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(54) CO2 REFRIGERATION SYSTEM FOR ICE-PLAYING SURFACE

(76) Inventor: **Serge Dubé**, St-Zotique (CA)

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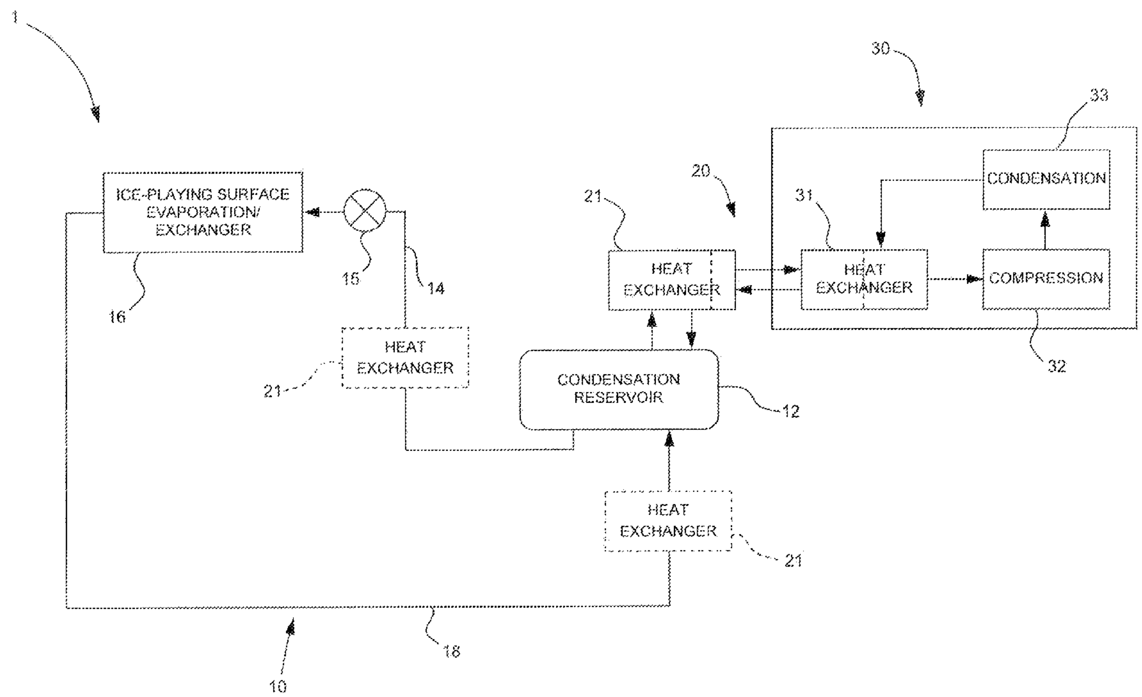
(57) **ABSTRACT**

A CO_2 refrigeration system for an ice-playing surface comprises a transfer circuit, a CO_2 refrigerant circuit and an independent condensation circuit. A transfer refrigerant circulates between a condensation heat exchanger and an evaporation heat exchanger. The CO_2 circuit is in relation with the condensation heat exchanger to release heat from the CO_2 refrigerant. The CO_2 circuit comprises a CO_2 condensation reservoir and an evaporation stage to receive the CO_2 refrigerant from the condensation reservoir. The independent circuit is in relation with the refrigerant of the transfer circuit at the evaporation heat exchanger. The independent circuit comprises a magnetically operated compressor to compress a secondary refrigerant, a condensation stage and an evaporation stage in which the secondary refrigerant absorbs heat.



