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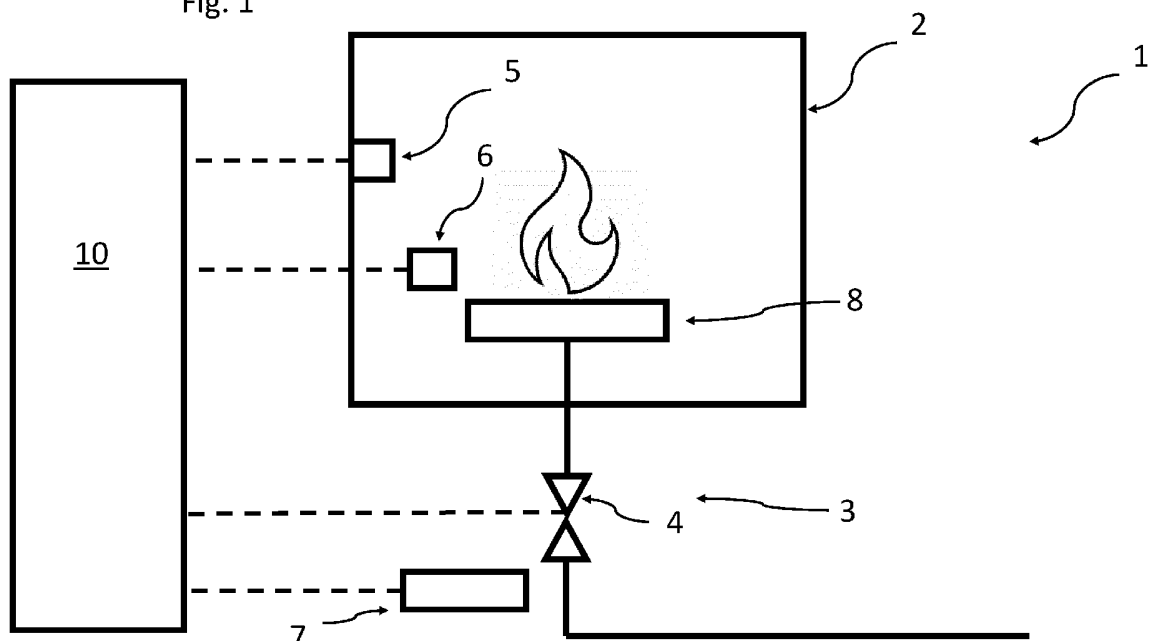
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(54) **GAS BURNING APPLIANCE AND METHOD FOR STARTING UP A GAS BURNING APPLIANCE**

(57) The invention relates to a method for starting up a gas burning appliance, comprising:
- activating an igniter for a predetermined ignition time,
- opening a gas supply for a predetermined safety time to supply combustible gas to the burning chamber,
- detecting the presence of a flame by means of a flame

detector,
- closing the gas supply if no flame has been detected at the end of the predetermined safety time,
wherein the predetermined safety time depends on the composition of the combustible gas.

Fig. 1



Description

[0001] The invention relates to a method for starting up a gas burning appliance. In addition, the invention relates to a gas burning appliance, the use of such as gas burning appliance and a computer program product.

[0002] Gas burning appliances are commonplace for heating purposes and for providing hot domestic / tap water. Such appliances typically have a burning chamber, in which a combustible gas is introduced. At start-up, a spark electrode is activated to create ignition and a stable flame.

[0003] Delayed ignition is a known problem and occurs when ignition doesn't take place immediately, while combustible gas continues to flow into the burning chamber causing a build-up of combustible gas. A delayed ignition, i.e. ignition of the accumulated combustible mixture, may cause an explosion with associated damage and noise. Delayed ignition may have different reasons, such as a malfunctioning spark electrode, insufficient flow of combustible gas or a nonoptimal ratio of air to combustible gas.

[0004] Delayed ignition is in particular a problem when the combustible gas comprises a high amount of hydrogen, as an explosion caused by a delayed ignition of a combustible airhydrogen mixture may not only damage internal components of the appliance, but these components may even be ejected from the boiler case of the appliance. Moreover, the high sound levels that such an explosion produces, could potentially lead to hearing damage of people who are in the vicinity of such an appliance.

[0005] To address the issue of delayed ignition, a controller may be provided that, at start up, activates the spark electrode for ignition and opens the gas valve to allow the fuel gas, in particular hydrogen, to flow into the burning chamber for a pre-set ignition safety time. The gas valve remains open if ignition and a stable flame is achieved during the pre-set ignition safety time. If not, the gas valve is closed, to prevent build-up of gas in the burning chamber.

[0006] EP4015904A1 discloses a method and device for protecting a heater during the ignition of a mixture of air and hydrogen-containing fuel gas. A method and corresponding device for igniting a combustion process in a combustion chamber of a heating device is provided, which is operated with hydrogen or a fuel gas containing hydrogen, and a flame monitor for detecting a flame with a response time after the beginning of the supply of an ignitable mixture of air and fuel gas to the combustion chamber. An ignition process is triggered for a maximum of the duration of a predeterminable ignition time interval, which is shorter than a safety time interval, after the end of which the supply of an ignitable mixture is terminated if no flame has been detected up to this point. According to this document this increases safety when starting a heating device operated with hydrogen or a fuel gas containing hydrogen and enables particularly gentle and safe

ignition processes.

