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(54) **AIR CURTAIN DEVICE MEASURING A TEMPERATURE PROFILE AND METHOD THERE FOR**

LUFTVORHANGVORRICHTUNG ZUR MESSUNG EINES TEMPERATURPROFILS UND VERFAHREN DAFÜR

DISPOSITIF DE RIDEAU D'AIR MESURANT UN PROFIL DE TEMPÉRATURE ET PROCÉDÉ ASSOCIÉ

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(73) Proprietor: **Biddle B.V.**
**9288 HA Kootstertille (NL)**

(72) Inventor: **WEENING, Freerk**
**NL-9283 XD Surhuizum (NL)**

(74) Representative: **Verdijck, Gerardus et al**
**Arnold & Siedsma**
**Bezuidenhoutseweg 57**
**2594 AC The Hague (NL)**

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## Description

**[0001]** The present invention relates to an air curtain device for providing an air curtain. More specifically, the invention relates to an air curtain preferably with a substantially vertical air flow. Such an air curtain device is usually provided in or close to an opening, in particular a door opening.

**[0002]** Known air curtain devices provide an air curtain in or close to an opening in a wall to minimize leakage, energy losses and discomfort for people. These air curtains are often provided in door openings with different climate conditions on both sides of the opening. These climate conditions may include temperature and humidity. Several external factors influence the quality of the air curtain that is produced by the air curtain device. Such factors may include wind, wind direction, and sun. However, these factors influence the quality of the air curtain such that the air curtain is in most cases overdimensioned and uses too much energy, or does not perform optimally such that leakages and energy losses are not fully prevented. This results in a not fully effective air curtain.

**[0003]** DE 44 20 167 C1 discloses the use of an infrared sensor for measuring a temperature of a reference point.

**[0004]** The present invention has for its object to provide an air curtain device for realizing an air curtain that is more effective in a broad range of conditions and disturbances, and wholly or partially obviates the abovestated drawbacks, such that a desired air curtain quality is achieved.

**[0005]** Therefore, the present invention provides for this purpose an air curtain device for providing an air curtain in or close to an opening in a wall according to claim 1 and a method for producing an air curtain in or close to an opening in a wall according to claim 10.

**[0006]** The housing of the air curtain device according to the invention comprises air displacing means, comprising for instance one or more fans. Air is supplied via an air inlet. In most cases this air inlet is situated in the immediate vicinity of the position where the air curtain is realized and used, although the air inlet channels can be provided at other positions such that air is transported to the desired position. If desired, a plurality of air inlet channels can be provided.

**[0007]** The air curtain device according to the invention provides the air curtain, preferably flowing substantially in a vertical direction, using an outflow opening or series of outflow openings that extend substantially in a horizontal direction, usually over substantially the same width of the opening in the wall. Preferably, the air curtain is provided over a somewhat larger distance as compared to the opening in which the air curtain is provided.

**[0008]** The air curtain is provided in or close to an opening in a wall, with the opening usually being a door opening, for instance an entrance to a shop or storage space. In use, the air curtain is provided substantially in or parallel to the opening in the wall to prevent or reduce leakage and energy losses.

**[0009]** According to the invention the air curtain device comprises a sensor for measuring a temperature profile. The temperature profile that is measured, in use, extends over a length through the air curtain in a substantially horizontal direction. In a presently preferred embodiment the measured temperature profile extends over the floor or ground surface, or at least along a line close thereto. The sensor measures the temperature profile over a length that extends perpendicular to the air curtain. The sensor also measures average temperatures in (sub)-intervals of the measurement length/interval or measure a more continuous temperature profile.

**[0010]** The sensor enables measuring the quality and/or effects of the air curtain in a direction substantially perpendicular to the main air flow direction of the air curtain. This enables measuring the (disturbing) effects of outside conditions and/or disturbances on the air curtain, such as wind, wind direction, and sun. For example, when the wind is blowing towards the air curtain from one side thereof the center or boundary line of the air curtain will be moved towards the other side. This center or boundary line of the air curtain divides the air of the air curtain towards either side of the air curtain when reaching the floor. Amongst other things, the measured temperature profile indicates the location of this center or boundary line.

**[0011]** Measuring a profile, such as a temperature profile, over a certain length, provides information over the effect of the air curtain including effects thereon by varying outside weather conditions, for example. Measuring the effect of an air curtain in a single location is insufficient. For example, due to a wind gust or wind storm the air curtain can be moved inwardly from the opening while the single location may provide insufficient information on the actual condition and the relevancy of adapting the settings of the air curtain device, for example.

**[0012]** A further advantageous effect of measuring a temperature profile as compared to measuring a temperature at a specific location/spot only is that erroneous control adjustments can be prevented. For example, adjusting the outflow angle of the air curtain device may improve the air curtain while increasing fan speed would only result in additional energy loss.

