

Electronically Controlled Burner

Description

Field of the Invention

The invention generally relates to an electronically controlled burner.

- 5 The invention more particularly relates to an electronically controlled burner adapted for combustion of liquid fuel such as ethanol, preferably liquid fuel comprising at least 96% bioethanol.

Background of the Invention

- 10 Electronically controlled burners that combust ethanol and in particular bioethanol are used for various purposes. Bioethanol is an alcohol producible from fermentation of wheat, sugars, potatoes, other suitable agricultural crops and organic household waste. Combusting of bioethanol will only emit water vapour, carbon dioxide and heat. Bioethanol fireplaces or burners burn cleanly with an orange/blue flame and are considered to be decorative and completely environmentally friendly. The colour of the flame depends on the purity of the bioethanol. Furthermore, installation of bioethanol fireplaces does not require any chimney or flue. They are smoke and odour-free and do not emit harmful gases.
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- Several types of electronically controlled ethanol burners are available. US 2011 0171587 A1 discloses an electronically controlled ethanol burner that comprises an electric heater configured to heat the fuel and hereby evaporate the fuel before the vapour is ignited. The fuel is poured into a fuel tank, wherefrom it flows into an evaporation plate that is brought into thermal contact with a set of heaters. The evaporated fuel (vapour) is hereafter guided through a magnetic valve to a vapour distribution plate.
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- 30 The fuel level in the evaporation plate is determined by the fuel level of the fuel tank due to the fact that the fuel is guided from the fuel tank to the evaporation plate by gravity. Therefore, the fuel evaporation rate is heavily influenced by the fuel level in the fuel tank. Since the evaporation rate is one of the main determinants of the magni-
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tude of the flames, it is difficult to control the magnitude of the flame by using an electronically controlled burner like the one described in US 2001 0171587 A1.

5 Accordingly, there is need for an electronically controlled ethanol burner in which the magnitude of the flame is both controllable and adjustable. There is especially need for an electronically controlled ethanol burner in which the magnitude of the flame may be kept
10 constant when set to a predefined level (flame height) – independently of the fuel level in the fuel tank.

A further problem of the prior art electronically controlled burners is that a significantly amount of fuel is present in the evaporation member (e.g. an evaporation plate) even when the electronically
15 controlled burner has been shut down. In fact the heated fuel remaining in the evaporation member potentially constitutes a major risk of explosion if the electronically controlled burner is ignited within e.g. 10-20 minutes after shut down of the electronics, because the warm bioethanol continues to produce an accumulation of vapour.
20 This vapour may self-ignite or explode during shut down or immediate upstart after shut down. However, a fast restart of the electronically controlled burner without the danger of causing a self-ignition or explosion is desirable.

25 Moreover, the presence of bioethanol vapours causes inconvenience for the user of the electronically controlled burner in form of undesired odours.

Object of the Invention

30 Accordingly, it is an object of the present invention to provide an electronically controlled ethanol burner that can be shut down faster than the prior art electronically controlled burners, and that can be restarted immediately after shutting down the electronically controlled burner.

It is also an object to provide an electronically controlled ethanol burner in which the magnitude of the flame can be kept constant independently of the fuel level in the fuel tank.

- 5 It is also an object to provide an electronically controlled ethanol burner in which the heating of the ethanol can be carried out in a controlled manner and in which the fuel consumption rate is controllable (e.g. so that a fuel consumption rate below 500 ml /hour can be achieved).

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Summary of the Invention

- The object of the present invention can be achieved by an electronically controlled burner having the features defined in claim 1. Preferred embodiments are defined in the dependant sub claims and explained in the following description and illustrated in the accompanying drawings.
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- The electronically controlled burner according to the invention is configured to combust bioethanol, which electronically controlled burner comprises at least one fuel tank being in fluid communication with an evaporation accelerator being in thermal contact with a heating element configured to heat and hereby evaporate fuel in the evaporation accelerator, a flame tray having an ignition member configured to ignite vapour delivered from the evaporation accelerator. The burner comprises one or more fuel pumps configured to pump fluid fuel from the at least one fuel tank to the evaporation accelerator, where the electronically controlled burner comprises means for actively emptying the evaporation accelerator.
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- Hereby it is achieved that the evaporation accelerator can be emptied fast so that the electronically controlled ethanol burner that can be shut down faster than the prior art electronically controlled burners, and that the electronically controlled ethanol burner can be restarted immediately after shutting down the electronically controlled burner. Moreover, in case of detection of a malfunction it is possible
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to empty the evaporation accelerator quickly, in order to extinguish the fire by interrupting the vapour supplies to the flame tray.

5 By the term *means* for actively emptying *the evaporation accelerator* is meant *means capable of emptying the evaporation accelerator in a fast and efficient way*. It is preferred that the means for actively emptying the evaporation accelerator is one or more pumps or a valve member.

10 The pump or pumps may be the same pump or pumps that is/are used to pump fuel from the tank to the evaporation accelerator. This requires that the pump or pumps can be reversed and hence pump in both directions (forward and backwards). The fuel from the evaporation accelerator may be pumped back to the tank from which it was
15 pumped into the evaporation accelerator, however, it may also be pumped into another tank by using another pump.

It is also possible to actively empty the evaporation accelerator by means of a valve member (e.g. a magnetic valve or any other suitable type of valve). The fuel from the evaporation accelerator may be
20 directed back to the tank from which it was pumped into the evaporation accelerator or into another tank.

The evaporation accelerator may provide a valve (or a valve arranged within an outlet pipe) at its bottom in order to empty any fuel contents in the evaporation accelerator by means of force of gravitation during shut down of the electronically controlled burner.
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The fuel pump may be configured to maintain a predefined fuel level in the evaporation accelerator in order to ensure that the magnitude of the flame or the fuel consumption rate can be controlled (e.g. be kept constant) at any given time. The magnitude of the flame can be controlled due to the fact that the evaporation rate is controllable or programmable because the fuel level in the evaporation accelerator
30
35 is controllable by means of one or more controllable pumps together

with the temperature of the evaporation accelerator by means of a controllable heating element.

5 It is preferred that the electronically controlled burner is configured to set the magnitude of the flames to a plurality of predefined levels so that the user of the electronically controlled burner can set the heat generation rate (heat output) and the fuel consumption rate according to specific requirements. It is especially preferred that the user of the electronically controlled burner can set the fuel consumption
10 rate to a level that is lower than or equal to 500 ml/hour.

By controlling the fuel level in the evaporation accelerator together with a controlled temperature of the heating element it is possible to control the evaporation rate.

15 The term "electronically controlled burner" means that the burner comprises an electrical heater configured to heat and hereby evaporate fuel in the evaporation accelerator.

20 The evaporation accelerator is a member adapted to facilitate evaporation of the fuel. In an electronically controlled burner evaporation facilitation is preferably carried out by using an electric heating element configured to generate a predefined amount of heat to evaporate the fuel at a defined and controlled rate. This is crucial when applying bioethanol as a fuel under low temperature conditions, since
25 only the bioethanol vapour is ignitable, and the evaporation temperature of bioethanol is around 17°C.

The evaporation accelerator may be any suitable member capable of vaporising the fuel. The evaporation accelerator may be a tank comprising an electric heating element.

30 It is preferred that the electronically controlled burner according to the invention is configured to combust bioethanol, since bioethanol

has several advantages over conventional fuels for electronically controlled burners.

Bioethanol has a number of advantages over conventional fuels.

- 5 Since bioethanol comes from a renewable resource such as crops and not from a finite resource it is an environmentally friendly fuel.

- 10 The fuel tank may be an integrated part of the electronically controlled burner, however, it is also possible to arrange the tank in a distance from the remaining parts of the electronically controlled burner. The tank may be arranged outside of the building in which the remaining parts of the electronically controlled burner are arranged.