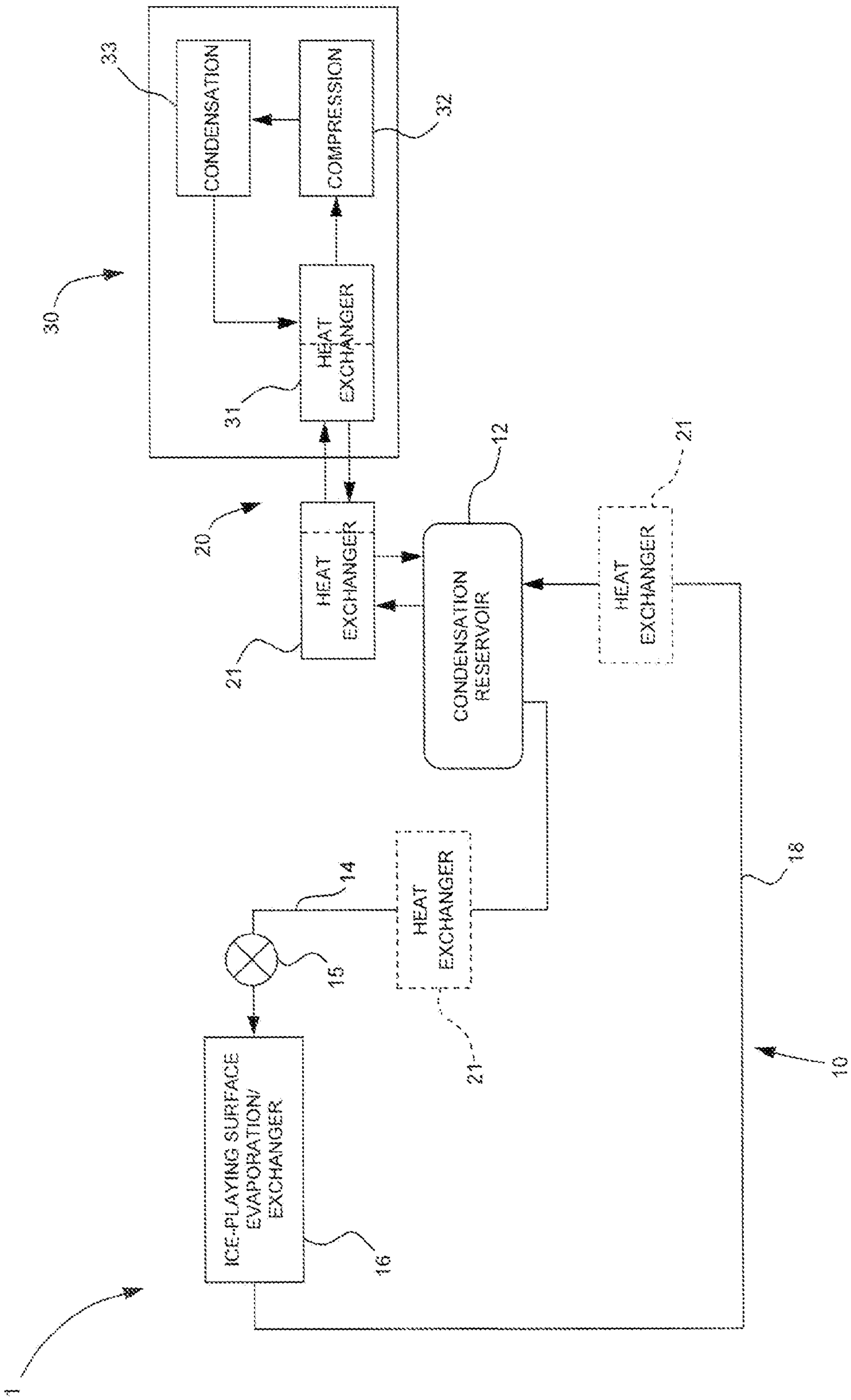

CONDENSATION
COMPRESSION
HEAT EXCHANGER
HEAT EXCHANGER
CONDENSATION RESERVOIR
HEAT EXCHANGER
HEAT EXCHANGER
ICE-PLAYING SURFACE EVAPORATION/ EXCHANGER
1
10
12
14
15
16
18
20
21
30
31
32
33

Fig. 1

CO2 REFRIGERATION SYSTEM FOR ICE-PLAYING SURFACE

CROSS-REFERENCE TO RELATED APPLICATION

[0001] The present application claims priority on Canadian Patent Application No. 2,735,347, filed on Mar. 28, 2011 and issued to Canadian Patent No. 2,735,347 on Oct. 11, 2011, incorporated herein by reference.

FIELD OF THE APPLICATION

[0002] The present application relates to refrigeration systems used to refrigerate ice-playing surfaces such as a skating rinks, curling sheets, etc, and more particularly to refrigeration systems using CO_2 refrigerant.

BACKGROUND OF THE ART

[0003] With the growing concern for global warming, the use of chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs) as refrigerant has been identified as having a negative impact on the environment. These chemicals have non-negligible ozone-depletion potential and/or global-warming potential.

[0004] As alternatives to CFCs and HCFCs, ammonia, hydro-carbons and CO_2 are used as refrigerants. Although ammonia and hydrocarbons have negligible ozone-depletion potential and global-warming potential as does CO_2, these refrigerants are highly flammable and therefore represent a risk to local safety. On the other hand, CO_2 is environmentally benign and locally safe.

