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(54) REFRIGERATED CONTAINER INCLUDING AIRFLOW INDICATOR

(71) We, SHIPOWNERS REFRIGERATED CARGO RESEARCH ASSOCIATION, a British Company, of 31/35 Fenchurch Street, London, EC3M 3PD, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:-

The present invention relates to refrigerated containers and in particular to monitoring the correct operation thereof by use of airflow indicators.

As refrigerated containers are normally kept closed and the interior of cooling airflow conduits are often out of sight, failures due, for example, to airflow obstructions can often remain undetected for considerable periods of time.

It is an object of the present invention to provide in a simple economic manner indicator means for giving immediate notice of a fall in airflow in a refrigerated container.

The present invention provides a refrigerated container having at least one airflow indicator device, said airflow indicator device comprising a thermistor sensing head having a first temperature-sensitive airflow rate-sensitive thermistor and a second temperature-sensitive airflow rate-insensitive thermistor, means connectable in use of the device to a power supply for supplying a current to said first and second thermistors, voltage comparator means arranged for comparing voltage drop across said thermistors in use of the device, and indicator means for indicating a change in the voltage difference sensed by said voltage comparator means.

In a further aspect, the present invention provides a refrigerated container having at least one airflow indicator device of the invention with a sensing head of said device disposed in an airflow zone through which

an airflow is normally maintained in use of the container, so that the airflow passes directly over said thermistors.

It will be appreciated by those skilled in the art that if only an airflow-sensitive thermistor were to be used the variation of voltage across it with airflow speed would be distorted by any temperature fluctuations in the airflow. However, by using two thermistors in accordance with the invention, the effect of temperature fluctuations can be substantially eliminated.

Further features of the invention will appear from the following description of a preferred embodiment illustrated with reference to the accompanying drawings, in which:-

Figure 1A is a schematic cross-section of a thermistor sensing head of an airflow indicator device;

Figure 1B is a partially cut away side elevation of the sensing head of Figure 1A;

Figure 2 is a circuit diagram of an airflow indicator device, and

Figure 3 is a circuit diagram of a stabilised voltage supply suitable for use with the device of Figure 2.

Figures 1A and 1B show a thermistor sensing head 1 in the form of a tubular T-piece, conveniently of copper tubing, comprising a cross-piece 2 and leg-piece 3. First and second thermistors, 4 and 5, are disposed in the cross-piece 2 adjacent its joint to the leg-piece 3, and conductor leads 6 extend from them through the leg piece 3 to a terminal strip 7.

The sensing head 1 is placed, in use, in an airflow with the longitudinal axis of the cross-piece corresponding generally to the direction of the airflow at that point, though this is not critical. Thus, part, at least, of the airflow will pass through the cross-piece 2 over the thermistors 4 and 5 which at the same time are physically protected from damage or displacement by accidental con-

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tacts, by means of the cross-piece 2 surrounding them.

The first thermistor 4 is a temperature-sensitive airflow-rate sensitive type such as a directly heated bead type whilst the second thermistor 5 is a temperature-sensitive airflow-rate insensitive type conveniently in the form of a conventional thermistor embedded in a solid glass pellet.

The above described thermistor sensing bead can be used with various circuits within the scope of the present invention providing various types of indication. Thus, if desired, a circuit with indicator means providing a continuous variable output, e.g. through a volt-meter or ammeter and/or in the form of a continuous chart trace, may be used. On the other hand, a circuit with indicator means providing only a positive or negative indication of the presence or absence of a particular predetermined airflow may be used. Examples of suitable indicator means in the latter case include light means or audible warning means.

Figure 2 shows a circuit in which the first and second thermistors 4, 5 (P23 and G52 respectively) are supplied with a current and the voltage drop across them compared by an integrated circuit voltage comparator (710 OPA) whose output voltage changes from $-0.5V$ to $+3.2V$ when the airflow velocity exceeds 3 metres/sec plus or minus 0.2 metres/sec within the temperature range $-27^{\circ}C$ to $+20^{\circ}C$. This in turn biases a transistor (T3) which operates a relay 11 and thence warning lamps 12.

The velocities at which the comparator switches from negative to positive and from positive to negative do not differ by more than 0.3 metres/sec (i.e. the differential between the switch over point when the air velocity is rising, and the switch over point as the velocity falls).