- 15 By having a tank being in fluid communication with the evaporation accelerator, fuel can be pumped from the tank to the evaporation accelerator and a controlled or constant fuel level can be maintained. Besides, the evaporation accelerator can be emptied either by pumping fuel from the evaporation accelerator to the tank or by means of
20 a valve member working with gravitation, which may be a huge advantage for safety reasons.

- 25 The heating element may be any suitable type of electrical heating element. It is essential that the heating element is configured to heat and hereby evaporate fuel in the evaporation accelerator.

It may be an advantage that the heating element is integrated in the evaporation accelerator.

- 30 The flame tray may be any suitable type of flame tray capable of distributing and burning the vaporised fuel.

It may be beneficial that the flame tray has an elongate shape e.g. a rectangular, narrow box-like shape. The flame tray may, however,

also have another geometric shape (a circular arced shape or an elliptic shape by way of example).

5 It is essential that the flame tray is having an ignition member configured to ignite vapour delivered from the evaporation accelerator. The electronically controlled burner comprises one or more fuel pumps configured to pump fuel from the fuel tank to the evaporation accelerator and from the evaporation accelerator back to the tank. The pump may be configured to provide pulsating fuel pumping or it
10 may run constantly at a controlled speed.

It is preferred that the pump is an electric pump adapted to be controlled by a control unit in a way such that the pump is configured to maintain an essentially controlled fuel level in the evaporation accelerator.
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It may be an advantage that the electronically controlled burner comprises one or more fuel pumps configured to pump fuel from one or more tanks into the evaporation accelerator at a rate necessary in
20 order to keep a set or programmed parameter (e.g. flame level, heat output or energy consumption rate).

It is an advantage that the pump or pumps has/have two pumping directions so that the pump or pumps can be used to pump fuel both
25 between the fuel tank and the evaporation accelerator and between the evaporation accelerator and the fuel tank.

It is preferred that vapour is delivered from the evaporation accelerator via a vapour diffuser into the flame tray. It is preferred that the vapour
30 diffuser comprises a pipe member closed at the top and featuring a number of openings and being in fluid communication with the flame tray.

The electronically controlled burner according to the invention is preferably adapted for combusting of bioethanol.
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It is preferred that the ignition member is a filament. Using a filament as ignition member is beneficial because a filament is capable of igniting the vaporised fuel as soon as the vapour gets in contact with the filament. When a spark is used to ignite the vaporised fuel in an electric burner there is a risk of sudden ignition of a rather large volume of vapour which may cause a minor explosion. Another disadvantage of a spark ignition is the constant "clicking noise" which may be perceived as disturbing because it takes a considerable period of time before a sufficient amount of bioethanol vapour has been distributed to the flame tray. These drawbacks are solved by using a filament as ignition member.

The filament may have any suitable size, length and shape, and goes into operation as soon as the evaporation process is started so that the vapour that rises into the flame tray is lit instantly in order to avoid an explosive ignition of a build-up of vapour.

It may be an advantage that a first fuel pump is configured to pump fuel from a first fuel tank into the evaporation accelerator, preferably in a first mode, and then the first fuel pump or a second fuel pump to pump fuel from the evaporation accelerator into the first fuel tank or into a second fuel tank, preferably in another mode.

It is preferred that the fuel pump or pumps is/are configured to pump fuel from the fuel tank or tanks into the evaporation accelerator in a first mode and to pump fuel from the evaporation accelerator into the fuel tank or tanks in another mode. Hereby it is achieved that a required amount of fuel can be delivered to the evaporation accelerator by using the pump/s while the pump/s is/are operated in the first mode. On the other hand the pump/s can be used to empty the evaporation accelerator by pumping fuel from the evaporation accelerator into the fuel tank or tanks while the pump/s is/are operated in another mode.

It is important to underline that it is possible to operate the pump/s in a plurality of modes in order to meet various operation requirements. In case of detection of a malfunction it may be an advantage to be able to empty the evaporation accelerator as fast as possible, in order to extinguish the fire by interrupting the vapour supplies to the flame tray.

It may be an advantage that the burner comprises a control unit configured to control the fuel pump or pumps. Preferably, the control unit is configured to receive input from one or more sensors integrated in the electronically controlled burner or in proximity to the electronically controlled burner. Hereby the control unit can be used to control the electronically controlled burner according to received inputs and hereby provide a more specific control of the electronically controlled burner.

It may be an advantage that the electronically controlled burner comprises a control unit and a temperature sensor being in thermal contact with the evaporation accelerator. In this way the control unit can control the electronically controlled burner according to the temperature of the evaporation accelerator.

Preferably, the control unit is configured to control the heating element on the basis of temperature detected by a temperature sensor, preferably a temperature sensor being in thermal contact with evaporation accelerator and hereby the fuel.

It is preferred that the electronically controlled burner comprises a control unit and a temperature sensor being in thermal contact with the evaporation accelerator, where the control unit is configured to control the heating element on the basis of temperature detected by the temperature sensor, where the control unit is configured to switch off the ignition member when the detected temperature exceeds a defined upper temperature level T_2 , and/or where the control unit is configured to switch off the burner when the detected temperature is below a defined lower temperature level T_1 .

Hereby it is achieved that the control unit can be configured to switch off the ignition member in a situation where a certain temperature is reached. When the temperature exceeds a defined upper temperature flames are present in the flame tray and thus the filament can be
5 switched off. In another situation when the temperature in the flame tray does not rise during a pre-defined time period (indicating that no flames are burning) the filament may be switched off together with the remaining part of the electronically controlled burner. Therefore, an automatic switch off procedure of the electronically controlled burner (the
10 entire fireplace installation) can be conducted when a detected temperature (of the flame tray or an area close to the flame tray) is below a defined temperature level.

It is preferred that the electronically controlled burner comprises an
15 overflow sensor configured to detect fuel overflow of the tank. Hereby it is possible to monitor the tank. It is preferred that the electronically controlled burner is configured in such a way that fuel overflow detection information is being sent to the control unit and that the control unit is adapted to generate an action when fuel overflow detection information
20 is being received.

It is preferred that the electronically controlled burner comprises an overflow sensor configured to detect fuel overflow of the tank and to generate an alert in the case of an overflow condition. It is beneficial
25 that the control unit is configured to generate an alert that may inform the user of the burner about the overflow situation. The alert may be any suitable type of alert such as a visual alert (e.g. a warning light) or an acoustic alert (e.g. a warning noise). It is also possible to have a control unit that is configured to send a signal wirelessly to an external device
30 (a wireless receiver integrated in a watch, a mobile phone or a computer) or to send a signal via the Internet e.g. to a server that may be configured to send a text message or an email to one or more recipients.

It may be an advantage that the electronically controlled burner is configured to set the evaporation rate from the evaporation accelerator. By
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the term "set" is meant that the evaporation rate is controllable or constant. When an essentially constant evaporation rate is maintained the evaporation rate only varies slightly, preferably less than 25% or even more preferred less than 10%. It is preferred the electronically controlled burner is configured to set the evaporation rate from the evaporation accelerator to a number of predefined levels. Hereby a number of flame height levels can be achieved. Moreover, it is possible to control the fuel consumption rate including keeping the fuel consumption rate to a level below e.g. 500 ml/hour.

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By having a controlled evaporation rate a controlled flame "display" can be achieved. This means that each flame in the flame tray (there may be several flame openings) will keep an essentially controllable flame height – independently of the fuel level in the fuel tank or tanks. In this way the generated heat will also be basically controllable which makes the the electronically controlled burner controllable to a high degree. It is, by way of example to keep a constant heat generation rate.

