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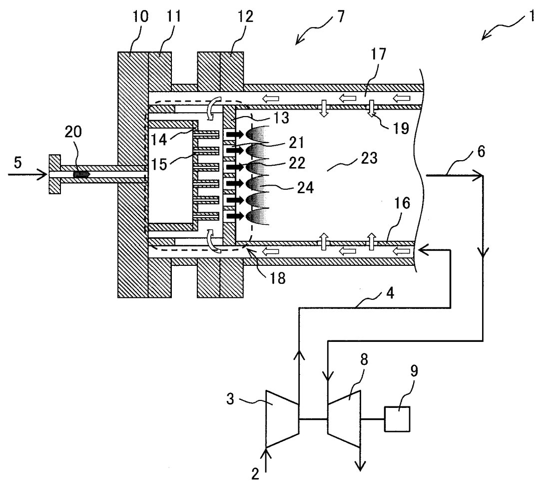
(54) GAS TURBINE COMBUSTOR

(57) A gas turbine combustor comprising a burner (18) including:
a plurality of fuel nozzles (15) to supply a fuel (5); a fuel nozzle plate (14) to supports end portions of the fuel nozzles structurally and being configured to distribute the fuel flowing from an upstream side to the fuel nozzles; and a swirler (13) including a plurality of air holes (21) to supply combustion air, wherein
the fuel nozzle plate is provided with a fuel nozzle receiving hole to receive the fuel nozzle, and the fuel nozzle plate and the fuel nozzle inserted in the fuel nozzle receiving hole are connected to each other from an upstream side of the fuel nozzle plate by welding.

FIG. 1



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Description

{Technical Field}

[0001] The present invention relates to a gas turbine combustor and to a method for building it and, more particularly, to a gas turbine combustor having a fuel nozzle to inject a fuel.

{Background Art}

[0002] In a gas turbine combustor, strict environmental standards for NOx exhausted upon the operation of the gas turbine combustor are set to reduce the load imposed on the environment by an exhaust gas.

[0003] The higher the flame temperature, the larger the amount of exhausted NOx. It is, therefore, necessary to achieve uniform combustion by suppressing the formation of flames having locally high temperatures in the gas turbine combustor.

[0004] For uniform combustion by the gas turbine combustor, it is effective to improve the fuel dispersibility. In a gas turbine combustor of the prior art, for example, Japanese Patent Laid-Open No. 2013-108667, a plurality of fuel nozzles are respectively arranged in the circumferential and radial directions of a swirler of the gas turbine combustor to improve the fuel dispersibility.

[0005] Also, in a gas turbine combustor of the prior art in Japanese Patent Laid-Open No. 2013-053814, a premixing pilot burner is provided at the head of a combustion sleeve which forms a combustion chamber, and a premixing main burner is provided on its outer periphery to sufficiently premix air and a fuel and thereby keep NOx low.

{Citation List}

{Patent Literature}

[0006]

{Patent Literature 1}
Japanese Patent Laid-Open No. 2013-108667
{Patent Literature 2}
Japanese Patent Laid-open No. 2013-053814

{Summary of Invention}

{Technical Problem}

[0007] The technique of gas turbine combustor described in Patent Literature 1 has the following problem. That is, as the number of fuel nozzles is increased to improve the fuel dispersibility, the distance between individual fuel nozzles or that between a set of fuel nozzles and a neighboring wall reduces.

[0008] In addition, the smaller the distance between individual fuel nozzles or that between a set of fuel nozzles and a neighboring wall, the narrower the space surrounding the fuel nozzle. Thus, in the technique of the gas turbine combustor described in Patent Literature 2, in connecting the end portion of the fuel nozzle from the downstream side to a fuel nozzle plate that structurally supports the fuel nozzles, a space sufficient for connection cannot be ensured.

[0009] An object of the present invention is to provide a gas turbine combustor and a manufacturing method thereof rendering an increased structural reliability by facilitating connection between a fuel nozzle and a fuel nozzle plate, even when the space surrounding the fuel nozzle is narrow, to improve the accuracy of connecting the fuel nozzle and the fuel nozzle plate to each other.

{Solution to Problem}

[0010] A gas turbine combustor according to the present invention comprising a burner includes: a plurality of fuel nozzles to supply fuel; a fuel nozzle plate to support end portions of the fuel nozzles structurally and being configured to distribute the fuel flowing from an upstream side to the fuel nozzles; and preferably a swirler including a plurality of air holes to supply combustion air. The fuel nozzle plate is provided with at least one fuel nozzle receiving hole to receive one of the fuel nozzles, and the fuel nozzle plate and the fuel nozzle inserted in the fuel nozzle receiving hole are connected to each other from an upstream side of the fuel nozzle plate by welding.

[0011] A method for building a gas turbine combustor comprising a burner comprises the steps of providing a plurality of fuel nozzles to supply fuel; providing a fuel nozzle plate to support end portions of the fuel nozzles structurally and being configured to distribute the fuel flowing from an upstream side to the fuel nozzles; providing in the fuel nozzle plate one or more fuel nozzle receiving holes, and inserting one or more of the fuel nozzles into one or more of the fuel nozzle receiving holes and connecting them to each other from an upstream side of the fuel nozzle plate by welding.

{Advantageous Effects of Invention}

[0012] The present invention realizes a gas turbine combustor with its structural reliability increased by facilitating connection between a fuel nozzle and a fuel nozzle plate, even when the space surrounding the fuel nozzle is narrow, to improve the accuracy of connecting the fuel nozzle and the fuel nozzle plate to each other.

{Brief Description of Drawings}

[0013]

{Fig. 1} FIG. 1 is a sectional view of a gas turbine combustor according to Embodiment 1 of the present invention, which shows outlines of flow of a fuel and air and a combustion process in the gas turbine combustor.

{Fig. 2} FIG. 2 is a partial sectional view showing components of a burner portion in the gas turbine combustor according to Embodiment 1 of the present invention shown in FIG. 1.

{Fig. 3} FIG. 3 is a partial sectional view showing a method of connecting to each other a fuel nozzle and a fuel nozzle plate in the gas turbine combustor according to Embodiment 1 of the present invention shown in FIG. 1.

{Fig. 4} FIG. 4 is a partial sectional view showing a method of connecting to each other a fuel nozzle and a fuel nozzle plate which form a burner portion of a gas turbine combustor according to conventional example.

{Fig. 5} FIG. 5 is a partial sectional view showing a method of connecting to each other a fuel nozzle and a fuel nozzle plate in a gas turbine combustor according to Embodiment 2 of the present invention.

{Fig. 6} FIG. 6 is a partial sectional view showing a method of connecting to each other a fuel nozzle and a fuel nozzle plate in a gas turbine combustor according to Embodiment 3 of the present invention.

{Fig. 7} FIG. 7 is a partial sectional view showing a method of connecting to each other a fuel nozzle and a fuel nozzle plate in a gas turbine combustor according to Embodiment 4 of the present invention.

