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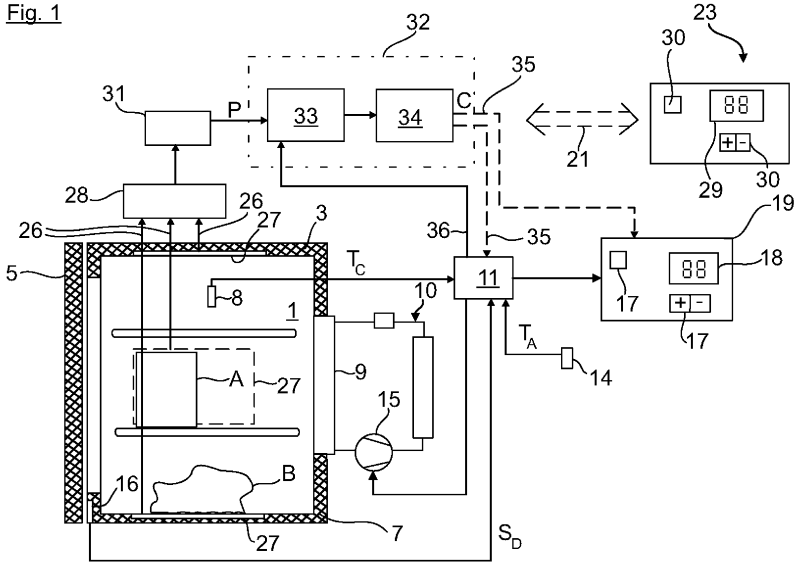
(54) Refrigerator and method for operating a refrigerator

(57) The invention refers to a refrigerator including a refrigerator control (11, 32) which comprises at least one sensor (8, 14, 16) for detecting at least one operational parameter, e.g. cooling compartment temperature (T_C), and at least one sensor (27) for detecting at least one product parameter (P) of products (A, B) introduced into said refrigerator. According to the invention said refrigerator control (11, 32) comprises an analyzing unit (33) by which the refrigeration power of said refrigerator can be configured on the basis of a combination of said product and operational parameters (P, T_C, T_A, S_D). The analyzing unit is also able to inform the user about noticeable events such as oversights, relevant product information, refrigerator malfunctioning, relevant changes in product stock and relevant changes in user behavior.

Fig. 1



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Description

[0001] The invention concerns a refrigerator according to the preamble of claim 1 as well as a method for operating a refrigerator according to claim 19.

[0002] Operating and managing household appliances in an easy way is of essence especially for elder people with or without disabilities in order to carry out a longer independent life. Therefore, especially advanced refrigerators can be equipped with additional functions which detect information about the operation of said household appliance as well as about products, like food or other goods, introduced into the refrigerator. Such information can be indicated in a display unit of the refrigerator.

[0003] A generic refrigerator includes a refrigerator control which comprises at least one sensor for detecting at least one operational parameter, e.g. cooling compartment temperature, and at least one sensor for detecting at least one product parameter of products introduced into said refrigerator. Said product parameter may relate to the expiry date of the product, the amount of product or to the kind of product.

[0004] From the KR 837050-B1 a refrigerator for managing stuff is known. This refrigerator has RFID reader that detects RFID tags attached to stuffs stored in a freezing and refrigerating compartment. The system has a data processing unit, a data storage section and a data input/output section. The refrigerator manages the stuffs stored in each compartment and inform to the user.

[0005] From the JP 2008242911-A a foodstuff management and purchasing support system is known which has RFID tag reader-writer to read a RFID tag attached to foodstuff and a database for managing information of foodstuff in refrigerator. This system manages information of foodstuff in refrigerator and determines foodstuff to be purchased based on recipe information. From the KR 2007116335-A a refrigerator with a RFID system and a method for displaying information on contents in the refrigerator for effective management of contents is known.

[0006] A food control type refrigerator for radio frequency identification is known from the CN 101071015-A. This is a food control type refrigerator for radio frequency identification tag, has hollow structure storage container used to store food and fixed inside refrigerator, and radio frequency identification unit fixed on one side of container. According to the KR2007091390-A, a refrigerator system for recognizing food by using single radio frequency identification is known. This is a refrigerator system using RFID, provided to control a plurality of antennas by using a single RFID reader for simplifying arrangement of the RFID reader. It has a system for switching the antennas. Further food refrigerator controlling and monitoring systems are known from the US2007/236357-A1 and WO2007/115794-A1. The system has a control unit for checking and storing a set of functioning parameters of a food refrigerator. A RFID reader reads date stored in a set of RFID tags attached to cold products. A communication unit connects the system to external device.