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It is preferred that the flame tray is provided with a plurality of flame openings having varying opening sizes and/or shapes. By having a plurality of varying opening sizes and/or shapes is achieved that a varying vapour flow is guided through the variously shaped openings. Due to the fact that the flame height depends heavily on the vapour flow, varying flame heights are achieved by a flame tray having a plurality of flame openings with varying opening sizes. The shape of the openings influences the visual characteristics of the flame and thus the shape of the flame openings may be chosen in order to achieve desired visual flame characteristics (e.g. a wide or narrow flame).

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It may be an advantage that the electronically controlled burner comprises a carbon monoxide (CO) sensor and/or a CO₂ (carbon dioxide) sensor. CO and/or CO₂ may be detected by the sensor(s) and information from the sensor(s) may preferably be send to the control unit. Since CO can be toxic to humans is preferred that the electronically controlled burner is configured to switch off automatically when a high level

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of CO (higher than a defined critical level) is detected. Preferably, the control unit is adapted to switch off the electronically controlled burner and empty the evaporation accelerator by either activating the fuel pump or pumps or opening the valve member in the evaporation accelerator when a high level of CO and/or CO₂ is detected by one or more sensors.

It is preferred that the electronically controlled burner comprises a tilt sensor. A tilt sensor may be any suitable type of tilt sensor capable of detecting change of orientation of the electronically controlled burner. By having a tilt sensor it is possible to switch off the burner in case that undesirable tilt conditions occur (e.g. when the electronically controlled burner is tilted unintended under operation).

It is preferred that the electronically controlled burner comprises at least one leakage detection sensor. The leakage detection sensor may be any suitable type of leakage sensor and preferably, the leakage detection sensor is configured to detect leakage in the area below the fuel tank so that leakage of the fuel tank or leakage from the fuel pump or from one of the connections to either the fuel pump, the tank or the evaporation accelerator, may be detected by using the leakage detection sensor. It is, however, also possible to have a leakage sensor arranged elsewhere in the electronically controlled burner.

It is preferred that the control unit is configured to communicate wirelessly with a remote control. It may be an advantage to use a mobile phone, e.g. a smart phone as a remote control.

In one embodiment according to the present invention the burner is configured to communicate through the Internet or through a wired or wireless network. In this way the electronically controlled burner may receive information (e.g. software updates) through the Internet or a wired or wireless network. The electronically controlled burner

may also be configured to send information via the Internet or alternatively through a wired or wireless network.

5 It may be an advantage that the electronically controlled burner is configured to be started (switched on) by using an interface, preferably an interface provided on the control unit. It is however, also possible to have an electronically controlled burner that is configured to be started by using a remote control. It is preferred that once the electronically controlled burner has been powered on by pressing an
10 on/off button, the remote control can be used to change the flame size levels and to start up the ignition.

It is preferred that the electronically controlled burner comprises a safety chamber arranged below the evaporation accelerator. Preferably, the burner comprises a fuel tank arranged below the evaporation
15 accelerator and a safety chamber arranged below the fuel tank.

It is preferred that one or more leakage detection sensor is arranged in the safety chamber and that the leakage detection sensor is arranged so that it is adapted to detect leakage from the fuel tank or
20 leakage from the fuel pump or from one of the connections to either the fuel pump, the tank or the evaporation accelerator.

In a preferred embodiment of the invention the electronically controlled burner comprises an electronic device, preferably a built-in
25 "Wi-Fi unit", configured to exchange data between an external device, preferably a smart phone, wirelessly using radio waves.

Hereby it is possible to use e.g. a smart phone as a remote control and to receive a message (e.g. a reminder that the tank needs to be
30 filled up, an alert or any other desirable message). By having a built-in "Wi-Fi unit" the electronically controlled burner does not require access to the Internet in order to communicate. However, it is possible to use the Internet as means for communication anyhow.

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It is possible to use Bluetooth technology for exchanging data over short distances between the electronically controlled burner and an extern device such as a smart phone, a tablet computer or a computer.

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It may be an advantage that the electronically controlled burner is configured to be wirelessly controlled by a smart phone, a computer or a tablet computer.

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It may be beneficial that the electronically controlled burner is configured to be set in one or more modes in which the energy consumption rate and/or the flame height level is fixed. This option makes it possible to adapt the electronically controlled burner to user specific requirements.

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It is preferred that the evaporation accelerator comprises an inlet and/or outlet and a bottom member having a shape that facilitates an effective emptying of the evaporation accelerator.

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It may be an advantage that the evaporation accelerator comprises an inlet and/or outlet and a bottom member declining towards the inlet and/or outlet. Hereby the shape of the evaporation accelerator facilitates an effective emptying of the evaporation accelerator. The bottom member may have any suitable geometric shape as long as its shape facilitates an effective emptying of the evaporation accelerator.

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Description of the Drawings

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The invention will become more fully understood from the detailed description given herein below. The accompanying drawings are given by way of illustration only, and thus, they are not limitative of the present invention. In the accompanying drawings:

- Fig. 1 shows a schematic cross-sectional view of an electronically controlled burner according to the invention;
- Fig. 2 shows a schematic top view of a flame tray according to the invention;
- 5 Fig. 3 shows a schematic side view of the flame tray shown in Fig. 2;
- Fig. 4 shows schematic side views of a flame tray in three different states of operation;
- Fig. 5 shows the flame tray with burning flames in two different flame level modes and
- 10 Fig. 6 shows schematically cross-sectional views of evaporation accelerators.

Detailed Description of the Invention

15 Referring now in detail to the drawings for the purpose of illustrating preferred embodiments of the present invention, an electronically controlled burner 2 of the present invention is illustrated in Fig. 1. In Fig. 1 a schematic side view of an electronically controlled burner 2 according to the invention is illustrated. The electronically controlled burner 2 is configured to combust bioethanol and thus no chimney is needed.

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The electronically controlled burner 2 comprises an elongate basically boxed-shaped flame tray 4 mechanically attached to a number of connection members 26 shaped as rods. The connection members extend perpendicular to the longitudinal axis X of the electronically controlled burner 2. The flame tray 4 is provided with a plurality of flame openings 34, 34', 34'' through which vaporised fuel can be distributed. It is intended a flame F is burning from flame opening 34, 34', 34'' as long as vapour is supplied through the flame opening 34, 34', 34''.

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The flame tray 4 is surrounded by a flame stabiliser 42 that also function as a heat transfer plate 42. The flame stabiliser/heat transfer plate 42 is capable of distributing the heat generated by the

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flames F back to an evaporation accelerator 10 that is mechanically and thermally connected to the flame tray 4.

5 A temperature sensor 14 is arranged in the top portion of the evaporation accelerator 10 above a heating element 12 that is arranged centrally in the evaporation accelerator 10.

10 A fuel level sensor 16 is provided at the lower side of the evaporation accelerator 10. The fuel level sensor 16 is configured to detect the fuel level in the evaporation accelerator 10. Fuel is being supplied to the evaporation accelerator 10 through a pipe 38 that is connected to an electric fuel pump 8 that is further connected to fuel tank 6. The connection members 26 are mechanically attached to the upper side of the fuel tank 6. A fuel overflow return pipe 41 is connected to the
15 evaporation accelerator 10 and the fuel tank 6.

A safety chamber 46 is arranged below the fuel tank 6. At the central part of the safety chamber 46 an indentation 50 is provided. A liquid
20 sensor 48 is arranged at the bottom of the indentation 50. The liquid detection sensor 48 is configured to detect leakage from the fuel tank 6, from the fuel pump 8 or from one of the connections between the pipe 38 and the evaporation accelerator 10, the pipe 38 and the fuel pump 8, the pipe 38' and the fuel pump 8 or the pipe 38' and the fuel tank 6.