{Fig. 8} FIG. 8 is a partial sectional view showing a method of connecting to each other a fuel nozzle and a fuel nozzle plate in a gas turbine combustor according to Embodiment 5 of the present invention.

{Fig. 9} FIG. 9 is a partial sectional view showing a method of connecting to each other a fuel nozzle and a fuel nozzle plate in a gas turbine combustor according to Embodiment 6 of the present invention.

{Fig. 10} FIG. 10 is a partial sectional view showing a method of connecting to each other a fuel nozzle and a fuel nozzle plate in a gas turbine combustor according to Embodiment 7 of the present invention.

{Description of Embodiments}

[0014] Embodiments of a gas turbine combustor according to the present invention will be described hereinafter with reference to the accompanying drawings.

[0015] Features in this specification shall be deemed combinable with each other also if their combination is not explicitly described, as far as their combination is not excluded by technical reasons. Features optional for the broadest described invention and described in combination with each other shall also be considered for them alone and combinable with other features, as far as possible under technical considerations. Method features shall be considered as disclosure also for means for implementing the method feature. Device features shall be considered as disclosure of method features implemented by the device, as far as applicable.

[0016] A feature described in the following in the context of a certain embodiment shall be considered also in the context of each of the other embodiments, as far as technically possible.

{Embodiment 1}

[0017] The arrangement of a gas turbine plant to which a gas turbine combustor according to Embodiment 1 of the present invention is applied will be described below with reference to FIG. 1.

[0018] In a gas turbine plant 1 to which a gas turbine combustor according to Embodiment 1 shown in FIG. 1 is applied, a gas turbine which constitutes a gas turbine plant 1 includes a compressor 3 which takes in air 2 from atmosphere and compresses it, a gas turbine combustor 7 which burns compressed air 4 compressed by the compressor 3 and a fuel 5 to generate a high-temperature and highpressure combustor exit gas 6, a gas turbine 8 which is driven by the combustor exit gas 6 generated by the gas turbine combustor 7 and extracts energy from the combustor exit gas 6 as rotational power, and an electric generator 9 which generates electric power using the rotational power of the gas turbine 8.

[0019] The gas turbine combustor 7 includes an end cover 10 which is provided at the end portion of the gas turbine combustor 7, a cylindrical front outer sleeve 11 which is attached to the end cover 10, and an elongated cylindrical rear outer sleeve 12 which is attached to the rear portion of the front outer sleeve 11.

[0020] A disk-shaped swirler 13 having a plurality of air holes 21 is provided inside the front outer sleeve 11 and the rear outer sleeve 12. A fuel nozzle plate 14 having a plurality of fuel nozzles 15 to inject a fuel toward air holes 21 formed in the swirler 13 is provided upstream of the swirler 13. An elongated cylindrical liner 16 to constitute a combustion chamber 23 in which air and a fuel are mixed and burned is provided downstream of the swirler 13.

[0021] The compressed air 4 compressed by the compressor 3 passes through an annular passage 17 formed between the rear outer sleeve 12 and the liner 16, and flows into a burner 18 formed in the gas turbine combustor 7.

[0022] The burner 18 includes a plurality of fuel nozzles 15 to inject a fuel, a fuel nozzle plate 14 to supports the end portions of the fuel nozzles 15 structurally and serves to distribute the fuel flowing into it from the upstream side to the fuel nozzles 15, and the swirler 13 having a plurality of air holes 21 to be supplied with combustion air, are formed downstream of the fuel nozzle plate 14 including the plurality of fuel nozzles 15.

[0023] Also, the compressed air 4 partially flows into the liner 16 from multiple cooling holes, formed in the liner 16, to serve as cooling air 19 for cooling the liner 16.

[0024] The fuel 5 supplied to the gas turbine combustor 7 flows into the fuel nozzle plate 14 through a fuel supply pipe 20 provided in the end cover 10, passes through the fuel nozzles 15 from the fuel nozzle plate 14, and is injected toward the plurality of air holes 21 formed in the swirler 13.

[0025] At the fuel nozzle-side inlet of the air hole 21 of the swirler 13, the fuel 5 injected by the fuel nozzle 15 and the compressed air 4 supplied through the annular passage 17 formed between the rear outer sleeve 12 and the liner 16 are mixed into an air-fuel mixture 22, which is injected toward the combustion chamber 23 and burned to form a high-temperature flame 24.

[0026] The gas turbine combustor 7 according to Embodiment 1 can use not only natural gas but also, for example, a coke oven gas, a refinery off-gas, or a coal gasification gas as the fuel 5.

[0027] FIG. 2 shows the arrangement of the burner 18 of the gas turbine combustor 7 according to Embodiment 1. As shown in FIG. 2, the burner 18 in the gas turbine combustor 7 according to Embodiment 1 includes the swirler 13, the fuel nozzle plate 14, and the fuel nozzles 15.

[0028] An upstream end portion 40 of the fuel nozzle 15 that injects a fuel is connected to the fuel nozzle plate 14 in a connecting portion, the connecting portion of which is sealed to prevent leakage of the fuel 5.

[0029] Since a downstream end portion 30 of the fuel nozzle 15 is neither connected to nor in contact with the air hole 21 formed in the swirler 13, the compressed air 4 can freely flow into the air hole 21 of the swirler 13.

[0030] The upstream end portion 40 of the fuel nozzle 15 is connected to the fuel nozzle plate 14 generally by, for example, bolting, welding, or brazing.

[0031] A method of connecting to each other the fuel nozzle 15 and the fuel nozzle plate 14 which form the burner 18 of the gas turbine combustor 7 according to Embodiment 1 will be described below with reference to partial enlarged view shown in FIGS. 3 and 4.

[0032] The partial enlarged view of FIG. 3 illustrates a method of connecting together by welding the fuel nozzle 15 and the fuel nozzle plate 14 which form the burner 18 of the gas turbine combustor 7 according to Embodiment 1.

[0033] Note, however, that in Embodiment 1, the method of connecting to each other the fuel nozzle 15 and the fuel nozzle plate 14 which form the burner 18 of the gas turbine combustor 7 is not limited to welding and there can be other methods.

[0034] As shown in the partial enlarged view of FIG. 3, with the method of connecting to each other the fuel nozzle 15 and the fuel nozzle plate 14 which form the burner 18 of the gas turbine combustor 7 according to Embodiment 1, a fuel nozzle receiving hole 44 to receive the fuel nozzle 15 is formed to extend through the fuel nozzle plate 14, and a connecting portion 45 is formed at an upstream end portion 40 of the fuel nozzle 15, inserted in the fuel nozzle receiving hole 44 and an upstream end portion 41 of the fuel nozzle plate 14 by welding them together from the upstream side of the fuel nozzle plate 14 to connect the upstream end portion 40 of the fuel nozzle 15 to the upstream end portion 41 of the fuel nozzle plate 14.