[0007] A radio frequency identification and personal digital assistant managing food in a refrigerator is known from KR2007006641-A. This consists on a food managing using RFID, a personal digital assistant is provided to effectively manage a refrigerator and readily obtain information of foods in the refrigerator. From the KR2006119580-A a system of controlling food management of a refrigerator is known for informing a user of diverse food information by displaying the information through the display picture unit. This is a system of controlling food management of a refrigerator through the RFID system reader and the display picture unit.

[0008] Another refrigerator for managing food information is known from KR2006008784-A. This is a refrigerator for managing food information and shelf life by using an RFID tag to prevent waste of food by displaying item, shelf life and cost of food on a display unit and alarming food approaching the expiration date to a user.

[0009] A refrigerator for efficiently managing food stored inside of refrigerator by using container information obtained through RFID as food management information is known from the KR2006104353-A. The KR2006081809-A and KR625472-B1 disclose a system and method for efficiently managing information of articles stored in refrigerator using RFID. Further refrigerators with RFID which set up storage condition are known from the EP1726899-A1, US2007/016852-A1, KR2006122596-A and KR673707-B1. The RFID tags store information relating to each kind of food stored in storage shelves of the refrigerator. A microcomputer sets up storage condition in each shelf with respect to the information read from the RFID tag.

[0010] A food managing refrigerator for obtaining food data from RFID tags and setting circulation time with control knob is known from the KR2006111008-A or KR660697-B1. This is a refrigerator for managing food information shelf life by using an RFID tag to prevent waste of food by displaying item, shelf life and cost of food on a display unit and alarming food approaching the expiration date to a user.

[0011] A refrigerator for accurately and easily managing stored goods by applying a RFID system is known from the KR2005092259-A. An input unit is installed to input information of stored goods by a user. A RFID reads information of stored goods from tags attached to the stored goods. The goods information is stored in a database and can be displayed in a display unit. Finally, a system and method for managing food of internet refrigerator using RFID is known from the KR2005077657-A. These documents disclose a system and a method for managing food in an Internet refrigerator using a RFID system, and a recording medium storing a program for management information of food.

[0012] The above mentioned refrigerators are not adapted to enable elder people to maintain an essentially independent housekeeping without needing any external

carer.

[0013] The object of the invention is to provide a refrigerator as well as a method for operating a refrigerator which can easily be handled especially by elder people with or without disabilities.

[0014] The object is solved by the features of claim 1 or claim 19. Preferred further developments of the invention are disclosed in the depended claims.

[0015] According to the characterizing part of claim 1 the refrigerator control includes an analyzing unit. The analyzing unit receives product parameters and operational parameters detected by product sensors and operational sensors. On the basis of a combination of said product and operational parameters the analyzing unit is able to configure the refrigeration power of the refrigerator. Therefore, according to the invention not only operational parameters, e.g. the cooling compartment temperature, but a combination of operational parameters and product parameters is used in order to adapt the refrigeration power when products are newly introduced into the cooling compartment. By means of said analyzing unit said refrigeration power can be aligned more exactly with said products introduced into said cooling compartment.

[0016] In a preferred embodiment the refrigerator control can automatically configure the refrigeration power on the basis of said combination of product and operational parameters without any activity of the user. Due to this, the refrigeration power of said refrigerator is always adapted to the inventory of said refrigerator automatically.

[0017] Alternatively, the refrigerator control may not configure the refrigeration power automatically, but may display a best mode configuration on a control panel. This best mode configuration proposed by the analyzing unit may be adopted by said user or not. In this case said user is involved in the process of optimizing said refrigeration power with respect to newly introduced food or other products.

[0018] The refrigerator control may comprise a micro controller which is linked to said operational sensor in order to detect said at least one operational parameter, e.g. the cooling compartment temperature, the status of the refrigerator door and/or the ambient temperature. To this end, the micro controller may be linked to a door sensor, a cooling compartment sensor and/or an ambient sensor.