25 The temperature sensor 14 is electrically connected to a control unit 20 via a cable 30 and the fuel level sensor 16 is electrically connected to the control unit 20 by a wire 30'''''. The control unit 20 is equipped with a display 22 configured to provide visual information
30 to the user of the electronically controlled burner 2. The control unit 20 moreover comprises an interface 24 consisting of a number of buttons that can be used to setup (e.g. by entering values) the control unit 20. The control unit 20 is supplied with electricity from a power supply 44.

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The control unit 20 is electrically connected to the temperature sensor 14 by a cable 30. Thus, the control unit 20 is configured to receive temperature measurements (detected by the temperature sensor 14). The control unit 20 is electrically connected to the heating element 12 in the evaporation accelerator 10 by a cable 30'. The control unit 20 is configured to control the heating element 12 on the basis of the detected temperature and control unit settings.

The control unit 20 may be configured to switch off an ignition member formed as a filament 36 when the detected temperature exceeds a defined upper temperature level T_2 since there is no need for the filament to be switched on when the temperature has reached a certain level where flames F are burning perfectly without assistance from the filament 36. The control unit 20 may be configured to switch off the electronically controlled burner 2 when the detected temperature is below a defined lower temperature level T_1 .

The control unit 20 is electrically connected to the fuel pump 8 by a cable 30''. The control unit 20 is configured to control the pump (turn the fuel pump 8 on, switch off the fuel pump 8 or change the pumping direction or speed of the fuel pump 8).

The control unit 20 is further electrically connected to a fuel level sensor 16 that is adapted to send fuel level information to the control unit 20. By using the fuel level sensor 16 it is possible to provide information about the fuel level in the evaporation accelerator 10 and send the information to the control unit 20 so that the control unit 20 can use these data to regulate or control the fuel pump 8, the heating element 12 or another device being adapted to be controlled by the control unit 20.

A fuel level sensor 18 is arranged at the side of the fuel tank below the control unit 20. The fuel level sensor 18 is electrically connected to the control unit 20 by a cable 30''' and configured to send fuel level information to the control unit 20. During filling up the tank 6 with fuel the fuel level sensor 18 may be configured to indicate when

a predefined percentage of the tank volume, 75% by way of example, has been reached. The control unit 20 can preferably, be adapted to generate an acoustic indication (e.g. one or more loud beeps) so that the user of the electronically controlled burner 2 is aware that the tank 6 is close to being filled up. It is also possible to use the control unit 20 generate an alert when a low fuel level (e.g. 25% or 10% of the tank volume) is detected by the fuel level sensor 18.

10 A temperature sensor 45 is arranged at the flame tray 4 and configured to communicate wirelessly with the control unit 20. It is also possible to have a wired electrically connection between the flame tray 4 and the control unit 20.

15 The tank 6 has a tank inlet 32 and a lid 28 for the tank inlet 32. The lid 28 is configured to be mechanically attached to the inlet 32 e.g. by a screwed connection. The lid 28 and the inlet 32 may be provided with corresponding threads. A fuel spillage tray 52 is arranged around the inlet 32 and is adapted to accumulate fuel that is spilled when filling fuel into the tank 6.

20 A vapour diffuser 43 is arranged inside the flame tray 4. The vapour diffuser 43 is pipe-shaped and closed at the top. The pipe-shaped vapour diffuser 43 is provided with a plurality of apertures 58 configured to distribute the vapour from the evaporation accelerator 10 into the flame tray 4.

25 The apertures 58 in the evaporation diffuser 43 will guide vapour to the sides while a pipe-shaped evaporation diffuser 43 without apertures 58 would guide all of the vapour straight upwards to the flame opening next to the filament 36.

30 A ball 56 is arranged inside the vapour diffuser 43. When vapour is guided upwards through the vapour diffuser 43 the ball 56 will be displaced vertically by the rising vapour. When no vapour is generat-

ed (e.g. when the evaporation accelerator 10 is empty, the temperature in the evaporation accelerator 10 is falling or the pump 8 starts reversing thus emptying the evaporation accelerator 10) the ball 56 will plug the evaporation diffuser 43. Accordingly, the evaporation
5 diffuser 43 functions as a ball valve that can be used to facilitate a fast switch down procedure of the electronically controlled burner 2.

A liquid sensor (an overflow detection sensor) 54 is arranged in the fuel spillage tray 52. The liquid sensor 54 is adapted to detect when
10 overflow occurs. When overflow occurs the liquid sensor 54 (e.g. constructed as a humidity sensor) sends information to the control unit 20 via a cable 30'''. The control unit 20 generates an alert (e.g. a beep) and prevents a start-up of the electronically controlled burner 2 until the liquid sensor 54 no longer indicates the present of an
15 overflow condition. The liquid sensor 54 prevents that the tank 6 is filled to overflowing.

A tilt sensor (not shown) is integrated in the electronically controlled burner 2. The tilt sensor is be configured to send about the orientation of the electronically controlled burner 2 (e.g. measured as the
20 angle between the longitudinal axis X of the electronically controlled burner 2 and the horizontal direction) to the control unit 20.

Any of the sensors 45, 14, 54, 18, 48, 16 may be configured to communicate wirelessly or by means of cables with the control unit
25 20.

A remote control 40 is configured to communicate wirelessly with the control unit 20. The remote control 40 may be used to change setting in the control unit 20, to read a log or to provide any other form
30 of communication with the control unit 20. It is possible to use a mobile phone (smart phone) as remote control.

Fig. 2 illustrates a top view of a flame tray 4 according to the invention. The flame tray 4 has a rectangular cross section and comprises
35 a plurality of small flame openings 34, medium sized flame openings

34' and larger flame openings 34''. The flame tray 4 is provided with a plurality of flame openings having varying opening sizes. In this way, the vapour flow being guided through openings of different sizes will differ and thus a more natural flame image (varying flame height as shown in Fig. 4 c) can be achieved.

A vapour diffuser (see Fig. 1) extends basically perpendicular to the longitudinal axis Y of the flame tray 4. A filament 36 is arranged above the vapour diffuser over a central flame opening at the central portion C of the flame tray 4.

The filament 36 is configured to ignite the vapour that is guided to the openings 34, 34', 34'' via the vapour diffuser. Initially, prior to start-up of the electronically controlled burner 2, fuel will be pumped to the evaporation accelerator 10 and the heater 12 will be switched on in order to warm up the fuel. When vapour is present at the vapour diffuser, the vapour will initially be distributed through the flame opening provided at the central portion C of the flame tray 4. The filament will be turned on and thus the vapour will be ignited as soon as the filament is in contact with vapour.

Compared to the prior art ignition members formed as spark generators, the filament provides a less noisy and safer ignition member (avoiding any sudden explosive ignition of vapour accumulation).

As the temperature of the flame tray 4 increases from the central portion C of the flame tray 4 towards the end portions E, E' of the flame tray 4 the flames will start spreading from the central portion C of the flame tray 4 towards the end portions E, E' of the flame tray 4.

When the electronically controlled burner 2 is switched off the fuel will be pumped away from the evaporation accelerator 10 by using the fuel pump 8. After a short time the ball 56 (see Fig. 1) will be sucked downwards and plug the bottom opening of the vapour dif-

fuser 43 (see Fig. 1). Therefore, no vapour will be sullied to the flame tray 4 and thus the flames F in the flame tray 4 will be put out.

5 It can be seen that the number and size of the flame openings shown in Fig. 2 correspond to the number and size of flame openings of the flame tray 4 shown in Fig. 1.

10 Fig. 3 illustrates a schematic cross-sectional view of the flame tray 4 shown in Fig. 1 and in Fig. 2. Since no vapour is generated from the evaporation accelerator 10, the ball 56 is arranged in a position where it plugs the vapour diffuser 43. In this situation no vapour can reach the flame tray 4 and be ignited by the filament 36. The number and size of the flame openings 34, 34', 34'' shown in Fig. 3 correspond to the number and size of flame openings 34, 34', 34'' of the flame tray 4 shown in Fig. 1 and in Fig. 2. It is possible to use different sizes and shapes of the flame openings 34, 34', 34''.

