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(54) **A liquid fuel-fired furnace appliance for fireplace**

(57) The invention consists of a liquid fuel-fired furnace appliance for a fireplace, in the form of metallic housing (11), comprising fuel tanks (2,21) and a furnace (P), mounted therein a fuel vaporising fence (3) and a fuel vapours distributing fence (9), a heating system (5) and a stop valve (10) blocking the vapours flow, and an electronic system (E) containing the controllers coupled with the sensors supervising combustion parameters and furnace switch-on/switch-off elements, which is characterised in that in one embodiment (A1) in the inside of the vaporising fence (3) an insert made from highly hygroscopic material (6) is placed, and the heating system (5) contains flat heating elements (51) and a built-in temperature sensor (C8), whereas a cover plate (111) of the furnace (P) housing (11) is fit out with a guide (112), and

the casing (11) contains ventilation openings with built-in cooling fans (12) and placed inside thermal shields (113), whereas the fuel tanks (2,21) contain a temperature sensor (C9) coupled with an electronic system (E) and a set of the fuel level contact sensors (C7,C71) signalling minimal and maximal levels of the fuel (4), whereas another embodiment (A2) with one fuel tank (22) is characterised in that in the system delivering the fuel (4) from the fuel tank (22) to the furnace (P) an air pump (13) and an equalising chamber (14) equalising the fuel level with the fuel (4) level in the vaporising fence (3) are installed, and the fuel tank (22) is placed on any level, whereas a sensor (C18) placed inside the equalising chamber (14) equalising the fuel level controls switching-on and switching-off of the air pump (13).

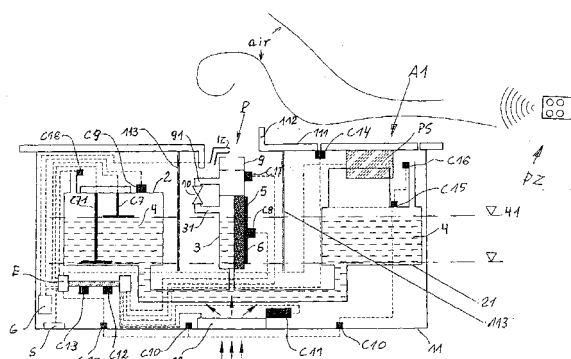


Fig. 1

Description

[0001] The invention consists of a liquid fuel-fired furnace appliance for a fireplace, where liquid fuel is an environment-friendly alcohol. This, burning in the furnace appliance in the fireplace emits heat used for heating of the room where it has been mounted, and creates also decorative effect of the flames.

[0002] The liquid fuel-fired furnace appliance for the fireplace and a method of its operation are known from the patent application PL 387513 A1, and it is characterised in that only the vapours of liquid fuel are burned. Liquid fuel conducted from a tank to the combustion zone is previously heated to preset temperature in a heating chamber, until the fuel vapour of advantageous degree of vaporisation is received. Then under created pressure it is conducted in known way to the combustion zone, which is a surface of arbitrarily shaped distributing chamber with numerous holes, preferably shaped as slots, where outgoing fuel vapours are ignited and are a subject of controlled process of combustion. The furnace appliance in this solution consists of a fuel tank with an outlet joined by a pipeline to the heating chamber, which is connected to the distributing chamber with numerous shaped holes. The fuel tank in its upper part has a fuel filler, while in its bottom part it has an outlet equipped with a conduit conducting the fuel to the heating chamber furnished with an electric heater with a thermocouple.

