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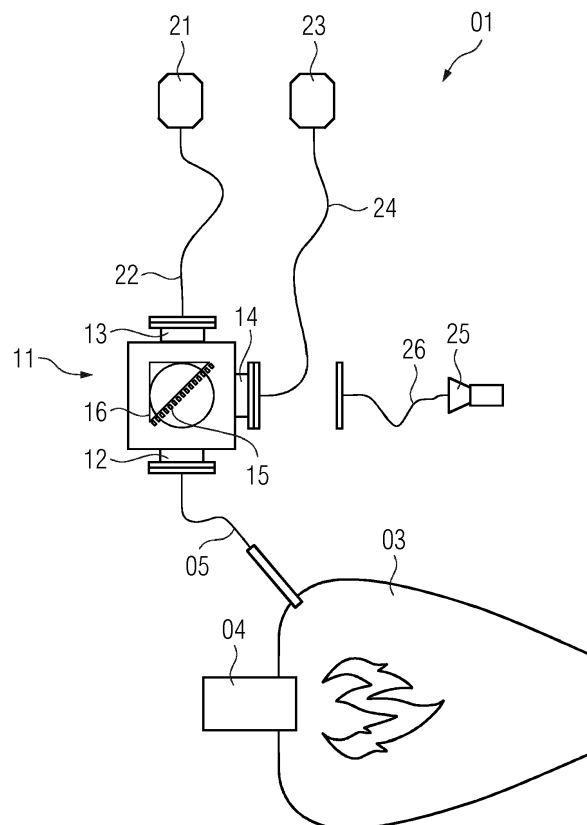
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(54) **FLAME DETECTION SYSTEM**

(57) The invention is about a flame detection system (01) to identify a flame within a combustion chamber of a gas turbine. Therefore, the system (01) comprises a light guiding device (05), which is mounted at the combustion chamber (03), and a connection device (11), which is attached at the light guiding device (05), and a first light detector (21), which is attached at the connec-

tion device (11) and is able to detect a light. To increase the reliability the flame detection system (01) further comprises a second light detector (23), which is also attached to the connection device (05) and is able to detect a light. To send the light to both light detectors (21, 23) a semi-transparent mirror (15) is provided inside the connection device (05).

FIG 1



Description

[0001] The invention is about a system to identify the existence of a flame inside a combustion chamber.

[0002] To operate a gas turbine, especially for the start of a gas turbine, it is essential to have the certainty about the existence of a flame inside the combustion chamber respectively about a successful ignition at the start of the gas turbine. Therefore, it is commonly known to use light detectors to determine a flame inside the combustion chamber. These light detectors could not be attached directly to the combustion chamber due to the high temperatures during operation of the gas turbine. The solution of the state of the art comprises a light guiding device, which is in most times just a hollow tube, which allows a direct view inside the combustion chamber through a high temperature resistance sight glass. At the other end of the light guiding device opposite to the combustion chamber, regular outside or at the outer casing of the gas turbine a connection device is arranged, from whereon the further guiding of the light could be done with a fiber optics at which end the light detector is arranged.

[0003] Even if the solution is well established and provides the necessary information about the existence of a flame it could happen, that the light detector doesn't indicate a flame even that a flame exists. This leads especially at the start of the gas turbine to cancel the start and repeat the ignition.

[0004] The task for the current invention is therefore to increase a reliable detection of a flame inside of a combustion chamber.

[0005] The task is solved by a system according claim 1. A method to solve the problem is given in claim 10. Advantageous solutions are subject of the dependent claims.

[0006] A generic flame detection system is used to detect a flame inside of a combustion chamber. Preferably, the flame detection system is used at a gas turbine. The flame detection system comprises a light guiding device, a connection device and a first light detector. It is essential for the implementation, that an optical view inside the combustion chamber is able with the usage of the light guiding device. The connection device is arranged next at the light guiding device. This has at least an input to attach the light guiding device and an output. At regular operation the first light detector is arranged in such a kind, that light coming from the output of the connection device is send to the light detector. Therefore, the light detector could be attached direct to the output or with other means in-between. It must be possible to identify a flame with the first light detector, which therefore must be able to determine at least the existence of a light.

