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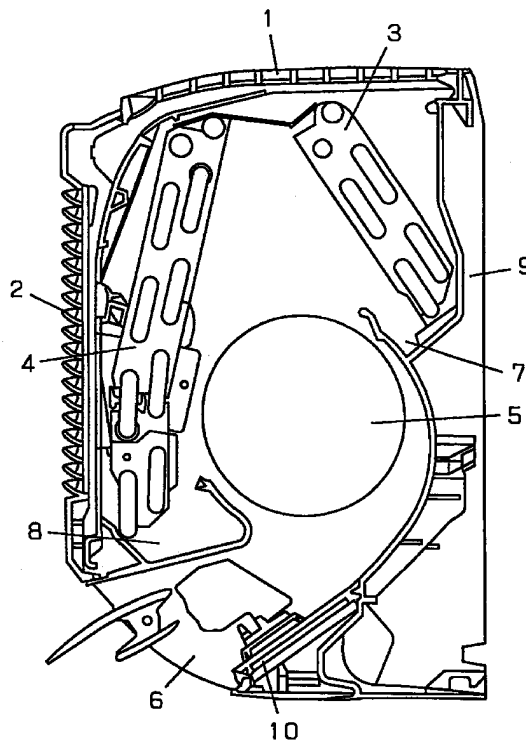
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(54) **Air conditioner**

(57) When the air conditioner is discarded and incinerated, generation of harmful matter is prevented. Recycling of material and thermal recycling are easy, and environmental loads are decreased. Preventive effect of leak of dew condensation water is improved. Long-term aging of drain cap is decreased, and the preventive effect of leak of dew condensation water lasts for a longer period, and the long-term reliability of air conditioner is enhanced. When moving the air conditioner, it is easier to detach and attach the drain cap. It includes a heat exchanger for exchanging heat with air, a drain pan unit disposed in the lower direction of the heat exchanger, a first discharge port and a second discharge port disposed to communicate with the drain pan unit, a drain hose connected to the first discharge port, and a drain cap disposed in the second discharge port. The drain pan unit has a function of receiving the dew condensation water generated from the heat exchanger, and the drain cap is composed of a hydrogenated polymer of copolymer including styrene group and unsaturated hydrocarbon group. The hydrogenated polymer of copolymer including styrene group and unsaturated hydrocarbon group includes a hydrogenated polymer of styrene-butadiene block copolymer or a hydrogenated polymer of styrene-isoprene block copolymer. Preferably, the drain pan unit is made of high-impact styrene resin.

Fig. 1



Description

TECHNICAL FIELD OF THE INVENTION

5 [0001] The present invention relates to an indoor unit of a separate type air conditioner, and more particularly to a drain cap used in the indoor unit.

BACKGROUND OF THE INVENTION

10 [0002] In a conventional separate type air conditioner, a drain pan unit playing the role of a drain pan was installed beneath a heat exchanger in order to collect dew condensation water generated in the indoor heat exchanger. A main body base frame and an air diffuser grill also played the role of this drain pan unit. Through the drain pan unit, dew condensation water was discharged outside by way of a drain hose. Considering the ease of installation, the discharge port is disposed at two positions at both sides in the lower part of the indoor unit. The discharge port not in use was closed
15 by a drain cap. As the drain cap, hitherto, soft vinyl chloride resin has been generally used. The vinyl chloride resin has an excellent forming property and a low material price, and hence has been used widely.

[0003] However, recently, as the environmental problems are becoming serious, the concept about vinyl chloride resin is being changed. That is, when vinyl chloride resin is incinerated, chlorine contained in the resin reacts with incineration dust, and it is said to generate dioxin in low temperature combustion state around 400 to 600°C. Therefore,
20 although no problem occurs as far as the waste electric household appliance is disposed as land filling refuse, when waste electric household appliance is discarded as incineration refuse, the waste electric household appliance using vinyl chloride resin poses a serious problem. In the future, the waste electric household appliance will be intensively recycled by material recycling or thermal recycling. In thermal recycling, when resin materials are sorted correctly, there is no problem, but if vinyl chloride resin is mixed in the resins for thermal recycling, there is a fear of generation of diox-
25 ide at the time of disposal and incineration.