**[0013]** By comparing the measured temperature profile with a reference temperature profile and providing the differences to a controller that may act on differences between these two profiles, the air curtain can be adjusted. In a presently preferred embodiment the controller adjusts the air curtain with adjusting means. These adjusting means may involve one or more of fan speed, size of inlet opening and/or outlet opening, temperature conditions of the air for the air curtain, guide vanes, other air flow directors or manipulators for adjusting the air flow direction etc.

**[0014]** By correcting and/or compensating the air curtain based on the difference between a measured temperature profile and a reference temperature profile the

air curtain may fulfill its duties over a broad range of conditions and disturbances. This provides an air curtain with good quality.

**[0015]** For example, if one side of the air curtain shows a desired temperature profile and the other side shows a temperature profile that is too high as compared to the reference profile there appears to be too much air in the air curtain such that the amount of air in the air curtain can be reduced without adversely affecting the desired quality of the air curtain. On the other hand, in an example wherein the inside temperature of the temperature profile is too low, there may be energy losses towards the other, colder, side of the air curtain. This may be a reason to increase the amount of air in the air curtain by increasing the fan speed and/or increasing the air temperature in the air curtain.

**[0016]** The adjustments of the air curtain in the air curtain device according to the invention assure that the air curtain quality can be maintained over a broad range of conditions and disturbances. This reduces leakage and energy losses over a broad range of conditions and disturbances.

**[0017]** In a presently preferred embodiment the sensor comprises an infra-red sensor. This infra-red sensor is capable of measuring the temperature profile accurately in a robust manner such that can be relied on the measured temperature profile for adjusting the temperature and optimizing the air curtain quality.

**[0018]** In one of the preferred embodiments according to the invention comparing the measured profile with a reference profile involves determining the maximum temperature gradient along the length of the measured temperature profile. This gradient is sensitive to disturbances. This renders the gradient useful for adjusting the air curtain. The gradient can be determined by the controller that preferably comprises calculating means configured for determining the maximum temperature gradient along the length of the measured temperature profile. Adjusting the air curtain may involve changing parameters of the air curtain device, such as fan speed, outflow direction, and air temperature. Adjustments can be made by the controller in view of differences between measured and reference temperature profile. The differences may relate to the actual value for the gradient and/or the location along the temperature profile length with the maximum gradient, for example.

**[0019]** Typically, the length of the temperature profile is in the range of 1-20 m, more preferably in the range of 2-10 m. It is shown that this range for the length of the measured temperature profile will suffice in most relevant cases. Providing information about this temperature profile to the controller enables adjusting the air curtain and maintaining the air curtain quality at a desired level.

**[0020]** In an advantageous preferred embodiment according to the present invention the temperature profile has a width in a direction substantially parallel to the plane of the opening in the wall. Preferably, the width of the temperature profile corresponds to the width of the opening in the wall.

**[0021]** By providing information not only for a temperature profile having a length, but also having a significant width, air curtain information is collected over a plane preferably extending in a substantially horizontal direction and substantially perpendicular to the air curtain. Measuring in a width direction can be achieved by providing measurements along different more or less parallel lines and/or performing a measurement more continuously over the desired surface.

**[0022]** Providing measurement information about a temperature profile extending over a plane with a length and a width may provide additional information to the controller. For example, in a presently preferred embodiment this additional information relates to the edges or boundaries of the air curtain and/or close to the sides of the opening. This enables taking into account so-called side effects of the air curtain. For example, wind gusts may influence the air curtain especially at the sides/edges thereof. Using the measured two dimensional temperature profile information enables the controller to adjust the air curtain accordingly, thereby further improving and/or maintaining the air curtain quality.

**[0023]** In a further advantageous preferred embodiment according to the present invention the air curtain device further comprises a detector for detecting people approaching the air curtain.

**[0024]** Providing a detector for detecting people approaching the air curtain enables adapting the air curtain when people are about to pass through. This may not only maintain the quality of the air curtain, but may also improve the comfort for the people passing through the air curtain. In a presently preferred embodiment the detector is combined with the sensor for measuring a temperature profile, more preferably with the infra-red sensor.

**[0025]** In a further advantageous preferred embodiment according to the present invention the device further comprises a door position detector for enabling the controller to compensate the air curtain for the door position.

**[0026]** When an opening is partly closed the air curtain requirements are significantly influenced. A(n) (unknown) door position can be deduced from the measured temperature profile and/or with a separate door position detector. The use of this measured information by the sensor and/or detector enables the controller to adjust the air curtain taking into account the actual door position. In a presently preferred embodiment the door position detector is integrated in the sensor, more preferably the infra-red sensor.

**[0027]** The sensor of the air curtain device according to the invention can be provided integrally or separately from the air curtain device thereby improving installation flexibility. The sensor may communicate with the air curtain device wired or wireless using a transmitter and/or a receiver.

