



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
15.09.2021 Bulletin 2021/37

(51) Int Cl.:
F25D 21/02 (2006.01) **F25D 21/08** (2006.01)
F25D 21/00 (2006.01) **F24F 11/41** (2018.01)

(21) Application number: **21161323.7**

(22) Date of filing: **08.03.2021**

(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
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(72) Inventors:
• **FILIPPINI, Stefano**
21040 Uboldo (VA) (IT)
• **MERLO, Umberto**
21040 Uboldo (VA) (IT)

(74) Representative: **Rastelli, Franco**
Dott. Franco Cicogna & C. SRL
Via Visconti di Modrone, 14/A
20122 Milano (IT)

(30) Priority: **11.03.2020 IT 202000005218**

(71) Applicant: **LU-VE S.p.A.**
21100 Varese (IT)

(54) **A METHOD FOR CONTROLLING THE FORMATION OF FROST IN COOLING UNITS OF REFRIGERATION SYSTEMS**

(57) A method for controlling the formation of frost in cooling units of refrigeration systems which comprise at least one heat exchange battery (2) equipped with a fan (3) and defrosting devices for the heat exchange surfaces, in which the defrosting cycle is automatically started upon reaching predetermined threshold values of the air

flow rate at the fan (3), or of the air pressure in said cooling unit (1). The method has the main advantage of automatically determining the moment when it is necessary to start the defrosting cycle, thus avoiding starting the system in the absence of frost formation.

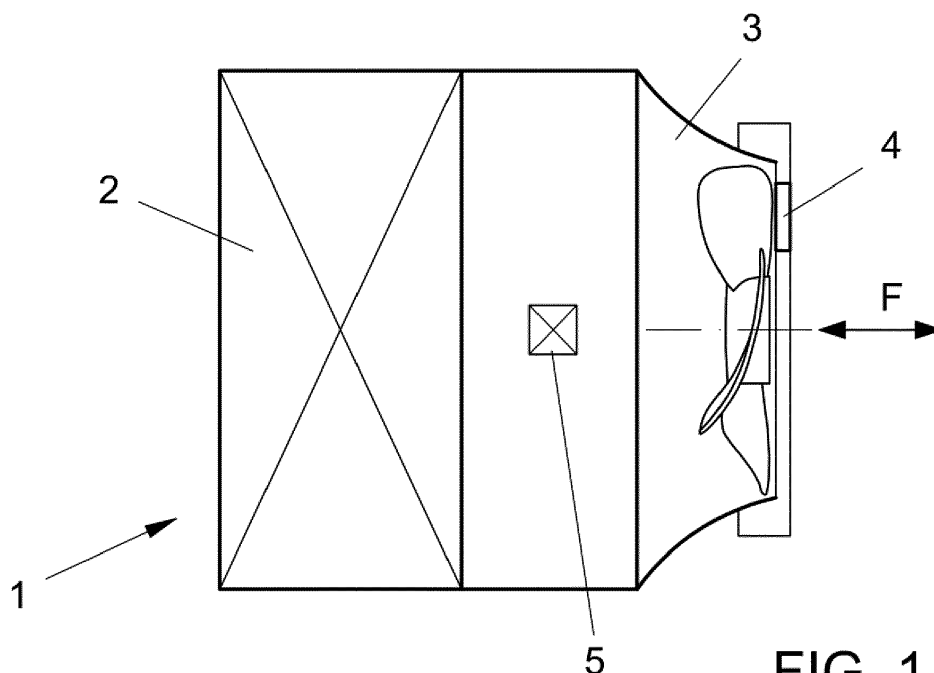


FIG. 1

Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to an improved process for controlling the formation of frost in cooling units of refrigeration systems.

[0002] The formation of frost on the heat exchange surfaces in contact with humid air of appliances intended for refrigeration and air conditioning, including heat pumps, air-evaporators and air-coolers with single-stage fluids, hereinafter referred to for brevity as "evaporators" or "UR" cooling units, causes progressive deterioration in the performance of the appliances themselves, with adverse consequences on the energy performance of the systems in which the appliances are installed.

[0003] To limit the adverse influence of frost it is customary to provide for defrosting modes for evaporators of different types (electric, water, hot gas, etc.), which restore the operating conditions to those of a "clean" evaporator. In current use it is also envisaged that the defrosting cycles take place at constant time intervals, which can be set by the operator (for example a defrosting every six hours), regardless of the actual need to perform this operation. Carrying out a defrosting cycle without it being required involves obvious drawbacks. In terms of energy consumption in particular; in addition to waste of the energy required by defrosting, it must be borne in mind that much of the thermal energy used to defrost ends up in the room which is to be cooled and must therefore be removed, with further energy consumption. Furthermore, there is no cooling capacity during the defrosting cycle, and therefore the installed cooling capacity must be increased at same cooling. Significant energy disadvantages also occur when defrosting takes place later than the optimal time, since the evaporator is forced to operate under poor conditions, with consequent worse COP (coefficients of performance) for the refrigeration / heat pump cycle.

SUMMARY OF THE INVENTION

[0004] The main purpose of the present invention is to provide an "intelligent" defroster, that is to say a system capable of determining when the optimal time to defrost is, regardless of the time interval elapsed since the previous defrosting cycle.

[0005] This object is accomplished through the method of claim 1. Preferred embodiments of the invention will be apparent from the remaining claims.

[0006] The method according to the invention has the main advantage of automatically determining the moment at which it is necessary to start the defrosting cycle, thus avoiding the system coming into operation if no frost has formed.

[0007] According to a further advantage, the method according to the invention lends itself for application to any type of evaporator, regardless of its potential, the

refrigerant fluid used, the operating conditions under which it works, the number of compressors with which it is interfaced and the number of evaporators with which it is in parallel.

[0008] A further advantage of the method according to the invention is the fact that it does not require any calibration, neither by the evaporator manufacturer, nor by the installer, nor by the user.

[0009] Yet another advantage is the fact that the method according to the invention allows a degree of freedom to the user, who can vary the preset value of the time of the defrosting cycle at will, according to his needs.

[0010] In addition to optimizing the defrosting cycles, the method according to the invention has the advantage of allowing to determine and report any non-operation (due to failures or other) of one (or more) fans and one (or more) resistors.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] These and other objects, advantages and features will be apparent from the following description of some preferred embodiments of the method according to the invention illustrated by way of non-limiting examples in the figures of the attached drawings sheets.

[0012] In these:

- Figure 1 diagrammatically illustrates in lateral view a cooling unit with which the method according to the invention is carried out;
- Figure 2 shows the detail of the ventilation system mounted on the cooling unit in Figure 1;
- Figure 3 is a flow chart in which the main stages of the method according to the invention are illustrated;
- Figure 4 illustrates the trend of the air speed and the number of revolutions of the fan as a function of time in the defrosting method illustrated in Figure 3;
- Figure 5 is a flow chart in which the main stages of a variant of the method according to the invention are illustrated;
- Figure 6 illustrates the trend of the difference in air pressure to the fan as a function of time in the method shown in Figure 5;
- Figure 7 illustrates the hardware structure for managing several cooling units with the method according to the invention; and
- Figure 8 illustrates the characteristic curve of the fan of the cooling unit in Figure 1 and the relative signal curve for the air speed sensor.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0013] The cooling unit 1 illustrated in Figure 1 comprises a heat exchange battery 2 (with the relative exchanger or finned pack, not shown) and a fan 3, advantageously of the axial type, provided with a sensor 4 for measuring the speed of the air entering or exiting the fan

in the direction of arrow F.