[0035] FIG. 4 shows a method of connecting to each other the fuel nozzle 15 and the fuel nozzle plate 14 which form the burner 18 of the gas turbine combustor 7 according to conventional Example. With the connecting method according to conventional example shown in FIG. 4, a side surface 40b of the fuel nozzle 15 on the upstream side and a downstream end portion 41b of the fuel nozzle plate 14 are connected to each other by forming a connecting portion 42 on them from the downstream side of the fuel nozzle plate 14.

[0036] However, the method of connecting the fuel nozzle 15 and the fuel nozzle plate 14 to each other according to conventional example shown in FIG. 4 poses the following problem. That is, when multiple fuel nozzles 15 are densely arranged downstream of the fuel nozzle plate 14 and a space 43 surrounding the fuel nozzle 15 is narrow, an operation space which is wide enough to connect the fuel nozzle 15 and the fuel nozzle plate 14 to each other cannot be ensured on the downstream side of the fuel nozzle plate 14.

[0037] In addition, in the method of connecting the fuel nozzle 15 and the fuel nozzle plate 14 to each other according to conventional example shown in FIG. 4, no operation space for connecting the fuel nozzle 15 and the fuel nozzle plate 14 to each other is present on the upstream side of the fuel nozzle plate 14, as is apparent from the structure shown in FIG. 4.

[0038] In the gas turbine combustor 7 according to Embodiment 1 shown in FIG. 3, with the method of connecting to each other the fuel nozzle 15 and the fuel nozzle plate 14 which form the burner 18 of the gas turbine combustor 7, even when multiple fuel nozzles 15 are densely arranged, the fuel nozzle receiving hole 44 to receive the fuel nozzle 15 is formed to extend through the fuel nozzle plate 14, and the fuel nozzle 15 inserted in the fuel nozzle receiving hole 44 projects to the downstream side of the fuel nozzle plate 14.

[0039] A connecting portion 45 is formed at the upstream end portion 40 of the fuel nozzle 15, inserted in the fuel nozzle receiving hole 44, and the upstream end portion 41 of the fuel nozzle plate 14 by welding them together from the upstream side of the fuel nozzle plate 14 to connect the upstream end portion 40 of the fuel nozzle 15 to the upstream end portion 41 of the fuel nozzle plate 14.

[0040] More specifically, since the gas turbine combustor 7 of Embodiment 1 has the fuel nozzle 15 that does not extend to the upstream side of the fuel nozzle plate 14, an operation space wide enough to connect the fuel nozzle 15 and the fuel nozzle plate 14 to each other is ensured on the upstream side of the fuel nozzle plate 14. This improves both the accuracy of connecting the fuel nozzle 15 and the fuel nozzle plate 14 to each other and, with the improvement in connecting accuracy, the structural reliability of the connecting portion between the fuel nozzle 15 and the fuel nozzle plate 14 is heightened.

[0041] Also, with the method of connecting to each other the fuel nozzle 15 and the fuel nozzle plate 14 which form the burner 18 of the gas turbine combustor 7 according to Embodiment 1, when combustion oscillation occurs upon burning of the air-fuel mixture 22 containing the fuel 5 and the compressed air 4 in the combustion chamber 23 of the gas turbine combustor 7 so that any fuel nozzle 15 oscillates perpendicularly to the central axis of the fuel nozzle 15, the side surface of the fuel nozzle 15 comes into contact with the inner surface of the fuel nozzle receiving hole 44, formed in the fuel nozzle plate 14 to receive the fuel nozzle 15, thus suppressing the oscillation. This makes it possible to reduce the load acting on the connecting portion 45 that is formed on the fuel nozzle plate 14 and the fuel nozzle 15 to weld them together.

[0042] Moreover, forming a small space between the side surface of the fuel nozzle 15 and the inner surface of the fuel nozzle receiving hole 44 of the fuel nozzle plate 14 makes it possible to generate a frictional force between the side surface of the fuel nozzle 15 and the inner surface of the fuel nozzle receiving hole 44 of the fuel nozzle plate 14 upon their contact. The obtained frictional force can produce an effect of damping oscillation acting on the fuel nozzle 15.

[0043] Present Embodiment 1 realizes a gas turbine combustor with its structural reliability increased by facilitating connection between a fuel nozzle and a fuel nozzle plate, even when the space surrounding the fuel nozzle is narrow, to improve the accuracy of connecting the fuel nozzle and the fuel nozzle plate to each other.

{Embodiment 2}

[0044] A method of connecting to each other a fuel nozzle 15 and a fuel nozzle plate 14 which form a burner 18 of a gas turbine combustor 7 according to Embodiment 2 of the present invention will be described below with reference to a partial enlarged view shown in FIG. 5.

[0045] The partial enlarged view of FIG. 5 illustrates details of the structure of the burner 18 in the gas turbine combustor 7 according to Embodiment 2. Since the basic arrangement and the method of connecting to each other the fuel nozzle 15 and the fuel nozzle plate 14 which form the burner 18 of the gas turbine combustor 7 according to Embodiment 2 are similar to those according to the above-mentioned Embodiment 1 of the present invention, parts common to both embodiments will not be described and only different parts will be described below.

[0046] The partial enlarged view of FIG. 5 shows the fuel nozzle 15 connected to an upstream end portion 41 of the fuel nozzle plate 14 at an upstream end portion 40 of the fuel nozzle 15, in the burner 18 of the gas turbine combustor 7 according to Embodiment 2.

[0047] The burner 18 of the gas turbine combustor 7 according to Embodiment 2 shown in FIG. 5 includes stepped portions 51 and 50. The stepped portion 51 is formed upstream of the fuel nozzle receiving hole 44 formed to extend through the fuel nozzle plate 14 and has a diameter larger than that of the downstream portion of the fuel nozzle receiving hole 44. The stepped portion 50 is formed at the upstream end portion 40 of the fuel nozzle 15 inserted in the fuel nozzle receiving hole 44 and has a diameter larger than that of the downstream portion of the fuel nozzle 15. The stepped portion 50 formed at the upstream end portion 40 of the fuel nozzle 15 abuts against the stepped portion 51 formed upstream of the fuel nozzle receiving hole 44.

[0048] A connecting portion 45 is formed at the upstream end portion 40 of the large-diameter stepped portion 50, formed on the fuel nozzle 15, and the upstream end portion 41 of the fuel nozzle plate 14, facing the upstream portion of the large-diameter stepped portion 51 formed in the fuel nozzle receiving hole 44, by welding them together from the upstream side of the fuel nozzle plate 14 to connect the upstream end portion 40 of the fuel nozzle 15 to the upstream end portion 41 of the fuel nozzle plate 14.

