United States Patent [19]

McCarty

[11] **3,720,073**

[45] **March 13, 1973**

[54] **AIR CONDITIONER**

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[73] Assignee: **General Electric Company**

[22] Filed: **July 2, 1971**

[21] Appl. No.: **159,236**

[52] **U.S. Cl.** **62/183**, 62/177, 62/181

[51] **Int. Cl.**.....**F25b 39/04**

[58] **Field of Search**.....62/183, 184, 180, 181

[56] **References Cited**

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1,886,607	11/1932	Van Derenter	62/181
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3,040,543	6/1962	Atchison	62/181
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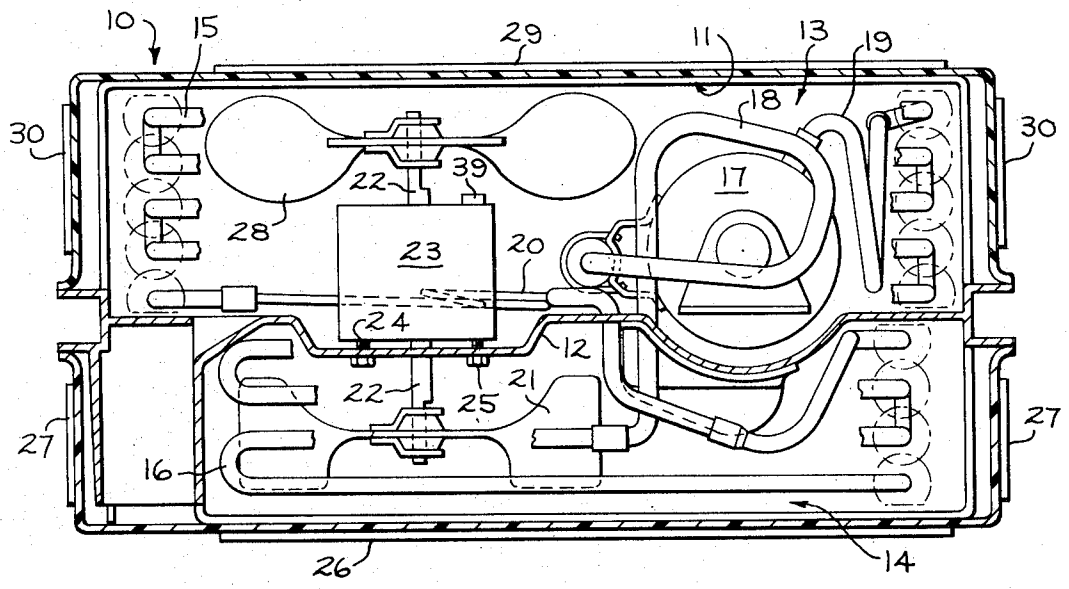
[57] **ABSTRACT**

This invention provides an improved air-conditioner. Basically, it comprises: a casing mountable in an opening into a room and having openings communicating with indoor and outdoor air; a refrigeration system mounted in the casing and including a compressor, a condenser and an evaporator interconnected in a refrigerant flow relationship; and a fan mounted in the casing for circulating outdoor air over the condenser. However, in accordance with the present invention, a multi-speed electric motor is mounted in the casing with its output shaft connected to the condenser fan. The motor has a slower first speed and a faster second speed. In particular accordance with the present invention, thermally responsive switch means are mounted on the motor for cooling by the outdoor air and have a movable switch member that will remain in a first position causing the motor to operate the condenser fan at the slower and consequently quieter first speed unless the outdoor air temperature is sufficiently high to cause the switch means to sense a temperature exceeding a first predetermined temperature. Then, the switch member will move to a second position causing the motor to operate the condenser fan at the faster and consequently louder second speed, but only until the outdoor air temperature becomes sufficiently low to cause the switch means to sense a second predetermined temperature that is lower than the first. Then, the switch member will return to its first position causing the motor to resume operation of the condenser fan at the slower and quieter first speed.

