

July 18, 1939.

W. E. WHITNEY

2,166,191

REFRIGERATING SYSTEM

Filed Oct. 27, 1937

Fig. 1

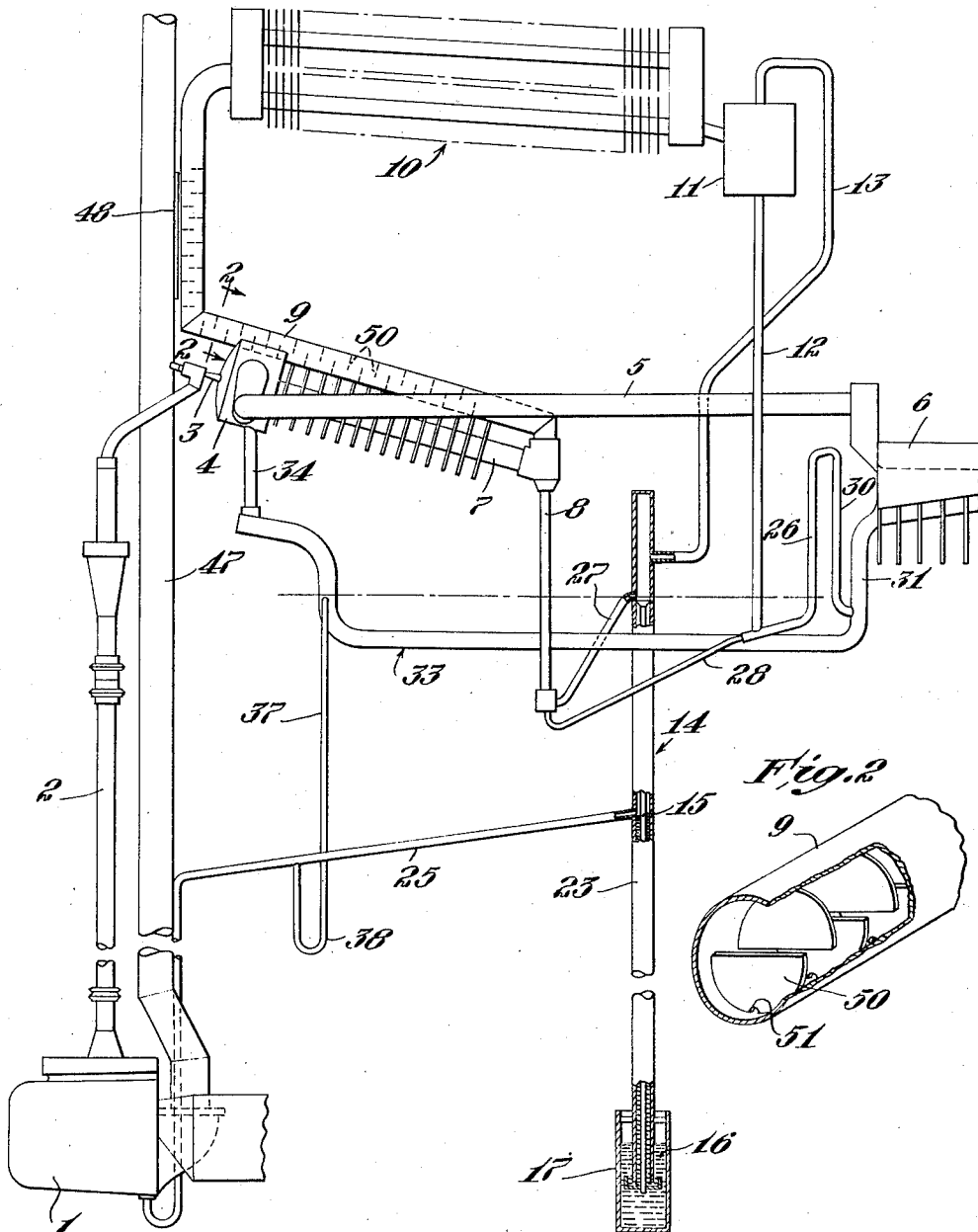


Fig. 2

Inventor
William E. Whitney
by Roberts, Cushman & Hoodberry,
att'ys.