[0049] In the burner 18 of the gas turbine combustor 7 according to Embodiment 2 shown in FIG. 5, the stepped portion 50 formed at the upstream end portion 40 of the fuel nozzle 15 has an outer diameter larger than that of the downstream portion of the fuel nozzle 15, and the stepped portion 51 formed in the upstream portion of the fuel nozzle receiving hole 44 of the fuel nozzle plate 14 has an inner diameter larger than that of the downstream portion of the fuel nozzle receiving hole 44. This structure allows the lower surface of the large-diameter stepped portion 50 formed on the fuel nozzle 15 to abut against the lower surface of the large-diameter stepped portion 51 formed in the fuel nozzle receiving hole 44 to prevent the fuel nozzle 15 from falling off the fuel nozzle receiving hole 44 to the downstream side.

[0050] With the above-mentioned structure, even if the connecting portion 45 between the upstream end portion 40 of the fuel nozzle 15 and the upstream end portion of the fuel nozzle receiving hole 44 formed to extend through the fuel nozzle plate 14 is damaged and broken, the lower surface of the large-diameter stepped portion 50 formed at the upstream end portion 40 of the fuel nozzle 15 abuts against the lower surface of the large-diameter stepped portion 51, formed in the fuel nozzle receiving hole 44 formed in the fuel nozzle plate 14, to prevent the movement of the fuel nozzle 15. This, in turn, prevents the fuel nozzle 15 from falling off the fuel nozzle receiving hole 44 of the fuel nozzle plate 14 to the downstream side and damaging other components of the gas turbine combustor.

[0051] Also, the use of the stepped portions 50 and 51 allows the fuel nozzle 15 to be positioned in its axial direction 52.

[0052] Present Embodiment 2 realizes a gas turbine combustor with its structural reliability increased by facilitating connection between a fuel nozzle and a fuel nozzle plate, even when the space surrounding the fuel nozzle is narrow, to improve the accuracy of connecting the fuel nozzle and the fuel nozzle plate to each other.

{Embodiment 3}

[0053] A method of connecting to each other a fuel nozzle 15 and a fuel nozzle plate 14 which form a burner 18 of a gas turbine combustor 7 according to Embodiment 3 of the present invention will be described below with reference to a partial enlarged view shown in FIG. 6.

[0054] The partial enlarged view of FIG. 6 illustrates details of the structure of the burner 18 in the gas turbine combustor 7 according to Embodiment 3. Since the basic arrangement and the method of connecting to each other upstream end portion 40 of the fuel nozzle 15 and upstream end portion 41 of the fuel nozzle plate 14, respectively, which form the burner 18 of the gas turbine combustor 7 according to Embodiment 3 are similar to those according to the above-mentioned Embodiment 1 of the present invention, parts common to both embodiments will not be described and only different parts will be described below.

[0055] FIG. 6 shows details of the structure of the burner 18 in the gas turbine combustor 7 according to Embodiment 3.

[0056] In the burner 18 of the gas turbine combustor 7 according to Embodiment 3 shown in FIG. 6, a connecting portion 45 is formed at the upstream end portion 40 of the fuel nozzle 15, inserted in a fuel nozzle receiving hole 44 formed to extend through the fuel nozzle plate 14, and the upstream end portion 41 of the fuel nozzle plate 14 by welding them together from the upstream side of the fuel nozzle plate 14 to connect the upstream end portion 40 of the fuel nozzle 15 to the upstream end portion 41 of the fuel nozzle plate 14.

[0057] In the burner 18 of the gas turbine combustor 7 according to Embodiment 3, the fuel nozzle 15 has a tapered outer shape portion 60 in which a portion of the fuel nozzle 15 projecting to the downstream side from the fuel nozzle receiving hole 44 formed to extend through the fuel nozzle plate 14 has its outer diameter being gradually smaller from its basal portion toward a downstream end portion 30.

[0058] In the burner 18 of the gas turbine combustor 7 according to Embodiment 3, the fuel nozzle 15 has the tapered outer shape portion 60 in which a portion of the fuel nozzle 15 projecting to the downstream side from the fuel nozzle receiving hole 44 has its outer diameter being gradually smaller toward the downstream end portion 30. This allows the fuel nozzle 15 to be relatively lightweight by the weight of the portion gradually smaller in outer diameter of the fuel nozzle 15. It is, therefore, possible to reduce the load acting upon combustion oscillation on the connecting portion 45 that connects the upstream end portion 40 of the fuel nozzle 15 to the upstream end portion 41 of the fuel nozzle plate 14.

[0059] Present Embodiment 3 realizes a gas turbine combustor with its structural reliability increased by facilitating connection between a fuel nozzle and a fuel nozzle plate, even when the space surrounding the fuel nozzle is narrow, to improve the accuracy of connecting the fuel nozzle and the fuel nozzle plate to each other.

{Embodiment 4}

[0060] A method of connecting to each other a fuel nozzle 15 and a fuel nozzle plate 14 which form a burner 18 of a gas turbine combustor 7 according to Embodiment 4 of the present invention will be described below with reference to a partial enlarged view shown in FIG. 7.

[0061] The partial enlarged view of FIG. 7 illustrates details of the structure of the burner 18 in the gas turbine combustor 7 according to Embodiment 4. Since the basic arrangement and the method of connecting to each other upstream end portion 40 of the fuel nozzle 15 and upstream end portion 41 of the fuel nozzle plate 14, respectively, which form the burner 18 of the gas turbine combustor 7 according to Embodiment 4 are similar to those according to the above-mentioned Embodiment 2 of the present invention, parts common to both embodiments will not be described and only different parts will be described below.

[0062] In the burner 18 of the gas turbine combustor 7 according to Embodiment 4 shown in FIG. 7, a stepped portion 50 formed at the upstream end portion of the fuel nozzle 15 has an outer diameter larger than that of the downstream portion of the fuel nozzle 15, and a stepped portion 51 formed in the upstream portion of the fuel nozzle receiving hole 44 of the fuel nozzle plate 14 has an inner diameter larger than that of the downstream portion of the fuel nozzle receiving hole 44. This structure allows the lower surface of the large-diameter stepped portion 50 formed on the fuel nozzle 15 to abut against the lower surface of the large-diameter stepped portion 51, formed in the fuel nozzle receiving hole 44, to prevent the fuel nozzle 15 from falling off the fuel nozzle receiving hole 44 to the downstream side.

[0063] With the above-mentioned structure, even if a connecting portion 45 between the upstream end portion 40 of the fuel nozzle 15 and the upstream end portion 41 of the fuel nozzle plate 14 is damaged and broken, the lower surface of the large-diameter stepped portion 50 formed on the fuel nozzle 15 abuts against the lower surface of the large-diameter stepped portion 51, formed upstream of the fuel nozzle receiving hole 44 formed in the fuel nozzle plate 14, to prevent the movement of the fuel nozzle 15. This structure prevents the fuel nozzle 15 from falling off the fuel nozzle receiving hole 44 of the fuel nozzle plate 14 to the downstream side and damaging other components of the gas turbine combustor.