2 Claims, 2 Drawing Figures



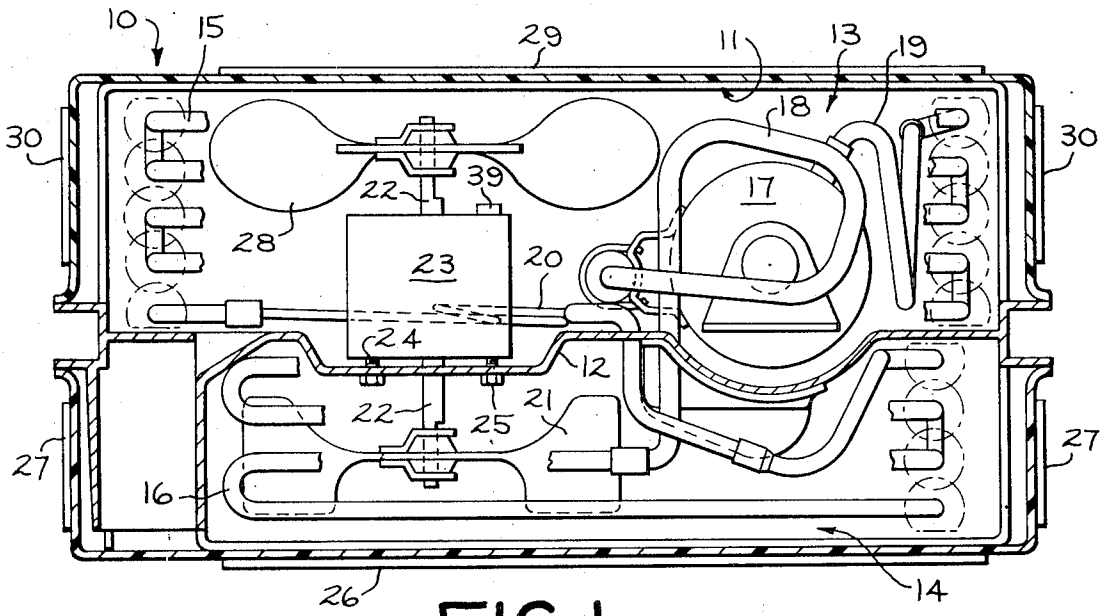


FIG. 1

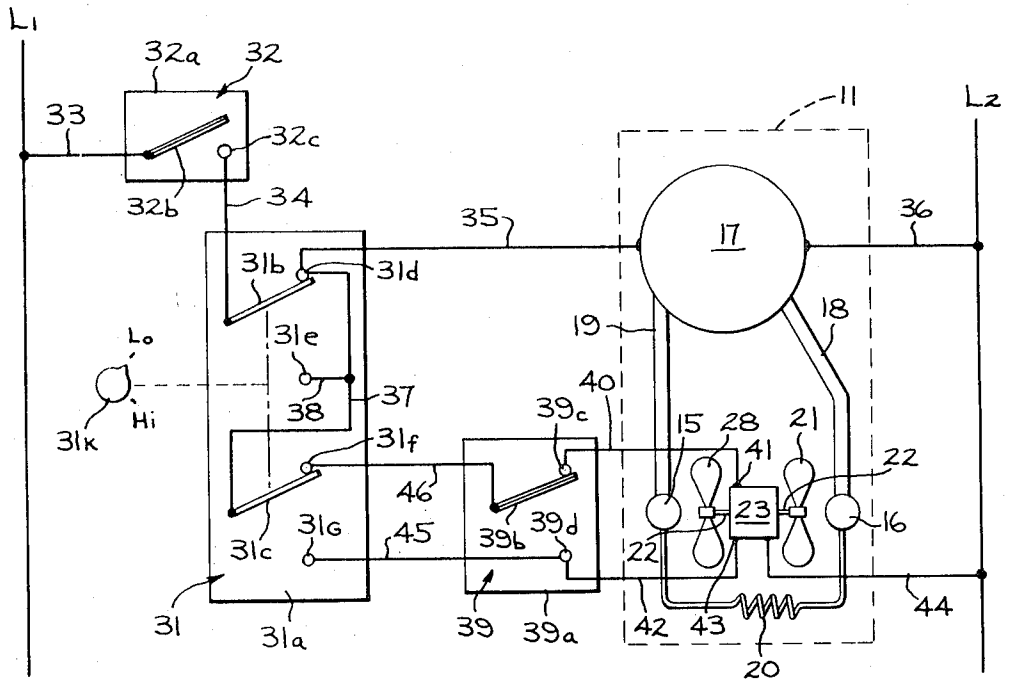


FIG. 2

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AIR CONDITIONER

BACKGROUND OF THE INVENTION

This invention relates to air-conditioning apparatus and, more particularly, to self-contained air-conditioner units of the type adapted to be mounted in a window or other opening in the wall of a building.

