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# (54) AIR CIRCULATION SYSTEM

LUFTZIRKULATIONSSYSTEM

SYSTÈME DE CIRCULATION D'AIR

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## Description

### Field of the Invention

**[0001]** The present invention refers to an air circulation system, particularly intended for application in household appliances of refrigerator type, said system comprising innovative technical and functional aspects capable of improving air flow circulation, in addition to optimizing the space occupied by the fan. More preferably, the present invention discloses a system comprising a radial fan coupled to a panel, both disposed in a configuration which allows for reducing the noise caused by the operation of the system components as well as for increasing the capacity and efficiency of the air flow circulation inside household appliances.

### Background of the Invention

**[0002]** According to the state of the art, such as US 3 365 118 A, US 3 364 695 A, JP 2013 100974, JP 2013 100973 and EP 2 584 295, it is of general knowledge that refrigeration apparatuses are normally integrated by an air circulation system to cool the contents of the refrigeration housing, either in the refrigeration compartment or in the freezer of the apparatus. More particularly, this system can be defined by the concept of thermal gas convection, which postulates that denser cold air tends to go down and less dense air tends to go up. Thus, the ascending cold air is cooled by a refrigerated plate coupled to the structural refrigerating equipment housing, and the descending cold air gains heat from the bottom of the refrigeration housing.

**[0003]** The structure of a refrigerating equipment comprises at least one inner box and a structural housing, which in turn comprises the outer structure of said refrigerating equipment, defining not only structural but also aesthetic aspects. Therefore, it is known that conventional refrigeration systems are basically composed of at least one compressor, at least one condenser, at least one expansion device and at least one evaporator.

**[0004]** Also a person skilled in the art is aware of the fact that the evaporator is disposed between the refrigerated housing and the structural housing of a refrigerating equipment, which is then capable of refrigerating the air contained between said refrigerated housing and the structural housing of said refrigerating equipment. Hence, cooling of the refrigerated housing is effected through air passing through the evaporator and then blown within the refrigerated housing.

**[0005]** To this effect, according to the state of the art, there has been used a system comprising an axial fan arranged between the refrigerated housing and a region near the evaporator, whose main purpose is to carry out a constant air exchange between these two environments. By this way, a suction zone in the region near the evaporator and a discharge zone inside the refrigerated housing are created.

**[0006]** Therefore, it is noted that many models of refrigerating equipments known in the art comprise high volume refrigerated housings which demand high capacity air circulation systems and, consequently, the use of large axial fans is required. Nevertheless, as can be appreciated by those skilled in the art, fans of this type produce high intensity noise, in addition to presenting considerable restrictions for installation because they occupy large spaces.

**[0007]** In order to reduce these noise drawbacks, there have been developed refrigerating equipments having air circulation systems, which fan speed is reduced. However, as it should also be known by a person skilled in the art, in these cases, it is necessary to increase the fan diameter to make up for refrigeration efficiency, which brings up more problems relative to space for installation of such air circulation systems.

**[0008]** In this sense, in order to solve these drawbacks concerning space, some models of refrigerating equipments which air circulation system comprises centrifugal fans, permitting to reduce dimensions and space occupied by these components and also partially reducing work noises are also known from the state of the art.

**[0009]** Nevertheless, in spite of improving the operation conditions compared to axial fans, it was observed that these air circulation systems with centrifugal fans present other drawbacks, particularly concerning the air circulation capacity and efficiency. This is due to the fact that such fans are disposed in parallel to the walls of the refrigeration housing and the refrigerating equipment structural housing, effectively occupying the region formed by the suction duct and air discharge of said refrigerating equipment. Such a construction arrangement causes the air flow in the suction duct to face barriers and/or sudden contacts with the inner walls of said duct, thus causing energy loss and forcing in the air flow prior to reaching the fan itself.

**[0010]** Moreover, among the models of air circulation systems with centrifugal fans most of which, if not all, have a configuration whose fan is disposed at the front portion of the fan, in the region of the suction duct air flow passage. This stems from the fact that these systems present a drawback of optimizing space, mainly due to the parallelism between ventilation mechanisms with suction and discharge ducts. As a result, problems of air flow charge loss in the suction duct increase before effective actuation of the fan and, consequently, the air flow capacity and efficiency responsible for the refrigeration of the refrigerating equipment housings are affected.

