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(54) **REFRIGERATOR HAVING CIRCULATION FAN CONTROLLER FOR SAVING POWER CONSUMPTION**

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(57) **ABSTRACT**

Disclosed is a refrigerator comprising: a compressor ON/OFF detector configured to detect an operation of the compressor when the compressor is operated; a circulation fan operation controller checks an operation of the compressor based on a signal input from the compressor ON/OFF detector and set and output an operation condition of a circulation fan; a circulation fan power source (**50**) configured to supply drive power to the circulation fan (**60**) in response to an output signal of the circulation fan operation controller (**30**); and a circulation fan control switch (**40**) configured to interrupt the power of the circulation fan power source (**50**) in response to an output signal of the circulation fan operation controller (**30**).

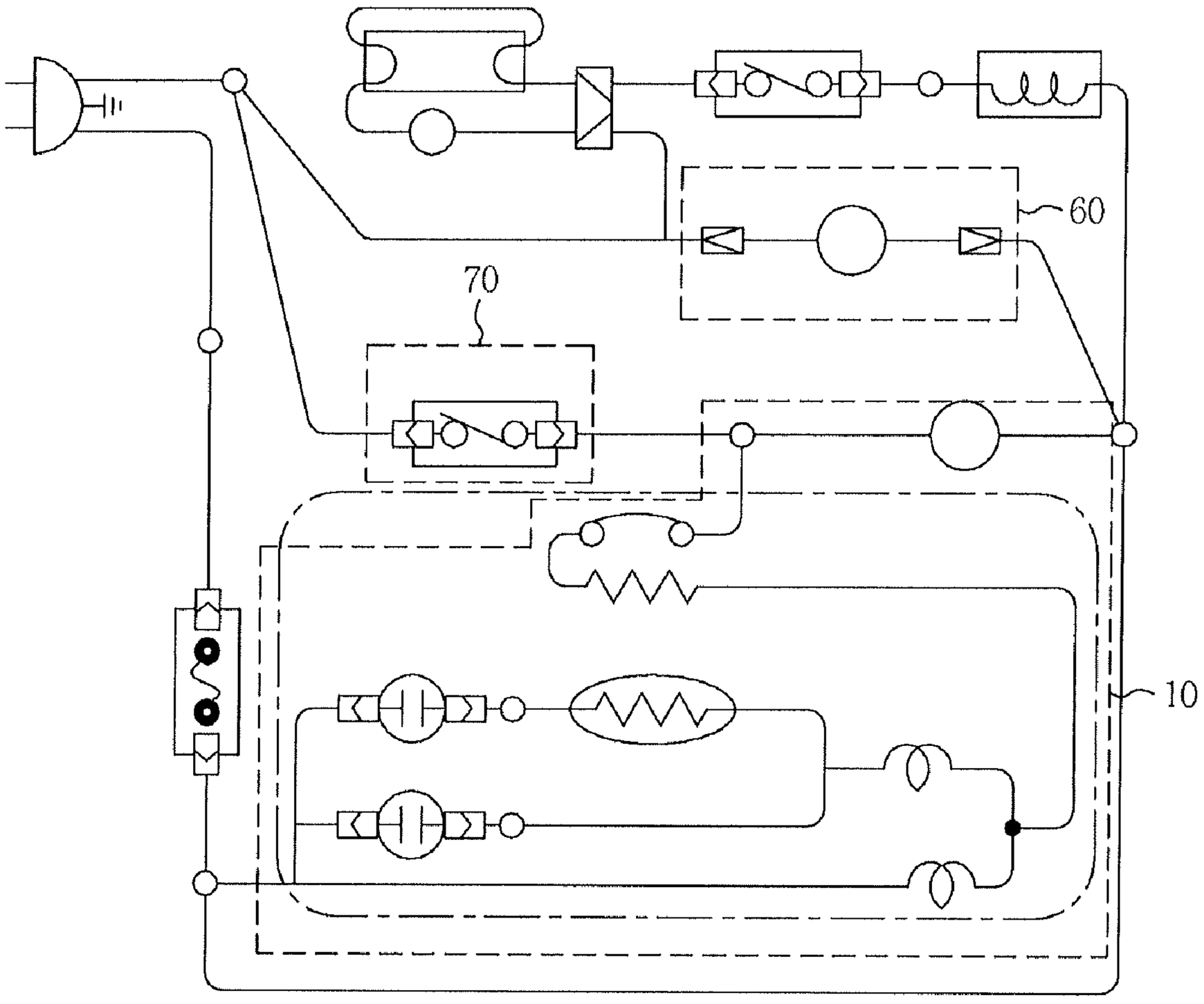


FIG. 1

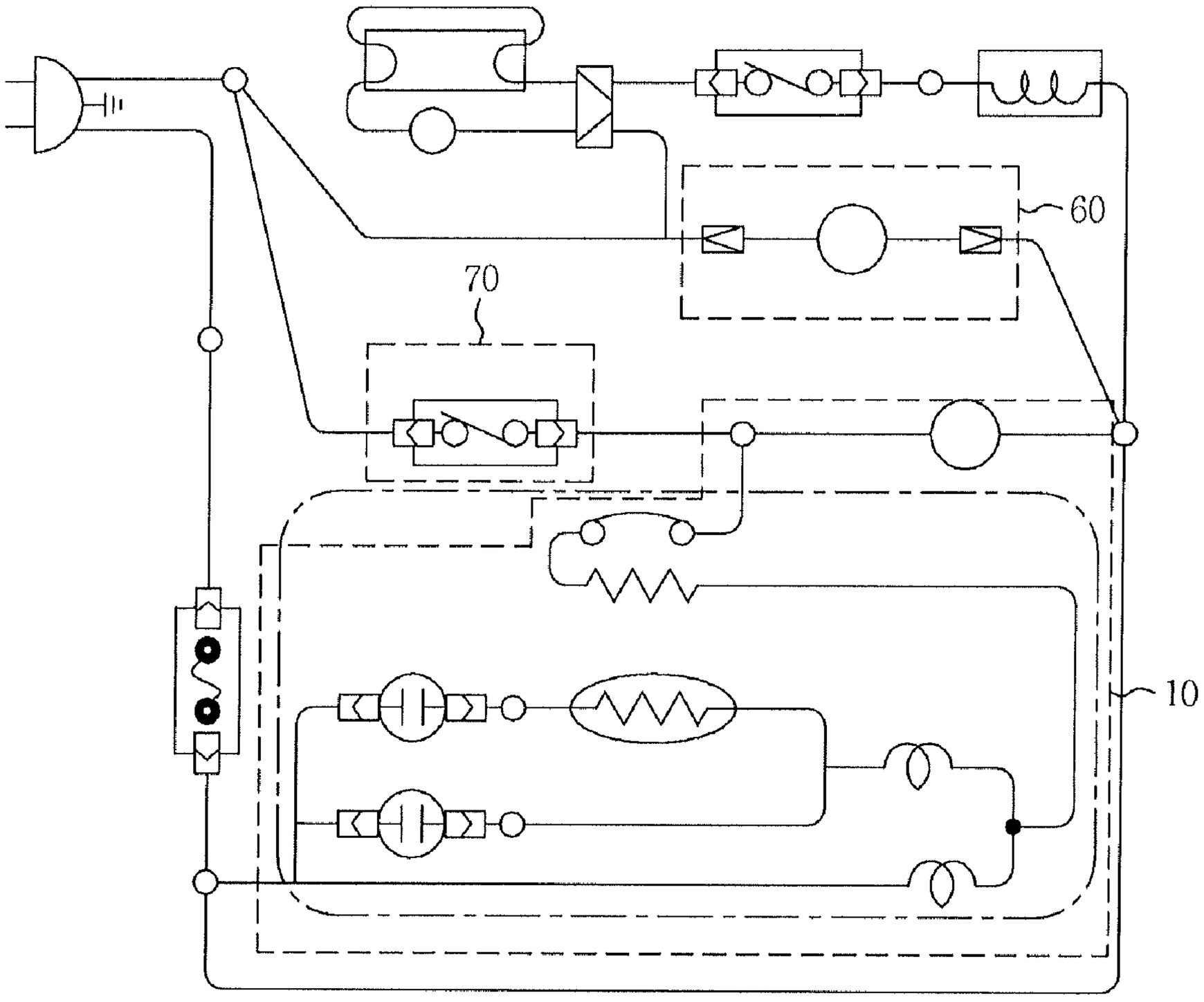


FIG. 2

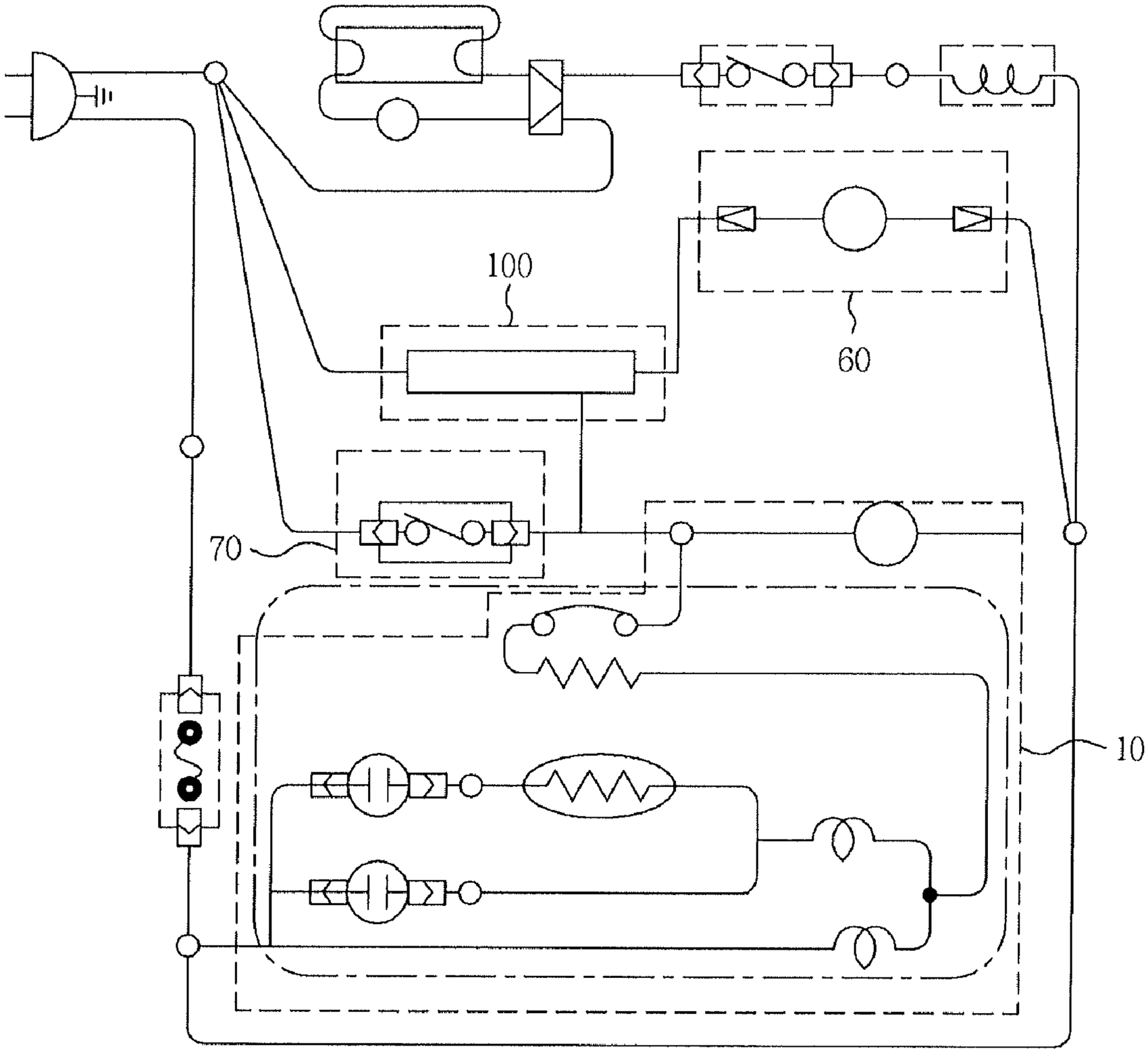


FIG. 3

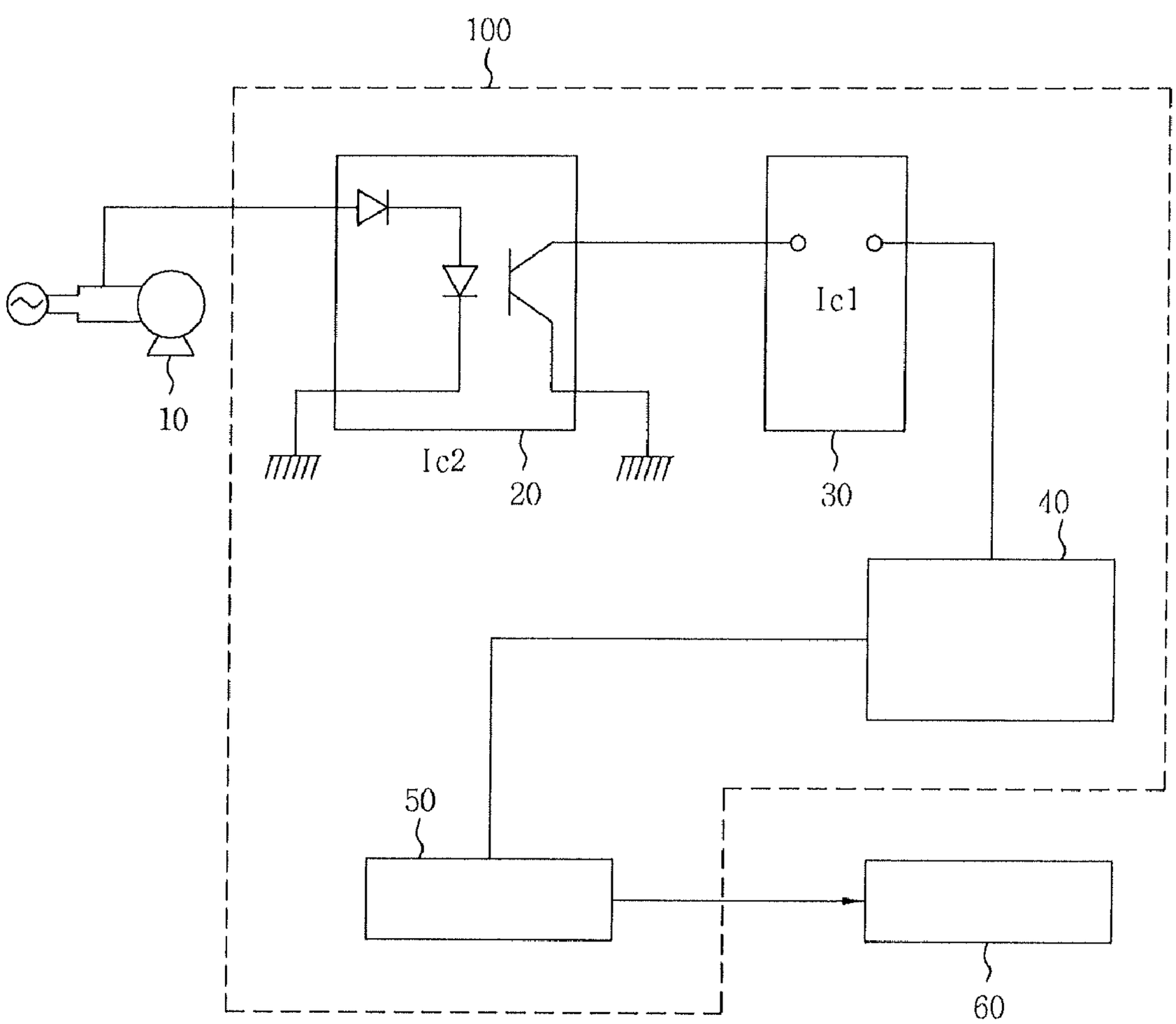
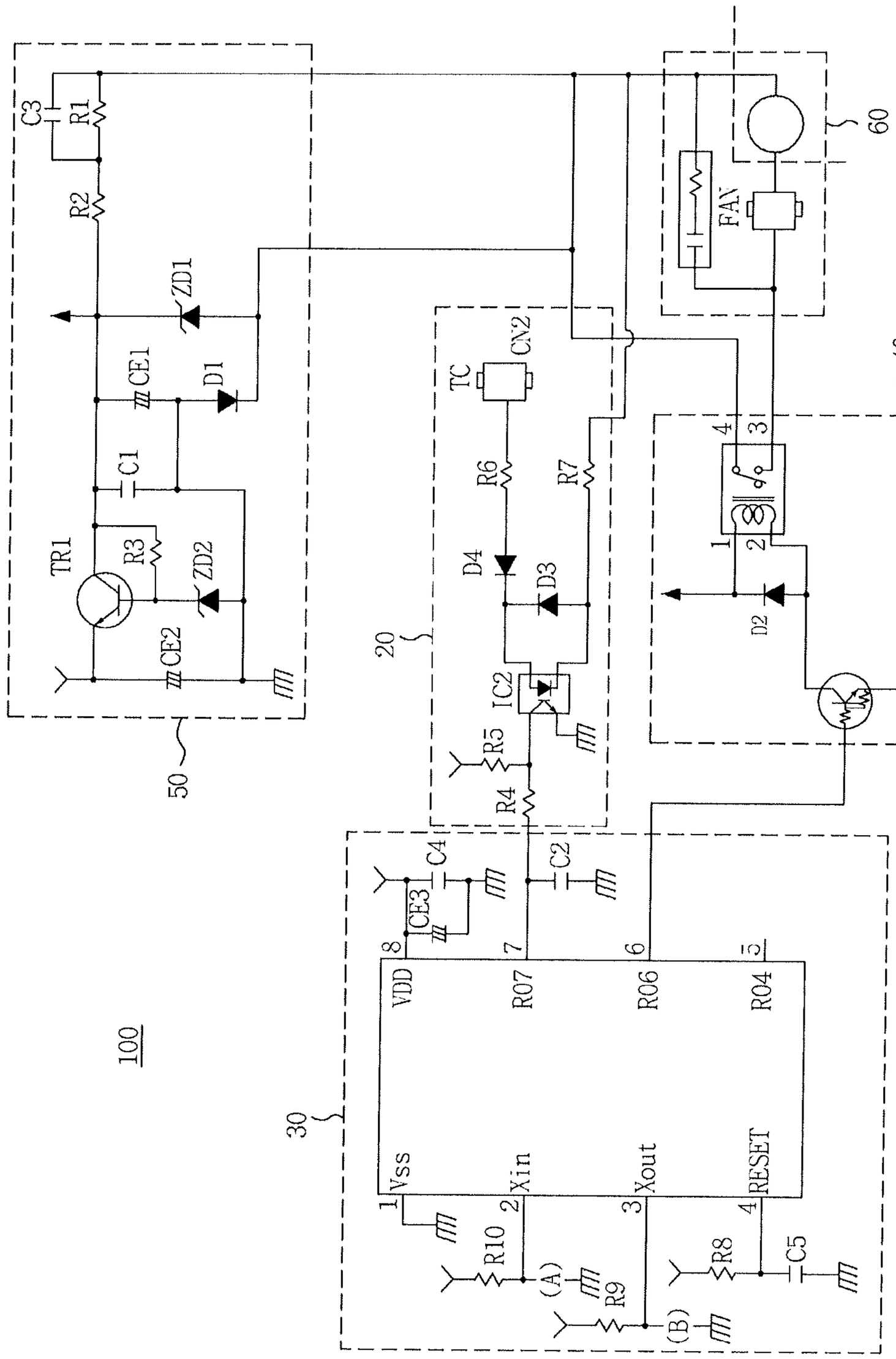