[0003] The furnace appliance described in the patent application PL 389408 A1 is characterised in that it consists of four main parts, i.e. a fuel tank, a fuel vaporising fence, a fuel vapour distributing fence, and a stop valve, cutting-off the vapours flow. The fuel tank is connected to the fuel vaporising fence with a conduit, and the vaporising fence is furnished with the vapours outlet connected to the stop valve and it has a warming strip mounted outside with a fuel filler for ignition. The fuel vapour distributing fence is connected with an inlet connector pipe and in its upper part it has the shaped holes for emission of the fuel vapours. In this appliance the fuel is supplied gravitationally through a conduit to the vaporising fence on the basis of communicating vessels so, that the air layer is left above the surface of liquid fuel which is prevented from entering the connector pipe, then little dose of fuel is delivered to the fuel filler and it is ignited in the warming strip, quickly warming the vaporising fence together with the fuel contained inside. Resulting vapours of fuel because of vaporisation and elevated pressure move towards the connector pipe and through the inlet pipe towards the distributing fence, where they propagate and get out through the holes shaped in it above the fence on its entire length, and they ignite from the flame in the warming strip. When the amount of fuel in the warming strip runs out, the vapours combusting above the distributing fence warm it and the heat is transferred to the vaporising fence. This supports automatically the process of the fuel vaporisation and its combustion on preset

level, until the fuel runs out from the tank. The furnace appliance in preferred embodiment comprises two fuel tanks arranged parallel to each other and connected by a pipe conduit. The vaporising fence and the distributing fence are placed between them, and the main tank, apart from the fuel filler for ignition, is furnished with a dosing pump, and beneath the fuel filler the igniting gutter with a match is mounted, and all mentioned parts are closed in a housing with ventilation holes. In an automated embodiment, the furnace appliance is controlled with a remote controller, making possible automatic ignition by a spark from the spark generator, and automatic extinguishing. After the process of the vapours combustion is initiated, the furnace appliance is self-controlled automatically in a range of the combustion parameters, by detection of undesired concentration of generated gases, the system leakage or its unwanted fall or movement. Described furnace appliance has a shape of cubicoid, metallic casing comprising all mentioned elements, and on its upper surface which is a metallic plate the only recess lays open the part of the distributing fence where the vapours are released and burned.

[0004] The aim of the invention is to deliver the furnace appliance eliminating inconveniences of the inventions described in hereinbefore mentioned patent applications, namely:

1. the fire size (the amount of the fuel used during a time unit) varies according to changes of the fuel levels in the tanks;
2. univocal signalling of the fuel level in the tank is missing;
3. the level of the temperature transfer to the elements of the vaporising fence is insufficient because of the heaters shape which forces small contact surface between adjacent elements;
4. the difficulties appear with precise controlling of power of the heating system because of placing of the temperature sensor on the vaporising fence, the temperature of which is strongly dependent on the fuel vaporisation point, thus not reflecting the amount of the vapours production;
5. the tanks system's protection against excessive increase of the fuel temperature inside the tanks is missing;
6. at higher lengths of the furnace (above 1 m) deformations of the cover plate appear due to heating by the flame, which deflects towards back part of the plate because of the air flow in the housing;
7. undesired heating of the elements occurs in vicinity of the heating system;

8. self-cooling time of the appliance after switching-off is long;

9. the tank and the vaporising fence have to be placed on the same level.

[0005] Formulated aim was fulfilled according to this invention in the furnace appliance, containing at least one fuel tank, the furnace in the form of metallic housing with mounted within the vaporising fence and the fuel vapours distributing fence, the heating system and the stop valve blocking the vapours flow, and the electronic system containing the sensors supervising the combustion parameters and the furnace switch-on/switch-off elements, where at least one fuel tank is connected through the conduit to the vaporising fence, and the vaporising fence is fit with the vapours outlet connected to the stop valve, said furnace appliance is characterised in that inside the vaporising fence an insert made from highly hygroscopic material is placed, and the heating system contains flat heating elements and built-in the temperature sensor, whereas the cover plate of the furnace housing is fit out with a guide, and the casing contains the ventilation openings with built-in cooling fans and placed inside the thermal shields, whereas at least one fuel tank contains the temperature sensor coupled with an electronic system and a set of contact sensors signalling minimal and maximal levels of fuel.

