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(54) AIR CONDITIONER

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(52) **U.S. Cl.** **62/159**

(57) **ABSTRACT**

An air conditioner includes: an air passage **23** that is formed in a cabinet **20** so as to connect a suction port **21** and a blowoff port **22** to each other, which are open on a surface of the cabinet **20**; a blower fan **25** that is disposed inside the air passage **23** so as to extend in one direction; a heat exchanger **27** that is disposed so as to be opposed to the suction port **21** and cools air flowing in through the suction port **21**; a heater **28***a* that is disposed between the blower fan **25** and the heat exchanger **27** in order to heat air flowing in through the suction port **21** and is shorter in a longitudinal direction than the blower fan **25**; a control element **52** that controls the heater **28***a* and is disposed outside the air passage **23** adjacently to the air passage **23**; and a heat sink **70** that is in close contact with the control element **52** and is disposed between the blower fan **25** and the heat exchanger **27**, on an outside of the heater **28***a* in the longitudinal direction.

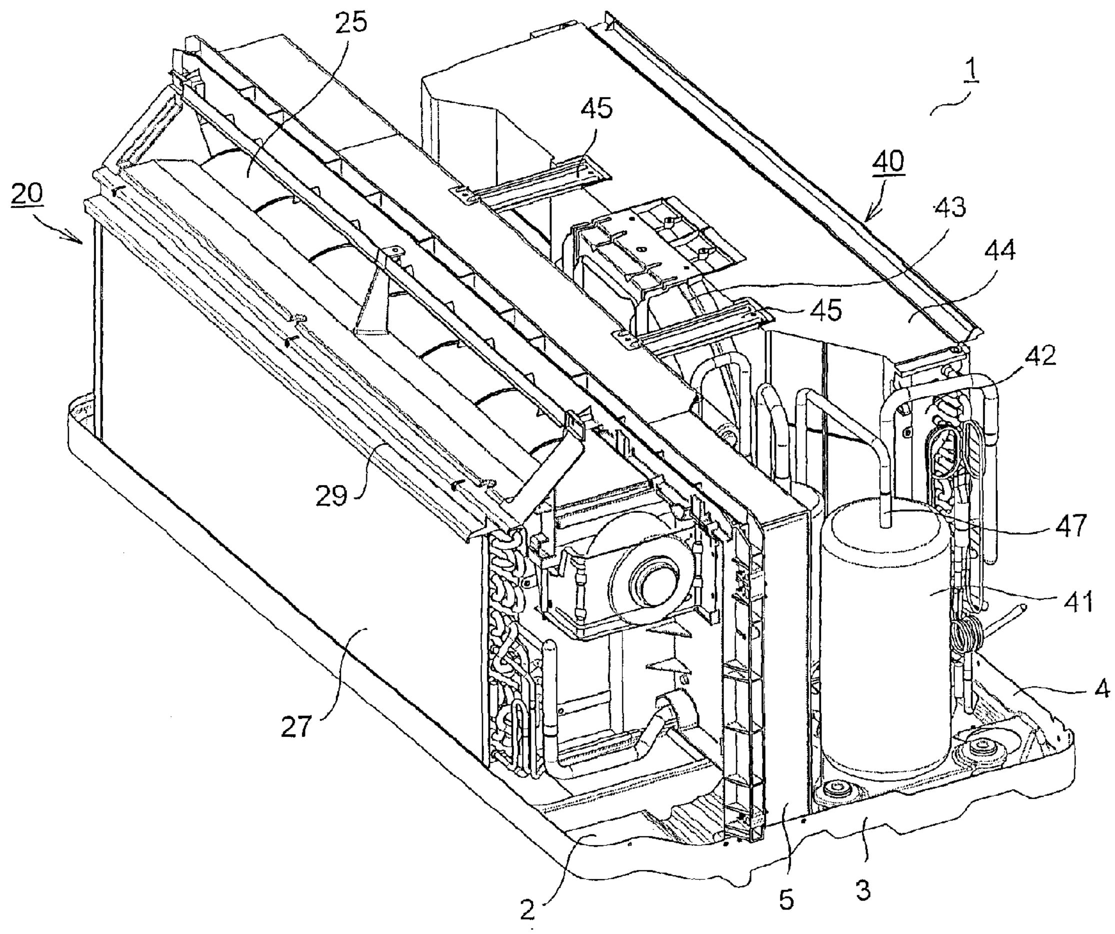


FIG.1

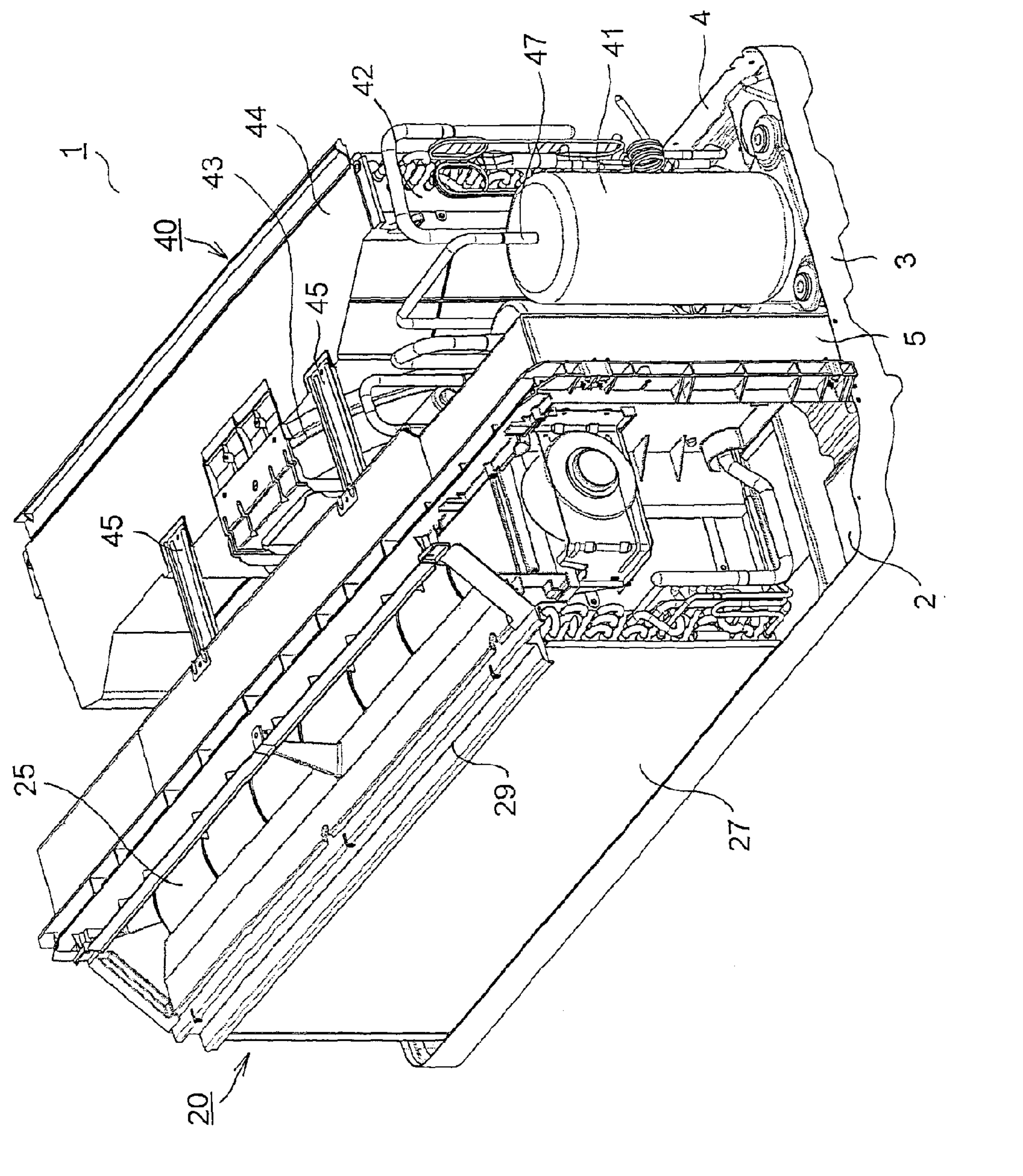
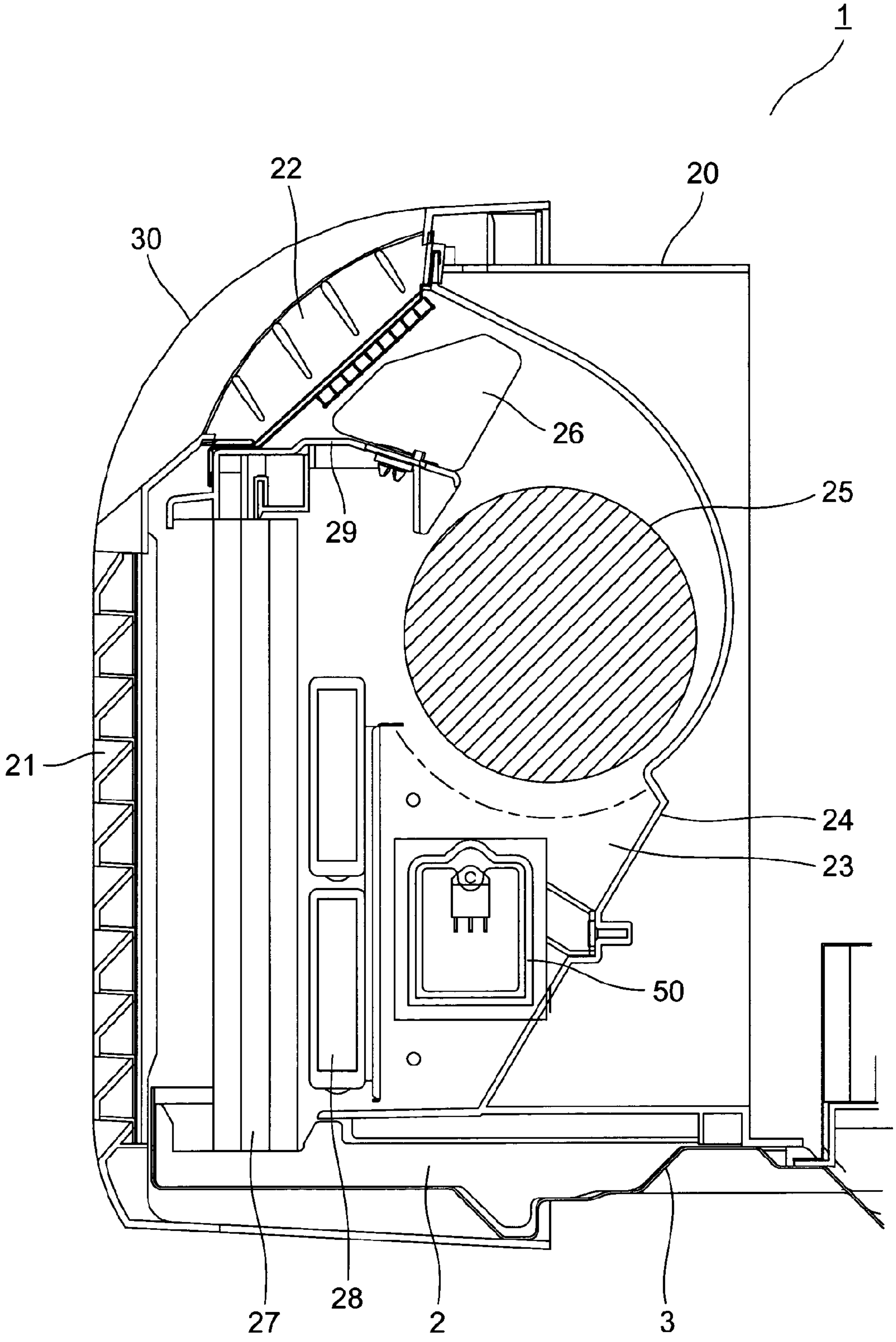


