United States Patent

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[54] **ABSORPTION REFRIGERATION MACHINE**
4 Claims, 2 Drawing Figs.

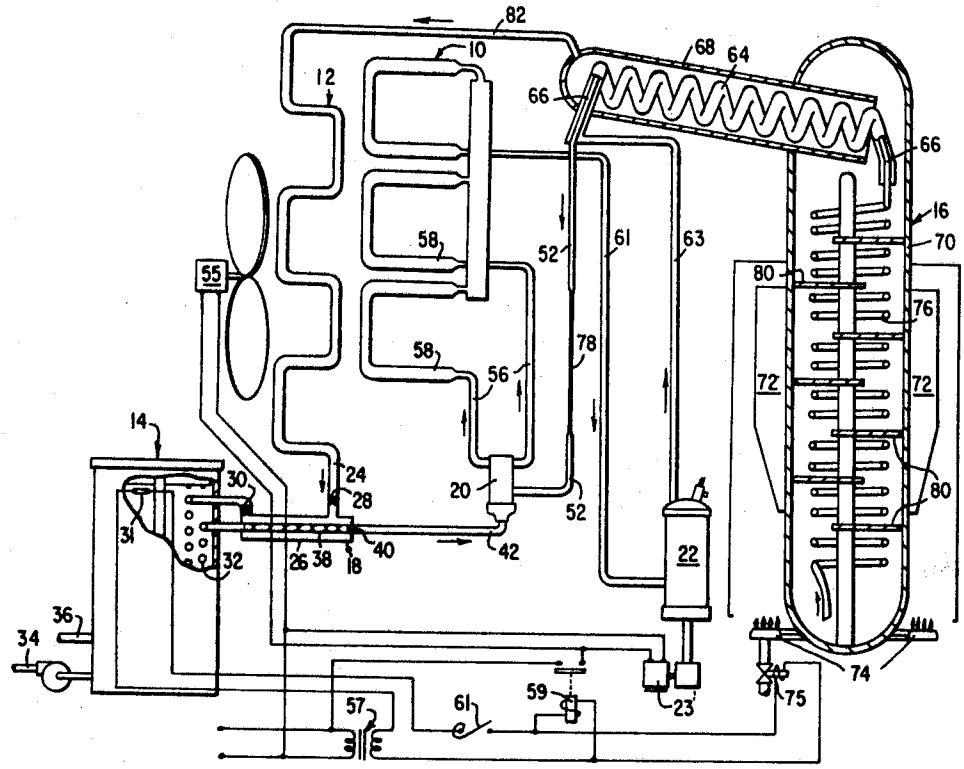
[52] **U.S. Cl.** **62/126,**
62/148, 62/476, 165/11, 200/61.03
[51] **Int. Cl.** **F25b 15/04,**
H01h 35/24
[50] **Field of Search** 62/125,
126, 129, 141, 476; 73/86, 148; 165/11, 70;
200/61.03, 61.04, 61.08

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ABSTRACT: An aqua-ammonia absorption refrigeration system employing an ammonia sensor in the chilled water circuit to detect the presence of ammonia therein and shut down the system to prevent serious corrosion of the chilled water circuit by ammonia.



