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PORTABLE OPEN SYSTEM REFRIGERATOR

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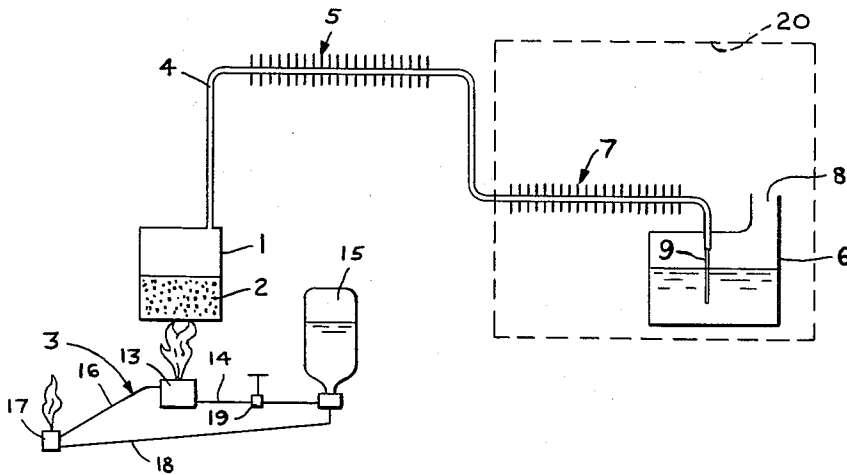


FIG. 1

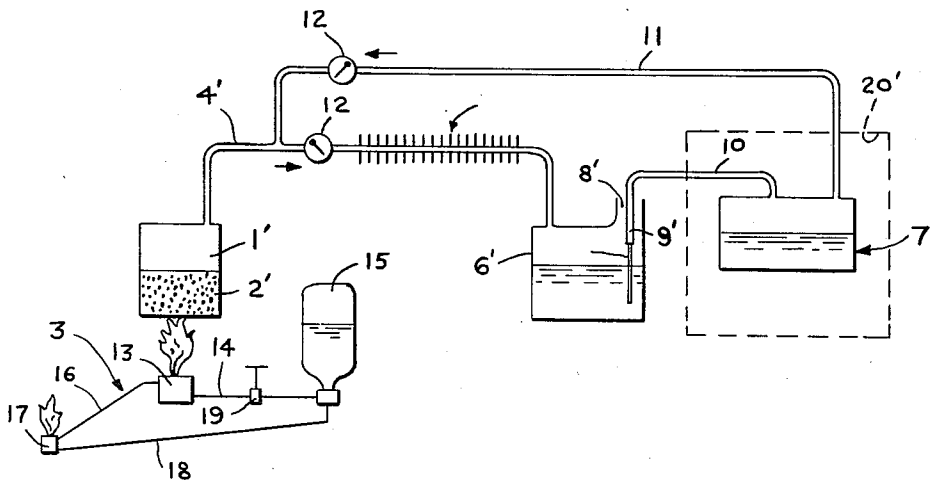


FIG. 2

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PORTABLE OPEN SYSTEM REFRIGERATOR

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2 Claims. (Cl. 62—478)

This invention relates to a refrigeration apparatus which is particularly adapted for portable equipment, and which operates with a novel open system providing intermittent desorption and sorption of an absorbent to produce refrigeration in an area to be cooled.

As used herein, it is intended that the term "absorbent" include any substance, either solid or liquid, which has the property of retaining and attracting a gas, vapor or liquid used as a refrigerant; the term "desorption" denotes the process during which the refrigerant retained by the absorbent is rejected; and the term "sorption" denotes the process during which the refrigerant is attracted and retained by the absorbent.

In the operation of the several types of prior art intermittent closed system refrigerators, it is known that there exists the following disadvantages: First, if the refrigerator uses a pressurized system, then it is potentially explosive; Second, if it uses a vacuum system, then it is likely to become inoperative due to air accumulation within the system.

In my experiments, however, I have found that these prior art operational disadvantages can be effectively minimized if the maximum pressure of the refrigerator is limited to the existing atmospheric pressure. Operating below this maximum, the refrigerator is comparatively safe, and whenever the unit is intermittently brought to atmospheric pressure, air and other non-condensable gases can readily be purged from the system.

In reducing my invention to practice I have therefore provided an open receiver unit in combination with the refrigerating producing elements of a refrigeration apparatus whereby the said apparatus operates with a novel open system in which the operating pressure is automatically nominally limited to atmospheric pressure, and in which, therefore, the operational disadvantages associated with closed system refrigerators are effectively minimized.

More particularly, it is my object to provide an open receiver unit for a refrigeration apparatus adapted to receive the refrigerant during the desorption cycle so that any excessive quantity of refrigerant vapor liberated during this cycle and tending to raise the pressure within the system above atmospheric pressure will automatically be vented from the said open receiver unit.