**[0011]** By this way, it is observed that there is a need in the state of the art for air circulation system which is capable of providing suitable cooling for the refrigeration housings, without substantially affecting the capacity and efficiency of the air flow generated to refrigerate the refrigerating equipments. In addition, by virtue of the construction arrangements known in the art, it is noted that there are still problems concerning power consumption and complexity in the manufacture and mounting of the

components of these systems.

Objects of the Invention

**[0012]** In view of the foregoing, one object of the present application is to provide an air circulation system which is capable of mitigating and/or effectively solving the problems, drawbacks and restrictions disclosed by the state-of-the-art systems.

**[0013]** More particularly, one object of the present invention is to provide an air circulation system that is capable of promoting air flow with elevated cooling capacity and efficiency, mainly allowing for reducing power consumption during air flow distribution process.

**[0014]** Furthermore, the air circulation system, according to the present invention, intends to minimize noises produced by the fan which is a component of the circulation system, but mainly to improve the air flow circulation conditions inside the refrigerating equipment.

Summary of the Invention

**[0015]** These and other objects of the present invention are achieved by means of an air circulation system according to claim 1, particularly intended to be used in household appliances of refrigerating equipment type, which is provided with at least one air passage channel, within which a radial fan is installed in an inclined position and dividing said air passage channel into two ducts, that is, one suction duct that pulls air from within the refrigerating equipment and a sprinkling duct which returns the cold air to within the refrigerating equipment.

**[0016]** Additionally, the outer box wall of said refrigerating equipment comprises a recess aligned with the radial fan inlet to improve the air flow direction conditions. Said fan is fixed inside the air passage channel of the refrigerating equipment by securing its structure, respectively, with the lower end only to the inner box walls while the upper end is adjustably secured between the walls of the inner box and the outer box of the refrigerating equipment.

**[0017]** Further, according to another preferred embodiment of the present invention, said fan structure comprises a configuration which motor is disposed in the rear region of its rotor, increasing the yield and efficiency of the present air circulation system. Logically, said motor can also be disposed in the front region or in the center of said rotor.

**[0018]** Another alternative embodiment of said air circulation system, in accordance with the present invention, comprises a suction duct having an equivalent proportion ratio ranging between 2 and 3.5 times the size of the sprinkling duct and then it is possible to ensure that the air flow is integrally directed inward the refrigerating equipment.

**[0019]** According to a preferred embodiment of the present invention, said fan is inclined at an angle which can vary between 10 and 30°, and more preferably around 15°, wherein said inclination combined with disposition of the recess at the outer box wall permits to further enhance the efficiency and yield of the present system.

Brief Description of the Drawings

**[0020]** Features, advantages and technical effects of the present invention, as disclosed above, are better understood by a person skilled in the art from the following merely exemplary, not limitative, detailed description of the preferred embodiments, and referring to the attached schematic drawings, in which:

Fig. 1 illustrates an exemplary refrigerating equipment of side-by-side type;
Fig. 1A illustrates an enlarged cut view of a portion of the refrigerated housing - freezer - within which the air circulation system is arranged, in accordance with the present invention.
Fig. 2 illustrates an enlarged cut view of the inner region of the refrigerator which constitutes the structural assembly of the air circulation system in accordance with the present invention.
Fig. 3 illustrates a view similar to Fig. 2 but showing the air flow through the air circulation system in accordance with the present invention.

Detailed Description of the Invention

**[0021]** According to the schematic drawings above, some examples of possible embodiments of the present invention will be described in further detail below, wherein it should be emphasized that it refers to a merely, not limitative, exemplary description, once the present air circulation system can comprise and be configured by means of different technical, structural and dimensional features without departing from the intended scope of protection.

**[0022]** According to the above-mentioned figures, the air circulation system of the present invention is particularly intended to be used in a refrigerating equipment (R) comprising an outer box (E) surrounding an inner box (C), which can be divided into two refrigerated housings, for example, the freezer housing (F) and the refrigerator housing (G). Said two inner (C) and outer (E) boxes are disposed to form in the rear region of the refrigerating equipment an air flow passage channel (A) to pull air at a more elevated temperature and to carry it toward the refrigeration system evaporator so that it is then sent back to the refrigerated housing of the apparatus at lower temperatures.