**[0028]** The invention further relates to a method for realizing an air curtain in or close to an opening in a wall,

the method comprising the steps of:

- providing an air curtain device as described above;
- producing the air curtain with a device;
- measuring the temperature profile extending over a length extending through the air curtain in a substantial horizontal direction and substantially perpendicular to the air curtain;
- comparing the measured temperature profile with the reference temperature profile; and
- adjusting the air curtain based on comparing the measured temperature profile with the referenced profile by the controller.

**[0029]** Such a method provides the same effects and advantages as those in respect of the air curtain device.

**[0030]** In a presently preferred embodiment according to the invention the air curtain is adjusted by the controller on basis of temperature gradient, more preferably on basis of differences between the measured and reference temperature gradient. Preferably, the temperature gradient comprises the maximum temperature gradient along the length of the measured temperature profile. Alternatively, or in addition to the value of the temperature gradient, the air curtain is adjusted on basis of location exhibiting maximum temperature gradient. This provides an effective means to adjust the air curtain by manipulating the angle of the outflow of air through the outflow opening, air temperature of the outflow of air through the outflow opening and/or speed of the outflow of air through the outflow opening, in case of disturbances, such as wind gusts of a wind "storm".

**[0031]** Further advantages, features and details of the invention are elucidated on the basis of preferred embodiments thereof, wherein reference is made to the accompanying drawings, in which:

- Fig. 1 shows a view of an air curtain device according to the invention;
- Fig. 2A-B shows two measured temperature profiles; and
- Fig. 3 shows a schematic overview of a method for adjusting with the air curtain according to the invention.

**[0032]** Air curtain device 2 (Fig. 1) produces air curtain 4. In the illustrated embodiment air is provided to device 2 via air inlet 6 and leaves device 2 through a series of outflow openings 8. The housing of device 2 comprises one or more fans 10 and, optionally, one or more heater elements 12. Outflow openings 8 can be provided with guide vanes, an airflow directing grille and/or other guides 14. In the illustrated embodiment device 2 is connected via construction elements 16 to ceiling 18. In the illustrated embodiment air curtain 4 is provided in opening 20 in wall 22 and extends in a substantially vertical direction towards floor or ground surface 24. Air curtain 4 comprises a central or boundary line 26 separating air of air curtain 4 going to either one of the two sides of opening 20.

**[0033]** Air curtain device 2 is provided with infra-red sensor 28 capable of measuring a temperature profile on ground surface 24 with a detection area 30. Sensor 28 measures a temperature profile over a length B in a direction substantially perpendicular to air curtain 4 and preferably along ground surface 24. Optionally, sensor 28 also measures temperature profiles in a direction C perpendicular to the direction B and parallel to opening 20 and air curtain 4. This achieves a measuring temperature profile over a surface are preferably corresponding to ground surface 24 or close thereto.

**[0034]** A measured temperature profile 32 ($T_m$) (Fig. 2A-B) is compared with a reference temperature profile 34 ($T_{ref}$) over the length B and/or width C of the profile. In the illustrated examples of temperature profiles 32, 34 the vertical axis corresponds to the central or boundary line 26 in a neutral position, i.e. without disturbances acting on air curtain 4.

**[0035]** In the illustrated temperature profiles (Fig. 2A-B) reference maximum temperature gradient 48 at location $x_1$ (Fig. 2A) along length B is compared with measured maximum temperature gradient 48a. Alternatively, or in addition therewith, the location $x_2$ (Fig. 2B) of the measured maximum temperature gradient 50a is compared with the location $x_1$ of the reference maximum temperature gradient 50. The comparison(s) may lead to adjustments of the air curtain and/or air curtain device.

**[0036]** The method 36 for operating device 2 (Fig. 3) starts with initiating step 38 for starting device 2, followed by activating step 40 to produce air curtain 4. In measuring step 42 a temperature profile 32 is measured to enable controller 44 to perform a comparing step 46 and define control actions to adjust air curtain 4.

**[0037]** For example, in case the measured temperature profile 32 shows a too high temperature as compared to the reference temperature profile 34 on the inside of opening 20, i.e. inside the building, the air curtain produces too much energy such that the amount of air can be reduced and/or the temperature of the air in the air curtain 4 can be reduced, for example. In case the temperature on the outside of opening 20 of the measured profile 32 is below the reference temperature profile 34 the outside conditions appear to affect the quality of air curtain 4 and leakage and energy losses may increase. In this case, for example, controller 44 may adjust air curtain 4 by manipulating the fan speed, heater and/or flow direction of outflow 8 to enhance the quality of air curtain 4.

**[0038]** The present invention is by no means limited to the above described preferred embodiment thereof. The rights sought are defined by the following claims, within the scope of which many modifications can be envisaged. Air curtain device 2 can thus be applied to many locations. Examples hereof are for instance entrances to shops, loading and/or unloading positions, warehouses or logistical centers, and climate-controlled spaces.