Such self-contained air-conditioner units are frequently employed to cool the air within a single residential room or confined spaced and are widely referred to as "room air-conditioners". Conventionally, such room air-conditioner units usually include a casing mountable within an opening into a room and having openings communicating with indoor and outdoor air, a refrigeration system mounted in the casing and including a compressor, a condenser and an evaporator interconnected in a refrigerant flow relationship and an electric motor-powered fan means mounted in the casing for respectively circulating indoor air over the evaporator and outdoor air over the condenser.

Frequently, the room that is to have its air cooled by such an air-conditioner unit is a sleeping room and, hence, it is desirable that the noise generated by the unit be minimized, especially during night hours which are normally utilized for sleeping. The present invention is particularly concerned with providing such a unit with control means for automatically reducing the noise generated by at least its condenser fan and, preferably, by both its condenser and evaporator fans unless the outdoor air temperature exceeds a predetermined level.

As described in commonly-assigned U.S. Pat. No. 3,040,544 — Atchison, it has been known previously to provide a room air-conditioner with non-automatic (manually operable) control means whereby both the evaporator and condenser fans can be operated at reduced speed according to the desires of the operator to thus achieve noise reduction at certain times, such as at night when the outdoor air temperature and the cooling load of the room are both usually at a minimum. As further illustrated by U.S. Pat. No. 2,952,991 — St. Pierre and 3,293,876 — Geisler, it has also been known previously to automatically control the speed of a condenser fan in accordance with outdoor air temperature. However, such previously known automatic controls are distinguished from the present invention in that they have been mounted on the condenser-compressor sections of so-called "split system" central air-conditioning units that are located wholly outside of the building, rather than within a casing that is installed in an opening through the building wall, as presently described. These prior-art air-conditioners are further distinguished from the present invention in that their prior-art controls have their temperature or pressure sensors mounted at the condenser inlet or discharge, whereas the thermally responsive control means of the present invention are mounted on the fan means drive motor.

SUMMARY OF THE INVENTION

Basically, the improved air-conditioner of the present invention comprises: casing means mountable in an opening into a room and having openings communicating with indoor and outdoor air; a refrigeration system mounted in the casing and including a compressor, a condenser and an evaporator interconnected in a refrigerant flow relationship; and a fan mounted in the casing for circulating outdoor air over the condenser. However, in accordance with the present invention, a multi-speed electric motor is mounted in the casing with its output shaft connected to the condenser fan. The motor has at least a first speed and a second speed, with the first speed being slower than the second speed.

In particular accordance with the present invention, thermally responsive switch means are mounted on the motor for cooling by the outdoor air and have a movable switch member that will remain in a first position causing the motor to operate the condenser fan at the slower and consequently quieter first speed unless the outdoor air temperature is sufficiently high to cause the switch means to sense a temperature exceeding a first predetermined temperature. Then, the switch member will move to a second position causing the motor to operate the condenser fan at the faster and consequently louder second speed, but only until the outdoor air temperature becomes sufficiently low to cause the switch means to sense a second predetermined temperature that is lower than the first, whereupon the switch member will return to its first position causing the motor to resume operation of the condenser fan at the slower and quieter first speed.

Preferably, but not necessarily, the air-conditioner also has an evaporator fan connected to the output shaft of the multi-speed motor.

Hence, with the improved structure provided by the present invention, the noise generated by the fan means of a room air-conditioner in the room cooled by it can be automatically reduced during the night hours when sleeping usually occurs and the outdoor air temperature is at its cooler levels.

BRIEF DESCRIPTION OF THE DRAWING

The present invention is illustrated in the accompanying drawing, wherein:

FIG. 1 is a partly-sectioned top plan view of a presently preferred form of an improved air-conditioner that is provided in accordance with the present invention; and

FIG. 2 is a schematic diagram of a presently preferred form of electric control circuit that can be employed with the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawing and particularly to FIG. 1 thereof, there is illustrated a presently preferred form of an improved self-contained air-conditioning unit or room air-conditioner **10** that is provided in accordance with the present invention. The air-conditioner **10** comprises generally hollow box-like casing **11** that can be easily mounted within an opening into a room, such as can be provided by a hole in a building outer wall, a window, or the like.