UNITED STATES PATENT OFFICE

2,166,191

REFRIGERATING SYSTEM

William E. Whitney, Cambridge, Mass., assignor,
by mesne assignments, to Stator Corporation,
a corporation of Rhode Island

Application October 27, 1937, Serial No. 171,301

7 Claims. (Cl. 62—115)

This invention relates to an improved refrigerating apparatus of the general type disclosed in United States Patent No. 1,761,551 to Eastman A. Weaver, and in the copending applications of Lyman F. Whitney, Serial Nos. 171,325 and 171,324, filed on even date herewith.

As taught in the first-identified application, systems of this character, particularly when employing an aqueous refrigerant with an anti-freeze agent, sometimes are characterized by a tendency to develop sludge, such a sludge consisting of mercury particles and liquid refrigerant and having varying characteristics quite closely resembling the characteristics of muds of different consistencies. Such a sludge ordinarily collects in the cooler and, in many cases, apparently may be due to some interaction of refrigerant and mercury particles which pass into the condenser and which return from the same to the cooler.

As taught in the second above-identified application, the arrangement of a hot pipe between the aspirator and the refrigerant condenser is advantageous in impeding or preventing the formation of sludge in the cooler. I have discovered that this effect may be substantially enhanced if the hot pipe is arranged so that the vapor must follow a somewhat tortuous course. The pipe, for example, may be provided with a plurality of internal fins against which the vapor passing from the aspirator to the condenser may strike. Such fins affect the refrigerant vapor stream and the included stray mercury particles in such a manner that the mercury tends to settle out of the refrigerant upon condensation, and thus return to the trap means in the lower part of the system, rather than being suspended in the refrigerant to form sludge which passes into the body of liquid refrigerant in the cooler.

In the accompanying drawing:

Fig. 1 is a diagrammatic view of a refrigerating system in which the present invention is incorporated; and

Fig. 2 is a broken isometric view of a portion of the pipe extending between the aspirator and the condenser showing the arrangement of the fins in the same in accordance with this invention, the position of this portion of the pipe being indicated by line 2—2 of Fig. 1.

The present invention may be employed in a refrigerating system of the general type disclosed in the above-identified Weaver patent, which is characterized by a propellant circuit through which a heavy propellant circulates to pump refrigerant vapor through a refrigerant

circuit, the circuits having a part in common where the refrigerant vapor is entrained in a stream of the propellant vapor, and where the propellant vapor may be condensed.

Such a system is provided with a boiler 1, which may contain a body of liquid mercury and which is connected by a riser pipe 2 to an aspirator nozzle 3, the latter being arranged to emit mercury vapor at high velocity into a mixing chamber 4, which receives refrigerant vapor from the cooler 6 through a vapor duct 5. The mixed vapors pass into a funnel 7, where the refrigerant is compressed and where propellant is condensed. Condensed propellant passes from the funnel into a drain 8, while the refrigerant vapor passes through a duct 9 to the refrigerant condenser 10.

The refrigerant condenser is arranged so that condensate may flow into a chamber 11 provided with an outlet drain 12. The chamber 11 is also connected to a gas-receiving duct 13, which is arranged to supply non-condensable gases to a purger 14, of the type fully disclosed in the copending application of Lyman F. Whitney, Serial No. 167,402 filed October 5, 1937. This purger includes a drop tube 15 of restricted diameter, which receives condensed mercury in the form of separate drops or globules. The mercury globules fall through this tube and compress the gases which are exhausted to the atmosphere through a mercury body 16 arranged in a vat 17 at the lower part of the purger. The mercury rises in a return duct 23 disposed about the drop tube 15, and is received from the latter by a pipe 25 containing a pressure balancing column of the mercury and serving as a boiler return pipe.

The lower part of the drain 8 may be connected to two upwardly extending pipes, one pipe 27 being connected to the upper part of the purger to supply mercury to the same, and the other pipe 28 inclining upwardly to a connection with the refrigerant return pipe 12, which extends downwardly from the refrigerant condenser. The inclined pipe 28 extends above this connection and is provided with an upwardly extending continuation 26, the upper part of which is above the level of the liquid refrigerant in the cooler 6, and is connected to a downwardly extending pipe section 30. The lower part of the latter has a connection with a duct 31, which in turn is connected to the lower part of cooler 6. Duct 31 forms one leg of a trap 33, the opposite leg of which is connected to a drain 34 receiving mercury, which condenses in the mixing chamber 4. This leg of the trap is also provided with

a spill-over connection with a pipe 37, the lower part of which provides one leg of a trap 38, the opposite leg of which is connected to the mercury return pipe 25. When mercury fills the trap 33 to the level with its connection to the pipe 37, the mercury spills over into this pipe. Thus the connection between pipes 30 and 31 normally contains a body of liquid which tends to have about the same level as this spill-over connection.