## Claims

1. Air curtain device (2) for providing an air curtain (4) in or close to an opening (20) in a wall (22), the device comprising:

   - a housing with air displacing means (10);
   - at least one air inlet (6) for supplying air to the housing;
   - at least one outflow opening (8) for achieving the air curtain;
   - a sensor (28); and
   - a controller (44) with connecting means configured for connecting with the sensor, **characterized in that** the sensor is configured for measuring a temperature profile (32) extending over a length (B), wherein the length is extending through the air curtain in a substantial horizontal direction and substantially perpendicular to the air curtain thereby measuring the effects of outside conditions and/or disturbances on the air curtain, wherein the sensor (28) measures temperatures in (sub)-intervals of the length or a continuous temperature profile, and wherein the controller is configured for adjusting the air curtain based on differences between the measured temperature profile (32) and the reference temperature profile (34).

2. Air curtain device according to claim 1, wherein the sensor comprises an infra-red sensor (28).

3. Air curtain device according to claim 1, 2 or 3, wherein the controller comprises calculating means configured for determining the maximum temperature gradient along the length of the measured temperature profile.

4. Air curtain device according to claim 1, 2 or 3, further comprising adjusting means for adjusting the air curtain based on the differences between the measured and reference temperature profiles.

5. Air curtain device according to one or more of the foregoing claims, wherein the length (B) is in the range of 1-20 m, preferably in the range of 2-10 m.

6. Air curtain device according to one or more of the foregoing claims, wherein the temperature profile has a width (C) in a direction substantially parallel to the plane of the opening in the wall.

7. Air curtain device according to one or more of the foregoing claims, further comprising a detector for detecting people approaching the air curtain.

8. Air curtain device according to on or more of the foregoing claims further comprising a door position detector for enabling the controller to compensate the air curtain.

9. Air curtain device according to one or more of the foregoing claims, wherein the sensor is integrally provided with the device.

10. Method for producing an air curtain (4) in or close to an opening (20) in a wall (22) the method comprising the steps of:

    - providing an air curtain device (2) according to one or more of the foregoing claims;
    - producing the air curtain with the device;
    - measuring the temperature profile (32) extending over a length B extending through the air curtain in a substantial horizontal direction and substantially perpendicular to the air curtain, wherein the sensor (28) measures temperatures in (sub)-intervals of the length or a continuous temperature profile;
    - comparing the measured temperature profile with the reference temperature profile; and
    - adjusting the air curtain based on comparing the measured temperature profile (32) with the reference temperature profile (34) by the controller (44).

11. Method according to claim 10, wherein the air curtain is adjusted on basis of temperature gradient.

12. Method according to claim 11, wherein the temperature gradient (48) comprises the maximum temperature gradient along the length of the measured temperature profile.

13. Method according to claim 10, 11 or 12, wherein the air curtain is adjusted on basis of location exhibiting maximum temperature gradient.

14. Method according to one or more of the claims 10-13, wherein the controller adjusts the air curtain by adjusting the angle of the outflow, air temperature of the outflow and/or speed of the outflow.

## Patentansprüche

1. Luftvorhangvorrichtung (2) zur Bereitstellung eines Luftvorhangs (4) in oder nahe einer Öffnung (20) in einer Wand (22), wobei die Vorrichtung Folgendes aufweist:

   - ein Gehäuse mit einer Luftverdrängungseinrichtung (10);
   - mindestens einen Lufteinlass (6) zum Zuführen von Luft in das Gehäuse;
   - mindestens eine Ausströmöffnung (8) zum Er-

zielen des Luftvorhangs;
- einen Sensor (28); sowie
- eine Steuerung (44) mit einer Verbindungseinrichtung, die zum Verbinden mit dem Sensor konfiguriert ist,

**dadurch gekennzeichnet, dass** der Sensor zum Messen eines Temperaturprofils (32) konfiguriert ist, das sich über eine Länge (B) erstreckt, wobei die Länge durch den Luftvorhang in einer wesentlich horizontalen Richtung sowie im Wesentlichen senkrecht zu dem Luftvorhang verläuft, wodurch die Auswirkungen von äußeren Bedingungen und/oder Störungen auf den Luftvorhang gemessen werden, wobei der Sensor (28) Temperaturen in (Teil)-Abständen der Länge oder ein durchgehendes Temperaturprofil misst, und wobei die Steuerung zum Anpassen des Luftvorhangs auf der Basis von Unterschieden zwischen dem gemessenen Temperaturprofil (32) und dem Bezugstemperaturprofil (34) konfiguriert ist.