The casing **11** is divided by a barrier **12** into two separate compartments, including a condenser or outdoor compartment **13** and an evaporator or indoor compartment **14**. A condenser heat exchanger **15** is mounted in the outdoor compartment **13** and an evaporator heat exchanger **16** is mounted in the indoor compartment **14**. The condenser **15** and the evaporator

16 are connected by conduit means in a refrigerant flow relationship with an electrically powered, hermetic compressor 17, which is also located in the condenser compartment 13. More specifically, a suction tube 18 delivers low pressure suction gas to the inlet of the compressor 17 and a discharge tube 19 is connected to the outlet of the compressor 17 for delivering high pressure, high temperature discharge gas to the condenser 15. Suitable expansion means, such as a capillary tube 20, are connected between the condenser 15 and the evaporator 16 for creating a pressure drop between the condenser 15 and evaporator 16 to promote vaporization of the liquid refrigerant flowing between the two heat exchangers 15 and 16.

It is intended that the casing 11 be mounted within the building wall opening with the barrier 12 arranged generally vertically and in such a manner that the condenser compartment 13 is in fluid communication with outdoor air and the evaporator compartment is in fluid communication with indoor or room air.

In order to circulate indoor air through evaporator compartment 14 for cooling, an evaporator fan 21 is mounted in the evaporator compartment 14. This evaporator fan 21 is driven by an output shaft 22 of an electric motor 23 that is connected to the barrier 12 by fastener means such as motor bolts 24 and nuts 25.

Room air is drawn into the evaporator compartment 14 via louvered casing room air inlet openings 26 and circulated past the evaporator 16 by the evaporator fan 21 and is returned to the room via louver casing room air outlet openings 27.

In order to circulate a stream of outdoor air past the condenser 15 a condenser fan 28 is mounted within the casing condenser compartment 13. Outdoor air is drawn into the condenser compartment 13 through louvered casing outdoor air inlet openings 29 and circulated past the condenser 15 by the condenser fan 28 and is then discharged to the outdoors via louvered casing outdoor air outlet openings 30.

As illustrated in FIGS. 1 and 2, both the evaporator fan 21 and the condenser fan 28 are powered by the same drive means, namely the electric motor 23 through its output shaft 22 that is also connected to the condenser fan 28. It should, of course, be understood that separate motors could also be used to drive each of these two fans 21 and 28. However, in accordance with the illustrated form of the present invention, a multi-speed (two-speed) motor is employed for the single motor 23 that is used to drive both the evaporator and condenser fans 21 and 28. The motor 23 has at least a first speed and a second speed, with the first speed being slower than the second speed.

Preferably the two speeds of the motor 23 and the size of the condenser fan 28 are made such that operation of the motor 23 at its first or slower speed will provide adequate cooling for the condenser 15 unless the outdoor air temperature exceeds about 95° F and the extra cooling required by the condenser 15 when the outdoor air temperature exceeds 95° F will be provided by operation of the motor 23 at its second or faster speed.

As shown in FIG. 2, the compressor 17 and fan motor 23 are connected in an electrical parallel with one another through a manually operable fan speed control switch 31, which has a base 31*a*, a pair of mechanically interlinked, pivotally mounted, movable switch members 31*b* and 31*c*, and four fixed contacts 31*d–g*. The interlinked switch members 31*b* and 31*c* can be manually moved simultaneously by means, such as a knob 31*k*, between a first position in which their free ends respectively engage the first 31*d* and third 31*f* fixed contacts and a second position in which their free ends respectively engage the second 31*e* and fourth 31*g* fixed contacts. The compressor 17, fan motor 23 and switch 31 are, in turn, connected in electrical series across a pair of electric power source lines L_1 and L_2 with a room temperature control switch 32, which has a base 32*a*, a single pivotally mounted, bimetallic movable switch member 32*b* and a single fixed contact 32*c*.

As more specifically illustrated in FIG. 2, the switch member 32*b* has its pivoted end electrically connected by a conductor 33 to one of the power supply lines L_1. Its opposite or free end is movable into and out of engagement with the fixed contact 32*c* that is electrically connected by a conductor 34 to the pivoted end of one of the movable switch members 31*b* of the switch 31. The first fixed contact 31*d* is connected in electrical series with the compressor 17 to the other power line L_2 by conductors 35 and 36. The first fixed contact 31d is also electrically connected to the pivoted end of the other movable switch member 31*c* of the switch 31 by a conductor 37, which is, in turn, electrically connected to the second fixed contact 31*e* by another conductor 38.

