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(54) **Expansion valve**

(57) An expansion valve has a valve main body 10, a valve member 40, and a power element 100. The power element 100 includes a diaphragm 130 sandwiched between an upper cover member 110, and a receiving member 120. Outer peripheries of the upper cover member 110, the diaphragm 130, and the receiving member 120 are joined by laser welding. The distance from a fulcrum position of the diaphragm 130 to an outer periphery of the power element 100 is set to be a distance obtained by adding 0.2 mm to 1.0 mm to the length dimension of the welding part formed by laser welding. The assembled power element 100 is inserted into a cylindrical part 12 provided at an upper part of a valve main body 10, and is fixed by a caulking part 12a formed by caulking-processing, thereby to reduce the size of the power element 100.

FIG. 1A

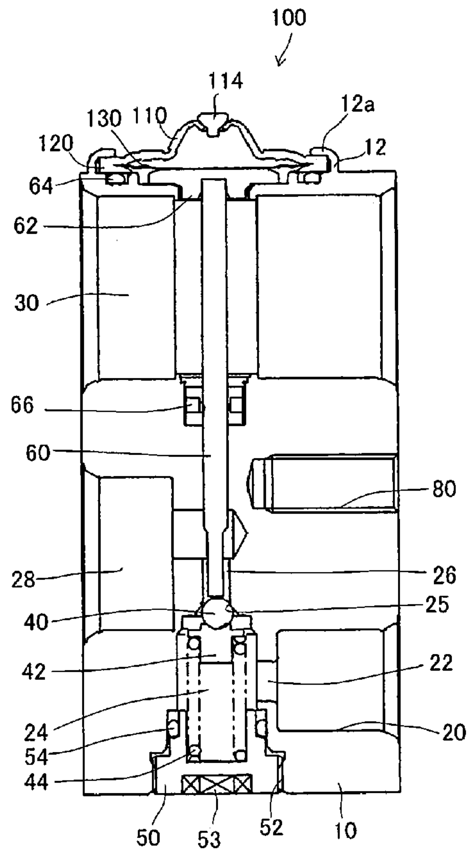

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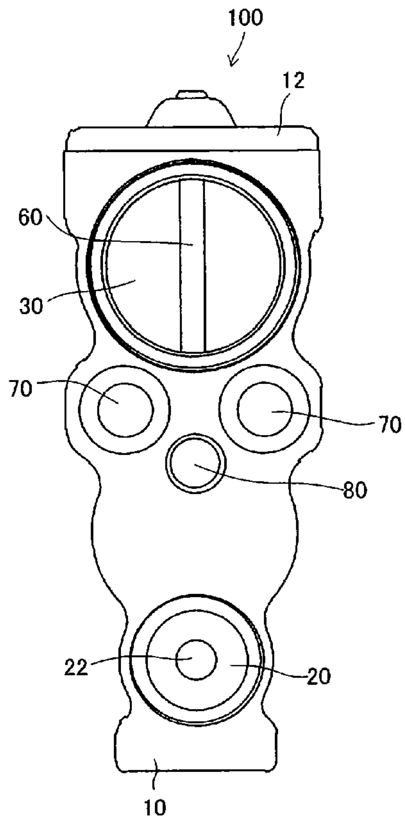
FIG. 1B



Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to an expansion valve with a built-in thermo-sensitive mechanism used for a refrigerating cycle.

Description of the Conventional Art

[0002] For a refrigerating cycle used for an air conditioner or the like mounted on automobiles, a thermal expansion valve with a built-in thermo-sensitive mechanism has been conventionally used for saving an installation space and wiring. The thermal expansion valve can adjust the amount of refrigerant flow in response to a temperature.

[0003] Japanese Unexamined Patent Publication No. 2008-180475 discloses such a kind of expansion valve proposed by the present applicant.

[0004] A valve main body of the expansion valve includes an inlet port for introducing a high-pressure refrigerant, and a valve chamber communicating with the inlet port. A spherical valve member is disposed in the valve chamber opposing to a valve seat formed at a valve hole which opens to the valve chamber, and operated by a valve rod which is driven by a power element to control an opening degree of a throttle passage between the valve member and the valve seat.

[0005] The refrigerant passing through the valve hole is sent to the evaporator side from an outlet port. The refrigerant returning from the evaporator to the compressor side passes through a return passage provided at the valve main body.