FIG. 4


100
50
C3
R1
R2
ZD1
CE1
D1
C1
TR1
R3
ZD2
CE2
60
FAN
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TC
CN2
R6
R7
D4
D3
IC2
R5
R4
40
D2
30
C4
CE3
C2
VDD
R07
R06
R04
Vss
Xin
Xout
RESET
R10
(A)
R9
(B)
R8
C5

REFRIGERATOR HAVING CIRCULATION FAN CONTROLLER FOR SAVING POWER CONSUMPTION

BACKGROUND

[0001] 1. Field of the Invention

[0002] The present invention relates to a fan control circuit for saving power consumption of a refrigerator by controlling an evaporator fan, and more particularly, to a power saving circuit using control of a fan of a refrigerator that saves power consumption by controlling the operation of an evaporator fan located within the refrigerator in association with the operation of a compressor.

[0003] 2. Discussion of Related Art

[0004] Refrigerators, air conditioners, and refrigerating show cases all includes a refrigeration cycle. The refrigeration cycle includes a compressor configured to compress a gaseous refrigerant of low temperature and low pressure to produce a gaseous refrigerant of high temperature and high pressure, a condenser connected to a discharge opening of the compressor and configured to condense the gaseous refrigerant of high temperature and high pressure produced by the compressor into a liquefied state, a capillary tube configured to decompress the pressurized liquefied refrigerant which has passed through the condenser, and an evaporator configured to produce cold air by absorbing heat from the liquefied refrigerant decompressed by the capillary tube, and a circulation fan (also, referred to as an evaporator fan) configured to circulate the cold air produced by the evaporator into a compartment is installed around the evaporator.