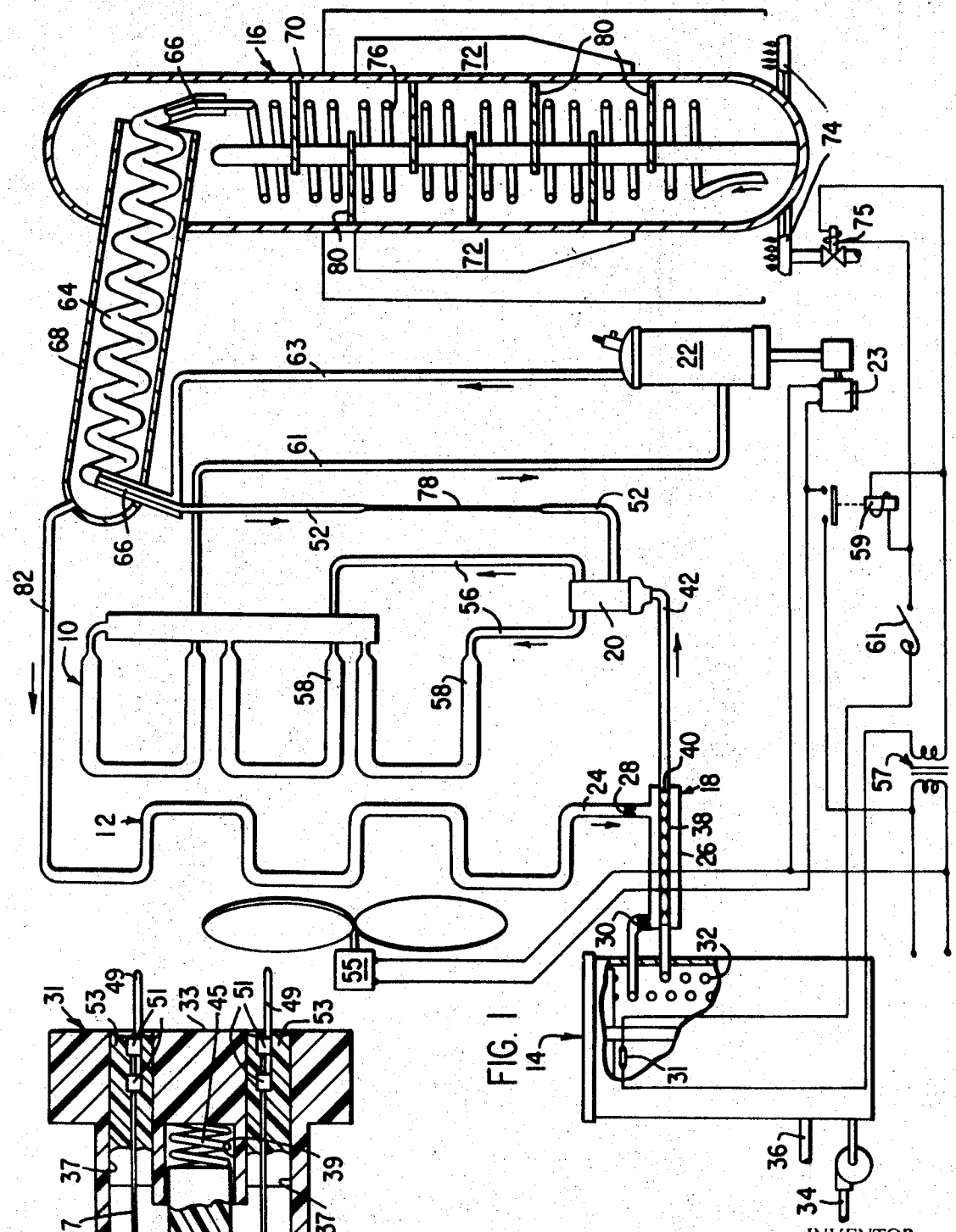


FIG. 1

FIG. 2

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ABSORPTION REFRIGERATION MACHINE

BACKGROUND OF THE INVENTION

In aqua-ammonia refrigeration machines used for air conditioning, a coil for direct expansion of refrigerant to cool the air within the conditioned space can not be utilized due to the possibility of a leak in the coil or associated tubing and the poisonous nature of ammonia which could escape into the conditioned space. The machine may therefore be used to chill water or a suitable antifreeze solution which is supplied to the conditioned space for cooling the air therein. However, if a leak should occur in the ammonia-chilled water heat exchanger, ammonia could be circulated through the chilled water circuit. Since the chilled water circuit is ordinarily fabricated from copper which readily corrodes in the presence of ammonia, there still exists a remote possibility of introducing ammonia into the conditioned space through an opening in the chilled water circuit created by this corrosion. Irrespective of the ammonia danger, unless the ammonia leak into the chilled water circuit is detected very early, the circuit would be badly corroded and replacement thereof would be necessary.

SUMMARY OF THE INVENTION

The present invention relates to an aqua-ammonia refrigeration system employing an ammonia sensor in the chilled water circuit of the system. Means are provided for stressing a piece of brass which is associated with the electrical control circuit of the system. The stressed brass maintains a closed circuit unless it is corroded by ammonia and fails, thereby opening the electrical circuit and shutting down the system.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a schematic diagram of an absorption refrigeration system; and

FIG. 2 is an enlarged sectional view of the ammonia sensor employed with the refrigeration system.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1 of the drawing, there is shown a refrigeration system comprising an absorber **10**, a condenser **12**, an evaporator or chiller **14**, a generator **16**, a liquid-suction heat exchanger **18**, and a vapor distributor **20**, connected to provide refrigeration. A pump **22** actuated by pump motor **23** is employed to circulate weak absorbent solution from absorber **10** to generator **16**.

