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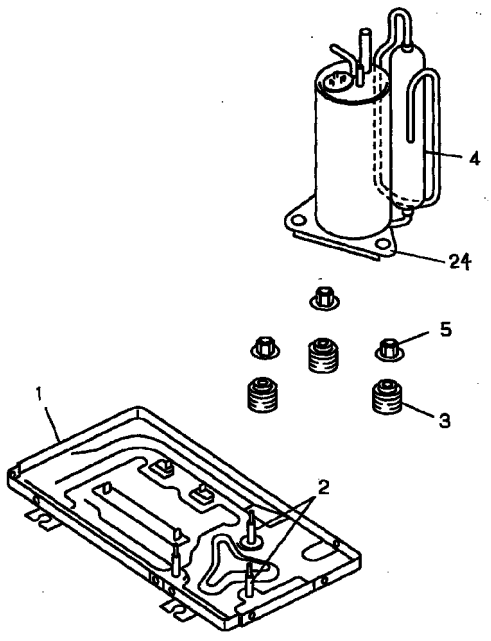
(54) Refrigeration cycle apparatus

(57) When the product is discarded or presented for thermal recycling, generation of harmful substances having adverse effects on environments such as dioxin can be prevented, and the environmental load is lessened. By sorting out the vibration insulation rubber (3,8), material recycling is possible. It includes a compressor (4,9), a frame (1,6) for supporting the compressor (4,9), and vibration insulation rubber (3,8) placed between the compressor (4,9) and the frame (1,6). The vibration insulation rubber (3,8) has a thermoplastic elastomer. Preferably, the vibration insulation rubber (3,8) is a molding made of a chlorine-free thermoplastic elastomer.

Fig. 1



EP 1 043 554 A2

Description

TECHNICAL FIELD OF THE INVENTION

[0001] The present invention relates to a refrigeration cycle apparatus, and more particularly to a vibration insulation rubber used in a compressor of refrigeration cycle apparatus.

BACKGROUND OF THE INVENTION

[0002] The refrigeration cycle apparatus such as separate type air conditioner and refrigerator comprises a compressor. In the case of a vertical type compressor, three support bases are fixed at equal intervals around the lower outer circumference of the compressor, and these support bases are supported on a support frame through vibration insulation rubber. In the case of a horizontal type compressor, four support bases are fixed at lower four corners of the compressor at intervals, and these support bases are supported on a support frame through vibration isolation rubber.

[0003] Bolts are welded and fixed to the lower side of the support frame, and the bolts penetrate through the vibration insulation rubber vertically. Nuts are put on the upper ends of the bolts either directly or through washers. As the vibration insulation rubber for this purpose, CR rubber or NBR rubber is used.

[0004] However, as the environmental problems are becoming more serious recently, the public concept about resin containing chlorine or rubber containing chlorine is being changed. That is, when the chlorine derivative resin or chlorine derivative rubber is disposed by incineration, the chlorine contained in the resin and rubber acts with the incineration dust, and it is highly possible that dioxin and other harmful substances may be generated in the state of low temperature combustion at about 400 to 600°C. Therefore, if the refrigeration cycle apparatus using such compounds containing chlorine is discarded as incineration refuse and the refrigeration cycle apparatus is burned, materials generated by incineration have adverse effects on the environments. In the future, materials for composing electric household appliances are reused by material recycling or thermal recycling. If resin, rubber and other materials for composing the products are not correctly sorted, and the materials containing resin such as chlorine derivative resin and chlorine derivative rubber are mixed in the materials for thermal recycling, it leads to a fear of generation of dioxin. Generally, rubber materials are difficult to handle from the viewpoint of material recycling.

[0005] In this sense, materials used in the refrigeration cycle apparatus are demanded to have no effects on the environments.

SUMMARY OF THE INVENTION

[0006] The refrigeration cycle apparatus of the invention comprises a compressor, a frame for supporting the compressor, and vibration insulation rubber placed between the compressor and the frame, and the vibration insulation rubber has a thermoplastic elastomer.