**[0023]** More specifically, the air circulation system of the present invention comprises a refrigerating equipment (R) provided with an air flow passage channel (A), inside which a radial fan 1 is arranged at an inclined position at a angle (g) and separating said air flow passage channel (A) into two ducts, a suction duct 2 and a sprin-

kling duct 3. Further, the wall of said outer box (E) of the refrigerating equipment (R) is provided with a recess 4 positioned such that it is aligned with said fan 1 to allow the air flow in the suction duct 2 to be smoothly directed toward the inlet 5 of fan 1. More particularly, the main purpose of said recess 4 is to guide the air flow to the radial fan so as to reduce loss of energy along the path that the air flow travels.

**[0024]** More specifically, in accordance with the present invention, the inclination of said fan 1 within the air flow passage channel (A) is obtained by securing the structure 6 of said fan 1, particularly the lower end 7 of said structure 6 is secured only to the wall of the inner box (C) while the upper end 8 of the fan structure is adjustably fixed between the walls of said inner box (C) and the outer box (E) to ensure that the entire air flow is conducted to the sprinkling duct 3.

**[0025]** Furthermore, as can be seen from the attached figures, said structure 6 of fan 1 comprises a configuration which motor 9 is arranged in the rear portion of the fan, that is, it is completely out of contact with the air flow generated by the system of the present invention. Hence, it is observed that there is no loss of loads in the air flow and as a result excessive power consumption is avoided once rotor 10 can work continuously and with no need to make up for any loss of energy from the air flow caused by collision shock with walls and surfaces alive within the suction duct 2. Clearly, depending on the refrigerating equipment model, there would be eventually the case of adapting said motor to the front region or to the center of said rotor.

**[0026]** According to a particularly advantageous embodiment, said suction duct 2 has an equivalent proportion ratio ranging from 2 to 3.5 times the size of the sprinkling duct and therefore it allows for said structure 6 of fan 1 to be duly positioned inside the air flow passage channel (A) to ensure the appropriate operation of the air circulation system of the present invention to occur.

**[0027]** Additionally, said fan 1 is inclined at angle ($\alpha$) that may vary between 10 and 30°, more preferably around 15°, which will enhance the air flow conduction and guiding conditions, mainly by virtue of the disposition of said recess 4, which substantially facilitates to guide the air toward the inlet 5 of fan 1.

**[0028]** Fig. 3 schematically illustrates the air flow conduction through the air circulation system of the present invention. More specifically, as can be noted, the air flow at hotter temperature is suctioned from the lower portion of the refrigerated housing and conducted through the air passage air flow channel (A) up to fan 1. At this time, as illustrated by indicative arrows, the air flow direction is guided by the configuration of the recess 4 of the wall of the outer box E so as to force all air flow to the inlet 5 of fan 1. Next, after passing by rotor 10, the air flow is directed to the sprinkling duct 3 and finally returned to the refrigerated housing (F), and restarting the air flow circulation of the refrigerating equipment.

**[0029]** As appreciated by a person skilled in the art, along the air flow circulation, preferably within the air flow passage channel (A) there are provided refrigeration system components responsible for cooling the air flow, for example, an evaporator, which is not shown in the figures, once it refers to a conventionally element widely used in the apparatuses known in the art, and therefore no further details about it are required.

**[0030]** It is important to clarify that, despite the fact that the attached figures illustrate a refrigerating equipment comprising two independent refrigerated housings, with a freezer and a refrigerator, the air circulation system of the present invention can be easily applied in any refrigerating equipment type, either being of single housing or eventually being modern models having more than two exclusive or complementary refrigeration housings and/or compartments.

**[0031]** Furthermore, it should also be clear that the description above only intends to describe in an exemplificative form some of the preferred embodiments of the air flow circulation system of the present invention. Therefore, those skilled in the art will understand that many construction and structural modifications, variations and combinations of elements having substantially the same function to achieve the same results will be within the scope of protection limited by the appended claims.

## Claims

1. Air flow circulation system, comprising a refrigerating equipment (R) provided with at least an air passage channel (A), within which a fan (1) is disposed, said system wherein said fan (1) is of radial type and inclined at an angle ($\alpha$), dividing said air passage channel (A) into two ducts, a suction duct (2) and a sprinkling duct (3), wherein:

   a wall of an outer box (E) of said refrigerating equipment (R) is provided with at least one recess (4) aligned with an inlet (5) of said fan (1); the fan (1) is secured inside the air passage channel (A) by fixing its structure (6), wherein a lower end (7) is secured only onto a wall of an inner box (C), the system being **characterized in that** an upper end (8) of the fan structure (6) is adjustably secured between the walls of said inner box (C) and outer box (E).