[0007] Other approaches to safely ignite hydrogen burning appliances are provided by the prior art.

[0008] EP3971475A describes an alternative manner of dealing with delayed ignition, i.e. by describing an air-gas mixture burning appliance that comprises a burning unit for burning a combustible air-gas mixture, a flame detector for sensing presence of a flame in the burning unit, an air-gas mixing unit that is arranged upstream of the burning unit for mixing of air and fuel gas to form the combustible air-gas mixture, and a gas supply unit that is arranged upstream of the air-gas mixing unit, wherein the gas supply unit is adapted to regulating a flow of fuel gas to the air-gas mixing unit such that the combustible air-gas mixture has a variable equivalence ratio between fuel gas and air that is based on whether the flame detector senses the presence of the flame in the burning unit or fails to sense the presence of a flame in the burning unit.

[0009] WO2021078949 relates to a surface stabilized fully premixed gas premix burner for burning hydrogen gas, and method for starting such burner. A method is provided for starting a burner wherein a premixed gas comprising a combustible gas and air is supplied, wherein the combustible gas comprises at least 50% by volume of hydrogen. The method comprises the following steps: during a start-up phase: supplying premixed gas having a first lambda-value to the burner surface, wherein the first lambda-value is at least 1.85, and igniting the supplied premixed gas having the first lambda-value using an ignition source. During an operation phase after the premixed gas has been ignited: supplying premixed gas having a second lambda-value to the burner surface, wherein the first lambda-value is larger than the second lambda-value. The lambda-value is defined as a ratio between an actually supplied quantity of air and the quantity of air required for stoichiometric combustion of the premixed gas,

[0010] The object of the invention is to provide a gas burning appliance and a method of operating such a gas burning appliance that reduces the risk of delayed ignition, by reducing the chance of delayed ignition occurring and/or by reducing the consequences of an unwanted delayed ignition.

[0011] The object is solved by a method for starting up a gas burning appliance, the gas burning appliance comprising a burning chamber, a gas supply for supplying combustible gas to the burning chamber, a flame detector for detecting the presence of a flame in the burning chamber and an ignitor for igniting the combustible gas in the burning chamber, wherein the method comprises an ignition sequence comprising:

- activating the igniter for a predetermined ignition time,
- opening the gas supply for a predetermined safety time to supply combustible gas to the burning chamber,

- detecting the presence of a flame by means of the flame detector,
- closing the gas supply if no flame has been detected at the end of the predetermined safety time,

wherein the predetermined safety time depends on the composition of the combustible gas.

[0012] It has been found that the chance of delayed ignition, as well as the consequences of a delayed ignition, can be reduced for burning appliances by choosing a predetermined safety time that depends on the composition of the combustible gas.

[0013] By making the predetermined safety time depended on the composition of the combustible gas, a gas burning appliance is provided that can deal with different combustible gas compositions.

[0014] Of course, when a flame has been detected before the end of the predetermined safety time, the combustible gas supply is kept open and the gas burning appliance continues to operate in a normal operation modus.

[0015] As combustible gas a mixture of air and fuel gas is understood. The fuel gas can be hydrogen or comprise hydrogen. The combustible gas is the gas that is supplied to the burner and burnt in the combustion chamber.

[0016] The safety time is the time that elapses between the order to open and the order to close the combustible gas supply, in particular the hydrogen supply, to the burner in the event of ignition not taking place.

[0017] The ignition time is the total time in which the ignitor is active and the gas valve, in particular the hydrogen valve, is open. During this phase the gas burner appliance can ignite.

[0018] According to an embodiment, if the combustible gas comprises more than 20 mol% hydrogen, the predetermined safety time is less than 3,0 seconds, less than 2,5 seconds, less than 2,0 seconds, less than 1,5 seconds, less than 1,0 second or less than 0,5 second.

[0019] When the combustible gas comprises a certain amount of hydrogen, in particular gas that comprise more than 20 mol% hydrogen, the predetermined safety time can be effectively reduced by using pre-set hydrogen specific safety times, preferably less than 3,0 seconds.

[0020] When the predetermined safety time is reduced, the opening time of the gas supply valve is reduced therefore the volume containing (potentially explosive) H₂ mixture is reduced as well. Therefore, the impact in case delayed ignition takes place is reduced as less hydrogen or hydrogen comprising gas has built up in the burning chamber.

[0021] Hydrogen has a higher flammable range, higher flame speed and requires lower ignition energies compared to natural gas. Therefore, relatively short ignition safety times can be used for ignition.

