(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: 0 392 521 A2

(12) EUROPEAN PATENT APPLICATION

(21) Application number: 90106983.1

(22) Date of filing: 11.04.90

(51) Int. Cl.5: F25D 11/02, F25D 29/00

(30) Priority: 14.04.89 IT 6727789

(43) Date of publication of application:
17.10.90 Bulletin 90/42

(84) Designated Contracting States:
DE ES FR GB

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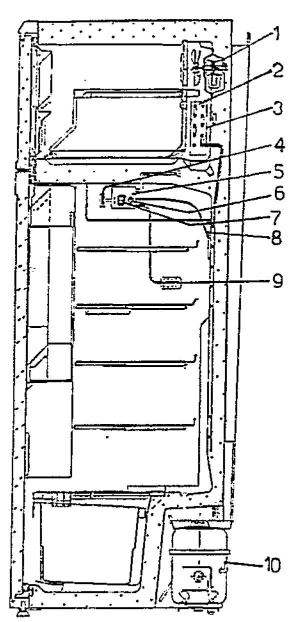
(54) Improved refrigerating device.

(57) The present invention relates to a refrigerating device comprising two compartments and precisely a first compartment used for the storage of fresh food and a second compartment used for the freezing and storing of foods, a refrigerating circuit comprising a compressor, a first and a second evaporators arranged in said first and second compartments, respectively, and a condenser, and also comprising a temperature control system, having manual regulation possibility, located in said first compartment. The main feature of the refrigerating device according to the present invention is that automatic regulation means are provided, which operate on the basis of the room temperature so assuring the correct operation in both said two compartments.

Fig.1



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IMPROVED REFRIGERATING DEVICE

The present invention relates to a refrigerating device comprising two compartments and precisely a first compartment used for the storage of fresh food and a second compartment used for the freezing and storing of foods, a refrigerating circuit comprising a compressor, a first and a second evaporators arranged in said first and second compartments, respectively, and a condenser, and also comprising a temperature control system, having manual regulation possibility, located in said first compartment.

Refrigerating devices of the above mentioned type are known; they represent probablythe most widespread type of domestic refrigerators. The two evaporators located respectively in the first compartment (fresh food compartment or 'refrigerator') and in the second compartment ('freezer'), are arranged in series on the same refrigerating circuit, driven, for costs reasons, by one compressor only.

In such refrigerating devices the freezer compartment is practically 'towed' by the fresh food compartment (normally called 'refrigerator' compartment), the two evaporators being in series between themselves, and the thermostatic control being done with reference to the 'refrigerator' compartment only.

Such a thermostatic control is done by means of a normal electromechanical thermostat just placed into the refrigerator compartment, equipped with a knob for the manual setting of the desired temperature, within certain limits.

The control of the satisfactory operation in the different environmental conditions, both in the 'refrigerator' compartment and in the 'freezer' compartment, has always caused various and well known problems for refrigerating devices of this type, due to the poor flexibility of the system.

Many changes have been proposed to the simple basic system, to obviate such drawbacks, with poor results and always with increments of manufacturing costs and consequently of selling prices, and with diminution of the reliability of the apparatus.

For example the italian patent application nr. 21201-A/79 describes a refrigerating device of the above cited type, where two sensor are provided in the fresh food compartment: one in air and the other on the plate of the evaporator; the control system comprises a thermostatic system of electronic type and the compressor is enabled when the plate of the evaporator reaches the temperature of $+4^{\circ}$; the compressor is then disabled when the air probe detects that the temperature is fallen to the value manually input by the user.

Said patent has the aim of overfreezing foods placed in the 'freezer' compartment.

The italian patent application nr. 68230-A/80 also describes a refrigerating device of the above cited type, similar to the one described in the previous patent application, which provides, besides the usual thermostat, a thermistor placed in the fresh food compartment, in the point where the air is lower; when the compressor must operate for a long time, to fastly freeze the food, the thermistor commutates the output of the comparator, which acts on the circuit of the thermostat and switches off the compressor in order to impede that in the other compartment the temperature falls below zero degree.

The known systems have many drawbacks, first of all that, into very cold rooms, the compressor remains disabled for long time intervals and the temperature of the 'freezer' compartment reaches dangerous values for the storing of the food therein contained.

Aim of the present invention is to indicate how it is possible to realize a refrigerating device which can correctly operate at different room temperatures, which allows manufacturing uniformity, reliability in use and a reduced cost.

To achieve such purpose the aim of the present invention is to indicate a refrigerating device comprising two compartments and precisely a first compartment used for the storage of fresh food and a second compartment used for the freezing and storing of foods, a refrigerating circuit comprising a compressor, a first and a second evaporators arranged in said first and second compartments, respectively, and a condenser, and also comprising a temperature control system, having manual regulation possibility, located in said first compartment, characterized by the fact that automatic regulation means are provided, which operate on the basis of the room temperature so assuring the correct operation in both said two compartments.