In particular accordance with the present invention, the fan motor 23 is electrically connected between the third and fourth fixed contacts 31*f* and 31*g* of the switch 31 and the other power line L_2 with thermally responsive switch means comprising a switch 39 that is mounted on the fan motor 23 (FIG. 1) for cooling by the condenser fan 28. The thermally responsive switch 39 includes a base 39*a*, a single pivotally mounted, bimetallic movable switch member 39*b* and a pair of fixed contact members 39*c* and 39*d*. One of the fixed contacts 39*c* is electrically connected by a conductor 40 to the first or low speed tap 41 of the motor 23 and the other 39*d* is electrically connected by a conductor 42 to the second or high speed tap 43 of the motor 23 that is, in turn, electrically connected by a conductor 44 to the power line L_2. The second fixed contact 39*d* is also electrically connected by a conductor 45 to the fourth fixed contact 31*g* of the manual fan control switch 31. The switch member 39*b* has its pivoted end electrically connected by a conductor 46 to the third fixed contact 31*f* of the switch 31.

It is intended that the free end of the bimetallic switch member 39*b* shall remain in a first position engaging the first fixed contact 39*c* of the switch 39 and electrically connecting the third fixed contact 31*f* of the manual fan control switch 31 to the low speed tap 41 of the motor 23 unless the temperature sensed by the motor-mounted switch 39 exceeds a first predetermined temperature. Then, the switch member 39*b* will move to a second position engaging the second fixed contact 39*d* of the switch 39 and electrically connecting the third fixed contact 31*f* of the switch 31 to the high speed tap 43 of the motor 23 and will remain in this second position but only until the switch 39 senses a second predetermined temperature that is lower than the first predetermined temperature, whereupon the switch member 39*b* will return to its first position.

In operation, the manual fan switch **31** is preferably moved to its first position, as shown in solid lines in FIG. 2, by rotating its control knob **31***k* to its "Lo" position. This will simultaneously respectively engage the movable switch members **31***b* and **31***c* with the first **31***d* and third **31***f* fixed contacts of the switch **31**. Then, engagement of the free end of the movable member **32***b* of the room air temperature control switch **32** with its fixed contact **32***c* will energize a first circuit causing operation of the compressor **17** and will simultaneously energize a second circuit causing the motor **23** to operate both the evaporator and condenser fans **21** and **28** at its slower and consequently quieter first speed unless the temperature sensed by the motor-mounted switch **39** exceeds the first predetermined temperature. The first circuit includes the first power line L_1, conductor **33**, switch member **32***b*, fixed contact **32***c*, conductor **34**, switch member **31***b*, fixed contact member **31***d*, conductor **35**, compressor **17**, conductor **36**, and second power line L_2. The second circuit includes the first power line L_1, conductor **33**, switch member **32***b*, fixed contact **32***c*, conductor **34**, switch member **31***b*, conductor **37**, switch member **31***c*, fixed contact **31***f*, conductor **46**, switch member **39***b*, fixed contact **39***c*, conductor **40**, low speed motor tap **41**, motor **23**, conductor **44**, and second power line L_2.

Then, should the temperature sensed by the switch **39** exceed the first predetermined temperature, the switch member **39***b* will move to its second position de-energizing the second circuit and energizing the third circuit causing the motor **23** to operate both the fans **21** and **28** at its higher and consequently louder speed. This third circuit includes the first power line L_1, conductor **33**, switch member **32***b*, fixed contact **32***c*, conductor **34**, switch member **31***b*, fixed contact **31***d*, conductor **37**, switch member **31***c*, fixed contact 31f, conductor **46**, switch member **39***b*, fixed contact **39***d*, conductor **42**, high speed motor tap **43**, motor **23**, conductor **44**, and second power line L_2. The switch member **39***b* will remain in this second position but only until the switch **39** senses a second predetermined temperature that is lower than the first predetermined temperature, whereupon the switch member **39b** will return to its first position de-energizing the third circuit and re-energizing the second circuit, where upon the motor **23** will resume operation of both of the fans **21** and **28** at its slower and consequently quieter speed.

Preferably the motor-mounted thermally responsive switch **39** comprises a well-known, inexpensive type of thermostat wherein the second predetermined temperature that is required to return the bimetallic movable switch member **39***b* from its second or high speed position to its first or slow speed position is about 20° F lower than the first predetermined temperature which was first required to cause the switch member **39***b* to initially move from its first or low speed position to its second or high speed position.