2. Air flow circulation system, in accordance with claim 1, **characterized in that** said structure (6) of fan (1) has a configuration whose motor (9) is disposed in a rear region of rotor (10) of the fan (1).

3. Air flow circulation system, in accordance with claim 1, **characterized in that** said structure (6) of fan (1) comprises a configuration whose motor (9) is disposed in a front region of said rotor (10) of fan (1).

4. Air flow circulation system, in accordance with claim 1, **characterized in that** said structure (6) of fan (1) comprises a configuration whose motor (9) is arranged in the center of the rotor (10) of fan (1).

5. Air flow circulation system, in accordance with claim 1, **characterized in that** said suction duct (2) comprise an equivalent proportion ratio ranging from 2 to 3,5 times the size of the sprinkling duct (3).

6. Air flow circulation system, in accordance with claim 1, **characterized in that** said angle ($\alpha$) varies between 10° and 30°, and more preferably around 15°.

**Patentansprüche**

1. Luftstrom-Zirkulationssystem, enthaltend eine Kühlausstattung (R), das mit wenigstens einem Luftdurchgangskanal (A) versehen ist, innerhalb dem ein Gebläse (1) angeordnet ist, wobei das System, in dem das Gebläse (1) vom radialen Typ ist und unter einem Winkel ($\alpha$) geneigt ist, den Luftdurchgangskanal (A) in zwei Leitungen teilt, eine Saugleitung (2) und eine Berieselungsleitung (3), wobei:

   eine Wand eines äußeren Behältnisses (E) der Kühlausstattung (R) mit wenigstens einer Ausnehmung (4) versehen ist, die mit einem Einlass (5) des Gebläses (1) ausgerichtet ist;
   das Gebläse (1) innerhalb des Luftdurchgangskanals (A) durch Fixieren seiner Struktur (6) befestigt ist, wobei ein unteres Ende (7) nur an der Wand eines inneren Behälters (C) befestigt ist, wobei das System **dadurch gekennzeichnet ist, dass** ein oberes Ende (8) der Gebläse-Struktur (6) zwischen den Wänden des inneren Gehäuses (C) und des äußeren Gehäuses (E) einstellbar befestigt ist.

2. Luftstrom-Zirkulationssystem nach Anspruch 1, **dadurch gekennzeichnet, dass** die Struktur (6) des Gebläses (1) eine Konfiguration hat, deren Motor (9) in einem hinteren Bereich des Rotors (10) des Gebläses (1) angeordnet ist.

3. Luftstrom-Zirkulationssystem nach Anspruch 1, **dadurch gekennzeichnet, dass** die Struktur (6) des Gebläses (1) eine Konfiguration hat, deren Motor (9) in einem vorderen Bereich des Rotors (10) des Gebläses (1) angeordnet ist.

4. Luftstrom-Zirkulationssystem nach Anspruch 1, **dadurch gekennzeichnet, dass** die Struktur (6) des Gebläses (1) eine Konfiguration hat, deren Motor (9) im Zentrum des Rotors (10) des Gebläses (1) angeordnet ist.

5. Luftstrom-Zirkulationssystem nach Anspruch 1, **dadurch gekennzeichnet, dass** die Saugleitung (2) ein äquivalentes Proportionsverhältnis hat, das vom 2- bis zum 3,5-fachen der Größe der Berieselungsleitung (3) reicht.

6. Luftstrom-Zirkulationssystem nach Anspruch 1, **dadurch gekennzeichnet, dass** der Winkel ($\alpha$) zwischen 10° und 30°, und weiter vorzugsweise um 15° variiert.

**Revendications**

1. Système de circulation d'air, comprenant un équipement de réfrigération (R) pourvu d'au moins un conduit de passage d'air (A), dans lequel est disposé un ventilateur (1), ledit système dans lequel ledit ventilateur (1) est de type radial et incliné selon un angle ($\alpha$), divisant ledit conduit de passage d'air (A) en deux conduites, une conduite d'aspiration (2) et une conduite de soufflage/ (3), dans lequel
   une paroi d'une enveloppe extérieure (E) dudit équipement de réfrigération (R) est pourvue d'au moins une partie en creux (4) alignée avec une entrée (5) dudit ventilateur (1) ;
   ledit ventilateur (1) est fixé à l'intérieur du conduit de passage d'air (A) en se fixant par sa structure (6), dans laquelle une extrémité inférieure (7) est fixée uniquement sur une paroi d'une enveloppe intérieure (C), le système étant **caractérisé en ce qu'**une extrémité supérieure (8) de la structure (6) du ventilateur est fixée de façon réglable entre les parois des dites enveloppe intérieure (C) et enveloppe extérieure (E).