[0007] To increase the reliability the inventive flame detection system further comprises a second light detector. To enable a detection of a flame, which means the determination of a light, at the same time with the first light detector and the second light detector, it is further necessary for the inventive solution to split the light com-

ing from the light guiding device into two further light-path. Here the connection device comprises a semitransparent mirror and in addition to the input and the output further an attachment. The semitransparent mirror is arranged and executed in such a way that the light entering the connection device at the input is send partly to the output and partly to the attachment. Accordingly, the second light detector needs to be attached directly or indirectly to the attachment. The second light detector could be of the same type as the first light detector, wherein the second light detector must analog be able to determine at least the existence of a light.

[0008] With the new inventive system, the reliability to detect a flame inside the combustion chamber is increased. This avoids in some circumstances a stop of the gas turbine, especially the start process, which prevents further a loss of time to produce electrical energy with the gas turbine (or for other tasks).

[0009] To enable a sufficient detection of light with both light detectors at the same time, it is advantageous if the connection device splits the light coming from the input in such a way, especially with the implementation of the semitransparent mirror, that at least 40% of the light at the input is send through the output to the first light detector and that at the same time at least 40% of the light at the input is send through the attachment to the second light detector.

[0010] The more-or-less equal split of the light and further a simple construction is achieved advantageously, if the semitransparent mirror is aligned at an angle of 45 degrees relative to a straight line from the input to the output. This enables an arrangement, where the output is opposite to the input at the connection device and the attachment is arranged crosswise to the input and the output.

[0011] To enable an advantageous analysis of the flame detection system itself, the semitransparent mirror is advantageously adjustable mounted, so that it could change the position. During regular operation of the gas turbine the semitransparent mirror is arranged in an operational position. Obviously, the light from the input is send at the same time to the output to be send further to the first light detector and to the attachment to be send further to the second light detector. To enable a test of the flame detection system the semitransparent mirror could further be set into a testing position. Here light coming from the attachment will be send to the output of vis-versa light from the output will be send to the attachment.

[0012] It is further advantageous to enable the different positions to arrange the semitransparent mirror 90 degrees pivotable. Obvious, the semitransparent mirror needs to be swiveled from the operational position by 90degrees to get into the testing position, wherein the rotation is limited in both positions.

[0013] To guide the light coming from the input to the output and to the attachment with the usage of the semitransparent mirror without further disturbance and especially to enable an easy bearing of the pivotable semi-

transparent mirror it is advantageous, if the semitransparent mirror is arranged on the surface of an transparent prism with the shape of a triangle with preferably 45deg x 45deg x 90deg.

[0014] To enable a further determination of the combustion by the analysis of the light coming from the flame inside the combustion chamber, it is further advantageous, if the first light detector is able to determine the intensity and/or the specific wavelength range (color) of the light. Analogous it is advantageous, if the second light detector is able to determine the intensity and/or the specific wavelength range (color) of the light.

[0015] There it is in particular advantageous, if the first light detector and the second light detector are of a different kind to each other to determine a different range of wave lengths (colors).

[0016] If the intensity of the light is known it is possible to draw conclusions regarding the combustion inside the combustion chamber. Also, if the color of the light could be determined and further with both information, the intensity and the color, an analysis of the combustion could be performed to get more information for example about the kind of fuel burned and/or how the combustion process inside the combustion chamber works.

[0017] To enable a useful analysis of the flame detection system itself, it is further advantageous, if the flame detection system further comprises a test light emitter as replacement for the test situation. As two light detectors are preferred used in the operation of the gas turbine, both could be analyzed by the usage of the test light emitter. Therefore, in a first solution the test light emitter is optically direct or in-direct attached to the attachment, wherein obviously the second light detector needs to be removed for the analysis. Analogous in a second solution the test light emitter is optically direct or in-direct attached to the output, wherein obviously the first light detector needs to be removed for the analysis.

