Dec. 2, 1969 R. A. ENGLISH 3,481,150

CHILLER STRUCTURE FOR REFRIGERATION SYSTEMS

Filed June 7, 1968

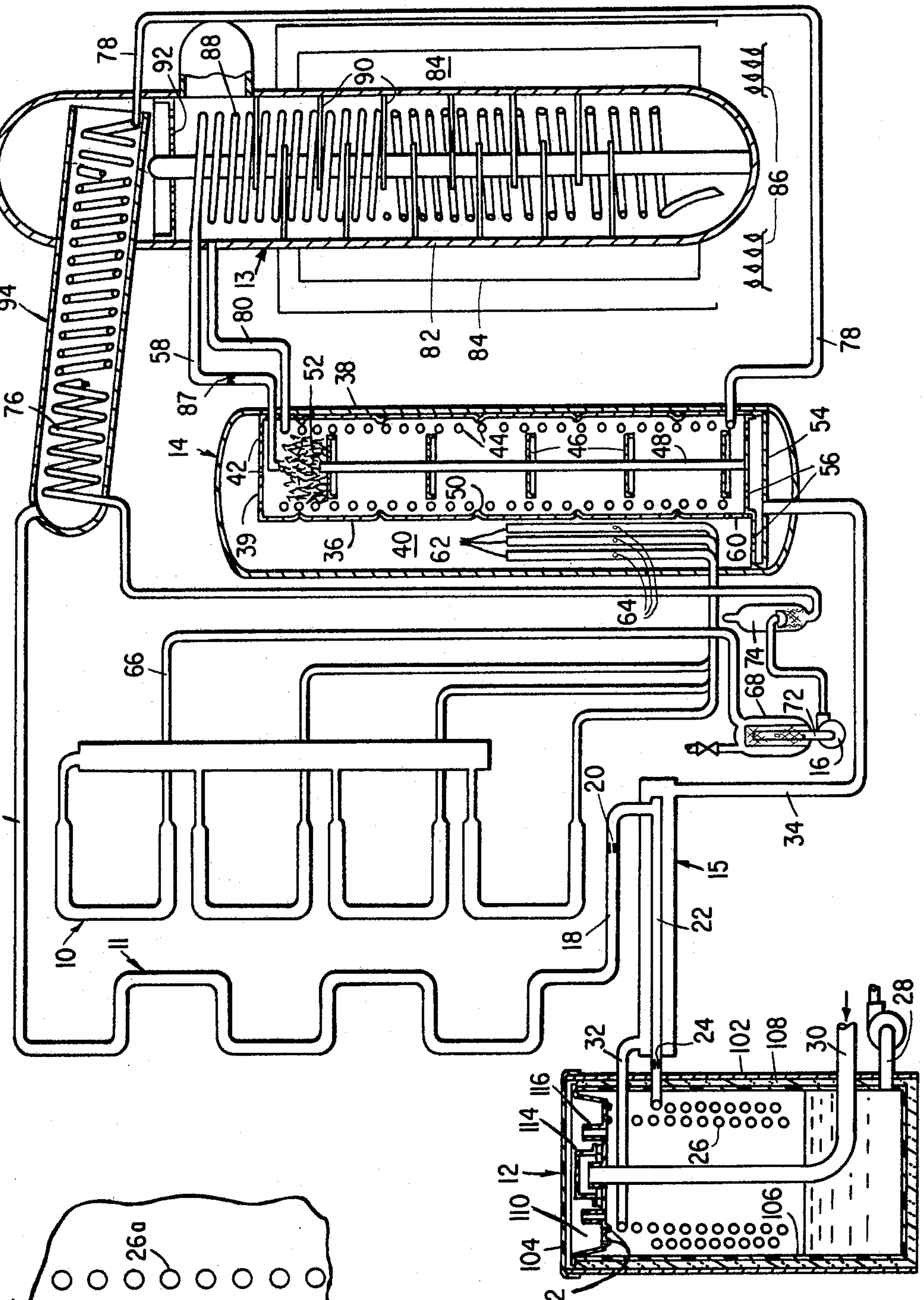

FIG. 1

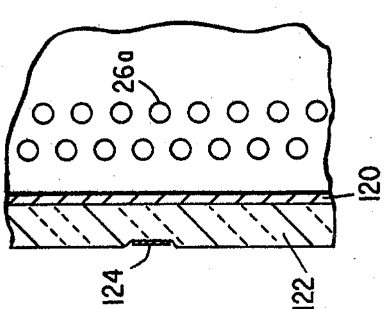

FIG. 2

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3,481,150

Patented Dec. 2, 1969

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3,481,150

CHILLER STRUCTURE FOR REFRIGERATION SYSTEMS

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Filed June 7, 1968, Ser. No. 735,379
Int. Cl. F25b *39/02, 47/00*
U.S. Cl. 62—85 5 Claims

ABSTRACT OF THE DISCLOSURE

A refrigeration system comprised of a generator, solution-cooled absorber, primary absorber, condenser, liquid-suction heat absorber, and chiller, the heat exchanger interiorly of the chiller being constructed of a non-hardening ferritic stainless steel of relatively low chromium content having superior corrosion resistance.

