

REFRIGERATOR SYSTEM FOR A CONTAINER

BACKGROUND OF THE INVENTION:

Field of the Invention:

The present invention relates to a refrigerator
5 system for a container.

Description of the Prior Art:

A known refrigerator system for a container in
the prior art is illustrated in a block diagram in Fig. 4,
and an arrangement of the same system within a container
10 is shown in Fig. 5. In these figures, reference numeral
1 designates a container, numeral 2 designates a compressor,
numeral 3 designates a condenser, numeral 4 designates an
electronic expansion valve, numeral 5 designates an evapo-
rator, numeral 6 designates a hot gas modulating valve,
15 numeral 7 designates a condenser fan, numeral 8 designates
an evaporator fan, numeral 9 designates a container out-
side temperature detector, numeral 10 designates a con-
tainer inside temperature detector, numeral 11 designates
an electric heater, and numeral 12 designates a controller.
20 Solid line arrows in Fig. 4 indicate the direction of flow
of a coolant, and dotted line arrows indicate the direction
of flow of air.

In the above-described system, a coolant com-
pressed by the compressor 2 enters the condensor 3, where
25 it is cooled by heat-exchange with air sent by the condenser

fan 7, and becomes a high-pressure liquid coolant. The coolant is reduced in pressure in the electronic expansion valve 4, and then enters the evaporator 5, where it is heated by heat-exchange with air sent by the evaporator fan 8, and it becomes a low-pressure gas coolant and returns to the compressor 2. The above-mentioned is a basic operation of a refrigerated system, and in this system the controller 12 compares the temperature detected by the temperature detector 10 within the container 1 with a preset temperature within the container 1, and according to the results of comparison it adjusts the extent of opening of the hot gas modulating valve 6, ON-OFF switching of the electric heater 11, or the extent of opening of the electronic expansion valve 4, and thereby serves to maintain the temperature within the container 1 constant.

However, in the case where the container 1 has superannuated or has been damaged due to any cause, the thermal insulation property of the container is degraded, resulting in large leakage of heat so that a preset temperature within the container cannot be attained; thereby an abnormal condition for the load in the container is produced. Also, even if the preset temperature within the container were to be attained, an abnormal condition would occur in that it would take a long time to attain the set temperature, or a heavy load

would be applied to the refrigerated system. Moreover,
when such an abnormal condition occurs, in the prior art
it is not known whether the problem involves the
5 refrigerator system or the container.

SUMMARY OF THE INVENTION:

10 It is therefore an object of the present invention to provide a refrigerator system for a container having an abnormal condition diagnostic capability.

15 According to the present invention, there is provided a refrigerating system for a container including an evaporator, an evaporator fan and an electric heater disposed inside of the container, which
20 is characterized by the provision of abnormal condition diagnostic facilities for the container comprising an inside temperature detector, an outside temperature detector, control means responsive to an abnormal condition diagnosis instruction for operating said
25 evaporator fan and said electric heater, and abnormal condition diagnostic means for diagnosing whether an abnormal condition is present or not in the container when the system is started-up in dependence upon the

temperatures detected by said respective temperature detectors after the evaporator fan and the electric heater have been operating for a predetermined period.

5 Preferably, said abnormal condition diagnostic means diagnoses the condition in the container to be normal if the temperature detected by the inside temperature detector has risen to a predetermined temperature or higher in relation to the temperature
10 detected by the outside temperature detector, but to be abnormal if it has not risen to said predetermined temperature.

15 Conveniently, message display means are provided for displaying the results of the diagnosis by the abnormal condition diagnostic means.

20 In accordance with the invention, there is provided a capability of checking to see if an abnormal condition exists in the container via the controller in the refrigerating system, which normally serves to control the refrigerator system so that the temperature within the container is maintained constant in use. Thus, by operating the system in
25 part in conjunction with the abnormal condition diagnostic facilities, any abnormal condition in the container can be readily discovered. In more detail, if the abnormal condition diagnostic facilities

are operated when the container is in an empty condition, the control means in the refrigeration system starts operations of the evaporator fan and the electric heater while the inherent refrigerating function is kept stopped. Thereby the inside of the container is heated up. After a predetermined period of time has elapsed, the temperatures on the inside and on the outside of the container detected by the respective temperature detectors are investigated automatically with reference to known correlation between the temperatures on the inside and on the outside of the container, and in the event that the temperature on the inside of the container has not risen up to a predetermined temperature, it is automatically determined that leakage of heat exists. In this way, the presence or absence of an abnormal condition can be automatically diagnosed. Therefore, prior to practical use of a refrigerating container, it can be automatically and easily checked to see whether or not an abnormal condition exists in the container.

The above-mentioned and other objects features and advantages of the present invention will become more apparent by reference to the following description of preferred embodiment of the invention taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS:

In the accompanying drawings:

Fig. 1 is a block diagram of one preferred embodiment of the present invention;

Fig. 2 is a diagram showing the relation between a container inside temperature and a container outside temperature to be referred to for explaining the principle of the present invention;

Fig. 3 is a flow chart of the operation of the illustrated embodiment;

Fig. 4 is a block diagram of a refrigerating system for a container in the prior art; and

Fig. 5 is a schematic view showing the arrangement of a refrigerating system for a container in the prior art.