[0005] The compressor functions to increase the pressure of a refrigerant by compressing a gaseous refrigerant of low pressure using the rotational force of a motor. The motor of the compressor may be an AC motor, a brushless motor, etc.

[0006] The compressor of the refrigeration cycle compresses a gaseous refrigerant of low pressure into a gaseous refrigerant of high pressure. The gaseous refrigerant compressed by the compressor undergoes a phase transition to a liquid state while passing through the condenser.

[0007] The refrigerant which has been liquefied while undergoing a phase transition is decompressed after it passes through the capillary tube and absorbs the surrounding heat in the evaporator to undergo a phase transition to a gaseous state. Then, the refrigerant is changed to a gaseous state by the phase transition. That is, the refrigerant undergoes a phase transition to a gas state in the evaporator.

[0008] If the circulation fan **60** is operated, heat exchange is further activated in the evaporator. Further activation of heat exchange in the evaporator means expedition of evaporation of the refrigerant in the evaporator.

[0009] As illustrated in FIG. **1**, in a refrigerator, a show case, etc. (hereinafter, referred to as "refrigerator") having a general refrigeration cycle, a circulation fan **60** is operated within an interior (hereinafter, referred to as "compartment") to efficiently exchange heat in the evaporator and make the temperature of the compartment uniform. The circulation fan **60** is controlled by a controller (FIG. **1** illustrates a mechanical refrigerator in which a compressor is controlled not by a separate controller but by a compartment temperature adjustor) according to the temperature of the compartment, the opening/closing state of the door, etc.

[0010] Technologies of controlling a circulation fan according to various operation conditions to enhance the operation efficiencies of a refrigerator, e.g. the condition of a compartment are disclosed in Korean Laid-Open Patent No. 2000-0055339, Korean Utility Model No. 20-0290179, etc.

[0011] However, according to the disclosed technologies, in controlling the circulation fan **60**, the operation of the circulation fan **60** is controlled only by opening and closing the door regardless of the operation of the compressor **10**, or is controlled to be operated during the operation of the compressor **10** and be stopped when the compressor is stopped, restraining frost generated in the evaporator (not shown) from being completely removed. As a result, the temperature of the compartment cannot be controlled to a desired temperature, which is complained by users during use.

[0012] In particular, in a mechanical temperature adjusting refrigerator where only the operation of the compressor **10** is controlled in association with the operation of the compartment temperature adjustor **70** and the circulation fan is operated at all times, the circulation fan **60** is normally operated regardless of the operation of the compressor **10**, causing loss of power.

[0013] In particular, in the case of a refrigerating show case, since the circulation fan motor is operated at all times, it rapidly radiates heat and circulates cold air. Accordingly, heat is transferred through a glass door and cold air is leaked, causing power to be wasted due to increase in the operation time of the compressor.

SUMMARY OF THE INVENTION

[0014] The prevent invention has been made in an effort to solve the above-described problems associated with the prior art, and an object of the present invention is to provide a fan control circuit that saves power consumption by checking an operation of a compressor and continuously operate a circulation fan or periodically switching on and off the circulation fan according to the operation of the compressor, and a control method thereof.

[0015] According to an aspect of the present invention for achieving the above object, there is provided a refrigerator including a refrigeration cycle having a compressor configured to compress a refrigerant, a condenser configured to condense the refrigerant compressed by the compressor, a capillary tube configured to decompress the liquid refrigerant condensed by the condenser, and an evaporator configured to evaporate the liquid refrigerant decompressed by the capillary tube to produce cold air by exchanging heat, and a circulation fan configured to circulate the cold air produced by the evaporator, comprising: a compressor ON/OFF detector configured to detect an operation of the compressor when the compressor is operated; a circulation fan operation controller checks an operation of the compressor based on a signal input from the compressor ON/OFF detector and set and output an operation condition of a circulation fan; a circulation fan power source **50** configured to supply drive power to the circulation fan **60** in response to an output signal of the circulation fan operation controller **30**; and a circulation fan control switch **40** configured to interrupt the power of the circulation fan power source **50** in response to an output signal of the circulation fan operation controller **30**.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] The above and other objects, features and advantages of the present invention will become more apparent to

those of ordinary skill in the art by describing in detail exemplary embodiments thereof with reference to the accompanying drawings, in which:

[0017] FIG. **1** is a control circuit diagram illustrating an operation of mechanically controlling a fan of a conventional refrigerator;

[0018] FIG. **2** is a circuit diagram illustrating an operation of controlling a fan of a refrigerator according to an embodiment of the present invention;

[0019] FIG. **3** is a block diagram of a circulation fan controller of the refrigerator according to the embodiment of the present invention; and

[0020] FIG. **4** is a circuit diagram of the circulation fan controller of the refrigerator according to the embodiment of the present invention.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0021] Hereinafter, exemplary embodiments of the present invention will be described below in detail with reference to the accompanying drawings such that those skilled in the art to which the present invention pertains can easily practice the present invention.

[0022] First, in a refrigerator including a refrigeration cycle of FIG. **2** according to an embodiment of the present invention, a compartment temperature adjustor **70** configured to detect the temperature of a refrigerator compartment or a freezer compartment (hereinafter, referred to as "compartment") such that the compartment temperature adjustor **70** is switched on and off according to a set temperature of the compartment and a compressor is operated or stopped according to the switching operation of the compartment temperature adjuster **70**.

[0023] Then, the circulation fan controller **100** detects the ON/OFF state of the compartment temperature adjuster **70** and controls an operation of the circulation fan **60** according to a predetermined period or condition.

[0024] FIGS. **3** and **4** are a block diagram and a circuit diagram of the circulation fan controller **100** of FIG. **2**, and the operation and configuration of a power saving circuit of the refrigerator according to the embodiment of the present invention will be described with reference to the drawings.

[0025] If the compressor is operated, a voltage applied to an input terminal of the compressor **10** is detected by a compressor ON/OFF switch **20**.

[0026] As illustrated in FIG. **4**, the compressor ON/OFF detector **20** photoelectrically converts a compressor operating voltage inputted to an input terminal of the compressor through a diode and a light emitting diode into an electrical signal, i.e. a CDs device commonly used in the field and sends it to an operation controller **30**.

[0027] When the compressor is switched on, the photoelectric device inputs a HIGH signal to the circulation fan operation controller **30** and, when the compressor is turned off, it inputs a LOW signal to the circulation fan operation controller **30**.

[0028] It is noted that HIGH and LOW signals can be determined according to a circuit design of a person skilled in the art to which the present invention pertains and can be set in the opposite way and such a photoelectric device is used to secure the reliability of the operation of the circulation fan operation controller **30** by preventing components such as noise, i.e. an unintended signal that may be contained in a detection signal from being introduced into the circulation fan operation controller **30**.

[0029] In the detection step, the circulation fan operation controller **30** checks an operation of the compressor **10** based on a signal input to the circulation fan operation controller **30**, and sets and outputs an operation condition of the circulation fan **60**.

[0030] A device commonly used to output a signal indicating an operation period or an ON/OFF state according to the state of a signal that is recognized by the circulation fan operation controller **30** when a signal is input to the circulation fan operation controller **30** is suitable for the circulation fan operation controller **30**. Meanwhile, although a commercialized device, e.g. MC814104 is used in the present invention, the present invention is not limited thereto and any device having the same function is available.

[0031] If the compressor **10** is switched on, the circulation fan control switch **30** outputs a signal for continuously operating the circulation fan **60**, and if the compressor **10** is switched off, the circulation fan control switch **30** outputs an interruption signal for switching off the circulation fan **30** for three minutes and switching on the circulation fan **30** for one minute.

[0032] The interruption period may be modified according to the design condition of a designer, but is an optimum embodiment in the present invention.

[0033] The circulation fan control switch **40** configured to apply and interrupt a voltage of the circulation fan power source **50** to the circulation fan **60** in response to an output signal of the circulation fan operation controller **30** includes a coil commonly utilized in the field, a relay having a contact point operated by an attractive or repulsive force of the coil, and a semiconductor device interrupting a voltage for energizing the coil in response to an output signal of the circulation fan operation controller **30**, i.e. a semiconductor device through which a current flows in response to a biased signal (or an applied signal) such as a transistor commonly used in the field.