Further aims and advantages of the present invention are clearly shown in the following detailed description and annexed drawings by way of an explicative and not limiting example, where:

- figure 1 shows schematically the refrigerating device according to the invention;
- figure 2 shows the block diagram of the electric circuit of the refrigerating device according to the invention;
- figure 3 shows schematically the circuit of one of the blocks of the circuit of fig. 2;
- figure 4 shows schematically a part of the circuit of fig. 2;
- figure 5 shows schematically the circuit of

a second block of the circuit of fig. 2;

- figure 6 shows schematically the circuit of a third block of the circuit of fig. 2.

In figure 1, showing schematically the refrigerating device according to the invention, number 1 indicates an electric fan; number 2 indicates the evaporator of the 'freezer' compartment; number 3 indicates a defrost heater located in the 'freezer' compartment; number 5 indicates the operation control device of the refrigerating device, number 4 indicates a knob for the regulation of the temperature (monoturn rotative linear potentiometer) which is part of said device; number 6 indicates a luminous warning light (LED) placed on said device; number 7 indicates a manual push (fast freezing) also located on said device; number 8 indicates the temperature probe of the evaporator of the 'refrigerator' compartment, connected to said device 5; number 9 indicates the air temperature probe of the same compartment, connected to the same device 5, and at last number 10 indicates the refrigerating fluid compressor.

The control device 5 consists of a plastic material casing, containing an integrated circuit, on which there are mounted in a known way, a certain number of components; among them there is comprised an integrated circuit of the semi-custom type, which is responsible for actuating the main control functions, and which will be described in more detail with reference to figure 2.

The dimensions of the casing of the device 5 are limited and are practically equivalent to those of a normal electromechanical thermostat.

Compressor 10 and the evaporators of the freezer and refrigerating compartments are over sized, in order to satisfy the refrigerating needs of the respective compartments even in tropical climates.

In figure 2, showing the block diagram of the control circuit of the refrigerating device according to the invention, the central rectangle (R) represents the semi-custom integrated circuit above cited; all around there are represented the accessory components connected to it. Specifically, inside the rectangle, symbol B indicates the block generating system time base; symbol T indicates the block performing the thermostatic control function (described in detail with reference to figure 3); symbol F indicates the block performing the control function of the operating ratio (described in detail with reference to figure 6); symbol S1 indicates the block performing the defrost function of the 'freezer' compartment (described in detail with reference to figure 5); symbol S2 indicates the block performing the defrost function of the 'refrigerator' compartment, which is similar to block S1; symbol A indicates the block performing the autotest function, which is realized all the times that the refrigerating device is switched on; at last symbol G indicates the block performing the loads handling function.

Outside the rectangle, symbol MC indicates the compressor; number 11 indicates the air temperature probe of the 'refrigerator' compartment; number 12 indicates a 50 Hz wave-form coming from the supply mains, which arrives to the block B; number 13 indicates the 'reset' terminal of the control system, in case that a mains supply failure occurs; number 14 indicates the temperature probe of the evaporator of the 'refrigerator' compartment; number 15 indicates the defrost heater of the 'freezer' compartment; number 16 indicates the contact of a bimetal placed on the 'freezer' evaporator (thermoprotector) which opens the circuit if the temperature reaches $+5^{\circ}$C; number 17 indicates the fan; number 18 indicates the heater of the 'refrigerator' compartment and at last number 19 indicates the wires of the 220 Volts supply mains.

The two temperature probes 11 and 14 are each connected in a bridge circuit, including a tension comparator (01,02) whose output is connected respectively to the block T for the probe 11 and to the block S2 for the probe 14.

Loads MC, 15, 17 and 18 are connected to the block G, which controls them.

In figure 3, showing schematically the circuit of one of the blocks of the circuit of figure 2, and precisely the block T, performing the thermostatic control function, the block 20 represents the start of the flowchart; the block 20 transmits the control to block 21, which is a test block to verify that there is at the moment a cold request (or that the temperature detected by the probe 11 is higher than the one input through the knob 4); in the affirmative case (output SI) the control goes over to block 27, in the negative (output NO) the control goes over to block 22.

Block 22 is a test block to verify that the compressor is disactived; in the affirmative case (output SI) the control goes over to block 23, in the negative (output NO) the control goes over to block 24.

Block 23 increases the count of the disactive compressor time and then transmits again the control to block 21; block 24 is a test block to verify that the active compressor time is equal to or higher than 8 minutes; in the affirmative case (output SI) the control goes over to block 25, in the negative (output NO) the control goes back to block 21.

Block 25 disables the compressor and transmits the control to block 26; block 26 resets the active compressor time and returns the control to block 21.

Block 27 is a test block to verify that the compressor is active; in the affirmative case (output SI) the control goes over to block 28, in the negative (output NO) the control goes over to block 29.

Block 28 increases the count of the active compressor time, and returns the control to block 21.

Block 29 is a test block to verify that the disactive compressor time is equal to or higher than 8 minutes; in the affirmative case (output SI) the control goes over to block 30, in the negative (output NO) the control goes back to block 21.

Block 30 activates the compressor and trasmits the control to. the subsequent block 31, which in his turn, resets the count of the disactive compressor time and returns the control to block 21.