**2.** Luftvorhangvorrichtung nach Anspruch 1, wobei der Sensor einen Infrarot-Sensor (28) aufweist.

**3.** Luftvorhangvorrichtung nach Anspruch 1 oder 2, wobei die Steuerung eine Berechnungseinrichtung aufweist, die zur Bestimmung des größten Temperaturgradienten entlang der Länge des gemessenen Temperaturprofils konfiguriert ist.

**4.** Luftvorhangvorrichtung nach Anspruch 1, 2 oder 3, weiterhin mit einer Anpassungseinrichtung zum Anpassen des Luftvorhangs auf der Basis der Unterschiede zwischen den gemessenen und den Bezugstemperaturprofilen.

**5.** Luftvorhangvorrichtung nach einem oder mehreren der vorhergehenden Ansprüche, wobei die Länge (B) im Bereich von 1-20 m, vorzugsweise im Bereich von 2-10 m liegt.

**6.** Luftvorhangvorrichtung nach einem oder mehreren der vorhergehenden Ansprüche, wobei das Temperaturprofil eine Breite (C) in einer Richtung im Wesentlichen parallel zu der Ebene der Öffnung in der Wand aufweist.

**7.** Luftvorhangvorrichtung nach einem oder mehreren der vorhergehenden Ansprüche, weiterhin mit einem Detektor zur Erfassung von Personen, die sich dem Luftvorhang nähern.

**8.** Luftvorhangvorrichtung nach einem oder mehreren der vorhergehenden Ansprüche, weiterhin mit einem Türpositionsdetektor, um zu ermöglichen, dass die Steuerung den Luftvorhang kompensiert.

**9.** Luftvorhangvorrichtung nach einem oder mehreren der vorhergehenden Ansprüche, wobei der Sensor einteilig mit der Vorrichtung vorgesehen ist.

**10.** Verfahren zur Erzeugung eines Luftvorhangs (4) in oder nahe einer Öffnung (20) in einer Wand (22), wobei das Verfahren folgende Schritte aufweist:

- Bereitstellen einer Luftvorhangvorrichtung (2) nach einem oder mehreren der vorhergehenden Ansprüche;
- Erzeugen des Luftvorhangs mit der Vorrichtung;
- Messen des Temperaturprofils (32), das sich über eine Länge B erstreckt, welche durch den Luftvorhang in einer wesentlich horizontalen Richtung und im Wesentlichen senkrecht zu dem Luftvorhang verläuft, wobei der Sensor (28) Temperaturen in (Teil)-Abständen der Länge oder ein durchgehendes Temperaturprofil misst;
- Vergleichen des gemessenen Temperaturprofils mit dem Bezugstemperaturprofil; sowie
- Anpassen des Luftvorhangs auf der Basis des Vergleichens des gemessenen Temperaturprofils (32) mit dem Bezugstemperaturprofil (34) durch die Steuerung (44).

**11.** Verfahren nach Anspruch 10, wobei der Luftvorhang auf der Basis eines Temperaturgradienten angepasst wird.

**12.** Verfahren nach Anspruch 11, wobei der Temperaturgradient (48) den größten Temperaturgradienten entlang der Länge des gemessenen Temperaturprofils aufweist.

**13.** Verfahren nach Anspruch 10, 11 oder 12, wobei der Luftvorhang auf der Basis einer Stelle angepasst wird, die den größten Temperaturgradienten aufweist.

**14.** Verfahren nach einem oder mehreren der Ansprüche 10 bis 13, wobei die Steuerung den Luftvorhang anpasst, indem sie den Ausströmwinkel, die Lufttemperatur der Ausströmung und/oder die Geschwindigkeit der Ausströmung anpasst.

**Revendications**

**1.** Dispositif de rideau d'air (2) pour fournir un rideau d'air (4) dans ou près d'une ouverture (20) dans une paroi (22), le dispositif comprenant :

- un boîtier avec des moyens de déplacement d'air (10) ;
- au moins une entrée d'air (6) pour alimenter

en air le boîtier ;
- au moins une ouverture d'écoulement (8) pour obtenir le rideau d'air ;
- un capteur (28) ; et
- un dispositif de commande (44) avec des moyens de connexion configurés pour se connecter au capteur, **caractérisé en ce que** le capteur est configuré pour mesurer un profil de température (32) s'étendant sur une longueur (B), dans lequel la longueur s'étend à travers le rideau d'air dans une direction horizontale importante et sensiblement perpendiculaire au rideau d'air mesurant ainsi les effets de conditions extérieures et/ou de perturbations sur le rideau d'air, dans lequel le capteur (28) mesure des températures dans des (sous-)intervalles de la longueur ou un profil de température continu, et dans lequel le dispositif de commande est configuré pour ajuster le rideau d'air sur la base de différences entre le profil de température (32) mesuré et le profil de température de référence (34) .