As used herein, the term "weak absorbent solution" refers to solution which is weak in absorbent power, and the term "-strong absorbent solution" refers to a solution which is strong in absorbent power. A suitable absorbent for use in the system described is water; a suitable refrigerant is ammonia.

Liquid refrigerant condensed in condenser **12** passes through refrigerant liquid passage **24** to the liquid-suction heat exchanger. The liquid-suction heat exchanger **18** includes a housing **26** having a refrigerant restrictor **28** at the upstream end and a refrigerant restrictor **30** at the downstream end thereof. A portion of the liquid refrigerant supplied to the liquid-suction heat exchanger **18** flashes upon passing through restrictor **28** due to the low pressure existing downstream of the restrictor, thereby cooling the remainder of the refrigerant in the housing **26**. The cooled refrigerant liquid and flashed refrigerant vapor then pass through restrictor **30** into heat exchanger **32** of chiller **14**.

A heat exchange medium such as water is passed over the exterior of heat exchanger **32** where it is chilled by giving up heat to evaporate the refrigerant within the heat exchanger. The chilled heat exchange medium passes out of chiller **14** through line **34** to suitable remote heat exchangers (not shown) after which it is returned to the chiller through inlet **36** for rechilling.

An ammonia sensor **31** as illustrated in FIG. **2** is disposed in the air space of the chiller and operably connected to the electrical circuit of the machine. The sensor **31** is comprised of a housing **33** having a cylindrically extending wall **35**, passageways **37** and a recess **39** formed therein. A button **41** having a slot **43** formed therein and a spring **45** are disposed in recess **39**. A brass wire **47**, which is attached to electrical leads **49** by crimp connectors **51** or other suitable means, is routed through passageways **37** and slot **43**. The sensor is assembled by tensioning leads **49** so that spring **45** and brass wire **47** are stressed. Potting material **53** such as epoxy is then utilized to fill passageways **37** and hold wire **47** within the passageways so that wire **47** is permanently stressed by spring **45**.

By way of illustration, a suitable control circuit, including gas valve **75**, pump motor **23**, absorber-condenser fan motor **55**, transformer **57**, relay **59**, room thermostat **61**, and ammonia sensor **31** is provided to control the machine. When the thermostat **61** closes in response to room temperature, the circuit including sensor **31**, relay **59**, and gas valve **75** is completed. The relay **59** in turn completes the circuit including fan motor **55** and pump motor **23**. In the event there is an ammonia leak in the chiller **14**, the ammonia will rapidly corrode stressed brass wire **47** causing it to break and open the control circuit. This will immediately shut off the machine to prevent passage of ammonia water into the copper-chilled water circuit. It should be understood that this circuit is merely schematic and that a number of safety controls such as high-temperature limit switches, motor-overload switches, etc. may also be employed in the circuit.

The cold refrigerant evaporated in heat exchanger **32**, along with a small quantity of absorbent which is carried over to the chiller with the refrigerant from the generator, passes into refrigerant vapor passage **38** of liquid-suction heat exchanger **18**. The refrigerant vapor and absorbent liquid, which has a large quantity of refrigerant absorbed therein, passes through refrigerant vapor passage **38** in heat exchange relation with the refrigerant passing through housing **26**. Refrigerant vapor passage **38** is provided with a turbulator **40** which consists of a twisted metal strip to provide a tortuous flow path for the vapor to provide optimum heat transfer between the vapor and liquid in passage **38** and the liquid refrigerant in housing **26**. By passing the vapor and liquid in passage **38** in heat transfer with the liquid refrigerant in housing **26**, a large quantity of refrigerant in the absorbent liquid in passage **38** is vaporized. The heat of vaporization is therefore removed from the liquid in housing **26**, thereby reducing the temperature of the liquid refrigerant supplied to heat exchanger **32**. This heat transfer within the liquid-suction heat exchanger **18** provides an increase in the absorption machine efficiency by transferring heat from the liquid supplied thereto from the condenser to the refrigerant vapor and absorbent liquid discharged from the chiller.