[0022] When no flame has been detected at the end of the predetermined safety time and the combustible gas supply is closed, the ignition sequence may be repeated repeatedly, until a flame is detected before the

end of the predetermined safety time or until a predetermined maximum number of ignition sequences have been tried. In between ignition sequences, certain actions can be executed, such as purging of the burning chamber.

[0023] Of course, when a flame is detected before the end of the predetermined safety time, the combustible gas supply is left open and the gas burning appliance can go into a continuous operation mode.

[0024] According to an embodiment the end of the predetermined ignition time is before the end of the predetermined safety time. This may be because the predetermined ignition time is shorter than the predetermined safety time and/or the activation of the igniter commences as a predetermined pre-ignition time interval before opening the gas supply, as explained in more detail below.

[0025] This is advantageous in situations when flame detection cannot take place during the ignition time, as an active igniter disturbs the flame detector. This may for instance be the case when using an ionisation-based flame detector or an UV-based flame detector, as the igniter could cause false flame detection.

[0026] Alternatively, in some embodiments the flame detection and the ignition can overlap. Thus, the flame can be detected during the ignition phase. This is possible in gas burning appliances which have an ionization pin and an ignition pin.

[0027] The pre-ignition time interval is the time interval in which the ignitor is activated and the gas valve, in particular the hydrogen valve, is closed. The pre-ignition time interval ends when the gas valve, in particular hydrogen valve, is opened. The predetermined ignition time can consist of the pre-ignition time interval and a remaining part of the predetermined ignition time in which the gas valve is open.

[0028] According to an embodiment activation of the igniter and opening of the gas supply can be initiated at the same moment.

[0029] According to an embodiment, if the combustible gas comprises more than 20 mol% hydrogen, the activation of the igniter commences at a predetermined pre-ignition time interval before opening the gas supply. The predetermined pre-ignition time interval may be at least 1,0 second, or at least 1,5 seconds, or at least 2,0 seconds, or at least 2,5 seconds, or at least 3,0 seconds. Furthermore, the method may comprise switching to an alarm state if a flame is detected during the predetermined pre-ignition time interval. The alarm state may involve closing or not opening the gas supply and/or aborting the ignition.

[0030] The predetermined pre-ignition time interval may be shorter than the predetermined ignition time. The pre-ignition time interval plus the safety time may be smaller than or equal to the ignition time. The predetermined safety time may be less than 3,0 seconds. According to an embodiment, the combustible gas comprises more than 40 mol% of hydrogen, more than 80 mol% of

hydrogen, more than 90 mol% of hydrogen or more than 98 mol% of hydrogen.

[0031] Having a higher hydrogen content results in higher flammable range, higher flame speed and requires lower ignition energies. Therefore, the higher the hydrogen content, the more the predetermined safety time can be effectively reduced. Also, higher hydrogen contents could result in a higher impact of delayed ignition, making it even more advantageous to make the predetermined safety time depended on the composition of the combustible gas.

[0032] According to an embodiment the ignition sequence comprises:

- obtaining an indication of the composition and/or a predetermined default of the combustible gas, including an indication of the amount of hydrogen present in the gas,
- setting the safety time based on the obtained amount of hydrogen present in the gas.

[0033] By obtaining an indication of the amount of hydrogen present in the gas, the safety time can be selected and set to better match the characteristics of the combustible gas. Optionally, also the pre-ignition time interval can be set based on the amount of hydrogen.

[0034] The predetermined default can be stored in an electric memory of the gas burning appliance. Alternatively or additionally, the predetermined default can be gathered from a network server. The predetermined default can comprise information about the gas composition or specification. In particular, the predetermined default can comprise information about at least one country parameter and/or gas type and/or gas category. The predetermined default can be used for setting the safety time.

[0035] In case a gas burning appliance is capable of combusting both natural gas and hydrogen the controller of the gas burning application may be made such that it sets the ignition safety time, and optionally the pre-ignition time interval, based on the amount of hydrogen selected or detected.

[0036] According to an embodiment a higher amount of hydrogen results in a short safety time. That means, the safety time can be shorter the larger the amount of hydrogen is. According to an embodiment the method further comprises:

- setting a first safety time if the amount of hydrogen present in the gas is equal to or greater than a predetermined hydrogen threshold, or
- setting a second safety time if the amount of hydrogen present in the gas is less than the predetermined hydrogen threshold.

[0037] The predetermined hydrogen threshold may be 20 mol% or more than 20 mol %.

[0038] According to an embodiment the first safety time

is smaller than the second safety time.

[0039] According to an embodiment obtaining an indication of the composition of the combustible gas comprises

- controlling a gas composition detector or hydrogen detector to perform one or more measurements and receiving such measurements and/or
- receiving one or more measurements from a gas composition detector or hydrogen detector, and/or
- receiving a user input, and/or
- receiving a message from a remote computer.

[0040] A gas composition detector may be provided by any suitable gas composition detector such as a thermal conductivity sensor configured to measure the thermal conductivity of the combustible gas or a sensor measuring the speed of sound in the combustible gas. Based on the obtained measurements, the composition of the combustible gas can be deduced. A hydrogen detector may be provided by an ionisation probe, in particular when there is a high concentration of hydrogen, e.g. more than 98 mol%.