[0064] Further, the fuel nozzle 15 has a tapered outer shape portion 60 in which a portion of the fuel nozzle 15 projecting to the downstream side from the fuel nozzle receiving hole 44 formed to extend through the fuel nozzle plate 14 has its outer diameter being gradually smaller from its basal portion toward a downstream end portion 30, as in the shape of the fuel nozzle 15 described in Embodiment 3.

[0065] In the burner 18 of the gas turbine combustor 7 according to Embodiment 4, the fuel nozzle 15 has the tapered outer shape portion 60 in which a portion of the fuel nozzle 15 projecting to the downstream side from the fuel nozzle receiving hole 44 formed in the fuel nozzle plate 14 has its outer diameter being gradually smaller toward the downstream end portion 30. This allows the fuel nozzle 15 to be relatively lightweight by the weight of the portion gradually smaller in outer diameter of the fuel nozzle 15. It is, therefore, possible to reduce the load acting upon combustion oscillation on the connecting portion 45 that connects the upstream end portion 40 of the fuel nozzle 15 to the upstream end portion 41 of the fuel nozzle plate 14.

[0066] In the burner 18 of the gas turbine combustor 7 according to Embodiment 4 shown in FIG. 7, the fuel nozzle 15 is relatively lightweight while keeping a sufficient strength. It is, therefore, possible to reduce the load acting upon combustion oscillation on the connecting portion 45 that connects the fuel nozzle 15 to the fuel nozzle plate 14.

[0067] Present Embodiment 4 realizes a gas turbine combustor with its structural reliability increased by facilitating connection between a fuel nozzle and a fuel nozzle plate, even when the space surrounding the fuel nozzle is narrow, to improve the accuracy of connecting the fuel nozzle and the fuel nozzle plate to each other.

{Embodiment 5}

[0068] A method of connecting to each other a fuel nozzle 15 and a fuel nozzle plate 14 which form a burner 18 of a gas turbine combustor 7 according to Embodiment 5 of the present invention will be described below with reference to a partial enlarged view shown in FIG. 8.

[0069] The partial enlarged view of FIG. 8 illustrates details of the structure of the burner 18 in the gas turbine combustor 7 according to Embodiment 5. Since the basic arrangement and the method of connecting to each other upstream end portion 40 of the fuel nozzle 15 and upstream end portion 41 of the fuel nozzle plate 14, respectively, which form the burner 18 of the gas turbine combustor 7 according to Embodiment 5 are similar to those according to the above-mentioned Embodiment 1 of the present invention, parts common to both embodiments will not be described and only different parts will be described below.

[0070] In the burner 18 of the gas turbine combustor 7 according to Embodiment 5 shown in FIG. 8, a fuel nozzle receiving hole 44 formed to extend through the fuel nozzle plate 14 has an inner wall surface defining a tapered portion 70 in which the fuel nozzle receiving hole 44 has its outer diameter being gradually larger from its intermediate portion to the upstream side. The fuel nozzle 15 inserted in the fuel nozzle receiving hole 44 has an outer wall surface defining a tapered portion 72 in which the fuel nozzle 15 has its outer diameter being gradually larger from its intermediate portion to the upstream side, in correspondence with the shape of the inner wall surface defining the tapered portion 70 of the fuel nozzle receiving hole 44.

[0071] A connecting portion 45 is formed on the inner wall surface defining the tapered portion 70, formed near an upstream end portion 41 of the fuel nozzle plate 14, and the outer wall surface defining the tapered portion 72, formed near an upstream end portion 40 of the fuel nozzle 15 inserted in the fuel nozzle receiving hole 44, by welding them together from the upstream side of the fuel nozzle plate 14 to connect the fuel nozzle 15 to the fuel nozzle plate 14.

[0072] The fuel nozzle 15 has an outer wall surface defining the tapered portion 72 in which a portion of the fuel nozzle 15 formed near the upstream end portion 40 has an outer diameter larger than that of the downstream portion of the fuel nozzle 15. Also, the fuel nozzle receiving hole 44 has an inner wall surface defining the tapered portion 70 in which a portion of the fuel nozzle receiving hole 44 formed near the upstream end portion 41 of the fuel nozzle plate 14 has an inner diameter larger than that of the downstream portion of the fuel nozzle receiving hole 44. This structure allows the outer wall surface defining the tapered portion 72 of the fuel nozzle 15 to abut against the inner wall surface defining the tapered portion 70 of the fuel nozzle receiving hole 44 to prevent the fuel nozzle 15 from falling off the fuel nozzle receiving hole 44 to the downstream side.

[0073] With the above-mentioned structure, even if the connecting portion 45 between the upstream end portion 40 of the fuel nozzle 15 and the upstream end portion 41 of the fuel nozzle receiving hole 44 is damaged and broken, the outer wall surface defining the tapered portion 72 formed near the upstream end portion 40 of the fuel nozzle 15 abuts against the inner wall surface defining the tapered portion 70, formed in the fuel nozzle receiving hole 44 near the upstream end portion 41 of the fuel nozzle plate 14, to prevent the movement of the fuel nozzle 15. This structure prevents the fuel nozzle 15 from falling off the fuel nozzle receiving hole 44 of the fuel nozzle plate 14 to the downstream side and damaging other components of the gas turbine combustor.

[0074] Also, the use of the tapered portion 72 formed on the fuel nozzle 15 allows the fuel nozzle 15 to be positioned in its axial direction 52 and radial direction 71 with respect to the tapered portion 70 of the fuel nozzle receiving hole 44 formed on the fuel nozzle plate 14.

[0075] Present Embodiment 5 realizes a gas turbine combustor with its structural reliability increased by facilitating connection between a fuel nozzle and a fuel nozzle plate, even when the space surrounding the fuel nozzle is narrow, to improve the accuracy of connecting the fuel nozzle and the fuel nozzle plate to each other.

{Embodiment 6}

[0076] A method of connecting to each other a fuel nozzle 15 and a fuel nozzle plate 14 which form a burner 18 of a gas turbine combustor 7 according to Embodiment

6 of the present invention will be described below with reference to a partial enlarged view shown in FIG. 9.

[0077] The partial enlarged view of FIG. 9 illustrates details of the structure of the burner 18 in the gas turbine combustor 7 according to Embodiment 6. Since the basic arrangement and the method of connecting to each other the fuel nozzle 15 and the fuel nozzle plate 14 which form the burner 18 of the gas turbine combustor 7 according to Embodiment 6 are similar to those according to the above-mentioned Embodiment 1 of the present invention, parts common to both embodiments will not be described and only different parts will be described below.

[0078] The burner 18 in the gas turbine combustor 7 according to Embodiment 6 shown in FIG. 9 includes flanged portions 80. The flanged portion 80 is formed at an upstream end portion 40 of the fuel nozzle 15 inserted in a fuel nozzle receiving hole 44 formed to extend through the fuel nozzle plate 14, and has a diameter larger than the outer diameter of the downstream portion of the fuel nozzle 15.