DESCRIPTION OF THE PREFERRED EMBODIMENTS:

One preferred embodiment of a refrigerating system for a container according to the present invention, which incorporates abnormal condition

diagnostic facilities, is illustrated in blocks in Fig. 1. These facilities consist of a portion included in the refrigerating system in the prior art, and a newly added portion, and these respective portions cooperate to achieve the desired object. Thus, those parts known from the prior art and described hereinbefore with reference to Figs. 4 and 5 are given like reference numerals. In Fig. 1, reference numeral 8 designates an evaporator fan, numeral 9 designates a container outside temperature detector, numeral 10 designates a container inside temperature detector, numeral 11 designates an electric heater, numeral 13 designates an abnormal condition diagnostic switch, numeral 14 designates control means, numeral 15 designates a timer, numeral 16 designates timer setting means, numeral 17 designates abnormal condition diagnostic means, and numeral 18 designates message display means. In addition, arrows in this figure represent the direction of transmission of information or instructions.

Now, a principle of the present invention will be explained with reference to Fig. 2, in which the temperature on the inside of the container is taken along an ordinate, and the temperature on the outside of the container is taken along an abscissa. Since heat generating rates of the evaporator fan motor and the electric heater as well as a heat leaking rate of a

normal container are respectively constant, when the inside of the container has been heated for a certain period of time by operating the evaporator fan motor and the electric heater under the condition where a load is not present in the container, in the case of a normal container the relation between the temperatures on the inside and on the outside of the container would be the relation represented by line A in Fig. 2. In the case of an abnormal container having a large heat leaking rate, since the temperature on the inside of the container does not rise so much, the relation of the temperatures on the inside and on the outside of the container will fall in the hatched region B in Fig. 2. In this way, an abnormal condition of the container can be determined by measuring the temperatures on the inside and on the outside of the container after the evaporator fan and the electric heater have been operated for a certain period of time, and investigating the measured temperatures with reference to the known data of the temperature relation as shown in Fig. 2.

Next, the operation of the illustrated embodiment of the present invention will be explained on the basis of the above-described construction and operation principle. Under the condition where a container 1 having the construction such as shown in Fig. 5 is held empty, the abnormal condition diagnostic switch 13 in Fig. 1 is actuated to start abnormal

condition diagnosis. At this moment, the control means 14 starts operations of the evaporator fan 8 and the electric heater 11 while the inherent refrigerating function is held stopped, and thereby the inside of the container is heated up. At the same time, the timer 15 starts counting, and after a time preset by the timer setting means 16 has elapsed, in response to an instruction issued from the control means 14, the abnormal condition diagnostic means 17 compares the temperatures detected by the container inside temperature detector 10 and the container outside temperature detector 9, respectively, and if the container inside temperature (T_{in}) has risen up to a predetermined temperature or higher in relation to the container outside temperature (T_{out}), then it is diagnosed that the container is normal, but if the container inside temperature (T_{in}) has not risen up to that predetermined temperature, it is diagnosed that leakage of heat is present, and this condition is displayed by the message display means 18. When the above-mentioned diagnosis has finished, the control means 14 stops the evaporator fan 8 and the electric heater 11. The above mentioned process is represented by the flow chart in Fig. 3.

As described in detail above, since the refrigerating system for a container according to the present invention is associated with abnormal

condition diagnostic facilities, the refrigerating
system per se can diagnose either presence or absence of
heat leakage of the container, that is, either presence
5 or absence of an abnormal condition of the container.

While the present invention has been described
above in connection to one preferred embodiment of the
10 invention, it will be appreciated that other embodiments
of the present invention can be made within the scope of
the appended claims.

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CLAIMS

1. A refrigerating system for a container including an evaporator, an evaporator fan and an electric heater disposed inside of the container, characterized by the provision of abnormal condition diagnostic facilities for the container comprising an inside temperature detector, an outside temperature detector, control means responsive to an abnormal condition diagnosis instruction for operating said evaporator fan and said electric heater, and abnormal condition diagnostic means for diagnosing whether an abnormal condition is present or not in the container when the system is started-up in dependence upon the temperatures detected by said respective temperature detectors after the evaporator fan and the electric heater have been operating for a predetermined period.

2. A refrigerating system for a container according to Claim 1, characterised in that said abnormal condition diagnostic means diagnoses the condition in the container to be normal if the temperature detected by the inside temperature detector has risen to a predetermined temperature or higher in relation to the temperature detected by the outside temperature detector, but to be abnormal if it has not risen to said predetermined temperature.



3. A refrigerating system for a container according to Claim 1 or 2, characterized by the provision of message display means for displaying the results of the diagnosis by said abnormal condition diagnostic means.

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4. A refrigerator system for a container constructed, arranged and adapted for use substantially as hereinbefore described with reference to, and as shown in Figs 1 to 3 of the accompanying drawings.

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5. A refrigerated container having a refrigeration system according to any one of the preceding claims.

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