[0006] The valve main body includes a driving mechanism of a valve member, which is called as a power element, at a top part thereof.

[0007] The conventional power element includes an upper cover member forming a pressure operation chamber, a thin plate-like diaphragm elastically deformed by received pressure, and a disc-like receiving member. The power element is formed by overlapping the three members and joining circumference parts thereof by means of TIG welding or the like.

[0008] The pressure operation chamber formed with the upper cover member and the diaphragm encloses an heat-sensitive gas. For enclosing the heat-sensitive gas in the pressure operation chamber, a hole is formed at a top part of the upper cover member, and after the heat-sensitive gas is enclosed from the hole, the hole is closed with a steel ball or the like to seal the pressure operation chamber by means of projection welding or the like.

[0009] The aforementioned conventional thermal expansion valve provided with a built-in thermo-sensitive mechanism has an advantage that an external dimension can be reduced. However, since many parts are disposed around the expansion valve in a closely-contact state, further downsizing is required for the expansion valve. Further, by downsizing, the expansion valve can also have an advantage that a production cost can be decreased.

[0010] The present invention is made in view of such circumstances, and an objective of the present invention is to provide an expansion valve aiming the downsizing by reducing the diameter of a power element.

[0011] To realize the aforementioned objective, according to an aspect of the present invention, an expansion valve includes a valve main body, a valve member, and a power element. The valve main body has an inlet port for introducing a high-pressure refrigerant, a valve chamber communicating with the inlet port, a valve hole which opens to the valve chamber, a valve seat formed at an inlet of the valve hole, and an outlet port for discharging the refrigerant passed through the valve hole. The valve member is disposed to be opposed to the valve seat. The power element has a pressure operation chamber enclosing an heat-sensitive gas for driving a valve rod operating the valve member.

[0012] The power element includes an upper cover member in which the pressure operation chamber is formed, a receiving member, and a diaphragm sandwiched between the upper cover member and the receiving member. Outer peripheral parts of the upper cover member, the diaphragm, and the receiving member are joined with a welding part formed by laser welding. The distance from a fulcrum position of the diaphragm, which is sandwiched between the upper cover member and the receiving member, to an outer periphery of the power element is set to be a distance obtained by adding 0.2 mm to 1.0 mm to the length of the welding part formed by laser welding.

[0013] According to another aspect of the present invention, the valve main body has a cylindrical part in which the power element is inserted, and the power element is fixed by caulking an upper part of the cylindrical part.

[0014] Since the expansion valve of the present invention includes the aforementioned structures, the downsizing of the expansion valve can be attained by reducing the diameter of the power element.

BRIEF EXPLANATION OF DRAWINGS

[0015]

Fig. 1A is a cross-sectional view illustrating an expansion valve according to one embodiment of the present invention, and Fig. 1B is a right-side view of the expansion valve shown in Fig. 1A.

Fig. 2 is an enlarged view of a main part in Fig. 1A.

Fig. 3A is an explanatory diagram illustrating a welding structure of a power element of the conventional expansion valve, and Fig. 3B is an explanatory diagram illustrating a welding structure of a power element of the present invention.

Fig. 4 is an explanatory diagram illustrating a thermal affection area to a the diaphragm having the welding structure shown in Figs. 3A and 3B.

Figs. 5A and 5B are explanatory diagrams illustrating a difference between welding structures of the power element of the conventional art and the present invention.

Fig. 6A is a cross-sectional view illustrating an expansion valve according to another embodiment of the present invention, and Fig. 6B is a right-side view of the expansion valve shown in Fig. 6A.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

[0016] Fig. 1A is a cross-sectional view illustrating an expansion valve according to one embodiment of the present invention, and Fig. 1B is a right-side face view of the expansion valve shown in Fig. 1A.

[0017] A valve main body 10 of an expansion valve of the present invention is produced by machining a material that is produced by an extrusion molding of an aluminum alloy, and has an inlet port 20 for introducing a high-pressure refrigerant.

[0018] A small diameter hole 22 is provided on a depth wall of the inlet port 20, and communicates with a valve chamber 24 having a center axis in the longitudinal direction of the valve main body 10. The valve chamber 24 communicates with a refrigerant outlet port 28 via a valve hole 26 formed coaxially with the valve chamber 24.

