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(72) Inventors:
• **FURUKUBO, Kei**
Tokyo 102-0073 (JP)
• **MORIKAWA, Yudai**
Tokyo 102-0073 (JP)
• **ASANUMA, Hiroaki**
Tokyo 100-8310 (JP)

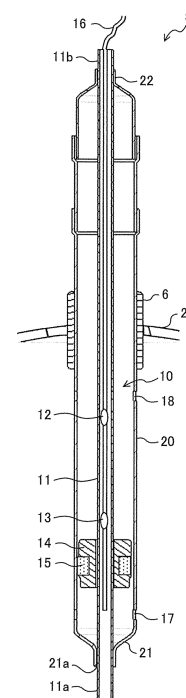
(71) Applicant: **MITSUBISHI ELECTRIC CORPORATION**
Chiyoda-ku
Tokyo 100-8310 (JP)

(74) Representative: **Witte, Weller & Partner**
Patentanwälte mbB
Postfach 10 54 62
70047 Stuttgart (DE)

(54) **ACCUMULATOR AND REFRIGERATION CYCLE DEVICE**

(57) An accumulator includes a container, and a liquid-level detection device. The liquid-level detection device penetrates an upper portion of the container, and is joined to the container. The liquid-level detection device extends in the direction along the height of the container. The liquid-level detection device includes a sensor unit and a protecting tube. The sensor unit includes a float that rises and lowers in accordance with upward and downward movement of the liquid surface of liquid refrigerant accumulated in the container. The sensor unit detects the position of the liquid surface using the float. The protecting tube is provided to surround the sensor unit, and protects the float.

FIG. 4



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Description

Technical Field

[0001] The present disclosure relates to an accumulator and a refrigeration cycle apparatus that include a liquid-level detection device.

Background Art

[0002] In the past, accumulators have been provided that include a liquid-level detection device to detect the position of the liquid surface of liquid refrigerant within a container (see, for example, Patent Literature 1). In Patent Literature 1, a liquid-level detection device is connected to a container from the outside of the container. To be more specific, the liquid-level detection device includes a tube, a float, and a sensor. The tube is connected to the container by two pressure equalizers. In the tube, the same liquid surface position as that in the container is reproduced. The float is provided within the tube, and rises and lowers in accordance with upward and downward movement of the liquid surface of liquid refrigerant in the tube. The sensor detects movement of a magnet provided at the float, to thereby detect the position of the liquid surface.

[0003] In the above configuration, the liquid-level detection device is connected to the container from the outside of the container. Therefore, the liquid surface is not disturbed by the momentum of a gas-liquid refrigerant mixture that flows into the accumulator from the outside. It is therefore possible to stably detect the accurate position of the liquid surface.

Citation List

Patent Literature

[0004] Patent Literature 1: Japanese Unexamined Patent Application Publication No. 3-186166

Summary of Invention

Technical Problem

[0005] In Patent Literature 1, the two pressure equalizers are joined to the container. Thus, refrigerant may leak from part of each of the pressure equalizers that is joined to the container by welding.

[0006] Also, in Patent Literature 1, the liquid-level detection device is externally connected to the container. Inevitably, the space for providing the components is large. By contrast, in a configuration in which a liquid-level detection device is provided in a container, the space for providing the components is not increased. However, the configuration needs to be designed such that detection is not affected by the undulation of a liquid surface that is caused by the momentum of a gas-liquid

refrigerant mixture that flows into an accumulator from the outside.

[0007] The present disclosure is applied to solve the above problems, and relates to an accumulator and a refrigeration cycle apparatus that can stably detect the level of a liquid surface because of provision of a configuration in which the number of joints between a container and a liquid-level detection device is reduced, to thereby reduce the possibility of a refrigerant leak occurring, and the effect of undulation of a liquid surface is reduced.

Solution to Problem

[0008] An accumulator according to an embodiment of the present disclosure includes a container and a liquid-level detection device. The liquid-level detection device penetrates an upper portion of the container, is joined to the container, and extends in a direction along the height of the container. The liquid-level detection device includes a sensor unit and a protecting tube. The sensor unit includes a float that rises and lowers in accordance with upward and downward movement of a liquid surface of liquid refrigerant accumulated in the container, and detects a position of the liquid surface, using the float. The protecting tube protects the float, and is provided to surround the sensor unit.

Advantageous Effects of Invention

[0009] According to an embodiment of the present disclosure, the liquid-level detection device and the container are joined together at a single location. Thus, the number of joints can be minimized, thus reducing the possibility of refrigerant leaking from such a joint. Furthermore, since the protecting tube that protects the float is provided, it is possible to reduce the influence of undulation of a liquid surface, and stably detect the level of the liquid surface.

Brief Description of Drawings

[0010]

[Fig. 1] Fig. 1 is a perspective view of an accumulator 1 according to Embodiment 1.

[Fig. 2] Fig. 2 is a sectional view of the accumulator 1 according to Embodiment 1, illustrating the internal configuration of the accumulator 1.

[Fig. 3] Fig. 3 is an enlarged view of an upper portion of the accumulator 1 according to Embodiment 1.

[Fig. 4] Fig. 4 is a sectional view of a liquid-level detection device 5 in the accumulator 1 according to Embodiment 1.

[Fig. 5] Fig. 5 is an explanatory view for an operation of the liquid-level detection device 5 of the accumulator 1 according to Embodiment 1.

[Fig. 6] Fig. 6 illustrates a comparative example.

[Fig. 7] Fig. 7 illustrates a refrigerant circuit of a re-

frigeration cycle apparatus including the accumulator according to Embodiment 1.

[Fig. 8] Fig. 8 is a sectional view of the liquid-level detection device 5 of the accumulator 1 according to Embodiment 2.

[Fig. 9] Fig. 9 is a sectional view indicating a positional relationship between components in a sensor unit 10 of the liquid-level detection device 5 of the accumulator 1 according to Embodiment 2.

Description of Embodiments

[0011] Embodiments of an accumulator 1 will be described with reference to the drawings. It should be noted that in the drawings, the configuration as illustrated in each of the figures is merely an example, that is, the actual configurations are not limited to the configurations as illustrated in the figures. In each of the figures, components that are the same as or equivalent to those of a previous figure or figures are denoted by the same reference signs. The same is true of the entire text of the specification. Furthermore, in the figures, the relationship between components may be different from an actual one.