[0041] Based on the measurements, user input or message received, the predetermined safety time and optionally the predetermined pre-ignition time interval can be set.

[0042] Measurements may be taken constantly or at regular time intervals and adjustments to the safety time and optionally pre-ignition time interval can be made when required.

[0043] User input may be received upon installation of the gas burning appliance, for instance by a certified installer. Based on the type of combustible gas that is available at the location site, the installer may provide user input to the gas burning appliance reflecting the composition of the combustible gas or at least reflecting the hydrogen content of the combustible gas.

[0044] A message may be received from a remote computer, for instance from the gas supplier with information on the composition of the combustible gas or at least the hydrogen content. A remote computer may also be a gas meter.

[0045] According to an embodiment the combustible gas supplied to the burning chamber during the predetermined safety time has a first lambda-value, wherein the method further comprises when a flame has been detected by the flame detector before the end of the predetermined safety time, the gas supply is kept open and the gas burning appliance continues to operate in a continuous operation mode, wherein the continuous operation mode comprises supplying combustible gas to the burning chamber having a second lambda-value, the first lambda-value being larger than the second lambda-value.

[0046] The lambda-value is defined as a ratio between a quantity of air and a quantity of fuel in the combustible gas. The first lambda-value may be at least 1.85. Accord-

ing to an embodiment, the first lambda-value may be larger than 2, in particular between 2-6, preferably larger than 3, in particular between 3-5, more preferably larger than 4, in particular between 4-5. According to an embodiment the second lambda-value is between 1-2, preferably between 1.05-1.5, more preferably between 1.05-1.3. According to an embodiment, the first lambda-value is at least 1.5 times as large as the second lambda-value, preferably at least 2 times as large, in particular at least 3 times as large.

[0047] The load in the starting up phase can be lower than the load in an operation phase of gas burning appliance. In the operation phase a flame is present. This embodiment even further reduces the risk as starting with a lower load means introducing less fuel into the burning chamber.

[0048] According to a further aspect there is provided a gas burning appliance comprising a burning chamber, a gas supply for supplying combustible gas to the burning chamber, a flame detector for detecting the presence of a flame in the burning chamber and an ignitor for igniting the combustible gas in the burning chamber, wherein the gas burning appliance comprises a controller configured to carry out the method according to the above.

[0049] The gas burning appliance may comprise input/output means to activate the igniter, open and close the combustible gas supply, receive information from the flame detector. The gas burning appliance may further comprise input/output means to send instructions and/or receive measurements from a gas composition detector or hydrogen detector, user input and/or a remote computer.

[0050] Further provided is the use of such a gas burning appliance in a boiler or a water heater.

[0051] Additionally, an advantageous embodiment is a computer program product comprising instructions cause such a gas burning appliance to execute the steps of the method according to the above. Furthermore, a data carrier is provided on which the computer program is stored and/or data carrier signal is provided which transmits the computer program.

[0052] In the figures, the subject-matter of the invention is schematically shown, wherein identical or similarly acting elements are usually provided with the same reference signs.

Figure 1 shows a gas burning appliance according to an embodiment,

Figure 2 shows an ignition sequence according to an embodiment,

Figure 3 shows an ignition sequence according to an alternative embodiment.

[0053] Fig. 1 schematically shows a gas burning appliance 1. The gas burning appliance comprises a burning chamber 2 with a burner 8. A combustible gas supply

3 is provided to supply combustible gas to the burner 8. In the gas supply 3 a gas supply control valve 4 is provided. The gas flows in a pipe of the gas supply 3. Additionally, the gas supply 3 can comprise a non-shown mixer for mixing the fuel gas, in particular hydrogen, with air.

[0054] A flame detector 5 is provided for detecting the presence of a flame in the burning chamber 2. The flame detector 5 can be any suitable flame detector, such as an optical flame detector, a temperature sensor, a thermocouple, a catalytic sensor or an O₂/lambda sensor.

[0055] Also, an ignitor 6 is provided for igniting the combustible gas in the burning chamber to create a flame. The ignitor 6 may be a spark electrode, arranged to generate sparks to ignite the combustible gas.

[0056] It will be understood that the gas burning appliance may comprise additional elements which are omitted in Fig. 1. For example, the gas burning appliance may further comprise a heat exchanger to allow water to be heated by the heat generated in the burning chamber 2.

[0057] Furthermore, a controller 10 is provided. The controller 10 may be a dedicated piece of hardware or a computer which can be programmed.

[0058] The controller 10 may control the igniter 6 to be active in order to ignite the combustible gas arranged in the combustion chamber. The controller 10 may also be arranged to switch the igniter 6 on and off when needed. The controller may be arranged to receive input from the flame detector 5 indicating the presence or absence of a flame.

