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ABSORPTION REFRIGERATION

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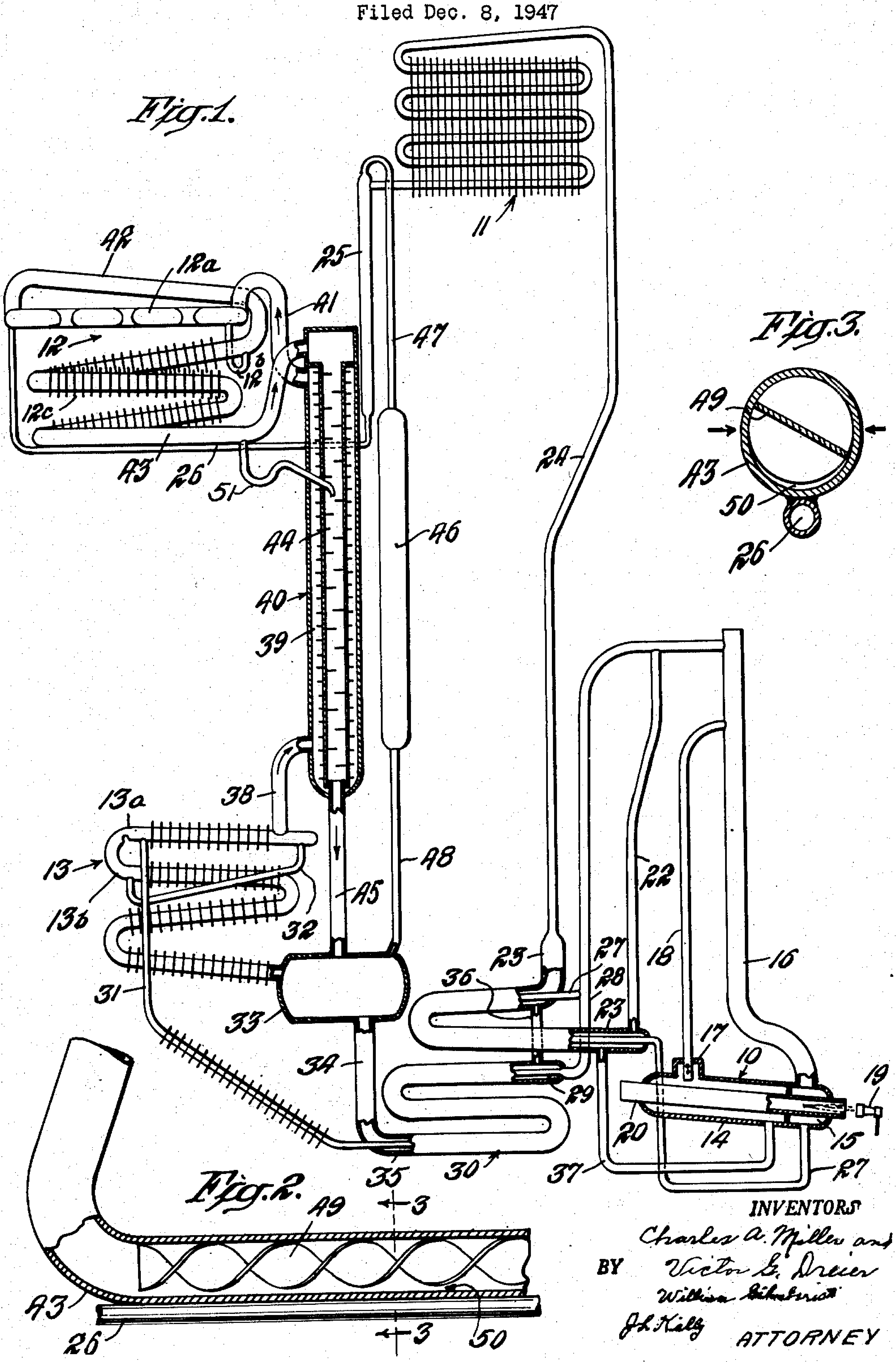

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ABSORPTION REFRIGERATION

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This invention relates to refrigeration and particularly to absorption refrigerating systems of the three-fluid or uniform pressure type.