Embodiment 1

[Configuration of Accumulator 1]

[0012] Fig. 1 is a perspective view of the accumulator 1 according to Embodiment 1. Fig. 2 is a sectional view of an internal configuration of the accumulator 1 according to Embodiment 1.

[0013] The accumulator 1 includes a vertically elongated container 2, an inlet pipe 3 that allows refrigerant to flow into the container 2, an outlet pipe 4 that allows refrigerant to flow out of the container 2, and a liquid-level detection device 5 that detects the position of the liquid surface of liquid refrigerant that is accumulated in the container 2.

[0014] The liquid-level detection device 5 is inserted into the container 2 in such a manner as to penetrate an upper portion of the container 2 and such that the liquid-level detection device 5 extends in a direction along the height of the container 2. The liquid-level detection device 5 is joined to the container 2 by welding, with a nipple 6 interposed between the liquid-level detection device 5 and the container 2. In such a manner, the liquid-level detection device 5 is joined to the container 2 at a single position where the nipple 6 is located. In the joint between the liquid-level detection device 5 and the container 2, it is possible to give likelihood to the level of each of contacts 12 and 13 of the liquid-level detection device 5. Furthermore, the liquid-level detection device 5 may be screwed into the container 2 as long as it is ensured that liquid-level detection device 5 is airtightly joined to the container 2.

[0015] Fig. 3 is an enlarged view of an upper portion

of the accumulator 1 according to Embodiment 1, which also illustrates the liquid-level detection device 5 in detail in a partial cut-away view. Fig. 4 is a sectional view of the liquid-level detection device 5 of the accumulator 1 according to Embodiment 1. Fig. 5 is an explanatory view for an operation of the liquid-level detection device 5 of the accumulator 1 according to Embodiment 1.

[0016] The liquid-level detection device 5 includes a sensor unit 10 that detects the position of a liquid surface by use of a float 14, and a protecting tube 20 that is provided in such a manner as to surround the sensor unit 10 and that protects the float 14. The sensor unit 10 includes contacts 12 and 13, a containment tube 11 that extends in the direction along the height of the container 2 and houses the contacts 12 and 13, and the float 14 that has an annular shape and rises and lowers in the protecting tube 20 in accordance with the movement of the liquid surface of liquid refrigerant accumulated in the container 2.

[0017] The containment tube 11 is made of a non-magnetic material. The containment tube 11 penetrates the float 14, and supports upward and downward movement of the float 14. In the float 14, a magnet 15 is embedded to turn on and off the contacts 12 and 13.

[0018] Each of the contacts 12 and 13 is, for example, a reed switch. The contacts 12 and 13 are connected by a wire 16, and provided at different levels in the containment tube 11. The contacts 12 and 13 are each turned on by the magnet 15, and the position of the liquid surface is detected based on a signal supplied from each of the contacts 12 and 13. The contact 12 is provided at a position corresponding to a maximum liquid surface level that is set for the purpose of preventing occurrence of liquid compression in the compressor (not illustrated) that would occur when excess liquid refrigerant accumulated in the container 2 flows from the container 2 into the compressor. The contact 13 is provided at a position corresponding to an optimum liquid surface level that is set for the purpose of preventing seizure and damage of the compressor that would occur because of a shortage of oil that is returned along with refrigerant from the accumulator 1 to the compressor. The positions and number of contacts to be provided are not limited to those described above, but are arbitrary.

[0019] A characteristic configuration of Embodiment 1 resides in provision of the protecting tube 20 that protects the sensor unit 10. The protecting tube 20 will be described.

[0020] The protecting tube 20 is a tube that extends in the direction along the height of the container 2, and is provided around an outer periphery of the sensor unit 10 to protect the sensor unit 10. The protecting tube 20 serves not only to protect the sensor unit 10 but also to stabilize the action of the float 14 by preventing the float 14 from unstably acting due to the undulation of the liquid surface in the container 2.

[0021] In a lower portion and an upper portion of a side surface of the protecting tube 20, a lower hole 17 and an

upper hole 18 are provided, respectively. Thus, refrigerant flows from the lower hole 17 into the protecting tube 20, and a stable liquid surface is maintained in the protecting tube 20. In other words, even if a liquid surface 30 (see Fig. 5) undulates in the container 2, a stable liquid surface 19 (see Fig. 5) is maintained in the protecting tube 20. The upper hole 18 is provided for degassing. Refrigerant that has gasified in the protecting tube 20 is caused to flow out from the upper hole 18 to the outside of the protecting tube 20. The lower hole 17 and the upper hole 18 are formed to have dimensions that are determined depending on the rate of refrigerant that flows into the protecting tube 20.

[0022] A lower end portion and an upper end portion of the protecting tube 20 are provided as a lower narrow portion 21 and an upper narrow portion 22, respectively, which are formed to have a smaller dimension than other portions. The lower narrow portion 21 is used as a space that is capable of keeps floating matter accumulated in the protecting tube 20 remaining in the space. An accumulated foreign matter 23 remains in the above space, and can thus be prevented from catching the float 14. The level of the lower hole 17 is set also in consideration of the amount of foreign matter 23 that is accumulated in the lower narrow portion 21 of the protecting tube 20. To be more specific, the level of the lower hole 17 is set such that the volume of part of the protecting tube 20 that is located below the lower hole 17 is greater than or equal to the volume of the accumulated foreign matter 23 that is expected to accumulate. Because of this setting, it is possible to prevent the lower hole 17 from being closed by the accumulated foreign matter 23.

[0023] The upper and lower narrow portions 22 and 21 of the protecting tube 20 support upper and lower end portions of the containment tube 11, respectively. More specifically, the upper narrow portion 22 supports an upper end portion 11b of the containment tube 11 because of welding connection, and the lower narrow portion 21 supports a lower end portion 11a of the containment tube 11, with a gap 21a interposed between the lower narrow portion 21 and the lower end portion 11a. The way of joining the upper narrow portion 22 of the protecting tube 20 and the upper end portion of the containment tube 11 is not limited to welding. It is possible to give likelihood to each of the contacts 12 and 13 of the sensor unit 10. Also, the upper end portion of the containment tube 11 may be screwed into the upper narrow portion 22 as long as the upper end portion of the containment tube 11 is airtightly joined to the upper narrow portion 22.