FIG.2



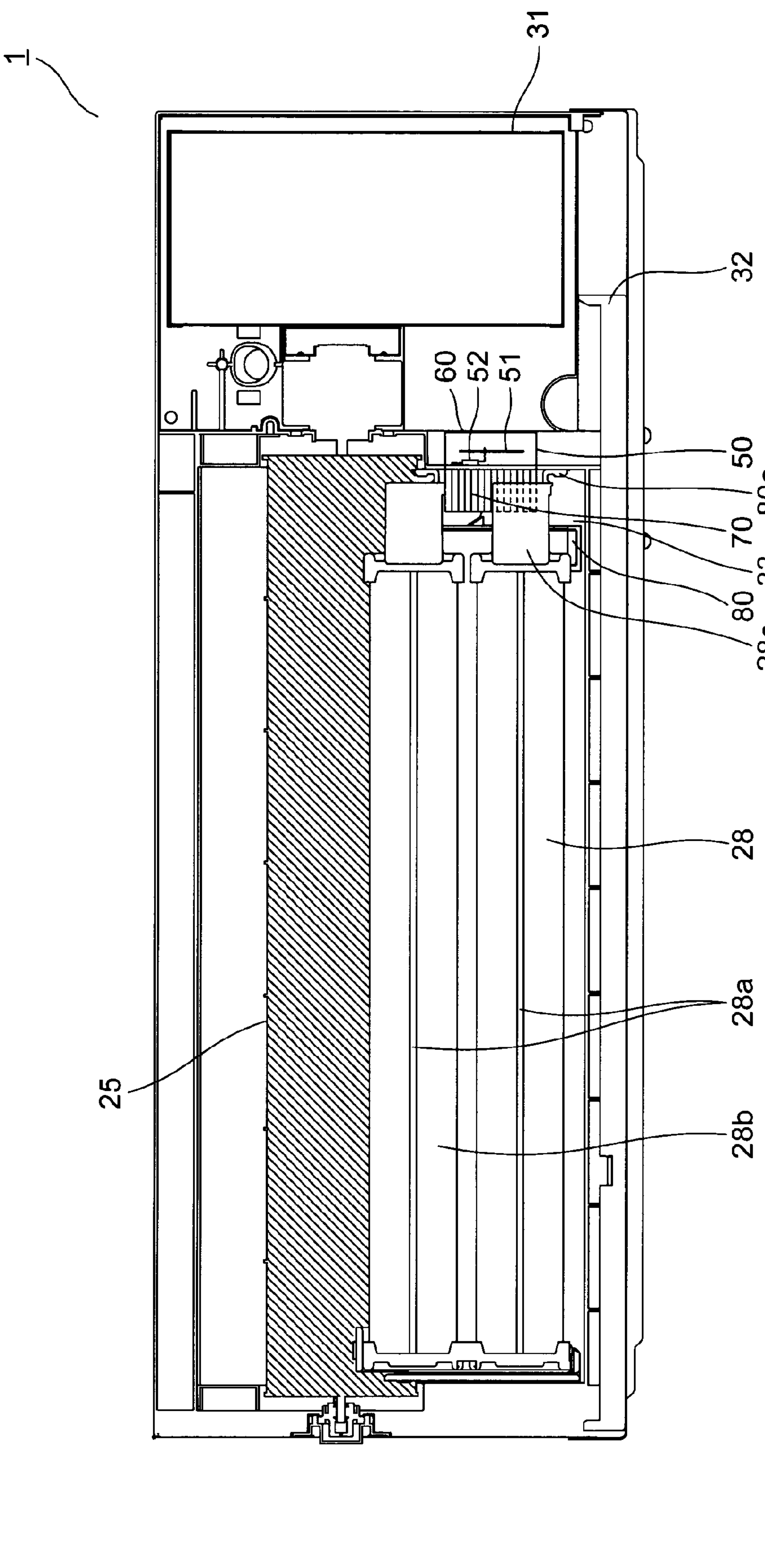


FIG.3

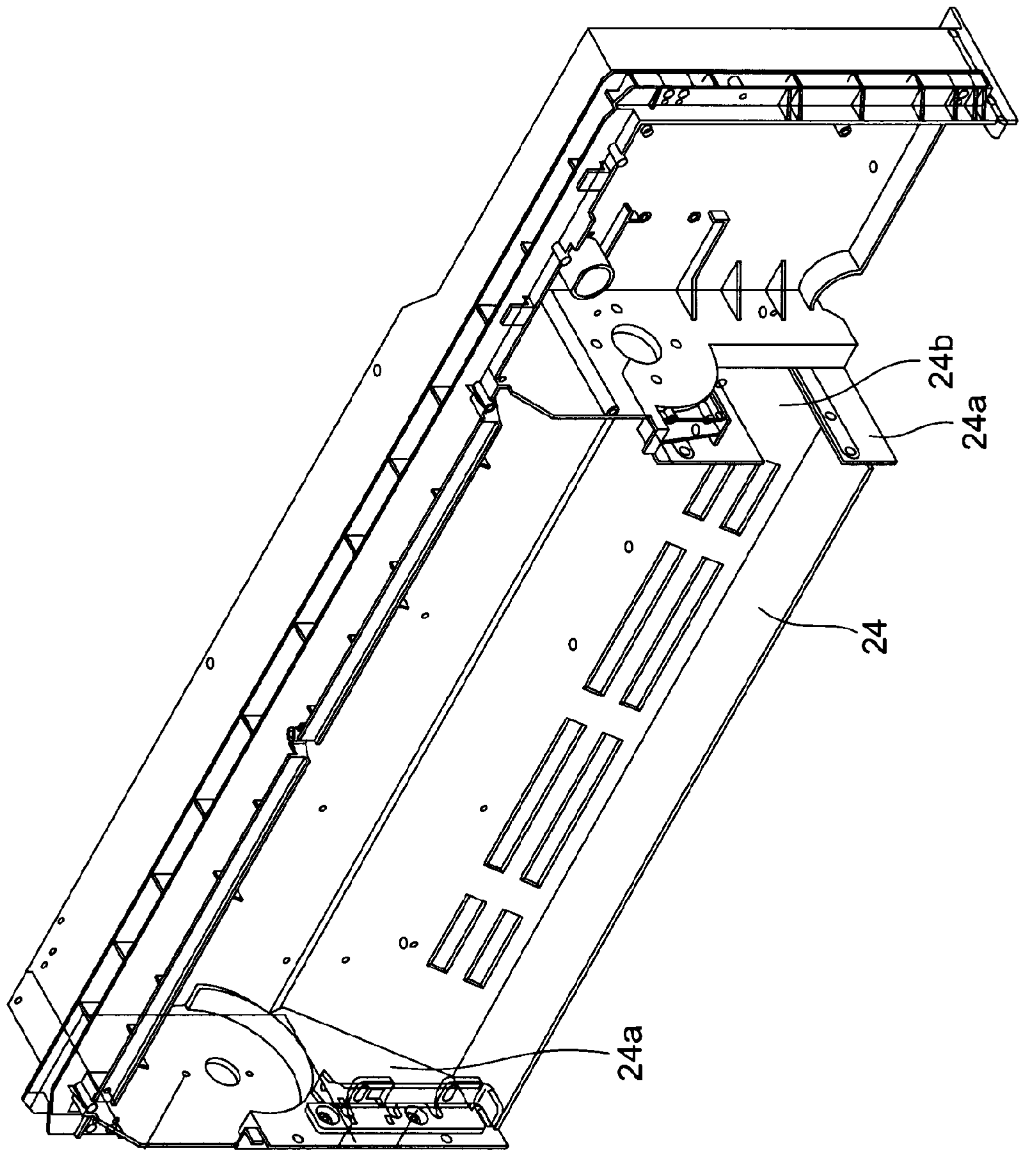
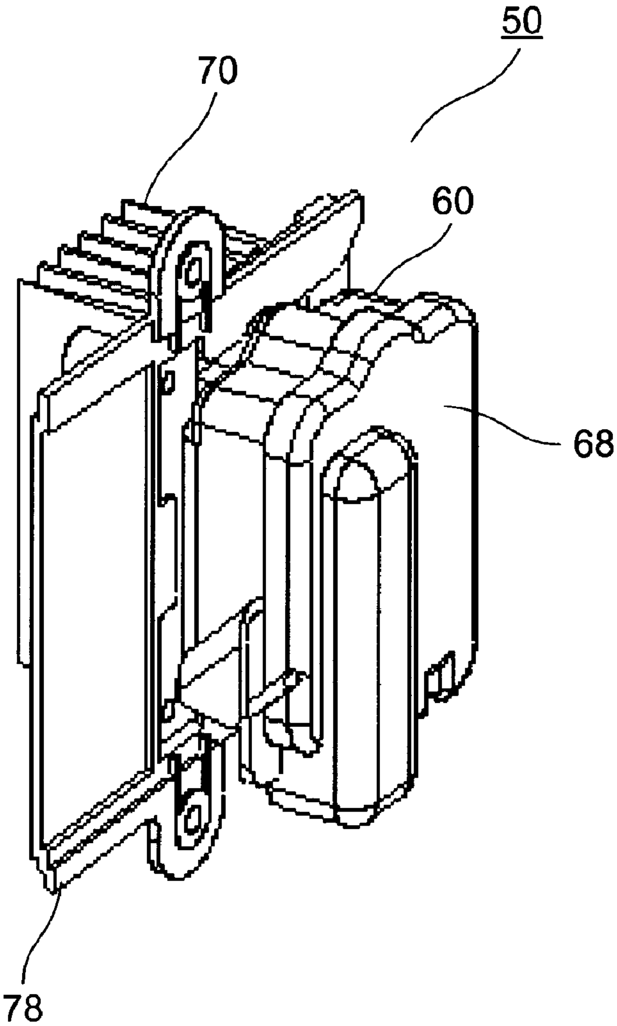