[0006] The furnace appliance is also characterised in that flat elements are by entire surface in direct contact with the vaporising fence through applied thermo-conductive paste.

[0007] Another important feature of the invention is in that the guide is arranged perpendicularly to the cover plate of the furnace casing, and the casing is fit with the fans built in the ventilation openings.

[0008] In preferred embodiment of the invention, in the system delivering the fuel from the fuel tank the air pump and a chamber equalising the fuel level with a level in the vaporising fence are installed, and the fuel tank is placed on any level, whereas the sensor placed inside the chamber equalising the fuel level controls switching-on and switching-off of the air pump.

[0009] Significant feature of the invention is also in that the thermal shields surfaces facing the furnace elements are reflective.

[0010] The furnace appliance according to the invention shows numerous technical and applicative qualities, if compared to the solutions known from the patent applications PL 387513 A1 and PL 389408 A1. These virtues are mainly in that:

1) placing inside the vaporising fence the insert from highly hygroscopic material causes, that irrespective of the fuel level in the tanks and in the distributing fence, it elevates the fuel on entire height of the element of the vaporising fence. Stabilisation of the amount of fuel being in contact with hot element of

the vaporising fence effects in stable quantity of produced vapours and constant flame in whole range of the fuel levels set for normal work of the appliance. Additional virtue of this solution is in that the fuel depletion is clearly visible in reduction of the flame height, which facilitates calibration of the fuel level sensors.

2) application of a set of flat heating elements of large contacting surface and the thermo-conductive pastes for the temperature sensor in this setup causes multiple reduction of the heating system temperature and better orientation of thermal energy, minimising undesired heating of the elements and reducing usage of electric energy. Additional quality of this solution is low heat capacity of the heating system resulting in moderate thermal inertia and short reaction time on regulation of the fire height. Increment of the flame is executed through elevation of the heating system temperature, whereas decrement of the fire is executed through diminution of the heating system temperature, which at high thermal inertia has been taking about 1-2 minutes. The invention ensures the reaction time on the fire height regulation in 2-5 seconds.

3) introduction of a deflection along entire furnace length acting as the air guide solved the problem of deformations of the cover plate of the furnace housing. The air entering the housing containing the furnace rebounds from the guide without deflecting of the flame towards back part of the plate, and additionally the guide stiffens the cover plate.

4) lack of univocal signalling of the fuel levels, causing the user's uncertainty of how much can he fill the fuel tank was solved by introduction to the appliance of contact sensors set signalling maximal or minimal level of the fuel in the tanks. This solution assures that undesirable overfilling of the fuel tank should not happen, and in case of automatic appliance it makes possible to inform the user about unacceptably high fuel level and to block the appliance. Also aiming to additionally secure the fuel tanks, another temperature sensor was applied. The sensor coupled with an electronic system informs the user about dangerous temperature of the inside of the appliance, and in critical conditions it stops the appliance, automatically switching-on the cooling system.

5) unwanted heating of the elements in vicinity of the heating system was also eliminated by thermal shields from smooth metal sheet reflecting thermal radiation. Additionally, the ventilation openings were made in the housing, making possible unrestricted flow of cooling air. Cooling fans were additionally mounted in the openings, used for faster cooling of the appliance after it is switched-off. In this case they

are not used for regulation but for cooling during operation (unrestricted air flow) and during cooling after switching-off (the fans are switched-on - forced air flow).

6) application in the fuel supply system of the air pump and equalising chamber enables installation of the fuel tank on any level.

[0011] An example of preferred embodiment of the appliance according to the invention is shown on the drawings in three practical embodiments, where:

fig. 1 illustrates schematically the furnace appliance powered from the power grid, with remote control showing the inside of the furnace housing in cross-section;

fig. 2 shows in schematic cross-section flat heating elements of the heating system and a coupling of the vaporising fence with distributing fence of the furnace;

fig. 3 explains schematically the furnace appliance with one fuel tank mounted on any level of the fuel, showing the inside of the furnace housing in cross-section.