[0024] In the liquid-level detection device 5 having the above configuration, the float 14 of the sensor unit 10 floats on the liquid surface 19 in the protecting tube 20 as illustrated in Fig. 5, and rises or lowers depending on an increase 31 or a decrease 32 of the level of the liquid surface 19. When the level of the float 14 reaches the level of the contact 12 or the contact 13, one of the contacts that is located at the same level as the float 14 is turned on by the magnet 15, whereas the other of the

contacts that is located at a different level from the level of the float 14 is turned off. The level of the liquid surface is detected based on a signal supplied from the contact turned on.

[0025] A function of the protecting tube 20 will be described. First of all, as a comparative example, a configuration in which no protecting tube 20 is provided will be described.

[0026] Fig. 6 illustrates the comparative example.

[0027] In the case where no protecting tube 20 is provided as illustrated in Fig. 6, the momentum of a gas-liquid refrigerant mixture that flows into the container 2 from the outside causes the liquid surface 30 to undulate, thereby causing the float 14 to rise and lower. Consequently, it is not possible to accurately detect the position of the liquid surface 30. When the float 14 is located at the same level as a contact (not illustrated), the float 14 rises and lowers due to the undulation of the liquid surface 30, as a result of which the contact to be turned on and off repeatedly. This may cause occurrence of a failure in the contact or other unfavorable conditions.

[0028] By contrast, in Embodiment 1, because of provision of the protecting tube 20 that protects the sensor unit 10, the float 14 of the sensor unit 10 floats on the liquid surface 19 in the protecting tube 20, which is stable, without being directly affected by the undulation of refrigerant in the container 2. It is therefore possible to accurately detect the position of the liquid surface.

[0029] In the comparative example as illustrated in Fig. 6, although the upper end portion 11b of the containment tube 11 that houses contacts is joined and secured to the container 2, the lower end portion 11a is free. Consequently, the undulation of the liquid surface 30 may cause the containment tube 11 to vibrate, with the joint in the upper end portion 11b acting as a pivot, as a result of which the joint may be damaged.

[0030] By contrast, in Embodiment 1, the upper narrow portion 22 of the protecting tube 20 supports the upper end portion 11b of the containment tube 11 because of welding connection, whereas the lower narrow portion 21 supports the lower end portion 11a of the containment tube 11, with the gap 21a interposed between the lower narrow portion 21 and the lower end portion 11a. Because of this configuration, even if part of the containment tube 11 that protrudes downward from the lower narrow portion 21 is vibrated by undulation of the liquid surface in the container 2, the range of the vibration is limited to the width of the gap 21a and is thus small. It is therefore possible to soften vibration of the joint at the upper end portion 11b of the containment tube 11, thereby preventing the joint from being damaged or broken. It should be noted that in Embodiment 1, the size of the gap 21a is, for example, 0.05 to 0.35 mm. However, the size of the gap 21a is not limited to the above size, and may be determined in consideration of the level of vibration, the workability for assembly, and processability.

[0031] The accumulator 1 according to Embodiment 1 as configured as described above is included in a refig-

eration cycle apparatus as illustrated in Fig. 7.

[0032] Fig. 7 illustrates a refrigerant circuit of a refrigeration cycle apparatus including the accumulator according to Embodiment 1.

[0033] A refrigeration cycle apparatus 60 includes the accumulator 1, a compressor 61, a condenser 62, a pressure reducing device 63 such as an expansion valve, and an evaporator 64.

[0034] An operation of the refrigerant circuit will be described. Also, examples of an operation of the liquid-level detection device 5 and of a control of the compressor 61 will be described in conjunction with the operation of the refrigerant circuit.

[0035] In the refrigerant circuit, when the compressor 61 is driven, a cycle is repeated in which refrigerant flows through the condenser 62, the pressure reducing device 63, the evaporator 64, and the accumulator 1 in this order, and then returns to the compressor 61. When the compressor 61 is rotated at a high speed, a large amount of refrigerant flows in the refrigerant circuit, and the refrigerant starts to temporarily accumulate in the accumulator 1.

[0036] As liquid refrigerant starts to accumulate in the accumulator 1 during this cycle, the float 14 rises depending on the level of the liquid surface of the liquid refrigerant. As a result, the upper contact, that is, the contact 12, is tuned on by the magnet 15 embedded in the float 14, and the position of the liquid surface is detected based on a signal supplied from the contact 12.

[0037] As described above, the contact 12 is provided at the maximum liquid surface level. Accordingly, when the contact 12 is turned on, the rotation speed of the compressor 61 is controlled to be changed from a high speed to a low speed, to thereby cause the liquid surface 19 to lower. As a result, it is possible to prevent the compressor 61 from being damaged due to liquid compression that would be caused when liquid refrigerant excessively flows into the compressor 61.

[0038] Furthermore, the contact 13 is provided at the minimum liquid surface level. Therefore, when the liquid surface 19 lowers and the contact 13 is turned on, the rotation speed of the compressor 61 is controlled to be changed from a low speed to a high speed, thereby causing the liquid surface in the accumulator 1 to rise. Because of this control, it is possible to prevent shortage of oil that is returned to the compressor, and thus prevent occurrence of seizure of the compressor that would be caused by shortage of the returned oil, and also prevent the compressor from being damaged.

[0039] In such a manner, in the case where the contacts 12 and 13 are provided at the maximum liquid surface level and the minimum liquid surface level, respectively, it is possible to prevent the compressor 61 from being damaged, by applying the result of liquid level detection to the control of the compressor 61.

Advantageous Effects

[0040] As described above, in Embodiment 1, the container 2 and the liquid-level detection device 5 are provided. The liquid-level detection device 5 penetrates the upper portion of the container 2, and is joined to the container 2. The liquid-level detection device 5 extends in the direction along the height of the container 2. The liquid-level detection device 5 includes the sensor unit 10 and the protecting tube 20. The sensor unit 10 includes the float 14 that rises and lowers in accordance with upward and downward movement of the liquid surface of liquid refrigerant accumulated in the container 2. The sensor unit 10 detects the position of the liquid surface using the float 14. The protecting tube 20 is provided to surround the sensor unit 10, and protects the float 14.