The imposition of an 8 minutes minimum time of activation-disactivation of the compressor has the aim to prevent stability problems, due to electric inteferences, realizing the hysteresis function which is normally obtained by the voltage comparator. It is so obtained a reduction of the number of components associated to the voltage comparator 01 (fig. 2), as the wired hysteresis (positive feedback) is no longer necessary, and an increase of the immunity to the electric inteferences (due to the absence of the said positive feedback).

The temperature hysteresis obtained in this way is equal to about one centigrade degree totally (half degree lower or higher).

In figure 4, showing schematically the circuit of a part of the circuit of fig. 2, and precisely the control part of the LED luminous warning light, block 40 represents the start of the flowchart; block 40 transmits the control to block 41, which is a test block to verify that the fast freezing function (so called 'fast freezer') is enabled; in the affirmative case (output SI) the control goes over to block 42, in the negative (output NO) the control goes over to block 43.

Block 42 switches on the warning light, or confirms its switching on, and returns the control to block 41; block 43 is a test block to verify that the defrost function is enabled; in the affirmative case (output SI) the control goes over to block 44, in the negative (output NO) the control goes over to block 45.

Block 44 activates or cornfirms the flashing operation of the warning light, and returns the control to block 41; block 45 switches off the warning light, or confirms its switching off, and returns the control to block 41.

In figure 5, showing schematically the circuit of one of the blocks of fig. 2, namely of the block S1, enabling the defrost function of the 'freezer' compartment, block 50 represents the start of the flowchart; block 50 transmits the control to block S1, which is a test block to verify that the defrost function must start (the defrost cycles are normally required by the system, namely in fast freezing absence, every 14 hours for the freezer and every 7 hours for the refrigerator); in the affirmative case (output SI) the control goes over to block 52, in the negative (output NO) the control goes back to block 50.

Block 52 is a test block to verify that the compressor is disactivated; in the affirmative case (output SI) the control remains to block 52, in the negative (output NO) the control goes over to block 53.

Block 53 resets the count of the active compressor time and transmits the control to block 55.

Block 55 is a test block to verify that the compressor is disabled; in the affirmative case (output SI) the control goes over to block 58, in the negative (output NO) the control goes over to block 56.

Block 56 is a test block to verify that the compressor has been active for 3 hours; in the affirmative case (output SI) the control goes over to block 57, in the negative (output NO) the control goes over to block 54.

Block 54 increases the count of the active compressor time and returns the control to block 55; block 57 disables the compressor (said forced disactivation after a three hours uninterrupted operation can be necessary in case of high external temperature, when the compressor could be ever on) and transmits the control to block 58.

Block 58 enables the defrost heater and transmits the control to block 59; block 59 resets the count of the defrost time and transmits the control to block 60.

Block 60 is a test block to verify that the count of the defrost time has reached the predetermined maximum value (30 minutes); in the affirmative case (output SI) the control goes over to block 63, in the negative (output NO) the control goes over to block 61.

Block 61 is a test block to verify that the contact of the thermoprotector 16 is opened; in the affirmative case (output SI) the control goes over to block 63, in the negative (output NO) the control goes over to block 62.

Block 62 increases the count of the defrost time and returns the control to block 60; block 63 disables the defrost heater and returns the control to block 50.

The refrigerator defrost cycle operates in the same way; the end of the defrost cycle is determined by the probe 11, and precisely when the temperature that it detects is $+4^\circ$ C.

In figure 6, showing schematically the circuit of one of the blocks of the circuit of fig. 2, and precisely of the block F, assuring the control function of the operating ratio, the block 65 represents the start of the flowchart; block 65 transmits the control to block 66, which is a test block to verify that the compressor is disabled; in the affirmative case (output SI) the control goes over to block 67, in the negative (output NO) the control goes back to block 66.

Block 67 resets the count of the disactive compressor time and transmits the control to block 68.

Block 68, which is a test block, verifies that the compressor is on; in the affirmative case (output SI) the control goes back to block 66, in the negative (output NO) the control goes over to block 69.

Block 69, which is a test block, verifies that the count of the disactive compressor time has reached the predetermined maxim value (80 minutes); in the affirmative case (output SI) the control goes over to block 71, in the negative (output NO) the control goes over to block 70.

Block 70 increases the count of the disactive compressor time, and transmits the control to block 68; block 71 enables the compressor and transmits the control to block 72.

Block 72 resets the count of the active compressor time and transmits the control to block 73.

Block 73, which is a test block, verifies that the count of the active compressor time has reached the predetermined maximum value (40 minutes); in the affirmative case (output SI) the control goes over to block 74, in the negative (output NO) the control goes over to block 75.

Block 74 disbles the compressor and transmits the control to block 66; block 75, which is a test block, verifies that the temperature in the refrigerator compartment is at the admissible minimum value (+1°); in the affirmative case (output SI) the control goes over to block 76, in the negative (output NO) the control goes over to block 77.

Block 76 activates the heater 18 of the refrigerator compartment and transmits the control to block 78; block 77 disables the heater 18 of the refrigerator compartment and transmits the control to block 78.