BACKGROUND OF THE INVENTION

The present invention relates to a gas air conditioning system having a chiller as one portion thereof and featuring therein a coil construction for passage of refrigerant therethrough composed of an alloy of relatively low cost, excellent oxidation and corrosion resistance and also possesses ease of weldability. The material utilized for this purpose is a non-hardening ferritic stainless steel having a relatively low chromium content and also including therein compounds having stabilizing and passivating influences.

Coil constructions for chillers or evaporators conventionally are of galvanized mild steel tubing welded in sections. Apparently, as a result of the welded joints, there develops ammonia seepage, causing attacks on the zinc coating and producing perforations in the tubing. Also, in the prior art constructions, inhibitors or other water treatment materials are required to reduce the detrimental effects of such ions as chloride or bicarbonate which induce corrosion and ultimately produce crevices in the coils.

SUMMARY OF THE INVENTION

The instant invention is particularly directed to a chiller package for use as an integral part of a refrigeration system, the chiller package embodying therein a tubular member for passage of refrigerant therethrough. The novel aspect of this invention is the construction of the tubular heat exchanger from a non-hardening ferritic stainless steel which during its formulation includes carbon, manganese, silicon, nickel, iron, chromium as a passivator and titanium as a carbide stabilizer. The alloy has a relatively low chromium content and it has been found that a coil arrangement so constructed is remarkably resistant to corrosion and oxidation, is of relatively low cost, possesses ease of weldability, and essentially avoids the need for inhibitors or other water treatment materials.

BRIEF DESCRIPTION OF THE DRAWING

FIGURE 1 illustrates schematically, and with portions thereof taken in section, a preferred form of air conditioning system; and

FIGURE 2 is a fragmentary sectional view of an additional form of the invention wherein both the chiller casing and coil member are of stainless steel.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawing, there is shown a refrigeration system comprising a primary absorber **10**, a condenser **11**, an evaporator or chiller **12** which forms the subject matter of the present invention, a generator **13**, a solution-cooled absorber **14** and a liquid-suction heat exchanger **15** connected to provide a refrigeration cycle. A pump **16** is employed to circulate weak absorbent solution from the primary absorber **10** to the generator **13**. As used herein, the term "weak absorbent solution" refers to a solution which is weak in absorbent power and the expression "strong absorbent solution" refers to a solution which is strong in absorbent power. A suitable absorbent solution for use in the system described is water and a suitable refrigerant is ammonia.

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Liquid refrigerant condensed in the condenser **11** passes through refrigerant liquid passage **18**, and refrigerant restriction **20** to heat exchange tube **22** of the liquid-suction heat exchanger **15**. The liquid refrigerant is cooled in the tube **22** and emerges from the liquid-suction heat exchanger and passes through refrigerant restriction **24** into heat exchanger **26** in the chiller **12**.

A fluid medium such as water to be chilled passes over the exterior of the heat exchanger **26**, where it is chilled by giving up heat to evaporate refrigerant within the heat exchanger. The chilled medium passes out of the chiller **12** through line **28** to suitable remotely located heat exchangers (not shown), after which it is returned to the chiller through inlet **30** for rechilling.

The cold refrigerant evaporated in the heat exchanger **26** passes through refrigerant vapor passage **32** and through the liquid-suction heat exchanger **15** in heat exchange relation with liquid refrigerant passing through the tube **22**. The refrigerant vapor then passes through refrigerant vapor passage **34** into the solution cooled absorber **14**.

The solution cooled absorber **14** is formed within a tubular or cylindrical vessel **38** by a tubular, preferably cylindrical, internal baffle **36** which divides the tubular cylindrical vessel **38** into the solution cooled absorber **14** and a second solution chamber **40**. The vessel **38** is preferably closed at opposite ends. The baffle **36** may be provided with a top cover plate **39** having a plurality of vapor discharge apertures **42** therein to allow vapor to escape from the solution cooled absorber **14** into the chamber **40**.