[0059] The controller 10 may control the combustible gas supply 3 to supply combustible gas to the burning chamber 2. The controller 10 may be arranged to control the flow rate of the combustible gas flowing into the burning chamber 2. The flow rate may be expressed as m³/s or kg/s.

[0060] The controller 10 is arranged to perform an ignition sequence comprising:

- activating the igniter 6 for a predetermined ignition time,
- opening the gas supply 3 for a predetermined safety time to supply combustible gas to the burning chamber 2,
- detecting the presence of a flame by means of the flame detector 5,
- closing the gas supply 3 if no flame has been detected at the end of the predetermined safety time.

[0061] Opening and closing of the gas supply 3 may be done by controlling the gas supply valve 4.

[0062] The predetermined safety time depends on the composition of the combustible gas. The ignition sequence is explained in more detail below with reference to Fig. 2. It will be understood that the controller 10 may perform other functions not described here to control the gas burning appliance 1.

[0063] With reference to the left-hand side of Fig. 2, an ignition sequence is depicted. First, the igniter 6 is acti-

vated and the combustible gas supply 3, in particular the valve 4, is opened, schematically depicted in the two top rows in Fig. 2. The gas supply 3 is opened for a predetermined safety time indicated by the double arrow S in Fig. 2. In this embodiment, the ignitor 6 is activated during a predetermined ignition time equal to the safety time. During the safety time, the flame detector 5 detects the presence or absence of a flame. The third line in Fig. 2 shows the actual presence of a flame in the burning chamber 2, while the fourth line shows the detection of a flame by the flame detector 5.

[0064] As shown in Fig. 2, if no flame has been detected at the end of the predetermined safety time, the gas supply 3 is closed. In that case, at the end of the predetermined safety time, the ignitor 6 may be de-activated. Optionally, the gas chamber may be purged to remove combustible gas from the gas chamber 2, before a new ignition sequence is initiated.

[0065] Purging means the forced introduction of air through the combustion chamber and flue passages in order to displace any remaining fuel/air mixture and/or products of combustion.

[0066] Purging may take place in between each ignition sequence. This is referred to as an inter-purge. Inter-purge is done between ignition sequences or attempts.

[0067] Purging may also be done before the first ignition sequence, for instance in case of flame loss during operation. This is referred to as a pre-purge. Pre-purge is a purge which takes place between a start signal and energization or activation of the igniter.

[0068] Ignition sequences may be initiated repeatedly, until the presence of a flame is detected by the flame detector 5 before the end of the predetermined safety time. The right-hand side of Fig. 2 shows a second ignition sequence. As shown, in this case a flame is present and detected and the gas supply 3 remains open. Still, the ignitor 6 is deactivated at the end of the predetermined ignition time.

[0069] The controller 10 may set the predetermined safety time based on information obtained regarding the composition of the combustible gas, in particular the amount of hydrogen present in the combustible gas. According to an embodiment, this indication may be obtained in different ways.

[0070] According to the embodiment depicted in Fig. 1 the indication is obtained by means of a gas composition detector 7. The gas composition detector 7 is arranged to obtain an indication of the composition of the fuel gas, in particular the amount of hydrogen, present in the combustible gas flowing through the gas supply 3 and provide such to the controller 10. The controller 10 is arranged to set the safety time based on the received information. Generally, a higher hydrogen content results in a shorter safety time interval. The combustible gas can comprise more than 20 mol% hydrogen.

[0071] Fig. 3 shows an alternative ignition sequence in which the combustible gas comprises more than 20 mol% hydrogen and the activation of the igniter 6 com-

mences at a predetermined pre-ignition time interval before opening the gas supply. The pre-ignition time interval is indicated in Fig. 3 with the double arrow P. The predetermined pre-ignition time interval is at least 1,5 second. The ignition time consists of the pre-ignition time interval and a remaining part of the predetermined ignition time in which the gas valve is open.

[0072] Furthermore, in this embodiment, the end of the predetermined ignition time is before the end of the predetermined safety time.

[0073] Similar to Fig. 2, the left-hand side of Fig. 3 shows a failed ignition sequence, the right-hand side shows a successful ignition sequence.

Reference Signs

[0074]

1. Gas burning appliance
2. Burning chamber
3. Gas supply
4. Gas supply control valve
5. Flame detector
6. Ignitor
7. Gas composition detector
8. Burning deck
10. Controller

Claims

1. Method for starting up a gas burning appliance (1), the gas burning appliance (1) comprising a burning chamber (2), a gas supply (3) for supplying combustible gas to the burning chamber (2), a flame detector (5) for detecting the presence of a flame in the burning chamber (2) and an ignitor (6) for igniting the combustible gas in the burning chamber (2), wherein the method comprises an ignition sequence comprising:

- activating the igniter (6) for a predetermined ignition time,
- opening the gas supply (3) for a predetermined safety time to supply combustible gas to the burning chamber (2),
- detecting the presence of a flame by means of the flame detector (5),
- closing the gas supply (3) if no flame has been detected at the end of the predetermined safety time,

wherein the predetermined safety time depends on the composition of the combustible gas.