**2.** Dispositif de rideau d'air selon la revendication 1, dans lequel le capteur comprend un capteur infrarouge (28).

**3.** Dispositif de rideau d'air selon la revendication 1 ou 2, dans lequel le dispositif de commande comprend des moyens de calcul configurés pour déterminer le gradient de température maximal le long de la longueur du profil de température mesuré.

**4.** Dispositif de rideau d'air selon la revendication 1, 2 ou 3, comprenant en outre des moyens d'ajustement pour ajuster le rideau d'air sur la base des différences entre les profils de température mesuré et de référence.

**5.** Dispositif de rideau d'air selon une ou plusieurs des revendications précitées, dans lequel la longueur (B) est dans la plage de 1 à 20 m, de préférence dans la plage de 2 à 10 m.

**6.** Dispositif de rideau d'air selon une ou plusieurs des revendications précitées, dans lequel le profil de température a une largeur (C) dans une direction sensiblement parallèle au plan de l'ouverture dans la paroi.

**7.** Dispositif de rideau d'air selon une ou plusieurs des revendications précitées, comprenant en outre un détecteur pour détecter des personnes s'approchant du rideau d'air.

**8.** Dispositif de rideau d'air selon une ou plusieurs des revendications précitées comprenant en outre un détecteur de position de porte pour permettre au dispositif de commande de compenser le rideau d'air.

**9.** Dispositif de rideau d'air selon une ou plusieurs des revendications précitées, dans lequel le capteur est fourni d'un seul bloc avec le dispositif.

**10.** Procédé pour produire un rideau d'air (4) dans ou près d'une ouverture (20) dans une paroi (22), le procédé comprenant les étapes consistant à :

- fournir un dispositif de rideau d'air (2) selon une ou plusieurs des revendications précitées ;
- produire le rideau d'air avec le dispositif ;
- mesurer le profil de température (32) s'étendant sur une longueur (B) s'étendant à travers le rideau d'air dans une direction horizontale importante et sensiblement perpendiculaire au rideau d'air, dans lequel le capteur (28) mesure des températures dans des (sous-)intervalles de la longueur ou un profil de température continu ;
- comparer le profil de température mesuré avec le profil de température de référence ; et
- ajuster le rideau d'air sur la base de la comparaison du profil de température (32) mesuré avec le profil de température de référence (34) par le dispositif de commande (44).

**11.** Procédé selon la revendication 10, dans lequel le rideau d'air est ajusté sur la base d'un gradient de température.

**12.** Procédé selon la revendication 11, dans lequel le gradient de température (48) comprend le gradient de température maximal le long de la longueur du profil de température mesuré.

**13.** Procédé selon la revendication 10, 11 ou 12, dans lequel le rideau d'air est ajusté sur la base d'un emplacement présentant un gradient de température maximal.

**14.** Procédé selon une ou plusieurs des revendications 10 à 13, dans lequel le dispositif de commande ajuste le rideau d'air en ajustant l'angle de l'écoulement, la température d'air de l'écoulement et/ou la vitesse de l'écoulement.