The level of the mercury in the trap assembly at the lower end of the return pipe 12, is determined by the height of the spill-over connection between the purger and pipe 27, the mercury tending to stand at this level in this trap assembly, as indicated by the dot and dash line of Fig. 1, when the system is not in operation. During operation of the system, however, the pressure in the cooler is lower than the pressure in the condenser, and a pressure-balancing column of liquid in the pipe 26 stands above the level indicated by the dot and dash line to balance this pressure difference.

Condensed refrigerant in pipe 12 tends to depress the mercury in the lower part of this pipe, piling up so that it passes through the trap provided by the lower part of pipe 12 and by pipe 26, thus rising through the latter and spilling over into the pipe 30. The refrigerant collecting in the latter depresses the mercury in the trap provided by the lower part thereof and by the pipe 31, thus rising through the pipe 31 to the cooler. Such a trap arrangement and the action of the same under different operating conditions, is more fully disclosed and claimed in the copending application of Lyman F. Whitney, Serial No. 171,325.

As explained in that above-identified application, a system of this character may employ an aqueous refrigerant with an anti-freeze agent, which tends to depress the freezing point of the refrigerant below the freezing point of water, so that a low temperature may be obtained in the cooler. Under some operating conditions, particularly when an anti-freeze agent is employed in the aqueous refrigerant, sludge may tend to collect in the cooler. This sludge apparently may be caused by the interaction of the mercury and refrigerant which passes into the refrigerant condenser as taught in the above-identified application Serial No. 171,325. The flow of mercury to the condenser and the development of sludge in this manner are materially impeded, if the vapor pipe extending from the aspirator to the condenser is heated. Thus such a pipe may, for example, be disposed adjoining one of the hot aspirator funnels or adjoining the stack which receives exhaust gases from the burner associated with the boiler 1, or, if desired, the pipe may be juxtaposed to the mercury riser pipe extending from the boiler to the aspirator, as disclosed in copending application Serial No. 171,324.

I have discovered that the effectiveness of such a pipe in preventing sludge formation may be materially increased if the warm portion of the pipe is provided with internal fins against which the vapor stream strikes as it flows to the cooler. As explained in the copending application of Lyman F. Whitney, Serial No. 171,324, filed on even date herewith, the formation of sludge may be partly due to electrically charged mercury particles coming into contact with water, and the particles, upon striking the warm pipe surfaces, may lose their charges so that they may thereafter coalesce into liquid mercury in the normal manner. Of course, the fins provided by the present invention afford additional warm surfaces di-

rectly in the paths of the particles and thus may materially aid in removing the electrical charges therefrom.

As shown more particularly in Fig. 2, the pipe 9 may be provided with a plurality of fins 50, each of which occupies at least one-half the internal cross-sectional area of the pipe, but preferably has a somewhat greater area, these fins being staggered upon alternate sides of the pipe, as shown in Fig. 2, and as indicated by the dotted lines in Fig. 1. Thus the vapors passing from the aspirator funnel 7 to the condenser 10 strike these fins and, rather than flowing directly through the duct, must pass about the edges of successive staggered fins in a somewhat tortuous course. In order to prevent the pocketing of condensed vapor between the fins, small openings 1 may be provided in the fins on the lower side of the pipe to permit liquid condensate to drain back to the lower part of the system.

For purposes of illustration, a portion of the pipe 9 adjoining the funnel 7 is shown as provided with fins. In the illustrated example of this invention, the funnel is shown provided with a plurality of cooling fins 46, from which the heat is radiated to the pipe 9. Also, as illustrated herein, the upper part of the pipe 9 may also be juxtaposed to the stack 47, which extends upwardly from the burner, which is associated with the boiler 1. In order to facilitate the heating of the pipe 9, a plate or strip 48 may be welded to the stack and arranged in close juxtaposition to the upper part of the pipe 9. It is to be understood, however, that the principles of this invention may be employed, if desired, when the pipe 9 is arranged to receive heat radiated from the riser pipe which extends from the boiler to the aspirator, such an arrangement of the pipe being shown in the copending application Serial No. 171,324.