[0004] To avoid such environmental problem, a material replacing vinyl chloride resin is being demanded.

SUMMARY OF THE INVENTION

30 [0005] The air conditioner of the invention comprises:

- a heat exchanger for exchanging heat with air,
- a drain pan unit disposed in the lower direction of the heat exchanger,
- a first discharge port and a second discharge port disposed to communicate with the drain pan unit,
- 35 a drain hose connected to the first discharge port, and
- a drain cap disposed in the second discharge port.

[0006] The drain pan unit has a function of receiving the dew condensation water generated from the heat exchanger, and the drain cap is composed of a hydrogenated polymer of copolymer including styrene group and
40 unsaturated hydrocarbon group.

[0007] Preferably, the hydrogenated polymer of copolymer including styrene group and unsaturated hydrocarbon group includes a hydrogenated polymer of styrene-butadiene block copolymer or a hydrogenated polymer of styrene-isoprene block copolymer.

[0008] Preferably, the drain pan unit is made of high-impact styrene resin.

45 [0009] In this constitution, when the air conditioner is disposed and incinerated, generation of harmful matter is prevented. Moreover, the materials can be recycled. Thermal recycling is facilitated. Thus, the environmental load is decreased. In addition, the effect of preventing leak of dew condensation water is improved.

[0010] Further, long-term aging of drain cap decreases, and the effect for preventing leak of dew condensation water lasts for a longer period, and the long-term reliability of the air conditioner is improved. When moving the air conditioner, the procedure of detaching the drain cap and attaching again is easier. More important, the drain cap is not
50 separated from the drain pan unit, and can be recycled by processing together.

BRIEF DESCRIPTION OF THE DRAWINGS

55 [0011]

Fig. 1 is a sectional view of indoor unit main body in an embodiment of the invention.

Fig. 2 is a back view of indoor unit main body in the embodiment of the invention.

Fig. 3 is a sectional shape view of drain cap in the embodiment of the invention.

Fig. 4(a), Fig. 4(b), and Fig. 4(c) are sectional shape views of drain cap in other embodiment of the invention.

Reference Numerals

[0012]

- 1 First suction grill
- 2 Second suction grill
- 3 First heat exchanger
- 4 Second heat exchanger
- 5 Cross flow fan
- 6 Air diffuser
- 7 First drain pan unit
- 8 Second drain pan unit
- 9 Base frame of indoor unit
- 10 Air diffuser grill
- 11 Drain hose
- 12 Drain cap
- 12a Cylindrical part
- 12b Knob part
- 12c Protrusion part
- 12d Columnar part
- 12e Columnar part
- 12f Cover part
- 12g Outer circumference
- 15 Discharge port
- 15a First discharge port
- 15b Second discharge port

DETAILED DESCRIPTION OF THE INVENTION

[0013] An air conditioner according to an embodiment of the invention comprises a heat exchanger for exchanging heat with air, a drain pan unit disposed in the lower direction of the heat exchanger, in which the drain pan unit has a function of receiving dew condensation water generated from the heat exchanger, a first discharge port and a second discharge port disposed to communicate with the drain pan unit, a drain hose connected to the first discharge port, and a drain cap disposed in the second discharge port, in which the drain cap is composed of a hydrogenated polymer of copolymer including styrene group and unsaturated hydrocarbon group. The drain pan unit has a function of receiving the dew condensation water generated from the heat exchanger.

[0014] Preferably, the unsaturated hydrocarbon group is butadiene.

[0015] Preferably, the unsaturated hydrocarbon group is isoprene.

[0016] Preferably, the hydrogenated polymer of copolymer including styrene group and unsaturated hydrocarbon group includes a block copolymer of styrene group and unsaturated hydrocarbon group.