[0018] Here it is advantageous, if the test light emitter could emit light equal to the light with similar wavelength range which is emitted by the flame of the combustion from inside of the combustion chamber. To enable a further analysis of the combustion it is particular advantageous, if the test light emitter is able to emit different kind of light representing different combustion situations for example with different load of the gas turbine or with different fuel.

[0019] Especially with the pivotable semitransparent mirror with the testing position, it is possible to analyze the first data of the first light detector and/or the second data of the second light detector dependent to different kind of light send from the test light emitter. This enables the knowledge about the correlation between the values from the light detectors and the flame respectively the combustion process.

[0020] For the implementation of the inventive solution preferably a hollow tube is used at the light guiding device as this is the suitable solution to guide a light and thereby to withstand the high temperatures of the combustion

chamber.

[0021] To arrange the first light detector respectively the second light detector relative to the connection device it is advantageous to use a first light conductor as optical connection between the output and the first light detector respectively to use a second light conductor as optical connection between the attachment and the second light detector. Here it is particular advantageous to use fire optics for the light conductor. Analogous it is advantageous to use a test light conductor with preferably a fiber optics to connect the connection device with the test light emitter in the test situation.

[0022] With the inventive flame detection device, it is possible to generate an inventive gas turbine. This comprises the combustion chamber and a flame detection device according preceding description. The further realization of the gas turbine could be of a common type, which is known by the expert for gas turbines.

[0023] Next the new inventive flame detection system enables a new inventive method to detect a flame. Accordingly, an inventive flame detection system according the preceding description is used. The method comprises at least the recording of a first data from the first light detector and a second data from the second light detector. The first data respectively the second data could be analyzed to identify a light and accordingly a flame inside the combustion chamber.

[0024] As two light detectors are used, where different results are possible, advantageously different situations needs to be considered:

If both data of both light detectors represent "no light" and accordingly "no flame", it is advantageously assumed, that no flame and therefore no combustion taking place inside the combustion chamber.

[0025] If both data of both light detectors represent "light" and accordingly "flame", it is advantageously assumed, that a flame exists and therefore a combustion takes place inside the combustion chamber.

[0026] As there could be no light inside the combustion chamber, when the gas turbine is in operation, except from the flame of the combustion it is assumed that there is a flame and accordingly a combustion, if at least one of the first data and the second data of the light detectors represents a light.

[0027] With a common solution from the state of the art with only one light detector if the data of the only one light detector represents "no light", it needs to be assumed, that there is no combustion, especially in the situation of the ignition of the combustion within the gas turbine. As result in the previous common solution the gas turbine needs to be stopped again and the start process needs to be repeated.

[0028] In contrast to this with the new inventive solution with the exemplary situation, that the second light detector reports a light while the first data of the first light detector represents "no light", it could still be assumed that a flame and therefore a combustion exists.

[0029] In this situation with one data indicating a flame

and another data indication "no flame" it is in particular advantageous to generate a combustion alert.

[0030] This is advantageously also the case if the recorded data not just indicate a flame but has furthermore information about the intensity and/or the range of wavelength (color) of the light and where the first data does not match the expected value of the second data dependent on the current operation condition. This enables the possibility to identify abnormal combustion situation quickly and gives the possibility to react on such situation quickly.

[0031] If a combustion alert is generated by the flame detection system different option to handle this alert are possible. First it is possible to draw the attention of the operating personal to this issue. Further a manual action could be required to handle this issue. In an advantage method further available information about the combustion status are analyzed. If that further information indicates a combustion without information about a fault of the combustion or a deviation from the planned combustion process, it is assumed, that at least one of the light detectors has a defect. It is in particular advantageous to determine the light detector with the defect by an analysis of the first data and the second data and the expected data from the assumed operational status of the combustion.

[0032] To verify the function of the first light detector respectively the second light detector a function test is performed with the steps:

1st, to test the first light detector the second light detector is replaced by the test light emitter. Respectively if the second light detector should be tested the first light detector is replaced by the test light emitter.