In absorption refrigerating systems of the uniform pressure type wherein the evaporator or cooling element includes a low-temperature or freezing section and a high-temperature or box cooling section, and wherein liquid refrigerant flows from the condenser first into the low-temperature section of the evaporator and from there into the high-temperature section, and wherein inert pressure-equalizing gas flows first in counterflow relation with liquid refrigerant in the low-temperature section of the evaporator and from there into the high-temperature section, it is highly desirable that the liquid refrigerant en route from the condenser to the low-temperature section of the evaporator be precooled before entering the said low-temperature section. The precooling of liquid refrigerant en route from the condenser to the low-temperature section of the evaporator increases the efficiency of the refrigerating system, permits the low-temperature section of the evaporator to operate at lower temperatures and results in a more uniform temperature across the low-temperature section of the evaporator.

It is an object of this invention to provide an improved means for precooling liquid refrigerant en route from the condenser to the low-temperature evaporator of a refrigerating system of the above type.

In accordance with this invention, a precooler is provided for liquid refrigerant en route from the condenser to the low-temperature section of the evaporator wherein the conduit flowing such liquid refrigerant is placed in good thermal contact with a conduit that flows cold rich inert gas from the outlet of the high-temperature section of the evaporator to a gas heat exchanger. This conduit which flows cold rich inert gas is provided with means, such as a helical insert, discs or the like, for increasing the length of the path of flow of such gas therethrough. Furthermore, any liquid refrigerant that flows from the outlet of the high-temperature section of the evaporator, which refrigerant would otherwise be more or less wasted, is evaporated and diffused into the rich inert gas flowing in the conduit between the outlet of the high-temperature section of the evaporator and the gas heat exchanger. In this manner, an additional refrigerating effect is produced and further cooling of the liquid refrigerant en route from the condenser in the low-temperature section of the evaporator is effected.

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The invention together with the above and other objects and advantages will be more clearly understood from the following detailed description and accompanying drawing wherein:

Fig. 1 is a view diagrammatically illustrating a refrigerating system incorporating this invention.

Fig. 2 is a side elevational view, partly in longitudinal section of a detail of this invention.

Fig. 3 is a transverse vertical sectional view taken substantially on line 3—3 of Fig. 2.

Referring to Fig. 1, for purposes of illustration, the invention has been incorporated in a uniform pressure type absorption refrigerating system, which system includes generally, a generator 10, a condenser 11, evaporator 12, an absorber 13 and conduits interconnecting said elements for flow of a refrigerating medium, an absorption liquid and an inert pressure-equalizing gas. The system may be charged, for example, with a refrigerant-absorbent solution, wherein ammonia may be the refrigerant and water the absorbent, and with hydrogen as the pressure-equalizing gas.

The generator 10 comprises a substantially horizontal shell divided into a strong solution chamber 14 and a weak solution chamber 15, which latter chamber is provided with an upright portion or standpipe 16. Chamber 14 is provided with a dome 17. A riser or vapor-lift conduit 18 is connected between chamber 14 and the upper part of standpipe 16. As shown, the lower end of conduit 18 extends downward into dome 17 of chamber 14. The generator is heated by any suitable means, such as a gas burner 19 arranged so that the flame therefrom is projected into the lower portion of a flue 20, which flue projects concentrically through the shell of the generator. The upper end of standpipe 16 is connected by a conduit 22 to the lower end of an analyzer 23. The upper or vapor outlet end of the analyzer is connected by a conduit 24 to the upper or inlet end of condenser 11. The outlet end of the condenser is connected by a relatively large conduit 25 and a small conduit 26 to the refrigerant inlet end of a low-temperature section 12^a of the evaporator. The refrigerant outlet end of section 12^a of the evaporator is connected by a drain conduit 12^b to a high-temperature section 12^c of the evaporator.

Weak solution chamber 15 of the generator is connected by a conduit 27, a conduit 28, a conduit 29 forming the inner passage of a liquid heat exchanger 30, and a conduit 31 to the upper part of section 13^a of the absorber. As shown, a portion of conduit 27 passes through the analyzer and conduit 28 is connected to the vapor conduit 22 leaving the standpipe. The lower part of section 13a of the absorber is connected by a conduit 32 to section 13b of the absorber. The lower or liquid outlet end of the absorber is connected by an absorber vessel 33, a conduit 34, a conduit 35 which forms the outer passage of liquid heat exchanger 30, a conduit 36, the analyzer 23, and a conduit 37 to the rich solution chamber 14 of the generator.