[0007] Preferably, the refrigeration cycle apparatus further comprises support bases placed in the compressor, and fixing pins for joining the frame and the support bases, and the vibration insulation rubber is placed on the outer circumference of the fixing pins.

[0008] Preferably, the vibration insulation rubber is a molding made from chlorine-free elastomer.

[0009] Preferably, the vibration insulation rubber is a molding made from polyolefin-containing elastomer.

[0010] Preferably, the vibration insulation rubber is a molding made from polyester-containing elastomer.

[0011] Preferably, the thermoplastic elastomer has a hardness in a range of about 40 degrees to about 95 degrees in JIS K 6301, testing method A.

[0012] Preferably, the vibration insulation rubber has a molding made from a recycled thermoplastic elastomer.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013]

Fig. 1 is an exploded view showing a fixing and supporting method of a frame of an outdoor unit main body and a vertical rotary compressor used in refrigeration cycle in an exemplary embodiment of the invention.

Fig. 2 is an exploded view showing a fixing and supporting method of a frame of an outdoor unit main body and a horizontal scroll compressor used in refrigeration cycle in other exemplary embodiment of the invention.

Fig. 3 is a diagram showing the shape of vibration insulation rubber used in the vertical rotary compressor.

Fig. 4 is a diagram showing the shape of vibration insulation rubber used in the horizontal scroll compressor.

Reference Numerals

[0014]

1	Base frame
2	Fixing pin
3	Vibration insulation rubber (Vibration isolation rubber)
4	Vertical compressor
5	Nut
6	Base frame
7	Fixing pin
8	Vibration insulation rubber (Vibration isolation rubber)

9 Horizontal scroll compressor
10 Soundproof sheet
11 Nut
24 Support base
29 Support base

DETAILED DESCRIPTION OF THE INVENTION

[0015] A refrigeration cycle apparatus in an embodiment of the invention comprises a frame for supporting a compressor, a pin, vibration isolation rubber, and a support base of the compressor, and the vibration insulation rubber has a thermoplastic elastomer. In this configuration, when the product is discarded for thermal recycling, generation of dioxin is prevented, and the environmental load is lessened. Moreover, by sorting out the vibration insulation rubber, the material can be recycled.

[0016] Preferably, the vibration insulation rubber has a chlorine-free elastomer. In this composition, when the vibration insulation rubber is discarded for incineration, generation of chlorine-containing harmful substance can be prevented. Further, after use, when the vibration insulation rubber is heated to high temperature and decomposed, and is regenerated into other material different in chemical structure, generation of chlorine-containing harmful substance is prevented. For example, the vibration insulation rubber is regenerated into liquid fuel. Thus thermal recycling is easily realized.

[0017] Preferably, the thermoplastic elastomer has a hard segment and a flexible soft segment. The hard segment and soft segment exist in a state of copolymer. Or the hard segment and soft segment exist in a state of mixture. Alternatively, the hard segment and soft segment exist in a state of compound. The hard segment has a thermoplastic property. The soft segment has a thermoplastic property. Or the soft segment has a crosslinked chemical structure. The thermoplastic copolymer is fused by heat and can be recycled. The thermoplastic hard segment is fused by heat and can be recycled. The thermoplastic soft segment is fused by heat and can be recycled. The soft segment having crosslinked chemical structure is crushed and can be recycled. For example, the crushed material is mixed with other material under heat and pressure, and can be recycled. Thus, the thermoplastic elastomer can be reused by material recycling.

[0018] Preferably, the chlorine-free elastomer is composed of polyolefin-containing elastomer or polyester-containing elastomer. In this composition, in addition to the above effects, the resistance to oil and damping property are improved, and excellent practical properties as the vibration insulation rubber for compressor are provided.

[0019] Preferably, the hardness of the thermoplastic elastomer is in a range from about 40 degrees to about 95 degrees in the measuring method A of JIS K 6301. Therefore, without giving adverse effects on the environments, the elastomer characteristics can be guaranteed for a long period. As a result, the vibration insulation rubber having excellent buckling resistance and damping property capable of withstanding the load of the compressor for a long period is obtained.