[0014] Preferably the aforementioned sensor 4 is constituted by a hot wire sensor, for detecting the speed of the air entering or exiting the fan 3. It is positioned radially on the protection / support grid, so as to allow to get an average speed value at the inlet or outlet of the fan. The signal is proportional to the air flow rate, which is taken into account in the method according to the invention.

[0015] Instead of the aforementioned sensor 4, the cooling unit 1 may comprise a sensor 5 for measuring the air pressure in said cooling unit 1, in particular between the heat exchange battery 2 and the fan 3.

[0016] Figure 8 shows the example of a characteristic curve for fan 3 and the related signal curve of the speed sensor. Means, for example resistors or the like, not illustrated, are also provided for defrosting the heat exchange surfaces.

[0017] Figure 3 shows the main stages in the method according to the invention, in the form of a flow chart that measures the air speed, i.e., the air flow processed by the fan 3.

[0018] Initially the value of the air flow rate with a clean battery is entered or acquired. This value is stored and maintained for the entire period of system operation. Then the input values of the following variables are entered: ratio between the final air flow rate (i.e., with frosted battery) and the initial air flow rate (with clean battery), the nominal and maximum rpm that can be reached by the fan 3 and the target defrosting time.

[0019] The complete logic consists of two main stages:

- A. controlling the revolutions of the fan 3 to keep the air flow rate constant during the first formation of frost on the finned pack;
- B. monitoring the air flow rate during the formation of frost at constant revolutions, up to the start-defrost command; followed by an auxiliary stage
- C. monitoring the defrosting (cleaning) degree of the finned pack of the heat exchange battery 2 and adjusting the defrosting time.

INPUT data

[0020] The Input data shown in the diagram in Figure 3 are the following, as set in the system control logic before the refrigeration unit is started:

- Vo: speed of the air at the sensor 4 of the fan 3 at the start of the frosting process, or with clean battery 2 exchanger;
- Vf: air speed at the end of the frosting process, or with the exchanger frosted;
- RVo = Vf / Vo: ratio between the air speed at the end of the frosting process and at the beginning thereof;
- Rpmo: nominal or initial number of revolutions of the fan;
- Rpmmax: maximum number of revolutions of the fan;

to: nominal defrosting time (initial time).

Stage A

[0021] In this stage, the decrease in the performance of the refrigeration unit due to the initial formation of frost on the heat exchange battery 2 is compensated by the increase in the number of revolutions of the fan 3, so as to keep the air flow rate on the same battery 2 constant.

[0022] This stage includes the following stages:

A1: the control system acquires the instantaneous number of revolutions of the fan 3, Rpmi, and the instantaneous air speed, Vi;

A2: speed Vi is compared with that Vi-1 measured in the previous cycle. If Vi > Vi-1 then the system continues with passive air speed monitoring. If on the other hand Vi < Vi-1 the system enters the stage:

A3: the instantaneous number of revolutions Rpmi of the fan 3 is increased by a value ΔRpm, so as to obtain an increase in the number of revolutions of the fan equal to:

$$Rpmi+1 = Rpmi + \Delta Rpm$$

Furthermore:

A4: if Rpmi+1 = Rpmmax set in the INPUT, the logic brings the method to stage B. If instead Rpmi+1 < Rpmmax, the cycle returns to stage A1 (passive monitoring of the number of revolutions of the fan).

Stage B

[0023] Stage B is a frosting stage, which occurs when the frost that has formed on heat exchange battery 2 has reached a level such that the fan 3 is no longer able to maintain the initial performance of the refrigeration unit on its own. This stage includes the following stages:

B1: reading the instantaneous values Vi of the air speed and Rpmi of the number of revolutions of the fan 3;

B2: in this stage, if Vi/Vo > RVo, where Vi is the instantaneous air speed, Vo and RVo are INPUT data, the system remains in a passive state of simply reading the refrigeration cycle parameters.

If instead Vi/Vo = RVo, then the system enters the stage:

B3: starting defrosting, in which the resistors that melt the frost are activated and the timer controls the defrosting time tdefrost. If tdefrost < to it then activates the stage:

B4: maintaining the defrosting stage.

If instead tdefrost = to, it enters the stage:

B5: stopping the defrosting stage.

From here the following stage is started:

B6: in this stage the number of revolutions Rpm of the fan 3 is reset to the initial value Rpmo and the system, if necessary, enters the following stage C.

Stage C

[0024] In this stage the defrosting (cleaning) degree of the finned pack or exchanger of the battery 2 is monitored and the defrosting time is readjusted to the INPUT to value. In particular, stage C includes the following stages:

C1: at this stage the system selects among:

- a logic for managing the defrosting stage at a predetermined time and in this case the cycle returns to stage A1;
- a logic for managing the defrosting stage with variable time, i.e., adjusted according to the presence of frost residues on the exchanger, which brings the system to the stage:

C2: reading the instantaneous data Rpmi of the fan and Vi of air speed.

C3: in this stage the values Vi measured in stage C2 and Vo of INPUT are compared and if $V_i = V_o$ the system enters the stage:

C4: where a new INPUT time to+1 is established, obtained by decreasing the initial time to by a difference Δt : $to+1 = to - \Delta t$. From here the cycle returns to stage A1, in which the INPUT time to is brought to the value to+1.

If, on the other hand, $V_i < V_o$, this means that there are frost residues on the exchanger. In this case it enters the stage:

C5: where the cycle returns to stage A1 with a new INPUT value to+1 of $to+1 = to + \Delta t$.

[0025] Then in stage A the system continues to monitor the value of the fan revolutions and the air flow rate. When the latter begins to decrease compared to the clean battery value Vo, this means that frost is forming on the finned pack of the refrigeration unit. Consequently, the system increases the fan revolutions, up to the maximum set value Rpmmax, to keep constant the air flow rate equal to Vo.

[0026] Once the maximum value of the number of revolutions of the fan Rpmmax has been reached, it enters the second control stage, called B. In this stage the system continues to monitor the fan revolutions and the air flow rate. The latter is compared to the initial one with clean battery and when this ratio reaches the set value RVo, the system activates the defrosting stage. A clock measures the defrosting time and when it reaches the set tdefrost value, the defrosting stage ends and all the variables are reset to their initial state.

[0027] At this point it is possible to set a fixed defrosting time mode, or to activate stage C for monitoring the defrosting (cleaning) degree of the refrigeration unit. This

stage C monitors the air flow rate at the end of the defrosting and if said value is lower than that of the clean battery Vo, the defrosting time to is extended. In the next cycle the defrosting time can be adjusted once again to achieve complete cleaning of the finned pack.