In practice, an arrangement of the type disclosed herein has been found particularly advantageous when the anti-freeze agent is in the form of the monomethyl ether of ethylene glycol, or the latter and a relatively small amount of ethylene diamine. Thus, for example, the refrigerant may comprise 70% by weight of water and 30% by weight of the monomethyl ether of ethylene glycol, or 70% by weight of water, 25% or more by weight of the monomethyl ether of ethylene glycol, and 5% or less by weight of ethylene diamine.

It should be understood that the present disclosure is for the purpose of illustration only and that this invention includes all modifications and equivalents which fall within the scope of the appended claims.

1. Refrigerating apparatus of the class described comprising a propellant circuit and a refrigerant circuit including a condenser and a cooler, said circuits having a part in common where a stream of propellant vapor pumps refrigerant vapor from the cooler to the condenser, said part being provided with cooling means to cause the condensation of propellant, the refrigerant circuit including a duct extending from said part to the condenser, said duct being arranged in juxtaposition to a warm part of the system and including a plurality of internal protuberances.

2. Refrigerating apparatus of the class described comprising a propellant circuit and a refrigerant circuit including a condenser and a cooler, said circuits having a part in common where a stream of propellant vapor pumps refrigerant vapor from the cooler to the condenser,

said part being provided with cooling means to cause the condensation of propellant, the refrigerant circuit including a duct extending from said part to the condenser, said duct being in heat transfer relation to a warm part of the system and being provided with a plurality of inwardly projecting fins against which the vapors must strike in flowing through the pipe.

3. Refrigerating apparatus of the class described comprising a propellant circuit and a refrigerant circuit including a condenser and a cooler, said circuits having a part in common where a stream of propellant vapor pumps refrigerant vapor from the cooler to the condenser, said part being provided with cooling means to cause condensation of propellant, the refrigerant circuit including a duct extending from said part to the condenser, said duct being in heat transfer relation to a warm part of the system and having a plurality of inwardly directed, oppositely disposed, staggered fins.

4. Refrigerating apparatus of the class described comprising a propellant circuit and a refrigerant circuit including a condenser and a cooler, said circuits having a part in common where a stream of propellant vapor pumps refrigerant vapor from the cooler to the condenser, said part being provided with cooling means to cause condensation of propellant, the refrigerant circuit including a pipe extending from said part to the condenser, said pipe being in heat transfer relation to a warm part of the system and having a plurality of inwardly directed, oppositely disposed, staggered fins, the fins in the lower part of the pipe being provided with openings to permit the drainage of condensate away from the condenser.

5. Refrigerating apparatus of the class de-

scribed comprising a propellant circuit and a refrigerant circuit including a condenser and a cooler, said circuits having a part in common where a stream of propellant vapor pumps refrigerant vapor from the cooler to the condenser, said propellant circuit containing a body of liquid propellant in the form of mercury, said cooler containing a body of aqueous refrigerant, the refrigerant circuit including a duct between said common part and the condenser, said duct being in heat transfer relation to a warm part of the system and being arranged to cause the vapor flowing through this duct to follow a tortuous course, whereby the formation of sludge is impeded.

6. Refrigerating apparatus of the class described comprising a propellant circuit and a refrigerant circuit including a condenser and a cooler, said circuits having a part in common where a stream of propellant vapor pumps refrigerant vapor from the cooler to the condenser, said part being provided with cooling means to cause the condensation of propellant, the refrigerant circuit including a duct extending from said part to the condenser, said duct having a plurality of internal protuberances projecting into the path of the vapor passing to the condenser.

7. Method of refrigeration comprising entraining refrigerant vapor from a region of refrigeration in a stream of mercury vapor, condensing the major portion of the mercury out of the resulting stream of mixed vapors, directing the remaining vapor in a stream against a plurality of warm surfaces directly in its path thereby to cause coalescing of mercury particles, then condensing the vapor and directing the condensate back to the region of refrigeration.

WILLIAM E. WHITNEY.