[0012] Example 1. The furnace appliance (A1) shown on Fig. 1 is powered from the power grid (S) with voltage of 230-250 V or 110-115 V. The appliance is fit with two fuel tanks (2, 21), which together with the vaporising fence (3) form a system of communicating vessels. Along with consumption of the fuel (4) in the fuel tanks (2, 21), the level of the fuel (4) also decreases in the vaporising fence (3), where the process of vaporisation of the fuel (4) is run under influence of the temperature of the heating system (5). The vaporising fence (3) which is a closed vessel has limited volume and as the fuel (4) level decreases, the volume of boiling ethyl fuel also decreases. This reduces production of vapours, which are later exposed to the process of combustion. This results in visually apparent reduction of the fire size while the furnace appliance (A) is still working. To eliminate this event, the insert made from highly hygroscopic material (6), e.g. hygroscopic wool, is put inside the vaporising fence (3). The insert made of hygroscopic wool (6) effects in that irrespective of the fuel (4) level in the tanks (2, 21) and the vaporising fence (3), it elevates the fuel (4) on entire height of the element of the vaporising fence (3). Stabilisation of the amount of fuel (4) being in contact with hot element of the vaporising fence (3) effects in stable quantity of produced vapours and constant flame in whole range of the fuel levels set for normal work of the furnace appliance (A). Additional virtue of this solution is in that the fuel (4) depletion is clearly visible in quick reduction of the flame height, which facilitates calibration of the fuel level sensors (C7, C71). The heating system (5) in this

embodiment, presented on Fig. 2, contains flat heating elements (51) and built-in temperature sensor (C8) for measurement of temperature of the heating system (5). Flat heating elements (51) are by entire surface (52) in direct contact with the surface (31) of the vaporising fence (3) through applied thermo-conductive paste (53). Fig. 2 also shows in magnified cross-section the structure of the furnace (P), the insert of hygroscopic wool (6) placed inside the vaporising fence (3), and connection of the vaporising fence (3) with the distributing fence (9) through the valve (10) placed between the outlet (31) of the vaporising fence (3), and the inlet (91) of the distributing fence (9). Fig. 2 shows also the inlet (32) of the fuel (4) to the vaporising fence (3) and its level (41). The cover plate (111) of the housing (11) of the furnace (P), as shown in Fig. 1, is fit with the guide (112) arranged perpendicularly to the cover plate (111) along the entire length of the furnace (P). The guide (112) causes the air which enters the housing containing the furnace appliance (A1) to rebound from the guide (112) without deflecting of the flame towards back part of the cover plate (111), and thus eliminating deformations of this plate. The housing (11) in its bottom part has the ventilation openings with built-in the ventilation fans (12). Inside the housing (11) are placed thermal shields (113) made from metal sheet, reflecting thermal radiation, which eliminates undesired heating of the elements in vicinity of the heating system (5). The fuel tanks (2, 21) contain the temperature sensor (C9) coupled with the electronic system, and a set of the fuel level contact sensors (C7, C71) indicating minimal and maximal levels of the fuel (4). The furnace appliance (A1) illustrated on Fig. 1 is equipped with the electronic system (E) containing the controllers coupled with the fuel level sensors (C7, C71) and the temperature sensors (C8, C9), and additionally coupled with the spill sensor (C10) indicating spill of the fuel (4) under the tanks (2, 21), and with the gases concentration sensor (C11) measuring concentrations of carbon monoxide CO, carbon dioxide CO₂ and oxygen O₂, also with the tilt sensor (C12) indicating angular position (tilt) of the appliance, then with the movement sensor (C13) indicating movement of the appliance, and the filler opening sensor (C14) sensing opening of the filler, then the fuel overflow sensor (C15) detecting spill of the fuel around the fuel tank filler, also the deaeration sensors (C16) signalling the fuel spill during deaeration, and the temperature sensor (C17) measuring the temperature of the distributing fence (9). The furnace appliance (A1) contains also the control panel (PS) fit with sockets (not shown on the drawing) to connect a computer, the remote device (PZ) for remote control of the furnace appliance (A1), and the spark generator (G) for ignition of the fuel vapours in the pilot-spark starting unit (IZ) above the distributing fence (9).

