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(54) Title: WATER-LEVEL DETECTION DEVICE AND WASHER WITH WATER-LEVEL DETECTION DEVICE

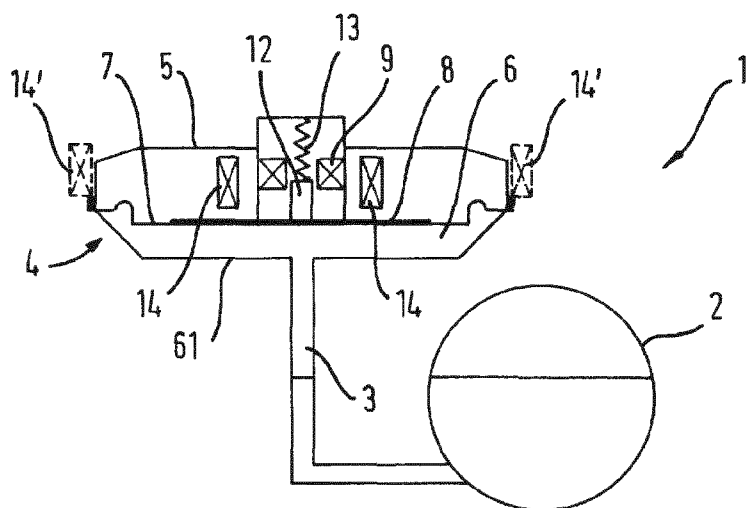


Fig. 1

(57) Abstract: The present invention discloses a water-level detection device, which includes: a housing (5); an air passage (3) connected to the housing (5); an air chamber (6) within the housing (5) and connected to the air passage (3); a partition board (8) within the housing (5) and capable of reciprocating based on a pressure change of the air chamber (6); an inductor (9) constituting a part of a resonant circuit (10); and a magnetic core (12) supported on the partition board (8) and capable of moving with movement of the partition board (8) to cause a frequency change of the resonant circuit (10) to which the inductor (9) is connected; a magnetic shield (14, 14') disposed around the inductor (9). As the magnetic shield (14, 14') is disposed outside the inductor (9), interference of metal parts for the water-level detection device is reduced, thereby improving detection precision. The present invention further discloses a washer (1) provided with the water-level detection device.

WATER-LEVEL DETECTION DEVICE AND WASHER WITH WATER-LEVEL DETECTION DEVICE

The present invention relates to a washer, and in particular, to parts of a washing
5 machine or a dishwasher, and further relates to a washer having such parts.

In order to control water consumption of a washer, for example, washing machines or
dishwashers, or perform other corresponding control according to the amount of water in
the washer, a detection device may often be disposed at an appropriated position in the
10 washer. A detection device used more commonly at present is a water-level detection
device. Document CN 102 560 976 A discloses in detail a structure and principle of such
a water-level detection device, which may serve as a reference for the present invention.

However, the thus known water-level detection device has the following defects: as a
15 washer often has various metal parts, especially metal housing, an output frequency of
the water-level detection device is easily interfered by the metal parts of the washer, so
that the detection result is biased, and finally errors occur in the control of the washer
based on the water-level detection result, thereby affecting the washing effect. It can be
seen from the first curve 100 in FIG. 3 of the attached drawing that the output frequency of
20 the existing water-level detection device varies to a larger extent as a distance to a metal
plate changes.

An objective of the present invention is to reduce or eliminate the influences gener-
ated by environmental factors on an output frequency of a water-level detection device.
25

With respect to the above objective, the present invention adopts a technical solution
as defined in the independent claims to a water-level detection device and a washer,
respectively. Preferred embodiments of the invention are defined independent claims, with
preferred embodiments of the water-level detection device corresponding to preferred
30 embodiments of the washer and vice versa even if not mentioned Preferred embodiments
are also apparent from the subsequent description and the attached drawing.

With respect to the above objective, the present invention adopts a technical solution as follows:

A water-level detection device including: a housing; an air passage connected to the housing; an air chamber within the housing and connected to the air passage; a partition
5 board within the housing and capable of reciprocating based on a pressure change of the air chamber; an inductor constituting a part of a resonant circuit; and a magnetic core supported on the partition board and capable of moving with movement of the partition board to cause a frequency change of the resonant circuit to which the inductor is connected; a magnetic shield being disposed around the inductor.

10 Preferably, the magnetic shield is in a sleeve-like structure with peripheral walls closed.

Preferably, the magnetic shield is disposed around an outer surface of the housing.
15 Such a structure makes assembly of the magnetic shield simple, so that small changes may be made based on the existing water-level detection device without re-designing an internal structure of the device, which saves cost.

Preferably, the magnetic shield forms at least a part of the housing.

20 Preferably, the partition board is mounted on a diaphragm constituting a part of walls of the air chamber and is elastically retractable.

