

[54] GAS TURBINE ENGINE COMBUSTION EQUIPMENT

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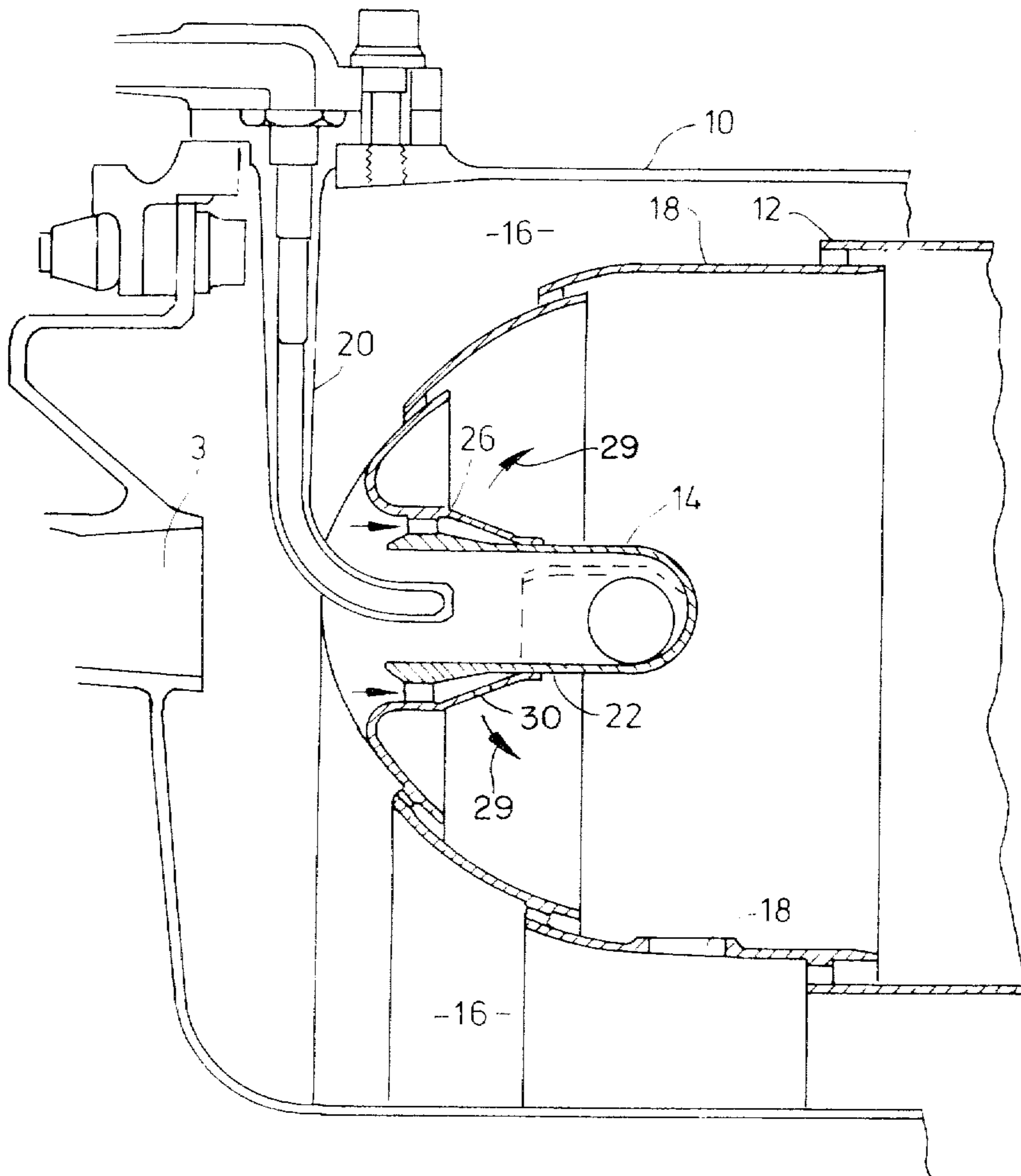