[0019] In addition, said refrigerator control may comprise a main controller which is linked with said micro controller and/or directly with a product sensor which detects said at least one product parameter. According to the invention, the main controller may receive signals directly from said product sensor as well as signals with respect to said operational parameters. In order to analyze both said operational parameters and said product parameters said main controller may comprise an analyzing unit in which an algorithm is stored so as to analyze said combination of product and operational parameters.

[0020] By means of the refrigerator control according to the invention a proper handling of said refrigerator is further simplified. For example, the refrigerator control can inform the user when the food just removed is expired. Alternatively or in addition, the refrigerator control may inform the user when the refrigerator is running out of food the user desires to have. Furthermore, the refrigerator control can be able to warn the user about possible oversights, for example if the refrigerator door has been forgotten opened. Moreover, the main controller may be in a wireless connection with a monitoring unit. In this case, said main controller may provide remote information to said monitoring unit, such as the food available to the user, to the technical service with technical information, etc. Apart from that, the monitoring unit or the main controller may store statistical information about the food log, the amount of food expired and use of the appliance (number of times when the door is opened, temperature, etc.). This information is useful to supervise for example the correct diet of the user and also detect changes in user behavior and habits. Furthermore, the remote monitoring unit may warn when something unusual happens; for example if the user has not opened the refrigerator in one day (when supposed to be at home) she/he might have a problem.

[0021] The product sensor for detecting the product parameter may be realized as a RFID-sensor unit which may include a RFID UHF reader. The RFID UHF reader controls a RFID UHF 4-way multiplexer that multiplexes in time the RFID UHF antennae. Thus, this system allows that every time that the refrigerators door is closed, all the tagged food inside are read by said RFID antennae.

[0022] The RFID UHF reader should be set to an output of radiated power between 0.1 and 1 W. Moreover, the multiplexer may be directly attached to each of said antennae with special HF cables. It may trigger each antenna at a defined interval which can be tuned according to the refrigerator used. The impedance will be between 45 to 55 Ohms, preferably 50 Ohms.

[0023] In order to guarantee that the tagged food inside the cooling compartment is detected the antennae setup within the refrigerator is of relevance. It may be of an advantage if the RFID sensors are disposed with respect to a transversal axis and/or an vertical axis symmetrically and facing each other. Such a setup is preferred in a refrigerator having a cooling compartment which has an opening at its front side. In this case, the RFID-sensors may be disposed at the left and right compartment sides as well as at the ceiling and the bottom side, respectively. Said RFID-sensors may be integrated in the insulating foam which is filled into the hollow spaces of said body restraining the cooling compartment. The antennas may be integrated into said insulating foam during the manufacturing process.

[0024] Preferably said remote monitoring unit may generate a user profile on the base of said operational and product parameters. In said user profile, said parameters may be stored over the time in tabular form. Thus,

any deviation of user activities with respect to the household appliance from the user profile can be detected. In this way, user behavior and habits can be monitored by e.g. an external carer who can detect any deviation from the user profile which could make it necessary for the external carer to support the user in his/her household.

[0025] An electronic product code (EPC) based on a SGTIN96 coding scheme should be used for coding of the RFID tags. A SGTIN96 coding scheme features the following structure:

- header (8 bit)
- special field (6 bit)
- company prefix (24 bit)
- item reference (20 bit)
- serial number (38 bit)

[0026] The header identifies the encoded data as an SGTIN-96 number. The special field contains data such as a filter value for pre-selection and a partition value that indicates the point where the division between the company prefix and the item reference is. The company prefix specifies the manufacturing company while the item reference identifies the object to be refrigerated. Accordingly, the item reference can be used to encode information concerning the object. Information concerning the object may comprise: type of item (e.g. food), food type (e.g. vegetables, pasta, etc), and/or weight (e.g. tenths of grams up to 10 kg). Additional information may be encoded in the serial number. Additional information may comprise: need of refrigeration, product ID with regard to a provider, nutritional facts, ingredients, lot, and/or packing date.

[0027] In the following, an embodiment of the invention is described with respect to the figures in which

Fig. 1 shows a block diagram of the refrigerator; and

Fig. 2 shows a setup of the RFID-antennae used within the refrigerator.