[0017] Preferably, the hydrogenated polymer of copolymer including styrene group and unsaturated hydrocarbon group includes a block copolymer of styrene and butadiene.

[0018] Preferably, the hydrogenated polymer of copolymer including styrene group and unsaturated hydrocarbon group includes a block copolymer of styrene and isoprene.

[0019] The hydrogenated polymer of copolymer including styrene group and unsaturated hydrocarbon group is elastic.

[0020] An air conditioner in other embodiment of the invention comprises a heat exchanger installed in an indoor unit of a separate type air conditioner, and a drain pan unit disposed beneath the heat exchanger. The drain pan unit has a discharge port for discharging the dew condensation water dripping from the heat exchanger, and the discharge port is disposed at two positions at both side in the lower part of the indoor unit main body. A drain hose is disposed at one opening of the discharge port. A cap is disposed at other opening of the discharge port. The cap is composed of hydrogenated matter of styrene-butadiene block copolymer, or hydrogenated matter of styrene-isoprene block copolymer, in particular, among other styrene elastomers.

[0021] In this constitution, when the air conditioner is discarded and presented for thermal recycling, generation of harmful substance such as chlorine compound and dioxin is prevented, and the environmental load is lowered. Among

styrene elastomers, in particular, by using hydrogenated matter of styrene-butadiene block copolymer, or hydrogenated matter of styrene-isoprene block copolymer, an excellent tensile strength is obtained, and a superior thermal aging resistance is achieved at the same time.

[0022] Preferably, the hardness of the drain cap is about 50 to 65 deg. in JIS K 6301-A testing method. In this constitution, an excellent water sealing performance is obtained, and the excellent water sealing performance is maintained for a longer period, and the water sealing performance is enhanced.

[0023] Preferably, the drain pan unit is made of a resin containing styrene.

[0024] Preferably, the drain pan unit is made of high-impact styrene resin.

[0025] In this constitution, when the air conditioner is discarded and processed., it is not necessary to sort out the drain cap from the drain pan unit, and the drain cap and drain pan unit can be thermally processed in a mixed state of drain cap and drain pan unit. As a result, the recycling process is extremely easy.

[0026] Exemplary embodiments of the invention are described in detail below.

Exemplary Embodiments

[0027] A sectional view of an indoor unit main body of an air conditioner in an embodiment of the invention is shown in Fig. 1. A back view of the indoor unit main body is given in Fig. 2. A sectional view of a drain cap used in the embodiment of the invention is shown in Fig. 3.

[0028] In Fig. 1 and Fig. 2, the indoor unit main body comprises a base frame 9, a first suction grill 1, a second suction grill 2, a first heat exchanger 3, a second heat exchanger 4, a first drain pan unit 7, a second drain pan unit 8, a discharge route (not shown), a cross flow fan 5, an air diffuser grill 10, a first discharge port 15a, a second discharge port 15b, a drain hose 11, and a drain cap 12. A water distribution route has a first water distribution route, a second water distribution route, and a third water distribution route.

[0029] The first suction grill 1 is installed in the upper part of the indoor unit main body, and the second suction grill 2 is installed at the front side of the indoor unit main body. The first heat exchanger 3 is installed near the first suction grill 1, and the second heat exchanger 4 is installed near the second suction grill 2. The first air diffuser grill 10 is installed at the lower side of the second suction grill 2, or in the lower part of the indoor unit main body, or at the corner of front part and lower part. The cross flow fan 5 is installed between the first heat exchanger 3 and second heat exchanger 4, near the first air diffuser grill 10.

