

(19)



(11)

**EP 2 570 546 B1**

(12)

**EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:  
**13.01.2021 Bulletin 2021/02**

(51) Int Cl.:  
**D06F 58/20<sup>(2006.01)</sup> D06F 58/04<sup>(2006.01)</sup>**

(21) Application number: **11181841.5**

(22) Date of filing: **19.09.2011**

**(54) A laundry dryer with a heat pump system**

Wäschetrockner mit Wärmepumpensystem

Sèche-linge avec système de pompe à chaleur

(84) Designated Contracting States:  
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR**

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(43) Date of publication of application:  
**20.03.2013 Bulletin 2013/12**

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(56) References cited:  
**EP-A1- 2 199 452 WO-A1-2008/077838**  
**DE-A1- 4 023 000 DE-A1- 4 212 700**  
**DE-A1-102005 013 051 DE-A1-102006 016 294**  
**DE-U1-202006 018 205 JP-A- 2007 000 386**  
**US-A1- 2005 072 022 US-A1- 2005 086 827**

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## Description

**[0001]** The present invention relates to a laundry dryer with a heat pump system according to the preamble of claim 1.

**[0002]** The heat pump technology in a laundry dryer is at present the most efficient way to dry clothes in terms of energy consumption. In a heat pump system of the laundry dryer an air stream flows in a closed air stream circuit. Further, the heat pump system includes a closed refrigerant circuit. The air stream is moved by a fan, passes through a laundry chamber, which is preferably formed as a rotatable laundry drum, and removes there water from wet clothes. Then, the air stream is cooled down and dehumidified in an evaporator, heated up in a condenser and re-inserted into the laundry drum again. The refrigerant is compressed by a compressor, condensed in the condenser, laminated in an expansion device and then vaporized in the evaporator. Thus, the condenser and the evaporator are components of the air stream circuit as well as the refrigerant circuit. The condenser and the evaporator are heat exchangers between the air stream circuit and the refrigerant circuit.

**[0003]** Usually, the components of the heat pump system are placed in a basement of the laundry dryer. In particular, the compressor, the evaporator and the condenser are arranged in said basement below the laundry drum. Thus an air duct of the air stream circuit has to pass the basement.

**[0004]** FIG 6 illustrates a top view of the open basement of the laundry dryer according to the prior art. The compressor 14, the evaporator 16, the condenser 18, the fan 20 and the motor 22 are arranged in the lower casing 10 of the basement. The evaporator 16 and the condenser 18 are placed in a straight air duct. The evaporator 16 and the condenser 18 are arranged in parallel. The straight air duct causes that the air stream has to pass an angle at the inlet and at the outlet of said straight air duct. Such angles in the air stream circuit cause pressure drops and turbulences increasing the energy consumption and the noise.

**[0005]** German patent application DE 42 12 700 A1 discloses a laundry dryer having a heat pump circuit.

**[0006]** International patent application WO 2008/077838 A1 discloses a washer/dryer that is more efficient and operates with less noise.

**[0007]** German patent application DE 10 2006 016294 A1 discloses a domestic appliance for care of items of laundry.

**[0008]** Japanese patent application JP 2007 000386 A discloses a clothes dryer.

**[0009]** It is an object of the present invention to provide a laundry dryer with a heat pump system, wherein the flow of the air stream is improved.

**[0010]** The object of the present invention is achieved by the laundry dryer according to claim 1.

**[0011]** According to the present invention the air duct comprises at least one curved portion, wherein the evaporator and the condenser are arranged inside said curved portion of the air duct.

orator and the condenser are arranged inside said curved portion of the air duct.

**[0012]** The core of the present invention is the combination of the curved portion of the air duct in the basement of the laundry dryer on the one hand and the arrangement of the evaporator and the condenser inside said curved portion of the air duct on the other hand. The curved portion prevents corners inside the air duct, so that pressure drops in the air duct are reduced. The air flow through the evaporator and condenser is optimized. The heat exchange between the refrigerant circuit and the air stream circuit increases. The dimensions of the evaporator and condenser may be reduced. This allows a redistribution of the components in the basement of the laundry dryer. The energy consumption of the motors for the compressor and the fan is reduced. Further, the noise of the laundry dryer is reduced.

**[0013]** At least a part of the curved portion of the air duct has the structure of an arc of a circle.

**[0014]** Further, the evaporator and the condenser are inclined to each other. The orientations of the evaporator and condenser are adapted to the structure of the air duct.

**[0015]** For example, the continuations of the main planes of the evaporator and the condenser intersect in the centre of the circle defining the arc of the air duct.

**[0016]** Additionally or alternatively, the main planes of the evaporator and condenser may be arranged perpendicular to the direction of the air duct.

**[0017]** In particular, the fan of the air stream circuit is arranged at the end of the air duct or at the end of the curved portion of said air duct in the basement.

**[0018]** For example, the air duct or the curved portion of said air duct extends horizontally in the basement. In this case, the bending of the air duct extends in a horizontal plane.

**[0019]** Preferably, the one or more curved portions of the air duct extend substantially over the whole air duct in the basement.

**[0020]** The novel and inventive features believed to be the characteristic of the present invention are set forth in the appended claims.