2nd, the position of the semitransparent mirror is changed from the operation position to the testing position.

3rd, with the usage of the test light emitter the function of the first light emitter respectively the second light emitter is tested/verified, or a defect is confirmed, and the light detector needs to be replaced.

[0033] The function test is advantageously done before the planned ignition of the combustion respectively start of the gas turbine.

[0034] The function test could also be done during combustion respectively the operation of the gas turbine. This is advantageously performed in case of an alert of the flame detection system. Taking further status data of the combustion respectively of the gas turbine into account, an assumed defect of at least one of the light detectors could be verified or excluded.

[0035] The following figures schematically show an exemplary arrangement of a flame detection system.

Fig. 1 shows schematically the exemplary flame detection system at the operation of the gas turbine.

5 Fig. 2 shows schematically the exemplary flame detection system arranged to test the function of on light detector.

[0036] In Fig. 1 an example for an inventive flame detection system 01 is shown schematically. The flame detection system is used intentionally at a combustion chamber 03, which 03 comprises a burner 04 to enable a combustion inside of the combustion chamber 03. To determine a combustion the flame detection system 01 is used to identify a light coming from the inside of the combustion chamber 03.

[0037] At the combustion chamber 03 the light guiding device 05 is attached, which 05 comprises preferably a hollow tube, which enables a direct view inside the combustion chamber 03. The light guiding device 05 is connected at an input 12 of a connection device 11. The connection device 11 is arranged at a position with lower temperature compared to the position, where the light guiding device 05 is attached at the combustion chamber 03. At the connection device 11 a first light conductor 22 is attached at an output 13. At the other end of the first light conductor 22 a first light detector 21 is arranged. A light coming from the inside of the combustion chamber 03 is guided from the light guiding device 05, through the connection device 11 over the first light conductor 22 to the first light detector 21. This 21 is enabled to detect preferably the intensity and the wavelength range (color) of the light.

[0038] To increase the reliability the flame detection system 01 comprises further a second light detector 23. This is also connected with the connection device 11 by means of a second light conductor 24. Therefore, the connection device 11 comprises an attachment 14, where the second light conductor 24 is attached. To enable the usage of both light detectors 21, 23 at the same time the connection device 11 comprises a semitransparent mirror 15, which 15 is arranged at an angle of 45 deg. relative to a straight line from the input 12 to the output 13 of the connection device 11, whereby the attachment 14 is arranged cross to this straight line. As result the light coming from the combustion chamber is split partly to the output 13 and further to the first light detector 21 and partly to the attachment and the second light detector 23. Preferably the semitransparent mirror 15 is arranged at a transparent prism 16.

[0039] The next Fig. 2 shows correspondent to figure 1 the flame detection system 01 in an arrangement, which enables a test of one light detector 21. To enable this function test, the light detectors 21, 23 are detachable at the output 13 respectively at the attachment 14. Here the second light detector 23 with the second light conductor 24 is removed from the attachment 14. Instead a test light conductor 26 is attached at the attachment 14 and

at the other end of the test light conductor 26 a test light emitter 25 is arranged. The test light emitter 26 could send light similar to the light send out from the combustion inside the combustion chamber 03. To guide the test light to the first light detector 21 the semitransparent mirror 15 is arranged in another position. Therefore, the transparent prism 16 is swivel able by 90 deg. This leads to two different positions of the semitransparent mirror 15 with the operational position shown in figure 1 and the testing position shown in figure 2.