20 Fig. 4 illustrates three schematic side views of a flame tray 4 of an electrically controlled burner 2 according to the invention. The flame tray 4 is enclosed by a flame stabiliser 42. In Fig. 4 a) one large flame F having a height H_3 is burning. This situation would occur during start-up of the electrically controlled burner 2.

25 In Fig. 4 b) the fire has been spread both towards the first end portion E and the second end portion E' of the flame stabiliser 42. A large sized flame is burning next to the central flame F in the direction towards the first end E of the flame stabiliser 42 while a medium sized flame with a flame height H_2 is burning next to the central flame F in the direction towards the second end E' of the flame stabiliser 42.

30 In Fig. 4 c) a flame F is burning from each of the flame openings in the flame tray 4 and the flame stabiliser 42. In this situation the flame stabiliser 42 transfers heat back to the evaporation accelerator 10. The heating element 12 can be switched off because a sufficient

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amount of heat, generated by the flames F, is transferred back to the evaporation accelerator 10. In Fig. 4 c) there are small flames F with a height H_1 , medium sized flames F with a height H_2 and large flames F with height H_3 . While the large flames burn from the large flame openings (see Fig. 1-3), the medium sized flames F burn from the medium sized flame openings (see Fig. 1-3) and the small sized flames F burn from the smallest flame openings (see Fig. 1-3).

Fig. 5 illustrates the flame tray 4 shown in Fig. 4 with burning flames F in two different flame level modes. In Fig. 5 a) the flames F are smaller than in Fig. 5 b). However; the ratio between adjacent flames F is remained the same. This means that the ratio between the smallest flame H_1 and the largest flame H_3 in Fig. 5 a) equals the ratio between the smallest flame H'_1 and the largest flame H'_3 in Fig. 5 b). The same goes for the medium sized flames H_2 , H'_2 . Accordingly, the following conditions are fulfilled.

$$(1) \quad \frac{H'_3}{H'_2} = \frac{H_3}{H_2} \quad (2) \quad \frac{H'_3}{H'_1} = \frac{H_3}{H_1} \quad (3) \quad \frac{H'_2}{H'_1} = \frac{H_2}{H_1}$$

Fig. 6 illustrates schematically cross-sectional views of evaporation accelerators 10 according to the invention. It should be underlined that details (e.g. the filament) the upper part of the evaporation accelerators 10 are omitted for simplicity (illustration purposes).

Fig. 6 a) illustrates an evaporation accelerator 10 into which fuel 66 has been pumped. An inlet 62 has been provided at the left side of the evaporation accelerator 10. The evaporation accelerator 10 is provided with a arced bottom member 60 with a centrally arranged outlet 64.

Fig. 6 b) illustrates an evaporation accelerator 10 into which fuel 66 has been pumped through an inlet 62 provided at the left side of the evaporation accelerator 10. The evaporation accelerator 10 is provided with an inclined bottom member 60 with a centrally arranged outlet 64.

Fig. 6 c) illustrates another evaporation accelerator 10 according to the invention. Fuel 66 has been pumped into the evaporation accelerator 10 through an inlet 62 provided at the left side of the evaporation accelerator 10. The evaporation accelerator 10 is provided with an inclined bottom member 60 and an outlet 64 is provided at the right side of the evaporation accelerator 10.

Fig.6 d) illustrates a preferred embodiment of an evaporation accelerator 10 according to the invention. Fuel 66 has been pumped into the evaporation accelerator 10 through an inlet 62 provided at the right side of the evaporation accelerator 10. The evaporation accelerator 10 is provided with an inclined bottom member 60. The inlet 62 also function an outlet. This embodiment requires that a pump is used to pump fuel into the evaporation accelerator 10 through an inlet 62 and that the same pump is capable of pumping fuel back from the evaporation accelerator 10 into a fuel tank (not shown) through the inlet 62. Together with the inclination of the bottom member 60 of the evaporation accelerators 10 towards the fuel outlet 64, a reverse pump action of the pump enables the fastest possible drainage time and consequently shut-down time of the fire.

By using evaporation accelerators like the ones shown in Fig. 6 it is easier to empty the evaporation accelerators 10 in a fast and efficient way.

List of reference numerals

	2	-	Electronic Bioethanol Burner
5	4	-	Flame Tray
	6	-	Fuel tank
	8	-	Fuel pump
	10	-	Evaporation accelerator
	12	-	Heating element
10	14	-	Temperature sensor
	16	-	Fuel level sensor
	18	-	Fuel tank level sensor
	20	-	Control unit
	22	-	Operator display
15	24	-	Interface
	26	-	Flame tray support
	28	-	Lid
	30, 30', 30''	-	Cable
	30''', 30'''', 30'''''	-	Cable
20	32	-	Tank inlet
	34, 34', 34''	-	Flame opening
	36	-	Filament
	38, 38'	-	Fuel pipe
	40	-	Remote control
25	41	-	Fuel overflow return pipe
	42	-	Flame stabiliser/heat transfer plate
	43	-	Vapour diffuser
	44	-	Power supply
	45	-	Temperature sensor
30	46	-	Safety chamber
	48	-	Leakage detection sensor
	50	-	Indentation
	52	-	Fuel spillage tray
	54	-	Liquid sensor

	56	-	Ball
	58	-	Aperture
	60	-	Bottom member
	62	-	Inlet
5	64	-	Outlet
	66	-	Fuel
	X	-	Longitudinal axis of the burner
	Y	-	Longitudinal axis of the flame tray
	C	-	Central portion
10	E, E'	-	End portion
	F	-	Flame
	H ₁ , H ₂ , H ₃	-	Flame height
	H' ₁ , H' ₂ , H' ₃	-	Flame height

Claims

1. An electronically controlled burner (2) configured to combust bioethanol, which electronically controlled burner (2) comprises at least one fuel tank (6) being in fluid communication with an evaporation accelerator (10) being in thermal contact with a heating element (12) configured to heat and hereby evaporate fuel in the evaporation accelerator (10), a flame tray (4) having an ignition member (36) configured to ignite vapour delivered from the evaporation accelerator (10) **characterised in** that the electronically controlled burner (2) comprises at least one fuel pump (8) configured to pump fluid fuel from the at least one fuel tank (6) to the evaporation accelerator (10), where the electronically controlled burner (2) comprises means (8) for actively emptying the evaporation accelerator (10).
2. An electronically controlled burner (2) according to claim 1 **characterised in** that the means (8) for actively emptying the evaporation accelerator (10) is a pump (6) or a valve member.
3. An electronically controlled burner (2) according to claim 1 or claim 2 **characterised in** that the ignition member (36) is a filament (36).
4. An electronically controlled burner (2) according to one of the preceding claims **characterised in** that a first fuel pump (8) is configured to pump fuel from a first fuel tank (6) into the evaporation accelerator (10), preferably in a first mode, and where the first fuel pump (8) or a second fuel pump to pump fuel from the evaporation accelerator (10) into the first fuel tank (6) or into a second fuel tank (6), preferably in another mode.
5. An electronically controlled burner (2) according to one of the preceding claims **characterised in** that the electronically controlled burner (2) comprises a control unit (20) and a temperature sensor being in thermal contact with the evaporation accelerator (10), where the control unit is configured to control the heating element (12) on the basis of temperature detected by the temperature sensor, where the control unit (20) is

configured to switch off the ignition member (36) when the detected temperature exceeds a defined upper temperature level T_2 , and/or where the control unit (20) is configured to switch off the ignition member (36) and the electronically controlled burner (2) when the detected temperature is below a defined lower temperature level T_1 .