[0028] The trend of the air speed and the number of revolutions measured on fan 3 as a function of time in the method illustrated in Figure 3 are shown in the diagram in Figure 4. In particular, Vo of the air is kept constant, thanks to the increase in the number of revolutions of the fan, up to the maximum value Rpmmax. Thereafter, this maximum number of revolutions of the fan remains constant and the air flow rate decreases due to the formation of frost or frosting. Once the Vf or RVo value is reached, the fan is stopped and the defrosting stage begins, in which the air flow rate and the relative number of revolutions of the fan are reset to zero. The cycle is then repeated.

[0029] According to the variant of the method of the invention illustrated in the flow diagram in Figure 5, the reference parameter is the air pressure measured, by the sensor 5 in Figure 1, in the heat exchange battery 2, in particular between the battery 2 exchanger and the fan 3.

[0030] In the method shown in Figure 5, the air pressure value with clean battery is initially entered or acquired. This value is stored and maintained for the entire period of system operation. The values of the following variables are then recorded: ratio between the final air pressure (i.e., with frosted battery) and the initial air pressure (with clean battery), the nominal and maximum number of revolutions that can be reached by the fan 3 and the defrosting time.

[0031] The complete logic consists of two main stages:

- A. controlling the revolutions of the fan 3 to keep the air flow rate constant during the first formation of frost on the finned pack;
- B. monitoring the air pressure during the formation of frost at constant revolutions, up to the start-defrost command; followed by an auxiliary stage:
- C. monitoring the defrosting (cleaning) degree of the finned pack of the heat exchange battery 2 and adjusting the defrosting time.

INPUT data

[0032] The Input data shown in the diagram in Figure 5 are the following, as set on the system control logic before starting the refrigeration unit:

- ΔP_o : air pressure on the sensor 5 of the battery 2 at the start of the frosting process, i.e., with clean battery 2 exchanger;
- ΔP_f : air pressure at the end of the frosting process, i.e., with frosted exchanger;
- $R P_o = \Delta P_f / \Delta P_o$: ratio between the air pressure at

the beginning and the end of the frosting process;
 Rpmo: nominal or initial number of revolutions of the fan;
 Rpmmax: maximum number of revolutions of the fan;
 to: nominal defrosting time (initial time).

Stage A

[0033] In this stage, the decrease in the performance of the refrigeration unit due to the initial formation of frost on heat exchange battery 2 is compensated by the increase in the number of revolutions of the fan 3, so as to keep the air flow to the same battery 2 constant.

[0034] This stage includes the following stages:

A1: the control system acquires the instantaneous number of revolutions Rpmi of the fan 3 and the pressure difference ΔP_i ;

A2: the pressure difference ΔP_i is compared with that $\Delta P_i - 1$ measured in the previous cycle. If $\Delta P_i \leq \Delta P_i - 1$ the system continues with the passive monitoring of the air speed. If instead $\Delta P_i > \Delta P_i - 1$, the system enters the stage:

A3: the instantaneous number of revolutions Rpmi of the fan 3 is increased by a value ΔRpm , so as to obtain an increase in the number of revolutions of the fan equal to:

$$Rpmi+1 = Rpmi + \Delta Rpm$$

Furthermore:

A4: if $Rpmi+1 = Rpmmax$ set in the INPUT, the logic brings the method to stage B. If instead $Rpmi+1 < Rpmmax$, the cycle returns to stage A1 (passive monitoring of the number of revolutions of the fan).

Stage B

[0035] Stage B is a frosting stage, which occurs when the frost that has formed on heat exchange battery 2 has reached a level such that the fan 3 is no longer able to maintain the initial performance of the refrigeration unit on its own. This stage includes the following stages:

B1: reading the instantaneous values ΔP_i of air pressure and Rpmi of the number of revolutions of the fan 3;

B2: in this stage if $\Delta P_i / \Delta P_o < RPo$, where ΔP_i is the measured instantaneous pressure difference of the air, ΔP_o is the pressure difference with clean battery and RPo is the INPUT data, the system remains in a passive state of simply reading the parameters of the refrigeration cycle. If instead $\Delta P_i / \Delta P_o \geq RPo$ then the system enters stage:

B3: starting defrosting, in which the resistors that melt the frost are activated and the timer controls the

defrosting time tdefrost.

If tdefrost < to it then it activates the stage:

B4: maintaining the defrosting stage.

If instead tdefrost = to, it enters the stage:

B5: stopping the defrosting stage.

From here the following stage is started:

B6: in this stage the number of revolutions Rpm of the fan 3 is reset to the initial value Rpmo and the system, if necessary, enters the following stage C.

Stage C

[0036] In this stage the defrosting (cleaning) degree of the finned pack or exchanger of battery 2 is monitored and the defrosting time is readjusted to the INPUT to value. In particular, stage C includes the following stages:

C1: at this stage the system chooses between:

- a logic for managing the defrosting stage at a predetermined time and in this case the cycle returns to stage A1;
- a logic for managing the defrosting stage with variable time, i.e., adjusted according to the presence of frost residues on the exchanger, which brings the system to the stage:

C2: reading the instantaneous data Rpmi of the fan and ΔP_i of air pressure difference.

C3: in this stage the ΔP_i values measured in stage C2 and the INPUT ΔP_o values are compared and if $\Delta P_i \leq \Delta P_o$ the system enters the stage:

C4: where a new INPUT time to+1 is established, obtained by decreasing the initial time to by a difference to+1 = to - Δt . From here the cycle returns to stage A1, in which the INPUT time to is brought to the value to+1.

If, on the other hand, $\Delta P_i > \Delta P_o$, this means that there are frost residues on the exchanger. In this case it enters the stage:

C5: where the cycle returns to stage A1 with a new INPUT value to+1 of to+1 = to + Δt .

[0037] Then in stage A the system continues to monitor the value of the fan revolutions and the air pressure difference. When the latter begins to increase in comparison with the Po value of a clean battery, this means that frost is forming on the finned pack of the refrigeration unit. Consequently, the system increases the fan revolutions, up to the maximum set value Rpmmax, to keep the air flow rate constant.

[0038] Once the maximum value of the number of revolutions of the fan Rpmmax is reached, the second control stage, called B, is entered. In this stage the system continues to monitor the fan revolutions and the air pressure difference. This difference is compared to the initial one with clean battery and when said ratio reaches the set value RPo, the system activates the defrosting stage.

A clock measures the defrosting time and when it reaches the set tdefrost value, the defrosting stage ends and all the variables are reset to their initial state.

[0039] At this point it is possible to set a fixed defrosting time mode, or to activate stage C to monitor the defrosting (cleaning) degree of the refrigeration unit. This stage C monitors the air pressure difference at the end of defrosting and if said value is higher than the ΔP_i value of a clean battery, then the defrosting time is extended. In the next cycle the defrosting time can be adjusted once again to achieve complete cleaning of the finned pack.

[0040] The trend of the air pressure difference measured at the sensor 5 as a function of time in the method illustrated in Figure 5 is shown in the diagram in Figure 6. In particular, to keep the air flow rate constant, the number of fan revolutions is increased, up to the maximum limit Rpmmax. The pressure continues to rise due to the formation of frost, until it reaches the limit value ΔP_f . At this point the defrosting stage in which ΔP_f and Rpm are reset to zero is activated and then the defrosting cycle starts again.