2. Method according to claim 1, wherein the combustible gas comprises more than 20 mol%, in particular more than 30 mol%, hydrogen, the predetermined

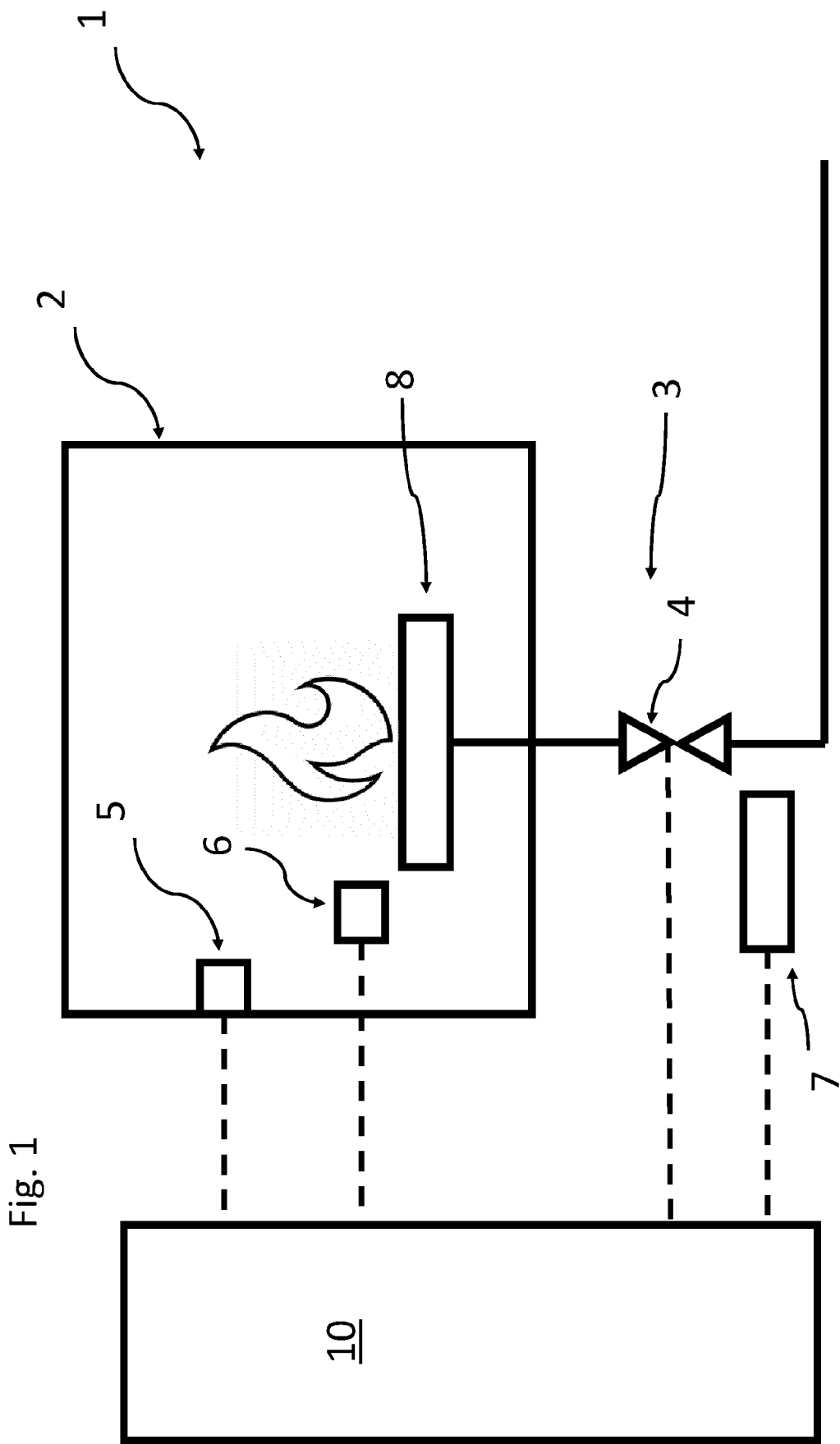
safety time is less than 3,0 seconds, less than 2,5 seconds, less than 2,0 seconds, less than 1,5 seconds, less than 1,0 second or less than 0,5 second.

