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(71) Applicant: **DNM Refrigeration Limited**
Wetherby LS23 7FS (GB)

(72) Inventors:
- **DOWNHAM, Lee**
  Wetherby, LS23 7FS (GB)
- **HINCHCLIFFE, Andy**
  Wetherby, LS23 7FS (GB)

(74) Representative: **Cookson, Barbara Elizabeth**
Filemot Technology Law Ltd
Popes Head Court Offices
Peter Lane
York YO1 8SU (GB)

(54) TEMPORARY REFRIGERATION UNIT

(57) A portable suitcase sized cooling system that can be connected to external water and electricity supplies to provide refrigeration on a temporary basis in applications such as trailers and at locations where there has been a system failure and trailer access is not possible such as at shopping centres or airports

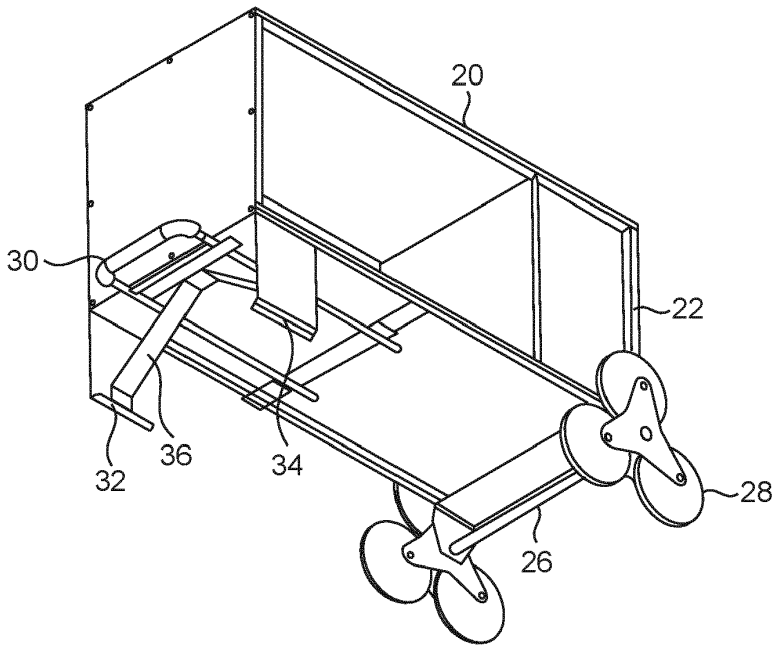

FIG. 2

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Description

Technical Field

[0001] The present invention relates to backup or temporary refrigeration systems that can be used for short periods or in emergency situations where an existing system has broken down.

Technical problem

[0002] When an existing original refrigeration system breaks down in a cellar, cold room and/or walk-in freezer, there is a risk of significant product waste or impairment of quality. There can also be major disruption to site operations with significant loss of trade and brand damage. A temporary solution is required to minimise this waste while repairs are undertaken.

[0003] Typically temporary solutions would involve a trailer that could be parked outside the facility affected by the breakdown. This is not suitable for applications where access is limited such as in cellars of public houses.

Solution of the Present Invention

[0004] The present invention is defined in the appended claims.

[0005] By providing a portable or mobile cooling unit that can be connected to external water or, less desirably, a closed water loop, and electricity supplies (3 pin plug top), it is possible to provide refrigeration on a temporary basis in applications such as trailers and at locations where there has been a system failure and trailer access is not possible such as at shopping centres or airports. The system is preferably provided in a suitcase sized unit so that it can be handled by one person. The unit is free standing.

[0006] The system of the present invention is therefore designed to resolve the above described technical problems and prevent excessive wastage that could easily be of the order of £10,000 if an engineer were unable to effect immediate repairs on a cooling system. As well as the loss of stock, a chiller failure can also result in loss of trade. There is therefore a demand for a free standing temporary cooling system that is equally suitable for chillers, freezers and cellar coolers, whereas prior art solutions have always been specifically designed for one or other application. Such systems are required to operate within the range -20 to 10° C

[0007] Examples of movable air-conditioners are described in CN 282 1442 Y KUNTUO COOLER CO LTD SUZHOU 27-09-2006 and CN 173 1029 A SUZHOU QUTU REFRIGERATOR CO) 08 -02 2006. While these systems use a water cooled condenser, they are operating at a significantly higher temperature range. These prior art air-conditioners claim not to be affected by environmental humidity. When operating as a chiller or freezer, a significant technical problem would arises with the production of condensate from the atmosphere within the housing. The systems are not suitable as temporary backup refrigeration units.