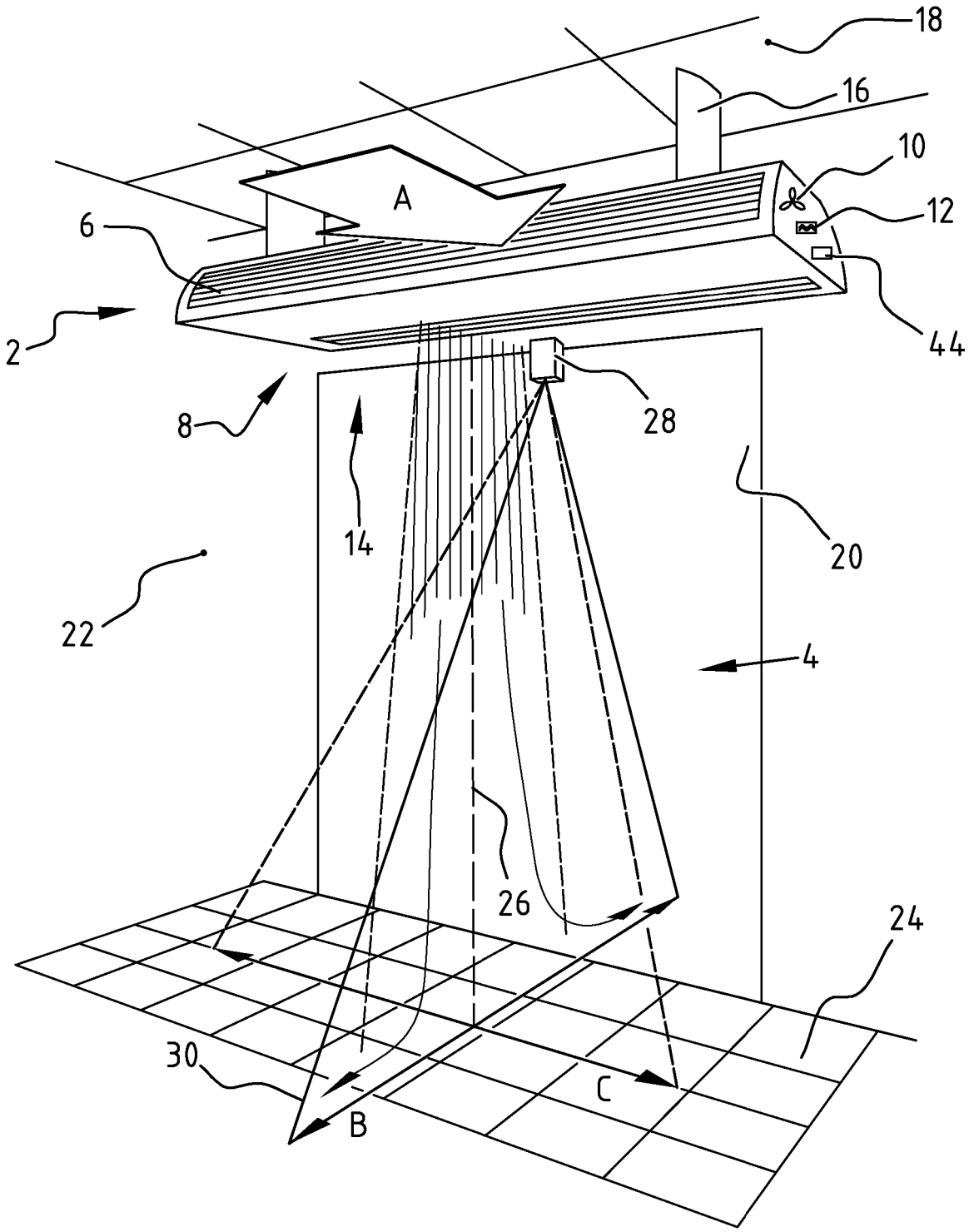



FIG. 1

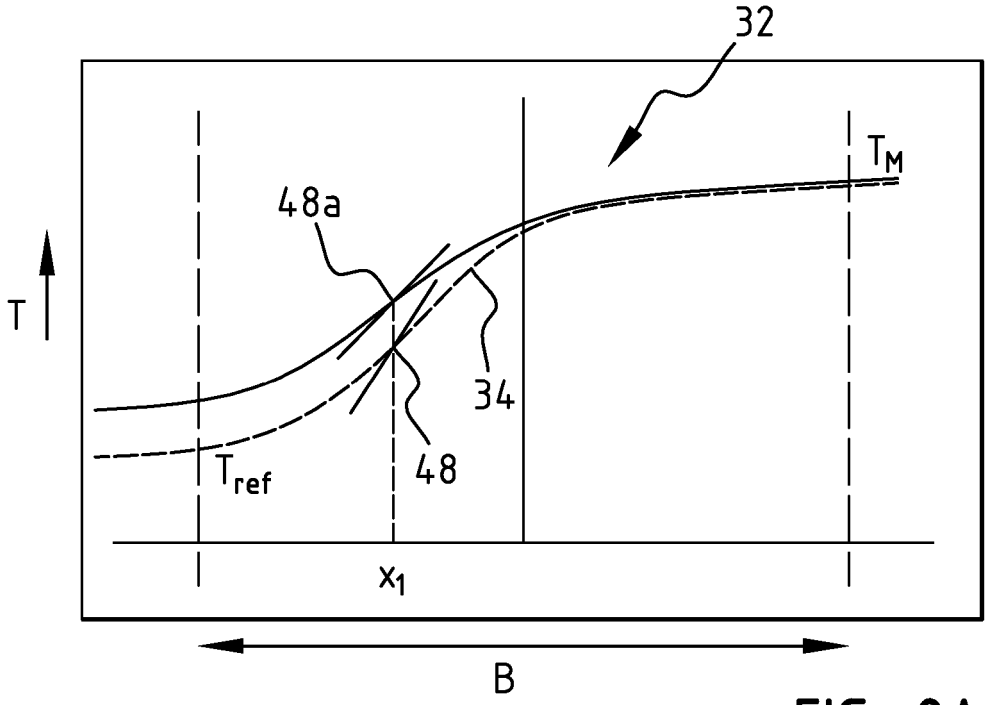



FIG. 2A

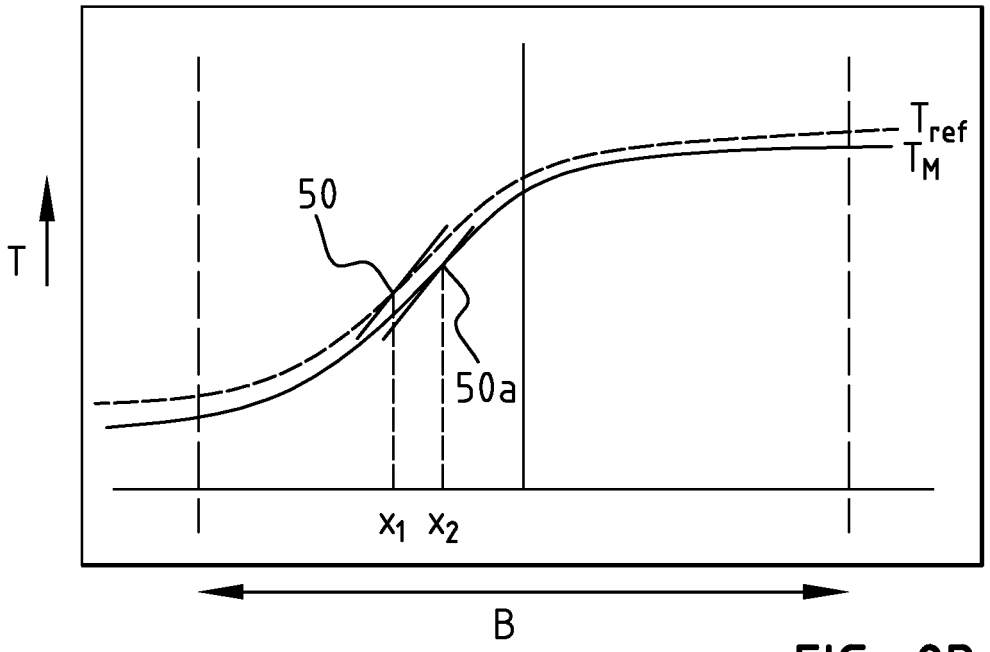



FIG. 2B

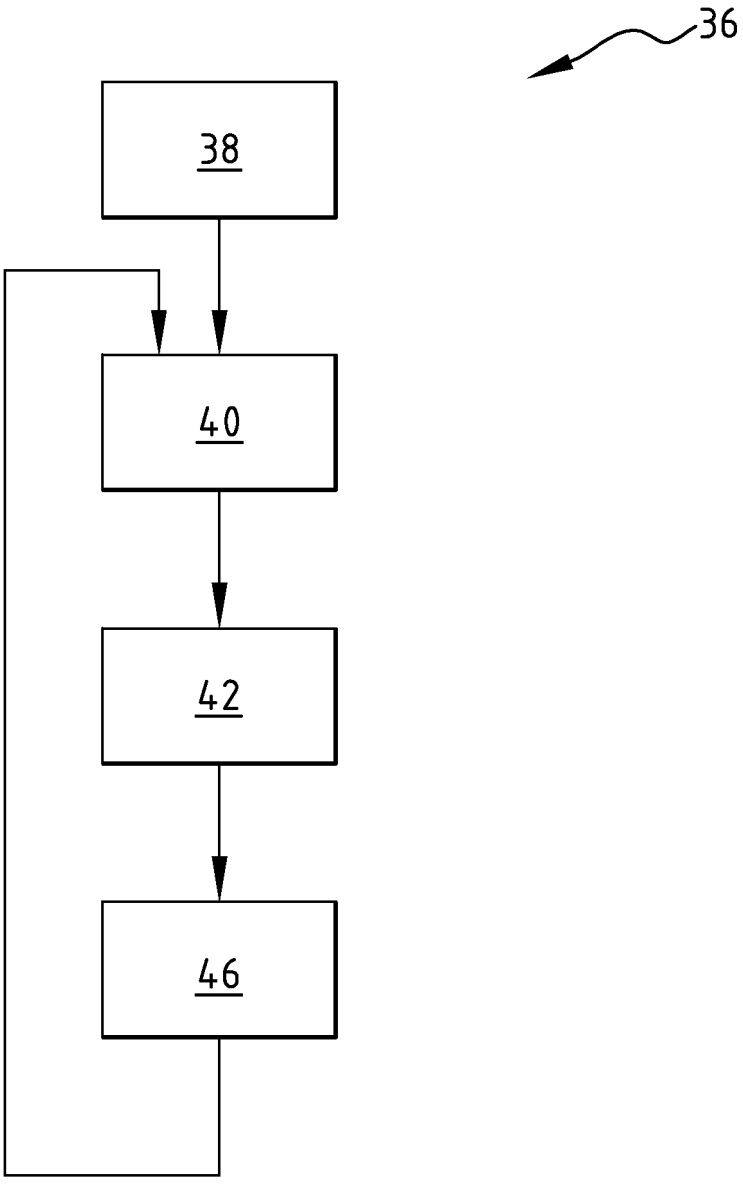



FIG. 3

## REFERENCES CITED IN THE DESCRIPTION

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### Patent documents cited in the description


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