[0019] A valve seat 25 is formed between the valve chamber 24 and the valve hole 26, and a spherical valve member 40 disposed in the valve chamber 24 is opposed to the valve seat 25.

[0020] The valve member 40 is supported by a supporting member 42, and the supporting member 42 is supported by a plug 50 for sealing an opening part of the valve chamber 24 via a coil spring 44. The plug 50 is screwed to the opening part of the valve chamber 24 of the valve main body 10 with a screw part 52. Since the plug 50 can be rotated by inserting a wrench into a bottomed hexagonal hole 53, the spring force of the coil spring 44, which supports the valve member 40, can be adjusted by adjusting a screw-in amount of the plug 50.

[0021] A seal member 54 is provided at an outer peripheral part of the plug 50, and seals the valve chamber 24.

[0022] A refrigerant sent from the outlet port 28 is sent to an evaporator, performs heat-exchange with outside air, and evaporates. A refrigerant returning from the evaporator to the compressor side passes through a return passage 30 provided at the valve main body 10.

[0023] A power element 100 is attached to a top part of the valve main body 10 with a caulking part 12a formed by caulking an upper part of a cylindrical part 12 formed at an upper part of the valve main body 10. A seal member 64 is disposed between the power element 100 and the valve main body 10.

[0024] The power element 100 is produced by an aspect described below. The power element 100 includes an upper cover member 110, a ring-like receiving member 120, and a diaphragm 130 sandwiched between the upper cover member 110 and the receiving member 120.

[0025] A pressure operation chamber 112 defined by the upper cover member 110 and the diaphragm 130 encloses an heat-sensitive gas and is sealed by a plug 114. A stopper member 62 is disposed on a lower face of the diaphragm 130, and a movement of the stopper member 62 is transmitted to the valve member 40 via a valve rod 60. A spring member 66 is disposed at an outer peripheral part of the valve rod 60 and adds sliding resistance to the valve rod 60, so that the vibration of the valve member 40 is prevented.

[0026] The valve main body 10 has two through holes 70 penetrating the valve main body 10, and the through holes 70 are used as an insertion hole for a bolt for attaching the valve main body 10 to another member. Further, one bottomed screw hole 80 is formed at a central part of the valve main body 10.

[0027] Fig. 2 is an enlarged view of the power element 100.

[0028] The power element 100 is obtained by overlapping the upper cover member 110, the diaphragm 130, and the receiving member 120, forming a welding part W on an outer peripheral part by welding, and integrating them into a unit. The upper cover member 110 has a convex part formed at a central part thereof, and has a hole 116 provided at a top part of the convex part. The heat-sensitive gas is injected from the hole 116 into the pressure operation chamber 112 partitioned by the diaphragm 130, and the hole 116 is sealed by closing the hole 116 with the plug 114 and welding.

[0029] For downsizing the expansion valve, it is necessary to also reduce an outer diameter dimension D of the power element 100.

[0030] Fig. 3A illustrates a conventional welding structure in which a welding part W_1 is formed by TIG welding. A thermal affection area H_1 is generated at a portion, in which the upper cover member 110, the diaphragm 130, and the receiving member 120 are overlapped, in a length dimension L_1 of the welded portion of the welding part W_1 which is formed by TIG welding. The TIG welding generates much quantity of heat input when the welding part W_1 is formed, so that the thermal affection area H_1 also comes to be large. In this area, the diaphragm 130 is also annealed, so that the characteristic as a diaphragm is lowered.

[0031] For exercising the predetermined performance of the power element 100, it is necessary to secure an effective diameter D_5 which is inside a diaphragm fulcrum position P_1.

[0032] When the welding part W1 is formed by the TIG welding as illustrated in Fig. 3A, the outer diameter dimension D_1 of the power element 100 needs to be large for securing the effective diameter D_5 of the diaphragm

130.

[0033] Fig. 3B illustrates a welding structure according to one embodiment of the present invention in which welding part W_2 is formed by laser welding. In the laser welding, the welding part W_2 is formed inside the end faces of the upper cover member 110 and the receiving member 120, as having a length dimension L_2.

[0034] Further, also less amount of the heat quantity is required for forming the welding part W_2. As a result, a thermal affection area H_2 comes to be small.