SUMMARY OF THE APPLICATION

[0005] It is therefore an aim of the present disclosure to provide a CO_2 refrigeration system for ice-playing surfaces that addresses issues associated with the prior art.

[0006] Therefore, in accordance with the present application, there is provided a CO_2 refrigeration system for an ice-playing surface, comprising: a transfer circuit in which a transfer refrigerant circulates between a condensation heat exchanger to absorb heat, and an evaporation heat exchanger to release heat; a CO_2 refrigerant circuit in heat-exchange relation with the condensation heat exchanger to release heat from the CO_2 refrigerant, the CO_2 refrigerant circuit comprising a condensation reservoir accumulating a portion of the CO_2 refrigerant in a liquid state and an evaporation stage receiving the CO_2 refrigerant from the condensation reservoir to absorb heat from the ice-playing surface; and an independent condensation circuit in heat-exchange relation with the transfer refrigerant of the transfer circuit at the evaporation heat exchanger, the independent condensation circuit comprising a compression stage with at. least one magnetically operated compressor to compress a secondary refrigerant, a condensation stage in which the secondary refrigerant releases heat, and an evaporation stage in which the secondary refrigerant is in heat-exchange relation with the transfer refrigerant of the transfer circuit at the evaporation heat exchanger to absorb heat therefrom.

BRIEF DESCRIPTION OF DRAWINGS

[0007] FIG. **1** is a block diagram of a CO_2 refrigeration system for ice-playing surface in accordance with an embodiment of the present application.

DESCRIPTION OF PREFERRED EMBODIMENTS

[0008] Referring to the drawings and more particularly to FIG. **1**, there is illustrated a CO_2 refrigeration system **1** for ice-playing surface.

[0009] In FIG. **1**, the CO_2 refrigeration system **1** has a CO_2 evaporation closed circuit **10**, in which cycles CO_2 refrigerant. The CO_2 evaporation circuit **10** comprises a condensation reservoir **12** accumulating CO_2 refrigerant in a liquid and gaseous state.

[0010] Line **14** directs CO_2 refrigerant from the condensation reservoir **12** to an evaporation stage, with a flow of CO_2 refrigerant induced by pump and/or an expansion valve(s) as generally indicated as **15**. As is shown in FIG. **1**, the CO_2 refrigerant is then fed to the ice-playing surface evaporation stage **16**.

[0011] The ice-playing surface evaporation stage **16** of FIG. **1** may consist of a circuit of pipes positioned under the ice-playing surface, in which the CO_2 refrigerant circulates to absorb heat from fluid being frozen to form the ice-playing surface, or to maintain the ice-playing surface frozen.

[0012] The ice-playing surface evaporation stage **16** of FIG. **1** may also consist of an evaporation exchanger, by which the CO_2 refrigerant of the evaporation circuit **10** absorbs heat from a closed circuit of pipes of the ice-playing surface refrigeration stage **16**. An alternative refrigerant circulates in the closed circuit of pipes of the ice-playing surface refrigeration stage **16**, such as brine, glycol, or the like.

[0013] CO_2 refrigerant exiting the evaporation stage **16** is directed to the condensation reservoir **12**, by way of line **18**.

[0014] The CO_2 evaporation circuit **10** is in a heat-exchange relation with a transfer circuit **20**. The transfer circuit **20** is a closed circuit for instance of the type in which a transfer refrigerant (e.g., alcohol-based such as glycol, water, brine or the like) cycles. A condensation heat exchanger **21** is in fluid communication with the condensation reservoir **12**, so as to receive CO_2 refrigerant in a gaseous state, whereby the transfer refrigerant absorbs heat from the CO^2 refrigerant in the heat exchanger **21**. According to an embodiment, the condensation heat exchanger **21** has a coil that is positioned inside the condensation reservoir **12**.

[0015] The condensation heat exchanger **20** cycles the transfer refrigerant between the heat exchanger **21** and an evaporation heat exchanger **31** of an independent condensation circuit **30**. Although not shown, appropriate flow-inducing devices may be used, such as a pump. Accordingly, the transfer refrigerant absorbs heat from the CO_2 refrigerant circulating in the CO_2 evaporation circuit **10**, and releases the heat to the refrigerant circulating in the condensation circuit **30**.