Block 78, from its side, increases the count of the active compressor time and returns the control to block 73.

The semi-custom integrated circuit, included in the control device 5 according to the invention, besides the described characteristics, has also a memory function.

Such a function has the aim to memorize that a mains supply failure lasted for more than 10 seconds; in this case, when the mains supply returns, the compressor is activated for 45 minutes; simultaneously the regulation of the temperature to be maintained in the refrigerator compartment is simulated at +1° C.

Such a function is used in the manufacturing process to comparate the performance (temperature progress referred to a fixed time interval).

The characteristics of the refrigerating device as described above are clearly shown in the description and annexed drawings.

Also the advantages of the improved refrigerating device according to the present invention are clear.

Specifically they are represented by the following features:

- low cost and manufacturing uniformity;
- thermostatic control independent from the room temperature;
- compressor safety from unbalanced starts;
- the freezer is not heated even in the case that the external temperature is low;
- excessive ice is not formed even when the external temperature is higher than 30° C.

It is obvious that many other changes are possible for the man skilled in the art to the refrigerating device described by way of example, without departing from the scope of the innovating criteria inherent of the present invention.

By way of example it is suggested that the probe to measure the air temperature of the refrigerator compartment is represented by a resistor with negative temperature coefficient (NTC), directly welded on the printed circuit contained in the control device 5.

Claims

1. Improved refrigerating device comprising two compartments and precisely a first compartment used for the storage of fresh food and a second compartment used for the freezing and storing of foods, a refrigerating circuit comprising a compressor, a first and a second evaporators arranged in said first and second compartments, respectively, and a condenser, and also comprising a temperature control system, having manual regulation possibility, located in said first compartment, characterized by the fact that automatic regulation means (5, 8, 9) are provided, which operate on the basis of the room temperature so assuring the correct operation in both said two compartments.

2. Improved refrigerating device according to claim 1, characterized by the fact that said automatic regulation means comprise an electronic printed circuit including:
- a digital part (T, F, S1, S2);
- an analogic part (01, 02)
- a temperature sensor (11) detecting the air temperature.

3. Improved refrigerating device according to claim 2, characterized by the fact that said temperature sensor (11) is realized by means of a NTC type resistence directly welded on the printed cir-

cuit.

4. Improved refrigerating device according to claim 2, characterized by the fact that said electronic circuit comprises an integrated circuit realized in accordance with the semi-custom technology (R).

5. Improved refrigerating device according to claim 2, characterized by the fact that said temperature control system (5) is contained in a plastic material casing presenting external dimensions similar to the ones of a normal electromechanic thermostat.

6. Improved refrigerating device according to claim 2, characterized by the fact that said temperature control system (5) of the air presents a very reduced hysteresis in temperature and that there is provided a protection consisting in the imposition of a minimum time elapsing between each activation and each disactivation of the compressor and viceversa.

7. Improved refrigerating device according to claim 6, characterized by the fact that said hysteresis in temperature is of about one centigrade degree.

8. Improved refrigerating device according to claim 6, characterized by the fact that said minimum time is of about 8 minutes.

9. Improved refrigerating device according to claim 1, characterized by the fact that inside said second compartment no temperature sensors are provided, and that to avoid an excessive heating of said second compartment, in presence of very low room temperature, said control system controls the lenght of time of each compressor operation pause, and, in case it exceeds a determined value, behaves activating the compressor for a predefined fixed period of time.

10. Improved refrigerating device according to claim 9, characterized by the fact that said determined maximum pause value is of about 80 minutes.

11. Improved refrigerating device according to claim 9, characterized by the fact that said predefined fixed time is of about 40 minutes.

12. Improved refrigerating device according to claim 9, characterized by the fact that the ratio between said determined pause value and said predefined fixed time if of about 2.

13. Improved refrigerating device according to claim 2, characterized by the fact that the control system comprises a second temperature sensor (14), sensitive to evaporator temperature of said first compartment, and that it is used to handle the defrost cycles which, in normal operation conditions (namely if the fast freezing is not required), are started with regular time intervals, and are ended when the temperature detected by said second sensor (14) reaches a predetermined value.

14. Improved refrigerating device according to claim 13, characterized by the fact that said temperature predetermined value detected by said second sensor is of about +4° C.

15. Improved refrigerating device according to claim 13, characterized by the fact that said regular time intervals are of about 7 hours for said first compartment and of about 14 hours for said second compartment.

16. Improved refrigerating device according to claim 13, characterized by the fact that a signalling is provided to inform that the defrost cycle of said second compartment is active.

17. Improved refrigerating device according to claim 16, characterized by the fact that said signalling is a visual signalling.

18. Improved refrigerating device according to claim 17, characterized by the fact that visual signalling is obtained by the flashing of a luminous warning light, which, when continously on, gives a different information.

19. Improved refrigerating device according to claim 18, characterized by the fact that said warning light, when continously on, indicates that the fast freezing is active.

20. Improved refrigerating device according to claim 1, characterized by the fact that said control system comprises means to detect and memorize an electric mains supply failure exceeding a predetermined lenght of time.