Figure 3 shows a suitable stabilised voltage supply for powering one airflow indicator device according to Figure 2, and provides up to 100 mA at the rated voltage of $+12$ and -6 volts.

If, however, it is decided to power several such devices from a single supply then one capable of providing a higher current, up to several amps if necessary, will be required. This may be desirable in the case of a container complex having a number of airflow passages which all require monitoring.

Figure 4 is a circuit diagram of a modified form of embodiment of the device of Figure 3.

In the event of a fracture of the airflow-rate sensitive thermistor, the input to pin 4, of the operational amplifier, will go negative and the circuit will indicate the "presence of an airflow" regardless of the actual state of the airflow. Should the temperature sensi-

tive airflow-rate insensitive thermistor fracture then the "absence of an airflow" will be indicated. The airflow sensitive thermistor, being of a rather delicate construction could fracture in service and therefore some method of indicating such an occurrence is desirable.

Figure 4 shows a circuit similar to that described above with reference to Figure 2, but in which a second level detector has been added to the circuit. Its output relay contacts are in series with an indicator lamp supply. This will compare the voltage drop across the airflow-rate sensitive thermistor P23 with a voltage determined by the 10 K potentiometer. This is done in such a way that as long as the potential drop across P23 remains in the normal operating range then the relay B contacts remain closed. In the event of a thermistor fracture, the potential drop will no longer be in the normal operating range so that the relay will open and both indicator lamps will be extinguished.

The temperature sensitive thermistor is quite robustly constructed and is unlikely to break in service. Should it do so the resulting "absence of airflow" indication would lead to investigation which would subsequently determine circuit malfunction.

WHAT WE CLAIM IS:

1. A refrigerated container having at least one airflow indicator device, said airflow indicator device comprising a thermistor sensing head having a first temperature-sensitive airflow-rate sensitive thermistor and a second temperature-sensitive airflow-rate insensitive thermistor, means connectable in use of the device to a power supply for supplying a current to said first and second thermistors, voltage comparator means arranged for comparing voltage drop across said thermistors in use of the device, and indicator means for indicating a change in the voltage difference sensed by said voltage comparator means.

2. A container according to claim 1, wherein said comparator means comprises a differential amplifier having its input connected to said first and second thermistors.

3. A container according to claim 1 or 2, further including means for monitoring the voltage drop across said first thermistor, and monitoring means being connected to said indicator means whereby said indicator means indicates any change in voltage drop across said first thermistor.

4. A container according to claim 3, wherein said monitoring means comprises a voltage comparator means which, in use, compares the voltage drop across the first thermistor with a reference voltage.

5. A container according to any preceding claim, wherein said indicator means comprises light-emitting or audible indica-

tors operated by relays connected to the outputs of the or each voltage comparator means.

5 6. A container according to any of claims 1 to 4 wherein, said indicator means comprises a voltmeter or ammeter providing a continuous variable output.

10 7. A container according to any of claims 1 to 4 wherein, said indicator means comprises means for providing a continuous chart trace.

15 8. A container according to any preceding claim wherein, said sensing head comprises a T-shaped tubular member having a cross-piece and a leg-piece joined to and extending perpendicular from the wall of the cross-piece, said first and second thermistors being positioned in said cross-piece adjacent its joint to the leg-piece.

20 9. A refrigerated container substantially as hereinbefore described with reference to and as shown in Figures 1 and 2, Figures 1 and 4, Figures 1, 2 and 3, or Figures 1, 3 and 4 of the accompanying drawings.

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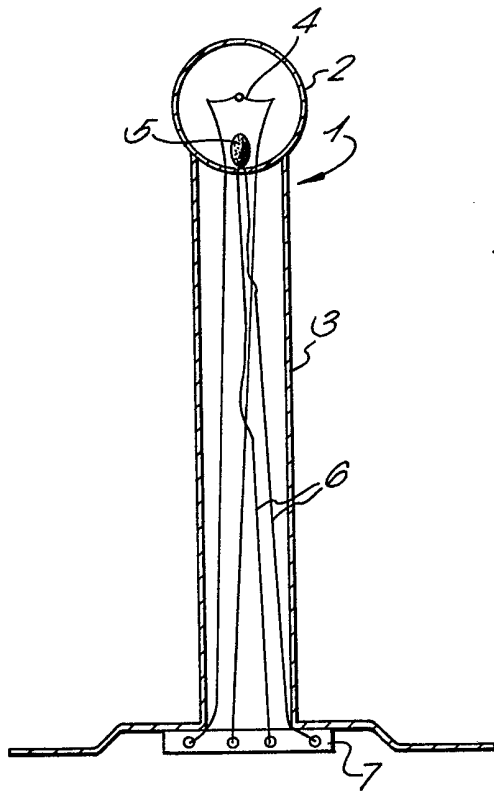


FIG. 1A.