FIG.4

FIG.5



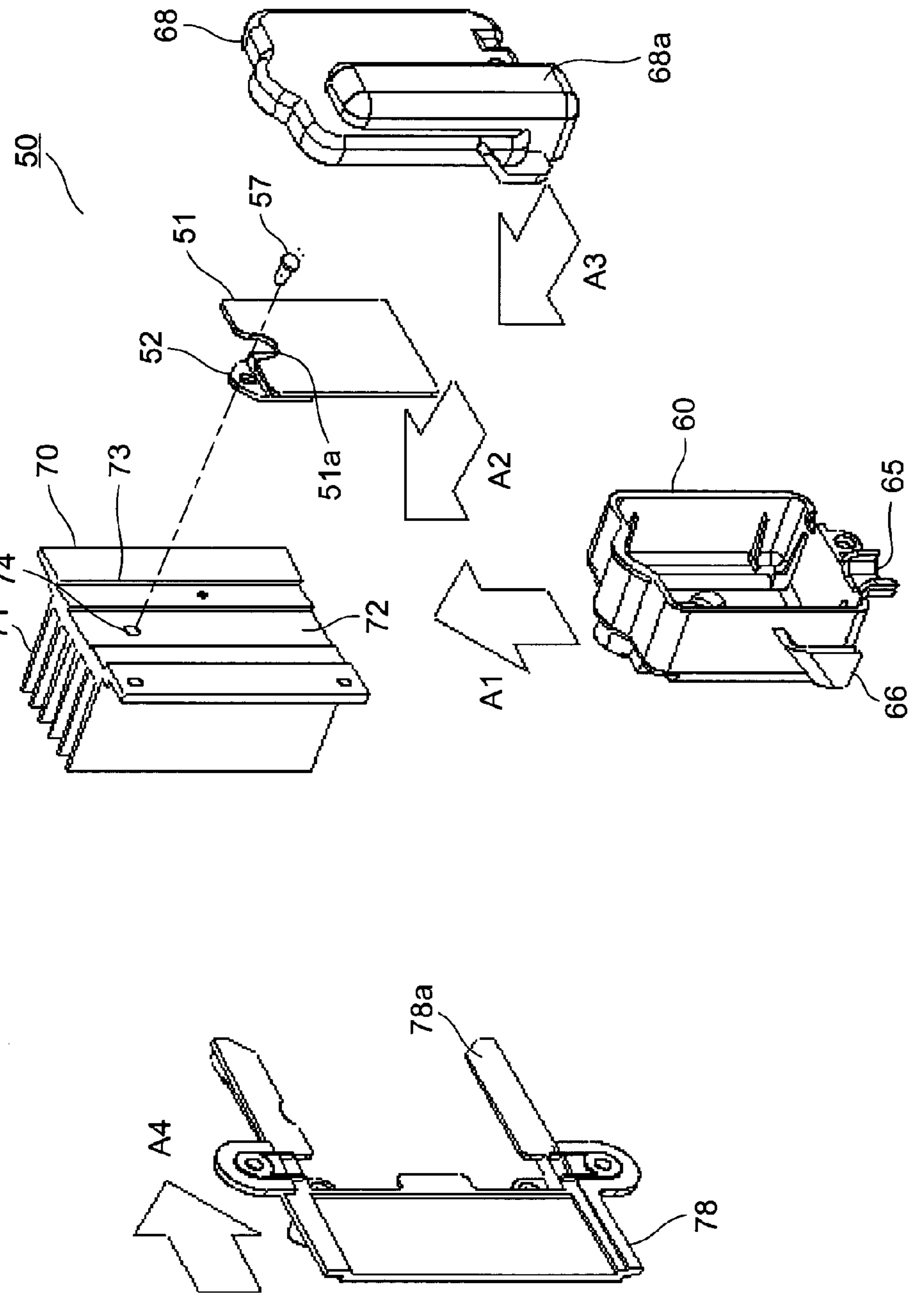


FIG.6

FIG.7

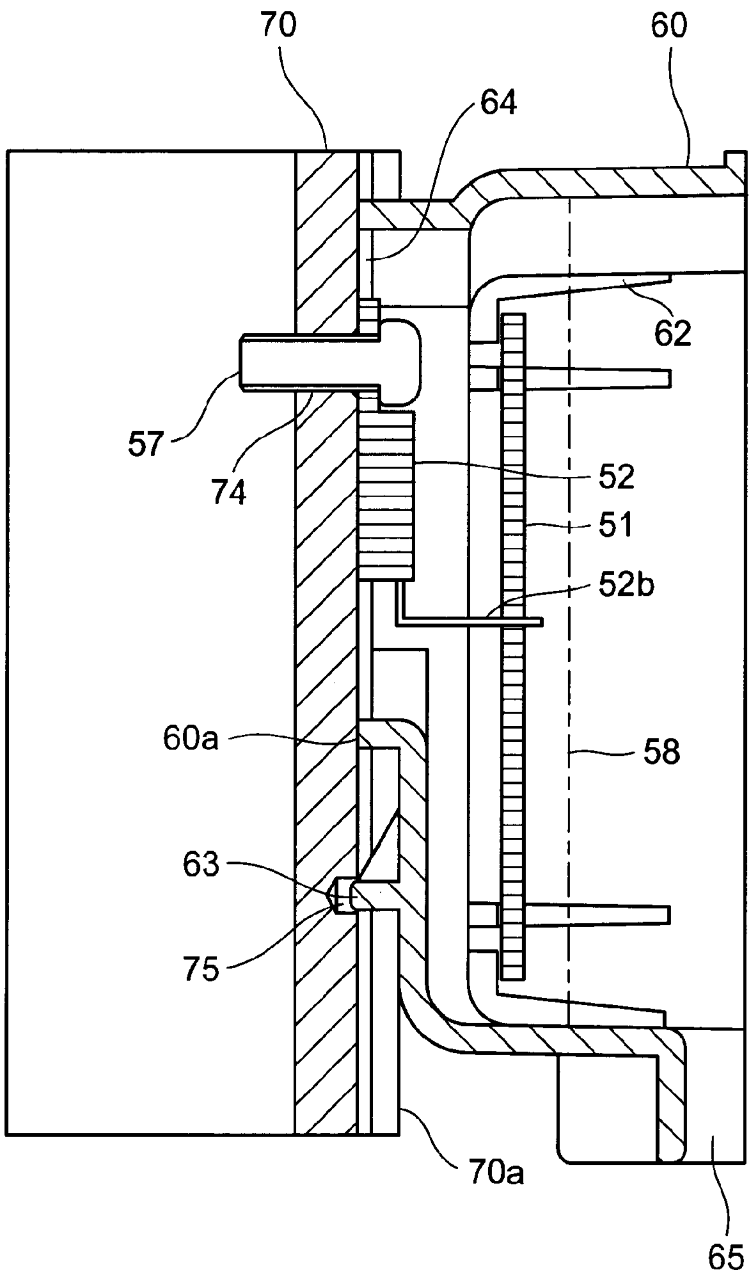


FIG.8

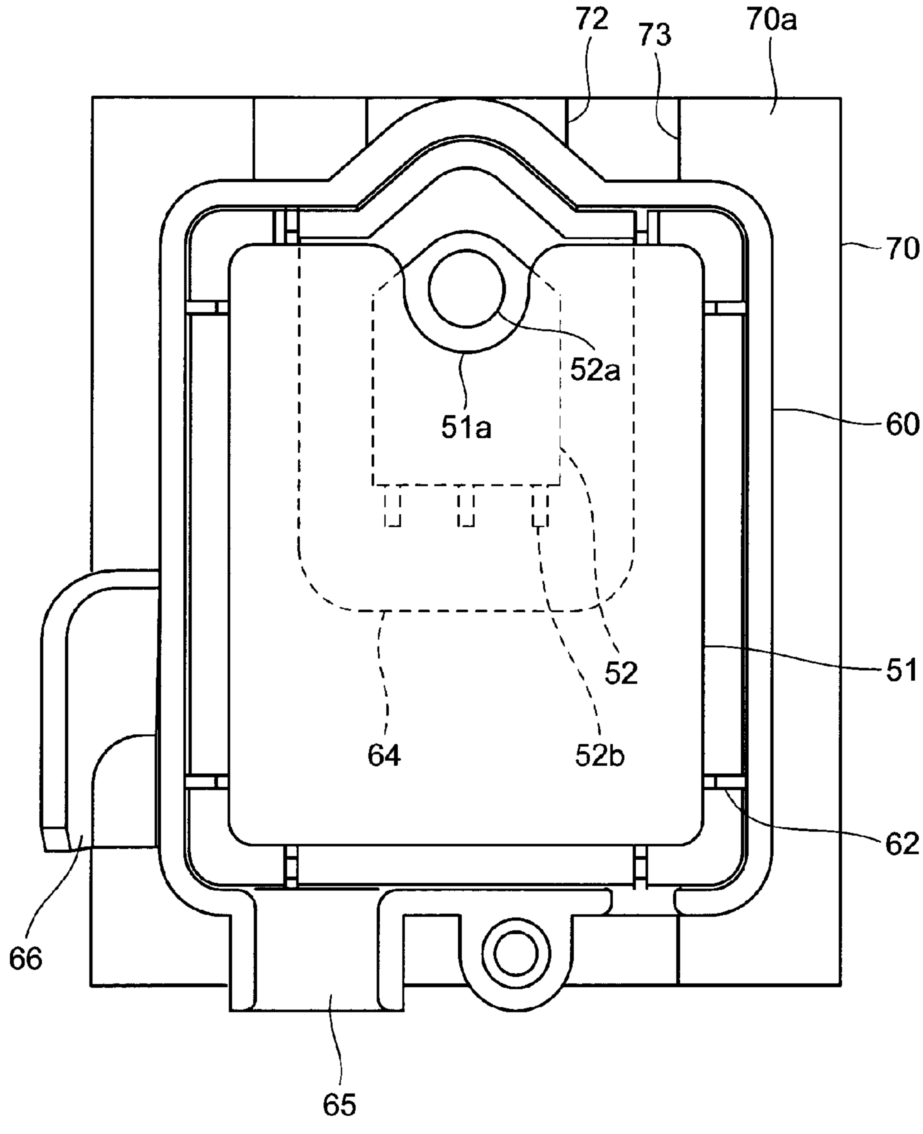


FIG.9

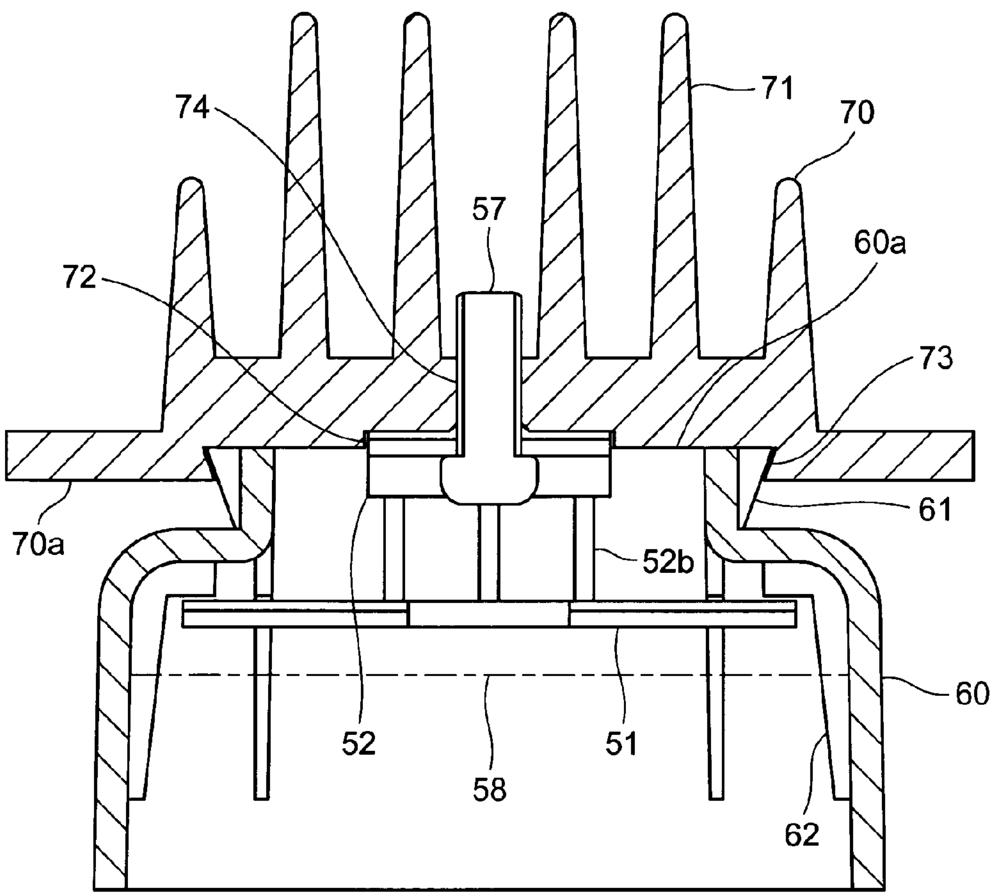


FIG.10

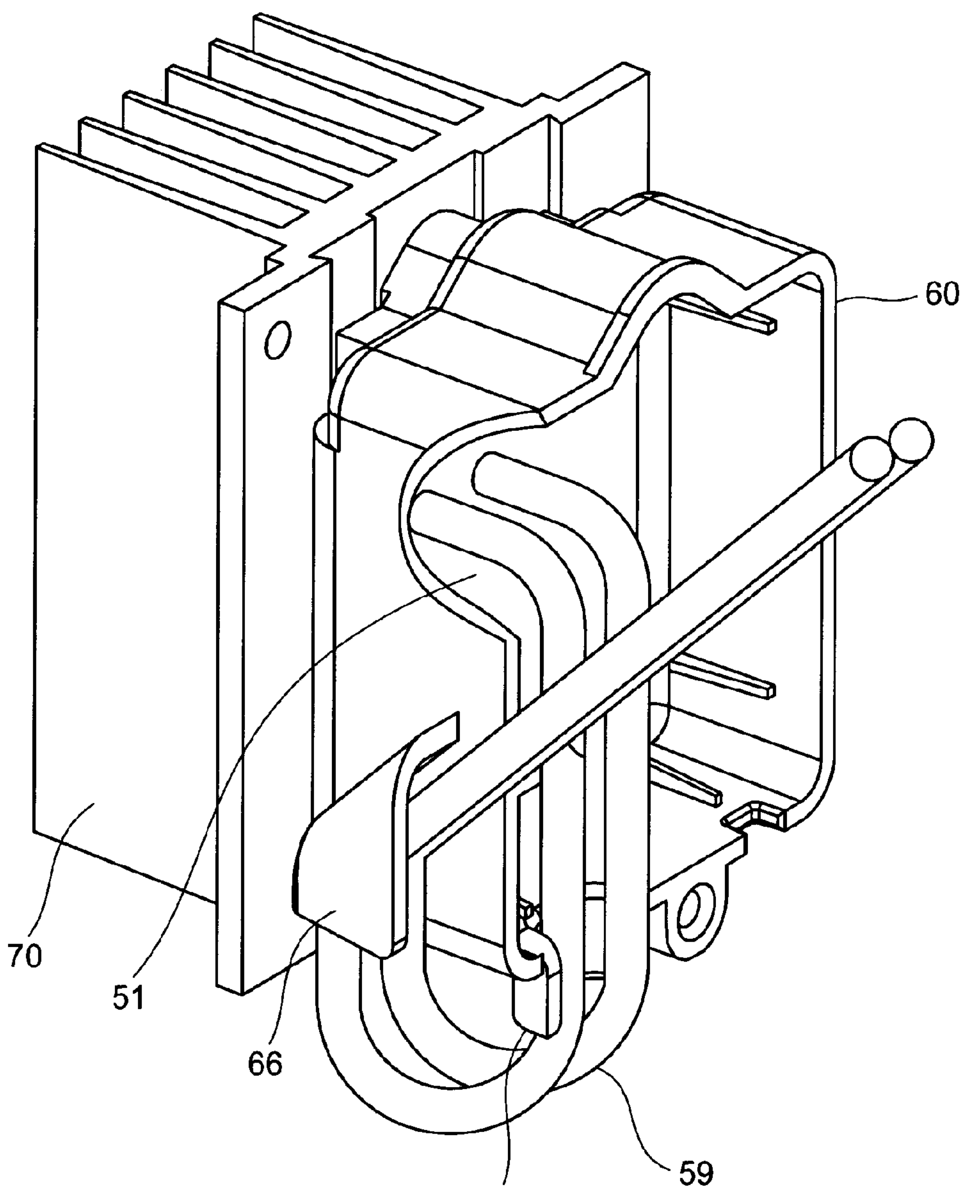


FIG.11

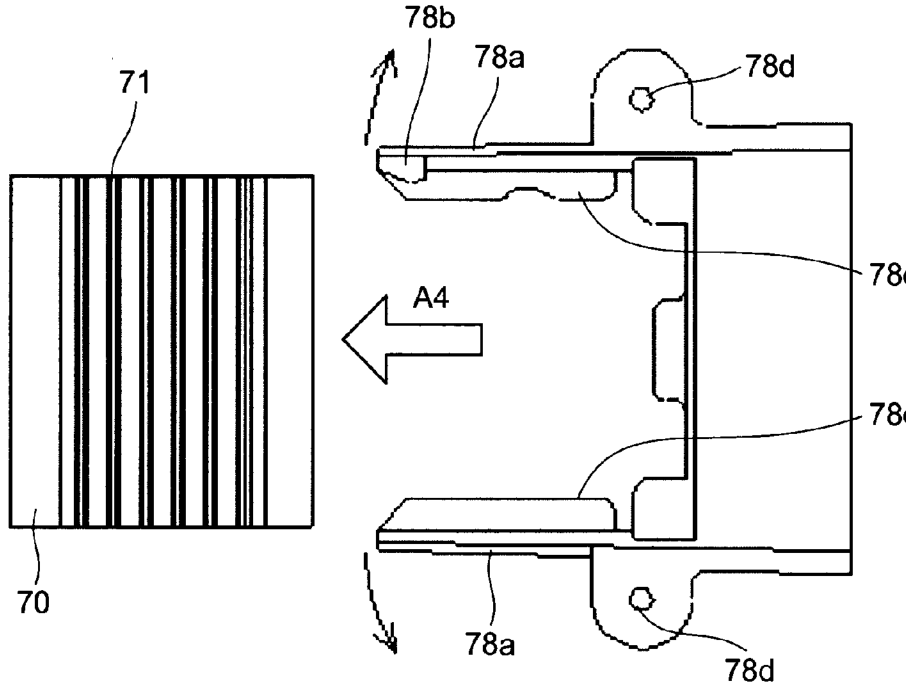
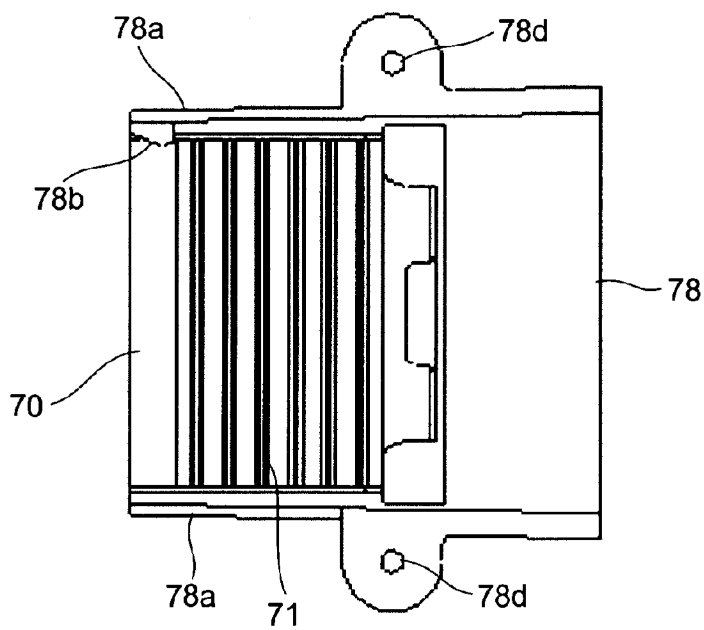


FIG.12



AIR CONDITIONER

[0001] This application is based on Japanese Patent Application No. 2010-046934 filed on Mar. 3, 2010, the contents of which are hereby incorporated by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to an air conditioner including a heater and a control element that controls the heater.

[0004] 2. Description of Related Art

[0005] A conventional air conditioner is disclosed in JP-A-H8-152179. This air conditioner is configured as an integrated type in which an indoor section that is disposed indoors is installed at its front portion, and an outdoor section that is disposed outdoors is installed at its back portion. In the outdoor section, a compressor that operates a refrigeration cycle is disposed. At the rear surface of the outdoor section, an outdoor heat exchanger that is connected to the compressor is disposed, and an outdoor fan that cools the outdoor heat exchanger is provided so as to face the outdoor heat exchanger.

[0006] A suction port is open on the front surface of the indoor section, and a blowoff port is open at a position above the suction port. In the indoor section, an air passage is formed that is constituted by a blower duct connecting the suction port and the blowoff port to each other, and a blower fan is provided inside the air passage. Between the blower fan and the suction port, an indoor heat exchanger is disposed that is connected to the compressor via a refrigerant pipe. Between the blower fan and the indoor heat exchanger, a PTC (positive temperature coefficient) heater is disposed.

[0007] Upon the start of a cooling operation, the compressor is driven to operate the refrigeration cycle. In this operation, the indoor heat exchanger functions as an evaporator on a low temperature side of the refrigeration cycle, and the outdoor heat exchanger functions as a condenser on a high temperature side of the refrigeration cycle. The outdoor fan is driven to cause the outdoor heat exchanger to exchange heat with the outside air thereby to radiate heat. The blower fan is driven to cause air inside a room to flow into the air passage through the suction port and the air cooled by heat exchange with the indoor heat exchanger to be sent out into the room through the blowoff port. Thus, cooling of the room is performed.