6. An electronically controlled burner (2) according to one of the preceding claims **characterised in** that the electronically controlled burner (2) comprises an overflow sensor configured to detect fuel overflow of the tank (6) and to generate an alert in the case of an overflow condition.

7. An electronically controlled burner (2) according to one of the preceding claims **characterised in** that the electronically controlled burner (2) is configured to maintain a set evaporation rate from the evaporation accelerator (10).

8. An electronically controlled burner (2) according to one of the preceding claims **characterised in** that the flame tray (4) is provided with a plurality of flame openings (34, 34') having varying opening sizes and/or shapes.

9. An electronically controlled burner (2) according to one of the preceding claims **characterised in** that the electronically controlled burner (2) comprises a CO sensor and/or a CO₂ sensor.

10. An electronically controlled burner (2) according to one of the preceding claims **characterised in** that the electronically controlled burner (2) comprises a tilt sensor.

11. An electronically controlled burner (2) according to one of the preceding claims **characterised in** that the electronically controlled burner (2) comprises a leakage detection sensor and/or one or more liquid sensors.

12. An electronically controlled burner (2) according to one of the preceding claims **characterised in** that the electronically controlled burner (2) comprises an electronic device, preferably a built-in "Wi-Fi unit", configured to exchange data between an extern device, preferably a smart phone, wirelessly using radio waves.

13. An electronically controlled burner (2) according to claim 12 **characterised in** that the electronically controlled burner (2) is configured to be wirelessly controlled by a smart phone, a computer or a tablet computer.

14. An electronically controlled burner (2) according to one of the preceding claims **characterised in** that the electronically controlled burner (2) is configured to be set in one or more modes in which the energy consumption rate and/or the flame height level is controlled or fixed.

15. An electronically controlled burner (2) according to one of the preceding claims **characterised in** that the evaporation accelerator (10) comprises an inlet (62) and/or outlet (64) and a bottom member (60) inclining towards the inlet (62) and/or outlet (64).