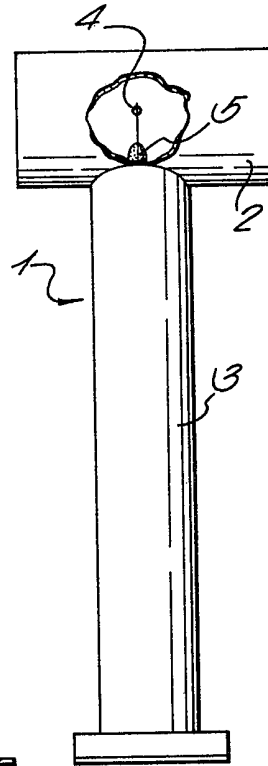


FIG. 1B.

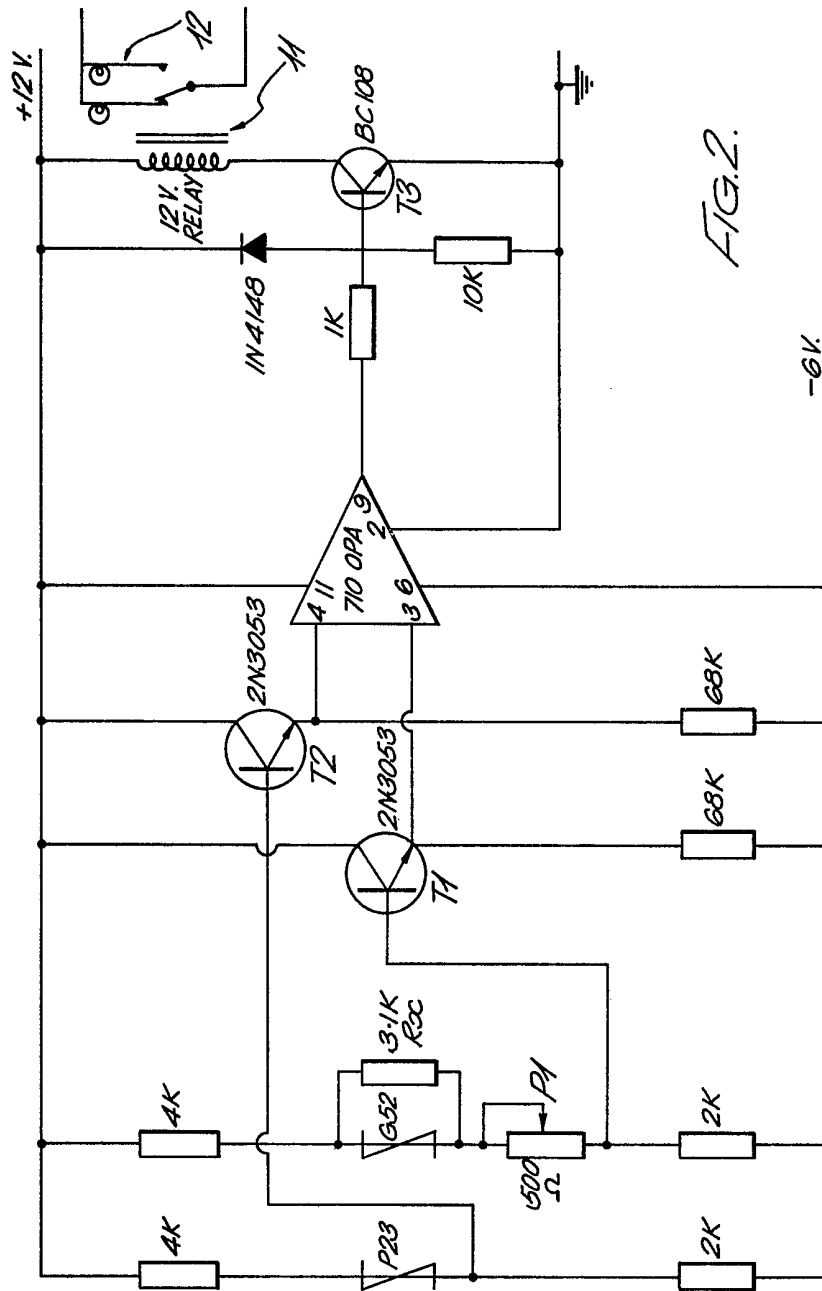


FIG. 3.