[0008] Upon the start of a heating operation, the compressor is driven to operate the refrigeration cycle. In this operation, the indoor heat exchanger functions as the condenser on the high temperature side of the refrigeration cycle, and the outdoor heat exchanger functions as the evaporator on the low temperature side of the refrigeration cycle. The outdoor fan is driven to cause the outdoor heat exchanger to exchange heat with the outside air thereby to absorb heat. The blower fan is driven to cause air inside a room to flow into the air passage through the suction port, which is then heated by heat exchange with the indoor heat exchanger. Furthermore, by the driving of the PTC heater, the air inside the air passage is further heated. The air thus heated is sent out into the room through the blowoff port, and thus heating of the room is performed.

[0009] The PTC heater is made up of a heat generation element having PTC characteristics and electrodes sandwiching the heat generation element therebetween, and a voltage is applied between the electrodes to drive the PTC heater. When the heat generation element is heated to a temperature higher than its Curie point, the resistance value thereof increases rapidly, leading to a decrease in the current value and heat generation amount of the heat generation element. This stabilizes the heat generation amount of the PTC heater, so that hot air at a predetermined temperature can be easily generated, and the occurrence of overheating can be prevented.

[0010] In this case, however, at start-up, the PTC heater is at a low temperature and the heat generation element therefore has a low resistance value, so that an overcurrent might flow to exceed a tolerable current level based on a power supply capacitance. As a solution to this, JP-A-2003-59623 discloses a method of controlling the driving of a PTC heater, in which an electric current flowing through the PTC heater at start-up is monitored in order to prevent the electric current from exceeding a tolerable current level based on a power supply capacitance. That is, by a control circuit employing a triac element, duty control of the PTC heater is performed so that, at start-up, the PTC heater is driven with the duty ratio thereof increased gradually. This can prevent an overcurrent from occurring at the start-up of the PTC heater.

[0011] According to the above-described conventional air conditioner, however, due to a large heat generation amount of the triac element, electrical equipment provided in the air conditioner are heated. This impairs the safety of the air conditioner, which has been problematic. Furthermore, installing a fan for cooling the triac element increases the power consumption and cost of the air conditioner, which is also problematic.

SUMMARY OF THE INVENTION

[0012] It is an object of the present invention to provide an air conditioner that achieves a reduction in power consumption and cost and can improve safety.

[0013] In order to achieve the above-described object, the present invention includes: an air passage that is formed in a cabinet so as to connect a suction port and a blowoff port to each other, which are open on a surface of the cabinet; a blower fan that is disposed inside the air passage so as to extend in a longitudinal direction; a heat exchanger that is disposed so as to be opposed to the suction port and exchanges heat with air flowing in through the suction