Refrigerant vapor and absorbent solution from passage **38** is supplied to refrigerant distributor **20** through line **42**. Strong solution, which is supplied from the generator to distributor **20** through line **52** mixes with the vapor and solution supplied to the distributor through line **42**. The refrigerant vapor-absorbent solution mixture from distributor **20** is supplied to individual circuits **58** of the absorber **10** through absorber supply tubes **56**. Suitable fan means, including motor **55**, are provided for passing ambient air over the surface of the absorber in heat exchange relation with the solution therein for cooling the absorbent solution to promote the absorption of the refrigerant vapor by the solution. The same cooling medium may be supplied to condenser **12** in heat exchange relation with refrigerant vapor therein to condense the refrigerant.

Cold weak absorbent solution passes from absorber **10** through line **61** into pump **22**. Liquid from pump **22** is passed through line **63** to rectifier heat exchange coil **64**. The weak solution passes through coil **64** in heat exchange relation with hot strong solution passing through heat exchange coil **66** disposed within coil **64** and with the hot refrigerant vapor flowing through rectifier shell **68** in contact with the outer sur-

face of coil **64**. The weak solution from coil **64** is discharged into the upper portion of generator **16** along with any vapor which is formed in coil **64** due to heat exchange with the hot vapor passing thereover and the hot solution flowing therethrough.

Generator **16** comprises a shell **70** having tapered fins **72** suitably affixed thereto as by welding. Suitable heating means, including gas burner **74** and gas valve **75**, are provided for heating the generator. The weak solution is boiled in generator **16** to concentrate the solution, thereby forming a strong solution and refrigerant vapor.

The hot strong absorbent solution passes upwardly through the analyzer section of generator **16** through analyzer coil **76** in heat exchange with the weak solution passing downwardly over the coil. The warm strong solution then passes through heat exchange coil **66** within coil **64** and line **52** into the distributor **20**. A restrictor **78** is provided in line **52** so that the solution supplied to the vapor distributor **20** is at the same pressure as the vapor in line **42**.

Refrigerant vapor formed in generator **16** passes upwardly through the analyzer section thereof where it is concentrated by mass heat transfer with weak solution passing downwardly over analyzer coil **76**. Analyzer plates **80** in generator **16** provide a tortuous path for flow of solution and vapor to assure intimate contact therebetween to improve the mass heat transfer. The vapor then passes through rectifier **68** in heat exchange relation with the weak solution passing through coil **64**. Absorbent condensed in rectifier **68** flows downwardly into the generator along with the weak solution discharged from coil **64**. Refrigerant vapor passes from rectifier **68** through line **82** to condenser **12** to complete the refrigeration cycle.

While I have described a preferred embodiment of my invention, it is to be understood the invention is not limited thereto since it may be otherwise embodied within the scope of the following claims.

I claim:

1. An aqua-ammonia absorption refrigeration machine having a generator, a condenser, an absorber and an evaporator connected to provide refrigeration,

an electrical control circuit including an ammonia sensor associated with said machine to control the operation thereof, said ammonia sensor including a brass sensing element disposed in a position to sense an ammonia leak in said evaporator, said brass element forming an electrically conductive portion of said control circuit which corrodes rapidly in the presence of ammonia to open said electrical control circuit and shut off the machine.

2. An aqua-ammonia absorption refrigeration machine according to claim **1** further including means to stress said element to increase the corrosion rate thereof.

3. An aqua-ammonia absorption refrigeration machine according to claim **2** wherein said sensing element is a brass wire, and said means for stressing said element includes a spring.

4. An aqua-ammonia absorption refrigeration machine according to claim **3** wherein said ammonia sensor includes a housing having a central recess formed therein, said housing having two passageways extending therethrough parallel to the recess therein and on opposite sides thereof, said spring being disposed in the recess,

means adapted for engagement with said spring for movement axially within the recess, said brass wire being disposed within said housing having one end thereof in each passageway and forming a loop over said engagement means, the ends of said wire being suitably secured within the passageways so that said engagement means is held within the recess in said housing against said spring, said wire being stressed by said spring and said engagement means so that when said wire is exposed to ammonia and is weakened thereby, said spring will exert sufficient force to break said wire to open said electrical control circuit.