[0041] Figure 7 shows the complete hardware structure of the system for managing a refrigeration plant, consisting of several cooling units 11, 12, 13 and the corresponding general controller 14. The latter may or may not incorporate control of electronic motors 151, 152, 153 and a series of contacts 161, 162, 163 for communication with the respective controllers 171, 172, 173 in the cold room. Communication with these cell controllers can also be performed via a Modbus system (or equivalent).

[0042] Several refrigeration units are managed by the system according to a stand-by logic. This is to prevent all the units from starting defrosting at the same time. If a first refrigeration unit requires defrosting while a second unit is already defrosting, the first is kept in stand-by until the second has completed its full cycle. Management of the defrosting of several units at the same time can be set as an initial variable, by entering the maximum number of cooling units used.

[0043] The system includes a series of checks, followed by refrigeration unit operating status alarm signals. The system also constantly monitors the operating status of the fan and the defrosting resistors (or other defrosting devices). A check on possible anomalous formation of frost at the end of defrosting is also provided.

[0044] Among the alarms inserted in the system there are those that monitor for:

- a fan on anomaly during defrosting: detection of the air flow rate during the defrosting stage $V_i > 0$, or detection of the air pressure during the defrosting stage $\Delta P_i > 0$;
- resistor failure: defrosting time (tdefr) higher than the set safety limit value;
- fan failure: air flow rate equal to zero after the defrosting stage or via Modbus message directly from the motor, or air pressure equal to zero after the de-

frosting stage;

- lack of cleaning of the finned pack: flow rate value detected after defrosting stage lower than the initial value V_0 , or pressure value detected after defrosting stage higher than the initial value ΔP_0 ;
- air flow/pressure sensor failure: air flow / pressure equal to zero with fan revolutions greater than zero, $R_{pmi} > 0$.

Claims

1. A method for controlling the formation of frost in cooling units of refrigeration systems which include at least one heat exchange battery (2) equipped with a fan (3) and defrosting devices for the heat exchange surfaces of said cooling units, **characterized in that** it provides for automatic starting of the defrosting cycle when predetermined threshold values of the air flow rate at the fan (3), or of the air pressure in said cooling unit (1), are reached.

2. The method according to claim 1, **characterized in that** it includes the following stages:

(A) controlling the fan (3) revolutions to keep the air flow rate constant during the first formation of frost on the finned pack;

(B) monitoring the air flow rate during the formation of frost at constant revolutions, up to the start-defrost command.

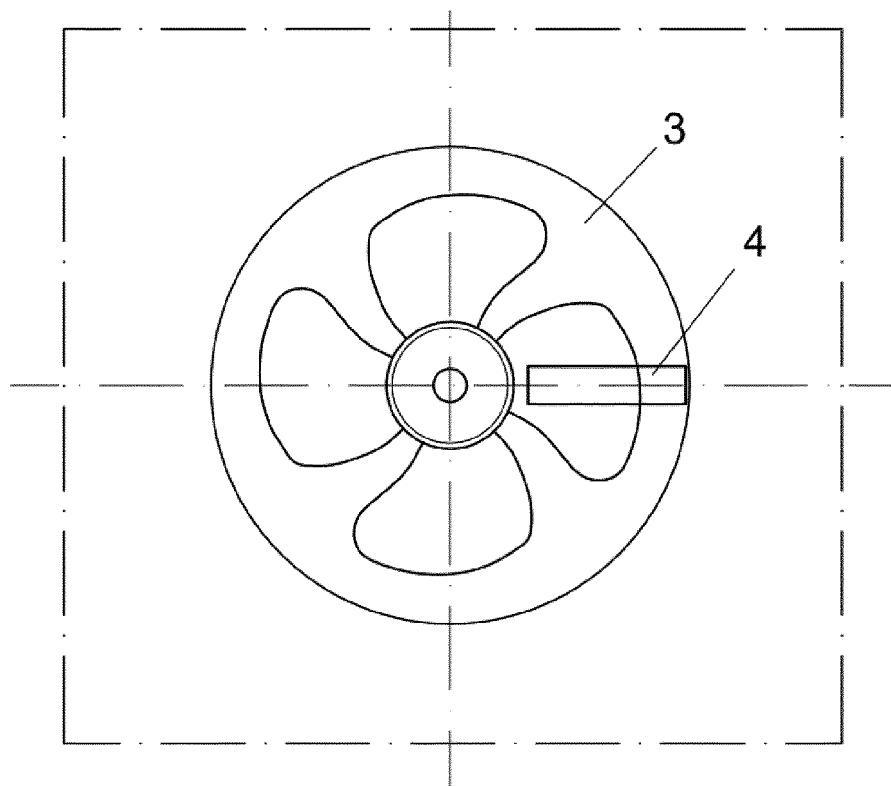
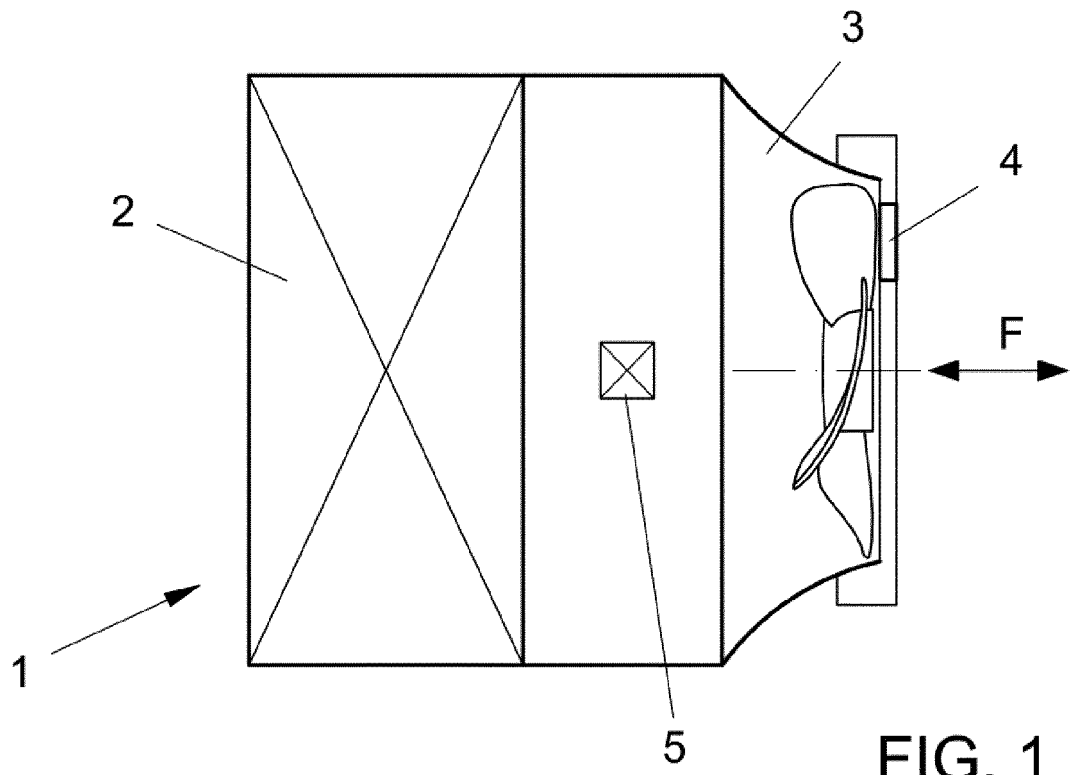
3. The method according to claim 2, **characterized in that** it also includes the following stage:

(C) monitoring the defrosting (cleaning) degree of the finned pack of the heat exchange battery (2) and adjusting the defrosting time.