port; a heater that is disposed between the blower fan and the heat exchanger in order to heat air flowing in through the suction port and is shorter in a longitudinal direction than the blower fan; a control element that controls the heater and is disposed outside the air passage adjacently to the air passage; and a heat sink that is in close contact with the control element and is disposed between the blower fan and the heat exchanger, on an outside of the heater in the longitudinal direction.

[0014] According to this configuration, when a cooling operation is performed, air taken from a room into the air passage through the suction port by the driving of the blower fan exchanges heat with the heat exchanger and thus is cooled, and the air is then sent out into the room through the blowoff port. When a heating operation is performed, air taken from the room into the air passage through the suction port by the driving of the blower fan is heated by the heater that is controlled by the control element. During the heating operation, the air flowing through the air passage may be further heated by the heat exchanger. The control element is disposed outside the air passage adjacently to the air passage, and in order to avoid heat radiation of the heater, the heat sink in close contact with the control element is disposed between the blower fan and the heat exchanger, on the outside of the heater in the longitudinal direction. The control element is cooled by an airflow flowing through the air passage via the heat sink.

[0015] The control element that controls the heater is disposed adjacently to the air passage and the heat sink is disposed inside the air passage, and thus the control element can be cooled by an airflow flowing through the air passage via the heat sink. This eliminates the need to install a fan for cooling the control element, and thus power consumption and cost can be reduced and the safety of the air conditioner can be improved.

[0016] Furthermore, in the longitudinal direction, the heat sink is disposed on the outside of the heater that is shorter than the blower fan, and thus the temperature rise of the control element due to heat radiation of the heater can be suppressed. Moreover, air heated by heat exchange with the heat sink is sent out from an end portion of the air passage, and thus the efficiency of a heating operation can be improved. In addition, the heat sink is disposed in a dead space between the blower fan and the heat exchanger, on the outside of the heater in the longitudinal direction, and thus the air conditioner can be prevented from increasing in size due to the installation of the heat sink.

[0017] Furthermore, in the present invention, preferably, in the air conditioner configured as above, the heater is formed by a PTC heater, and the control element is formed by a triac element. According to this configuration, duty control of the PTC heater is performed by the triac element, and thus the occurrence of an overcurrent at the start-up of the PTC heater is prevented.