Description of the Drawings

[0008] In order that the invention can be well understood some embodiments thereof will now be described, by way of example only, with reference to the accompanying diagrammatic drawings, in which:

Figure 1 shows a diagram of the component parts of the backup refrigeration system;

Figure 2 is a perspective view of the refrigeration unit showing the housing for the refrigeration system and mobility features;

Figure 3 is a side view of the unit in an operable position;

Figure 4 is a diagrammatic side view of the housing showing how condensate generated in the evaporator section of the housing is drained and fed into the return water path;

Figure 5 shows a detail of the intersection of a condensate pipe with the return water pipe;

Figure 6 is a wiring diagram for the control system of the refrigeration system; and

Figure 7 shows how the unit can be adapted for dual use as a mobile cooling unit or heater.

Description of Embodiments

[0009] As shown in Figure 1, the refrigeration system used is a standard compression refrigerator cycle. Refrigerant flows in a closed-circuit 2 through an expansion valve 4, in which the pressure of the refrigerant is reduced, to an evaporator 6 in which the refrigerant is evaporated into a low-pressure vapour, absorbing heat from the environment to be cooled. The vapour then passes to a compressor 8 which sends the refrigerant vapour at high pressure into a condenser 10 which in this case is a plate heat exchanger. The plate heat exchanger may for example be a 5kw 31bar max pressure plate heat exchanger. By using a plate heat exchanger, the size of the unit can be limited without loss of efficiency.

[0010] Typically with a compression refrigeration system, the condensation of the refrigerant would take place by exchanging heat in the coil with the ambient air. However, in this case the unit is designed to be located in the chilled space. Therefore it must be possible to remove the heat from the chilled space.

[0011] Using a closed water system would be possible

but it would not result in the same level of efficiency and therefore the unit employs a connection to a mains water supply 12. A mains water supply with a constant 10°C water flow is used because it has good heat capacity. For example mains water has a flow rate of about 0.35 l/s at a temperature of 10° C with a temperature difference in this system of system of 5° C and specific heat capacity of water of 4.2j/kg.

KW=Specific heat capacity x letters per second of water x Temperature difference). Therefore 4.2x0.35x5 = 7.35KW of heat removed.

[0012] The described temporary replacement refrigeration unit is operable to provide cooling between -20 and 10°C within a surrounding space. A mobile housing 20, as shown in Figure 2, has first and second compartments separated by a panel through which a refrigerant pipe and a condensate drain pipe 13 pass. The first compartment has two side panels and houses the compression refrigerator elements, namely the expansion device, the evaporator 6 which incorporates a fan 7 for circulating air from the surrounding space, and the compressor 8. The side panels can be perforate to allow through flow of air. As shown in Figure 3 a grating is used in front of the fan 7.

[0013] The second compartment houses the plate heat exchanger 10. As is standard, the plate heat exchanger 10 has first and second sides, the first side being connected into the closed refrigerant loop and the second side being connected to the mains water supply by means of an inlet water pipe 12 and a return water pipe 16 to return water from the plate heat exchanger to a drain point.

[0014] The condensate drain pipe 13 collects water which has been condensed from atmospheric water vapour at in the second compartment of the housing 20. The condensate pipe can have, for example, a 9.53 mm diameter. It may be wrapped around by a heat tape 15. The pipe 13 is tapped into and projects into the return pipe 16 which typically has a 22 mm diameter. This configuration, as shown in Figure 5, ensures that the condensate water uses the path of least resistance and flows to the drain point via the outlet pipe 16. This arrangement of returning condensate into the outlet pipe avoids the need to provide a separate pump or other collection mechanism to remove condensate from within the unit.