[0028] In figure 1 a refrigerator comprising a cooling compartment 1 is shown which is enclosed by an appliance body 3 as well as an appliance door 5. The hollow spaces of said body 3 and said door 5 are filled with a heat insulating foam 7 and are defined by inner walls and outer walls. At the rear wall of the body 3 an evaporator 9 is disposed which is integrated in a refrigeration cycle 10 in order to cool the cooling compartment 1. The actual temperature Tc of the cooling compartment 1 is detected by a temperature sensor 8 and passed to a micro controller 11. In addition, the micro controller 11 is linked with an ambient sensor 14 which detects the ambient temperature outside of said cooling compartment 1. Said micro controller 11 is also connected to a door sensor 16. Both sensors 14, 16 forward the ambient temperature T_A and the present status of the refrigerator door S_D to said micro controller 11.

[0029] By means of the above mentioned sensors 8, 14, 16 the cooling compartment temperature T_C, the ambient temperature T_A as well as the status of the door S_D are detected as operational parameters on the basis of which the micro controller 11 configures the refrigeration power. The micro controller 11 compares said actual temperature of the cooling compartment 1 with a target temperature which is set by the user. On the base of this comparison and by considering the door status S_D and the ambient temperature T_A, the micro controller 11 switches a compressor 15 integrated within the refrigeration cycle 10 on or off. In order to set the target temperature inside the cooling compartment 1 the micro controller 11 is linked with a control panel 19 which carries operational and/or display elements 17, 18.

[0030] In order to also detect information about food A, B inside the cooling compartment 1 the refrigeration control 11 comprises RFID-sensors or RFID antennae 27 which are integrated in the heat insulating foam 7. In order to be detected each of said food A, B inside the refrigerator needs a RFID tag with their respective information.

[0031] The RFID-sensors 27 are - via signal lines 26 - linked with a RFID UHF 4-way multiplexer 28 which passes on the product parameters P to a RFID-reader 31 and further to a main controller 32.

[0032] In the following, the setup of the RFID-sensors 27 within said refrigerator is described with respect to figure 2. Figure 2 shows the inner wall of said body 3 which defines the cooling compartment 1. The RFID-sensors 27 are disposed behind the ceiling as well as behind the bottom as well as the side walls of the cooling compartment 1. According to figure 2 the cooling compartment 1 has front side opening 37. Said RFID-sensors 27 are disposed symmetrically with respect to a transversal axis 41 as well as with respect to a vertical axis 42. Moreover, the sensors 27 are directly integrated into said insulating foam 7 during the manufacturing process. At the back side of said cooling compartment 1 said evaporator 9 is disposed. The antennae should be patch antennae, preferably polarized micro strip antennae with dual capacitive coupled feeds and a Wilkinson power divider. It is very important that the antennas are robust as possible, that is why they have a high bandwidth, from 700 MHz up to 1.2 GHz. The impedance will be between 45-55 Ohms, preferably 50 Ohms. Circular polarization will ensure reading tags in two dimensions rather than one, and with circular tags on the items, three-dimensional reading is possible. The antenna gain should be medium, around 4-6 dbi. The radiating/receiving angle should be wide between 70 and 90, preferably around 80°. The antennas have to receive anti-corrosion treatment. Each antenna covers a specific space of the fridge.

According to figure 1, the main controller 32 includes an analyzing unit 33 and an output unit 34 which is linked to said micro controller 11 and/or to said control panel 19 by means of signal lines 35. Said analyzing unit 33 of said main controller 32 is also linked via a signal line 36

to said micro controller 11. The micro controller 11 transmits the operational parameters T_C, T_A and S_D toward said analyzing unit 33 in which the operational parameters T_C, T_A, S_D and the product parameters P are put together within an algorithm so as to configure a refrigeration power on the basis of the present inventory of said cooling compartment 1.

[0033] After said configuration of the refrigeration power the main controller 32 transmits control signals C via the output unit 34 and the signal lines 35 toward that micro controller 11 and/or to said control panel 19. Due to this, said micro controller 11 can adopt the proposed configuration automatically. Alternatively, a best mode configuration proposed by the analyzing unit 34 may be displayed in the display element 18 of said control panel 19. This best mode configuration may be selected by the user.

As may also be gathered from figure 1, the main controller 11 is in wireless communication 21 with a monitoring unit 23 which is located remotely from the refrigerator. By means of the monitoring unit 23 a user profile can be generated. On the base of the user profile an external carer can be provided with statistical information about the actual inventory inside the cooling compartment 1, about the dwell time of the food A and B inside the cooling compartment 1, about food with lapsed expiry dates as well as about a malfunction of the refrigerator.