[0034] It is noted that while the present invention illustrates a mechanical relay as an example of the circulation fan control switch **40**, the present invention is not limited thereto and a switch circuit or a switch device having an electronic circuit may be utilized as the circulation fan control switch **40**.

[0035] The circulation fan power source **50** is a power supply that supplies drive power of the circulation fan **60** supplied through the circulation fan control switch **40** and is limited to the specification of the circulation fan **60**. The circulation fan power source **50** includes a condenser for interrupting unnecessary noise and a Zener diode transistor.

[0036] Although not illustrated in the present invention, the power supplied to the circulation fan power source **50**, the circulation fan control switch **40**, and the circulation fan operation controller **30** is generally obtained by rectifying and AD-converting a common power of 50 to 60 Hz and 100 to 240 V.

[0037] The power may be supplied by an SMPS (Switching Mode Power Supply) generated by a power electronic circuit disposed on the printed circuit board on which the circulation fan controller **100** is mounted, and may be a DC power supplied through a separate power source.

[0038] In the operation of the circulation fan controller **100** comprises a step of detecting and checking an operation of the compressor **10** by the compressor ON/OFF detector **20** when

the compressor **10** is operated, a step of checking an operation of the compressor **10** based on an input signal by the circulation fan operation controller **30** and setting and outputting an operation condition of the circulation fan, and a step of supplying and interrupting an operation power of the circulation fan **60** through the circulation fan control switch **40** such that drive power can be supplied to the circulation fan **60** in response to an output signal of the circulation fan operation controller **30**.

[0039] As described above, the operation of the circulation fan **60** is controlled by determining an operation of the compressor according to the present invention so that the circulation of cold air can be limited when the circulation fan motor is off in the case of a freezer show case such that heat is refrained from being transferred through a glass door and cold air is refrained from being leaked, making it possible to reduce operation time. Moreover, consumption of power of the motor is reduced by stopping the circulation fan when the compressor is off.

[0040] In order to measure the power saving effect of the refrigerator of the present invention, the California Energy Saving Test Standard is applied in a condition of a peripheral temperature of 24 degrees Celsius, a relative humidity of 50%, measurement of 24 hours, opening and closing of a door by an interval of 10 minutes for 8 hours, and 3 minutes OFF and 1 minute ON of a cooling fan when a compressor is switched off The result shows that the power consumption of the refrigerator of the present invention is decreased by 12 to 15% as compared with a conventional refrigerator regardless of the ON/OFF state of a compressor.

[0041] It will be apparent to those skilled in the art that various modifications can be made to the above-described exemplary embodiments of the present invention without departing from the spirit or scope of the invention. Thus, it is intended that the present invention covers all such modifications provided they come within the scope of the appended claims and their equivalents.

What is claimed is:

1. A refrigerator including a refrigeration cycle having a compressor configured to compress a refrigerant, a condenser configured to condense the refrigerant compressed by the compressor, a capillary tube configured to decompress the liquid refrigerant condensed by the condenser, and an evaporator configured to evaporate the liquid refrigerant decompressed by the capillary tube to produce cold air by exchanging heat, and a circulation fan configured to circulate the cold air produced by the evaporator, comprising:

a compressor ON/OFF detector configured to detect an operation of the compressor when the compressor is operated;

a circulation fan operation controller configured to check an operation of the compressor based on a signal input from the compressor ON/OFF detector and set and output an operation condition of a circulation fan;

a circulation fan power source configured to supply drive power to the circulation fan in response to an output signal of the circulation fan operation controller; and

a circulation fan control switch configured to interrupt the power of the circulation fan power source in response to an output signal of the circulation fan operation controller.

2. The refrigerator as claimed in claim **1**, wherein the compressor ON/OFF detector includes a photoelectric switch.

3. The refrigerator as claimed in claim **1**, wherein the circulation fan control switch includes a relay having a coil and a contact point operated by an attractive or repulsive force of the coil, and a semiconductor device configured to interrupt power energizing the coil in response to an output signal of the circulation fan operation controller.

4. The refrigerator as claimed in claim **1**, wherein the circulation fan operation controller includes a circulation fan controller that controls the circulation fan control switch to output a signal for continuously operating the circulation fan if the compressor is switched on and controls the circulation fan control switch to output an interruption signal for operating the circulation fan such that the circulation fan is stopped for three minutes and is operated for one minute if the compressor is switched off.

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