[0030] The first drain pan unit 7 is installed at the lower side of the first heat exchanger 3, and the second drain pan unit 8 is installed at the lower side of the second heat exchanger 4. The third water distribution route (not shown) is disposed so as to connect the first drain pan unit 7 and second drain pan unit 8. In this embodiment, the outer frame 9 functions as the third water distribution route. The first discharge port 15a and second discharge port 15b communicate with the second drain pan unit 8. The first discharge port 15a is positioned in the left end region at the back side of the indoor unit main body, and the second discharge port 15b is positioned in the right end region at the back side of the indoor unit main body. The first water distribution route (not shown) is positioned between the second drain pan unit 8 and first discharge port 15a, and the second water distribution route (not shown) is positioned between the second drain pan unit 8 and second discharge port 15b. The drain hose 11 is connected to the first discharge port 15a or second discharge port 15b. For example, in this embodiment, the drain hose 11 is connected to the second discharge port 15b. The drain cap 12 is disposed at the discharge port side not connected to the drain hose 11. For example, in this embodiment, the drain cap 12 is disposed at the first discharge port 15a. In an alternative constitution, either the first water distribution route or the second water distribution route may be omitted, and at least one of the first discharge port 15a and second discharge port 15b may be directly disposed in the second drain pan unit 8.

[0031] The drain cap 12 has, for example, a cylindrical part 12a, a knob part 12b, and a protrusion part 12c as shown in Fig. 3. The knob part 12b has such a shape as to close the opening of the cylindrical part. The drain cap 12 is attached to the discharge port 15 so that the cylindrical part 12a is inserted into the discharge port 15, and that the protrusion part 12c contacts with the end portion of the discharge port 15. The shape of the drain cap 12 is not limited to the example shown in Fig. 3, but the shape may be arbitrary. For example, the drain cap may be shaped as shown in Fig. 4 (a), Fig. 4 (b) and Fig. 4 (c), that is, a columnar shape, a columnar shape forming a protrusion, and a shape enclosing the inner circumference and outer circumference of the end portion of the discharge port. In Fig. 4 (a), the cylindrical part 12d is inserted into the discharge port 15. In Fig. 4 (b), the columnar part 12e is inserted into the discharge port 15, and the cover part 12f covers the outer circumference of the leading end of the discharge port 15. In Fig. 4 (c), the outer circumference 12g is disposed to cover the outer circumference of the discharge port 15. The drain cap 12 as an elasticity of rubber.

[0032] In this embodiment, the discharge port 15 has the first discharge port 15a and second discharge port 15b, but not limited to this constitution, a plurality of discharge ports may be formed. For example, a third discharge port may be formed, and the drain hose or drain cap may be fitted in this third discharge port.

[0033] The room air is sucked into the indoor unit main body through the first suction grill 1 and second suction grill

2. The sucked air is cooled and dehumidified by the first heat exchanger 3 and second heat exchanger 4. Then, the cooled and dehumidified air is sucked and blown by the cross flow fan 5, and is discharged into the room through the air diffuser 6. At this time, the air is dehumidified by the heat exchangers 3, 4, and dew condensation water is formed in the dehumidifying process. The formed dew condensation water is collected in the first drain pan unit 7 and second drain pan unit 8. The first drain pan unit 7 is formed integrally in the base frame 9 of the indoor unit, and the second drain pan unit 8 is formed integrally in the air diffusion grill 10. The dew condensation water collected in the first drain pan unit 7 is poured into the second drain pan unit 8 through the first water distribution route (not shown). The dew condensation water flowing into the second drain pan unit 8 is discharged outside of the indoor unit through the drain hose 11 connected to the discharge port.

[0034] The two discharge ports, that is, the first discharge port 15a and second discharge port 15b are installed at both sides in the lower part of the indoor unit main body. That is, the discharge ports are provided at both sides of the indoor unit main body, and when installing the air conditioner, the laying work of connection piping is easy, and the ease of installation of the air conditioner is enhanced. For example, corresponding to the position of installation of the air conditioner, the drain hose 11 is connected to one discharge port of the first discharge port 15a and second discharge port 15b. Therefore, the drain cap 12 is placed at the discharge port of the side not connected to the drain hose 11. For example, in Fig. 2, the drain hose 11 is installed at the second discharge port 15b, and the drain cap 12 is installed at the first discharge port 15a. Thus, by the use of the drain cap 12, sufficient water sealing is assured. On the other hand, when the indoor unit installed in the room is dismantled and moved to other place, the drain hose 11 may be connected to the first discharge port 15a instead of the original second discharge port 15b. In such a case, the drain cap 12 is detached from the first discharge port 15a, and the detached drain cap 12 is fitted to the second discharge port 15b. In such moving work of the air conditioner, it is important to assure ease of detaching and attaching of the drain cap 12 in the discharge port, and an excellent detaching and attaching performance.