[0041] As described above, the liquid-level detection device 5 and the container 2 are joined to each other at a single location. The number of joints can thus be minimized and is smaller than that in an existing accumulator that requires two joints. It is therefore possible to minimize leakage of refrigerant from such a joint. It should be noted that the liquid-level detection device 5 and the container 2 may be joined to each other by welding or the liquid-level detection device 5 may be screwed into the container 2. In the case where the liquid-level detection device 5 is screwed into the container 2, even if a failure occurs in the sensor unit 10 of the liquid-level detection device 5, the sensor unit 10 can be easily replaced by a new one.

[0042] In Embodiment 1, since the protecting tube 20 is provided to protect the sensor unit 10, the float 14 is not directly affected by the undulation of refrigerant in the accumulator 1, and can thus stably rise and lower. It is therefore possible to accurately detect the position of the liquid surface.

[0043] In Embodiment 1, the sensor unit 10 includes the magnet 15 that is embedded in the float 14, the contacts that are each turned on and off by the magnet 15, and the containment tube 11 that penetrates the float 14 having an annular shape, extends in the direction along the height of the container 2, and houses the contacts 12 and 13. The protecting tube 20 has the upper narrow portion 22 and the lower narrow portion 21 that have a smaller inside diameter, are provided at upper and lower end portions of the protecting tube 20, respectively, and also support the upper and lower end portions of the containment tube 11, respectively.

[0044] As described above, since the upper and lower narrow portions 22 and 21 of the protecting tube 20 support the upper and lower end portions of the containment tube 11, respectively, vibration of the containment tube 11 can thus be reduced, as compared with the existing accumulator in which the lower end portion 11a of the containment tube 11 is not supported but free. It is therefore possible to reduce vibration of the containment tube 11 that occurs during transportation of the accumulator or due to undulation of refrigerant in the accumulator 1,

and that may damage the containment tube 11. Furthermore, the lower narrow portion 21 is used as a space that is capable of keeping remaining in the space, foreign matter 23 accumulated in the protecting tube 20. Since the accumulated foreign matter 23 remains in the space, it is possible to prevent the float 14 from being caught by the accumulated foreign matter 23.

[0045] In Embodiment 1, the protecting tube 20 has the lower hole 17 that allows liquid refrigerant collected in the container 2 to flow into the protecting tube 20, and the upper hole 18 that allows gas filled in the protecting tube 20 to flow out from the protecting tube 20.

[0046] Thus, liquid refrigerant flows into the protecting tube 20 from the lower hole 17, and gas filled in the protecting tube 20 is caused to flow out from the upper hole 18. Because of provision of the lower hole 17 and the upper hole 18 as described above, it is possible to stably detect the level of refrigerant.

[0047] In Embodiment 1, the level of the lower hole 17 is set such that the volume of part of the protecting tube 20 that is located below the lower hole 17 is greater than or equal to the volume of foreign matter 23 that is expected to be accumulated in the protecting tube 20.

[0048] Because of the above configuration, it is possible to prevent the lower hole 17 from being closed by the accumulated foreign matter 23.

[0049] In Embodiment 1, the accumulator 1, the compressor 61, the condenser 62, the pressure reducing device 63, and the evaporator 64 form the refrigeration cycle apparatus 60. The refrigeration cycle apparatus 60 can be applied to, for example, as an air-conditioning apparatus or a refrigerator-freezer.

Embodiment 2

[0050] In a configuration according to Embodiment 2, the soundness of the liquid-level detection device 5 can be checked. An accumulator 1 according to Embodiment 2 is similar in basic configuration to the accumulator according to Embodiment 1. Embodiment 2 will be described mainly by referring to additional features not provided in Embodiment 1.

[0051] Before shipment of each of accumulators 1, the soundness of the liquid-level detection device 5 is checked. To be more specific, before that shipment, the following items are checked: the reliability of detecting operation, such as whether each of the contacts 12 and 13 is turned on by the magnet 15 or not, and the correctness of the set positions, that is, whether each of the contacts 12 and 13 is set at a correct position. Embodiment 2 relates to a technique that is suitable for checking of the soundness of the liquid-level detection device in the above items. This will be more specifically described.

[Configuration of Liquid-Level Detection Device 5]

[0052] Fig. 8 is a sectional view of the liquid-level detection device 5 of the accumulator 1 according to Em-

bodiment 2. Fig. 9 is a sectional view of the sensor unit 10 of the liquid-level detection device 5 of the accumulator 1 according to Embodiment 2, which indicates a positional relationship between components in the sensor unit 10.

[0053] Embodiment 2 is different from Embodiment 1 in the configuration of the liquid-level detection device 5. The liquid-level detection device 5 according to Embodiment 2 includes a detection-rod insertion tube 40 that penetrates the float 14, that extends in the direction along the height of the container 2, and that houses the containment tube 11. In the detection-rod insertion tube 40, a space 42 is provided between the detection-rod insertion tube 40 and the containment tube 11 provided in the detection-rod insertion tube 40. The space 42 is a space into which a detection rod 41 is to be inserted. A magnet 43 is attached to a tip of the detection rod 41 in a direction where the detection rod 41 is inserted, that is, the magnet 43 is attached to a lower end of the detection rod 41. The other configurations of Embodiment 2 are similar to those of Embodiment 1.

(Checking of Detecting Operation)

[0054] If the detecting operation of each of the contacts is checked without using the detection rod 41, the float 14 is moved to the position of each of the contacts 12 and 13 and it is checked whether each of these contacts is turned on or not. As the way of moving the float 14 to the position of each of the contacts 12 and 13, it is conceivable that the container 2 itself is turned upside down. This, however, is heavy work in the case where the accumulator 1 is heavy, and it is hard to ensure safety. It is therefore hard to check the detection operation.

[0055] By contrast, in Embodiment 2, whether the detection operation of each of the contacts 12 and 13 can be checked by inserting the detection rod 41 from a top opening 40a of the detection-rod insertion tube 40. That is, when the magnet 43 attached at the lower end of the detection rod 41 reaches the level of each of the contacts 12 and 13, each of the contacts 12 and 13 is turned on by the magnet 43. According to this method, it is possible to check the soundness of the operation of each of the contacts 12 and 13 without turning the accumulator 1 upside down. It is preferable that such an operation check be performed not only before the shipment, but also after installation of a product. In Embodiment 2, the operation check can be performed not only before the shipment, but also after the setting time of the product, simply by inserting the detection rod 41 into the detection-rod insertion tube 40.