[0016] The independent condensation circuit uses the heat exchanger **31** as an evaporation stage. The condensation circuit is closed and comprises a condensation refrigerant that circulates in the heat exchanger **31** so as to absorb heat from the transfer refrigerant.

[0017] In the condensation circuit, the condensation refrigerant circulates between the heat exchanger **31** in which the condensation refrigerant absorbs heat, a compression stage **32** in which the condensation refrigerant is compressed, and a condensation stage **33** in which the condensation refrigerant releases heat. The compression stage **32** may use Turbocor™ compressors, or any other appropriate magnetically operated type of compressor. In an example, the condensation stage **33** features heat reclaiming (e.g., using a heat exchanger with a heat-transfer fluid) in parallel or in series with other components of the condensation stage **33**, so as to reclaim heat from the CO_2 refrigerant.

[0018] It is pointed out that the condensation circuit may be used with more than one CO_2 refrigeration circuit. In such a case, the condensation circuit features a plurality of heat exchangers **20**, for instance with one for each of the CO_2 refrigeration circuits.

[0019] Examples of the condensation refrigerant are refrigerants such as R-404 and R-507, amongst numerous examples. It is observed that the condensation circuit may be confined to its own casing as illustrated in FIG. **1**. Moreover, considering that the condensation circuit is preferably limited to absorbing heat from stages on a refrigeration pack (e.g., condensation reservoir **12**, suction header in line **18**), the condensation circuit does not contain a large volume of refrigerant when compared to the CO_2 refrigeration circuit, of a secondary refrigerant circuit defined hereinafter.

[0020] Although not fully illustrated, numerous valves are provided to control the operation of the CO_2 refrigeration system **1** as described above. Moreover, a controller ensures that the various stages of the refrigeration system **1** operate as described, for instance by having a plurality of sensors placed throughout the refrigeration system **1**. Numerous other components may be added to the refrigeration system **1** (e.g., valves, tanks, pumps, compressors, pressure-relief systems, etc.), to support the configurations illustrated in FIG. **1**.

[0021] It is within the ambit of the present invention to cover any obvious modifications of the embodiments described herein, provided such modifications fall within the scope of the appended claims.

1. A CO_2 refrigeration system for an ice-playing surface, comprising:

- a transfer circuit in which a transfer refrigerant circulates between a condensation heat exchanger to absorb heat, and an evaporation heat exchanger to release heat;
- a CO_2 refrigerant circuit in heat-exchange relation with the condensation heat exchanger to release heat from the CO_2 refrigerant, the CO_2 refrigerant circuit comprising:
  - a condensation reservoir accumulating a portion of the CO_2 refrigerant in a liquid state;
  - an evaporation stage receiving the CO**2** refrigerant from the condensation reservoir to absorb heat from the ice-playing surface;
- an independent condensation circuit in heat-exchange relation with the transfer refrigerant of the transfer circuit at the evaporation heat exchanger, the independent condensation circuit comprising:
  - a compression stage with at least one magnetically operated compressor to compress a secondary refrigerant;
  - a condensation stage in which the secondary refrigerant releases heat; and
  - an evaporation stage in which the secondary refrigerant is in heat-exchange relation with the transfer refrigerant of the transfer circuit at the evaporation heat exchanger to absorb heat therefrom.

2. The CO_2 refrigeration system according to claim **1**, further comprising a line extending from a top of the condensation reservoir to the heat exchanger, such that gaseous CO_2 refrigerant in the condensation reservoir is directed to the independent condensation circuit.

3. The CO_2 refrigeration system according to claim **1**, wherein the condensation heat exchanger is positioned in a line extending from the condensation reservoir to the evaporation stage.

4. The CO_2 refrigeration system according to claim **1**, wherein the condensation heat exchanger is a coil inside the condensation reservoir.

5. The CO_2 refrigeration system according to claim **1**, wherein the evaporation stage has a circuit of pipes arranged under the ice-playing surface, whereby the CO_2 refrigerant circulating in the circuit of pipes of the evaporation stage absorbs heat from the ice-playing surface.

6. The CO_2 refrigeration system according to claim **1**, wherein the evaporation stage has a heat exchanger for the heat exchange between the CO_2 refrigerant and another refrigerant circulating in a circuit of pipes arranged under the ice-playing surface, whereby the other refrigerant circulating in the circuit of pipes of the evaporation stage absorbs heat from the ice-playing surface.

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