[0015] A pressure controlled water regulating valve 14 is located in the water supply pipe 12 to control the flow of water into the plate heat exchanger 10. Water leaving the heat exchanger via pipe 16 is fed to the drain.

[0016] The cold mains water at 10° C acts as the condensing agent for the refrigerant. The water regulator 14 regulates the amount of water used. When controlling the amount of water, the water solenoid valve 14 ensures that water is only used when the compressor is running. However, when the system is operating in -20° C conditions the water needs to remain flowing so for this we bypass the valve with a switch which can be operated from a control panel 11 on the face of the housing unit.

[0017] The refrigerant loop in the first compartment of the housing can incorporate a filter/dryer 19 and a sight glass 18 downstream of the heat exchanger. The sight glass 18 allows the operator to check the state of the refrigerant prior to entry to the expansion valve 4.

[0018] The system as described can be located in a relatively small housing as shown in Figure 2. It requires a mains electricity connection to drive the evaporator and compressor as well as a control system as shown in Figure 6. The unit also requires a connection to a mains water supply and to a drain point. These are typically available in commercial walk-in chillers, walk-in freezers, and cellar coolers where it is envisaged that this unit could be deployed on a temporary basis.

[0019] The whole unit is designed to be freestanding and be portable and preferably mobile. The embodiment shown in Figure 2 comprises a box -shaped housing 20 with approximately square ends and longer rectangular sides so that it can be manipulated like a suitcase. The housing can be fabricated from a framework of square hollow section mild steel struts 22 defining the edges and with 2mm aluminium sheet forming the side panels. The side infill panels 24 on either side of the evaporator 6 are perforate to allow through flow of air between the chilled surrounding space and the interior of the first compartment of the unit.

[0020] The housing is provided with two hose connectors for a standard 15 mm water hose to respectively connect mains water to the water regulation valve 14, and to the output of one side of the plate heat exchanger 10 so that waste water can be sent to an available drain point such as a sink.

[0021] A power cable can be connected to the unit by any suitable means.

[0022] The housing is provided with an axle 26 fitted with a pair of tri-wheels 28 to give the unit easy stair climbing ability which is particularly desirable when the unit has to be deployed in a cellar location. At the other end of the unit from the axle 26, a slidable, extending U-shaped bar handle 30 is provided in order to guide transport of the unit. The arrangement of handle and tri-wheels allows the unit to be manoeuvred by one man and transported up and down stairs.

[0023] At either side of the handle 30, legs 32 are formed with in inwardly turned feet 34 so that when the unit is in use, it can be set down horizontally with one side supported on the tri-wheels and the other side on the feet of legs 32 so that it adopts a level configuration as shown in Figure 2. It will be appreciated that a stable, freestanding unit is advantageous as it imposes fewer conditions on the environment in which it can be introduced. Diagonal braces 36 can be used as shown in Figure 2 to support the legs 32. Other leg arrangements for allowing the rectangular housing to be supported in a horizontal configuration may be provided.

[0024] In one embodiment the housing is 970 mm long, with a base 450 x 430 mm. The legs can be 200mm in-depth to balance the height of the tri-wheels. A housing

of this size can accommodate the complete compression refrigerator, cooling fan 7 and electrical controls. It will be appreciated that the housing could be slightly bigger or a different size or shape provided it is mobile and free-standing.

[0025] The electrical system for controlling the operation of the unit is shown in Figure 6. A thermostat 38 controls operation of the system. The thermostat 38 is programmable to the required pre-set temperature. When the temperature is above the desired pre-set temperature level, the thermostat controls switches 40, 42 that enable power to the compressor 8. Switch 40 is a high pressure switch located in the refrigerant pipe to the expansion device. The switch 40 is preferably a high pressure mini cartridge switch that can be mounted directly on the pipeline that cuts out at 20 bars and cuts in at 26 bars. Switch 42 is a low pressure switch 42. The switch 42 is preferably a low pressure mini cartridge switch that cuts out at 0.5 bars and cuts in at 1.5 bars. In addition, the unit can have a body cooling fan 7 located in the housing to disperse heat created by the compressor. The fan is brought into operation when the compressor is powered up. The fan 7 may for example be a 15 W axial fan. In this embodiment, the evaporator fans runs continuously when the unit is connected to the mains power.