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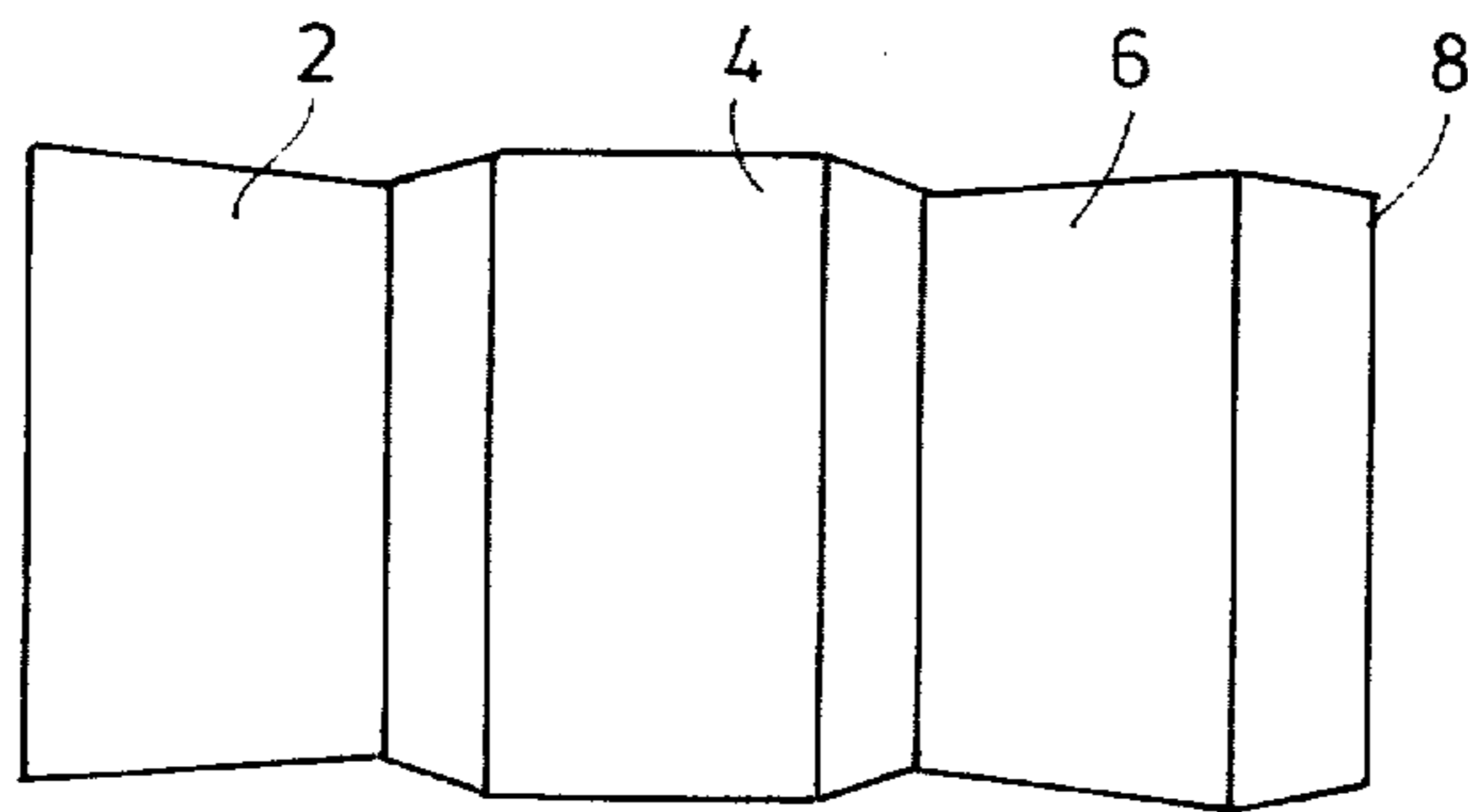