A weak solution heat exchanger **44** preferably comprising a helical coil is disposed within solution-cooled absorber **14**. A plurality of horizontally extending plates **46** are secured to a central support **48** and arranged interiorly of the baffle **36** to cooperate with annular grooves **50** and the heat exchanger **44** to provide a tortuous continual flow or passage for vapor and solution through the solution cooled absorber **14**. Suitable packing means, such as Raschig rings **52**, may chill the space between the uppermost plate **46** and the top of solution cooled absorber to reduce the tendency for solution froth to escape through the discharge apertures **42**.

A refrigerant vapor distributor header **54** is secured to close the bottom of the baffle **36**. The header **54** is provided with refrigerant vapor ports **56** for passage of refrigerant vapor from the line **34** into the solution cooled absorber **14** and the chamber **40**. Strong solution from the generator **13** is admitted to the top portion of the solution cooled absorber **14** through line **58**. The strong solution passes downwardly through the solution cooled absorber in counter-flow relation with upwardly passing refrigerant vapor and weak solution passing through the coil **44**. A strong solution discharge passage **60** is provided adjacent the lower portion of the baffle **36** for passage of solution from the solution cooled absorber into the chamber **40**.

Solution discharge passages **62** are provided for passing a mixture of refrigerant vapor and solution from the chamber **40** to the primary absorber **10**. Each of the discharge passages comprises a tubular member having open upper ends for admission of vapor and a solution inlet aperture **64** disposed below the level of absorbent solution in the chamber **40**. This insures a mixed flow of liquid and vapor to the primary absorber.

A cooling medium, preferably ambient air, is passed through the primary absorber **10** in heat exchange relation with the absorbent solution to cool the absorbent solution and promote the absorption of the refrigerant vapor in the absorber. The same cooling medium may be supplied to the condenser **11** in heat exchange relation with refrigerant therein to condense the refrigerant.

Cold weak absorbent solution passes from the primary absorber **10** through line **66** into pump inlet tank **68**. Weak solution from the inlet tank **68** is supplied to weak solution pump **16** through line **72**. Liquid from pump **16** passes through pump discharge tank **74** to a rectifier heat exchange coil **74** to a rectifier heat exchange coil **76**. From the coil **76** the weak solution passes through line **78** to the weak solution heat exchanger **44** in the solution cooled absorber **14**. The weak solution from the coil **44** passes through line **80** into the upper portion of the generator **13** along any vapor formed in the coil **44**.

The generator **13** comprises a shell **82** having fins **84** suitably affixed thereto, as by welding. The generator is heated by a gas burner **86** or any other desired heating means. The weak solution is boiled in the generator **13** to form a strong solution and refrigerant vapor.

The hot strong absorbent solution passes upwardly through the analyzer section of the generator **13** through analyzer coil **88** in heat exchange relationship with the weak solution passing downwardly over the coil. The warm strong solution then passes through the line **58** which has a solution restricter **87**, and is then discharged into the upper portion of the solution cooled absorber **14**.

Refrigerant vapor formed in the generator **13** passes upwardly through the analyzer section thereof where it is concentrated by mass transfer with weak solution passing downwardly over the analyzer coil **88**. Analyzer plates **90** in the generator **13** provides a tortuous path for flow of solution and vapor to assure intimate contact therebetween to improve the mass transfer. The refrigerant vapor from the analyzer section passes through reflux plate **92** in heat exchange relation with absorbent condensed in rectifier **94**. The vapor then passes through the rectifier **94** in heat exchange relation with the rectifier heat exchange coil **76**. Absorbent condensed in the rectifier **94** flows downwardly onto the plate **92** where it is heated by the refrigerant vapor passing therethrough. The heated absorbent is then passed to the generator along with the weak solution discharged into the generator from line **80**. Vapor passes through line **96** to the condenser **11** to complete the refrigeration cycle.

The water chiller **12** illustrated comprises an outer cylindrical shell **102** having a top member **104** secured thereto. A cylindrical liner **106** is disposed within the shell **102** in spaced relation thereto. A suitable insulating material **108** such as polyurethane or polystyrene foam is provided between the shell **102** and the liner **106** and along the bottom of the liner. The insulation is preferably foamed in place to form a complete assembly. The heat exchanger **26** in the chiller **12** is disposed interiorly of the liner **106** for passage of refrigerant therethrough. A distribution tray **110** which is disposed above the heat exchanger **26** receives water returned from the remote heat exchangers through return water line **30**. The distribution tray **110** is provided with two concentric rows of downwardly directed nozzles **112** which are aligned above the two rows of coil **26** for discharge of water from the tray **110** onto the coils **26**. A cap **114** is suitably affixed to the tray **110** to deflect the stream of water from the line **30** downward into the tray **110**. Overflow weirs **116** are also provided on trays **110** to prevent an excessive accumulation of water therein.