[0026] A pressure feedback loop 52 controls the water regulation valve 14 so that water supply is cut off when the high pressure switch 40 is open indicating that the refrigeration system is not operating. Cutting off the water supply when the desired pre-set temperature has been reached in the chilled space, and the thermostat has cut out, prevents unnecessary waste of mains water.

[0027] The temporary cooler can produce about 2kw of cooling at room temperature of 2°C or around 3kw at 10°C. Employing an inverter compressor will produce up to 5.3KW from the same system design.

[0028] Figure 7 shows how the unit described in the preceding specification could be adapted so that it can be switched between refrigeration as described and a reverse cycle where the unit could be used to heat the surrounding space instead of cooling it. This would make the unit as a whole more versatile for consumers. This system uses a four-way valve 60 and to bypass thousand 2 expansion valve to either heat or cool. This method is commonplace in the refrigeration sector and is known as reverse cycle. The unit can then either heat the water and call the surrounding space or call the water and heat the surrounding space.

Claims

1. A temporary backup replacement refrigeration unit operable to provide cooling between -20 and 10°C within a surrounding space, comprising
   a mobile housing (20) containing
   a first compartment provided with a condensate drain pipe (13) and housing a compression refrigerator having a closed loop through which refrigerant flows, the refrigerator comprising:

   an expansion device (4),
   an evaporator (6),
   a compressor (8), and

   a second compartment housing a plate heat exchanger acting as a condenser (10) for the compression refrigerator and having first and second sides, the first side being connected into the closed loop;
   said second compartment having an inlet water pipe with a connector adapted to connect the inlet water pipe to a mains water supply at 10° C and to supply water to a second side of the plate heat exchanger; and
   a return water pipe (16) to return water from the plate heat exchanger to a drain point; wherein the condensate drain pipe is connected into the outlet water pipe.

2. A temporary refrigeration unit as claimed in claim 1 wherein the condensate pipe has a narrower dimension than the return water pipe and an end of the condensate pipe project into the return water pipe.

3. A temporary refrigeration unit as claimed in any one of the preceding claims wherein the housing has rectangular sides and an approximately square base so that it can be manipulated like a suitcase.

4. A temporary refrigeration unit as claimed in claim 3, wherein the housing has an axle carrying a pair of tri-wheels (28) opposite a handle (30).

5. A temporary refrigeration unit as claimed in claim 3 or 4, wherein the housing has legs (32) to enable the unit to be supported in a horizontal orientation above a floor in use

6. A temporary refrigeration unit as claimed in any 1 of the preceding claims wherein the first compartment of the housing has at least one perforate side panel.

7. A temporary refrigeration unit as claimed in any one of the preceding claims wherein the compressor is an inverter compressor.

8. A temporary refrigeration unit as claimed in any one of the preceding claims further provided with a four-way valve to enable the system to operate in a reverse cycle to cool the water and heat the surrounding space instead of heating the water and cooling the surrounding space.