4. The method according to claim 2, **characterized in that** in said stage (A) the number of revolutions of the fan (3) and said air flow rate are monitored, as the latter decreases in comparison with the clean battery value (V_0), measured as the air speed at the fan (3), the number of revolutions of the same fan (3) being increased up to the maximum set value (Rpmmax) so as to keep the value of said air flow rate (V_0) constant.

5. The method according to claim 2, **characterized in that**, once the maximum value (Rpmmax) of the number of revolutions of the fan (3) has been reached, said stage (B) is started, in which stage the fan revolutions and the air flow rate continue to be monitored and when the air speed reaches the value (V_f) the defrosting stage is started, which defrosting stage ends when the defrosting time reaches the set value (tdefrost).

6. The method according to claim 3, **characterized in that** in said stage (C) the air flow rate is monitored at the end of defrosting and when this value is lower than that of the clean battery (V_o) the defrosting time ($t_{defrost}$) is extended. 5
7. The method according to claim 1, **characterized in that** it includes the following stages:
- (A) controlling the fan (3) revolutions to keep the air flow rate constant during the first formation of frost on the finned pack; 10
- (B) monitoring the air pressure during the formation of frost at a constant number of revolutions of said fan 3, up to the start-defrost command. 15
8. The method according to claim 7, **characterized in that** it also includes the following stage:
- (C) monitoring the defrosting (cleaning) degree of the finned pack of the heat exchange battery (2) and adjusting the defrosting time. 20
9. The method according to claim 7, **characterized in that** in said stage (A) the number of revolutions of the fan (3) and said air pressure are monitored, as the latter increases in comparison with the clean battery value (ΔP_o), the number of revolutions of the fan (3) being increased up to the maximum set value (R_{pmmax}), so as to keep the value of said air flow rate (ΔP_o) constant. 25 30
10. The method according to claim 7, **characterized in that**, once the maximum value (R_{pmmax}) of the number of revolutions of the fan (3) has been reached, said stage (B) is started, in which the fan revolutions and the air pressure continue to be monitored and when the latter reaches the defrost air pressure value (R_{Po}), the defrosting stage is started, which defrosting stage ends when the defrosting time reaches the set value ($t_{defrost}$). 35 40
11. The method according to claim 8, **characterized in that** in said stage (C) the air pressure is monitored at the end of defrosting and when this value is greater than that of the clean battery (P_o) the defrosting time is extended. 45
12. A cooling unit for carrying out the method according to one or more of the preceding claims, **characterized in that** it comprises a heat exchange battery (2), a fan (3), a sensor (4) for measuring the speed of the air entering or exiting said fan (3), or a sensor (5) for measuring the air pressure in said cooling unit (1) and the defrosting devices for said heat exchange surfaces. 50 55
13. A refrigeration plant, comprising a plurality of cooling units according to one or more of the preceding claims, **characterized in that** it comprises a hardware structure for management of said cooling units (11, 12, 13) and the corresponding general controller (14).
14. The plant according to claim 13, **characterized in that** it comprises a system for monitoring the operating status of said refrigeration units and for monitoring anomalous formation of frost at the end of defrosting, with monitoring of the operating status of the fan and the defrosting devices.