[0020] Preferably, the polyester-containing elastomer is a block copolymer having polybutylene terephthalate as hard segment and polyether as soft segment.

[0021] Preferably, the polyolefin-containing elastomer is a compound having a polypropylene as hard segment and crosslinked ethylene propylene rubber as soft segment.

[0022] Preferably, the compressor is of scroll type. The scroll type compressor is low in vibration as compared with the rotary type compressor, and in the composition using elastomer, there is no practical problem, and the elastomer can be used easily.

[0023] Preferably, the vibration insulation rubber has a molding made from a recycled thermoplastic elastomer.

[0024] The vibration insulation rubber means a vibration isolation rubber. The vibration insulation characteristic means vibration isolation characteristic

[0025] Exemplary embodiments of the invention are described in detail below.

Exemplary Embodiment 1

[0026] Fig. 1 is an exploded view showing a fixing and supporting method of a frame of an outdoor unit main body and a vertical rotary compressor used in refrigeration cycle in an exemplary embodiment of the invention. Fig. 2 is an exploded view showing a fixing and supporting method of a frame of an outdoor unit main body and a horizontal scroll compressor used in refrigeration cycle in other exemplary embodiment of the invention. Fig. 3 gives a sectional view and a front view of vibration isolation rubber used in the vertical rotary compressor. Fig. 4 gives a sectional view and a front view of vibration insulation rubber used in the horizontal scroll compressor.

[0027] In Fig. 1, the refrigeration cycle apparatus comprises a vertical rotary compressor 4, a base frame 1, a support base 24, fixing pins 2, and vibration insulation rubber 3. The welded fixing pins 2 are disposed in specified positions on the frame 1. The vibration insulation rubber 3 is disposed so as to contact internally with the outer circumference of the fixing pins 2. With the support base 24 of the vertical rotary compressor 4 placed on the vibration insulation rubber 3, the support base 24 of the vertical rotary compressor 4 is fixed on the base frame 1 by nuts 5. The shape of the vibration insulation rubber 3 is shown in Fig. 3. The vibration insulation rubber 3 shown in Fig. 3 has a nearly cylindrical shape, and has a specific wall thickness. This vibration insulation rubber 3 has a shape of bellows with an undulated outer surface.

[0028] In Fig. 2, the refrigeration cycle apparatus

comprises a horizontal scroll compressor 9, a base frame 6, a support base 29, fixing pins 7, and vibration insulation rubber 8. The welded fixing pins 7 are disposed in specified positions on the frame 6. The vibration insulation rubber 8 is disposed so as to contact internally with the outer circumference of the fixing pins 7. The support base of the horizontal scroll compressor 9 is placed on the vibration insulation rubber 8. To prevent release of noise from the horizontal scroll compressor 9, a soundproof sheet 10 is placed between the horizontal scroll compressor 9 and the frame 6. Finally, in this state, the support base 29 of the horizontal scroll compressor 9 is fixed on the base frame 6 by means of nuts 11. The shape of the vibration isolation rubber 8 is shown in Fig. 4. The vibration insulation rubber 8 shown in Fig. 4 has a nearly cylindrical shape, and has a specific wall thickness.

[0029] The vibration insulation rubber 3, 8 are composed of thermoplastic elastomer. As the thermoplastic elastomer, polyester derivative elastomer was used. The polyester derivative elastomer is a copolymer having hard segment and soft segment. That is, the polyester derivative elastomer is an elastomer containing polyester. The thermoplastic elastomer is a copolymer of polybutylene terephthalate group as hard segment, and polyether group as soft segment. For example, the thermoplastic elastomer is a block copolymer of polybutylene terephthalate and polyalkyl ether. The vibration insulation rubber 3 and 8 can be manufactured from a mixture containing such thermoplastic elastomer and additive such as filler.