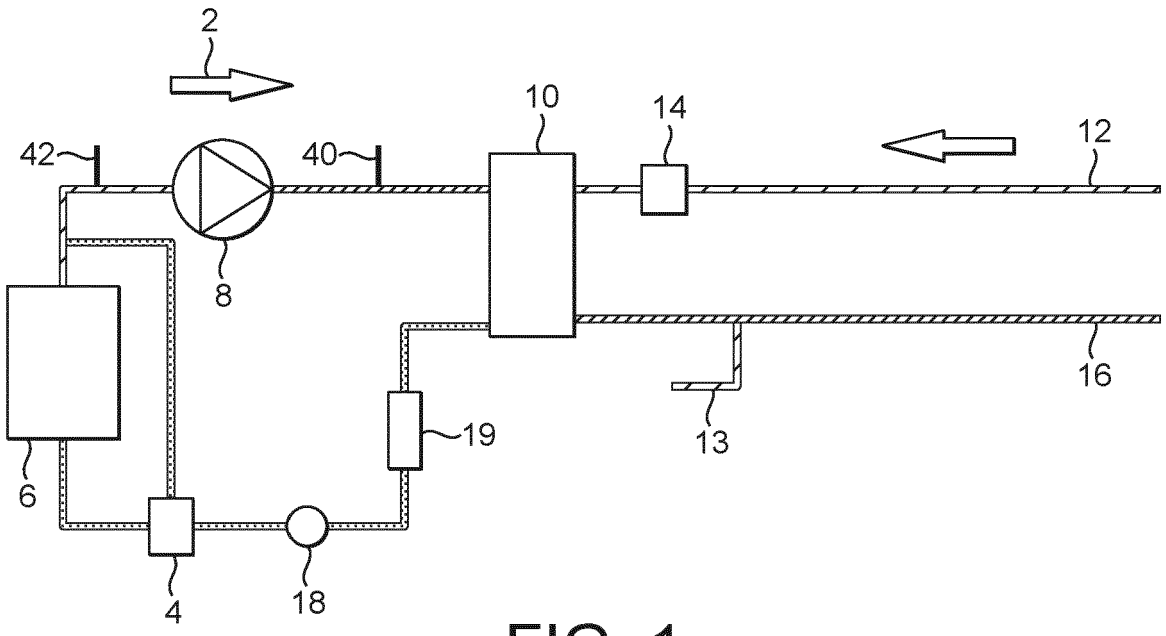

FIG. 1

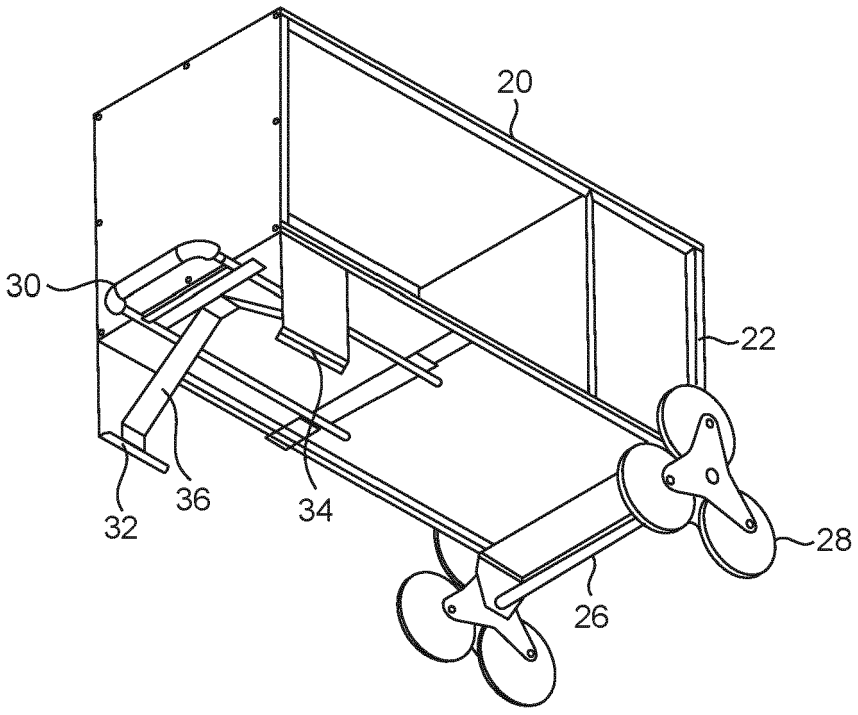

FIG. 2

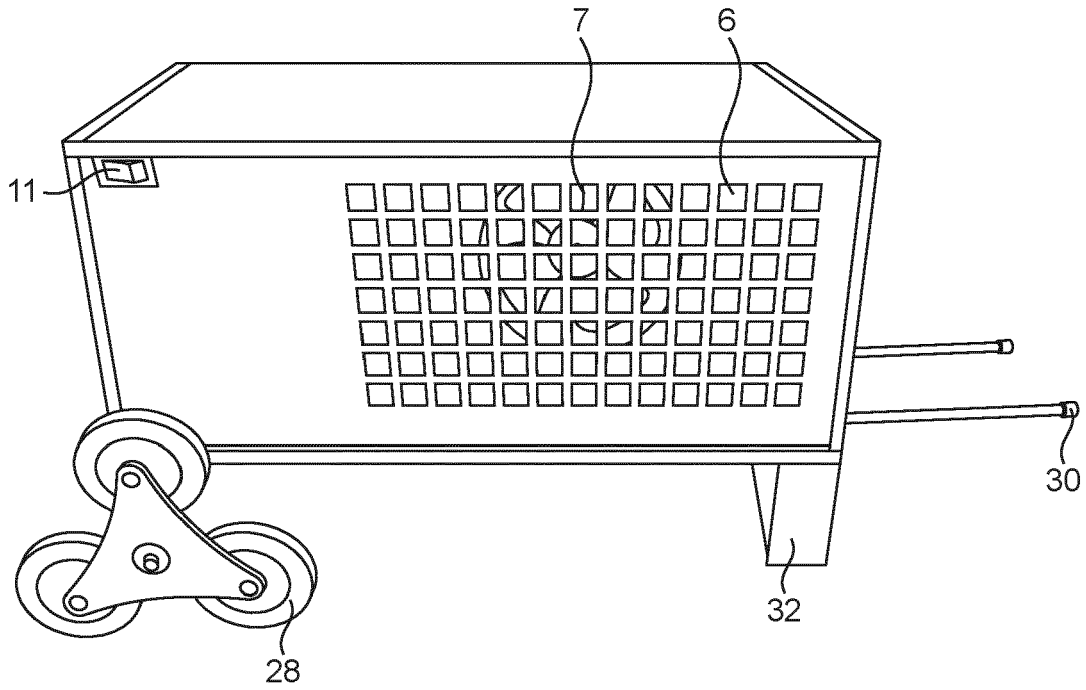

FIG. 3

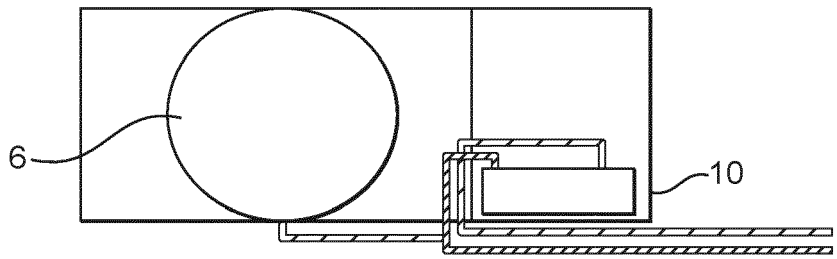

FIG. 4

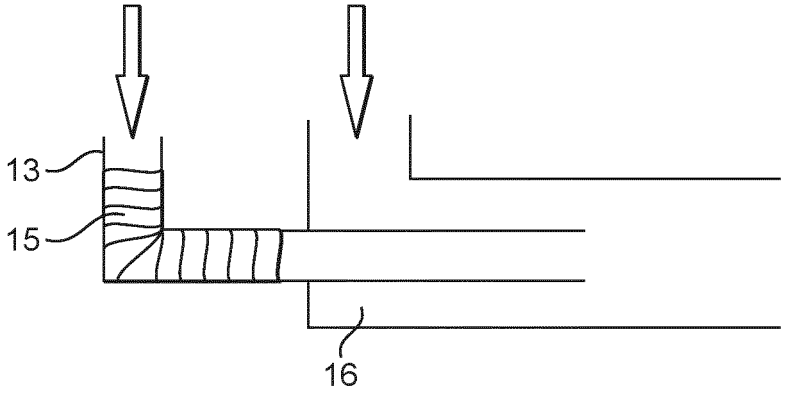

FIG. 5

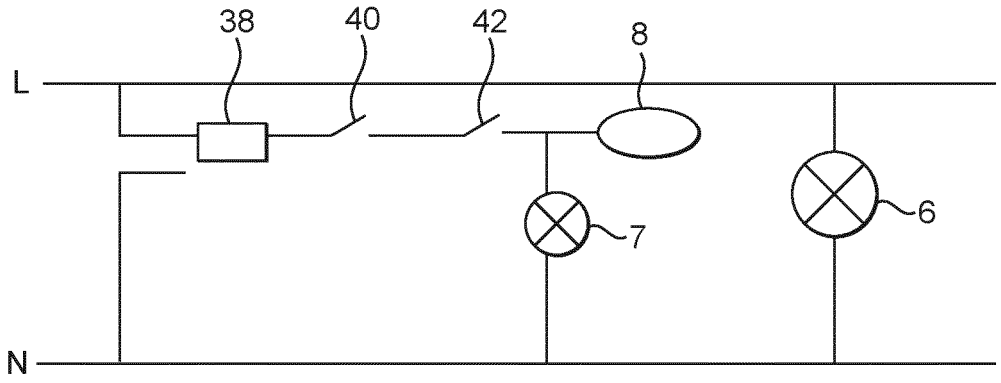

FIG. 6

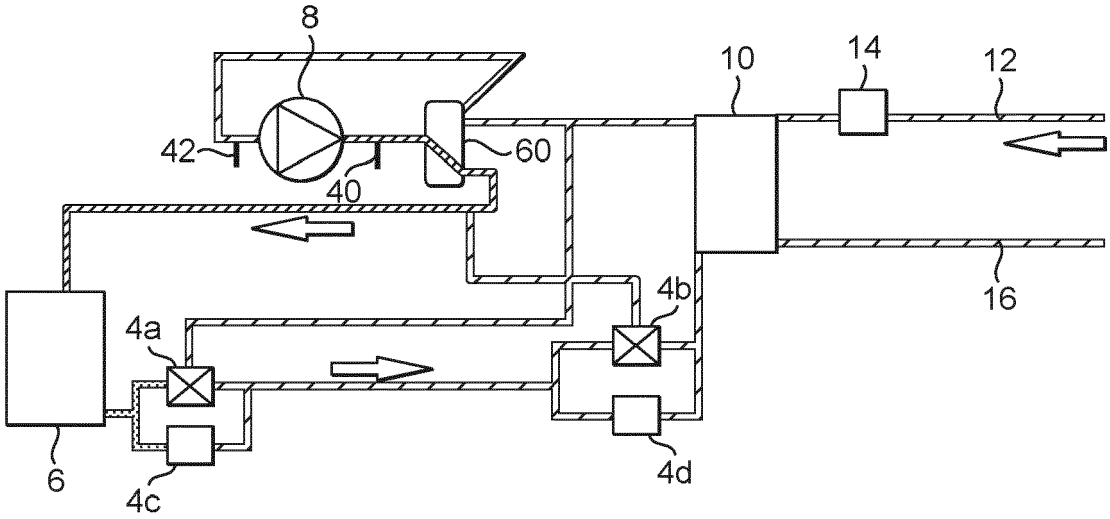

FIG. 7

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EUROPEAN SEARCH REPORT

Application Number
EP 20 18 7688

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	CN 105 423 442 A (DONGGUAN JHS ELECTRICAL CO LTD) 23 March 