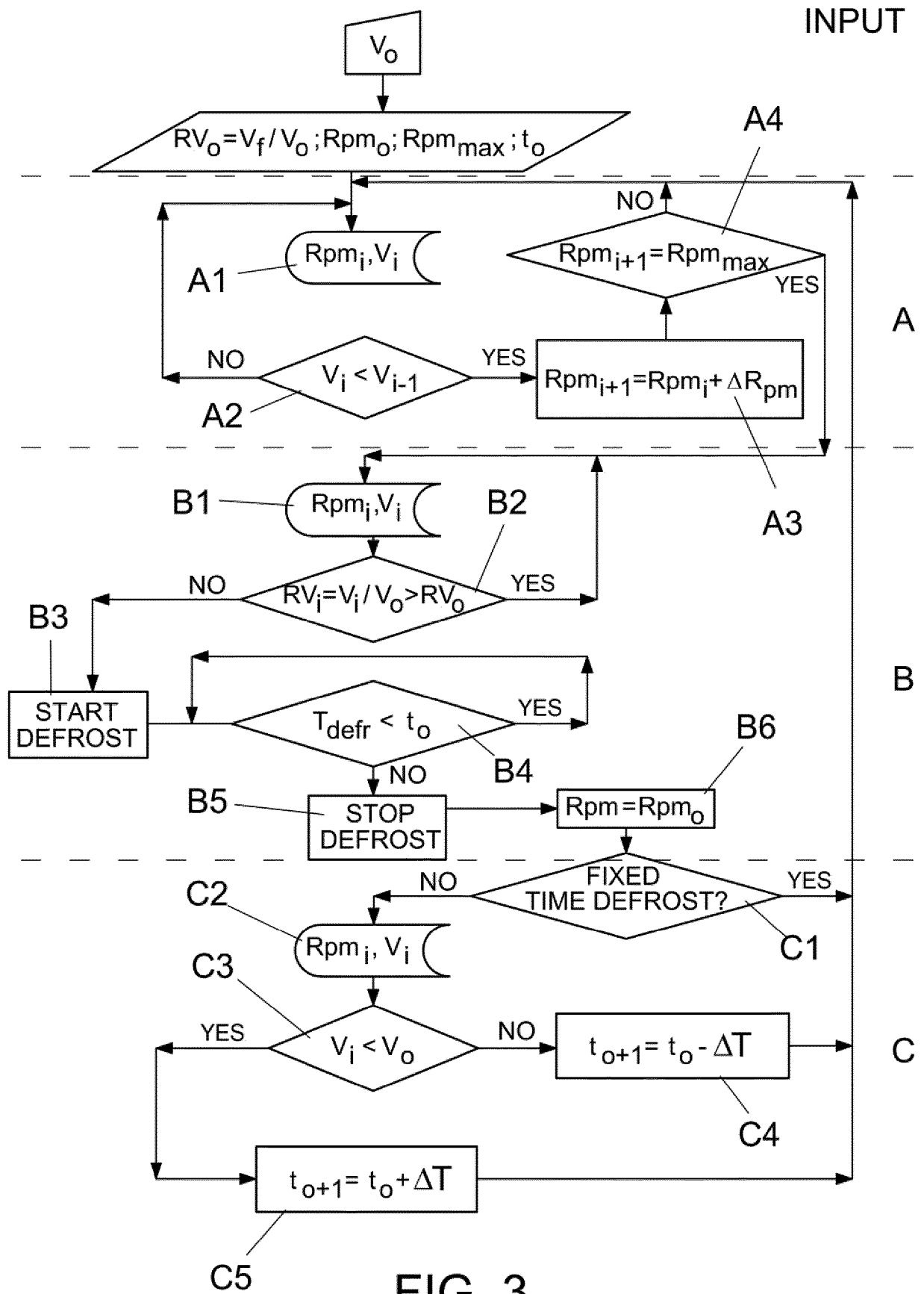
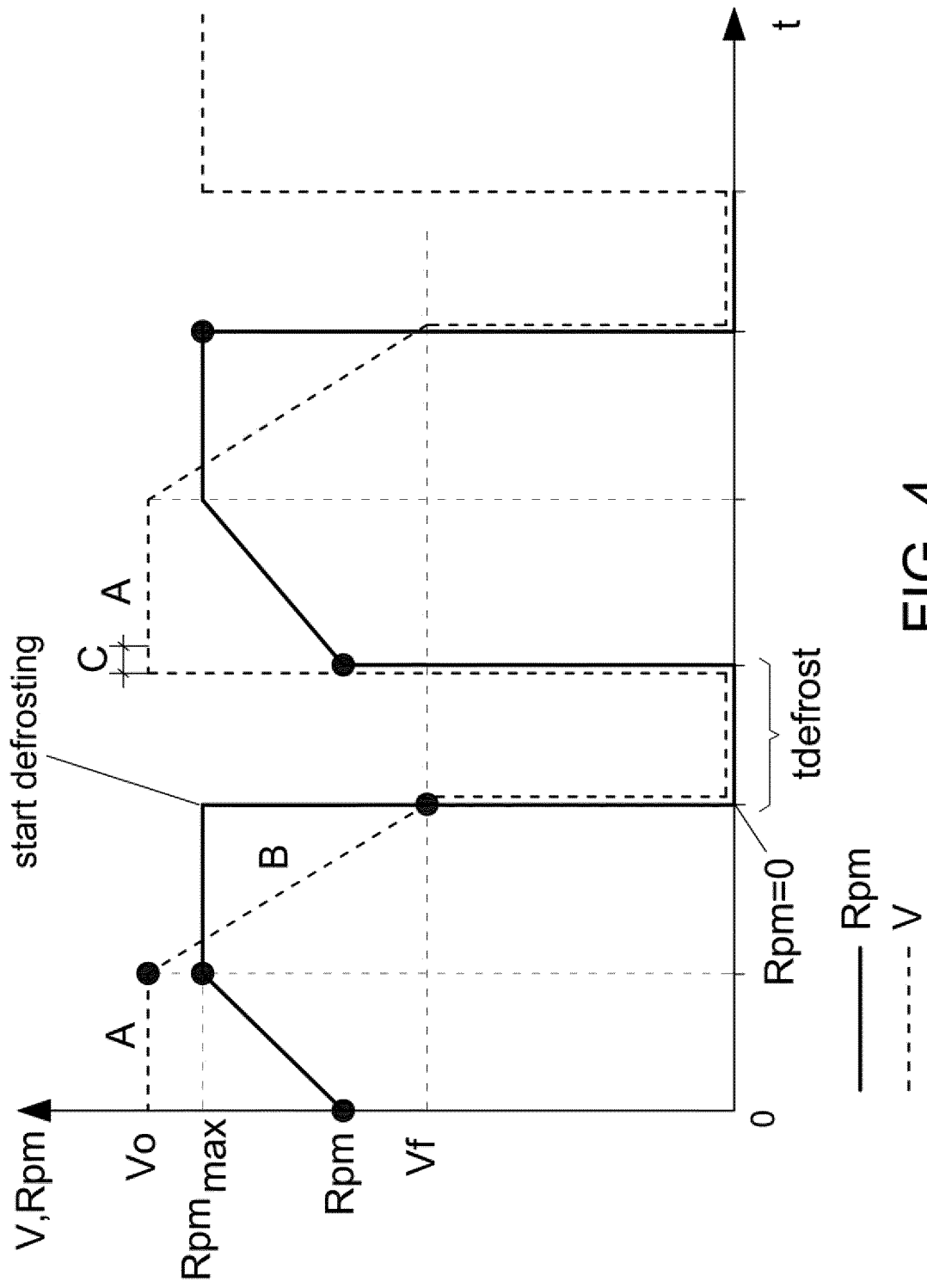