[0013] Example 2. The furnace appliance (A2) shown in Fig. 3 differs from the furnace appliance (A1) shown in Fig. 1 and 2 in that its construction makes possible to supply the fuel (4) from the fuel tank (22), where the fuel

level (41) is not necessarily the same as in the vaporising fence (3). In this embodiment, in the system delivering the fuel (4) to the vaporising fence (3) from the fuel tank (22) the air pump (13) and the equalising chamber (14) equalising the fuel (4) level with a level in the vaporising fence (3) are installed, and the fuel (4) is delivered by a conduit (15) to the equalising chamber (14). This solution is additionally advantageous if compared to the furnace appliance (A1) described beforehand in the Example 1, because:

- minimal volume (size) of the equalising chamber (14) enables free shaping of the housing (11) and reduction of its dimensions. The volume of the equalising chamber (14) should be slightly greater or equal to the volume of the vaporising fence (3);
- the insert from the hygroscopic material (6) is no longer needed, because the fuel (4) level is kept constant by the fuel level sensor (C18) controlling the work of the air pump (13);
- the filler is removed from the housing (11), thus minimising a risk of the fuel (4) spill during filling of the fuel tanks (2, 21), as may happen in previously described embodiment of the furnace appliance (A1). In this embodiment of the furnace appliance (A2) the user connects to the fuel delivery system a disposable fuel tank (22), which is discarded when emptied;
- elimination of a possibility of heating of the fuel tank (22) by placing it outside of the housing (11).

[0014] The furnace appliance (A2) apart from changes described above, has identical both electronic outfit and the housing (11) as the furnace appliance (A1). The housing (11) on its cover plate (111) has the guide (112), and the appliance is fit with the electronic system with the controllers of the sensors (C8, C9, C10, C11, C12, C13, C16, C 17 and C 18). It is also fit with the spark generator (G) for ignition in the pilot-spark starting unit (IZ), the control panel (PS) and the remote device (PZ) for remote control.

[0015] Operation of the furnace appliance (A2) is as follows. The fuel tank (22) shall be placed in any place below the equalising chamber (14). The air pump (13) generates pressure in the fuel tank (22) thus making the fuel (4) to flow into the equalising chamber (14). The fuel level sensor (C18) mounted in the equalising chamber (14) controls switching-on and switching-off of the air pump (13), ensuring constant level of the fuel (4) in the equalising chamber (14). From the equalising chamber (14) the fuel moves by gravity to the vaporising fence (3), where after being heated it vaporises, and the vapours are delivered through the valve (10) to the distributing fence (9), and combusted above it.