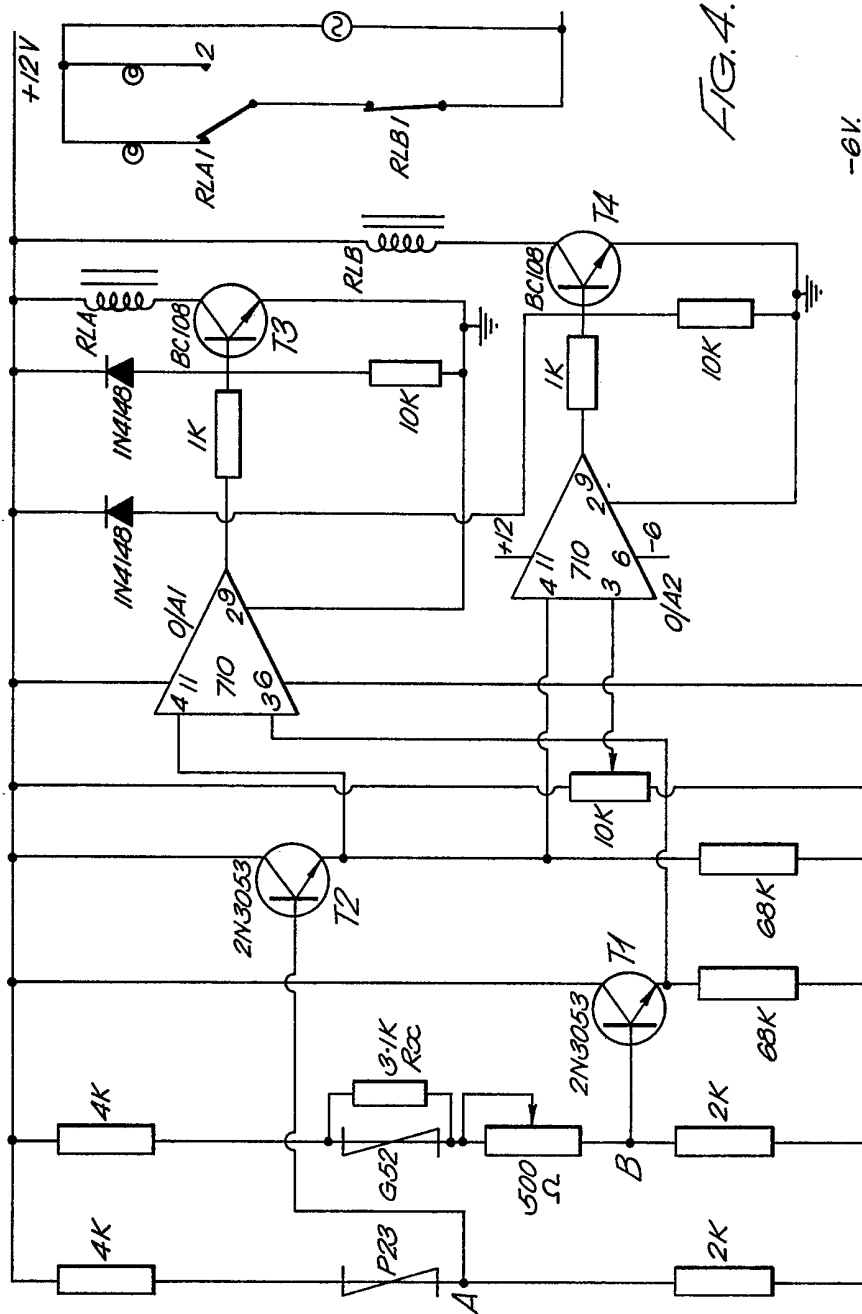


FIG. 4.