[0035] The material of the drain cap 12 includes hydrogenated polymer of styrene-butadiene block copolymer, or hydrogenated polymer of styrene-isoprene block copolymer. In a chemical structure, the hydrogenated polymer of styrene-butadiene block copolymer has hydrogen (H) added to the unsaturated group of styrene-butadiene block copolymer. In a chemical structure, the hydrogenated polymer of styrene-isoprene block copolymer has hydrogen (H) added to the unsaturated group of styrene-isoprene copolymer. These materials do not contain chlorine in the chemical formula.

[0036] The material of the drain cap 12 may also contain additives such as reinforcing filler, deterioration inhibitor and forming aid in the hydrogenated polymer of styrene-butadiene block copolymer, or hydrogenated polymer of styrene-isoprene block copolymer. In this embodiment, the hydrogenated polymer of styrene-butadiene block copolymer is used. The properties of the hydrogenated polymer of styrene-butadiene block copolymer are shown in Table 1.

[0037] As a comparative example, properties of conventional soft vinyl chloride resin are also given in Table 1. A comparative example of indoor unit was fabricated by using soft vinyl chloride resin as the material for the drain cap 12.

[0038] Using the indoor unit of the embodiment using drain cap made of hydrogenated polymer of styrene-butadiene block copolymer, and the comparative example of the indoor unit using drain cap made of soft vinyl chloride resin, properties of the drain cap and practicability of the indoor unit were evaluated. The drain cap 12 having the shape as shown in Fig. 3 was used. In the practicability test, the initial pulling strength was measured when pulling out the drain cap to the discharge port. The indoor unit provided with the drain cap was kept in a 60°C atmosphere for 7 days, and the drain cap was pulled out from the discharge port, and the pulling strength was measured. When the indoor unit is kept in the atmosphere of 60°C for 7 days, the drain cap 12 deteriorates thermally. In this test, it is estimated whether the drain cap can be removed easily or not when removing the drain cap from the indoor unit when moving the indoor unit after long-term use of the indoor unit in the room. The ease of pulling of drain cap 12 after thermal aging is thus evaluated. The detachability was measured by pulling the drain cap out of the discharge port. The results are summarized in Table 1.

Table 1

	Embodiment	Comparative example
Density	0.90	1.36
Hardness (JIS K 6301-A)	58	70
Pulling strength (kgf): initial value	3.0	4.0
Pulling strength (kgf): after 7-day standing in 60°C atmosphere	3.0	6.1
Detachability	Easy	Easy

[0039] In detachability evaluation, assuming actual work, by pulling the knob 12b of the drain cap 12 by using radio pliers, the drain cap 12 was removed from the discharge port 10 times repeatedly. The hardness is measured in accordance with JIS K 6301-A testing method.

[0040] As a result of measurement, the hydrogenated polymer of styrene-butadiene block copolymer presented equal or better ease of detachability as compared with the conventional soft vinyl chloride resin. That is, the drain cap of the embodiment had a proper strength of attaching and detaching. As a result of pulling test in the initial phase and after thermal aging, in the indoor unit using the drain cap of the embodiment, the drain cap could be pulled out with nearly same force as in the indoor unit using the conventional soft vinyl chloride resin. In particular, the drain cap of the embodiment maintained the same pulling strength as in the initial phase even after thermal aging. By contrast, the conventional drain cap required greater pulling strength after thermal aging. In other words, the drain cap of the embodiment can be easily removed from the discharge port when moving the indoor unit installed in the room for a long period and installing in other place. Moreover, the drain cap of the embodiment has a smaller density than the conventional drain cap, and hence the weight of the indoor unit can be reduced.