**[0021]** The invention will be described in further detail with reference to the drawings, in which

45 FIG 1 shows an upper perspective exploded view of a basement of a laundry dryer according to a preferred embodiment of the present invention,

FIG 2 shows a lower perspective exploded view of the basement of the laundry dryer according to the preferred embodiment of the present invention,

FIG 3 shows a perspective view of the open basement of the laundry dryer according to the preferred embodiment of the present invention,

55 FIG 4 shows a top view of the open basement of the laundry dryer according to the preferred em-

bodiment of the present invention,

FIG 5 shows a perspective view of the laundry dryer according to the preferred embodiment of the present invention, and

FIG 6 shows a top view of the open basement of the laundry dryer according to the prior art.

**[0022]** FIG 1 illustrates an upper perspective exploded view of a basement of a laundry dryer according to a preferred embodiment of the present invention. The basement is provided for a laundry dryer with a heat pump system. The basement forms a lower portion of the laundry dryer and is arranged below a laundry drum.

**[0023]** The basement advantageously includes a lower casing 10 and an upper casing 12. Further, the basement includes a compressor 14, an evaporator 16, a condenser 18, a fan 20 and a motor 22. The lower casing 10 and the upper casing 12 enclose the compressor 14, the evaporator 16, the condenser 18, the fan 20 and the motor 22.

**[0024]** The laundry dryer comprises a closed air stream circuit. The air stream circuit includes the fan 20, the laundry drum, the evaporator 16 and the condenser 18. The heat pump system comprises a closed refrigerant circuit. The refrigerant circuit includes the compressor 14, the evaporator 16, the condenser 18 and an expansion device. The expansion device is not shown in FIG 1.

**[0025]** In the air stream circuit an air stream is moved by the fan 20, passes the laundry drum and removes water from wet clothes inside said laundry drum. The motor 22 is provided for driving the fan 20. Then, the air stream is cooled down and dehumidified in the evaporator 16, heated up in the condenser 18 and re-inserted into the laundry drum again. In the refrigerant circuit the refrigerant is compressed by the compressor 14, condensed in the condenser 18, laminated in the expansion device and vaporized in the evaporator 16. The evaporator 16 and the condenser 18 are heat exchangers between the air stream circuit and the refrigerant circuit.

**[0026]** The air stream circuit comprises an air duct 24. The air duct 24 is formed by the lower casing 10 and the upper casing 12. In FIG 1 a lower part of the air duct 24 formed by the lower casing 10 is visible. The air duct 24 has the structure of an arc of a circle. Thus, the air duct 24 has no corners and edges. The evaporator 16 and the condenser 18 are arranged in the air duct 24. The orientations of the evaporator 16 and condenser 18 are adapted to the run of the air duct 24, so that the flow directions through the evaporator 16 and condenser 18 are substantially the same as in the air duct 24. The fan 20 is arranged at the end of the air duct 24.

**[0027]** The structure of the curved air duct 24 and the orientations of the evaporator 16 and condenser 18 allow an improved air stream. Pressure drops and turbulences of the air stream are reduced. The noise generated by the air stream is also reduced.

**[0028]** FIG 2 illustrates a lower perspective exploded view of the basement of the laundry dryer according to the preferred embodiment of the present invention. The basement includes the lower casing 10 and the upper casing 12. The compressor 14, the evaporator 16, the condenser 18, the fan 20 and the motor 22 are enclosed by the lower casing 10 and the upper casing 12.

**[0029]** The air duct 24 is formed by the lower casing 10 and the upper casing 12. In FIG 2 an upper part of the air duct 24 formed by the upper casing 12 is visible. The air duct 24 has the structure of an arc of a circle.

**[0030]** FIG 3 illustrates a perspective view of the open basement of the laundry dryer according to the preferred embodiment of the present invention. The compressor 14, the evaporator 16, the condenser 18, the fan 20 and the motor 22 are arranged in the lower casing 10 and covered by the upper casing 12.

**[0031]** In particular, FIG 3 clarifies the orientation of the evaporator 16 and the condenser 18 inside the air duct 24. The flow directions of the air stream through the evaporator 16 and condenser 18 are adapted to the flow direction in the air duct 24.

**[0032]** FIG 4 illustrates a top view of the open basement of the laundry dryer according to the preferred embodiment of the present invention. The compressor 14, the evaporator 16, the condenser 18, the fan 20 and the motor 22 are arranged in the lower casing 10 of the basement.

**[0033]** The side walls of the air duct 24 are smooth and have no corner or edges. FIG 4 clarifies the orientations of the evaporator 16 and condenser 18, wherein the flow directions through the evaporator 16 and condenser 18 are substantially the same as the air flow direction in the air duct 24. In other words, the evaporator 16 and the condenser 18 are inclined to each other, wherein their main planes advantageously intersect in the central point of the circle defining the arc of the air duct 24. The arrows 30 represent the air stream through the air duct 24.

**[0034]** FIG 5 illustrates a perspective view of the laundry dryer according to the preferred embodiment of the present invention. The laundry dryer comprises the laundry drum 26 and the basement 28. The laundry drum 26 is arranged in a central portion of the laundry dryer. The basement 28 forms a lower portion of the laundry dryer. In this example, the air duct 24 extends along a horizontal direction inside the basement.