The lower portion of section 13a of the absorber is connected by a conduit 38, an outer passage 39 of a gas heat exchanger 40, and a conduit 41 to the inert gas inlet end of section 12a of the evaporator. The inert gas outlet end of section 12a of the evaporator is connected by a conduit 42 to the inert gas inlet end of section 12c of the evaporator. The inert gas outlet end of section 12c of the evaporator is connected by a conduit 43, an inner passage 44 of the gas heat exchanger, a conduit 45, and absorber vessel 33 to the lower or gas inlet end of the absorber. A pressure vessel 46 is connected at its upper end to conduit 25 by conduit 47, and at its lower end the pressure vessel is connected to the absorber vessel by a conduit 48.

In accordance with this invention, and as best shown in Figs. 2 and 3, conduit 26 which conveys liquid refrigerant from the condenser to low-temperature section 12a of the evaporator is placed in good thermal contact, as by welding, soldering or the like, to conduit 43 which conveys cold inert gas from high-temperature section 12c of the evaporator to the gas heat exchanger. The portion of conduit 43 that is arranged in heat transfer relation with conduit 26 is provided with a helical insert 49. As shown best in Fig. 3, the lower portion of conduit 43 is distorted or drawn out of round so that a channel 50 is provided between the lower part of the helical insert and the inner bottom surface of conduit 43.

In operation, heat applied to the flue 20 of the generator causes expulsion of refrigerant vapor from solution therein. Refrigerant vapor is expelled from solution in both strong solution chamber 14 and weak solution chamber 15. Refrigerant vapor expelled from solution in strong solution chamber 14 collects in the dome 17 and passes therefrom into and through vapor-lift conduit 18, lifting absorption solution therewith into the upper part of standpipe 16. The refrigerant vapor that passes into standpipe 16 from the vapor-lift conduit, along with the vapor that passes from weak solution chamber 15 through the standpipe, flows from the upper part of the standpipe through conduit 22 into the lower end of analyzer 23. In the analyzer the refrigerant vapor flows upward in counterflow relation with rich absorption solution that enters the upper part thereof through conduit 36, and the refrigerant vapor flows from the upper end of the analyzer through conduit 24 into the condenser wherein the vapor is liquefied. The liquid refrigerant flows from the outlet end of the condenser through conduits 25 and 26 into the refrigerant inlet end of section 12a of the evaporator.

Inert gas weak in refrigerant flows through conduit 41 into section 12a of the evaporator wherein the refrigerant and weak inert gas flow in countercurrent relation through this section of the evaporator, thereby producing a refrigerating effect in this section of the evaporator. The partially enriched inert gas flows from section 12a of the evaporator through conduit 42 into section 12c of the evaporator wherein the inert gas flows in concurrent relation with liquid refrigerant which enters this section of the evaporator through drain conduit 12b. The cold rich mixture of inert gas and refrigerant vapor flows from the lower or outlet end of section 12c of the evaporator through conduit 43 into the inner passage of the gas heat exchanger, and from there the rich inert gas flows through conduit 45, and absorber vessel 33 into the lower or gas inlet end of the absorber.

Absorption solution weak in refrigerant flows into the upper part of section 13a of the absorber wherein this absorption solution flows in concurrent relation with inert gas and tends to push the inert gas toward conduit 38. In this manner, the direction of flow of inert gas is started and maintained in the proper direction in the inert gas circuit. The absorption solution flows from the lower end of section 13a of the absorber through conduit 32 into the next lower section 13b, and from there the absorption solution flows countercurrent to inert gas flowing upward through the absorber, whereby the refrigerant vapor is absorbed into the absorption solution and the inert gas stripped of refrigerant vapor flows from the gas outlet end of the absorber through conduit 38, outer passage 39 of the gas heat exchanger, and conduit 41 back to section 12a of the evaporator.