[0041] In the invention, other materials suited to the drain cap include hydrogenated polymer of styrene-isoprene block copolymer. Using the hydrogenated polymer of styrene-isoprene block copolymer, the drain cap was similarly fabricated, and the properties and practicability were measured. As a result, the same findings as above were obtained. That is, the pulling strength after thermal aging was same as the initial pulling strength, deterioration of drain cap was not recognized. In the practicability test, the drain cap of the embodiment can be removed more easily than the conventional drain cap.

[0042] Since the copolymers used in these examples do not contain unsaturated bond, and were excellent in heat resistance and weatherability.

[0043] On the other hand, the hardness of the drain cap 12 used in the indoor unit is preferred to be in a range of about 50 to 65 deg. as measured in accordance with JIS K 6301-A. If the hardness is less than 50, the pulling strength is extremely small, and the leak preventing effect (that is, water sealing effect) of dew condensation water from the discharge port for a long period tends to be inferior. If the hardness is over 65, the pulling strength is extremely large, and as detaching and attaching test was repeated, the knob breakage rate increased.

[0044] An object of the invention is to reduce the environmental load and improve the recycling performance. To achieve the object further, the drain pan unit is preferred to be made of high-impact styrene resin. The high-impact styrene resin is a resin containing styrene having a high impact strength. The hydrogenated polymer of styrene-butadiene block copolymer and hydrogenated polymer of styrene-isoprene block copolymer used in the invention are excellent in compatibility with high-impact styrene resin. when the drain cap is discarded together with the drain pan unit, and melted by heating, the fused mixture is easily melted together. Therefore, using the mixture, it may be recycled as other part. That is, the material recycling is easy. Properties of the part made of the recycled mixed material were not lowered. For example, the mechanical strength, hardness and other properties maintained the specified performance. Incidentally, the specific gravity of drain cap and air diffusion grill is small, and by material recycling in their mixed state, the properties were hardly lowered. Therefore, when discarding and recycling the air conditioner, it is not required to remove the drain cap from the drain pan unit, and material recycling is facilitated.

Claims

1. An air conditioner comprising:

a heat exchanger (3, 4) for exchanging heat with air,
 a drain pan unit (7, 8) disposed in a lower direction of said heat exchanger, said drain pan unit having a function of receiving dew condensation water generated from said heat exchanger,
 a first discharge port (15a) and a second discharge port (15b) disposed to communicate with said drain pan unit,
 a drain hose (11) connected to the first discharge port, and
 a drain cap (12) disposed in the second discharge port,
 characterized by that
 said drain cap is composed of hydrogenated polymer of copolymer including styrene group and unsaturated hydrocarbon group.

2. The air conditioner of claim 1, wherein said unsaturated hydrocarbon group is butadiene.

3. The air conditioner of claim 1, wherein said unsaturated hydrocarbon group is isoprene.

4. The air conditioner of claim 1, wherein said hydrogenated polymer of copolymer of styrene group and unsaturated

hydrocarbon group includes hydrogenated polymer of block copolymer of styrene group and unsaturated hydrocarbon group.

- 5 5. The air conditioner of claim 1, wherein said hydrogenated polymer of copolymer of styrene group and unsaturated hydrocarbon group includes hydrogenated polymer of block copolymer of styrene and butadiene.
6. The air conditioner of claim 1, wherein said hydrogenated polymer of copolymer of styrene group and unsaturated hydrocarbon group includes hydrogenated polymer of block copolymer of styrene and isoprene.
- 10 7. The air conditioner in any one of claims 1 to 6, wherein said drain pan unit is composed of resin containing styrene.
8. The air conditioner in any one of claims 1 to 6, wherein said drain pan unit is composed of high-impact styrene resin.
- 15 9. The air conditioner in any one of claims 1 to 8, wherein said drain cap has a hardness in a range of about 50 to 65 according to JIS K 6301-A testing method.
- 20 10. The air conditioner in any one of claims 1 to 9, wherein said first discharge port and second discharge port have a mutually same shape, said drain may can be detached from said second discharge port, said drain hose may be detached from said first discharge port, and said detached drain cap may be fitted to said first discharge port.