(Checking of Set Position)

[0056] In order to check the position where each of the contacts 12 and 13 is set, a mark is put on the detection rod 41 in advance. More specifically, a mark that indicates the position of the detection rod 41 in a state in which

the detection rod 41 is inserted into the detection-rod insertion tube 40 and the magnet 43 reaches a regular level of the contact 12 is put on the detection rod 41 in advance. The same is true of the contact 13. Then, when the detection rod 41 is inserted into the detection-rod insertion tube 40 until the detection rod 41 reaches the position where the mark is put, if an associated contact is activated at this time, it can be determined that the level of the contact is correct. The result of checking of the set position of the contact can be indicated not only before the above shipment, but also installation of the product, simply by inserting the detection rod 41 into the detection-rod insertion tube 40.

[Advantageous Effects]

[0057] As described above, according to Embodiment 2, in addition to the same advantages as in Embodiment 1, it is possible to obtain the following advantages. In Embodiment 2, the detection-rod insertion tube 40 is provided. The detection-rod insertion tube 40 penetrates the float 14, extends in the direction along the height of the container 2, and houses the containment tube 11. The detection-rod insertion tube 40 and the containment tube 11 housed in in the detection-rod insertion tube 40 define the space 42. The space 42 is a space into which the detection rod 41 is to be inserted.

[0058] By virtue of the above configuration, the operation of each of the contacts 12 and 13 can be checked simply by inserting the detection rod 41 including the magnet 43 into the detection-rod insertion tube 40. Thus, it is not necessary to turn the accumulator 1 upside down. Accordingly, the checking operation can be more easily performed and the accuracy of detection can be improved. In addition, the checking operation can be performed not only before shipment of products, but also installation of products. Therefore, after installation of a product, even if a failure is suspected to occur in each of the contacts 12 and 13, it is possible to easily check whether a failure occurs in each of the contacts 12 and 13 or not.

[0059] The accumulator 1 according to Embodiment 2 can be applied to the refrigeration cycle apparatus 60 as illustrated in Fig. 7, as in Embodiment 1.

[0060] According to Embodiment 2, it is possible to improve the accuracy of checking the level of the set liquid-level detection device 5 for the container 2; and improve the ease of checking the soundness of each contact before shipment of the product and after installation of the product. That is, it is possible to satisfy the above most important requirements.

[0061] Although the above descriptions are made regarding Embodiments 1 and 2, they are not limiting. For example, it is also possible to put the whole or part of each of the embodiments into practical use.

Reference Signs List

[0062] 1: accumulator, 2: container, 3: inlet pipe, 4: outlet pipe, 5: liquid-level detection device, 6: nipple, 10: sensor unit, 11: containment tube, 11a: lower end portion, 11b: upper end portion, 12: contact, 13: contact, 14: float, 15: magnet, 16: wire, 17: lower hole, 18: upper hole, 19: liquid surface, 20: protecting tube, 21: lower narrow portion, 21a: gap, 22: upper narrow portion, 23: accumulated foreign matter, 30: liquid surface, 31: increase, 32: decrease, 40: detection-rod insertion tube, 40a: top opening, 41: detection rod, 42: space, 43: magnet, 60: refrigeration cycle apparatus, 61: compressor, 62: condenser, 63: pressure reducing device, 64: evaporator

Claims

1. An accumulator comprising:

a container; and
a liquid-level detection device that penetrates an upper portion of the container, that is joined to the container, and that extends in a direction along a height of the container, wherein the liquid-level detection device includes

a sensor unit that includes a float that rises and lowers in accordance with upward and downward movement of a liquid surface of liquid refrigerant accumulated in the container, the sensor unit being configured to detect a position of the liquid surface, using the float, and
a protecting tube that protects the float, and is provided to surround the sensor unit.

2. The accumulator of claim 1,

wherein the sensor unit includes

a magnet that is embedded in the float,
a contact configured to be turned on/off by the magnet, and
a containment tube that houses the contact, that penetrates the float having an annular shape, and that extends in the direction along the height of the container, and

wherein the protecting tube has an upper narrow portion and a lower narrow portion that have a smaller inside diameter, that are provided in upper and lower end portions of the protecting tube, respectively, and that support an upper end portion and a lower end portion of the containment tube, respectively.

3. The accumulator of claim 1 or 2, wherein the protecting tube has a lower hole and an upper hole for degassing, the lower hole allowing liquid refrigerant accumulated in the container to flow into the protecting tube, the upper hole allowing gas to flow out from an interior of the protecting tube to the outside of the protecting tube. 5
4. The accumulator of claim 3, wherein a level of the lower hole is set such that a volume of part of the protecting tube that is located below the lower hole is greater than or equal to a volume of an accumulated foreign matter that is expected to be accumulated in the protecting tube. 10 15
5. The accumulator of claim 3 or 4 as dependent on claim 2, comprising
- a detection-rod insertion tube that penetrates the float, that extends in the direction along the height of the container, and that contains the containment tube, 20
- wherein the detection-rod insertion tube defines a space between the detection-rod insertion tube and the containment tube contained in the detection-rod insertion tube, the space being a space into which a detection rod is to be inserted. 25
6. A refrigeration cycle apparatus comprising: the accumulator of any one of claims 1 to 5; a compressor; 30
- a condenser; a pressure reducing device; and an evaporator.