21. Improved refrigerating device according to claim 20, characterized by the fact that said predetermined lenght of time is of about 10 seconds.

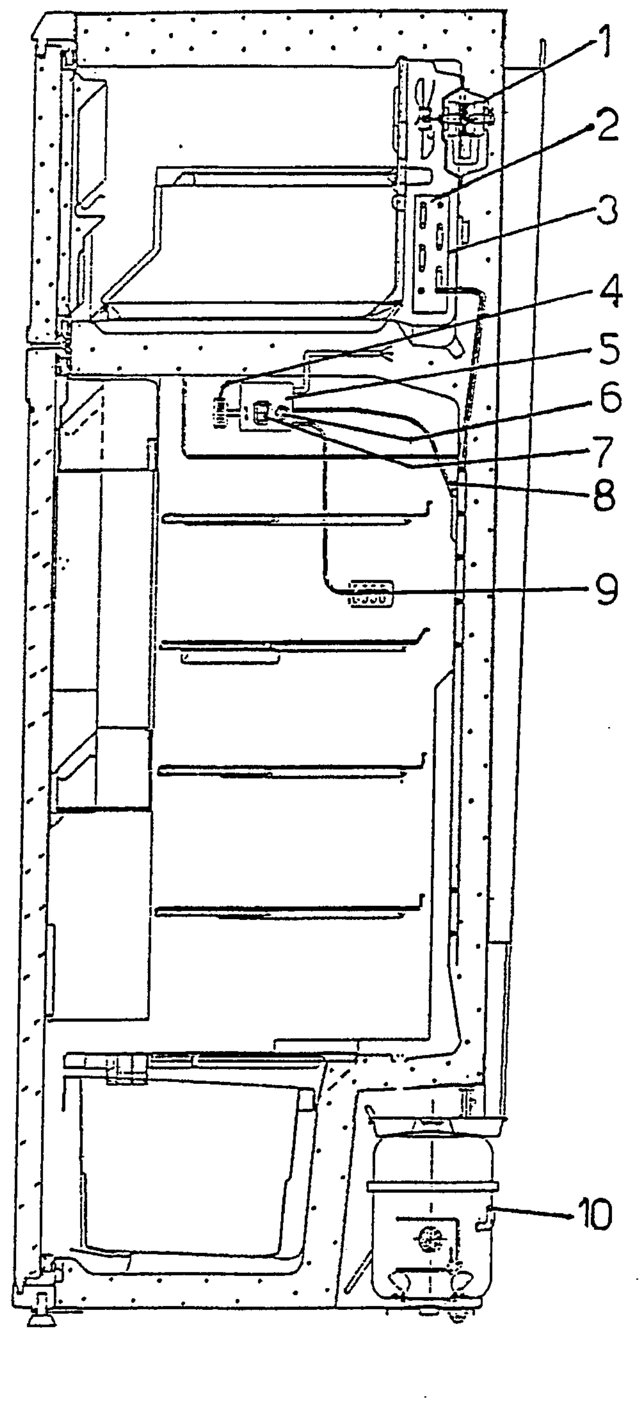
22. Improved refrigerating device according to claim 20, characterized by the fact that said control system, when the electric mains supply returns, after a failure longer than said predetermined lenght of time, activates the compressor for a predetermined period of time.

23. Improved refrigerating device according to claim 22, characterized by the fact that said predetermined period of time is of about 45 minutes.

24. Improved refrigerating device according to claim 22, characterized by the fact that said control system, in said occurrence, artificially alters the regulation of the temperature to be maintained in said first compartment.

25. Improved refrigerating device according to claim 1, characterized by the fact that said evaporators and said compressor are so dimensioned as to satisfy the refrigerating needs of said first and second compartments even in tropical climates.