Preferably, an edge of the diaphragm is connected to the housing.

25 Preferably, the inductor is disposed around a movement path of the magnetic core.

The other objective of the present invention is to improve detection precision of the washer for the water level. Based on the objective, the washer of the present invention
30 includes a controller and a liquid container, and the water-level detection device stated above is connected to the liquid container through the air passage.

In addition, the controller of the washer and the resonant circuit are such connected that the controller may determine a water level or a water level change of the liquid container according to a frequency of the resonant circuit.

- 5 The washer may be selected from a variety of machines using water to treat dirty objects, including a washing machine, a washer-dryer, a dishwasher and the like.

Compared with the prior art, as the magnetic shield is disposed outside the inductor, interference of metal parts for the water-level detection device is reduced, thereby
10 improving the detection precision. In terms of the washer using the water-level detection device in the present invention, due to improvement of the water-level detection precision, the washer may control more accurately, thereby obtaining an ideal washing effect, and appropriately lowering energy consumption of the washer at the same time.

- 15 Preferred embodiments of the invention are now explained in detail with reference to the attached drawing. In the drawing:

FIG. 1 is a schematic diagram of a washer provided with a water-level detection device (for the purpose of easy observation and understanding, only the water-level
20 detection device and a liquid container are displayed, and other components are omitted);

FIG. 2 is a circuit diagram of a connection between a resonant circuit in a water-level detection device and a controller of a washer; and

25

FIG. 3 is a curve of a change of frequencies output by different water-level detection devices relative to different distances from a metal plate obtained according to experiments.

- 30 As shown in FIG. 1, a washer 1 includes a liquid container 2, such as, an outer tub 2 of a washing machine. A bottom of the liquid container 2 is connected to a water-level detection device 4 through an air passage 3.

The water-level detection device 4 includes a housing 5. The housing is internally provided with an air chamber 6. The air chamber 6 is connected to fluids in the air passage 3 connected to the housing 5. The housing 5 is further provided with a diaphragm 7 with an edge connected to the housing. The diaphragm 7 constitutes a part of walls of the air chamber 6, and may be elastically retractable under a pressure action in the air chamber 6, away from or close to a bottom face 61 of the air chamber 6 opposite thereto. The diaphragm 7 is provided with a partition board 8. Then, the partition board 8 may reciprocate with a pressure change in the air chamber 6.

It can be seen in combination with FIG. 1 and FIG. 2 that, an upper part of the air chamber 6 is provided with an inductor 9, the inductor 9 and a capacitor as well as other ancillary electrical components constitute a resonant circuit 10. Output ends 10a and 10b of the resonant circuit 10 are connected to a controller 11 of the washer 1.

A magnetic core 12 is supported on the partition board 8, capable of moving with movement of the partition board 8. A reset spring 13 is disposed between a top of the magnetic core 12 and an inner wall of the housing 5. The magnetic core 12 passes through the inductor 9 along an axial movement path. The movement of the magnetic core 12 relative to the inductor 9 may change an output frequency of the resonant circuit 10 to which the inductor 9 is connected. The output frequency may be received by the controller 11, which thus determines a current water level or a water level change in the liquid container 2, and then performs corresponding control on the washer 1. Such control includes, but is not limited to, controlling a water inflow of the washer; deciding the amount of added detergent according to the water level; and determining the amount of water inflow in unit time according to the change of the water level.

A working principle of the water-level detection device 4 may be substantially described as follows: as the liquid container 2 is connected to the air passage 3, when a liquid is filled in the liquid container 2, a part of the liquid also enters the air passage 3, so as to seal the air chamber 6. As the water level in the liquid container 2 rises, pressure in the air chamber 6 gradually increases. Change of the pressure makes the diaphragm 7 stretch and expand, so as to make the partition board 8 move upward. The magnetic core 12 then moves upward in the inductor 9, which changes inductance of the inductor 9, and finally changes the output frequency of the resonant circuit 10. On the contrary, when the

water level in the liquid container 2 drops, the pressure in the air chamber 6 becomes small. Under the action of the reset spring 13, the magnetic core 12, the diaphragm 7 and the partition board 8 jointly move downward, to compress the air chamber 6. Due to the movement of the magnetic core 12, the output frequency of the resonant circuit 10 changes.

To reduce magnetic interference caused by environmental factors, in a first embodiment of the present invention, a magnetic shield 14 is disposed around an inductor 6 in the housing 5 of the water-level detection device 4.

To reduce the production and design costs, as a preferred alternative solution, in a second embodiment of the present invention, a magnetic shield 14' is disposed on an outer surface of the housing 5 of the water-level detection device 4.

As other alternative solutions, a magnetic shield may also be disposed in the housing 5 and on an outer surface thereof at the same time.