[0035] Utilizing this characteristic of the laser welding, the outer diameter dimension D_2 of the power element 100 can be reduced while securing the effective diameter D_5 of the diaphragm 130.

[0036] Fig. 4 is an explanatory diagram illustrating thermal affecting areas to the diaphragm 130 when the outer peripheral part of the power element 100 is subjected to TIG welding or laser welding.

[0037] It was confirmed by an experiment that TIG welding gave the annealing effect to the diaphragm 130 within a range up to about 1.0 mm from the length dimension due to melting of the welding part W. In contrast to TIG welding , the area was 1.0 mm or less and could be small up to about 0.2 mm according to laser welding.

[0038] As illustrated in Fig. 3B, utilizing the aforementioned property of laser welding, a distance dimension S_1 from the fulcrum position P1 of the diaphragm 130 to the outer periphery of the power element 100 is set to be a distance obtained by adding from 0.2 mm to 1.0 mm to the length dimension L_2 of the welding part W_2 formed by laser welding. In addition, the distance S_1 is a half of the difference between the outer diameter dimension D_2 of the power element 100 and the effective diameter dimension D_5 of the diaphragm 130. In addition, a distance added to the L_2 is preferably about 0.5 ± 0.2 mm, in order to make the outer diameter dimension of the power element 100 as small as possible while avoiding the thermal affection.

[0039] Accordingly, in the present invention, the outer diameter dimension of the power element 100 can be reduced, while securing the effective diameter dimension of the diaphragm 130.

[0040] Fig. 5A illustrates a conventional welding structure in which the welding part W_1 is formed by a torch T_1 in TIG welding.

[0041] As described in Fig. 3A, the outer diameter dimension D_1 of the power element 100 required for securing the effective diameter D_5 of the diaphragm 130 comes to be large.

[0042] Fig. 5B illustrates a welding structure according to one embodiment of the present invention in which the welding part W_2 is formed by laser beam B_1 irradiated from a laser torch T_2.

[0043] As described in Fig. 3B, the outer diameter dimension D_2 of the power element 100 required for securing the effective diameter D_5 of the diaphragm 130 can be small.

[0044] The expansion valve with a small size can be obtained by inserting the power element 100 into the cylindrical part 12 formed at the upper part of the valve main body 10 and fixing the power element 100 by the caulking part 12a.

[0045] In the expansion valve with such a caulking structure, the outer diameter of the upper part of the expansion valve is a dimension obtained by adding the value of two times thickness of the caulking part 12a to the outer diameter of the power element 100. In the conventional power element by TIG welding, since the outer diameter dimension is large, there is a problem that such a caulking structure is hardly used. In contrast to the conventional one, according to the present invention, since the power element 100 has a small diameter, the caulking structure can be used. Therefore, screw-processing for screwing the valve main body 10 to the power element 100 is not necessary, so that a production cost can be reduced.

[0046] Further, in the above described embodiment, the valve rod 60 contacts the diaphragm 130 via the stopper member 62, and the receiving member 120 has a ring shape. In addition, there is a space between an inner peripheral part of the receiving member 120 and the outer peripheral part of the stopper member 62. Thus, the stopper member 62 contacts the valve main body 10, so that the movement in the valve opening direction is restricted.

[0047] In the conventional expansion valve, as described in Figs. 6A and 6B, the stopper member 62 contacts the receiving member 120, so that the movement in the valve opening direction is restricted. Therefore, in the above described embodiment, a dimension in the height direction of the expansion valve can be shortened, comparing with the conventional expansion valve.

[0048] Furthermore, since the receiving member 120 is not interposed between the stopper member 62 and the valve main body 10, a position in the vertical direction of the stopper member 62 is not affected by the thickness of the receiving member 120. Thus, the position of the diaphragm 120 can be stable, and fluctuation of each performance can be reduced.

[0049] In addition, the present invention can be applied to an expansion valve according to another embodiment having a structure illustrated in Figs. 6A and 6B, in which the power element 100 is screwed to the valve main body 10 by a screw part 120a formed at the receiving member 120 and a screw part 10a formed at the valve main body 10.

[0050] In addition, the aforementioned embodiments can be variously changed within a range which does not depart from the objective of the present invention.

