A cold display cabinet has a non-recirculating air curtain (13) across an access opening (2) outside a refrigerated recirculating inner curtain (11, 12). The humidity of the air of the outermost curtain is controlled to be less than that of the ambient air (15). It may be cooled and then heated to reduce both absolute and relative humidity, or heated only to reduce relative humidity.
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REFRIGERATED DISPLAY CABINET AND
METHOD OF OPERATING IT

FIELD OF THE INVENTION
This invention relates to a refrigerated display cabinet, more particularly, to a cold display cabinet working, for example, at temperatures below freezing and typically at -15° to -20°C, and having an access opening which is covered by a plurality of air curtains.

BACKGROUND OF THE INVENTION
Such recirculating curtains on refrigerated display cabinets have been widely used to allow free access to the refrigerated goods kept inside the cabinets, see e.g., GB-A-997240. US-A-4026121 discloses a display cabinet having an arrangement for forming a non-recirculating outer air curtain by driven ambient air. This is said to provide a thermal shield between the cold air curtain and the remainder of the ambient air. One problem of this arrangement is the pick-up of moisture from the outer air curtain by the cold inner air curtain the temperature of which is much lower than that of the outer air curtain formed by the ambient air. The relative humidity of the ambient air
of at least the inner part of the outer air curtain is increased to saturation by the cooling effect of the inner air curtain and moisture carried by the outer curtain will be picked up by the inner air curtain, so that it causes frost build-up in the cabinet when the inner air curtain is circulated inside the cabinet.

Another disclosure with a non-recirculated outer curtain is GB-A-2251928. This outer curtain is cooled, which will increase its relative humidity. The disclosure is of a chilling cabinet for confectionery, wherein temperatures in the cabinet are of the order of 0 to 4°C.

In EP-A-334678 a largely recirculating outermost air curtain of a cold cabinet is cooled by a cooler mounted outside the main body of the cabinet. The cooler was switched in when the ambient air reached a fixed point of 25°C and/or 55% r.h.

This proposal suffered from a problem opposite to that of US-A-4026121. Because the outermost air curtain had been cooled it was at or near saturation point as it traversed the access opening. Contact with colder air of the inner curtain caused precipitation/freezing in the outermost curtain. However, since the air of the outermost curtain was cold it was desirable try to to recirculate it in the interests of energy economy despite the frost
accumulation which occurred. The colder the outer
curtain is made, paradoxically the greater (at least
under certain conditions) will be the heat transfer to
any inner curtain by the increased transfer of vapour
or snow with its latent heat.

SUMMARY OF THE INVENTION

The present invention has in common with US-A-
4026121 that the outermost curtain is non-
recirculating.

However, it incorporates the idea of control of
the humidity of the air of that outermost curtain in
such a way as to avoid the serious problems encountered
in those earlier proposals.

For this purpose we allow for heating of the
air which is to form that curtain, and also possibly
for its precooling; in short, we provide for the
control of the relative humidity of the air forming
that curtain so that we can have a curtain which
performs at the same time efficient thermal- and
humidity-shielding functions which have so far proved
incompatible, requiring as they do different criteria -
in the one case low temperature and in the other low
relative humidity.

The only proposal of which we are aware where
the idea of reheating air of an air curtain has been
seen is GB-A-941099. The air of that curtain is only
heated "a few degrees" after cooling; the curtain is at low temperature (probably maximum -5°C), must be recirculated to be energy efficient and will, as is stated in that document, cause problems in the recirculation due to freezing of the moisture it will pick up from the ambient atmosphere. This illustrates the conflict mentioned above could not be resolved in that way.

The present invention allows the solution of a longstanding problem regarding the use of these cabinets even though the air used for the outer curtain is the ambient air. Because of the inefficiency of the thermal or humidity barriers provided by the air curtains of existing cabinets, it is conventional wisdom that they must be sited in a controlled environment of temperature and relative humidity, usually requiring conditioning of the whole of the ambient air within the site.

This invention even using as it does, ambient air, allows operation of display cabinets outside of previous bounds of operation, without the requirement of conditioning of general ambient air in the store or other site.

The problem is solved by the present invention by providing an outer air curtain provided by the ambient air but having a reduced relative humidity, for
isolating the inner air curtain from the ambient air.

According to the present invention, there is provided a display cabinet with an access opening comprising:

means for forming a refrigerated inner air curtain, which covers said access opening, by circulating an inner air flow within said cabinet; and

means for forming an outer air curtain outwards relative to said inner air curtain, by an outer air flow formed outside the cabinet;

classified in that the outer air curtain forming means comprises means for taking in ambient air and reducing the relative humidity of said ambient air before forming said outer air curtain with it.

Normally these means will include a cooler to dry intaken ambient air and means for heating to lower the relative humidity of the dried air. However in some conditions e.g. when the cabinet is in a cold store, only heating may be necessary.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a side elevational section and Figure 2 is a simplified psychrometric chart.

DESCRIPTION OF A PREFERRED EMBODIMENT

Referring to Figure 1 of the accompanying drawings, a display cabinet 1 has an access opening 2 which provides free access to goods kept within the
cabinet. A recirculating multi-layer cold air curtain having a primary layer 11 and a secondary layer 12 is formed in a conventional manner with defroster 3 fan 16 and successive heat exchangers 5 and 7 in the stream forming the primary layer. The secondary layer is driven by backward-curve fan 17. A typical temperature of the primary layer at the access opening is about -29°C and of the secondary layer about -5°C. An outer air curtain 13 is formed by a driven ambient air flow 14, so as to isolate the inner air curtain 11 and 12 from the remaining ambient air 15.