The absorption solution rich in refrigerant vapor flows from the lower part of the absorber into absorber vessel 33, and from there the enriched absorption solution flows through conduit 34, outer passage 35 of the liquid heat exchanger, conduit 36, analyzer 23, and conduit 37 back to the strong solution chamber 14 of the generator. In the generator refrigerant vapor is expelled from solution and absorption solution is lifted through vapor-lift pump 18 by vapor-lift action to standpipe 16, as explained above. Absorption solution weak in refrigerant flows from weak solution chamber 15 through conduit 27, conduit 28, inner passage 29 of the liquid heat exchanger, and conduit 31 back to the section 13a of the absorber.

The liquid refrigerant flowing from the condenser en route to section 12a of the evaporator in passing through conduit 26 is cooled by transfer of heat from the warm liquid refrigerant to the cold rich inert gas flowing through conduit 43 from the outlet of section 12c of the evaporator to the gas heat exchanger. The helical insert 49 in conduit 43 causes the cold rich gas to sweep against the inside walls of conduit 43, thereby improving the heat transfer between the warm liquid in conduit 26 and the cold gas in conduit 43. For purposes of illustration, the channel 50, shown in Fig. 2 is exaggerated.

That portion of conduit 43 that is in heat exchange relation with conduit 26 is substantially horizontal, so that any liquid refrigerant that flows from the outlet of section 12c of the evaporator into this conduit forms a shallow pool of such liquid in the channel 50 at the bottom of this conduit. This liquid refrigerant is evaporated by heat picked up from the liquid refrigerant flowing through conduit 26 en route to the low-temperature section of the evaporator and the refrigerant vapor resulting from such evaporation diffuses into the inert gas that is caused to pass over the surface of the liquid refrigerant by the helical insert, thereby producing an additional refrigerating effect for precooling the liquid refrigerant. Any excess liquid that passes through conduit **43**, which with our improved precooler will be mostly absorption liquid that may have been carried into the evaporator with liquid refrigerant, is conveyed through trap **51** into the inner passage of the gas heat exchanger. The width of the ribbon of metal of which the helical insert **49** is formed is but slightly less than the inside diameter of conduit **43**, so that when this conduit is drawn out of round at the bottom portion thereof the helical insert fits rather snugly within this conduit, except for the shallow channel **50** that is formed in the bottom of the conduit. With this arrangement no additional means is required for holding the helical insert in proper position within the conduit, and no particular skill is required in fabricating the precooler. The arrows in Fig. 3 show that the helical insert **49** fits snugly within more than the upper half of conduit **43**.

Having thus disclosed our invention, we wish it understood that we do not desire to be limited to the specific structure illustrated and described, for obvious modifications may occur to a person skilled in the art.

What is claimed is:

1. A refrigerating system including a conduit for flow of liquid and gas therethrough, said conduit comprising a generally round tube, and a helical insert in said tube for lengthening the path of flow of gas therethrough, said tube being distorted sufficiently out of round to form a shallow channel throughout the length of the tube beneath said helical insert, the latter being formed to fit within said tube above said channel in any degree of rotation of the insert relative to the tube.

2. An absorption refrigerating system of the continuous cycle inert gas type including an evaporator having a low-temperature section and a high-temperature section connected for series flow of liquid refrigerant and inert gas, an absorber, a gas heat exchanger, gas conduits connecting said evaporator and absorber and gas heat exchanger in a circuit for inert gas, a conduit for conducting liquid refrigerant to the low-

temperature section of the evaporator, said liquid conduit being in thermal contact with one of said gas conduits in the path of flow of inert gas from the high-temperature section of the evaporator to the gas heat exchanger, and means in said gas conduit for lengthening the path of flow of inert gas therethrough.

3. A refrigerating system as set forth in claim 2 in which said gas conduit is provided with a channel for flow of liquid lengthwise thereof below said means for lengthening the path of gas flow.

4. A refrigerating system as set forth in claim 2 in which said gas conduit is a generally round tube distorted sufficiently out of round to form a shallow channel running the length of the tube beneath said means for lengthening the path of gas flow.

5. A refrigerating system as set forth in claim 2 in which said gas conduit is a generally round tube, and said means for lengthening the path of gas flow is a helical insert, said tube being distorted sufficiently out of round to form a shallow channel running the length of the tube beneath the helical insert.

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