Claims

1. An expansion valve comprising:

   a valve main body including an inlet port for introducing a high-pressure refrigerant, a valve

chamber communicating with the inlet port, a valve hole which is open to the valve chamber, a valve seat formed at an inlet of the valve hole, and an outlet port for sending the refrigerant passed through the valve hole,
a valve member disposed to be opposed to the valve seat, and
a power element including a pressure operation chamber enclosing an heat-sensitive gas for driving a valve rod which operates the valve member,
the power element including an upper cover member in which the pressure operation chamber is formed, a receiving member, and a diaphragm sandwiched between the upper cover member and the receiving member,
wherein outer peripheral parts of the upper cover member, the diaphragm, and the receiving member are joined with a welding part formed by laser welding, and
wherein the distance from a fulcrum position of the diaphragm sandwiched between the upper cover member and the receiving member to an outer periphery of the power element is set to be a distance obtained by adding 0.2 mm to 1.0 mm to the length dimension of the welding part formed by laser welding.

2. The expansion valve according to claim 1, wherein the valve main body includes a cylindrical part in which the power element is inserted, and the power element is fixed by caulking an upper part of the cylindrical part.

FIG. 1A

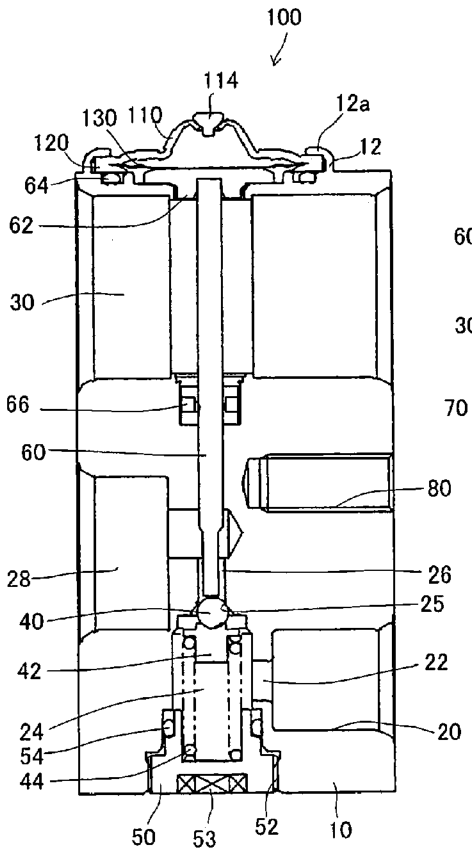


FIG. 1B

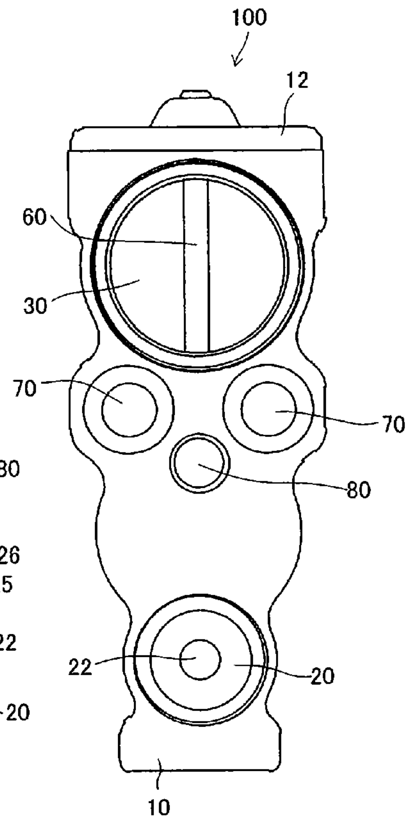
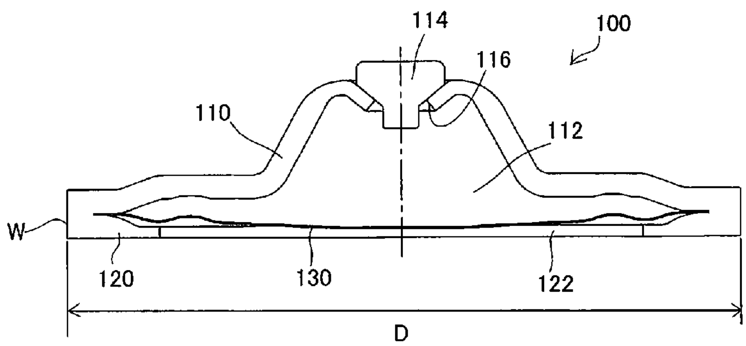