**[0035]** FIG 6 illustrates a top view of the open basement of the laundry dryer according to the prior art. The compressor 14, the evaporator 16, the condenser 18, the fan 20 and the motor 22 are arranged in the lower casing 10 of the basement. The evaporator 16 and the condenser 18 are placed in a straight air duct. The evaporator 16 and the condenser 18 are arranged in parallel. The straight air duct causes that the air stream has to pass an angle at the inlet and outlet of said straight air duct. Such angles in the air stream circuit cause pressure drops and turbulences increasing the energy consumption and the noise. His problems have been overcome

by the present invention.

**[0036]** Although an illustrative embodiment of the present invention has been described herein with reference to the accompanying drawings, it is to be understood that the present invention is not limited to that precise embodiment, and that various other changes and modifications may be affected therein by one skilled in the art without departing from the scope of the invention. All such changes and modifications are intended to be included within the scope of the invention as defined by the appended claims.

#### List of reference numerals

#### [0037]

10	lower casing
12	upper casing
14	compressor
16	evaporator
18	condenser
20	fan
22	motor
24	air duct
26	laundry drum
28	basement
30	air stream

#### Claims

1. A laundry dryer with a heat pump system comprising a refrigerant circuit for a refrigerant and an air stream circuit for an air stream, wherein
  - the refrigerant circuit includes a compressor (14), a condenser (18), an expansion device and an evaporator (16),
  - the air stream circuit includes at least one air stream fan (20), a laundry drum (26), the evaporator (16) and the condenser (18) connected in series and forming a closed loop,
  - the refrigerant circuit and the air stream circuit are thermally coupled by the evaporator (16) and the condenser (18),
  - the evaporator (16) is provided for cooling down the air stream and heating up the refrigerant,
  - the condenser (18) is provided for heating up the air stream and cooling down the refrigerant,
  - the air stream circuit includes an air duct (24) arranged in a basement (28) of the laundry dryer, and
  - the evaporator (16) and the condenser (18) are arranged inside the air duct (24), wherein the basement forms a lower portion of the laundry dryer and is arranged below a laundry drum and wherein the basement includes the compressor

(14), the evaporator (16), the condenser (18), the fan (20) and a motor (22) for driving the fan (20), **characterized in that**

- the air duct (24) comprises at least one curved portion when seen in top view,
- the evaporator (16) and the condenser (18) are arranged inside said curved portion of the air duct (24), and
- at least a part of the curved portion of the air duct (24) has the structure of an arc of a circle, wherein the evaporator (16) and the condenser (18) are inclined to each other when seen in top view.

2. The laundry dryer according to claim 1, **characterized in that** the fan (20) of the air stream circuit is arranged at the end of the air duct (24) or at the end of the curved portion of said air duct (24) in the basement (28).
3. The laundry dryer according to any one of the preceding claims, **characterized in that** the air duct (24) or the curved portion of said air duct (24) extends horizontally in the basement (28).
4. The laundry dryer according to any one of the preceding claims, **characterized in that** the one or more curved portions of the air duct (24) extend substantially over the whole air duct (24) in the basement (28).

#### Patentansprüche

1. Wäschetrockner mit einem Wärmepumpensystem, umfassend einen Kältemittelkreislauf für ein Kältemittel und einen Luftstromkreislauf für einen Luftstrom, wobei
  - der Kältemittelkreislauf einen Verdichter (14), einen Verflüssiger (18), eine Expansionseinrichtung und einen Verdampfer (16) enthält,
  - der Luftstromkreislauf mindestens ein Luftstromgebläse (20), eine Wäschetrommel (26), den Verdampfer (16) und den Verflüssiger (18) enthält, die in Reihe geschaltet sind und einen geschlossenen Kreislauf bilden,
  - der Kältemittelkreislauf und der Luftstromkreislauf durch den Verdampfer (16) und den Verflüssiger (18) thermisch gekoppelt sind,
  - der Verdampfer (16) zum Kühlen des Luftstroms und zum Erwärmen des Kältemittels vorgesehen ist,
  - der Verflüssiger (18) zum Erwärmen des Luftstroms und zum Kühlen des Kältemittels vorgesehen ist,
  - der Luftstromkreislauf einen Luftkanal (24) enthält, der in einem Sockel (28) des Wäschetrock-

ners angeordnet ist, und

- der Verdampfer (16) und der Verflüssiger (18) innerhalb des Luftkanals (24) angeordnet sind, wobei der Sockel einen unteren Abschnitt des Wäschetrockners bildet und unter einer Wäschetrockner angeordnet ist und wobei der Sockel den Verdichter (14), den Verdampfer (16), den Verflüssiger (18), das Gebläse (20) und einen Motor (22) zum Antreiben des Gebläses (20) enthält,

**dadurch gekennzeichnet, dass**

- der Luftkanal (24) in Draufsicht gesehen mindestens einen gekrümmten Abschnitt umfasst,  
 - der Verdampfer (16) und der Verflüssiger (18) innerhalb des gekrümmten Abschnitts des Luftkanals (24) angeordnet sind, und  
 - mindestens ein Teil des gekrümmten Abschnitts des Luftkanals (24) die Struktur eines Kreisbogens aufweist, wobei der Verdampfer (16) und der Verflüssiger (18) in Draufsicht gesehen zueinander geneigt sind.