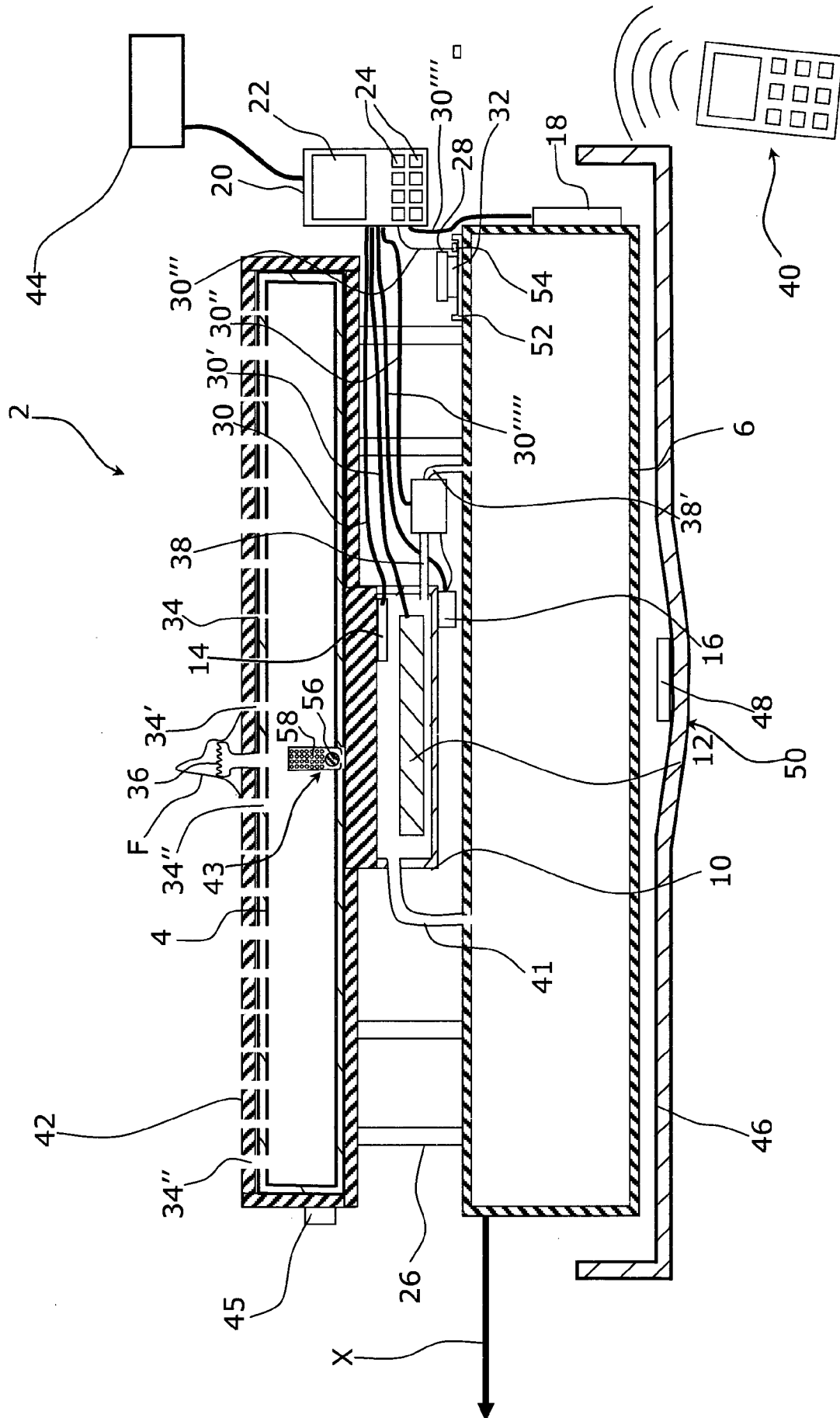


Fig.1

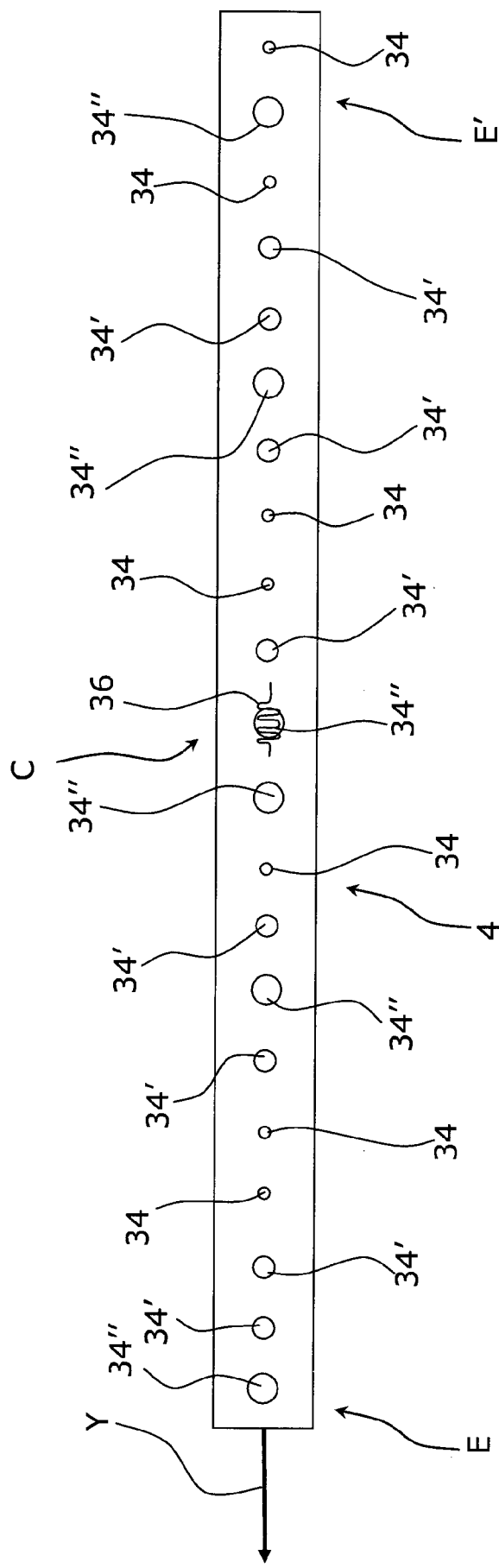


Fig.2

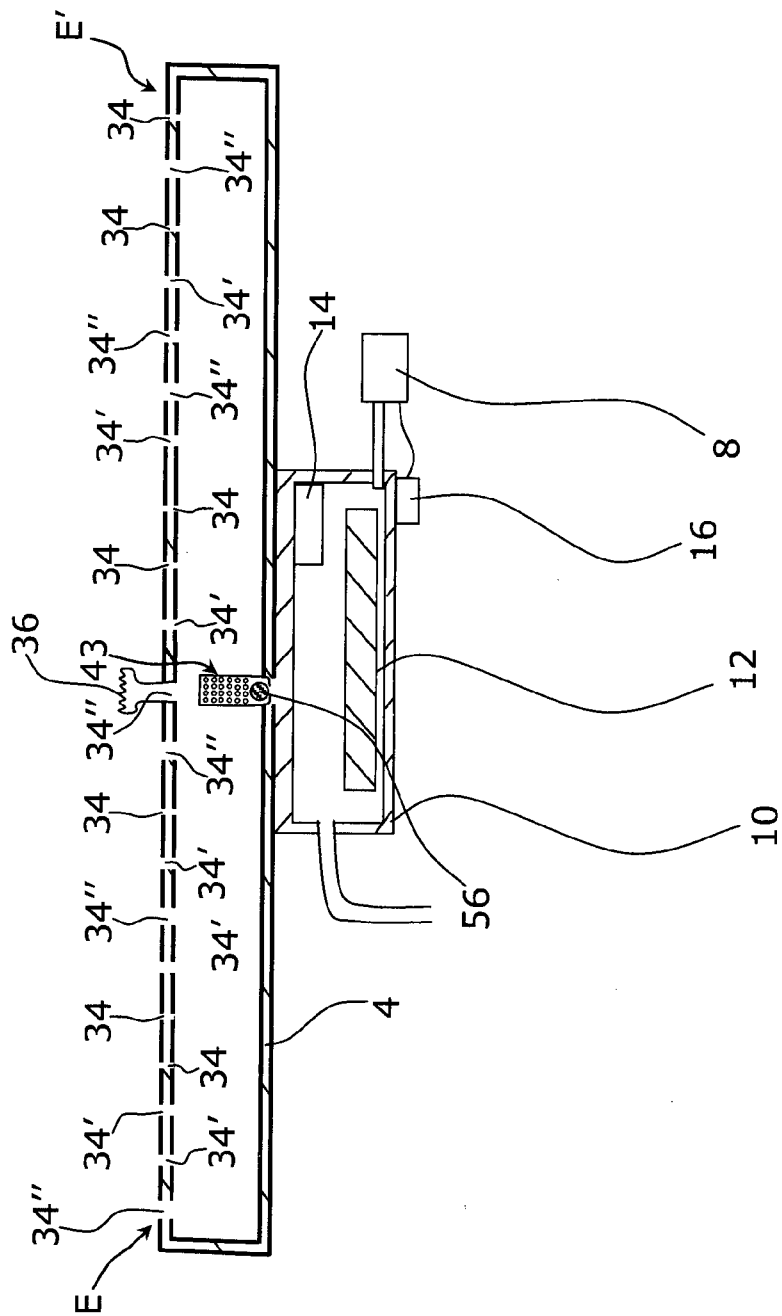


Fig. 3