FIG. 2



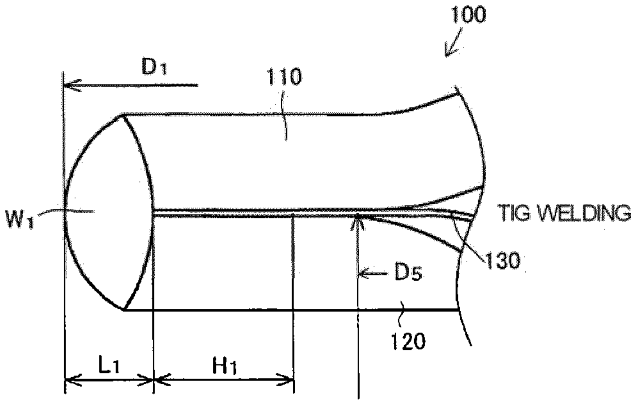

100
D1
110
W1
TIG WELDING
130
D5
120
L1
H1

FIG. 3A

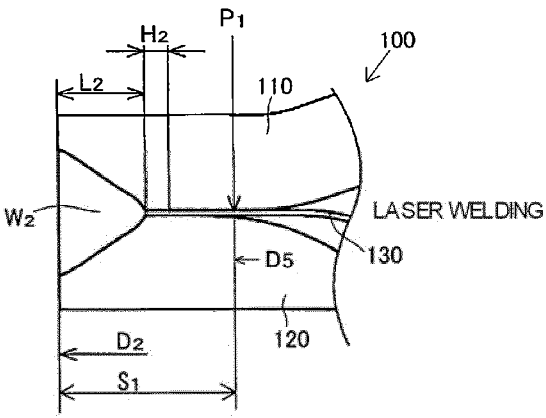
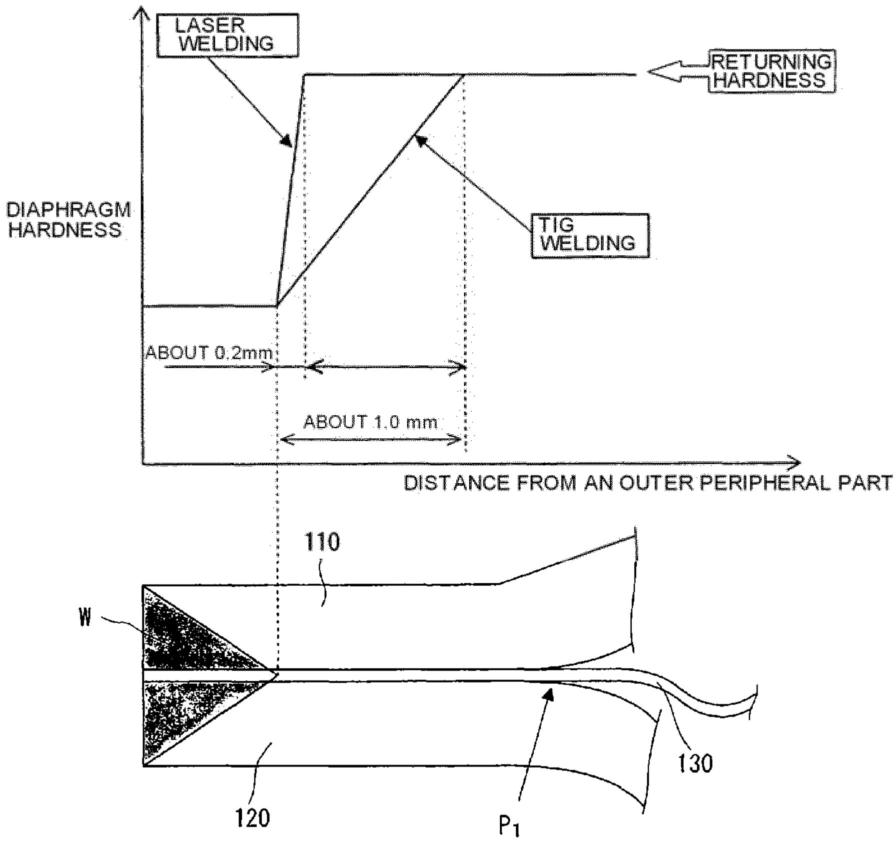