2. Système de circulation d'air selon la revendication 1, **caractérisé en ce que** ladite structure (6) du ventilateur (1) présente une configuration selon laquelle le moteur (9) est disposé dans une région arrière du rotor (10) du ventilateur (1).

3. Système de circulation d'air, selon la revendication 1, **caractérisé en ce que** ladite structure (6) du ventilateur (1) présente une configuration selon laquelle le moteur (9) est disposé dans une région avant dudit rotor (10) du ventilateur (1).

4. Système de circulation d'air selon la revendication 1, **caractérisé en ce que** ladite structure (6) du ventilateur (1) présente une configuration selon laquelle le moteur (9) est disposé au centre du rotor (10) du ventilateur (1).

5. Système de circulation d'air selon la revendication 1, **caractérisé en ce que** ladite conduite d'aspiration (2) présente un rapport de proportion équivalent allant de 2 à 3,5 fois la taille de la conduite de soufflage

(3).

**6.** Système de circulation d'air selon la revendication 1, **caractérisé en ce que** ledit angle ($\alpha$) varie entre 10° et 30°, et est plus préférentiellement voisin de 15°.

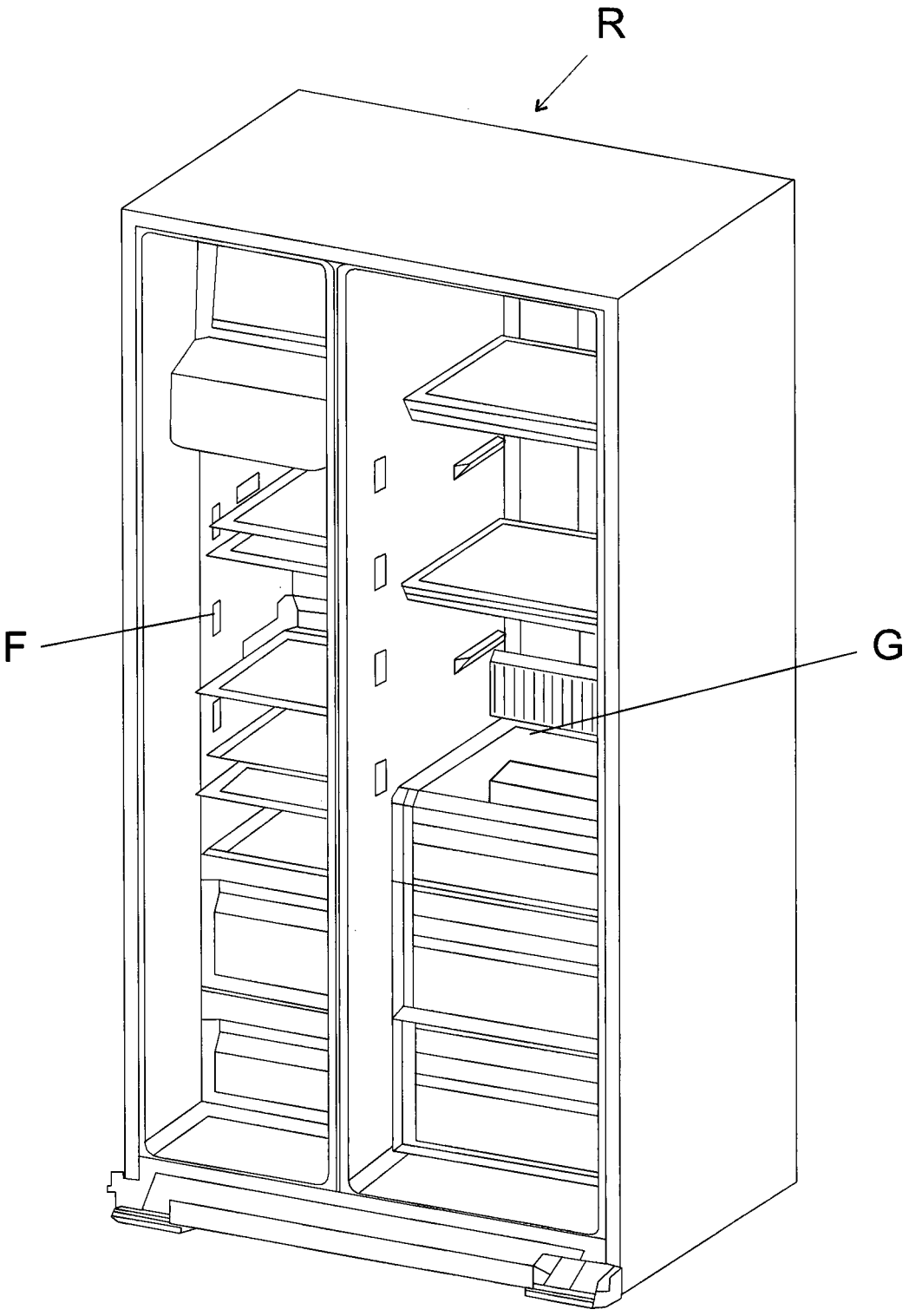



FIG.1

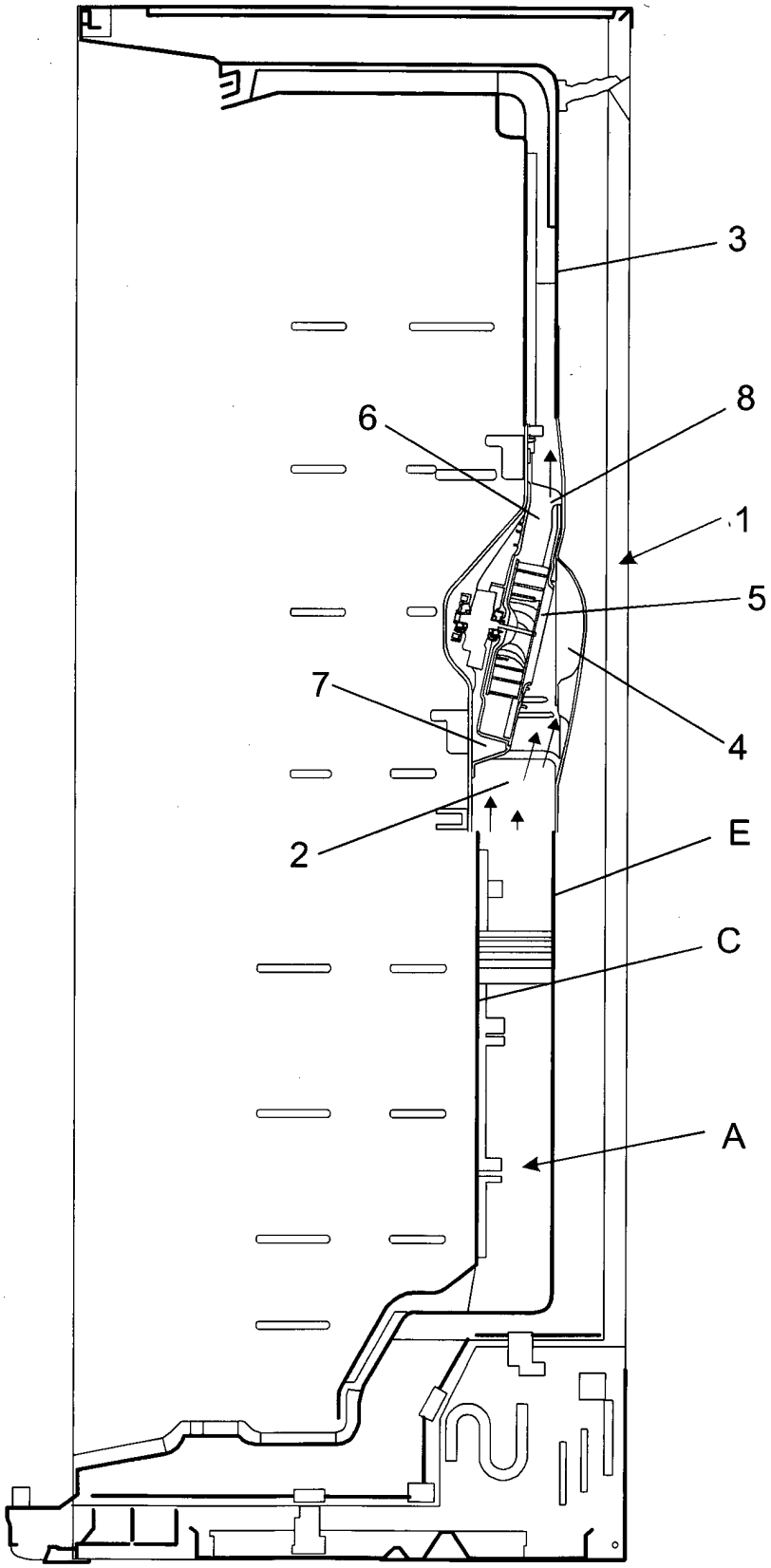



FIG.1A

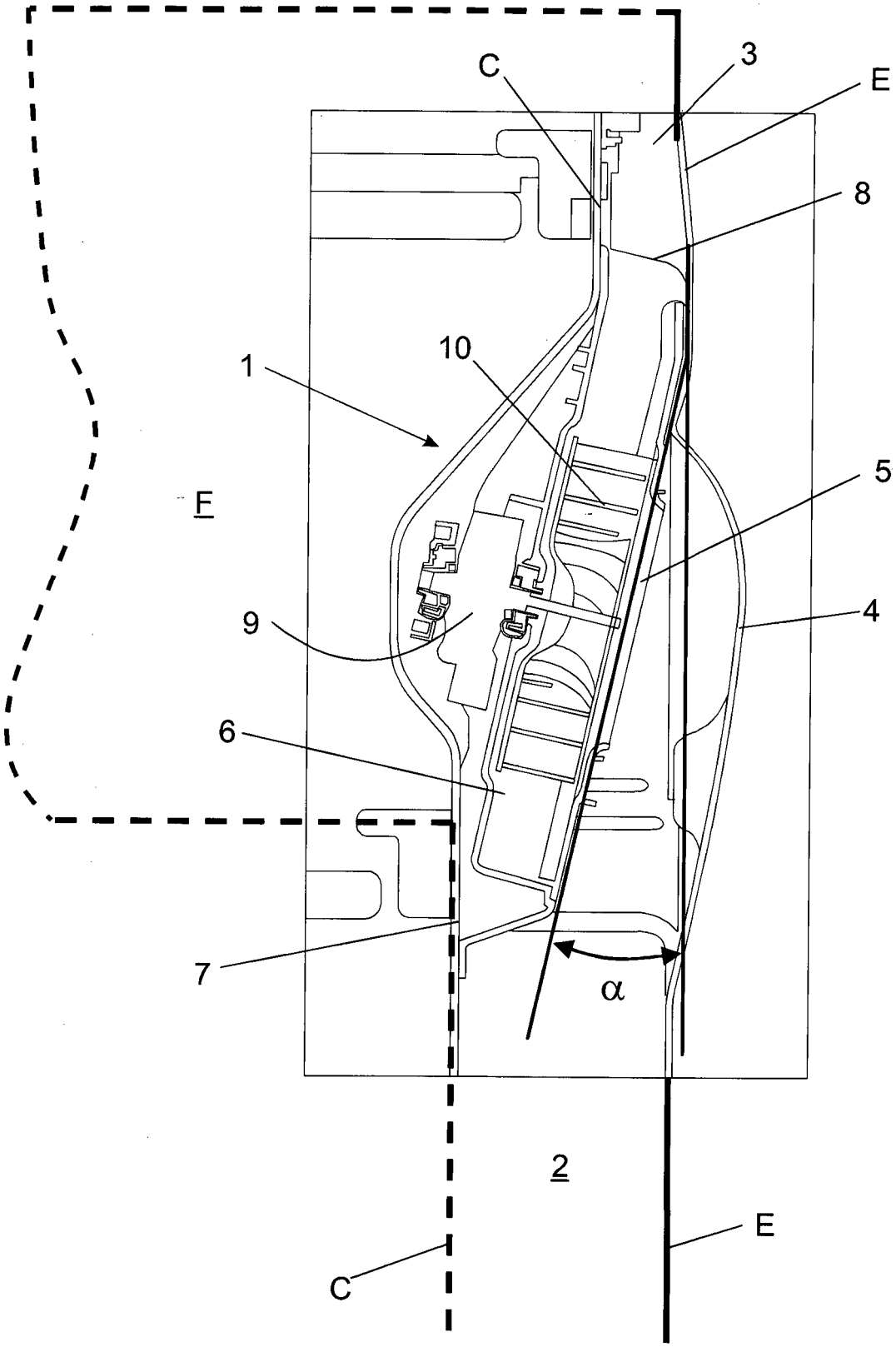



FIG.2

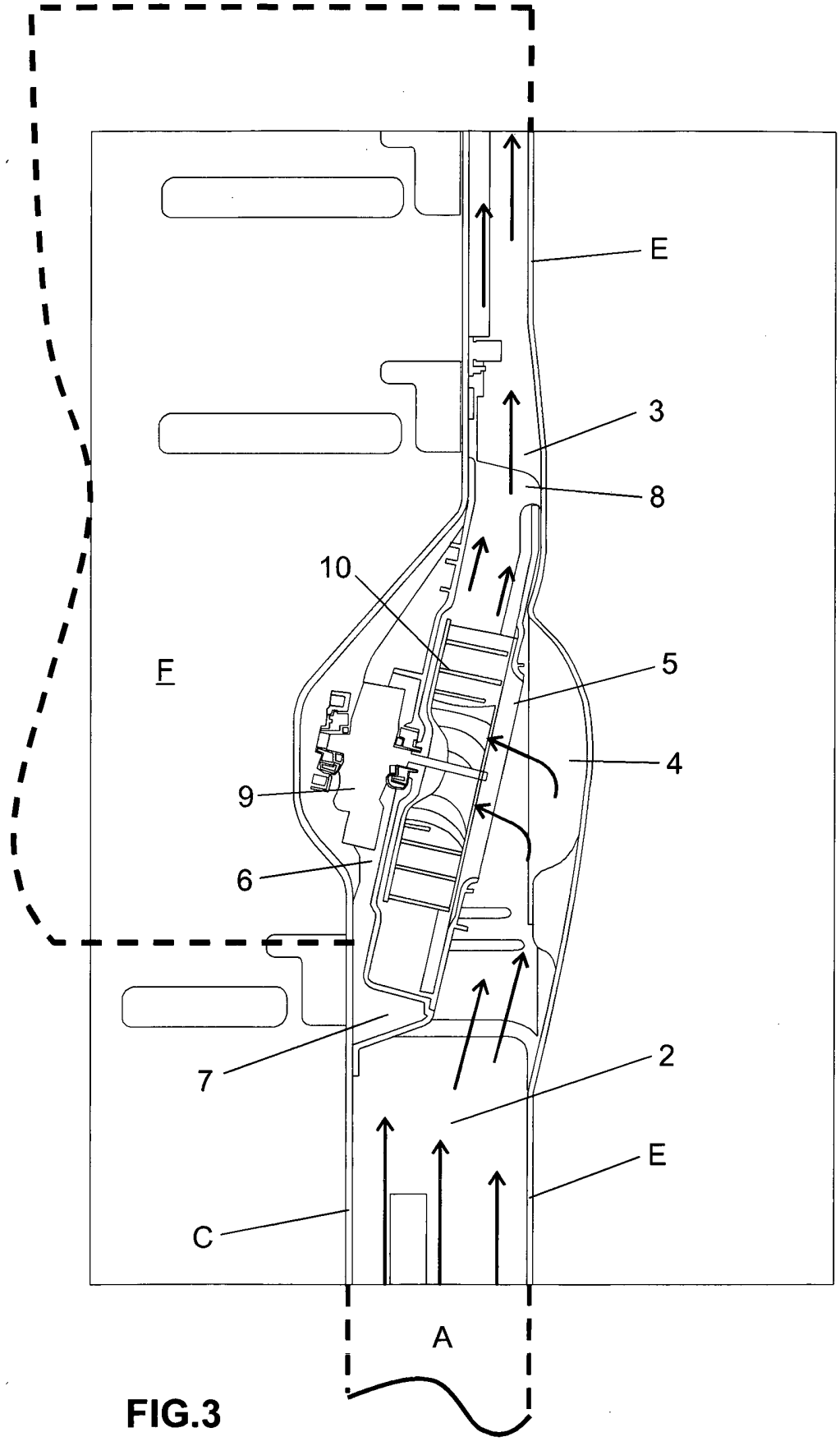



FIG.3

## REFERENCES CITED IN THE DESCRIPTION

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