3. Method according to any one of the preceding claims, wherein the end of the predetermined ignition time is before the end of the predetermined safety time. 5
4. Method according to any one of the preceding claims, wherein activation of the igniter and opening of the gas supply (3) are initiated at the same moment. 10
5. Method according to any of the claims 1-3, wherein if the combustible gas comprises more than 20 mol%, in particular more than 30 %, hydrogen, the activation of the igniter (6) commences at a predetermined pre-ignition time interval before opening the gas supply (3). 15
6. Method according to any one of the claims 2 - 5, wherein the combustible gas comprises more than 40 mol% of hydrogen, more than 80 mol% of hydrogen, more than 90 mol% of hydrogen or more than 98 mol% of hydrogen. 20
7. Method according to any one of the preceding claims, wherein the ignition sequence comprises: 25
 - obtaining an indication of the composition and/or at least one predetermined default of the combustible gas, including an indication of the amount of hydrogen present in the gas,
 - setting the safety time based on the obtained amount of hydrogen present in the gas. 30
8. Method according to claim 7, wherein the safety time is shorter the larger the amount of hydrogen is. 35
9. Method according to claim 7 or 8, wherein the method further comprises: 40
 - setting a first safety time if the amount of hydrogen present in the gas is equal to or greater than a predetermined hydrogen threshold, or
 - setting a second safety time if the amount of hydrogen present in the gas is less than the predetermined hydrogen threshold. 45
10. Method according to claim 9, wherein the first safety time is smaller than the second safety time. 50
11. Method according to any one of the claims 7 - 10, wherein obtaining an indication of the composition of the combustible gas comprises 55
 - controlling a gas composition detector (7) or

hydrogen detector to perform one or more measurements and receiving such measurements, and/or

- receiving one or more measurements from a gas composition detector (7) or hydrogen detector, and/or
- receiving a user input, and/or
- receiving a message from a remote computer.

12. Gas burning appliance (1) comprising a burning chamber (2), a gas supply (3) for supplying combustible gas to the burning chamber (2), a flame detector (5) for detecting the presence of a flame in the burning chamber (2) and an igniter (6) for igniting the combustible gas in the burning chamber (2), wherein the gas burning appliance comprises a controller (10) configured to carry out the method of one of the claims 1 - 11. 10
13. Use of a gas burning appliance (1) according to claim 12 in a boiler or a water heater. 15
14. Computer program product comprising instructions which cause the gas burning appliance (1) of claim 12 to execute the steps of the method of any one of the claims 1 - 11. 20
15. Data carrier on which the computer program of claim 14 is stored or data carrier signal transmitting the computer program according to claim 14. 25