The magnetic shields 14 and 14' are in a sleeve-like structure with peripheral walls closed, to facilitate assembly and manufacturing. Certainly, based on the objective of the present invention, the magnetic shields 14 and 14' may also be in any other shapes and structures adapted for assembly.

In a third preferred embodiment, the magnetic shield forms at least a part of the housing 5. That is, at least a part of the housing 5 is directly made of a magnetic shielding material.

A first curve 100 in FIG. 3 shows a change of the frequency output by a previously known water-level detection device relative to different distances to the metal plate; a second curve 200 shows a change of the frequency output by the water-level detection device relative to different distances to the metal plate after sleeve-like magnetic shield with peripheral walls not closed is disposed outside the inductor of the water-level detection device; and a third curve 300 shows a change of the frequency output by the water-level detection device relative to different distances to the metal plate after sleeve-like magnetic shield with peripheral walls closed is disposed outside the inductor of the water-

level detection device. It can be seen by contrast between the three curves that, the output frequency of the previously known water-level detection device not provided with magnetic shields is easily interfered by surrounding metal parts; after non-closed sleeve-like magnetic shields are installed, interference is suppressed to a certain extent; and after
5 closed sleeve-like magnetic shields are installed, the output of the water-level detection device is almost free from the interference of external metals.

The above embodiments are merely preferred embodiments of the present invention, and the present invention may have many other embodiments. Equivalent variations
10 made by persons of ordinary skill in the art with respect to the present invention under teachings of the present invention shall still fall within the scope of the claims of the present invention.

CLAIMS

- 5 1. A water-level detection device, comprising:
a housing (5);
an air passage (3) connected to the housing (5);
an air chamber (6) within the housing (5) and connected to the air passage (3);
a partition board (8) within the housing (5) and capable of reciprocating based on a
10 pressure change of the air chamber (6);
an inductor (9) constituting a part of a resonant circuit (10); and
a magnetic core (12) supported on the partition board (8) and capable of moving with
movement of the partition board to cause a frequency change of the resonant circuit
(10) to which the inductor (9) is connected;
- 15 **characterized in that**
a magnetic shield (14, 14') is disposed around the inductor (9).
- 20 2. The water-level detection device according to claim 1, characterized in that the
magnetic shield (14, 14') is in a sleeve-like structure with peripheral walls closed.
3. The water-level detection device according to claim 1, characterized in that, the
magnetic shield (14, 14') is disposed around an outer surface of the housing (5).
- 25 4. The water-level detection device according to claim 1, characterized in that the
magnetic shield (14, 14') forms at least a part of the housing (5).
5. The water-level detection device according to claim 1, characterized in that the
partition board (8) is mounted on a diaphragm (7) constituting a part of walls of the air
chamber (6) and is elastically retractable.
- 30 6. The water-level detection device according to claim 5, characterized in that an
edge of the diaphragm (7) is connected to the housing (5).

7. The water-level detection device according to claim 1, characterized in that the inductor (9) is disposed around a movement path of the magnetic core (12).

5 8. A washer, comprising a controller (11) and a liquid container (2), characterized in that the water-level detection device (4) according to any one of the preceding claims is connected to the liquid container (2) through the air passage (3).

10 9. The washer according to claim 8, characterized in that the controller (11) and the resonant circuit (10) are such connected that the controller (11) may determine a water level or a water level change of the liquid container (2) according to a frequency of the resonant circuit (10).

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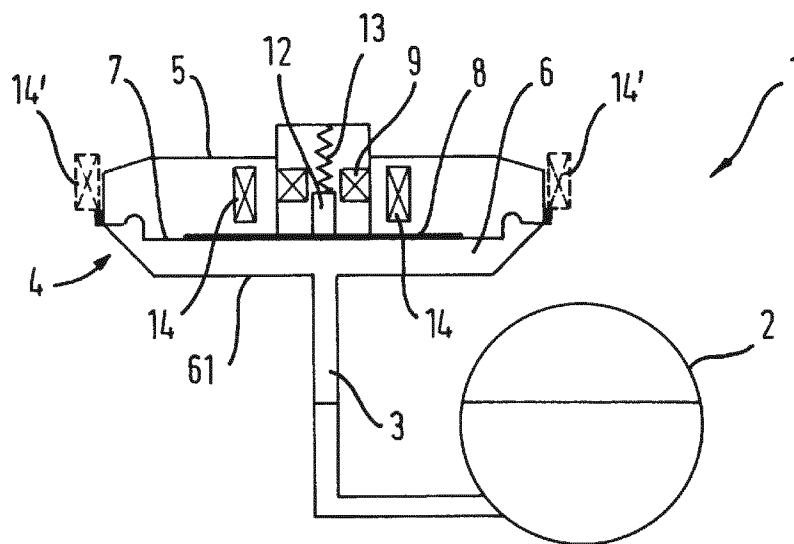