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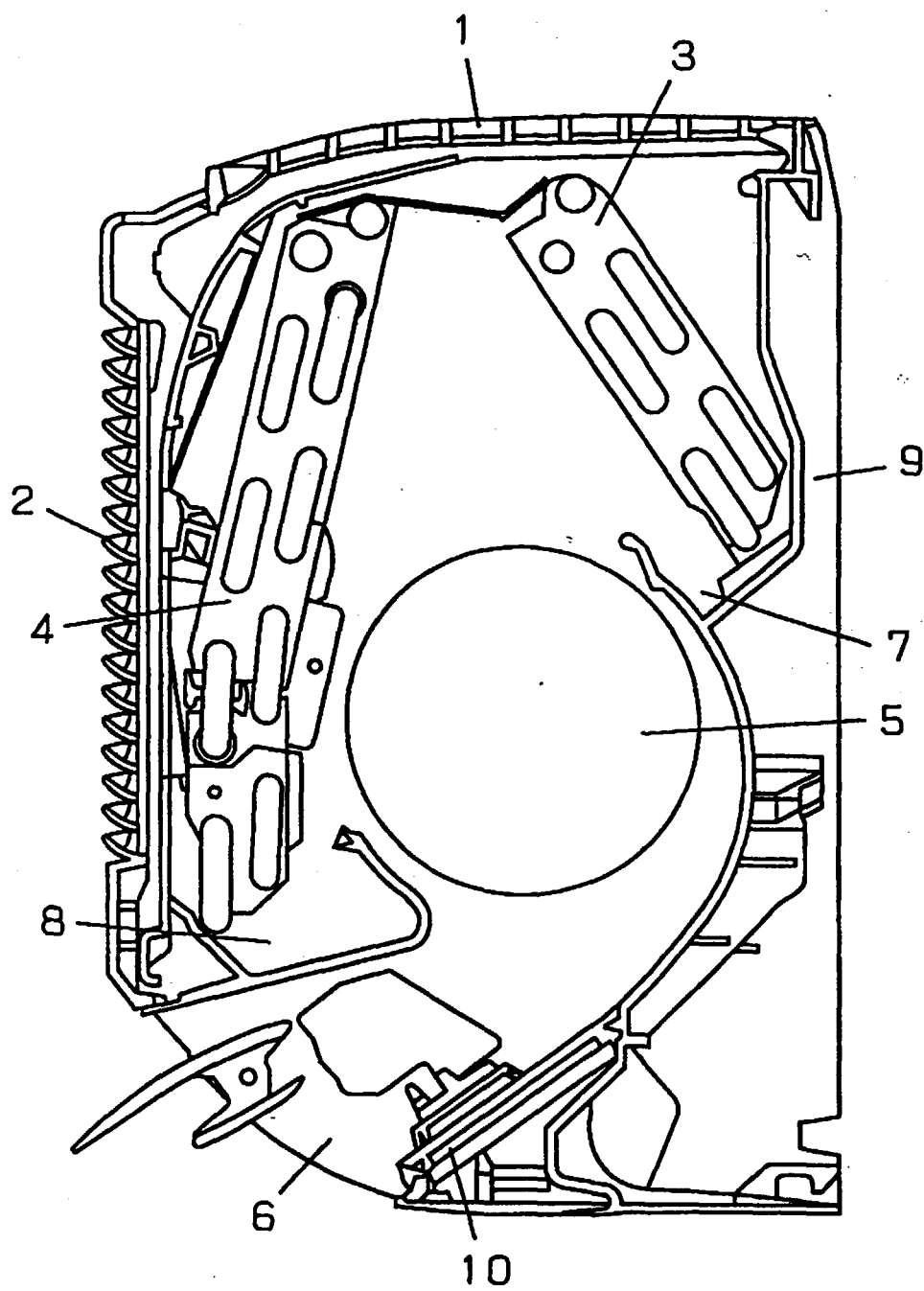
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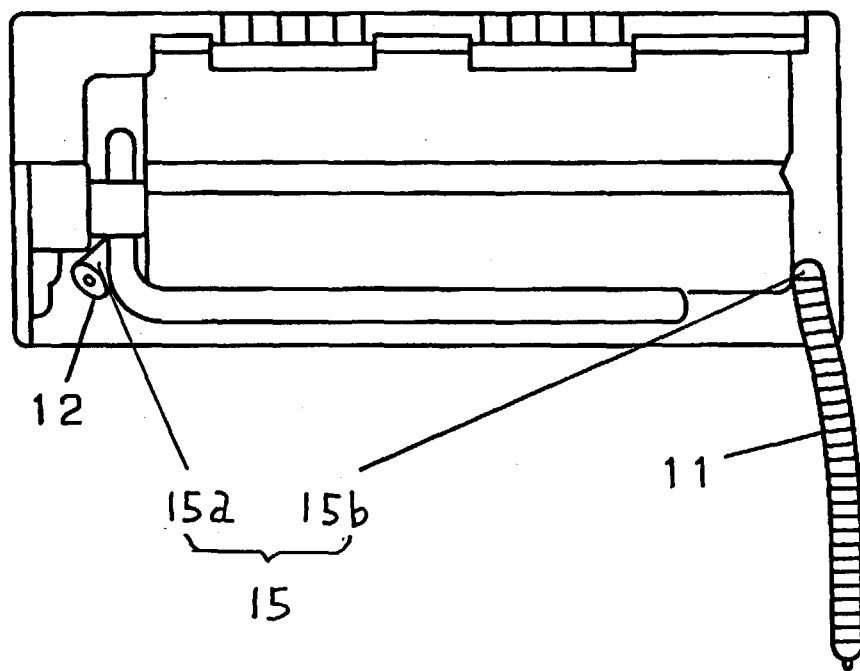
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