Referring specifically now to the composition of the coil **26** in the chiller **12**, a preferred range of elements for the stainless steel is as follows:

	Range, percent by wt.
Carbon	0.04–0.08
Manganese	0.20–1.00
Silicon	0.40–1.00
Chromium	10.50–11.75
Nickel	0.20–0.50
Titanium	0.20–0.75
Iron	Balance

Specific compositions which have proven themselves successful in practice are the following:

	I	II	III
Percent by weight:			
Carbon	0.04	0.08	0.08.
Manganese	0.50	1.00	0.20–1.00.
Silicon	0.40	1.00	1.00.
Chromium	11.00	10.50–11.75	10.50–11.75.
Nickel	0.20	0.50	0.50.
Titanium	0.50	5×C or 0.75.	0.35–0.75.
Iron	Balance	Balance	Balance.

As is manifest to those skilled in the art, the above compositions would normally contain therein trace amounts of sulphur and phosphorus, each generally being within the range of 0.025–0.05%, again by weight.

The composition employed in constructing a coil structure for use in the chiller package of this invention has been found to have the following physical properties:

Yield strength of between 30,000/40,000 p.s.i., 0.2% offset

Tensile strength of between 60,000/70,000 p.s.i.

Percent elongation at 2 inches of between 20/32.5

Rockwell B hardness of between 72/80

A Modulus of elasticity in tension of about 29.0×10^6, and

A melting range of between approximately 2700/2790° F.

Utilizing non-hardening ferritic stainless steel compositions within the range indicated avoids the necessity in chiller applications of periodically adding inhibitors or other water treatment materials. A typical inhibitor composition includes between 500/1000 parts of sodium chromate and 1½ to 3% borax. This mixture is available in powder or granular form, and when used with mild steel galvanized tubing of the prior art, was designed to prevent tube corrosion. However, inhibitors have been found to reduce to a degree the heat transfer coefficient of the coils, and have not been completely successful in avoiding the formation of scale deposits on the coils and the consequent formation of crevices in the coil presumably attributable to the action of chloride and bicarbonate ions. The coil structure of this invention, on the other hand, when formulated of a material within the range above set forth, has been found after passivation treatment, as in 10% nitric acid and 1% hydrofluoric acid, to present exceptional resistance to attack from various field tap waters at chilled water temperatures in aerated systems.

The chiller construction shown in FIGURE 1 of the drawings incorporates, as was earlier noted, a spaced wall construction having therein foamed insulation. However, it is also within the contemplation of this invention that the chiller wall may be constructed of a single shell, utilizing the stainless steel composition disclosed herein. A construction of this type is illustrated in FIGURE 2, and embodies a coil arrangement **26a** of the same type as shown in FIGURE 1, and also includes a shell or casing **120** surrounded by any suitable insulative material **122**, such as a glass fiber matte or foamed plastic, held in place by strapping **124** or other suitable means.

A range of elements of the chiller coil construction has been set forth above, and of course, variations can be practiced therein without departing from the novel concepts of this invention. Similarly, those skilled in the art can readily comprehend that it may be desirable to utilize this broad range and variations therein in other portions of the refrigeration system.

I claim:

1. A refrigeration system which comprises a generator, an absorber, a condenser and an evaporator which has heat exchange surfaces therein, said surfaces being constructed of a nonhardening ferritic stainless steel alloy containing 0.04 to 0.08% carbon, 0.20 to 1.00% manganese, 0.40 to 1.00% silicon, 10.50 to 11.75% chromium, 0.20 to 0.50% nickel, 0.20 to 0.75% titanium, and the balance iron, each being in percentages by weight.

2. A refrigeration system as defined in claim 1, wherein the stainless steel is composed of: 0.04% carbon, 0.50% manganese, 0.40% silicon, 11.00% chromium, 0.20% nickel, 0.50% titanium and the balance iron.

3. A refrigeration system of the character defined in claim 1, wherein the stainless steel is composed of: 0.08% carbon, 1.00% manganese, 1.00% silicon, 10.50 to 11.75% chromium, 0.50% nickel, 5×C or 0.75% titanium and the balance iron.

4. A refrigeration system as defined in claim 1, wherein the stainless steel is composed of: 0.08% carbon, 0.20 to 1.00% manganese, 1.00% silicon, 10.50 to 11.75% chromium, 0.50% nickel, 0.35 to 0.75% titanium and the balance iron.

5. A refrigeration system as defined in claim 1, wherein the heat exchange surfaces take the form of a tubular coil member.

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U.S. Cl. X.R.

62—476; 165—133