Claims

1. A liquid fuel-fired furnace appliance for a fireplace, containing at least one fuel tank, the furnace in the form of metallic housing with mounted within the vaporising fence and the fuel vapours distributing fence, the heating system and the stop valve blocking the vapours flow, and the electric system containing the sensors supervising the combustion parameters and the furnace switch-on/switch-off elements, where at least one fuel tank is connected through the conduit to the vaporising fence, and the vaporising fence is fit with the vapours outlet connected to the stop valve, **characterised in that** in the inside of the vaporising fence (3) an insert made from highly hygroscopic material (6) is placed, and the heating system (5) contains flat heating elements (51) and built-in the temperature sensor (C8), whereas the cover plate (111) of the furnace (P) housing (11) is fit out with a guide (112), and the casing (11) contains the ventilation openings with built-in cooling fans (12) and placed inside the thermal shields (113), whereas at least one fuel tank (2, 21, 22) contains the temperature sensor (C9) coupled with an electronic system (E) and a set of the fuel level contact sensors (C7, C71) signalling minimal and maximal levels of the fuel (4).
2. The furnace appliance according to claim 1 **characterised in that** the flat heating elements (51) are by entire surface (52) in direct contact with the surface (31) of the vaporising fence (3) through applied thermo-conductive paste (53).
3. The furnace appliance according to claim 1 **characterised in that** the guide (112) is arranged perpendicularly to the cover plate (111) of the housing (11) of the furnace (P).
4. The furnace appliance according to claim 1 **characterised in that** the surfaces of the thermal shields (113) facing the furnace (P) elements are reflective.
5. The furnace appliance according to claim 1 **characterised in that** in the system delivering the fuel (4) from the fuel tank (22) to the furnace (P) the air pump (13) and the equalising chamber (14) equalising the fuel level with the fuel (4) level in the vaporising fence (3) are installed, and the fuel tank (22) is placed on any level, whereas the sensor (C18) placed inside the equalising chamber (14) equalising the fuel level controls switching-on and switching-off of the air pump (13).

**Amended claims in accordance with Rule 137(2)
EPC.**

1. A liquid fuel-fired combustion appliance for a fire-
place, containing at least one fuel tank (2, 21, 22), a
furnace (P) in the form of a metallic housing (11)
wherein a vaporising fence (3) and a distributing
fence (9) for distribution of the fuel vapours are
mounted, a heating system (5) and a stop valve (10)
blocking the vapours flow, and an electronic system
(E) containing the controllers coupled with the sen-
sors supervising the combustion parameters and the
furnace (P) switch-on/switch-off elements, where at
least one fuel tank (2, 21, 22) is connected through
a conduit to the vaporising fence (3), and the vapor-
ising fence (3) is fit with the vapours outlet (31) con-
nected to the stop valve (10), **characterised in that**
in the inside of the vaporising fence (3) an insert
made from highly hygroscopic material (6) is placed,
and the heating system (5) contains flat heating el-
ements (51) and built-in a temperature sensor (C8),
whereas a cover plate (111) of the metallic housing
(11) of the furnace (P) is fit out with a guide (112),
and the metallic housing (11) contains the ventilation
openings with built-in the cooling fans (12) and
placed inside the thermal shields (113), whereas at
least one fuel tank (2, 21, 22) contains a temperature
sensor (C9) coupled with the electronic system (E)
and a set of the fuel level contact sensors (C7, C71)
signalling minimal and maximal levels of the fuel (4).
2. The combustion appliance according to claim 1
characterised in that the flat heating elements (51)
are by entire surface (52) in direct contact with a
surface (31) of the vaporising fence (3) through ap-
plied thermo-conductive paste (53).
3. The combustion appliance according to claim 1
characterised in that the guide (112) is arranged
perpendicularly to the cover plate (111) of the me-
tallic housing (11) of the furnace (P).
4. The combustion appliance according to claim 1
characterised in that the surfaces of the thermal
shields (113) facing the furnace (P) elements are
reflective.
5. The combustion appliance according to claim 1
characterised in that in the system delivering the
fuel (4) from the fuel tank (22) to the furnace (P) an
air pump (13) and an equalising chamber (14) equal-
ising the fuel level with the fuel (4) level in the vapor-
ising fence (3) are installed, and the fuel tank (22) is
placed on any level, whereas a sensor (C18) placed
inside the equalising chamber (14) equalising the
fuel level controls switching-on and switching-off of
the air pump (13).