[0018] Furthermore, in the present invention, more preferably, the air conditioner configured as above further includes: a circuit substrate on which the control element is mounted; a cup-shaped substrate holder that has a window portion for inserting the control element thereinto, open on an opposed surface of the substrate holder, which is opposed to the heat sink, and holds the circuit substrate; and a molding material that is filled in the substrate holder so as to mold the circuit substrate and the control element.

[0019] According to this configuration, the circuit substrate is disposed in the cup-shaped substrate holder, and the control element mounted on the circuit substrate is brought into close contact with the heat sink via the window portion. The molding material is filled in the substrate holder, so that the circuit substrate is molded and the control element disposed at the window portion is also molded. In a case where, during a cooling operation, low temperature air comes in contact with the heat sink and thus dew condensation occurs in the substrate holder, since the molding material is filled, it is possible to prevent dew condensation water from being deposited on the circuit substrate and the control element.

[0020] Furthermore, in the present invention, the air conditioner configured as above may have the following configuration. That is, the heat sink has a guide groove that is recessed therein so as to extend in one direction, and the substrate holder has a fitting portion to be fitted into the guide groove. Further, the width between both side walls of the guide groove is set to be greater at least part of a region between the side walls than at an open surface of the guide groove, and through fitting between the guide groove and the fitting portion, the substrate holder is guided to be slid in the one direction. According to this configuration, the fitting portion of the substrate holder is inserted in a sliding manner from one direction into the guide groove of the heat sink, after which the circuit substrate is disposed in the substrate holder, and the control element is mounted to the heat sink.

[0021] Furthermore, in the present invention, the air conditioner configured as above may have the following configuration. That is, an engaging protrusion is provided on the opposed surface of the substrate holder, and an engaging hole is provided in the heat sink, which is engaged with the engaging protrusion so that positioning of the heat sink and the substrate holder relative to each other is performed. According to this configuration, the fitting portion of the substrate holder is slid from one direction into the guide groove of the heat sink, and the engaging protrusion is engaged with the engaging hole, by which positioning of the substrate holder is performed.

[0022] Furthermore, in the present invention, more preferably, in the air conditioner configured as above, the control element is fastened to the heat sink with a screw, and a groove portion into which the control element is fitted is recessed in the heat sink. According to this configuration, the control element is installed by being fitted into the groove portion of the heat sink and then is fastened thereto with a screw. At this time, the groove portion prevents the control element from being rotated due to the screw being firmly screwed down.

[0023] Furthermore, in the present invention, more preferably, in the air conditioner configured as above, an opening portion is formed on one of wall surfaces of the air passage in the longitudinal direction, and a heat sink holder is provided that has an arm portion made of an elastic body and used to sandwich two circumferential surfaces of the heat sink, which are opposed to each other, and is mounted to the one of wall surfaces of the air passage by being fitted into the opening portion. According to this configuration, while holding the two surfaces of the heat sink between the arm portions that are deformed elastically, the heat sink holder is fitted into the opening portion and mounted to the wall surface of the air passage by, for example, being fastened thereto with a screw.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] FIG. **1** is a perspective view showing an air conditioner according to an embodiment of the present invention.

[0025] FIG. **2** is a cross-sectional side view showing the air conditioner according to the embodiment of the present invention.

[0026] FIG. **3** is a front view showing the air conditioner according to the embodiment of the present invention.

[0027] FIG. **4** is a perspective view showing an intermediate wall of the air conditioner according to the embodiment of the present invention.

[0028] FIG. **5** is a perspective view showing a control circuit unit of the air conditioner according to the embodiment of the present invention.

[0029] FIG. **6** is an exploded perspective view showing the control circuit unit of the air conditioner according to the embodiment of the present invention.

[0030] FIG. **7** is a cross-sectional side view showing a heat sink and a substrate holder of the control circuit unit of the air conditioner according to the embodiment of the present invention, in a state where they are fitted to each other.

[0031] FIG. **8** is a front view showing the heat sink and the substrate holder of the control circuit unit of the air conditioner according to the embodiment of the present invention, in the state where they are fitted to each other.

[0032] FIG. **9** is a cross-sectional top view showing the heat sink and the substrate holder of the control circuit unit of the air conditioner according to the embodiment of the present invention, in the state where they are fitted to each other.

[0033] FIG. **10** is a perspective view showing a wiring state of the control circuit unit of the air conditioner according to the embodiment of the present invention.

[0034] FIG. **11** is a front view showing the heat sink and a heat sink holder of the control circuit unit of the air conditioner according to the embodiment of the present invention, in a state before they are fitted to each other.

[0035] FIG. **12** is a front view showing the heat sink and the heat sink holder of the control circuit unit of the air conditioner according to the embodiment of the present invention, in a state where they are fitted to each other.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0036] The following describes an embodiment of the present invention with reference to the appended drawings. FIGS. **1**, **2**, and **3** are a perspective view, a cross-sectional side view, and a front view showing an air conditioner according to one embodiment, respectively. FIGS. **1** and **3** show a state without an exterior cover **30** (see FIG. **2**). An air conditioner **1** is configured as an integrated type including an indoor section **2** that is disposed indoors and an outdoor section **4** that is disposed outdoors adjacently to the indoor section **2**.

[0037] A suction port **21** is provided in a front portion of the indoor section **2**, and an outdoor heat exchanger **42** is provided in a front portion of the outdoor section **4**. In the following description, a front side refers to a suction port **21** side, and a back side (rear side) refers to an outdoor heat exchanger **42** side. Furthermore, a right side and a left side of the air conditioner **1** refer to the right side and the left side thereof in a view facing the suction port **21** from the front, respectively.

[0038] The indoor section **2** and the outdoor section **4** are installed on a bottom plate **3**, and a partition wall **5** is provided so that the indoor section **2** on the front side and the outdoor section **4** on the back side are separated from each other. The indoor section **2** constitutes a cabinet **20** surrounded on its outer side by the bottom plate **3**, the partition wall **5**, and the exterior cover **30**. At a right end portion in the cabinet **20**, an electrical equipment box **31** containing electrical equipment is provided. Similarly to the indoor section **2**, the outdoor section **4** constitutes a cabinet **40** surrounded on its outer side by the bottom plate **3**, the partition wall **5**, and an exterior cover (not shown).

[0039] In the outdoor section **4**, a compressor **41** that operates a refrigeration cycle is disposed at an end portion on the right side. At the rear surface of the outdoor section **4**, the outdoor heat exchanger **42** that is connected to the compressor **41** via a refrigerant pipe **47** is disposed. An outdoor fan **43** formed by a propeller fan is disposed at a center portion in the lateral direction in a view facing the outdoor heat exchanger **42** and cools the outdoor heat exchanger **42**. The outdoor fan **43** and the outdoor heat exchanger **42** are disposed in a housing **44** that is supported by the partition wall **5** via a bracket **45**. The housing **44** constitutes a duct that guides an airflow from the outdoor fan **43** to the outdoor heat exchanger **42**.

[0040] The suction port **21** is open on the front surface of the exterior cover **30** covering the indoor section **2**, and a blowoff port **22** is open at a position above the suction port **21**. In the indoor section **2**, an air passage **23** is provided that connects the suction port **21** and the blowoff port **22** to each other. The rear surface and side surfaces of the air passage **23** are constituted by an intermediate wall **24** mounted on the bottom plate **3**. A wall of the air passage **23** below and in the vicinity of the blowoff port **22** is constituted by a duct member **29** that can be mounted and demounted when the exterior cover **30** is removed. A louver **26** that can change a direction in which air is blown out through the blowoff port **22** is mounted to the duct member **29**.

[0041] Inside the air passage **23**, a blower fan **25** formed by a cross-flow fan is provided so as to extend in the lateral direction. Between the blower fan **25** and the suction port **21**, an indoor heat exchanger **27** that is connected to the compressor **41** via the refrigerant pipe **47** is disposed so as to be opposed to the suction port **21**. The indoor heat exchanger **27** is provided in the longitudinal direction of the blower fan **25** so as to have substantially the same width as that of the blower fan **25**. Below the indoor heat exchanger **27**, a drain pan **32** is disposed that collects dew condensation water from the indoor heat exchanger **27** and drains it to the outside. The drain pan **32** extends to below a control circuit unit **50**, which is described later, and collects dew condensation water produced from the control circuit unit **50**.

[0042] A heater unit **28** is disposed between the blower fan **25** and the indoor heat exchanger **27**. As described later, the heater unit **28** is held by an angle **80** fastened with a screw to a side surface portion **24***a* (see FIG. **4**) of the intermediate wall **24**. The indoor heat exchanger **27** and the heater unit **28** are covered above by the duct member **29**. When the screw used for mounting the angle **80** is unscrewed and the duct member **29** is removed, the heater unit **28** can be mounted and demounted from above.

[0043] The heater unit **28** is formed by lamination of a PTC heater **28***a* made up of a semiconductor element and electrodes sandwiching the semiconductor element therebetween and a fin **28***b* of a honeycomb structure. The PTC heater **28***a* is shorter in the longitudinal direction than the blower fan **25**, and inside the air passage **23**, a space portion **33** is formed on the right side of the PTC heater **28***a*. In the space portion **33**, a terminal portion **28***c* of the heater unit **28** is disposed.

[0044] The control circuit unit **50** including a triac element **52** that controls the PTC heater **28***a* is disposed behind the terminal portion **28***c*. By the triac element **52**, duty control of the PTC heater **28***a* is performed so that, at start-up, the PTC heater **28***a* is driven with the duty ratio thereof increased gradually. This can prevent an overcurrent from occurring at the start-up of the PTC heater **28***a*.

[0045] FIG. **4** shows a perspective view of the intermediate wall **24**. The intermediate wall **24** has the side surface portion **24***a* constituting each of side walls of the air passage **23**, and an opening portion **24***b* is provided on a right-side one of the side surface portions **24***a*. The control circuit unit **50** is mounted to the opening portion **24***b* astride the inside and outside of the air passage **23**. At this time, a heat sink **70** (see FIG. **5**) is disposed inside the air passage **23**, and a substrate holder **60** (see FIG. **5**) is disposed on the outside of the air passage **23**.