P1
H2
100
L2
110
W2
LASER WELDING
130
D5
120
D2
S1

FIG. 3B

FIG. 4



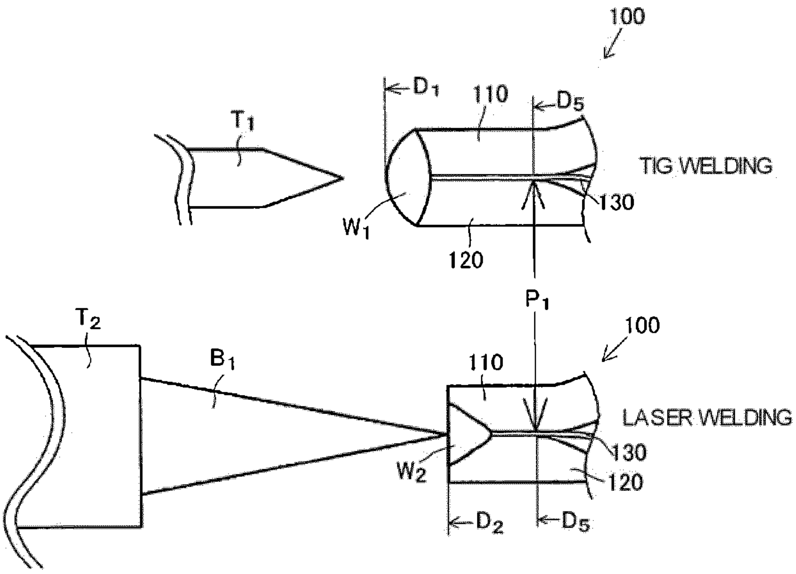


FIG. 5A

FIG. 5B

FIG. 6A

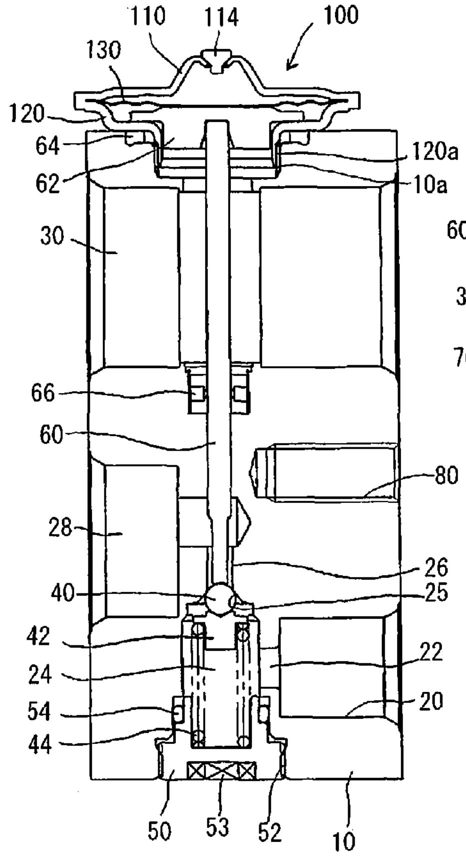

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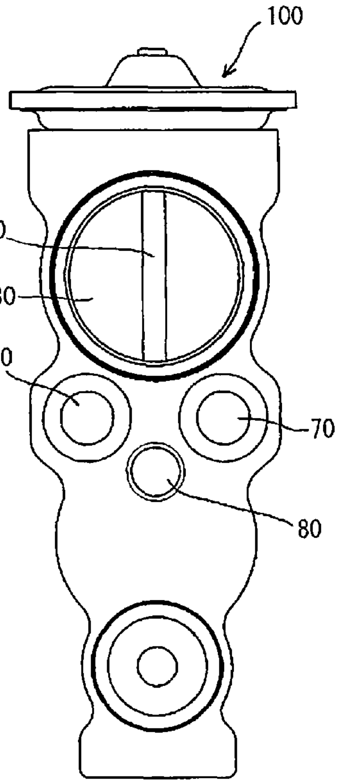
FIG. 6B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Patent documents cited in the description

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