Fig. 1



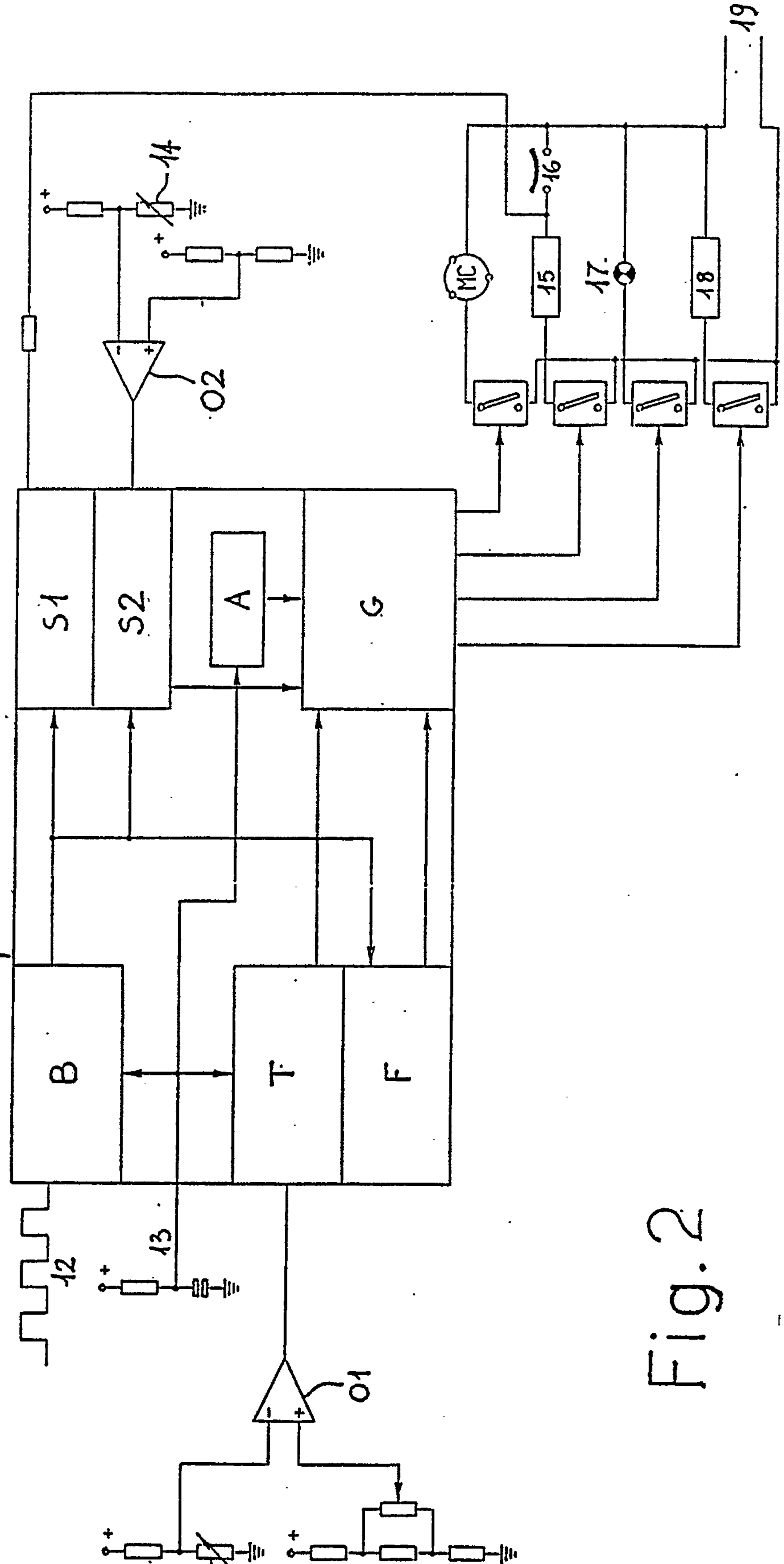
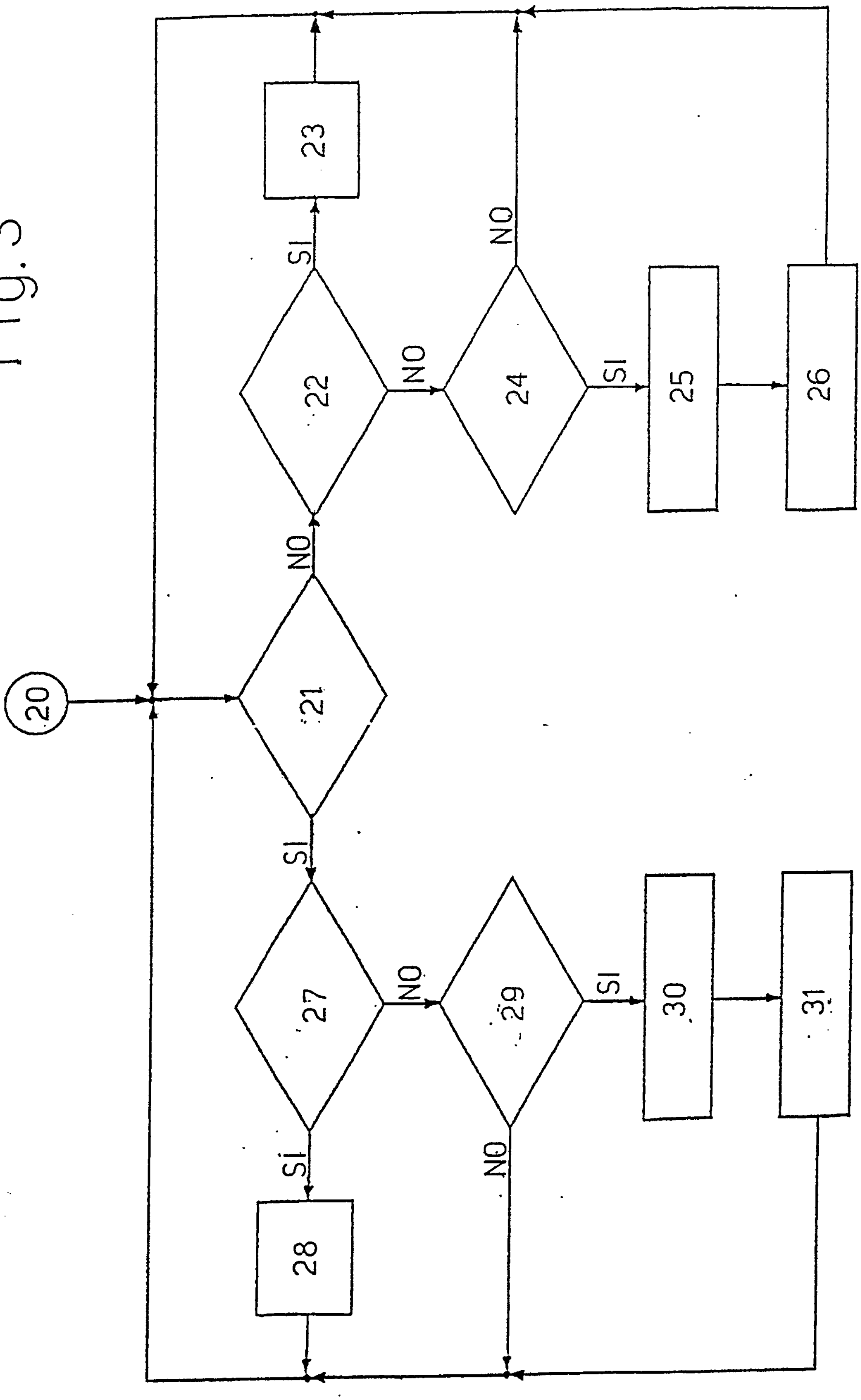