2. Wäschetrockner gemäß Anspruch 1, **dadurch gekennzeichnet, dass** das Gebläse (20) des Luftstromkreislaufs am Ende des Luftkanals (24) oder am Ende des gekrümmten Abschnitts des Luftkanals (24) im Sockel (28) angeordnet ist.
3. Wäschetrockner gemäß einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** sich der Luftkanal (24) oder der gekrümmte Abschnitt des Luftkanals (24) horizontal im Sockel (28) erstreckt.
4. Wäschetrockner gemäß einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** sich der eine oder die mehreren gekrümmten Abschnitte des Luftkanals (24) im Wesentlichen über den gesamten Luftkanal (24) im Sockel (28) erstrecken.

## Revendications

1. Sèche-linge équipé d'un système de pompe à chaleur comprenant un circuit de fluide frigorigène pour un fluide frigorigène et un circuit de flux d'air pour un flux d'air,  
 - le circuit de fluide frigorigène comportant un compresseur (14), un condenseur (18), un dispositif de détente et un évaporateur (16),  
 - le circuit de flux d'air comportant au moins une soufflante de flux d'air (20), un tambour à linge (26), l'évaporateur (16) et le condenseur (18) montés en série et formant une boucle fermée,  
 - le circuit de fluide frigorigène et le circuit de flux d'air étant couplés thermiquement par l'évaporateur (16) et le condenseur (18),  
 - l'évaporateur (16) servant à refroidir le flux d'air

et à réchauffer le fluide frigorigène,

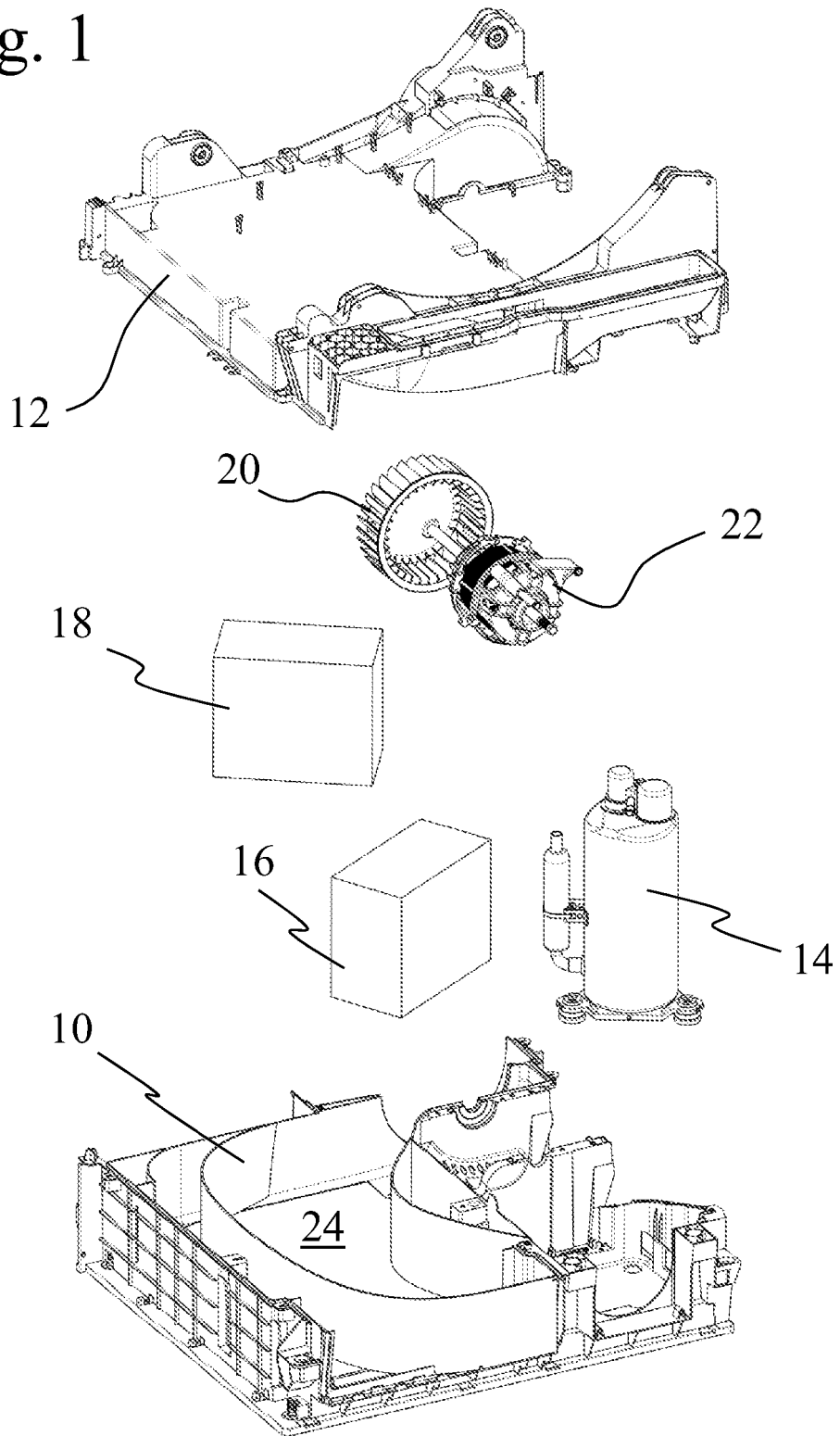
- le condenseur (18) servant à réchauffer le flux d'air et à refroidir le fluide frigorigène,  
 - le circuit de flux d'air comportant un conduit d'air (24) agencé dans un socle (28) du sèche-linge, et  
 - l'évaporateur (16) et le condenseur (18) étant agencés à l'intérieur du conduit d'air (24), le socle formant une partie inférieure du sèche-linge et étant agencé sous un tambour à linge, et le socle comportant le compresseur (14), l'évaporateur (16), le condenseur (18), la soufflante (20) et un moteur (22) destiné à entraîner la soufflante (20),