[0030] The thermoplastic elastomer has a hardness of about 60 degrees in the testing method A of JIS K 6301. The vibration insulation rubber 3, 8 made of such thermoplastic elastomer have properties of being melted by heating and solidified by cooling. The molten material can be processed into pellets, and the vibration insulation rubber can be formed again by using the pellets. That is, the material can be recycled.

[0031] A refrigeration cycle apparatus was assembled by using such vibration isolation rubber 3 and vertical rotary compressor 4. On the other hand, a refrigeration cycle apparatus was assembled by using vibration isolation rubber 8 and horizontal scroll compressor 9. The practical performance of the vibration insulation rubber 3, 8 was evaluated. That is, vibration measuring instruments were adhered to the ceiling of the compressors 4, 9 and the support bases 24, 29, and the vibration characteristics were measured in the total sound region. As a result, an excellent vibration insulation performance was obtained in practical use.

[0032] Next, the heat aging test of the vibration insulation rubber 3, 8 was conducted. The vibration insulation rubber 3 having the shape as shown in Fig. 3 was manufactured. Also the vibration insulation rubber 8 having the shape as shown in Fig. 4 was manufactured. The vibration insulation rubber 3 and 8 were exposed to loading state of 68.8 N for 240 hours at 100°C. Removing the load, the permanent set in fatigue was measured 30 minutes later. The permanent set in fatigue is the difference between the length before loading and the length by removing the load after a specified long-period loading. That is, the permanent set in fatigue is similar to the degree of permanent compressive strain. As a result, no practical problem was found. It is thus confirmed that the vibration insulation rubber 3, 8 have an excellent heat resistance in practical use.

[0033] Using the same vibration insulation rubber 3, 8 after heat aging test, the recycling performance of the vibration insulation rubber 3, 8 was evaluated. That is, 20 wt.% of the material recycled from the vibration insulation rubber 3, 8 after heat aging test, and 80 wt.% of fresh material were mixed, and a mixed material was prepared. Using the mixed material, the vibration insulation rubber 3, 8 as shown in Fig. 3 and Fig. 4 were manufactured. Using the regenerated vibration insulation rubber 3, 8, the vibration characteristics were measured same as mentioned above. As a result, the equal vibration characteristics were obtained. Further, using the regenerated vibration insulation rubber 3, 8, the same heat aging test was conducted. As a result, the equal heat resistance was obtained. That is, the vibration insulation rubber 3, 8 of the embodiment were confirmed by the reusable by recycling.

[0034] The vibration insulation rubber can be manufactured from 100% recycled material of vibration insulation rubber. Preferably, however, the vibration insulation rubber should be manufactured from a mixed material containing recycled material by less than about 80 wt.%. The vibration insulation rubber made from a mixed material containing the recycled material by more than about 80 wt.% tends to be slightly inferior in the permanent set in fatigue in heat aging test.

Exemplary Embodiment 2

[0035] As the vibration insulation rubber 3, 8 of exemplary embodiment 2, elastomer containing polyolefin was used. That is, the elastomer containing polyolefin has a compound of polypropylene as hard segment, and ethylene propylene rubber as soft segment. That is, the vibration insulation rubber 3, 8 have a mixture of polypropylene and ethylene propylene rubber. The ethylene propylene rubber may also have a crosslinked structure. For example, ethylene propylene rubber is an ethylene propylene terpolymer such as EPDM or EPT containing a third component. The third component may be. for example, 1,4-hexadine, dichloropentadiene, and ethylidene norbornene. The elastomer containing polyolefin has the hardness of about 60 degrees in the measuring method A (spring method A) of JIS K 6301.

[0036] Using this polyolefin-containing elastomer, the vibration insulation rubber 3 and 8 having the shapes as shown in Fig. 3 and Fig. 4 were manufactured. Using the vibration insulation rubber 3, 8, the

vibration characteristics, heat aging test, and recycling method were measured and evaluated in the same manner as in exemplary embodiment 1. As a result, nearly the same evaluation as in exemplary embodiment 1 was obtained.

[0037] That is, the refrigeration cycle apparatus having an excellent vibration insulation in practical use was obtained.