Fig. 2

Fig. 3



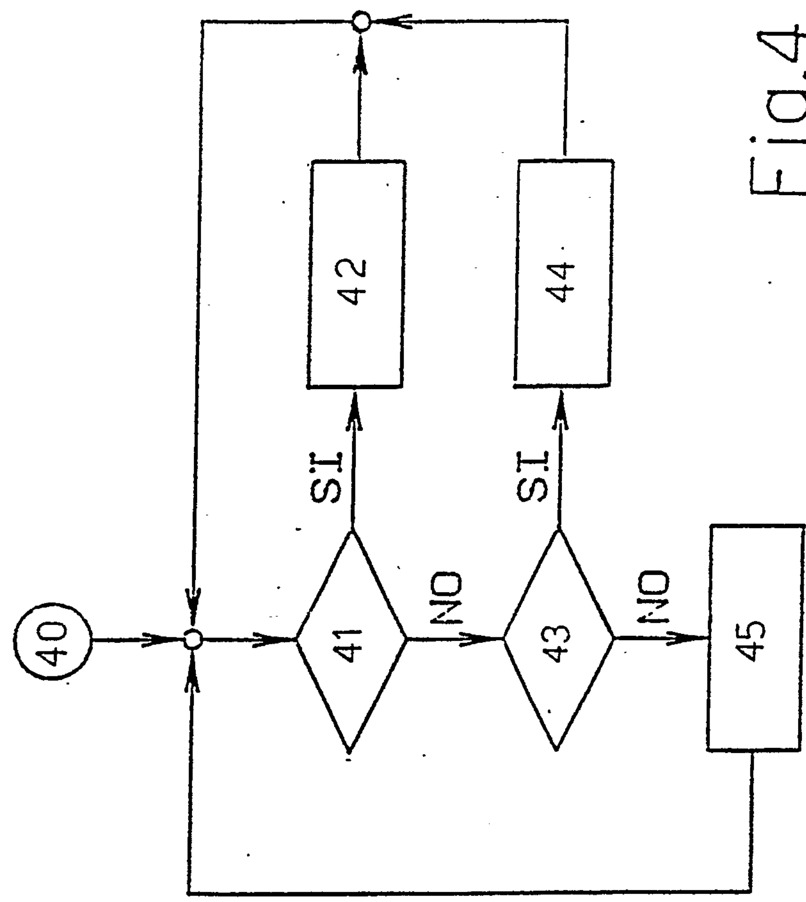
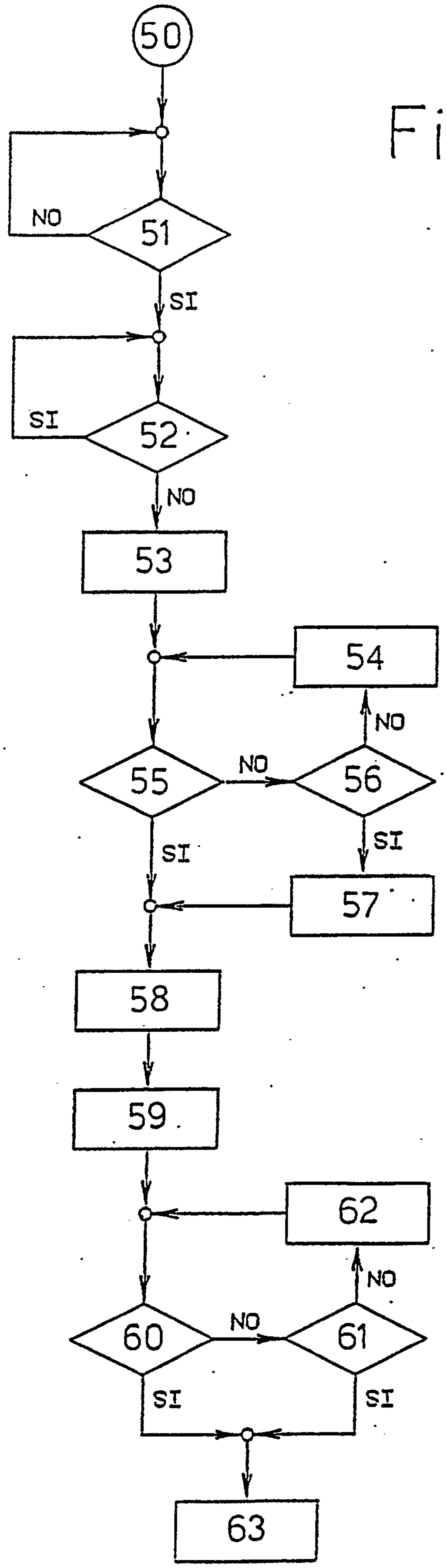