[0034] On the basis of said user profile statistical information about the actual inventory inside the refrigerator, about the dwell time of food A and food B as well as about lapsed expiry dates can be gathered. Thus, an external carer can get an overview of the user habits and behaviors without intervening into the housekeeping of the user personally. For example, a nutritional protocol of the user can be monitored which may be preset by a supervisor of the user. If necessary, i.e. in case of any kind of deviation from the user profile, the external carer can personally intervene so as to support the user.

[0035] As can be further gathered from figure 1, the monitoring unit 23 also comprises operational and display elements 29, 30 by which the external carer can intervene remotely without directly actuating the operational elements 17 of said refrigerator. Moreover, the external carer can also get information about the actual state of operation of the refrigerator via the display element 29 of the monitoring unit 23.

LIST OF REFERENCES

[0036]

1	cooling compartment
3	body
5	door
7	heat insulating foam
8	temperature sensor
9	evaporator
10	refrigeration cycle
11	micro controller
14	ambient sensor
15	compressor
16	door sensor
17, 18	operational and display elements
19	control panel
21	wireless communication
23	monitoring unit
26	signal line
27	RFID antennae
28	multiplexer
29, 30	operational and display elements
32	main controller
33	analyzing unit
34	output unit
35, 36	signal line
37	opening
41	transversal axis
42	vertical axis
T_S, S_D, T_A	operational parameters
P	product parameters
C	control signals

Claims

1. Refrigerator including a refrigerator control (11, 32) which comprises at least one sensor (8, 14, 16) for detecting at least one operational parameter, e.g. cooling compartment temperature (T_C), and at least one sensor (27) for detecting at least one product parameter (P) of products (A, B) introduced into said refrigerator, **characterized in that** said refrigerator control (11, 32) comprises an analyzing unit (33) by which the refrigeration power of said refrigerator can be configured on the basis of a combination of said product and operational parameters (P, T_C, T_A, S_D).

2. Refrigerator according to claim 1, **characterized in that** said refrigerator control (11, 32) configures the refrigeration power on the basis of said combination of product and operational parameters (P, T_C, T_A, S_D) automatically.

3. Refrigerator according to claim 1 or 2, **characterized in that** said refrigerator control (11, 32) displays a recommendation for the user to change the configuration of said refrigerator manually.

4. Refrigerator according to one of the preceding claims, **characterized in that** the refrigerator control (11, 32) comprises a micro controller (11) which is linked with said at least one operational sensor (8, 14, 16) for detecting said operational parameter (T_C, T_A, S_D), wherein said micro controller (11) controls said refrigeration power on the basis of a target value predefined by the user.

5. Refrigerator according to claim 4, **characterized in that** the refrigeration control (11, 32) comprises a main controller (32) which is linked with said micro controller (11) and/or with said product sensor (27) for detecting said at least one product parameter (P).

6. Refrigerator according to claim 5, **characterized in that** said micro controller (11) supplies said at least one operational parameter (T_C, T_A, S_D) to said main controller (32), and **in that** said main controller (32) comprises said analyzing unit (33) which analyzes said product and operational parameters (P, T_C, T_A, S_D).

7. Refrigerator according to one of claims 5 or 6, **characterized in that** said main controller (32) is especially in wireless connection (21) with a monitoring unit (23).

8. Refrigerator according to one of said preceding claims, **characterized in that** said product sensor (27) is a RFID-sensor unit, which RFID-sensor unit consists of at least one RFID UHF antenna (27), a RFID UHF 4-way multiplexer (28) that multiplexes in time the RFID UHF antenna (27) and that is connected to a RFID UHF reader (31) which controls said multiplexer (28) and which is linked with said main controller (32).

9. Refrigerator according to one of the preceding claims, **characterized in that** said refrigerator control (11, 32) informs the user when the food just removed is expired.

10. Refrigerator according to one of claims 8 or 9, **characterized in that** said RFID-sensors (27), especially said RFID antennae, are disposed symmetrically with respect to a transversal axis (41) or a vertical axis (42) and/or which are disposed facing each other.

11. Refrigerator according to one of the preceding claims, **characterized in that** a restraining wall for delimiting the cooling compartment of said refrigerator includes an inner wall and an outer wall as well as an insulating foam (7) being disposed in between, and **in that** said at least one product sensor (27) is integrated within said insulating foam (7) behind said inner wall.