[0046] FIGS. **5** and **6** show a perspective view and an exploded perspective view of the control circuit unit **50**, respectively. The control circuit unit **50** includes a circuit substrate **51**, a substrate holder **60**, a lid portion **68**, the heat sink **70**, and a heat sink holder **78**. The triac element **52** is mounted on the circuit substrate **51** and disposed in the cup-shaped substrate holder **60** made of a resinous molded article. As described later in detail, the substrate holder **60** is fitted to the heat sink **70**, and an opening surface of the substrate holder **60** is closed with the lid portion **68** made of a resinous molded article.

[0047] FIGS. **7**, **8**, and **9** are a cross-sectional side view, a front view, and a cross-sectional top view showing a state where the substrate holder **60** and the heat sink **70** are fitted to each other, respectively. The heat sink **70** is formed by extrusion molding of aluminum, and a plurality of the fins **71** are provided in a protruding manner on one surface of the heat sink **70**.

[0048] On a reference surface **70***a* of the heat sink **70** on the side opposite to the surface on which the fins **71** are formed, a guide groove **73** is provided so as to extend in the vertical direction. The guide groove **73** is formed by a croze whose both side walls are inclined and that thus is trapezoidal in cross section, and the width between the side walls of the guide groove **73** is set to be greater at part of a region between the side walls than at an open surface of the guide groove **73**. Part of the side walls of the guide groove **73** may be formed in a squared U-shape in cross section so that the width between the side walls is made greater at part of the region between the side walls than at the open surface. On the bottom surface of the guide groove **73**, a groove portion **72** squared U-shaped in cross section is recessed so as to extend in the vertical direction. At an upper portion of the bottom surface of the groove portion **72**, a screw hole **74** is provided, and at a lower portion thereof, an engaging hole **75** is recessed.

[0049] In the substrate holder **60**, a window portion **64** is open at an upper portion of an opposed surface **60***a* thereof, which is opposed to the heat sink **70**. On both sides of the window portion **64** on the opposed surface **60***a*, a fitting portion **61** to be fitted into the guide groove **73** is provided in a protruding manner at a plurality of positions. At a lower portion of the opposed surface **60***a*, an engaging protrusion **63** is provided in a protruding manner. Furthermore, a plurality of L-shaped ribs **62** are provided on the inner circumferential surface of the substrate holder **60**.

[0050] In assembling the control circuit unit **50**, first, as shown by an arrow A**1** (see FIG. **6**), the fitting portions **61** of the substrate holder **60** are inserted from below into the guide groove **73** of the heat sink **70**. The substrate holder **60** thus is guided by the guide groove **73** to be slid upward, and at a time when the engaging protrusion **63** is engaged with the engaging hole **75**, positioning of the heat sink **70** and the substrate holder **60** relative to each other is achieved. This eliminates the need to fasten the substrate holder **60** to the heat sink **70** with a screw, and thus the substrate holder **60** can be easily fixed.

[0051] Next, the circuit substrate **51** is mounted on the ribs **62** in the substrate holder **60**. A terminal **52***b* of the triac element **52** is bent, and the triac element **52** is disposed parallel to the circuit substrate **51**. The triac element **52** is fitted into the groove portion **72** of the heat sink **70** via the window portion **64**. Then, as shown by an arrow A**2** (see FIG. **6**), a screw **57** (see FIG. **6**) is inserted into a through hole **52***a* provided at an upper portion of the triac element **52** and screwed into the screw hole **74**. Thus, the triac element **52** is fixed to the heat sink **70** so as to be in close contact therewith.

[0052] At this time, since the triac element **52** is fitted into the groove portion **72** of the heat sink **70**, the triac element **52** is prevented from being rotated due to the screw **57** being firmly screwed down. This can prevent the terminal **52***b* of the triac element **52** from being warped to be broken. Furthermore, at the time of firmly screwing down the screw **57**, the circuit substrate **51** is not fixed to the substrate holder **60**, which can more reliably prevent the terminal **52***b* of the triac element **52** from being warped to be damaged.

[0053] Furthermore, at an upper end of the circuit substrate **51**, a concave portion **51***a* from which the through hole **52***a* is exposed is formed by cutting out a portion of the circuit substrate **51**, which is opposed to the through hole **52***a*. The triac element **52** is fixed with the screw **57** via the concave portion **51***a*. This can reduce the amount of two-dimensional protrusion of the triac element **52** from the circuit substrate **51**. Thus, the substrate holder **60** can be reduced in size and thereby allows the control circuit unit **50** to be reduced in size, and the amount of a molding material **58** used, which is described later, can be reduced.

[0054] After the triac element **52** is mounted to the heat sink **70**, the molding material **58** made of a resin such as urethane is filled in the substrate holder **60**. Through hardening of the molding material **58**, the circuit substrate **51** and the triac element **52** are molded, and thus the circuit substrate **51** is fixed. In this case, prior to the hardening, part of the molding material **58**, which flows along a gap between the periphery of the window portion **64** and the heat sink **70**, is prevented by surface tension from flowing out to the periphery of the substrate holder **60**. A shielding material that prevents the molding material **58** from flowing out may be provided at the periphery of the substrate holder **60**.

[0055] If, during a cooling operation, low temperature air flowing through the air passage **23** comes in contact with the heat sink **70**, dew condensation may occur in the substrate holder **60**. In such a case, since the molding material **58** is filled, it is possible to prevent dew condensation water from being deposited on the circuit substrate **51** and the triac element **52**.

[0056] Furthermore, the triac element **52** is disposed at an upper portion in the substrate holder **60**. If voids are formed in the molding material **58**, dew condensation water on the surface of the molding material **58** may reach the triac element **52**. In such a case, since the triac element **52** is disposed at the upper portion in the substrate holder **60**, the possibility that dew condensation water reaches the triac element **52** can be reduced to a greater degree than in the case where the triac element **52** is disposed at a lower portion in the substrate holder **60**.

[0057] FIG. **10** is a perspective view showing a state where the circuit substrate **51** is fixed by filling the molding material **58**. A lead **59** extending from the circuit substrate **51** is taken out through an opening portion **65** that is open on the lower surface of the substrate holder **60**. The lead **59** is bent into a U-shape below the substrate holder **60** and is guided upward by a holding portion **66** that is provided on a side surface of the substrate holder **60**.

[0058] The lead **59** is connected to the inside of the electrical equipment box **31** (see FIG. **3**) via an opening portion (not shown) provided at an upper portion of the electrical equipment box **31**. Thus, dew condensation water produced in the substrate holder **60** and allowed to slip along the lead **59** drips from a lower end of the lead **59** onto the drain pan **32** (see FIG. **3**) and thus is collected. This can prevent the entry of dew condensation water into the electrical equipment box **31**.

[0059] Next, as shown by an arrow A**3** (see FIG. **6**), the opening surface of the substrate holder **60** is closed with the lid portion **68**. On the inner surface of the lid portion **68**, a housing portion **68***a* is recessed so as to be opposed to the opening portion **65** of the substrate holder **60** and to extend in the vertical direction. The lead **59** is disposed in the housing portion **68***a*, which allows the lead **59** to be bent at an increased radius of curvature. This can prevent breakage of the lead **59**. Furthermore, this can also prevent the lead **59** from being displaced in the lateral direction.

[0060] Next, using the heat sink holder **78**, holding of the heat sink **70** is performed. FIGS. **11** and **12** are front views showing a state before the heat sink **70** and the heat sink holder **78** are fitted to each other and a state where they have been fitted to each other, respectively. The heat sink holder **78** is made of a resinous molded article, and at each of two portions thereof, which are upper and lower portions of the heat sink holder **78**, an arm portion **78***a* that constitutes an elastic body is provided in a protruding manner so as to extend in one direction. The arm portion **78***a* is formed in an L-shape in cross section and has a standing portion **78***c* that is to lie along the reference surface **70***a* of the heat sink **70**. At a tip end of the arm portion **78***a*, a nail portion **78***b* is formed so as to be opposed to the standing portion **78***c*.

[0061] As shown by an arrow A**4**, the heat sink **70** is inserted between both the arm portions **78***a* while causing the arm portions **78***a* to be bent elastically during the insertion. At this time, the standing portion **78***c* comes to lie along the reference surface **70***a* of the heat sink **70**, and the nail portion **78***b* provided at the tip end of the arm portion **78***a* is engaged with the fins **71**. The arm portions **78***a* thus sandwich therebetween two surfaces of the heat sink **70**, which are opposed to each other in the vertical direction, and thereby holds the heat sink **70**.

[0062] The heat sink holder **78** is fitted into the opening portion **24***b* (see FIG. **4**) of the intermediate wall **24**. Then, a screw is inserted into a through hole **78***d* provided at each of upper and lower ends of the heat sink holder **78** and into a through hole (not shown) provided on the periphery of the opening portion **24***b* and screwed to be secured to a screw portion **80***a* (see FIG. **3**) of the angle **80**. Thus, the control circuit unit **50** is mounted to the intermediate wall **24**.

[0063] At this time, the substrate holder **60** containing the triac element **52** is disposed outside the air passage **23** adjacently to the air passage **23**. The heat sink **70** in close contact with the triac element **52** protrudes into the air passage **23** and is disposed between the blower fan **25** and the indoor heat exchanger **27**, on the outside of the PTC heater **28***a* in the longitudinal direction.

[0064] A common screw is used for mounting the angle **80** and the control circuit unit **50** to the intermediate wall **24**, and thus the number of components used can be reduced. Furthermore, the use of the arm portions **78***a* allows the heat sink **70** to be easily held and thus eliminates the need for a screw for fitting the heat sink **70** and the heat sink holder **78** to each other, so that the number of components used can be reduced. In addition, the arm portions **78***a* are fitted onto the inner circumferential surface of the opening portion **24***b* while covering the upper and lower surfaces of the guide groove **73**, and thus it is possible to prevent air from leaking from the air passage **23** via the guide groove **73**.