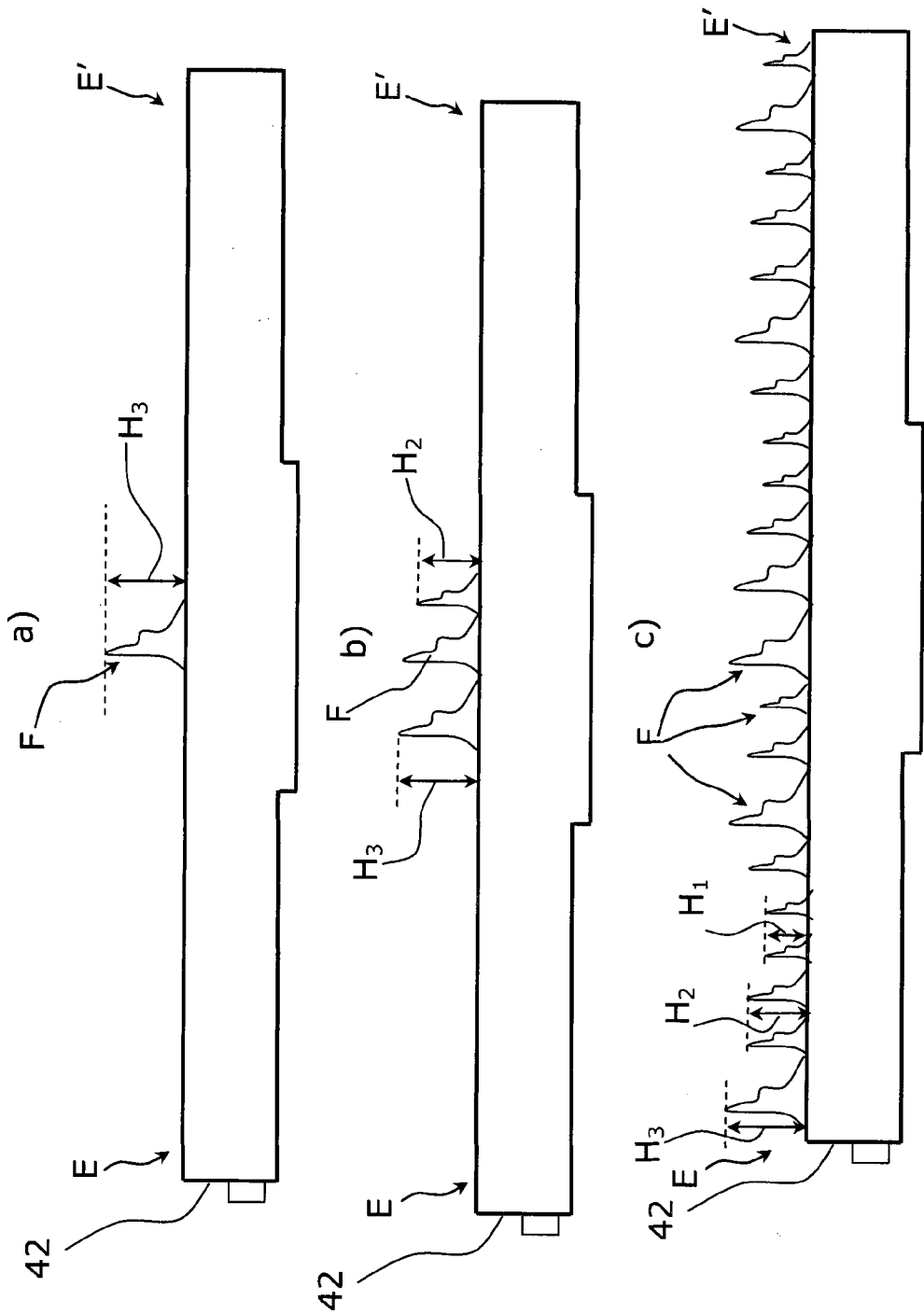


Fig.4

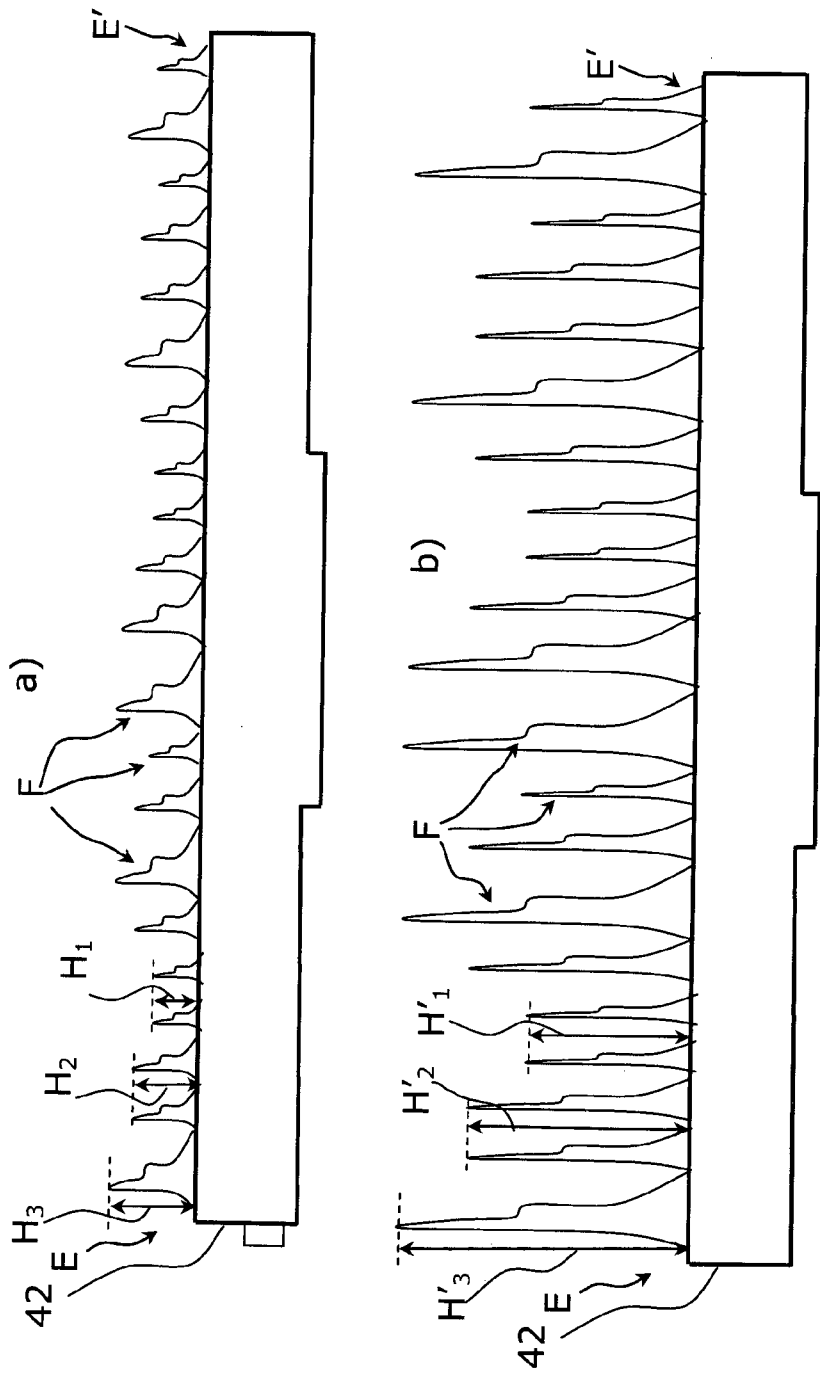


Fig.5

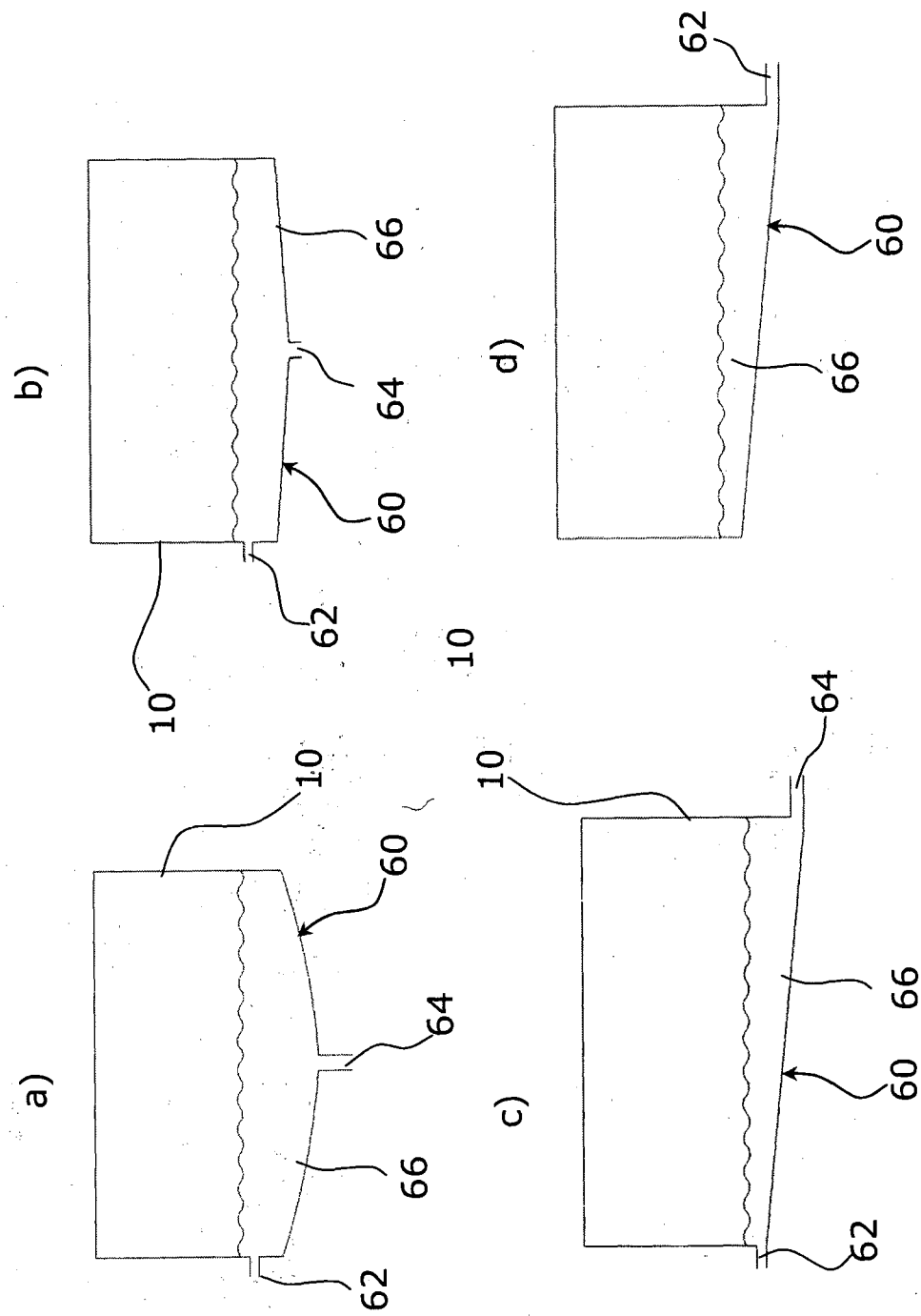


Fig.6