The outer air curtain 13 is formed by a backward-curve fan 4 which draws air 14 through a filter 9 and drives it into a relative humidity reduction means 10. There is a cooler 6. If the air flow 14 is cooled by the cooler 6, its relative humidity (r.h.) is increased so the moisture carried by the air flow 14 is deposited as condensate or frost on the cooler 6. As a result the air flow 14 is dried by the cooler 6 to a lower absolute humidity. After the air flow 14 passes through the cooler 6, it is heated by a heater 8 which increases its temperature and by that token reduces its r.h to a level below that of the ambient air 15. After the heater 8, the air flow 14 forms a very dry (in relative terms) outer air curtain 13. The outer air curtain 13, though it may be at or
near ambient temperature, effectively separates the
inner air curtain 11 and 12 from remaining ambient air
15 so it significantly reduces any chance for the inner
curtain 11 and 12 to pick up moisture from the
remainder of the ambient air 15.

It should be understood that on the one hand,
after the drying and heating process, the outer air
curtain 13 is in relative humidity terms much drier
than the ambient air. The outer air curtain 13 will
not increase the relative humidity of the part of the
ambient air 15 which is in contact with it on its outer
side. That is to say no vapour condensation or misting
will occur at the interface between the outer curtain
13 and the ambient air 15. On the other hand, since
the outer air curtain 13 has a very low r.h. after the
dehumidifying effects the heating by the heater 8 and
if necessary of the cooler 6, it can be made even drier
in terms of r.h. than the middle band 12 which has
contact with the inner side of the outer curtain 13.
That means the layer 12 will pick up less moisture from
the curtain 13.

Furthermore, since the outer curtain 13 does
not circulate within the cabinet 1, the whole opening 2
is completely shielded by a dry curtain and even the
limited amount of moisture picked up by the outer
curtain 13 will be carried away without entering the
A further advantage is that any frost build-up on the cooler 6 can be easily removed for example by heating the cooler 6 temporarily. Such operation can be done very quickly and it has no effect on the normal operation of the cabinet.

Since the reheated (and perhaps previously cooled) air 13 remains outside the cabinet, the cabinet refrigeration efficiency is not directly reduced. To the contrary, due to the significant reduction of frost build-up within the refrigeration system of the cabinet to that which would otherwise occur in an unsuitable store environment, the cabinet efficiency could be seen to be increased.

The energy level required to allow the cabinet to operate in this disagreeable environment will be increased.

This energy usage however would be only a fraction of that otherwise required should the whole of the adjacent store area need to be brought to more suitable conditions e.g. by general air-conditioning.

When a display cabinet is in a cold store having high humidity (e.g. 16°C at r.h. 65) it may be sufficient to reduce the r.h. of the outer curtain 13 by operation only of the heater 8 e.g. to raise the temperature of that air to 21°C at which it will have a
r.h. of about 50.

When the ambient temperature is higher as e.g. in a supermarket at about 21°C and r.h. 65 the cooler will operate to reduce the temperature of the air such that when it is reheated by heater 8 its r.h. is e.g. about 50.

Clearly, operating conditions between or beyond these examples may be dealt with by appropriate setting or capacity of the cooler 6 and/or heater 8.

The psychrometric chart which is Figure 2 has conventional "axes" namely a series of relative humidity (wet-bulb temperature) curves, a moisture content vertical and a dry-bulb temperature horizontal. This shows diagrammatically the region 27 to which the ambient air should be brought by cooling, by cooling and heating or by heating only. The chart has curve 20 representing 80% r.h. and curve 23 representing 55% r.h. If the air 15 is in the region 26, heating only will be necessary. Line 21 represents a level of absolute humidity of the ambient air 15 above which, in region 24, cooling and heating will be necessary. In region 25 to the right of line 22 i.e. at dry-bulb temperatures higher than e.g. 25°C-30°C but at comparatively low absolute humidities, only cooling of the ambient air will be needed. Sensors and appropriate control means detect the relevant
conditions of the ambient air and control the cooler 6 and/or heater 8 accordingly from any region of the chart, so as to bring the air to a condition within region 27 as it issues from the cabinet to form the outer curtain 13.
CLAIMS:

1. A cold display cabinet (1) with an access opening (2), comprising:

   means for forming a refrigerated inner air curtain (11,12), which covers said access opening, by circulating an inner air flow within said cabinet and guiding it across the opening; and

   means (4,6) for forming an outer air curtain (13) outwardly next to said inner air curtain, by drawing in ambient air;

   characterized in that the cabinet includes means (8) for reducing the relative humidity of the ambient air before it forms the outer air curtain (13).

2. A display cabinet according to claim 1 wherein said reducing means includes a heater (8) in a path of the indrawn air before it forms the outer air curtain (13).

3. A display cabinet according to claim 2, wherein said reducing means includes a cooler (6) preceding said heater (8) in said path.

4. A display cabinet according to claim 1, claim 2 or claim 3 wherein the inner air flow includes two layers (11,12), the inner layer being of a lower temperature than the outer.

5. A method of protecting an open-access cold
display cabinet by a multiple air curtain (11,12,13) of which the outer curtain (13) is a non-recirculating layer of driven air and the inner curtain (11,12) recirculates, which includes drawing in ambient air to form said outer curtain (13) and causing that air to have a relative humidity lower than that of the ambient air (15) before it forms the outer curtain (13).

6. A method according to claim 5 wherein the relative humidity reduction is by only heating the air.

7. A method according to claim 5 wherein the relative humidity reduction is an overall reduction by first cooling and then heating the air.
Fig. 2
### A. CLASSIFICATION OF SUBJECT MATTER

**IPC 5** A47F3/04

According to International Patent Classification (IPC) or to both national classification and IPC

### B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

**IPC 5** A47F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

### C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<td>see column 4, line 7 - line 37; figure</td>
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Date of the actual completion of the international search: 24 June 1994

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