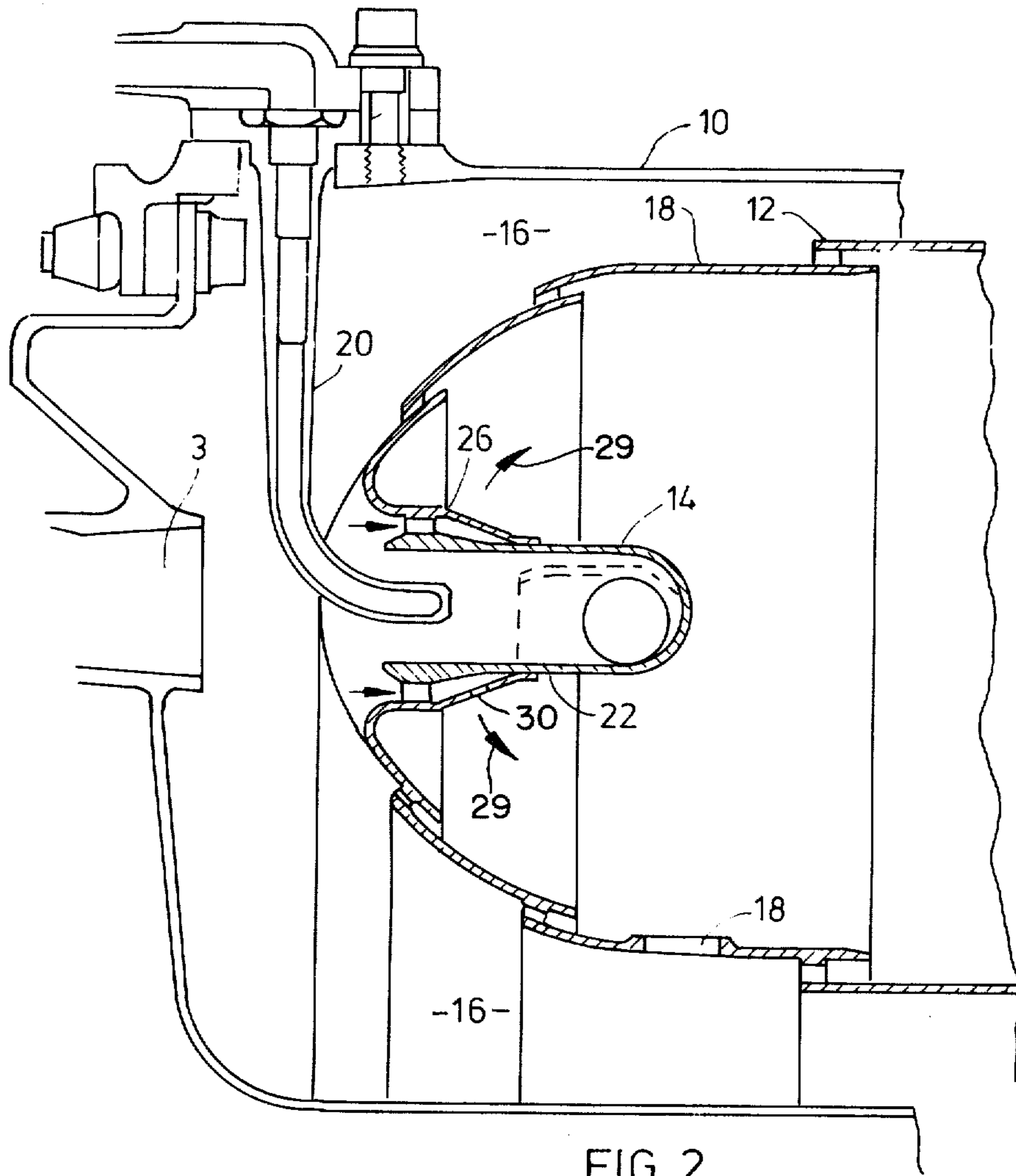
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