**caractérisé en ce que**

- le conduit d'air (24) comprend au moins une partie incurvée en vue de dessus,  
 - l'évaporateur (16) et le condenseur (18) sont agencés à l'intérieur de ladite partie incurvée du conduit d'air (24), et  
 - au moins une partie de la partie incurvée du conduit d'air (24) présente la structure d'un arc de cercle, l'évaporateur (16) et le condenseur (18) étant inclinés l'un par rapport à l'autre en vue de dessus.

2. Sèche-linge selon la revendication 1, **caractérisé en ce que** la soufflante (20) du circuit de flux d'air est agencée à l'extrémité du conduit d'air (24) ou à l'extrémité de la partie incurvée dudit conduit d'air (24) dans le socle (28).
3. Sèche-linge selon l'une quelconque des revendications précédentes, **caractérisé en ce que** le conduit d'air (24) ou la partie incurvée dudit conduit d'air (24) s'étend horizontalement dans le socle (28).
4. Sèche-linge selon l'une quelconque des revendications précédentes, **caractérisé en ce que** la ou les parties incurvées du conduit d'air (24) s'étendent sensiblement sur tout le conduit d'air (24) dans le socle (28).

Fig. 1



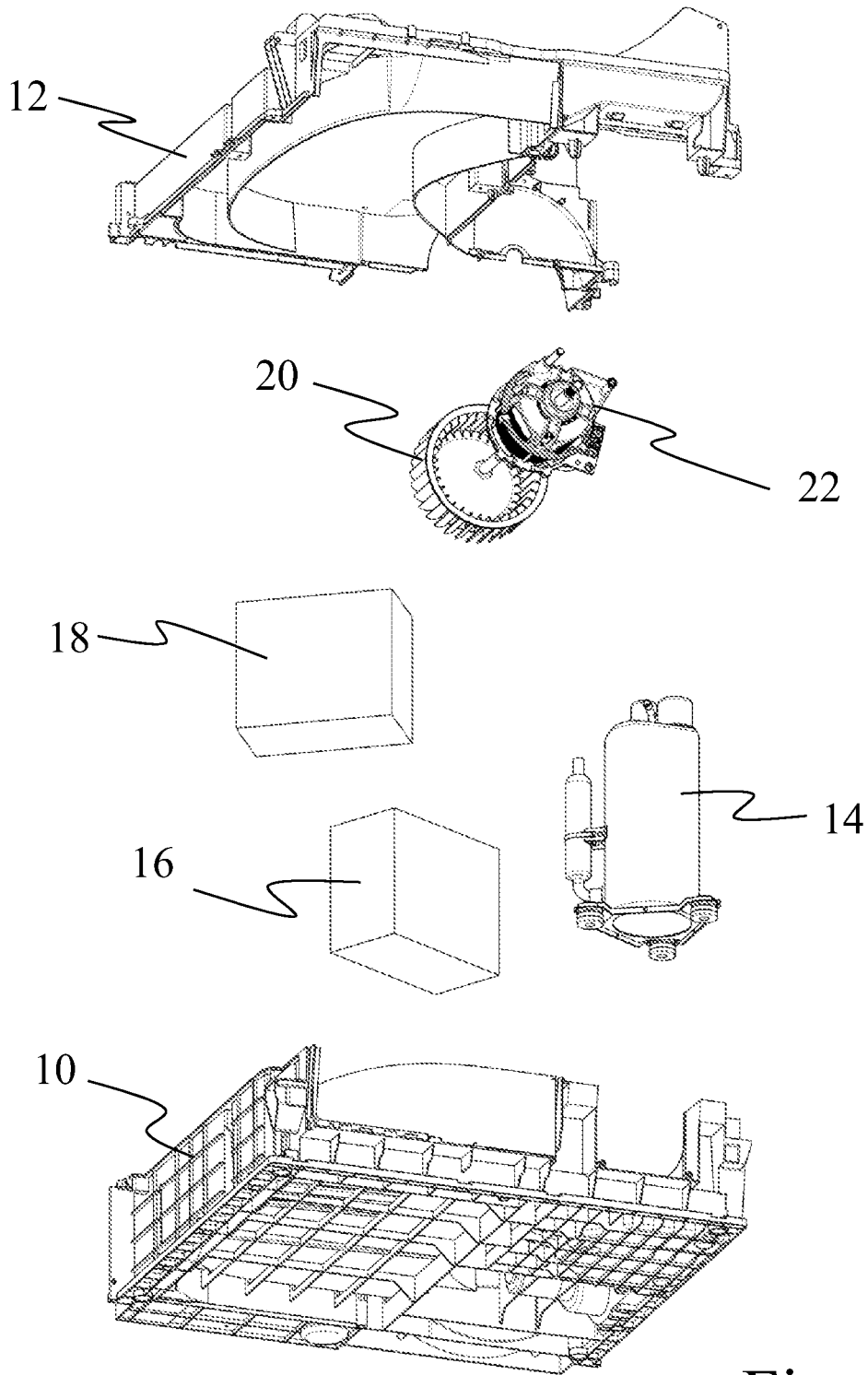


Fig. 2

Fig. 3

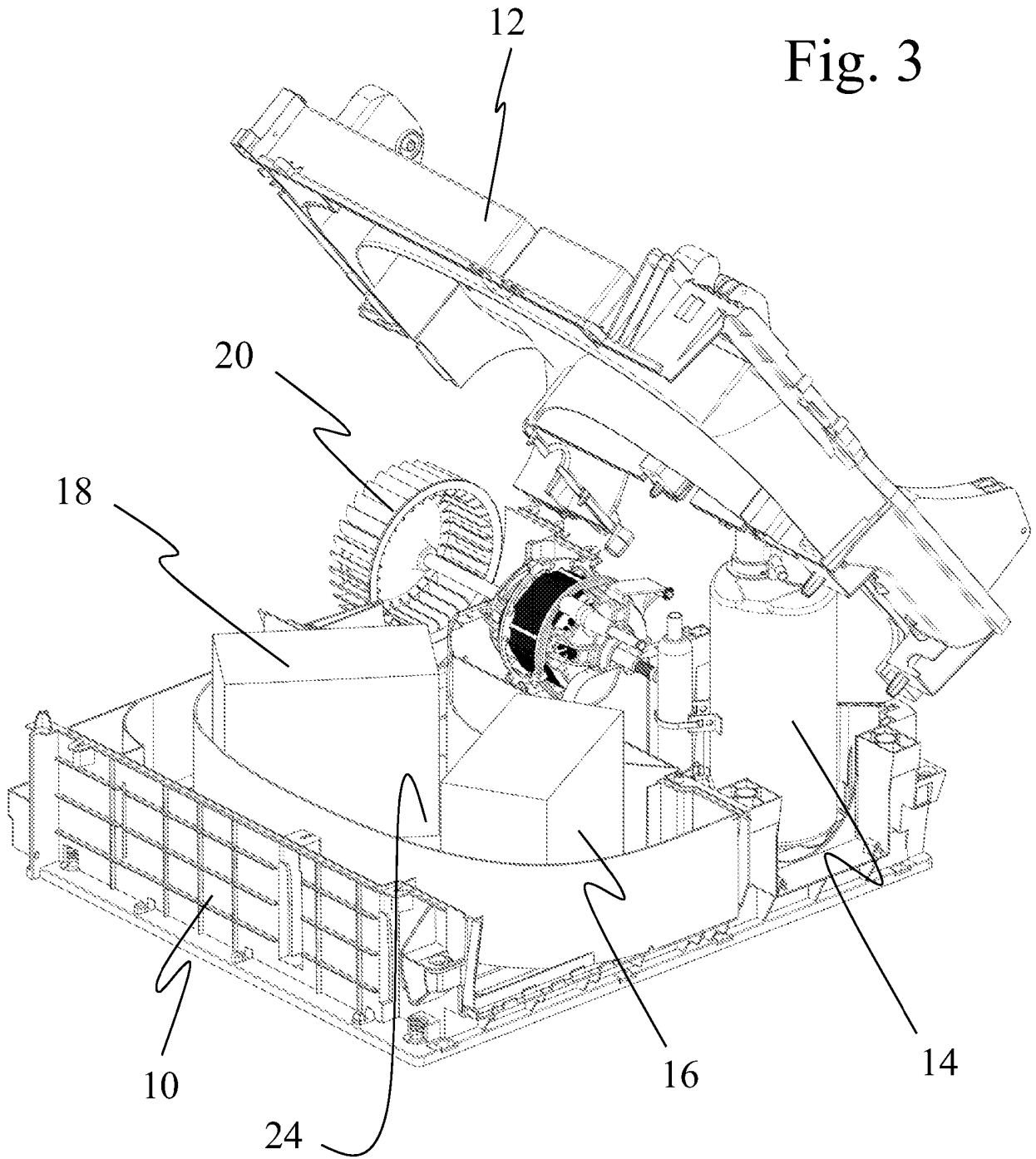