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FIG. 1

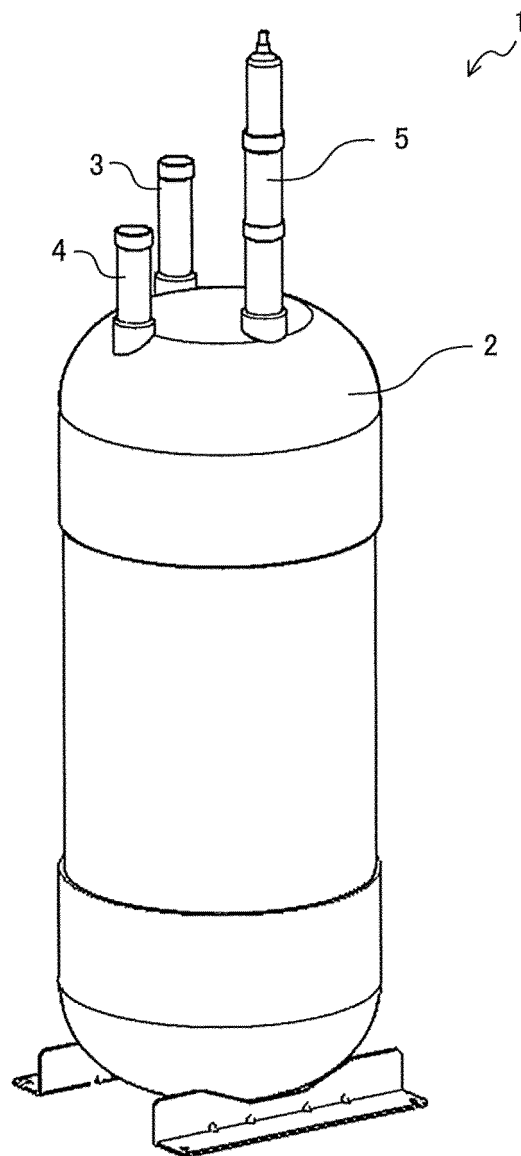


FIG. 2

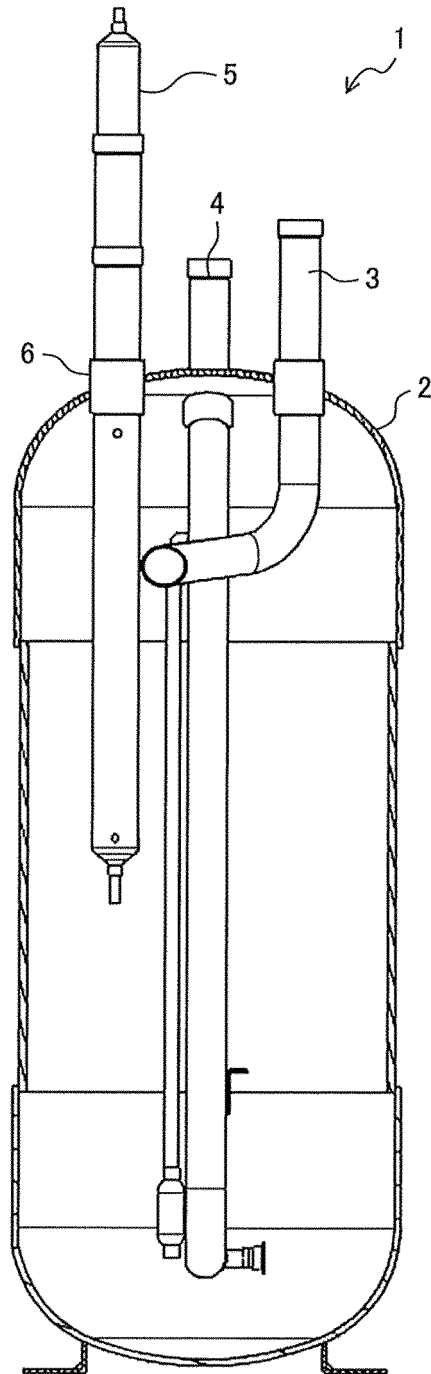


FIG. 3

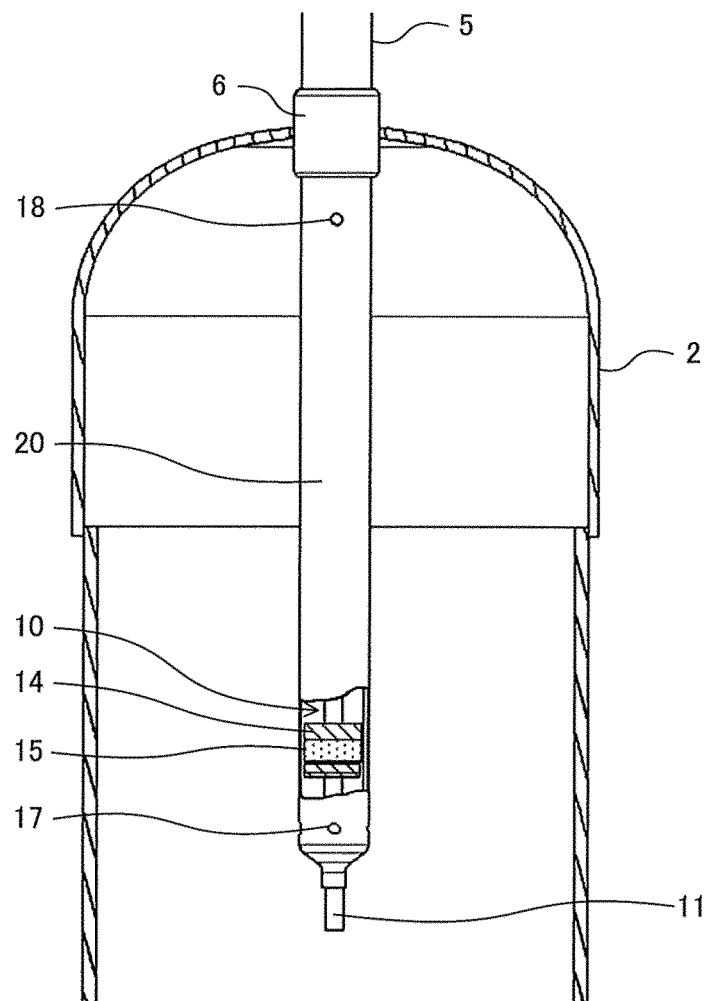


FIG. 4

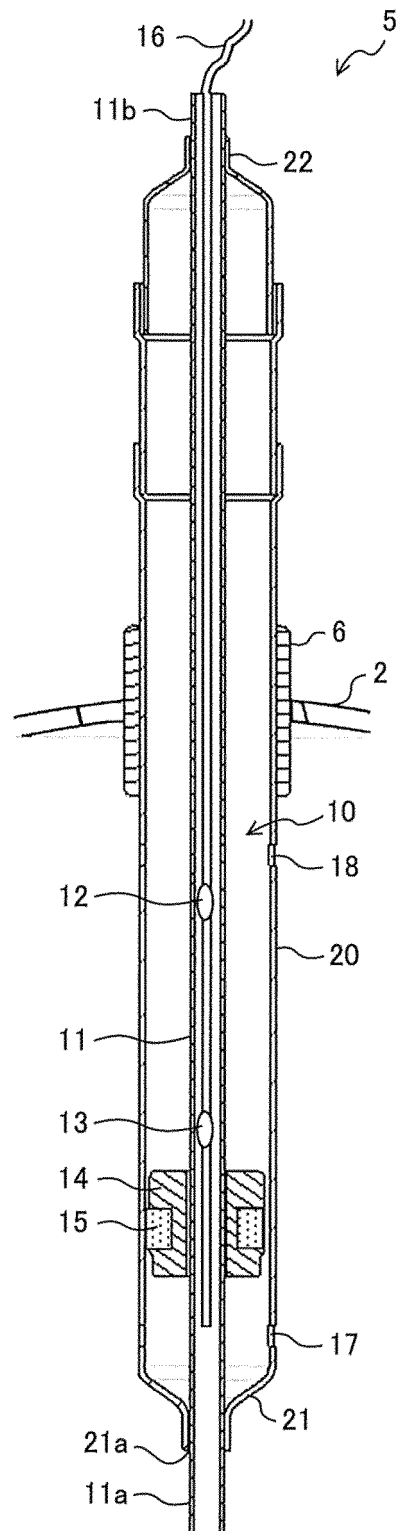


FIG. 5

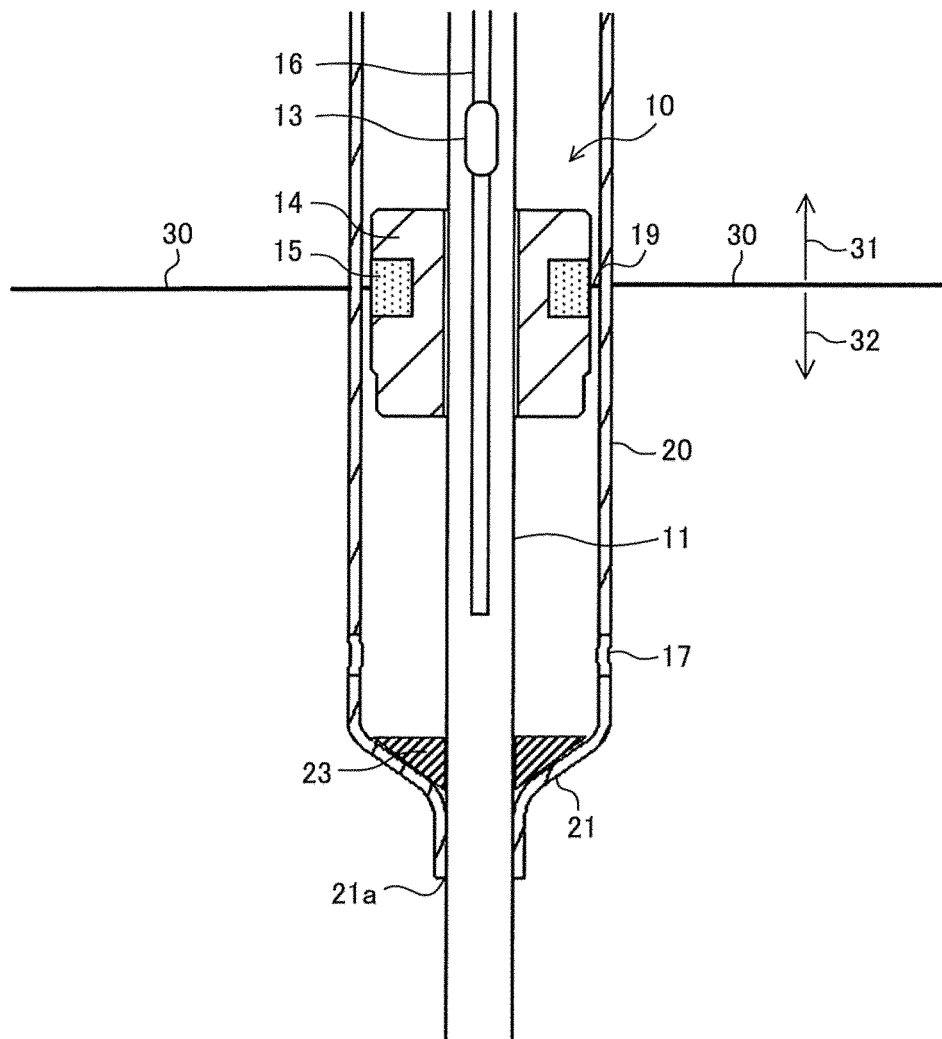


FIG. 6

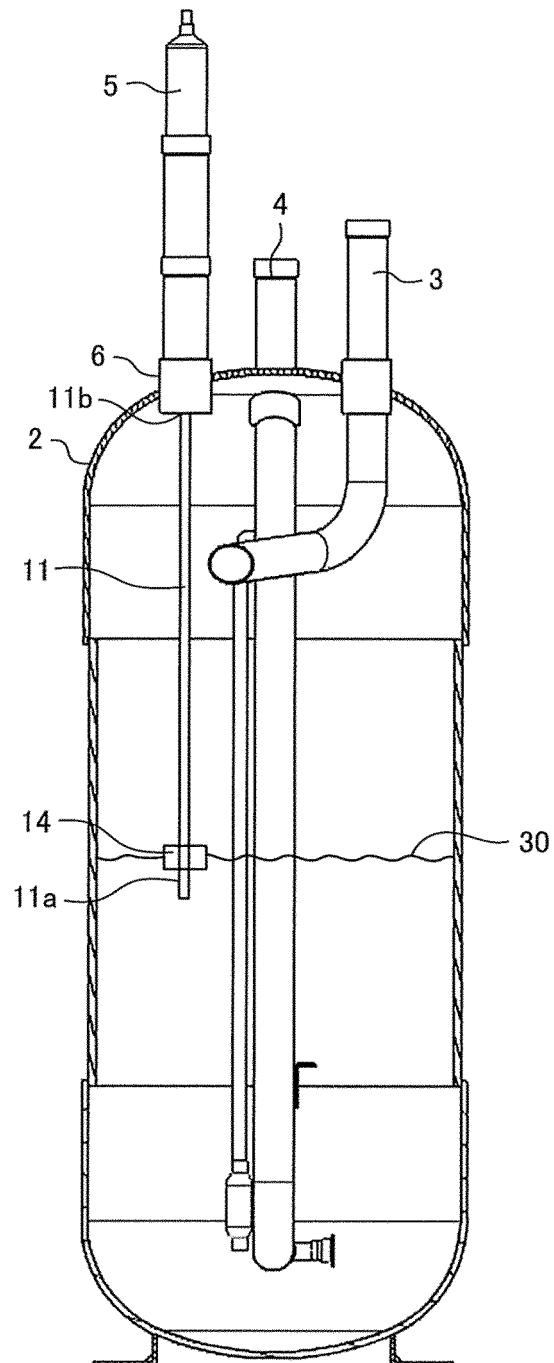


FIG. 7

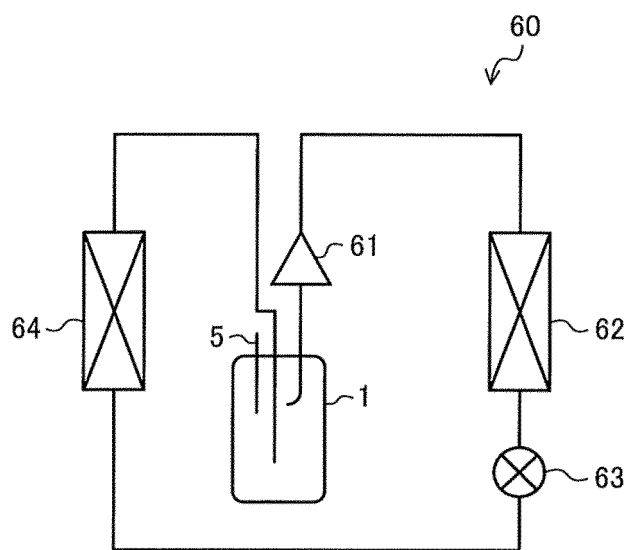


FIG. 8

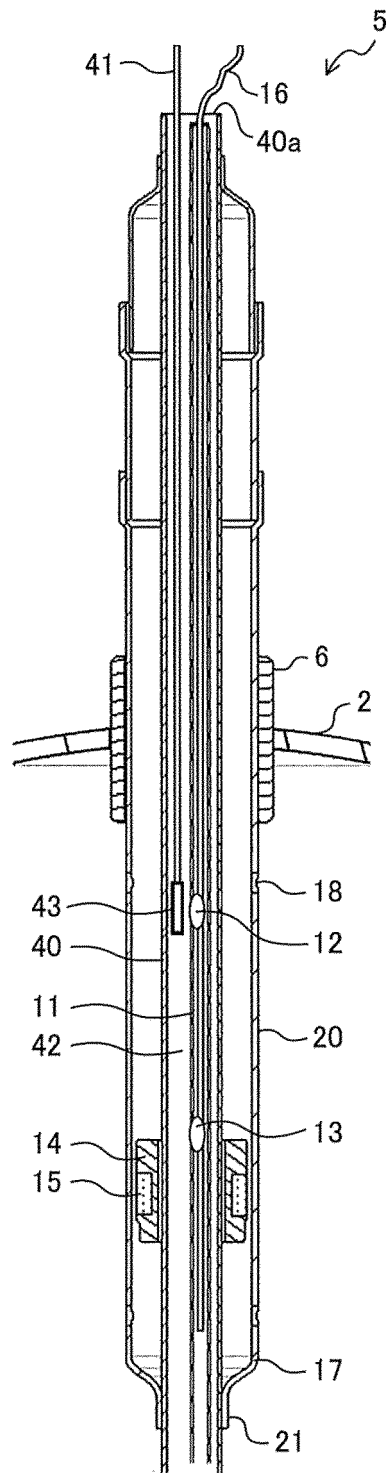
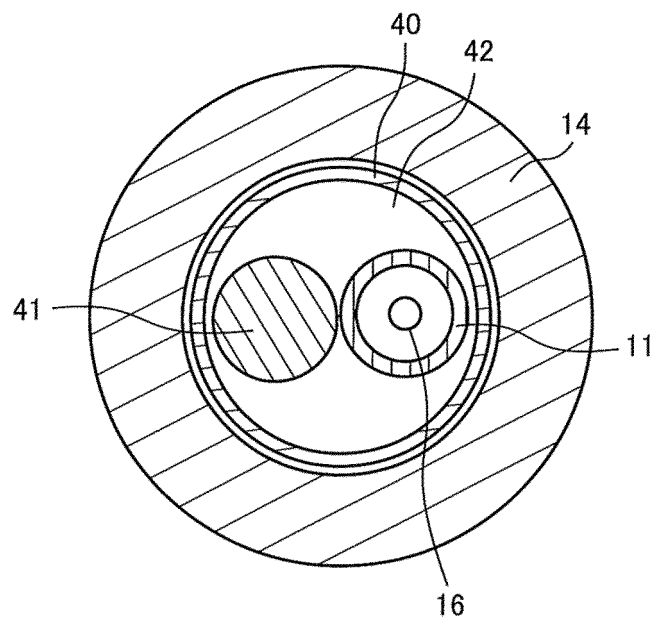


FIG. 9



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2019/011478

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl. F25B43/00 (2006.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int. Cl. F25B43/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2019