As a further object, it is my intention that any air within the system will be passed to the open receiver unit along with the refrigerant during the desorption cycle, and from this unit purged from the system.

It is still another object of my novel open system refrigeration apparatus to utilize the atmospheric pressure in the open receiver unit to induce the return of refrigerant to the absorbent during the sorption cycle, to thereby improve the performance of this cycle.

In addition, in one preferred embodiment of my invention which includes a flooded type evaporator, it is my object to utilize the atmospheric pressure in the open receiver unit to induce a high velocity flow in the refrigerant passing from the receiver unit to the said evaporator

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to thereby substantially minimize any sudden vaporization with explosive violence or "bumping" within this type of evaporator.

Another one of my objects is to construct my novel open system refrigeration apparatus so that it contains no moving parts, is lightweight and self-contained, and therefore readily adapted for portable equipment.

With these and other objects in mind, my invention will be better understood when considered in connection with the accompanying specification and drawings forming a part thereof, in which:

Figure 1 shows one preferred embodiment of a novel open system refrigerator constructed according to the teachings of my invention.

Figure 2 shows another preferred embodiment, including therein a flooded type evaporator unit.

Flash type embodiment

In the embodiment of my invention shown in Figure 1, the generator-absorber of the open system refrigerator is designated 1. To produce refrigeration, I prefer to use water as the refrigerant because of its cheapness and availability, and therefore I provide in the generator-absorber 1 an absorbent 2 such as lithium chloride, particularly suited for this type refrigerant. Beneath the generator-absorber 1 is an intermittently operating heating unit, generally designated 3, whose function is to intermittently heat the absorbent 2 in the generator-absorber 1 to initiate the desorption cycle.

During the desorption cycle, refrigerant vapor rejected by the absorbent 2 passes out of the generator-absorber 1 through a conduit 4 connected to the top of the generator-absorber 1 and enters a condenser 5 suitably connected in the conduit 4. In the condenser 5, the heat of the refrigerant is dissipated causing a change in phase to liquid, and in this state, the refrigerant is forced by further incoming refrigerant vapor through the conduit 4 emptying into an open receiver unit 6 through the end of the conduit 4 disposed in this open receiver 6. In passing from the condenser 5 to the open receiver unit 6, the refrigerant flows through an evaporator 7 suitably connected in the conduit 4. However, during the desorption cycle, this evaporator does not cause any change in phase in the refrigerant.

The receiver unit 6 is open to the atmosphere, as is clearly shown at 8, and it therefore provides a novel open system by which, the maximum operating pressure is automatically limited to atmospheric pressure. The receiver unit 6 is also used to store liquid refrigerant, and the end of the conduit 4 is at all times submerged in this stored liquid so that during the sorption cycle, the air in the open receiver unit 6 cannot make its way through the conduit 4 and into the generator-absorber 1. The refrigerant in the open receiver unit 6 returns to the generator-absorber 1 under a vacuum pressure differential between the generator-absorber 1 and the open receiver unit 6 during the sorption cycle and to assure that this vacuum pressure will reach a level sufficient to induce flashing of the refrigerant in the evaporator 7, a capillary tube 9 is connected in the end of the conduit 4 to initially oppose the return of the refrigerant to the generator absorber 1.

Flooded type embodiment

In the embodiment of my invention shown in Figure 2, I use substantially the same units shown in Figure 1, and have therefore designated these units by the same but primed numerals corresponding to those used in Figure 1. However, in this form of the invention, instead of permitting the refrigerant during the sorption cycle to return to the absorbent 2' through the conduit 4' through which it passed to the receiver unit 6' during the desorption cycle, I provide the conduits 10 and 11 for this pur-

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pose. Further, I provide suitable flow control valves 12 in the conduits 4' and 11 to maintain the desired direction of flow of the refrigerant during the desorption and sorption cycles respectively.

In addition, in this embodiment of the invention, I prefer to use a flooded type evaporator 7' because of its simplicity of operation and lower cost, and because as I will subsequently explain, I can successfully minimize its main operational disadvantage.

The heating unit

In each of the preferred forms of the invention shown in Figures 1 and 2, I utilize the same heating unit 3 to intermittently carry out the desorption cycle of my open system refrigerator. I prefer this type of heating unit because it is simple, self-contained, and is therefore particularly suited to the portability requirements of the invention.