[0038] The vibration insulation rubber 3, 8 were confirmed to have an excellent heat resistance in practical use.

[0039] The vibration insulation rubber 3, 8 using the material mixing the material after the heat aging test were confirmed to be reusable by recycling.

Exemplary Embodiment 3

[0040] Comparing the vibration characteristics between vertical rotary compressor and horizontal scroll compressor, the vibration characteristic generated from the compressor is mutually different. That is, the horizontal scroll compressor has a lower vibration than the vertical rotary compressor. The horizontal scroll compressor is an inverter scroll compressor.

[0041] In this exemplary embodiment, a vibration insulation rubber 8 having a hardness of about 80 degrees and a ring-shaped vibration insulation rubber 8 having a hardness of about 60 degrees were manufactured. Further, the vibration insulation rubber 8 was manufactured in various thicknesses, and using such vibration insulation rubber 3, 8. refrigeration cycle apparatuses using horizontal scroll compressor 9 were assembled. Using these refrigeration cycle apparatuses, the vibration characteristics were measured and evaluated. As a result, when the vibration level varies depending on the type of the compressor, the vibration insulation rubber 8 used in the horizontal scroll compressor 9 having a lower vibration is known to be preferred to be higher in hardness and smaller in wall thickness as compared with the vibration insulation rubber 3 used in the vertical rotary compressor 4 having a larger vibration. Considering the recycling aspect, it is easier to use the thermoplastic elastomer in the inverter scroll compressor of lower vibration than in the rotary compressor.

[0042] Thus, the material suitable as the vibration isolation rubber usable in the embodiment is a thermoplastic elastomer. In particular, the material having a better effect on environments is an elastomer containing polyolefin, or an elastomer containing polyester. A chlorine-free thermoplastic elastomer does not generate harmful chlorine compound.

[0043] When the elastomer made of such materials has a hardness in a range of about 60 degrees to 95 degrees in the spring method A of JIS K 6301, an excellent vibration insulation performance is obtained. That is, the vibration insulation rubber absorbs the vibration of the compressor, and the noise level is lowered extremely.

[0044] When the hardness of the elastomer is 40 degrees or less, in a long-term use and the heat aging test, permanent set in fatigue of the vibration insulation rubber occurs. As a result, a gap is formed between the nuts and the vibration insulation rubber, and the vibration insulation performance is lowered. Or, if the hardness was over about 95 degrees, sufficient vibration insulation characteristic was not obtained. Or, in the case of hardness of over 95 degrees, various shapes of vibration insulation rubber were prepared and the vibration insulation characteristics of refrigeration cycle apparatuses were evaluated by using these vibration insulation rubber samples, but sufficient vibration insulation characteristic was not obtained. In a long-term use, cracks were formed in the vibration insulation rubber. These cracks are caused by internal stress and strain due to repeated use. In a hardness range of about 60 degrees to about 95 degrees, the material having a large hardness is preferred to be small in the wall thickness of the vibration insulation rubber. The vibration insulation rubber having a thin shape requires a smaller amount of material in proportion to the wall thickness. It is hence effective for saving the resources.

[0045] In this constitution, the following effects are obtained.

[0046] When the product is discarded or presented for thermal recycling, generation of harmful substances having adverse effects on environments such as dioxin can be prevented, and the environmental load is lessened. By sorting out the vibration insulation rubber, material recycling is possible.

[0047] Further, the resistance to oil and damping characteristic are improved, and an excellent practical characteristic as the vibration insulation rubber for compressor is provided.

[0048] The elastomer characteristic can be guaranteed for a long period, and the vibration insulation rubber having an excellent resistance to permanent set in fatigue and damping characteristic withstanding the load of the compressor for a long time can be obtained.

[0049] Moreover, the vibration insulation rubber can be designed in a small wall thickness, and the resources can be saved.

Claims

1. A refrigeration cycle apparatus comprising:

a compressor (4, 9),
a frame (1, 6) for supporting said compressor, and
a vibration insulation rubber placed between said compressor and said frame,
characterized in that said vibration insulation rubber has a thermoplastic elastomer.