Fig. 4

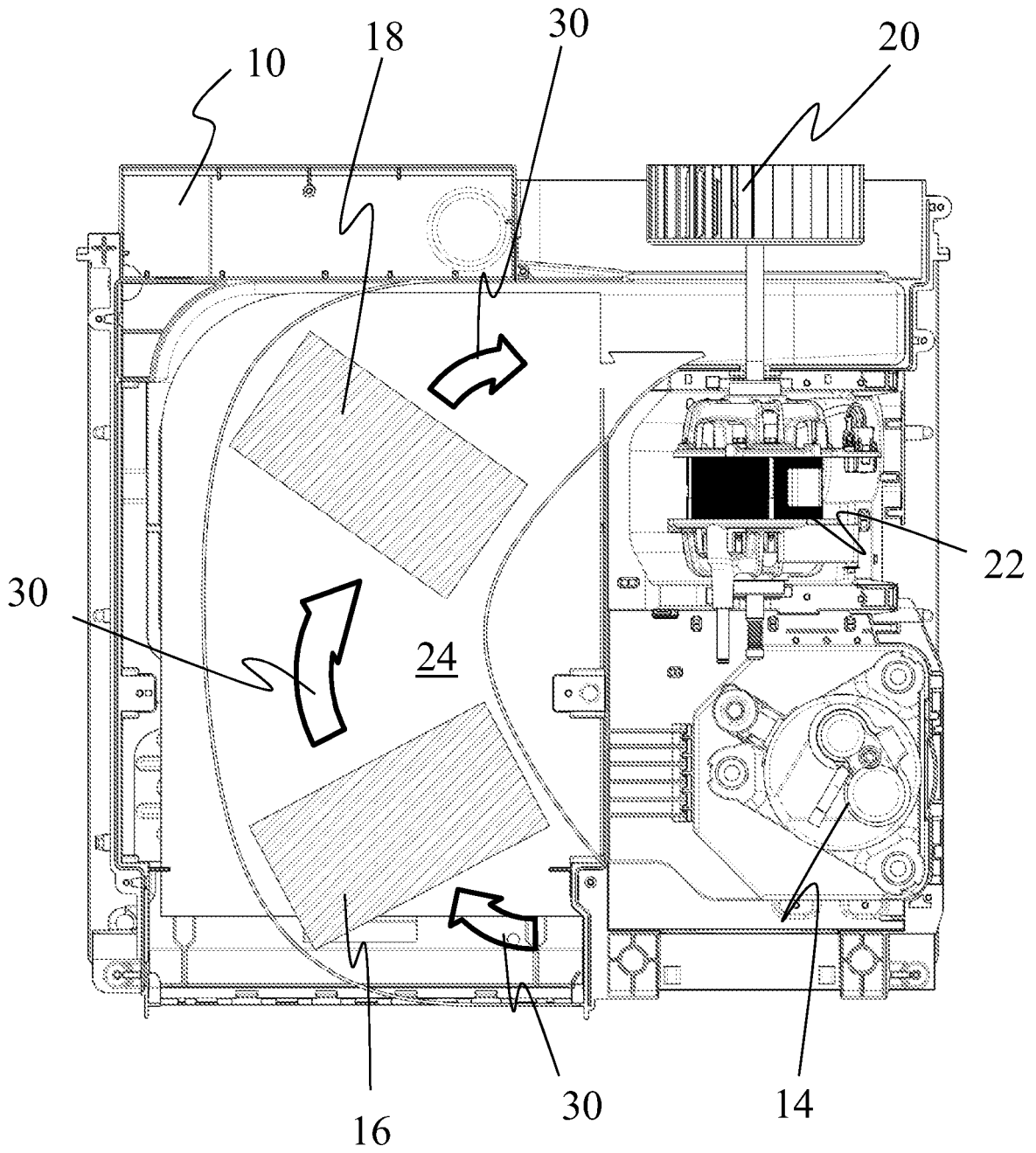


Fig. 5

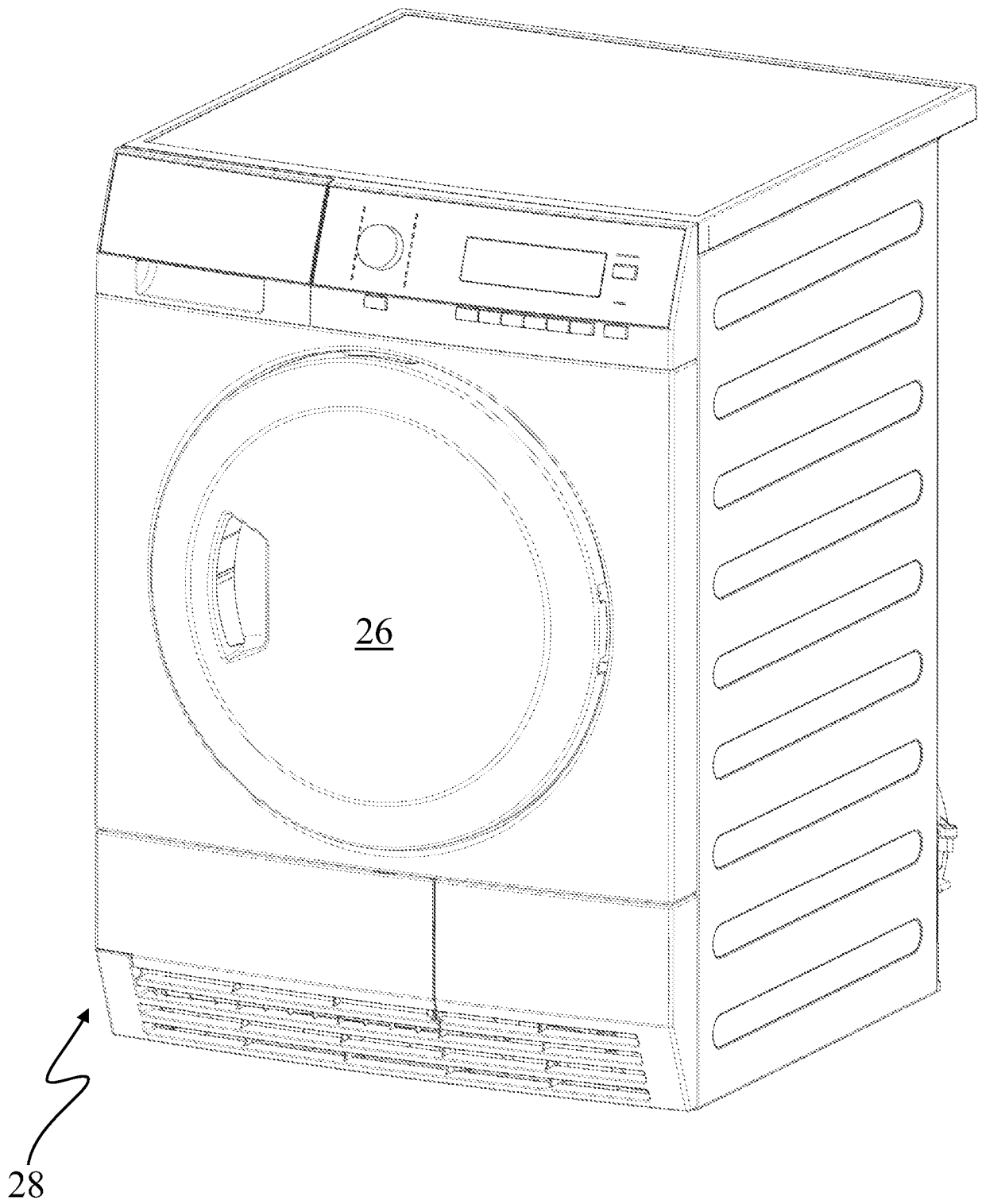
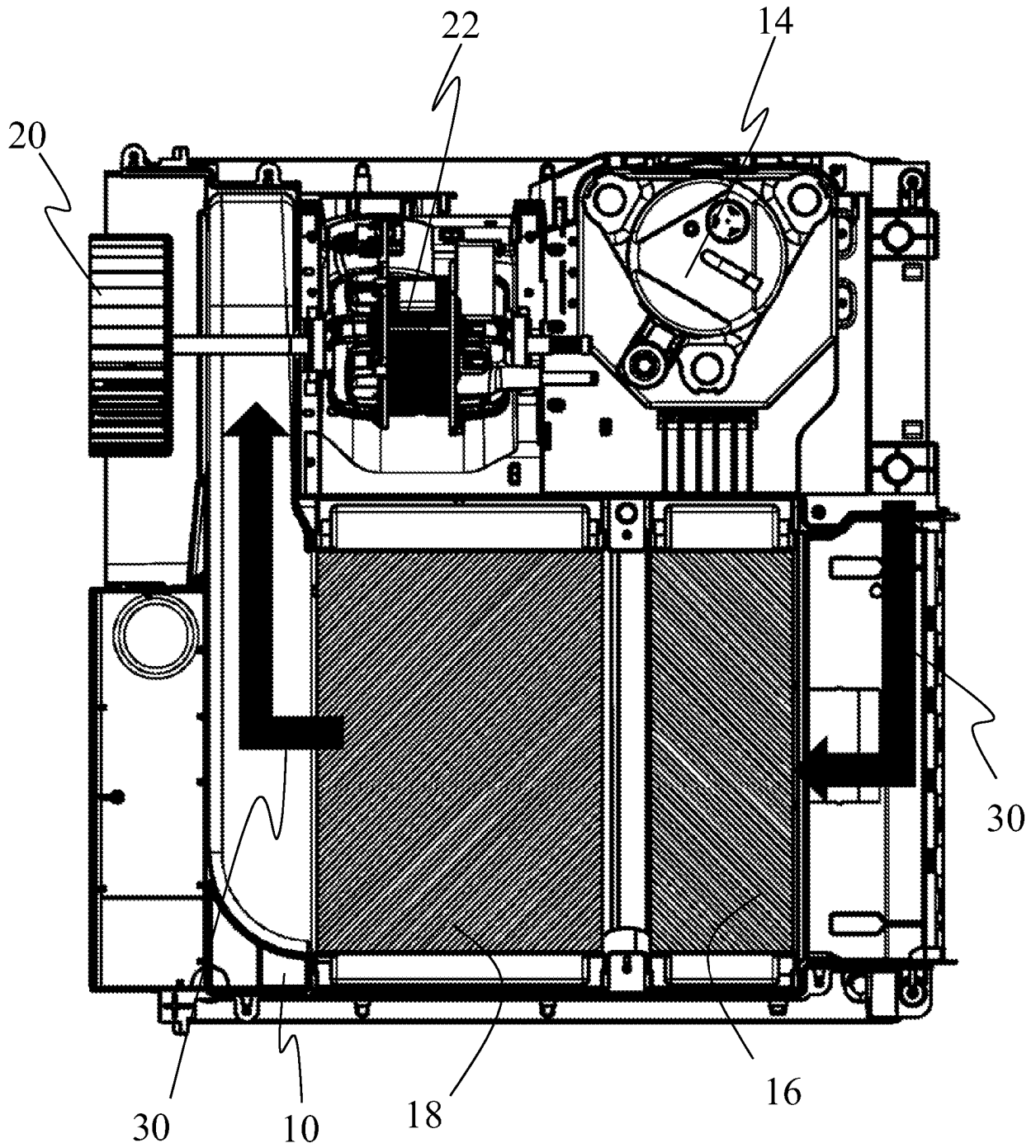


Fig. 6

PRIOR ART



**REFERENCES CITED IN THE DESCRIPTION**

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**Patent documents cited in the description**

- DE 4212700 A1 [0005]
- WO 2008077838 A1 [0006]
- DE 102006016294 A1 [0007]
- JP 2007000386 A [0008]