Registered utility model specifications of Japan 1996-2019
Published registered utility model applications of Japan 1994-2019

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2002-81801 A (MITSUBISHI ELECTRIC CORP.) 22	1, 3, 6
A	March 2002, paragraphs [0001]-[0040], fig. 1-7 (Family: none)	2, 4-5
Y	US 4972709 A (BAILEY, James R., Jr.) 27 November 1990, column 5, line 22 to column 7, line 16, fig. 1-7 & AU 4244789 A	1, 3, 6
Y	JP 8-284223 A (HOSHIZAKI ELECTRIC CO., LTD.) 29 October 1996, paragraphs [0014], [0015], [0018], fig. 1 (Family: none)	1, 3, 6
A	JP 47-387 Y1 (TOKYO SHIBAURA ELECTRIC CO., LTD.) 08 January 1972, column 1, line 20 to column 4, line 17, fig. 1-3 (Family: none)	1-6



Further documents are listed in the continuation of Box C.



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Date of the actual completion of the international search
08.04.2019

Date of mailing of the international search report
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INTERNATIONAL SEARCH REPORT

International application No.
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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2002-156274 A (MITSUBISHI ELECTRIC CORP.) 31 May 2002, paragraphs [0001]-[0049], fig. 1-7 (Family: none)	1-6
A	US 5076066 A (BOTTUM, Edward W.) 31 December 1991, column 1, line 6 to column 5, line 20, fig. 1-6 (Family: none)	1-6

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 3186166 A [0004]