Claims

1. Flame detection system (01) to identify a flame within a combustion chamber, in particular of a gas turbine, comprising a light guiding device (05) and a connection device (11) and a first light detector (21), wherein the connection device (11) has an input (12) and an output (13), wherein the light guiding device (05) could be mounted at the combustion chamber (03) and is connected with the input (12), wherein the first light detector (21) is optically connected with the output (13) and is able to determine existence and/or the intensity and/or the range of wavelength of light with a first data, wherein the first light detector (21) is optically connected with the output (13) and is able to determine existence of light,
characterized by
a second light detector (23), wherein the connection device (11) comprises further an attachment (14) and a semitransparent mirror (15), wherein the semitransparent mirror (15) is able to split the light from the input (12) partly to the output (13) and partly to the attachment (14), wherein the second light detector (21) is optically connected with the attachment (14) and is able to determine existence of light.
2. Flame detection system (01) according to claim 1, wherein
at least 40% of the light at the input (12) could be send to the first light detector (21) and at least 40% of the light at the input (12) could be send at the same time to the second light detector (23); and/or
the semitransparent mirror (15) is aligned at an angle of 45° relative to a straight line from the input (12) to the output (13).
3. Flame detection system (01) according to claim 1 or 2, wherein
the semitransparent mirror (15) is adjustable mounted with at least an operational position, in which the light is send to both light detectors (21, 23), and a testing position, in which light could be send from the attachment (14) to the first light detector (21) and/or vice-versa from the output (13) to the second light detector (23).
4. Flame detection system (01) according to claim 3, wherein
the semitransparent mirror (15) is 90degrees pivotable; and/or the semitransparent mirror (15) is arranged at a transparent prism (16).
5. Flame detection system (01) according to one of the claims 1 to 4, wherein
the first light detector (21) is able to determine the intensity and/or the range of wavelength of light with a first data and/or the second light detector (21) is able to determine the intensity and/or the range of wavelength of light with a second data.
6. Flame detection system (01) according to claim 5, wherein
the first light detector (21) and the second light detector (23) are different to each other to determine a light of a different range of wavelength.
7. Flame detection system (01) according to one of the claims 1 to 6, further comprising
a test light emitter (25),
the test light emitter (25) could be optically connected to the attachment (14) replacing the second light detector (23); and/or
the test light emitter (25) could be optically connected to the output (13) replacing the first light detector (21).
8. Flame detection system (01) according to claim 7, wherein
the test light emitter (25) is able to emit light equal to the light emitted from the combustion chamber (03) when in operation, in particular
the test light emitter (25) is able to emit different kind of light representing the range of possible light emitted from the combustion chamber (03) in different operation situations.
9. Flame detection system (01) according to one of the claims 1 to 8, wherein
the light guiding device (05) comprises a hollow tube, in particular sealed with a glass pane; and/or
a first light conductor (22), in particular with a fiber optics, connects the output (13) with the first light detector (21) and/or a second light conductor (24), in particular with a fiber optics, connects the attachment (14) with the second light detector (23); and/or
a test light conductor (26), in particular with a fiber optics, connects the connection device (11) with the test light emitter (25).
10. Gas turbine (03) with a combustion chamber (03) and a flame detection system (01) according to one

of the preceding claims.

11. Method to determine a flame in a combustion chamber (03), in particular of a gas turbine, comprising a flame detection system (01) according one of the claims 1 to 9, wherein a first data is recorded from the first light detector (21) and a second data is recorded from the second light detector (23). 5

12. Method according to claim 11, 10
 wherein
 - if none of the recorded data represents a flame it is assumed that no flame exists;
 - if both of the recorded data represents a flame it is assumed that a combustion exists; 15
 - if one of the recorded data represents a flame it is assumed that a combustion exists and if the second recorded data does not indicate a flame or at least does not match the expected value a combustion alert is generated. 20

13. Method according to claim 12,
 wherein
 in case of a combustion alert without any further information from the operation of the combustion about a fault or deviation of the combustion it is assumed that one of the light detectors (21, 23) has a defect. 25

14. Method according to one of the claims 11 to 13, 30
 wherein
 a function test is done with
 - replacement of the second light detector or the first light detector by the light emitter and 35
 - switching the position of the semitransparent mirror from the operation position to the testing position and
 - verifying the function of the first light detector respectively the second light detector with usage of the light emitter. 40

15. Method according to claim 14,
 wherein
 the function test is performed prior to the combustion start and in case of an assumed fault of either of the light detectors (21, 23). 45