[0065] In the air conditioner **1** configured as above, upon the start of a cooling operation, the compressor **41** is driven to operate the refrigeration cycle. In this operation, the indoor heat exchanger **27** functions as an evaporator on a low temperature side of the refrigeration cycle, and the outdoor heat exchanger **42** functions as a condenser on a high temperature side of the refrigeration cycle. The outdoor fan **43** is driven to cause the outdoor heat exchanger **42** to exchange heat with the outside air thereby to radiate heat. The blower fan **25** is driven to cause air inside a room to flow into the air passage **23** through the suction port **21** and the air cooled by heat exchange with the indoor heat exchanger **27** to be sent out into the room through the blowoff port **22**. Thus, cooling of the room is performed.

[0066] Upon the start of a heating operation, the compressor **41** is driven to operate the refrigeration cycle. In this operation, the indoor heat exchanger **27** functions as the condenser on the high temperature side of the refrigeration cycle, and the outdoor heat exchanger **42** functions as the evaporator on the low temperature side of the refrigeration cycle. The outdoor fan **43** is driven to cause the outdoor heat exchanger **42** to exchange heat with the outside air thereby to absorb heat. The blower fan **25** is driven to cause air inside a room to flow into the air passage **23** through the suction port **21**, which is then heated by heat exchange with the indoor heat exchanger **27**.

[0067] Furthermore, by the driving of the PTC heater **28***a*, the air flowing through the air passage **23** is further heated. In this regard, the blower fan **25** and the indoor heat exchanger **27** are formed so as to extend further to the lateral sides than the PTC heater **28***a*. This can increase a heat exchange area of the indoor heat exchanger **27**. Furthermore, air flowing through the space portion **33** on the lateral side of the PTC heater **28***a* cools the triac element **52** via the heat sink **70**. At this time, the air flowing through the space portion **33** exchanges heat with the heat sink **70** and thus is heated.

[0068] The air heated by the indoor heat exchanger **27** and the PTC heater **28***a* is sent out into the room through the blowoff port **22**, and thus heating of the room is performed.

[0069] During a heating operation, the compressor **41** may be deactivated so that air is heated by the PTC heater **28***a* alone. Furthermore, an integrated air conditioner capable only of cooling based on the operation of a refrigeration cycle may be modified so that a heating operation by the PTC heater **28***a* is enabled.

[0070] According to this embodiment, the triac element **52** that controls the PTC heater **28***a* is disposed adjacently to the air passage **23** and the heat sink **70** is disposed inside the air passage **23**, and thus the triac element **52** can be cooled by an airflow flowing through the air passage **23** via the heat sink **70**. This eliminates the need to install a fan for cooling the triac element **52**, and thus power consumption and cost can be reduced and the safety of the air conditioner **1** can be improved.

[0071] Furthermore, in the longitudinal direction, the heat sink **70** is disposed on the outside of the PTC heater **28***a* that is shorter than the blower fan **25**, and thus the temperature rise of the triac element **52** due to heat radiation of the PTC heater **28***a* can be suppressed. Moreover, air heated by heat exchange with the heat sink **70** is sent out from an end portion of the air passage **23**, and thus the efficiency of a heating operation can be improved. In addition, the heat sink **70** is disposed in a dead space between the blower fan **25** and the indoor heat exchanger **27**, on the outside of the PTC heater **28***a* in the longitudinal direction, and thus the air conditioner **1** can be prevented from increasing in size due to the installation of the heat sink **70**.

[0072] Furthermore, the substrate holder **60** is formed in a cup shape and has the window portion **64** open therein for inserting the triac element **52** thereinto, and by the molding material **58** filled in the substrate holder **60**, the circuit substrate **51** and the triac element **52** are molded. Thus, in a case where, during a cooling operation, low temperature air comes in contact with the heat sink **70** and thus dew condensation occurs in the substrate holder **60**, since the molding material **58** is filled, it is possible to prevent dew condensation water from being deposited on the circuit substrate **51** and the triac element **52**.

[0073] Furthermore, in the heat sink **70**, the guide groove **73** is so formed that the width between both the side walls thereof is greater at least part of the region between the side walls than at the open surface of the guide groove **73**, and the substrate holder **60** has the fitting portion **61** to be fitted into the guide groove **73**, so that the substrate holder **60** can be easily fitted to the heat sink **70**. Furthermore, since there is no need for a screw for fitting the substrate holder **60** to the heat sink **70**, it is possible to reduce a phenomenon in which, during a cooling operation, dew condensation occurs in the substrate holder **60** due to heat conduction via the screw.

[0074] Furthermore, the engaging protrusion **63** is provided in the substrate holder **60**, and the engaging hole **75** is provided in the heat sink **70**, so that through engagement between the engaging protrusion **63** and the engaging hole **75**, positioning of the heat sink **70** and the substrate holder **60** relative to each other can be easily performed, and thus assembling workability can be improved.

[0075] Furthermore, the triac element **52** is fitted into the groove portion **72** recessed in the heat sink **70** and is fastened in that state with the screw **57**, and thus the triac element **52** is prevented from being rotated due to the screw **57** being firmly screwed down. This can prevent the terminal **52***b* of the triac element **52** from being warped to be broken.

[0076] Furthermore, the heat sink holder **78** has the arm portion **78***a* that is made of an elastic body and used to sandwich the two circumferential surfaces of the heat sink **70**, which are opposed to each other, and is mounted by being fitted into the opening portion **24***b* on a wall surface of the air passage **23**, so that the heat sink **70** can be easily held by the heat sink holder **78**.

[0077] In this embodiment, air flowing through the air passage **23** is heated by the PTC heater **28***a* that is controlled by the triac element **52** in close contact with the heat sink **70**. There is, however, no limitation thereto. Heating may be performed using a heater that is controlled by a control element of another type provided in close contact with the heat sink **70**.

[0078] The present invention can be applied to air conditioners each including a heater and a control element that controls the heater.

LIST OF REFERENCE NUMERALS

[0079] **1** Air conditioner
[0080] **2** Indoor section
[0081] **3** Bottom plate
[0082] **4** Outdoor section
[0083] **5** Partition wall
[0084] **20**, **40** Cabinet
[0085] **21** Suction port
[0086] **22** Blowoff port
[0087] **23** Air passage
[0088] **24** Intermediate wall
[0089] **24***b* Opening portion
[0090] **25** Blower fan
[0091] **26** Louver
[0092] **27** Indoor heat exchanger
[0093] **28** Heater unit
[0094] **28***a* PTC heater
[0095] **29** Duct member
[0096] **30** Exterior cover
[0097] **31** Electrical equipment box
[0098] **41** Compressor
[0099] **42** Outdoor heat exchanger
[0100] **43** Outdoor fan
[0101] **47** Refrigerant pipe
[0102] **50** Control circuit unit
[0103] **51** Circuit substrate
[0104] **52** Triac element
[0105] **58** Molding material
[0106] **59** Lead
[0107] **60** Substrate holder
[0108] **61** Fitting portion
[0109] **63** Engaging protrusion
[0110] **64** Window portion
[0111] **70** Heat sink
[0112] **71** Fin
[0113] **72** Groove portion
[0114] **73** Guide groove
[0115] **75** Engaging hole
[0116] **78** Heat sink holder
[0117] **78***a* Arm portion

What is claimed is:

1. An air conditioner, comprising:
an air passage that is formed in a cabinet so as to connect a suction port and a blowoff port to each other, which are open on a surface of the cabinet;
a blower fan that is disposed inside the air passage so as to extend in a longitudinal direction;
a heat exchanger that is disposed so as to be opposed to the suction port and exchanges heat with air flowing in through the suction port;
a heater that is disposed between the blower fan and the heat exchanger in order to heat air flowing in through the suction port and is shorter in a longitudinal direction than the blower fan;
a control element that controls the heater and is disposed outside the air passage adjacently to the air passage; and
a heat sink that is in close contact with the control element and is disposed between the blower fan and the heat exchanger, on an outside of the heater in the longitudinal direction.

2. The air conditioner according to claim **1**, wherein
the heater is formed by a PTC heater, and the control element is formed by a triac element.

3. The air conditioner according to claim **1** or **2**, further comprising:
a circuit substrate on which the control element is mounted;
a cup-shaped substrate holder that has a window portion for inserting the control element thereinto, open on an opposed surface of the substrate holder, which is opposed to the heat sink, and holds the circuit substrate; and
a molding material that is filled in the substrate holder so as to mold the circuit substrate and the control element.

4. The air conditioner according to claim **3**, wherein

the heat sink has a guide groove that is recessed therein so as to extend in one direction, and the substrate holder has a fitting portion to be fitted into the guide groove,

a width between both side walls of the guide groove is set to be greater at least part of a region between the side walls than at an open surface of the guide groove, and

through fitting between the guide groove and the fitting portion, the substrate holder is guided to be slid in the one direction.

5. The air conditioner according to claim **4**, wherein

an engaging protrusion is provided on the opposed surface of the substrate holder, and an engaging hole is provided in the heat sink, which is engaged with the engaging protrusion so that positioning of the heat sink and the substrate holder relative to each other is performed.

6. The air conditioner according to claim **3**, wherein

the control element is fastened to the heat sink with a screw, and a groove portion into which the control element is fitted is recessed in the heat sink.

7. The air conditioner according to claim **1** or **2**, wherein

an opening portion is formed on one of wall surfaces of the air passage in the longitudinal direction, and

a heat sink holder is provided that has an arm portion made of an elastic body and used to sandwich two circumferential surfaces of the heat sink, which are opposed to each other, and is mounted to the one of wall surfaces of the air passage by being fitted into the opening portion.

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