[0079] A connecting portion 45 is formed on an upstream end portion 41 of the fuel nozzle plate 14 and the large-diameter flanged portion 80, formed at the upstream end portion 40 of the fuel nozzle 15, by welding them together from the upstream side of the fuel nozzle plate 14 to connect the lower surface of the upstream end portion 40 of the fuel nozzle 15 to the upstream end portion 41 of the fuel nozzle plate 14.

[0080] In Embodiment 6, the flanged portion 80 formed at the upstream end portion 40 of the fuel nozzle 15 has an outer diameter larger than the inner diameter of the fuel nozzle receiving hole 44 of the fuel nozzle plate 14. With this structure, even if the connecting portion 45 that connects the lower surface of the upstream end portion 40 of the fuel nozzle 15 to the upstream end portion 41 of the fuel nozzle plate 14 is damaged, the fuel nozzle 15 is prevented from falling off the fuel nozzle receiving hole 44 of the fuel nozzle plate 14 to the downstream side and damaging other components of the gas turbine combustor.

[0081] Also, the fuel nozzle 15 can be positioned in its axial direction 52 in a contact portion 81 where the lower surface of the upstream end portion 40 defining the flanged portion 80 of the fuel nozzle 15 comes into contact with the upstream end portion 41 of the fuel nozzle plate 14.

[0082] Present Embodiment 6 realizes a gas turbine combustor with its structural reliability increased by facilitating connection between a fuel nozzle and a fuel nozzle plate, even when the space surrounding the fuel nozzle is narrow, to improve the accuracy of connecting the fuel nozzle and the fuel nozzle plate to each other.

{Embodiment 7}

[0083] A method of connecting to each other a fuel nozzle 15 and a fuel nozzle plate 14 which form a burner 18 of a gas turbine combustor 7 according to Embodiment 7 of the present invention will be described below with reference to a partial enlarged view shown in FIG. 10.

[0084] The partial enlarged view of FIG. 10 illustrates details of the structure of the burner 18 in the gas turbine combustor 7 according to Embodiment 7. Since the basic arrangement and the method of connecting to each other upstream end portion 40 of the fuel nozzle 15 and upstream end portion 41 of the fuel nozzle plate 14, respectively, which form the burner 18 of the gas turbine combustor 7 according to Embodiment 7 are similar to those according to the above-mentioned Embodiment 2 of the present invention, parts common to both embodiments will not be described and only different parts will be described below.

[0085] The burner 18 in the gas turbine combustor 7 according to Embodiment 7 shown in FIG. 10 includes an orifice portion 90 formed in the intermediate portion of the fuel passage of the fuel nozzle 15. A connecting portion 45 is formed at an upstream end portion 40 of a large-diameter stepped portion 50 of the fuel nozzle 15 and an upstream end portion 41 of the fuel nozzle plate 14, provided upstream of a large-diameter stepped portion 51 of a fuel nozzle receiving hole 44 formed in the fuel nozzle plate 14, by welding them together from the upstream side of the fuel nozzle plate 14 to connect the upstream end portion 40 of the fuel nozzle 15 to the upstream end portion 41 of the fuel nozzle plate 14.

[0086] In the method of connecting the fuel nozzle 15 and the fuel nozzle plate 14 to each other according to conventional structure shown in FIG. 4, thermal deformation occurs due to factors associated with welding and the inner diameter of the orifice portion 90 formed in the intermediate portion of the fuel passage of the fuel nozzle 15 changes. In contrast to this, with the structure of the burner 18 in the gas turbine combustor 7 according to Embodiment 7, the direction of thermal deformation caused by welding is not a radial direction 71 of the fuel nozzle 15 but an axial direction 52 of the fuel nozzle 15. This keeps deformation, occurring in the orifice portion 90 of any fuel nozzle 15, small to accurately control the fuel flow rate.

[0087] Present Embodiment 7 realizes a gas turbine combustor with its structural reliability increased by facilitating connection between a fuel nozzle and a fuel nozzle plate, even when the space surrounding the fuel nozzle is narrow, to improve the accuracy of connecting the fuel nozzle and the fuel nozzle plate to each other.

[0088] A feature described above in the context of a certain embodiment shall be considered also in the context of each of the other embodiments, as far as technically possible.

{List of Reference Signs}

[0089]

1: gas turbine plant
2: air

3: compressor
4: compressed air
5: fuel
6: combustor exit gas
7: gas turbine combustor
8: gas turbine
9: electric generator
10: end cover
11: front outer sleeve
12: rear outer sleeve
13: swirler
14: fuel nozzle plate
15: fuel nozzle
16: liner
17: passage between rear outer sleeve and liner
18: burner
19: cooling air for cooling
20: fuel supply pipe
21: air hole in swirler
22: air-fuel mixture containing fuel and compressed air
23: combustion chamber
24: flame
30: downstream end portion of fuel nozzle
40: upstream end portion of fuel nozzle
40b: side surface of fuel nozzle on upstream side
41: upstream end portion of fuel nozzle plate
41b: downstream end portion of fuel nozzle plate
43: space surrounding fuel nozzle
44: fuel nozzle receiving hole
42, 45: connecting portion
50: stepped portion of fuel nozzle
51: stepped portion of fuel nozzle receiving hole
52: axial direction of fuel nozzle
60: tapered outer shape portion
70, 71: tapered portion
71: radial direction of fuel nozzle
80: flanged portion of upstream end portion of fuel nozzle
81: contact portion between flanged portion of fuel nozzle and fuel nozzle plate
90: orifice portion

Claims

1. A gas turbine combustor (7) comprising a burner (18) including:

a plurality of fuel nozzles (15) to supply fuel (5); and
a fuel nozzle plate (14) to support end portions of the fuel nozzles structurally and being configured to distribute the fuel flowing from an upstream side to the fuel nozzles;
characterized in that
the fuel nozzle plate (14) is provided with one or more fuel nozzle receiving holes (44) to receive one or more of the fuel nozzles (15), and
the fuel nozzle plate (14) and one or more of the fuel nozzles (15) inserted in the fuel nozzle receiving hole (44) are connected to each other from an upstream side of the fuel nozzle plate (14) by welding (45).

2. The gas turbine combustor according to claim 1, wherein an upstream portion (40) of the fuel nozzle (15) inserted in the fuel nozzle receiving hole (44) to receive the fuel nozzle (15) is formed to have an outer diameter larger than an outer diameter of a downstream portion (30) of the fuel nozzle (15).

3. The gas turbine combustor according to claim 2, wherein an upstream portion (41) of the fuel nozzle receiving hole (44) is formed to have an inner diameter larger than an inner diameter of a downstream portion of the fuel nozzle receiving hole.

4. The gas turbine combustor according to any one of claims 1 to 3, wherein the fuel nozzle (15) is provided with a flange (80) at an upstream end portion (40) of the fuel nozzle to have an outer diameter larger than an inner diameter of the fuel nozzle receiving hole inserted in the fuel nozzle.