2. The refrigeration cycle apparatus of claim 1, further

comprising:

a support base (24, 29) placed in said compressor, and
a fixing pin (7) for joining said frame and said support base,
characterized in that said vibration insulation rubber is placed on the outer circumference of said fixing pin.

3. The refrigeration cycle apparatus of claim 1 or 2, wherein said vibration insulation rubber is a molding made from chlorine-free thermoplastic elastomer.

4. The refrigeration cycle apparatus of claim 1, 2 or 3, wherein said vibration insulation rubber is a molding made from polyolefin-containing elastomer.

5. The refrigeration cycle apparatus of claim 1, 2 or 3, wherein said vibration insulation rubber is a molding made from polyester-containing elastomer.

6. The refrigeration cycle apparatus of any one of claims 1 to 5, wherein said thermoplastic elastomer has a hardness in a range of about 40 degrees to about 95 degrees in the testing method A of JIS K 6301.

7. The refrigeration cycle apparatus of claim 1, 2, 3, or 6, wherein said vibration insulation rubber has a block copolymer of polybutylene terephthalate as hard segment and polyether as soft segment.

8. The refrigeration cycle apparatus of claim 1, 2, 3, or 6, wherein said vibration insulation rubber is a molding having a mixture of polypropylene as hard segment and ethylene propylene rubber as soft segment.

9. The refrigeration cycle apparatus of any one of claims 1 to 8, wherein said compressor is a scroll compressor.

10. The refrigeration cycle apparatus of any one of claims 1 to 9, wherein said vibration insulation rubber has a molding made from a recycled thermoplastic elastomer.

11. The refrigeration cycle apparatus of any one of claims 1 to 9,
wherein said vibration insulation rubber has a molding made from a mixed material of an recycled thermoplastic elastomer and a fresh thermoplastic elastomer, and

the recycled thermoplastic elastomer is contained by about 80 wt.% or less.

12. The refrigeration cycle apparatus of any one of claims 1 to 11, further comprising:

a soundproof sheet placed between said compressor and said frame,
wherein said compressor is a horizontal scroll compressor, and
said vibration insulation rubber has a function of absorbing the vibration of said compressor.

13. The refrigeration cycle apparatus of any one of claims 1 to 12,
wherein said vibration insulation rubber has a hollow cylindrical shape,

said fixing pin penetrate through said hollow space,
said compressor is installed so as to load said vibration insulation rubber, and
said vibration insulation rubber has a function of absorbing the vibration of said compressor.

14. The refrigeration cycle apparatus of any one of claims 1 to 12, wherein said thermoplastic elastomer has a property of fusing by heating and solidifying by cooling.

15. The refrigeration cycle apparatus of claim 1, 2, 3, or 6, wherein said thermoplastic elastomer has a hard segment and an elastic soft segment.

16. The refrigeration cycle apparatus of claim 1, 2, 3, or 6,
wherein said thermoplastic elastomer has a hard segment and an elastic soft segment, and

said hard segment and said soft segment are a copolymerized copolymer.

17. The refrigeration cycle apparatus of claim 1, 2, 3, or 6,
wherein said thermoplastic elastomer has a hard segment and an elastic soft segment, and

said hard segment and said soft segment are a mixed mixture.