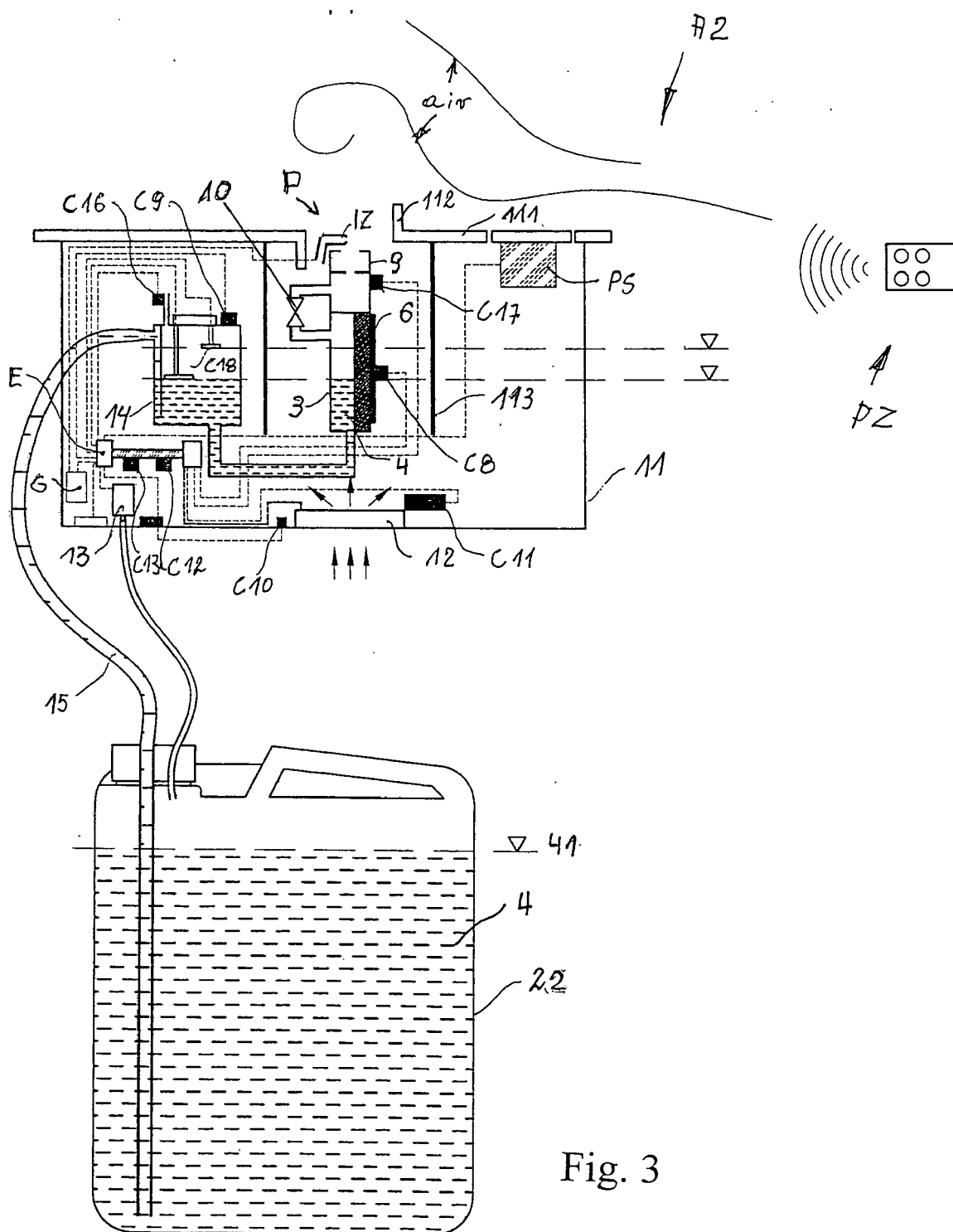


Fig. 3



EUROPEAN SEARCH REPORT

 Application Number
 EP 11 46 0037

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 13 January 2012	Examiner Harder, Sebastian
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

 1
 EPO FORM 1503 03.82 (F04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 11 46 0037

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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13-01-2012

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REFERENCES CITED IN THE DESCRIPTION

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