Fig.4

Fig.5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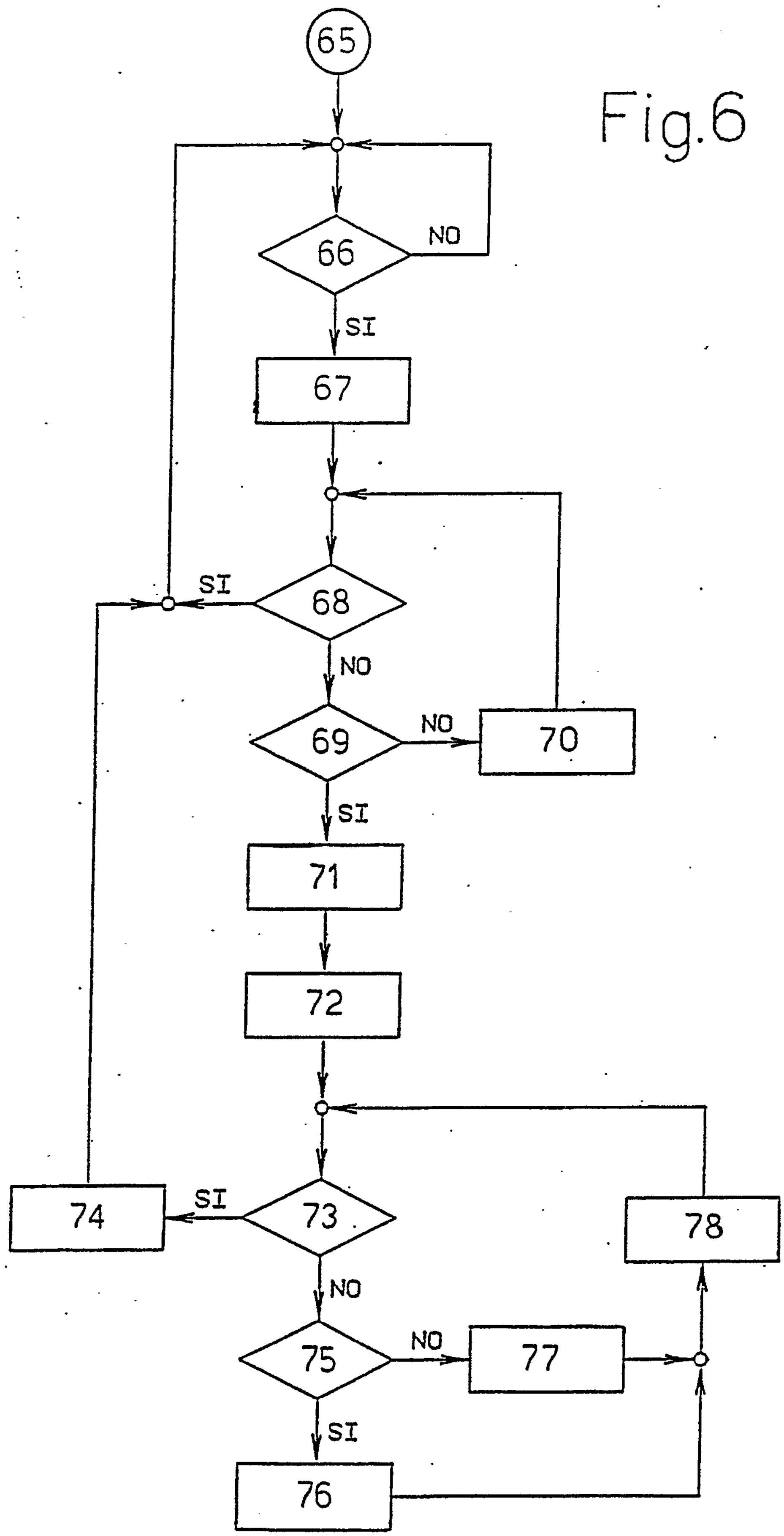

Fig.6