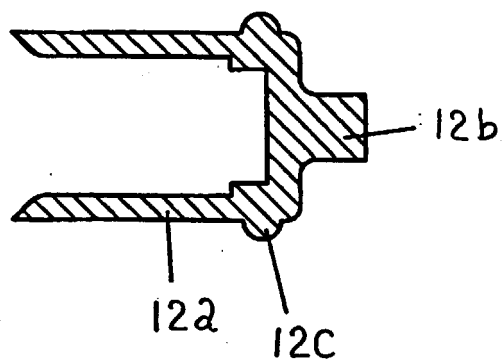
Fig. 1



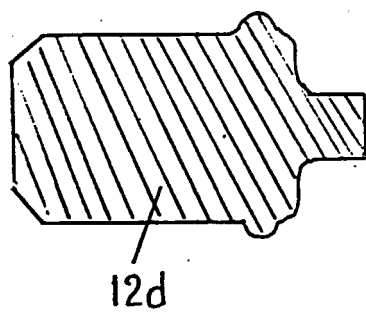
F i g. 2



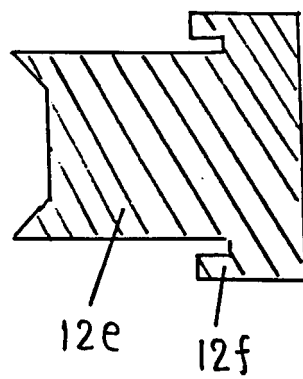
F i g. 3



F i g. 4 (a)



F i g. 4 (b)



F i g. 4 (c)