5. The gas turbine combustor according to claim 3, wherein a first stepped portion (51) is provided with an upstream portion (41) of the fuel nozzle receiving hole (44) formed in the fuel nozzle plate to receive the fuel nozzle, and is formed to have an inner diameter larger than an inner diameter of a downstream portion of the fuel nozzle receiving hole; and a second stepped portion (50) is provided with an upstream portion of the fuel nozzle (15) inserted in the fuel nozzle receiving hole, and is formed to have an outer diameter larger than an outer diameter of a downstream portion of the fuel nozzle, and the second stepped portion (50) of the fuel nozzle abuts against the first stepped portion (51) of the fuel nozzle receiving hole.

6. The gas turbine combustor according to claim 3, wherein a first tapered portion (70) is provided with an upstream portion of the fuel nozzle receiving hole (44) formed in the fuel nozzle plate (14), and is formed to have an inner diameter larger than an inner diameter of a downstream portion of the fuel nozzle receiving hole (44); and
a second tapered portion (72) is provided with an upstream portion (40) of the fuel nozzle (15) inserted in the fuel nozzle receiving hole (44), and is formed to have an outer diameter larger than an outer diameter of a downstream portion (30) of the fuel nozzle (15), and
an outer surface of the second tapered portion (72) of the fuel nozzle (15) abuts against the first tapered

portion (70) of the fuel nozzle receiving hole (44).

7. The gas turbine combustor according to any one of claims 1 to 6, wherein a gap is formed between an inner surface of the fuel nozzle receiving hole (44) formed in the fuel nozzle plate (14) to receive the fuel nozzle (15) and an outer surface of the fuel nozzle (15) inserted in the fuel nozzle receiving hole (44).

8. The gas turbine combustor according to any one of claims 1 to 7, wherein a portion (60) of the fuel nozzle (15) projecting to a downstream side from the fuel nozzle receiving hole (44) of the fuel nozzle plate (14) is formed to have an outer diameter being gradually smaller toward a downstream end portion of the fuel nozzle (15).

9. The gas turbine combustor according to any one of claims 1 to 8, wherein the fuel nozzle (15) is provided with an orifice (90) in a fuel passage formed inside the fuel nozzle (15) to narrow the passage.

10. A gas turbine combustor according to any one of claims 1 to 9, further comprising:

a swirler (13) including a plurality of air holes (21) to supply combustion air (4).

11. A method for building a gas turbine combustor (7) comprising a burner (18), the method comprising the steps of:

providing a plurality of fuel nozzles (15) to supply fuel (5);
providing a fuel nozzle plate (14) to support end portions of the fuel nozzles structurally and being configured to distribute the fuel flowing from an upstream side to the fuel nozzles;
providing in the fuel nozzle plate (14) one or more fuel nozzle receiving holes (44), and
inserting one or more of the fuel nozzles (15) into one or more of the fuel nozzle receiving holes (44) and connecting them to each other from an upstream side of the fuel nozzle plate (14) by welding (45).