2016 (2016-03-23) * & associated description; figures 1-4 *	1-8	INV. F25B13/00 F24F1/022 F24F1/04
X,D	CN 2 821 442 Y (KUNTUO COOLER CO LTD SUZHOU) 27 September 2006 (2006-09-27) * abtract & associated description; figure 1 *	1-8	
X,D	CN 1 731 029 A (SUZHOU QUTU REFRIGERATOR CO [CN]) 8 February 2006 (2006-02-08) * abstract & associated description; figure 1 *	1-8	
X	EP 2 447 622 A2 (LG ELECTRONICS INC [KR]) 2 May 2012 (2012-05-02) * paragraph [0025] - paragraph [0057]; figure 1 *	1-8	
			TECHNICAL FIELDS SEARCHED (IPC)
			F25B F24F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	9 December 2020	Gasper, Ralf

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 20 18 7688

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09-12-2020

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
CN 105423442 A	23-03-2016	NONE	
CN 2821442 Y	27-09-2006	NONE	
CN 1731029 A	08-02-2006	NONE	
EP 2447622 A2	02-05-2012	CN 102466374 A	23-05-2012
		EP 2447622 A2	02-05-2012
		KR 20120045916 A	09-05-2012
		US 2012102991 A1	03-05-2012

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- CN 2821442 Y **[0007]**
- CN 1731029 A **[0007]**