit 15 having the check valve 32 therein to the heater chamber 6, then continues by conduit 43 through trap 16 and check valve 44 into the bottom of the evaporator chamber 3. A one-way valve 45 bypasses valve 44, and a conduit 46 having a one-way valve 47 therein returns to the reservoir.

In the freezing cycle, valves 8 and 12 are open, and valves 20 and 22 are closed, so that gas is drawn from the evaporator to the condenser as previously described. Liquefied refrigerant flows from the reservoir by conduit 15 to chamber 6, then by conduit 43, trap 16, and valve 44 into the evaporator chamber, the valve 47 preventing flow of gas from the reservoir. In the thawing cycle, valves 8 and 12 are closed and valves 20 and 22 are open. This connects the suction side of the compressor by conduits 7′, 42 to the reservoir, and the compressed gas is conducted by conduits 11, 41 and 7 to the evaporator. Liquid refrigerant is forced out of the evaporator through check valve 45 and trap 16 and conduit 46 to the reservoir, the trap 16 serving to prevent flow of gas therethrough. Thus gas under pressure is trapped in the evaporator chamber, while the liquid in the reservoir is subject to the suction of the compressor to supply gas thereto.

I claim as my invention:

1. A reverse cycle refrigerating system operating alternately on freezing and thawing cycles comprising: a compressor; an evaporator chamber having tubes extending therethrough for receiving liquid to be frozen, said chamber being connected to the inlet side of the compressor and having a heating chamber adjacent the lower end of said tubes; a condenser and reservoir connected to the pressure side of the compressor; cycle control means to interchange the reservoir and evaporator with the compressor inlet and outlet; liquid flow means including a vapor trap connecting the reservoir, heating chamber and evaporating chamber in series for flow of liquefied refrigerant from the reservoir to the evaporating chamber; and reverse liquid flow means connecting the evaporating chamber with the reservoir including a vapor trap to allow rapid flow of liquid refrigerant and prevent flow of gas from the evaporating chamber to the reservoir.

2. A refrigerating apparatus as specified in claim 1 wherein said first mentioned liquid flow means and said reverse liquid flow means include a common vapor trap, and have one-way valves controlling flow therethrough.

3. A reverse cycle refrigerating system operating alternately on freezing and thawing cycles comprising: an evaporator chamber adapted to contain a liquid refrigerant during the freezing cycle and having at least one tube extending therethrough for receiving liquid to be frozen; a condenser; a receiver connected to the condenser to receive liquefied refrigerant therefrom; a compressor having its inlet connected to the evaporator chamber and its outlet connected to the condenser for flow of refrigerant gas during the freezing cycle in sequence to the compressor, condenser and receiver where the gas is liquefied and accumulated; cycle control means to reverse the flow of refrigerant gas between the evaporator chamber and said receiver to supply warm refrigerant gas to the evaporator to thaw the frozen liquid in said tube; and conduit means connecting said receiver and evaporator chamber including a common conduit section for flow of liquid refrigerant in either direction, and branch sections, at least one of said branch sections including vapor trap means to prevent escape of gas from the evaporator chamber past the vapor trap means to the receiver during the thawing cycle, and the other of said branch sections having an opposed one way liquid flow valve means therein allowing liquid flow in the opposite direction.

4. A reverse cycle refrigerating system operating alternately on freezing and thawing cycles comprising: an evaporator chamber adapted to contain a liquid refrigerant during the freezing cycle and having at least one tube extending therethrough for receiving liquid to be frozen, with the lower end portion of said tube projecting beyond the evaporator chamber into a heating chamber; conduit means connecting said chambers for flow of warm refrigerant fluid in sequence from the heating chamber to the evaporator chamber; a condenser-receiver; a compressor having its inlet connected to the evaporator chamber and its outlet connected to the condenser-receiver for flow of refrigerant gas during the freezing cycle in sequence to the compressor and condenser-receiver where the gas is liquefied and accumulated; cycle control means to reverse the flow of refrigerant gas between the evaporator chamber and condenser-receiver to supply warm refrigerant gas to the evaporator to thaw the frozen liquid in said tube; and conduit means connecting the condenser receiver and evaporator chamber including a common conduit section for flow of liquid refrigerant therein

in either direction, and branch sections, one of said branch sections including vapor trap means to prevent escape of gas from the evaporator chamber past the vapor trap means to the receiver during the thawing cycle, and the other of said branch sections having an opposed one way liquid flow valve means therein allowing liquid flow in the opposite direction.

5. A reverse cycle refrigerating system as specified in claim 4 wherein said first mentioned conduit means is normally closed and includes a gas flow connection from the compressor outlet to said heating chamber; and wherein said cycle control means includes means to open said conduit means.

6. A reverse cycle refrigerating system as specified in claim 5 wherein said gas flow connection is normally open between the compressor outlet and said heating chamber.

JESSE D. WILLIAMS, Jr.

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