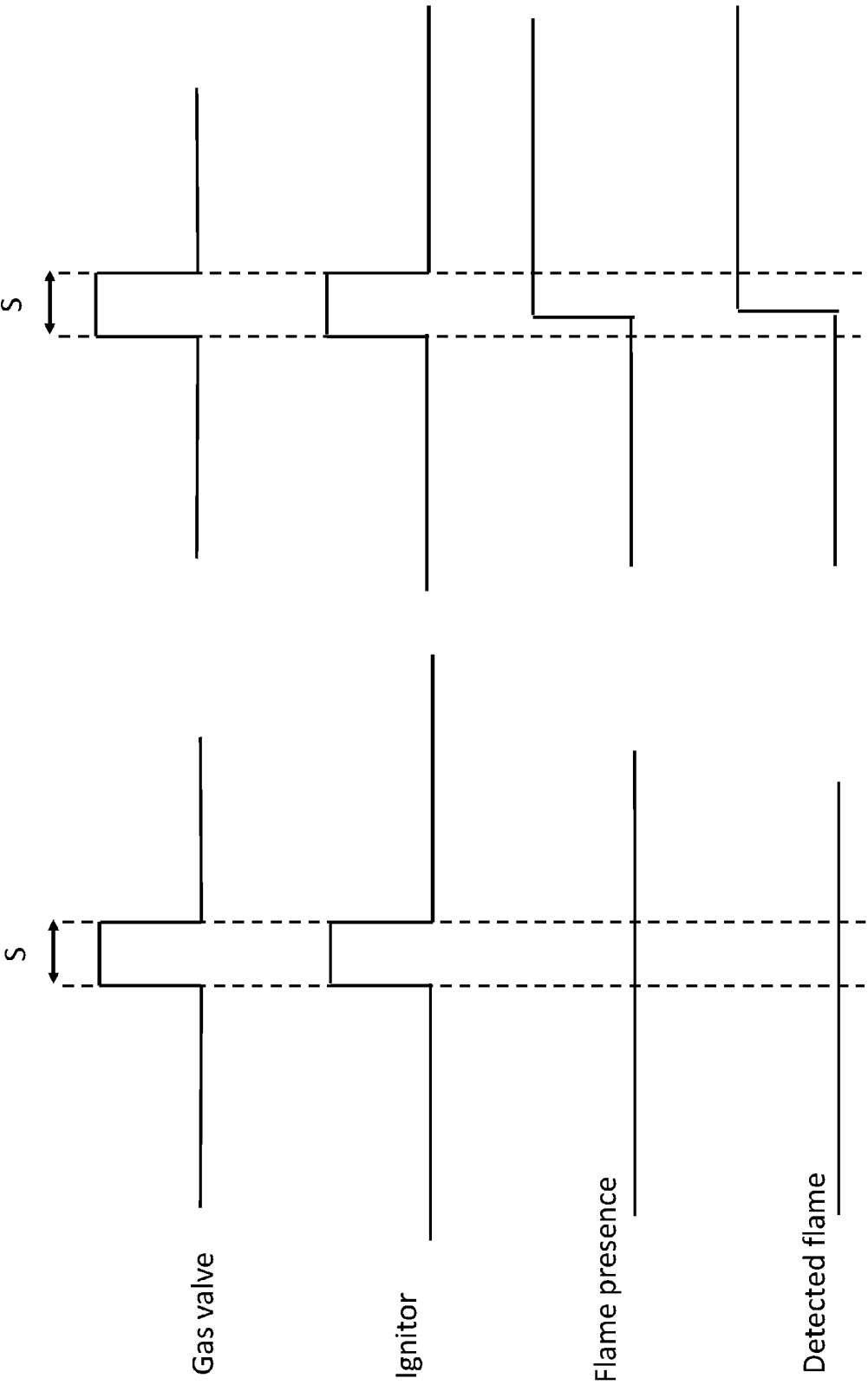


Fig. 2

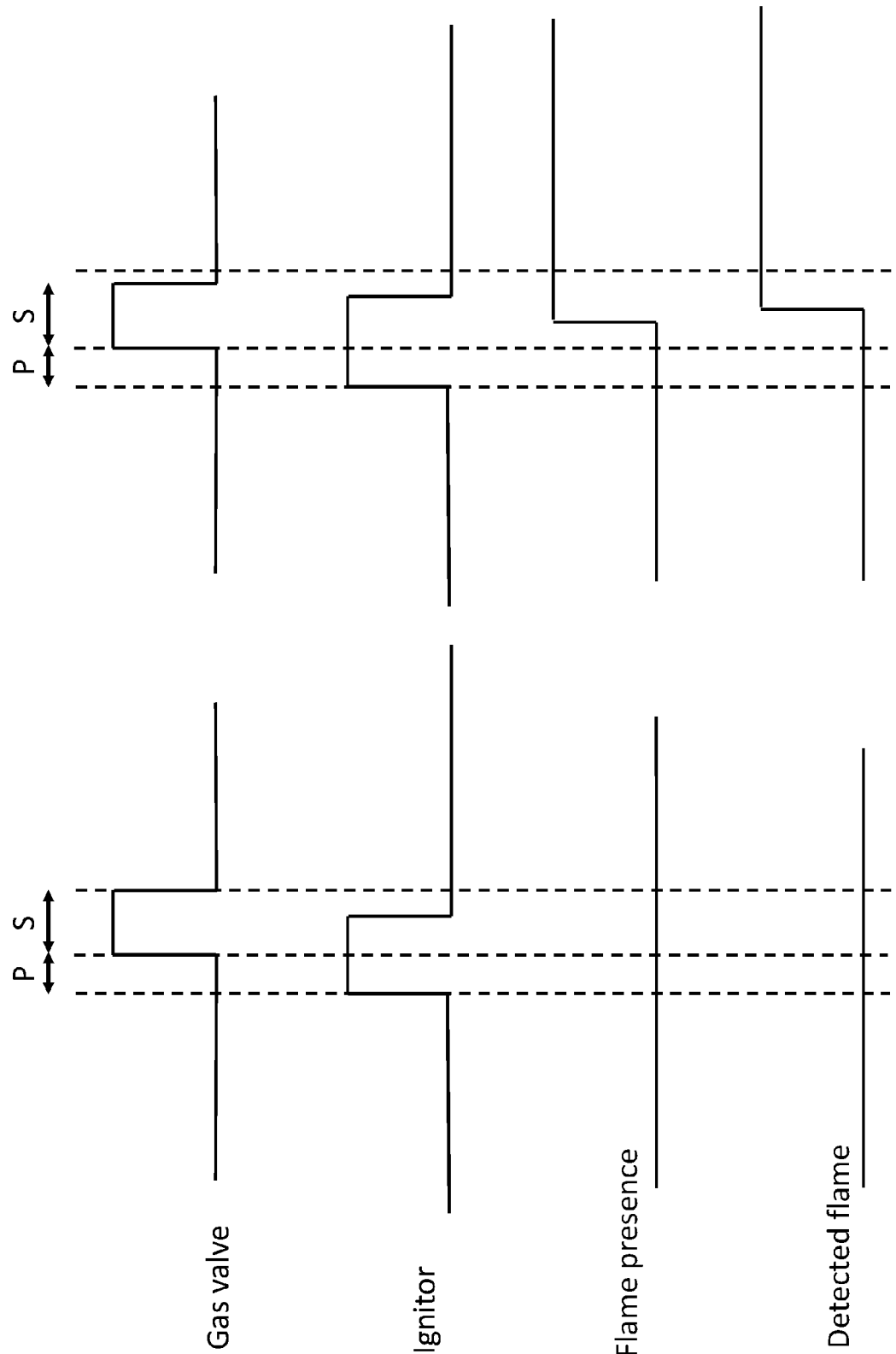


Fig. 3



EUROPEAN SEARCH REPORT

Application Number

EP 22 21 5286

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EPO FORM 1503 03.82 (P04C01)

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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	

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

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