Good results have been obtained by using a thermostat for the switch **39** wherein the first predetermined temperature is about 110° F and the second predetermined temperature is about 90° F when using the aforedescribed condenser fan **28** that is sized to provide adequate cooling for the condenser **15** at the first or slower speed operation by the motor **23** unless the outdoor air temperature exceeds 95° F, whereupon operation of the motor **23** at the second or higher speed is then required. With such an arrangement, it has been found that the switch **39** will cause the motor **23** to resume operation of the fans **21** and **28** at its slower and quieter speed when the outdoor air temperature is reduced to about 85° F. This indicates that the operating heat transferred to switch **39** from the motor **23** raises the temperature sensed by the switch **39** by about 10° F when the condenser fan **28** is operated by the motor **23** at its first or slower speed but only by about 5° F when the motor **23** is operated at its second or faster speed.

Should the operator wish to cause the fan motor **23** to run at its second or faster speed, regardless of the temperature sensed by the motor-mounted thermally responsive switch **39**, he may achieve this option by moving the manually operable fan switch **31** to its second position by rotating its control knob **31***k* to its "Hi" position (FIG. 2). This will simultaneously respectively engage the movable switch members **31***b* and **31***c* with the second **31***e* and fourth **31***g* fixed contacts. In this optional condition, engagement of the free end of the movable switch member **32***b* of the room temperature control switch **32** with the fixed contact **32***c* will energize a fourth circuit causing the compressor **17** to operate and will simultaneously energize a fifth circuit causing the motor **23** to operate both the fans **21** and **28** only at its faster speed. The fourth circuit includes the first power line L_1, conductor **33**, switch member **32***b*, fixed contact **32***c*, conductor **34**, switch member **31***b*, fixed contact **31***e*, conductors **38** and **37**, fixed contact **31***d*, conductor **35**, compressor **17**, conductor **36**, and second power line L_2. The fifth circuit includes the first power line L_1, conductor **33**, switch member **32***b*, fixed contact **32***c*, conductor **34**, switch member **31***b*, fixed contact **31***e*, conductor **38**, conductor **37**, switch member **31***c*, fixed contact **31***g*, conductor **45**, fixed contact **39***d*, conductor **42**, high speed motor tap **43**, motor **23**, conductor **44**, and second power line L_2.

It should be apparent to those skilled in the art that while there has been described what, at the present, is considered to be the preferred embodiment of this invention in accordance with the Patent Statutes, changes may be made in the disclosed apparatus without actually departing from the true spirit and scope of this invention. It is, therefore, intended that the appended claims shall cover such modifications and applications that may not depart from the true spirit and scope of the present invention.

What is claimed is:

1. An improved air conditioner comprising:
   a. casing means mountable within an opening into a room and having openings respectively communicating with indoor and outdoor air;
   b. a refrigeration system mounted in said casing means and including a compressor, a condenser and an evaporator interconnected in a refrigerant flow relationship;
   c. a condenser fan mounted in said casing for circulating outdoor air over said condenser;
   d. a multi-speed electric motor mounted in said casing and having an output shaft connected to said condenser fan,
   e. said motor having at least a first speed and a second speed, with said first speed being slower than said second speed; and

f. thermally responsive switch means mounted on said motor for cooling by said outdoor air and having a movable bi-metal operated switch member operable between a first position for connecting said motor across an electric power source and causing said motor to operate at said first speed and a second position for connecting said motor across an electric power source and causing said motor to operate at said second speed,

g. said movable switch member being operable to remain in said first position unless the temperature sensed by said switch means exceeds a first predetermined temperature, whereupon said switch member will then be operated to move to said second position and will remain in said second position until said switch means senses a second predetermined temperature that is lower than said first predetermined temperature, whereupon said switch member will then be operated to return to said first position such that said motor will operate said condenser fan at said slower and consequently quieter first speed unless the outdoor air temperature is sufficiently high to cause said switch means to sense a temperature exceeding said first predetermined temperature and said motor will operate said condenser fan at said faster and consequently louder second speed only until the outdoor air temperature becomes sufficiently low to cause said switch means to sense said second predetermined temperature, whereupon said motor will then resume operation of said condenser fan at said slower and quieter first speed;

h. said first predetermined temperature being about 110° F and being exceeded when said condenser fan is operating at said first speed and the outdoor air temperature exceeds about 95° F, and

i. said second predetermined temperature being about 90° F and the temperature sensed by said switch means being as low as said second predetermined temperature when said condenser fan is operating at said second speed and the outdoor air temperature is reduced to about 85° F.

2. The invention of claim 1 including an evaporator fan mounted in said casing for circulating indoor air over said evaporator, said evaporator fan being driven by said motor so that said motor will operate both of said fans at said slower and faster speeds.

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