Fig. 1

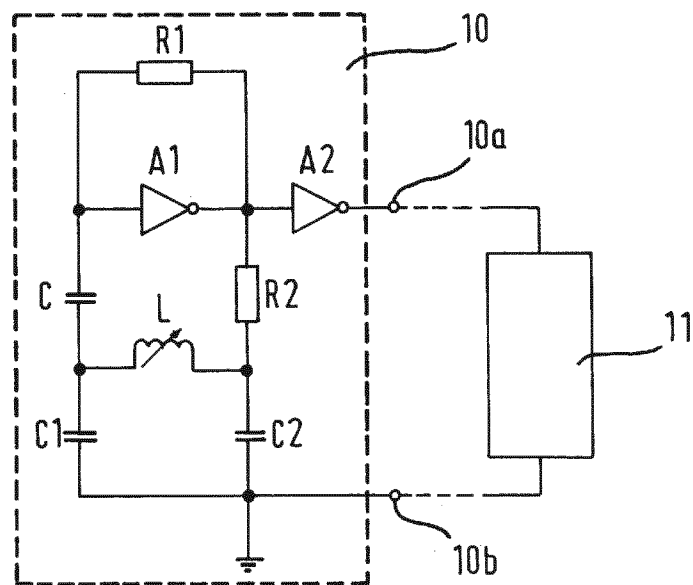
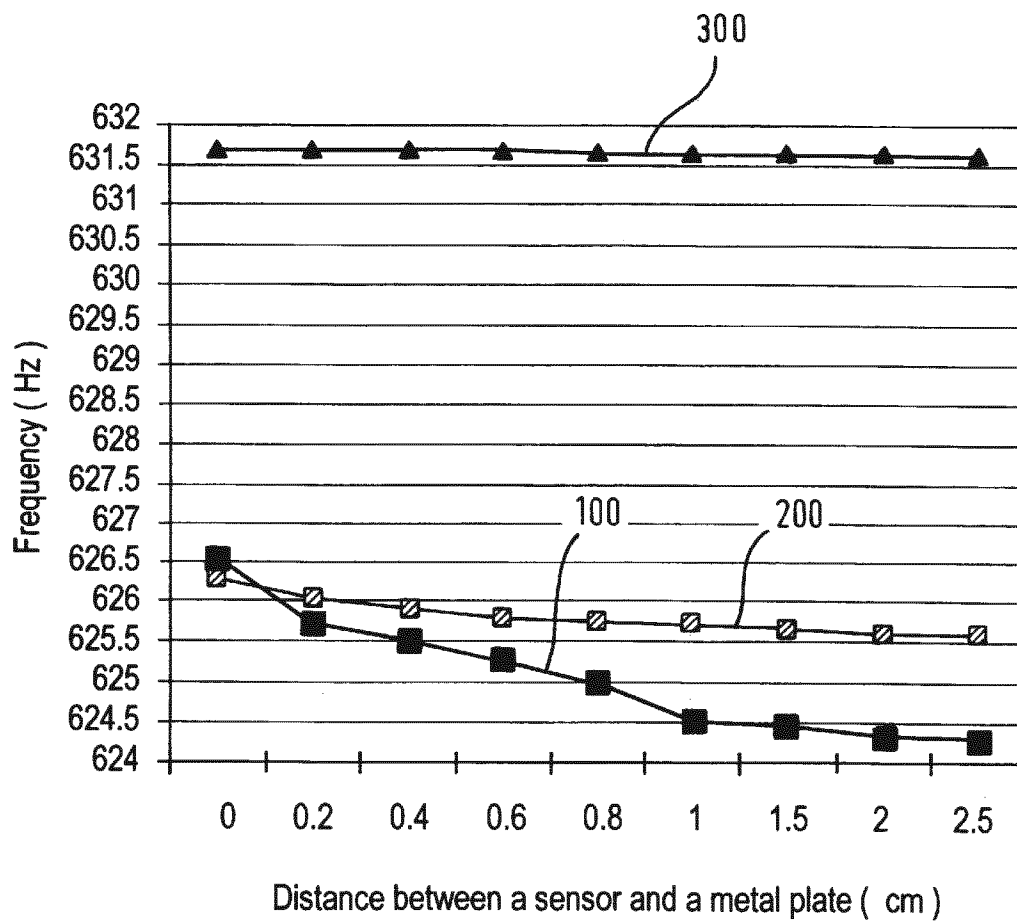


Fig. 2

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**Fig. 3**

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2013/069905

A. CLASSIFICATION OF SUBJECT MATTER

INV. D06F39/08 A47L15/42 G01F23/38 G01F23/16
ADD.

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)

D06F A47L G01F

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Further documents are listed in the continuation of Box C.



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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2013/069905

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Information on patent family members

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