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FIG 1

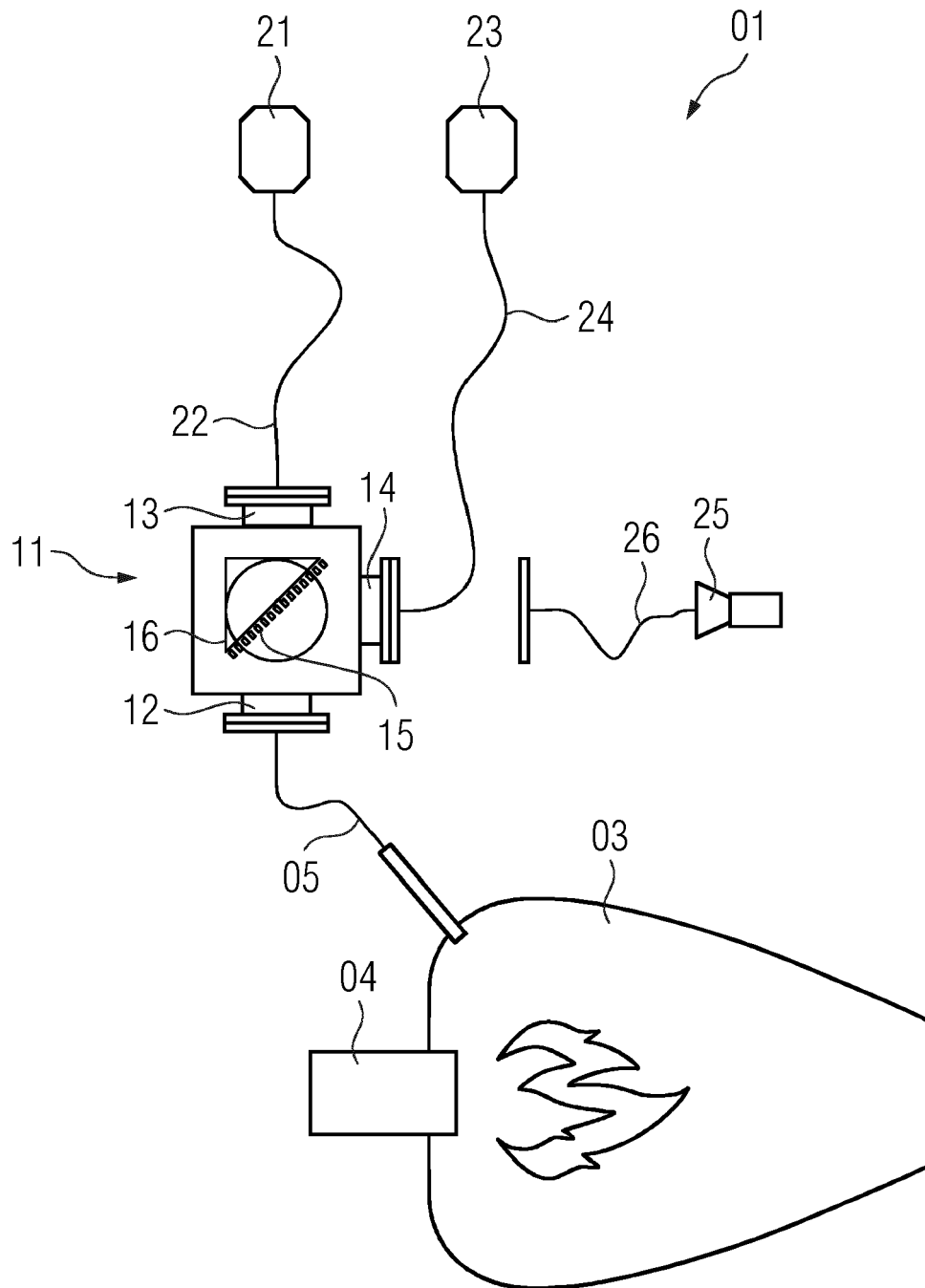
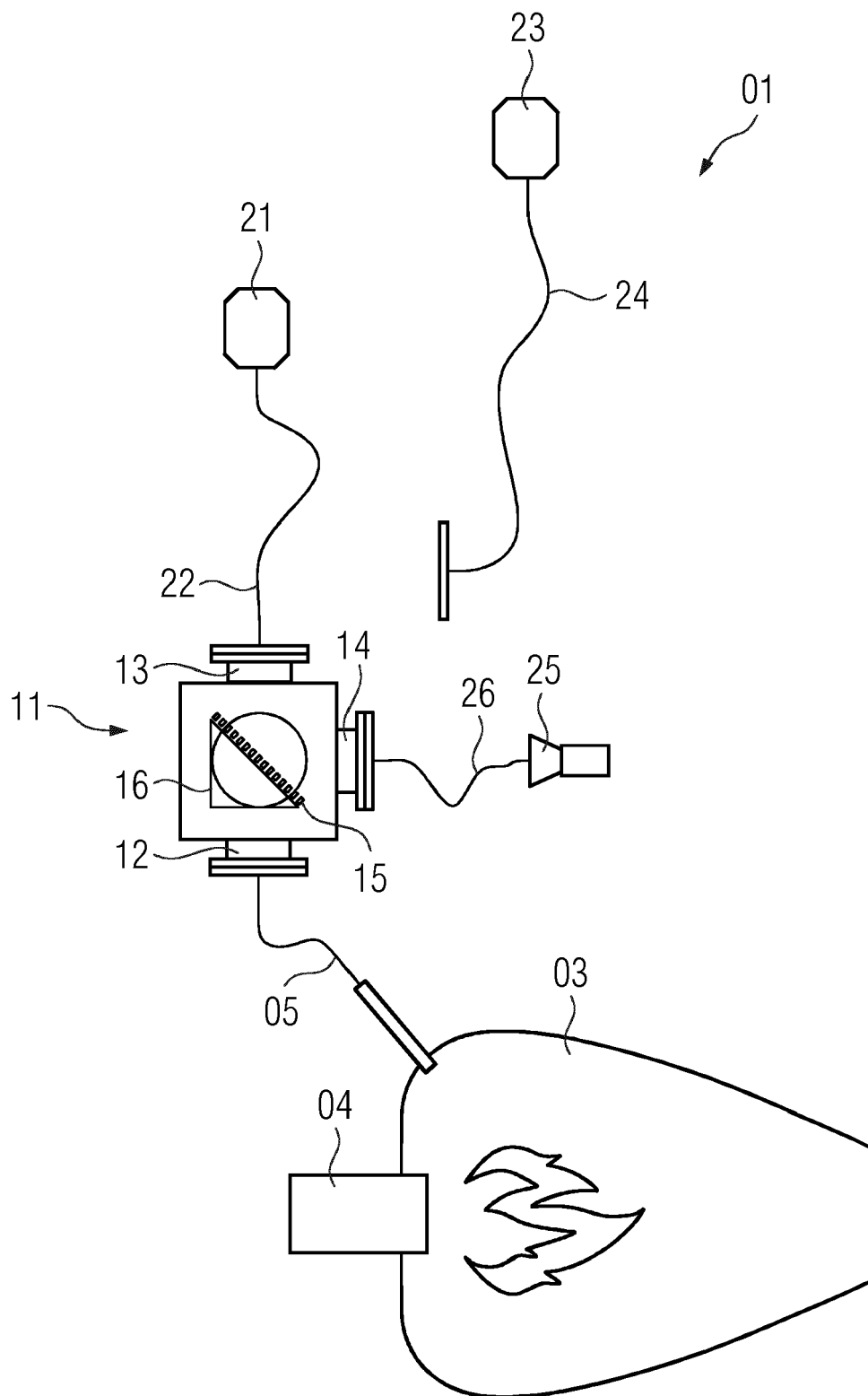


FIG 2





EUROPEAN SEARCH REPORT

Application Number
EP 19 21 0304

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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 21 April 2020	Examiner Theis, Gilbert
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			

EPO FORM 1503 03/02 (P04C01)

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

EP 19 21 0304

5 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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