FIG. 1

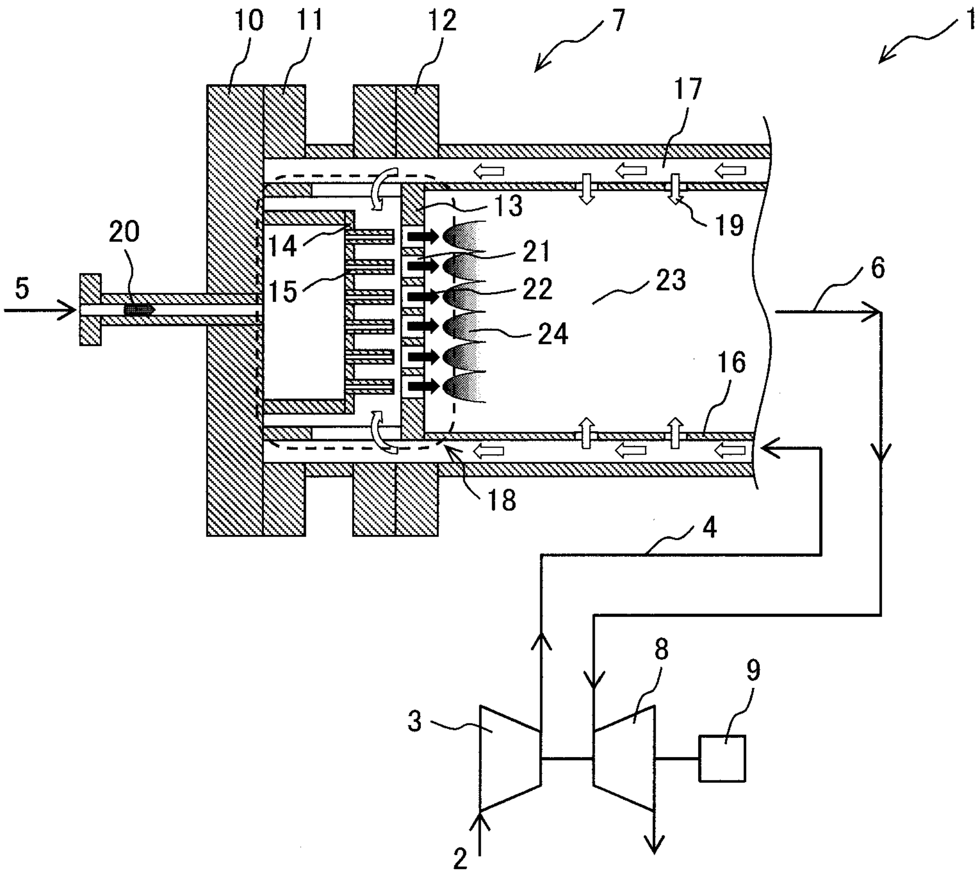


FIG. 2

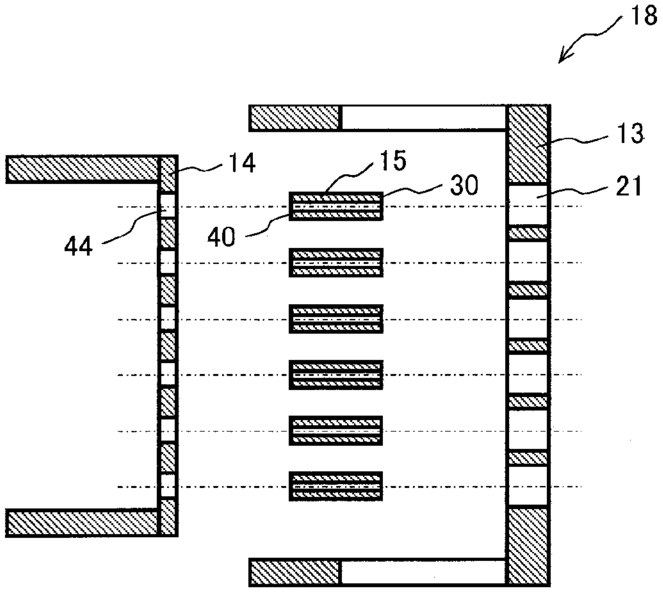


FIG. 3

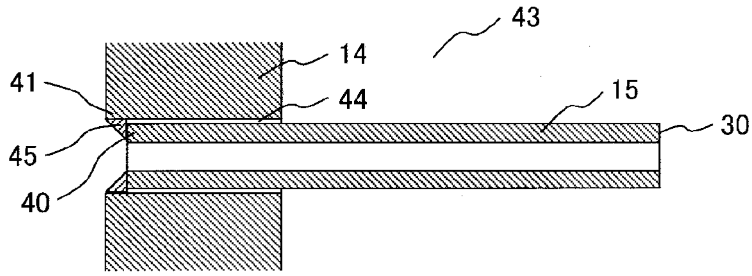


FIG. 4

(PRIOR ART)

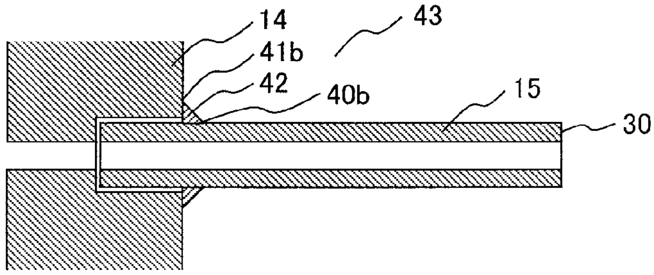


FIG. 5

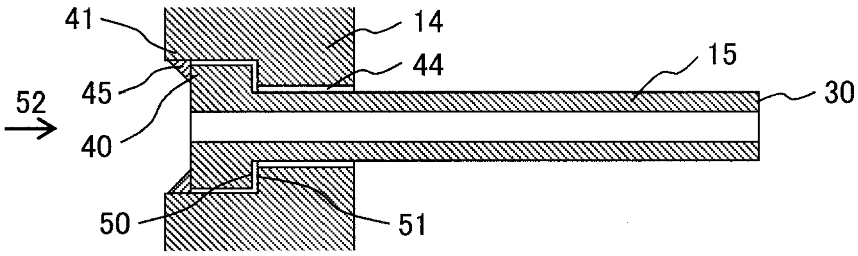


FIG. 6

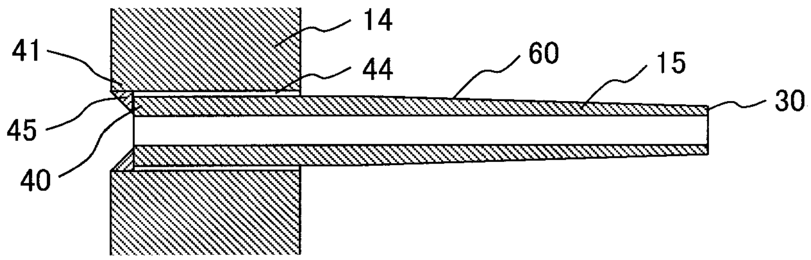


FIG. 7

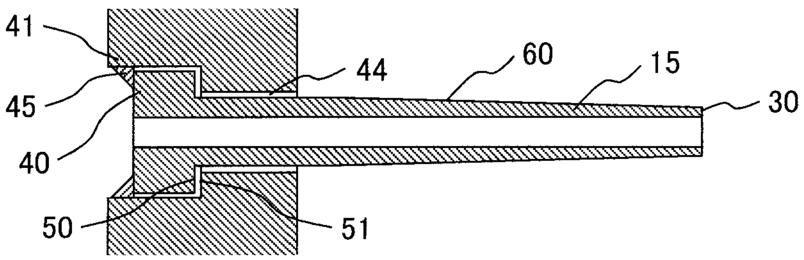


FIG. 8

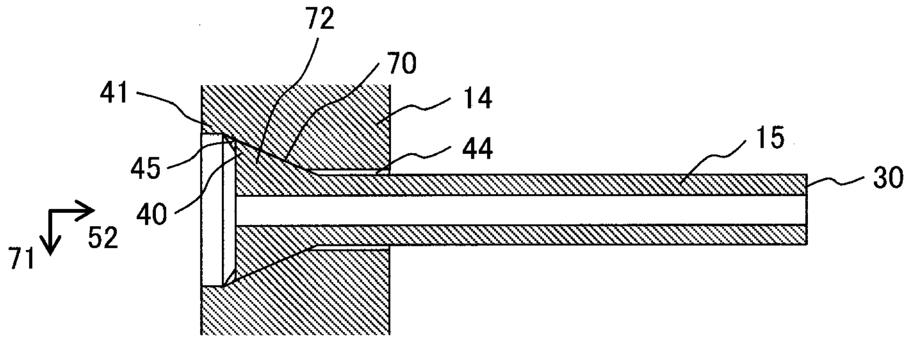


FIG. 9

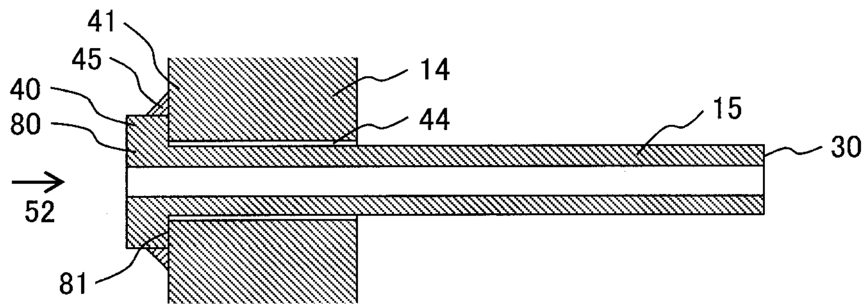
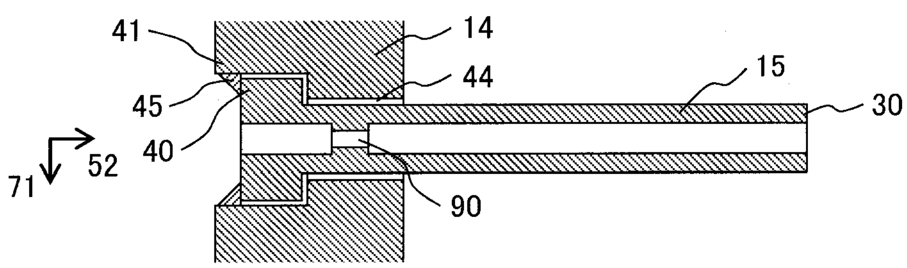


FIG. 10



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EUROPEAN SEARCH REPORT

Application Number
EP 15 17 9363

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2

Place of search	Date of completion of the search	Examiner
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