FIG. 3



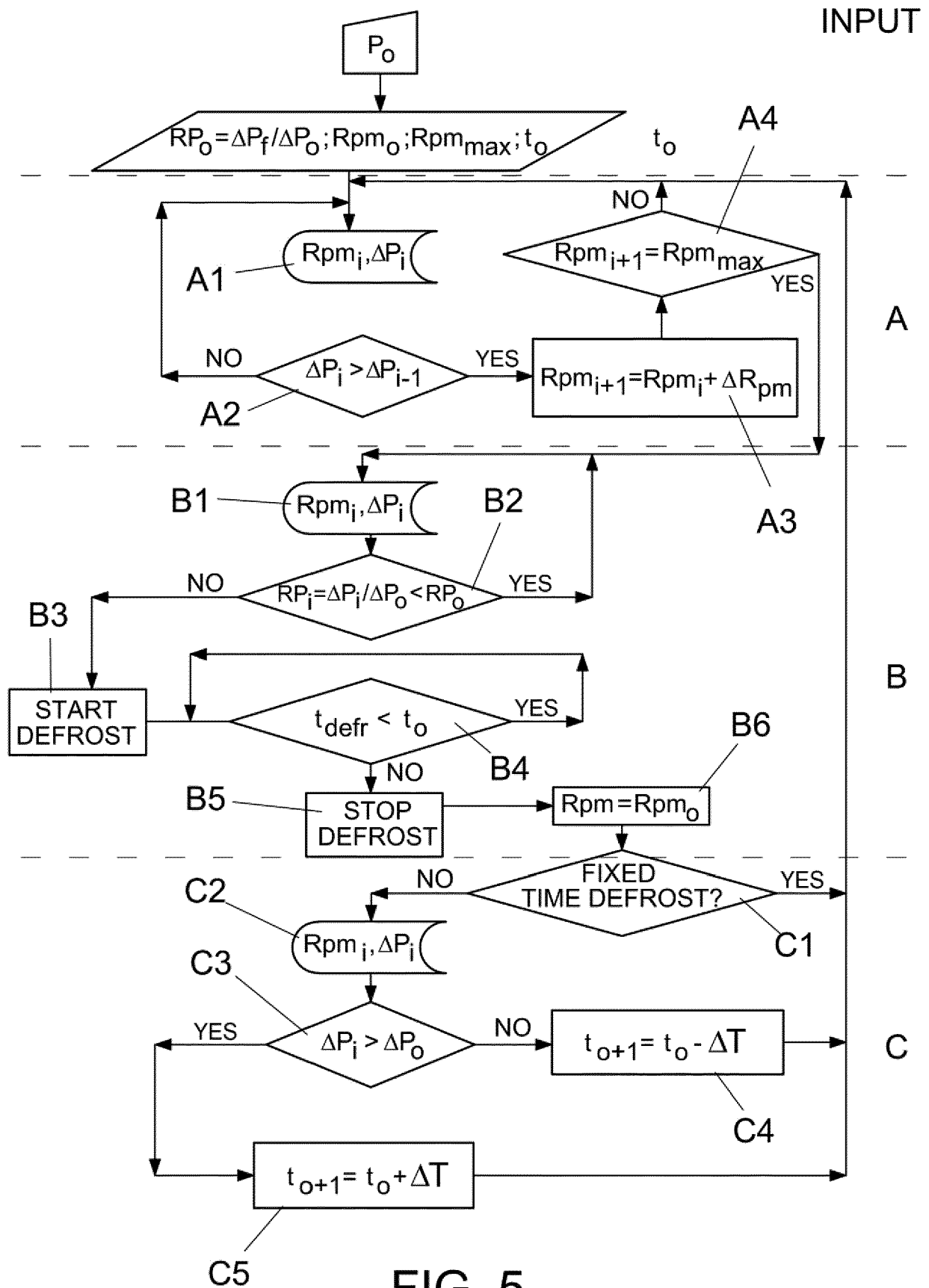


FIG. 5

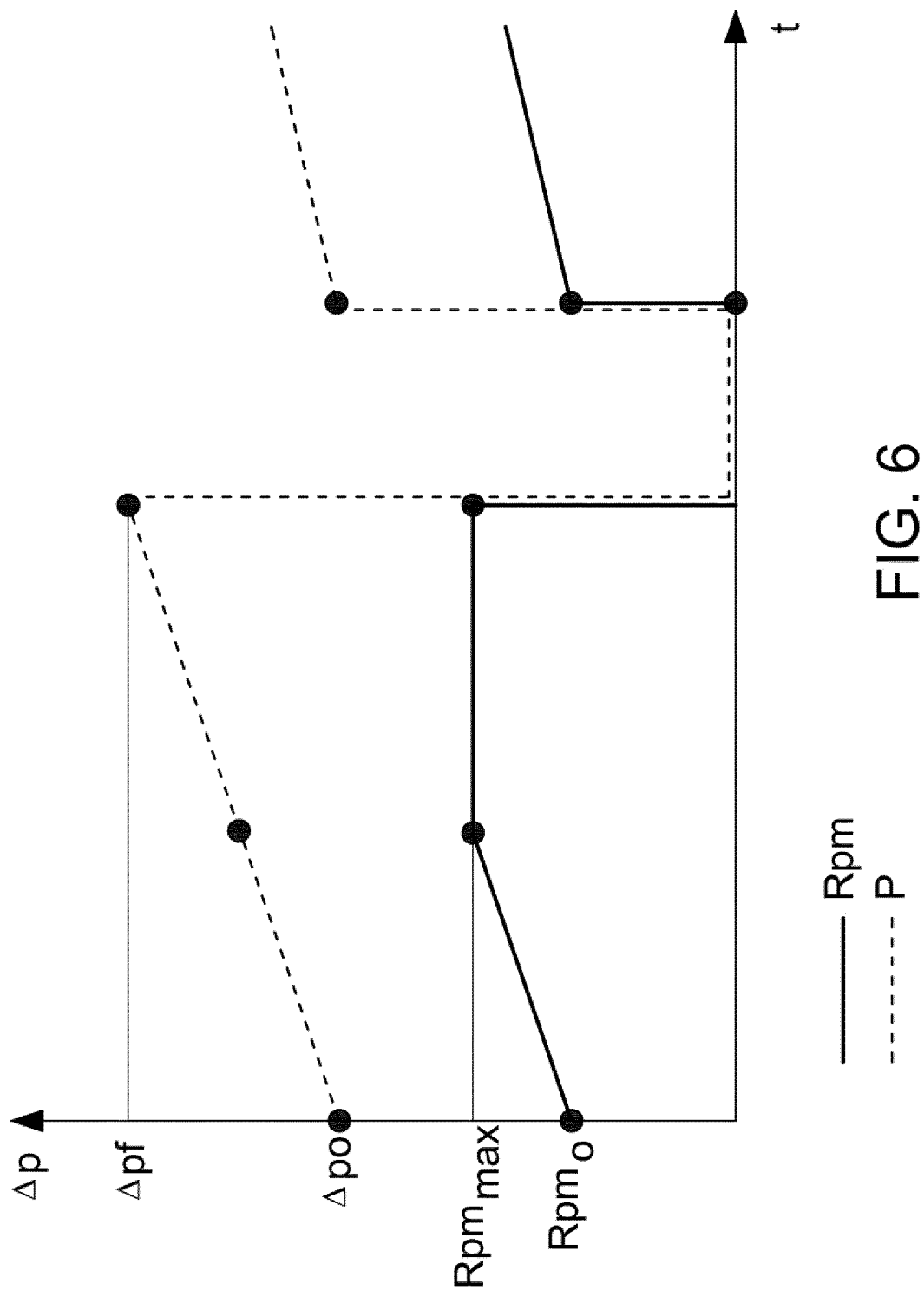


FIG. 6

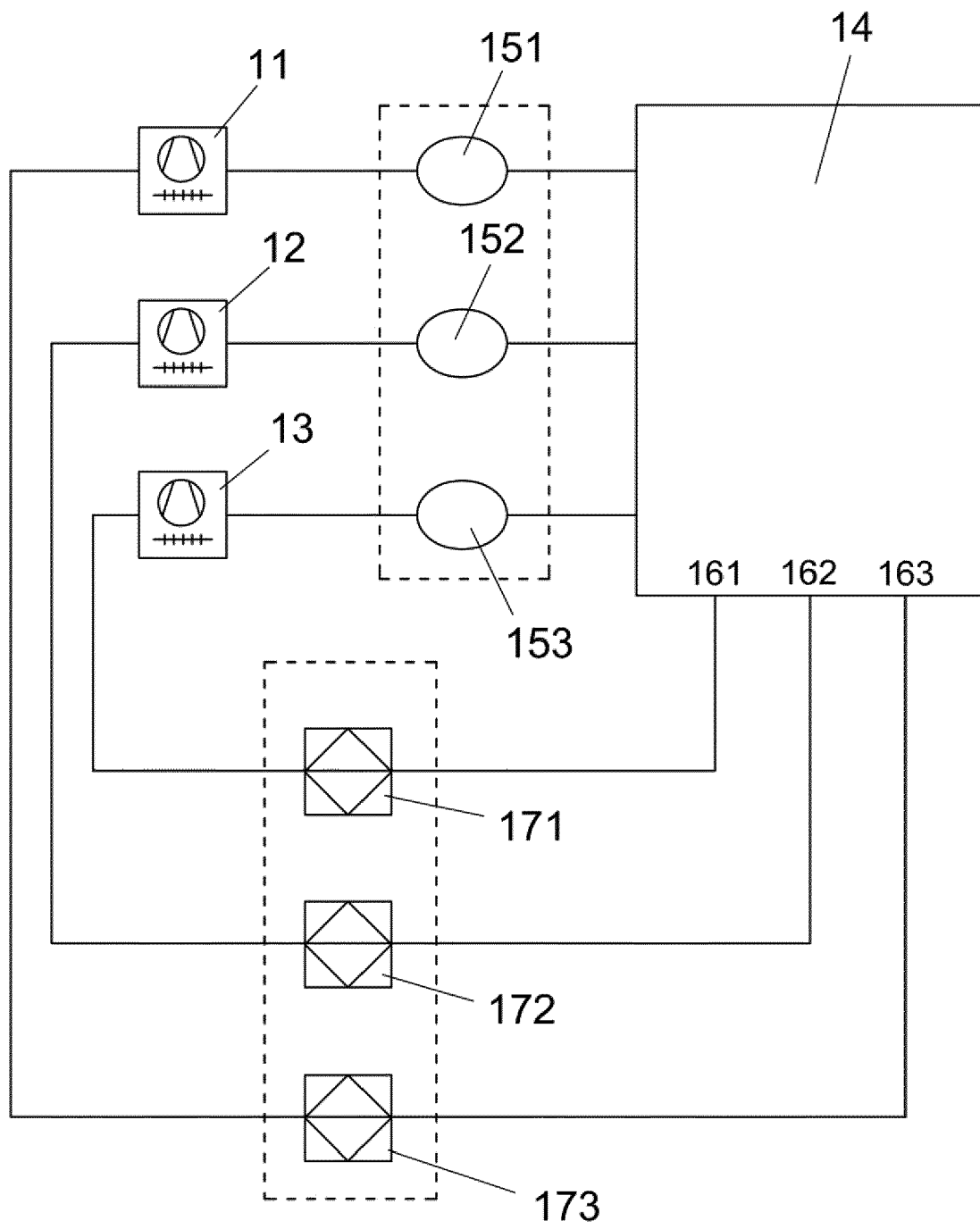


FIG. 7

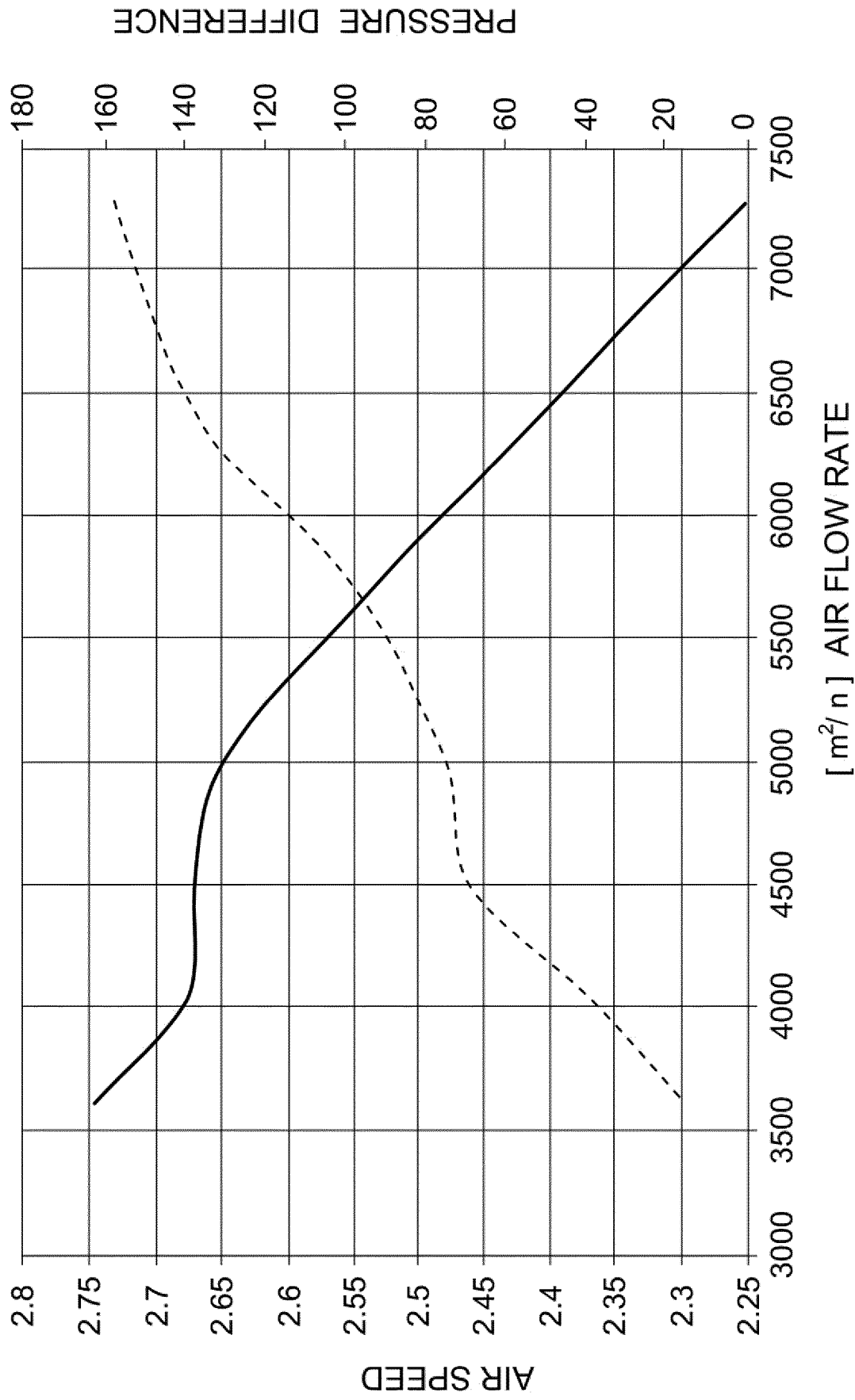


FIG. 8



EUROPEAN SEARCH REPORT

Application Number
EP 21 16 1323

5

10

15

20

25

30

35

40

45

50

55

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	JP H06 147602 A (MATSUSHITA SEIKO KK) 27 May 1994 (1994-05-27) * paragraphs [0009], [0013], [0014], [0017], [0020], [0023]; figures 1-3 *	1-14	INV. F25D21/02 F25D21/08 F25D21/00 F24F11/41
X	US 5 692 385 A (HOLLENBECK ROBERT K [US] ET AL) 2 December 1997 (1997-12-02) * column 6, lines 34-38, 49-53; figures 3A,3B,4 *	1-14	
X	DE 103 15 523 A1 (BSH BOSCH SIEMENS HAUSGERÄTE [DE]) 14 October 2004 (2004-10-14) * paragraph [0009] *	1	
X	JP 2011 247525 A (PANASONIC CORP) 8 December 2011 (2011-12-08) * paragraph [0020] - paragraph [0021] *	1	
			TECHNICAL FIELDS SEARCHED (IPC)
			F25D F24F
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 2 July 2021	Examiner Kuljis, Bruno
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

 1
EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 21 16 1323

5

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

02-07-2021

10

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP H06147602 A	27-05-1994	NONE	
US 5692385 A	02-12-1997	NONE	
DE 10315523 A1	14-10-2004	BR PI0409176 A CN 1798947 A DE 10315523 A1 EP 1613905 A1 RU 2380627 C2 US 2007006600 A1 WO 2004088221 A1	11-04-2006 05-07-2006 14-10-2004 11-01-2006 27-01-2010 11-01-2007 14-10-2004
JP 2011247525 A	08-12-2011	NONE	

15

20

25

30

35

40

45

50

55

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82