Fig. 1

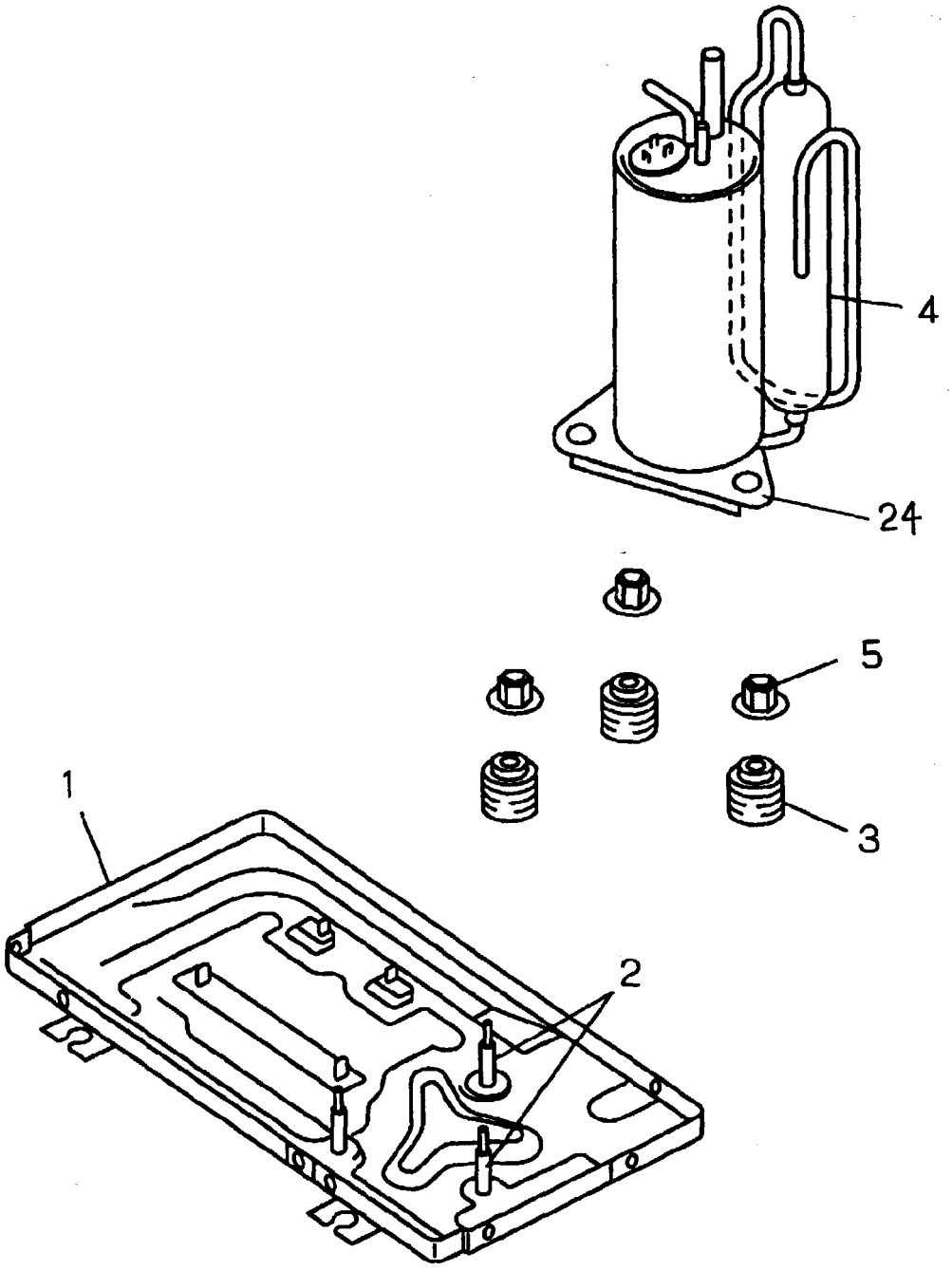


Fig. 2

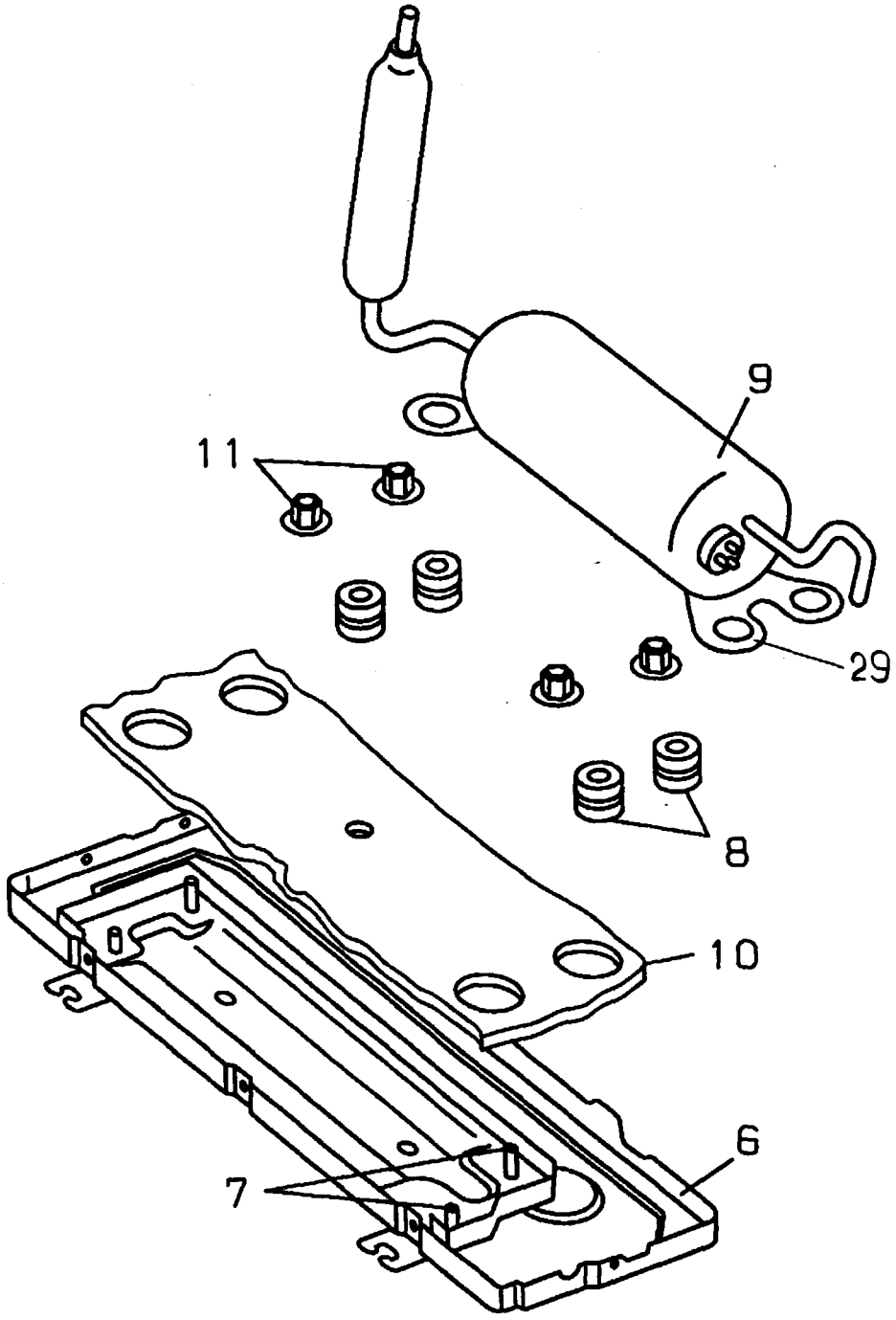


Fig. 3

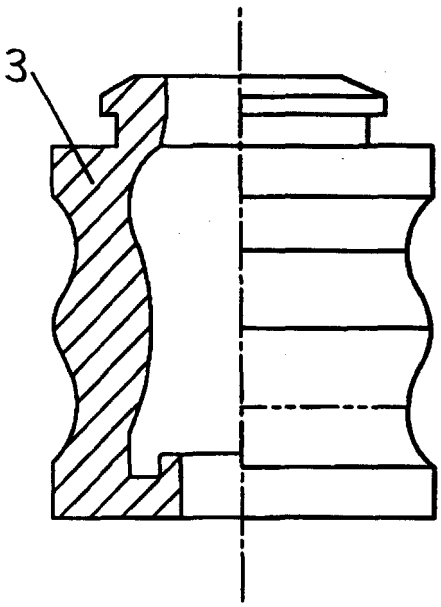


Fig. 4