12. Refrigerator according to one of claims 8 to 11, **characterized in that** said RFID antenna (27) is a patch antenna, preferably a polarized micro strip antenna with dual capacitive coupled feeds and a Wilkinson power divider, wherein said antenna (27) especially comprises a high band width from 700 mHz up to 1,2 GHz and/or an impedance between 45 to 55 Ohms, preferably 50 Ohms.

13. Refrigerator according to one of claims 8 to 12, **characterized in that** said detection of the products (A, B) is conducted via a circular polarization with circular tags on said products (A, B), whereas a three-dimensional reading is possible.

14. Refrigerator according to one of claims 7 to 13, **characterized in that** said monitoring unit (23) generates a user profile on the base of the detected product and operational parameters (P, T_C, T_A, S_D), in which user profile said parameters (P, T_C, T_A, S_D) are stored depending on the time, wherein a deviation of user activities relating to said household appliance from said user profile is detectable by said monitoring unit (23).

15. Method for operating a refrigerator, especially according to one of said preceding claims, in which at least one operational parameter (T_C, T_A, S_D), e.g. the cooling compartment temperature (T_C), and at least one product parameter (P) are detected, wherein the refrigerator power is configured on the basis of said combination of operational and product parameters (P, T_C, T_A, S_D).

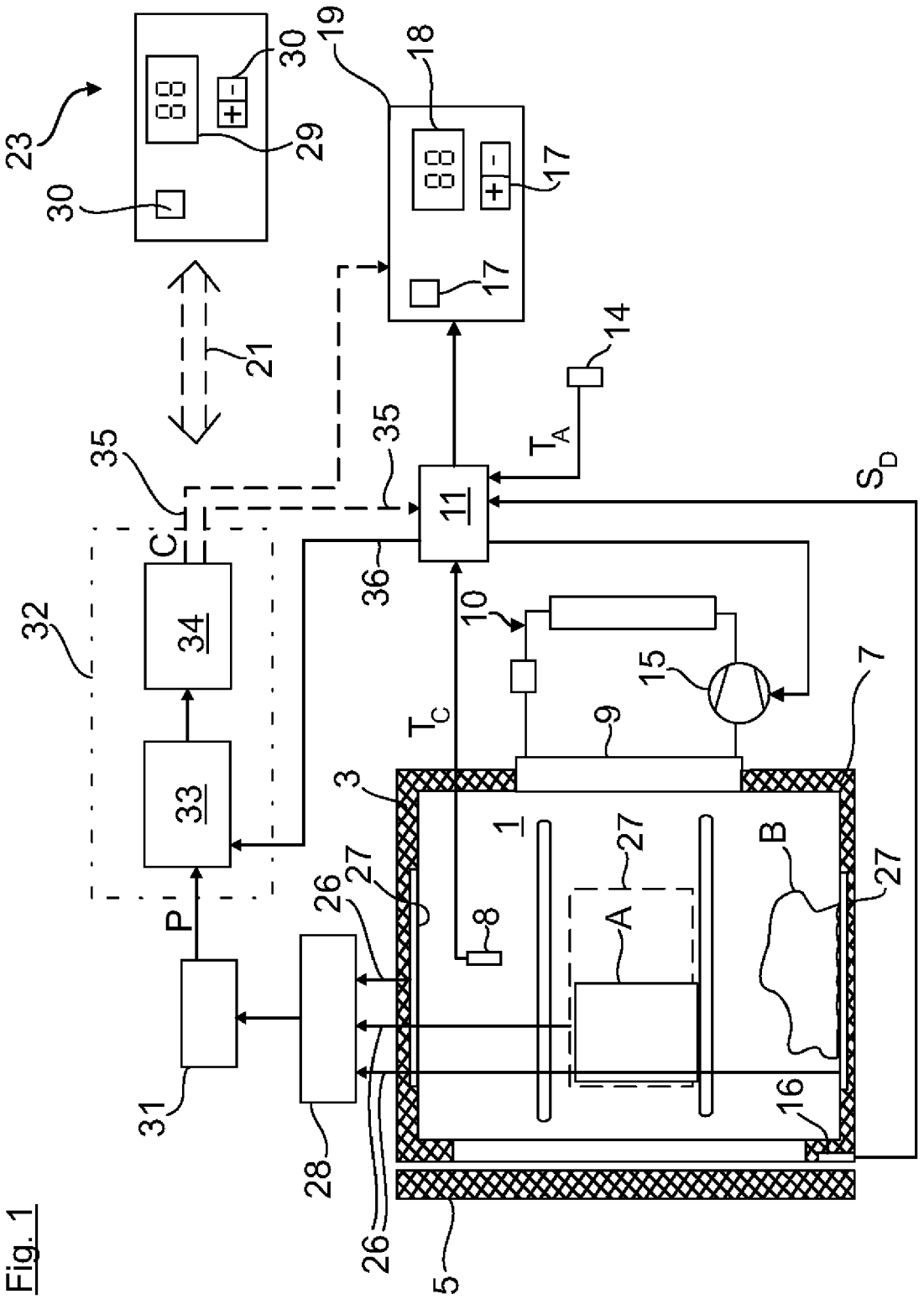
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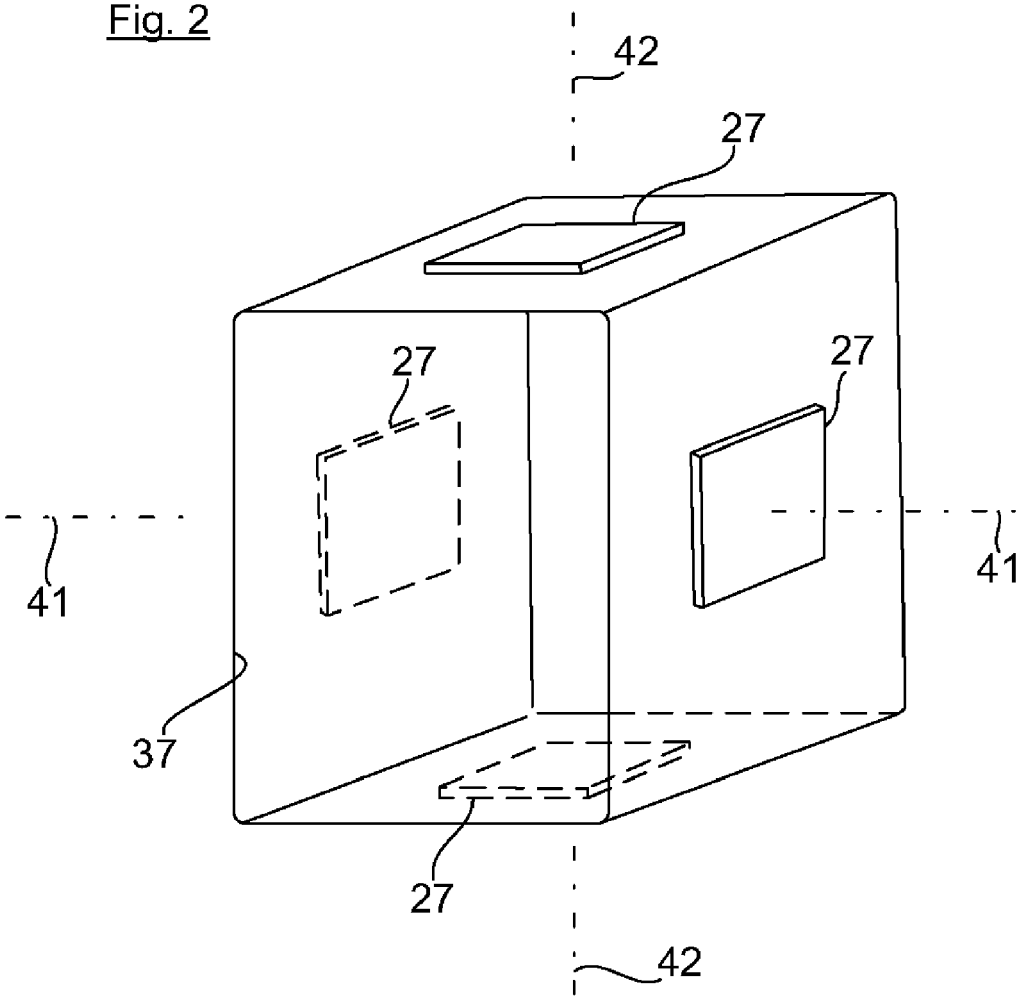
Fig. 1

Fig. 2



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EUROPEAN SEARCH REPORT

Application Number
EP 09 38 2181

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
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X : particularly relevant if taken alone
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- KR 2005092259 A **[0011]**
- KR 2005077657 A **[0011]**