This intermittently operating heating unit 3 consists of a main burner 13 connected from one side by a low line 14 to a fuel tank 15 containing a stored quantity of fuel. A high line 16 connects the main burner 13 from the other side to a continuously operating pilot burner 17 which receives fuel from the fuel tank 15 through the line 18. A flow control valve 19 in the line 14 meters the flow of fuel to the main burner 13 at a rate which is substantially slower than the burning rate of the fuel. Thus, if it is assumed that the quantity of fuel in the main burner 13 is at the level of the high line 16 to the pilot burner 17, the pilot burner 17 will ignite the main burner 13, but subsequently the main burner will go out when its fuel supply becomes exhausted. The pilot burner 17 then cannot operate to ignite the main burner 13 until the fuel being supplied to the main burner 13 again reaches the level of high line 16. Thus, the operation of the main burner 13 is intermittent as required for the purposes of my invention and operation is unrestricted as to location.

Open system refrigeration

Referring now to the method of operation of my open system refrigeration process I will first describe this process in connection with the embodiment shown in Figure 1.

The refrigeration process starts when the pilot burner 17 ignites the main burner 13, and this main burner 13 in turn heats the absorbent 2 in the generator-absorber 1 to initiate the desorption cycle. At this time, the pressure in the generator-absorber 1 begins to build up owing to the expansion of refrigerant from its liquid phase to its vapor phase. However, since the generator-absorber 1 is connected to an open receiver unit 6 through the conduit 4, the maximum pressure build-up that can occur is nominally limited to atmospheric pressure, any excessive quantity of liberated refrigerant vapor resulting in a pressure above this maximum limit being automatically vented through the open receiver unit 6.

The liberated refrigerant vapor in the generator-absorber 1 then passes through the conduit 4 into the condenser 5, where it is condensed to liquid, and as a liquid flows through the remainder of conduit 4, passing through the evaporator 7 and into the open receiver unit 6. If there is any air or other non-condensable gases in the generator-absorber 1, these gases will be carried along with the refrigerant into the open receiver unit 6, and through this open unit purged from the system.

The sorption cycle of the refrigeration process begins when the main burner 13 has its fuel supply cut off and is therefore no longer heating the absorbent 2 in the generator-absorber 1. At this time the absorbent 2 cools by radiation and natural convection and begins subjecting the refrigerant in the receiver unit 6 to an increasing vacuum pressure. This vacuum pressure builds up until sufficient to overcome the opposition to flow characteristic of the capillary tube 9, and refrigerant in metered

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quantities then passes from the receiver unit 6 through the capillary tube 9 into the evaporator 7. The atmospheric pressure pushing down on the refrigerant in the open receiver unit 6 serves as an additional force inducing this flow of refrigerant into the evaporator 7. In the evaporator 7, the refrigerant fluid flashes into vapor, and as a result of this change in phase causes a cooling or refrigeration effect within the area designated 20 surrounding the evaporator 7. The refrigerant then continues through the conduit 4 into the generator-absorber 1 to complete the sorption cycle and thus also the cycle in the refrigeration process.

The method of operation of the embodiment of the invention shown in Figure 2 is similar to that described for Figure 1 except that during the sorption cycle, the refrigerant flows from the receiver unit 6' through the conduit 10 into a flooded type evaporator 7'. In this form of the invention I use a flooded type evaporator 7' because with my open system of operation I am able to minimize any sudden vaporization with explosive violence or "bumping" from occurring within this type of evaporator. This is due to the fact that the atmospheric pressure in the open receiver unit 6' in pushing down on the refrigerant, causes it to flow through the conduit 10 into the flooded type evaporator at a fairly high velocity. Thus, considerable agitation is caused in the evaporator 7' by the inflowing refrigerant, and this in turn prevents the refrigerant therein from becoming superheated and existing in a condition of unstable equilibrium which eventually results in "bumping."

While I have described the operation of my open system process of producing refrigeration in connection with the preferred embodiments shown in Figures 1 and 2, it will be understood my novel process is not solely limited in use to these embodiments, but that other apparatus employing the principles of operation of my process may also be used.

In addition, as to the embodiments shown, it will be understood that my invention is not to be limited to the specific construction or arrangement of parts shown, but that they may be widely modified within the invention as defined by the claims.

What is claimed is:

1. In a desorption-sorption refrigerating apparatus operating with a liquid refrigerant in conjunction with an absorbent material and including, a generator-absorber, heating means for said generator-absorber, means for condensing the refrigerant during the desorption cycle, and means for evaporating the refrigerant during the sorption cycle, the combination therewith of an open receiver unit and a single conduit connected from said generator-absorber through said condensing means and through said evaporating means and terminating in said open receiver unit, the terminal end of said conduit being disposed in a body of refrigerant fluid stored in said receiver unit.

2. In the combination as claimed in claim 1 wherein the terminal end of the conduit disposed in the body of refrigerant fluid stored in the open receiver unit is comprised of a capillary tube for initially opposing and subsequently throttling the flow of refrigerant to the evaporating means during the sorption cycle.

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