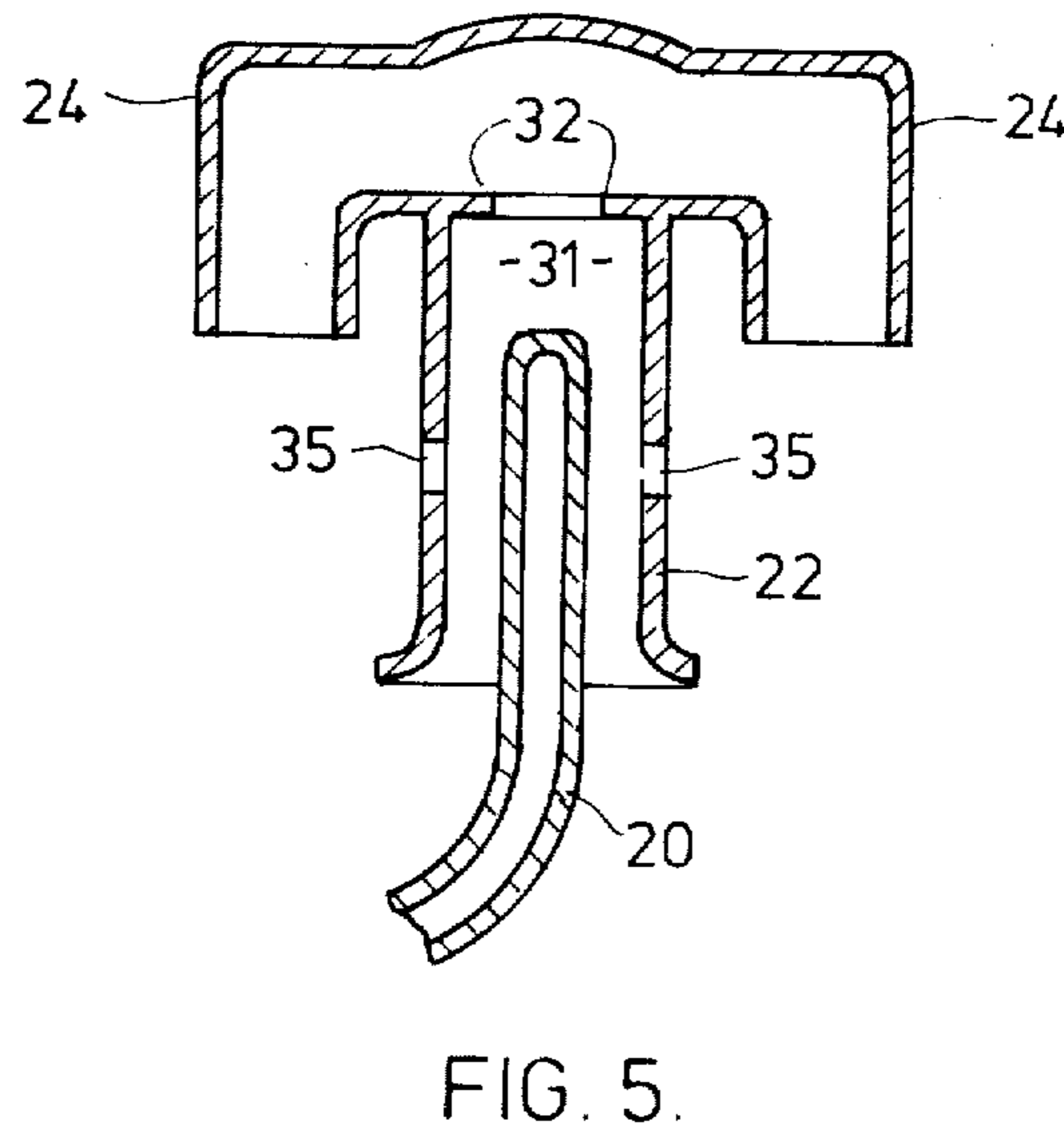
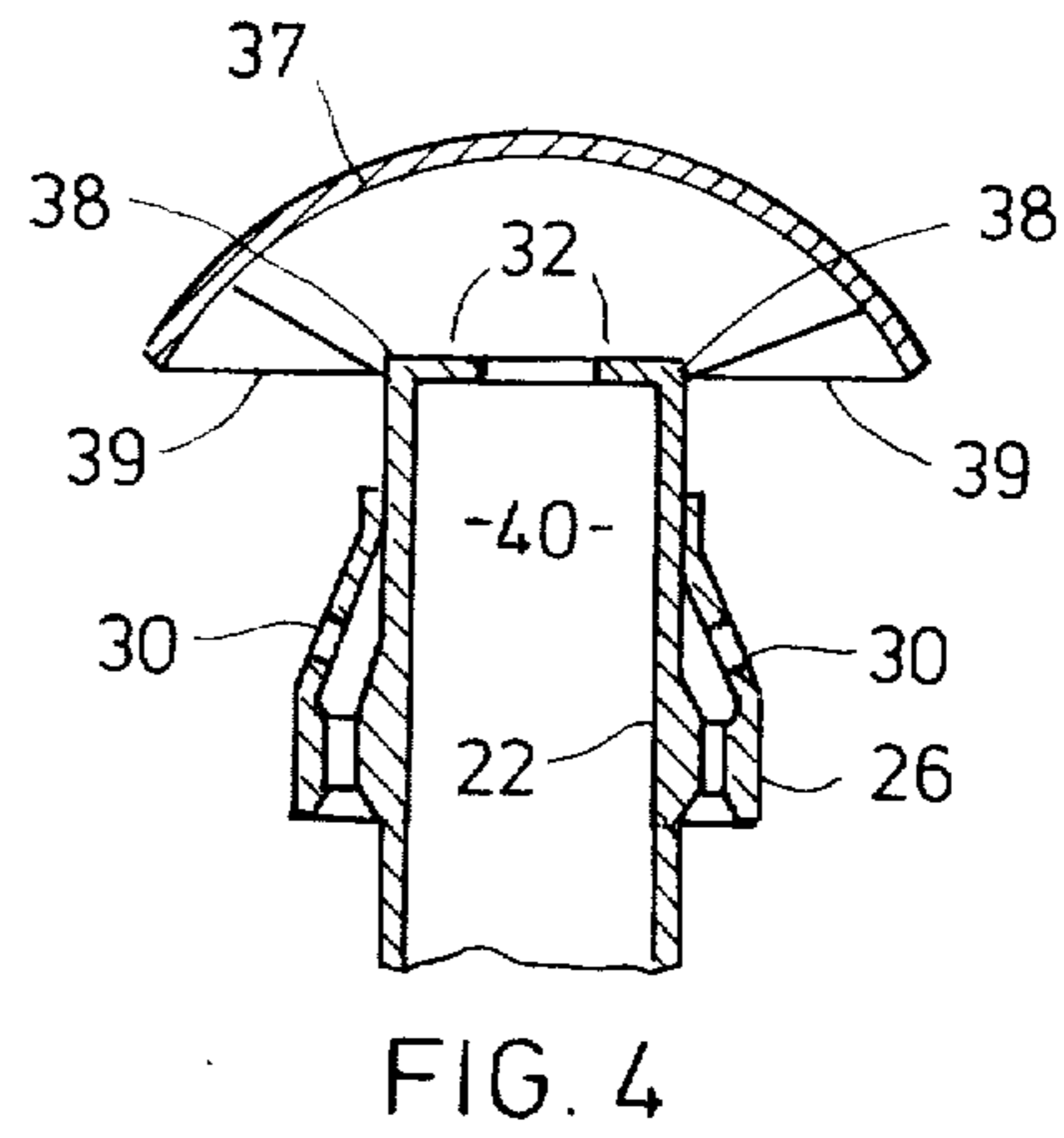
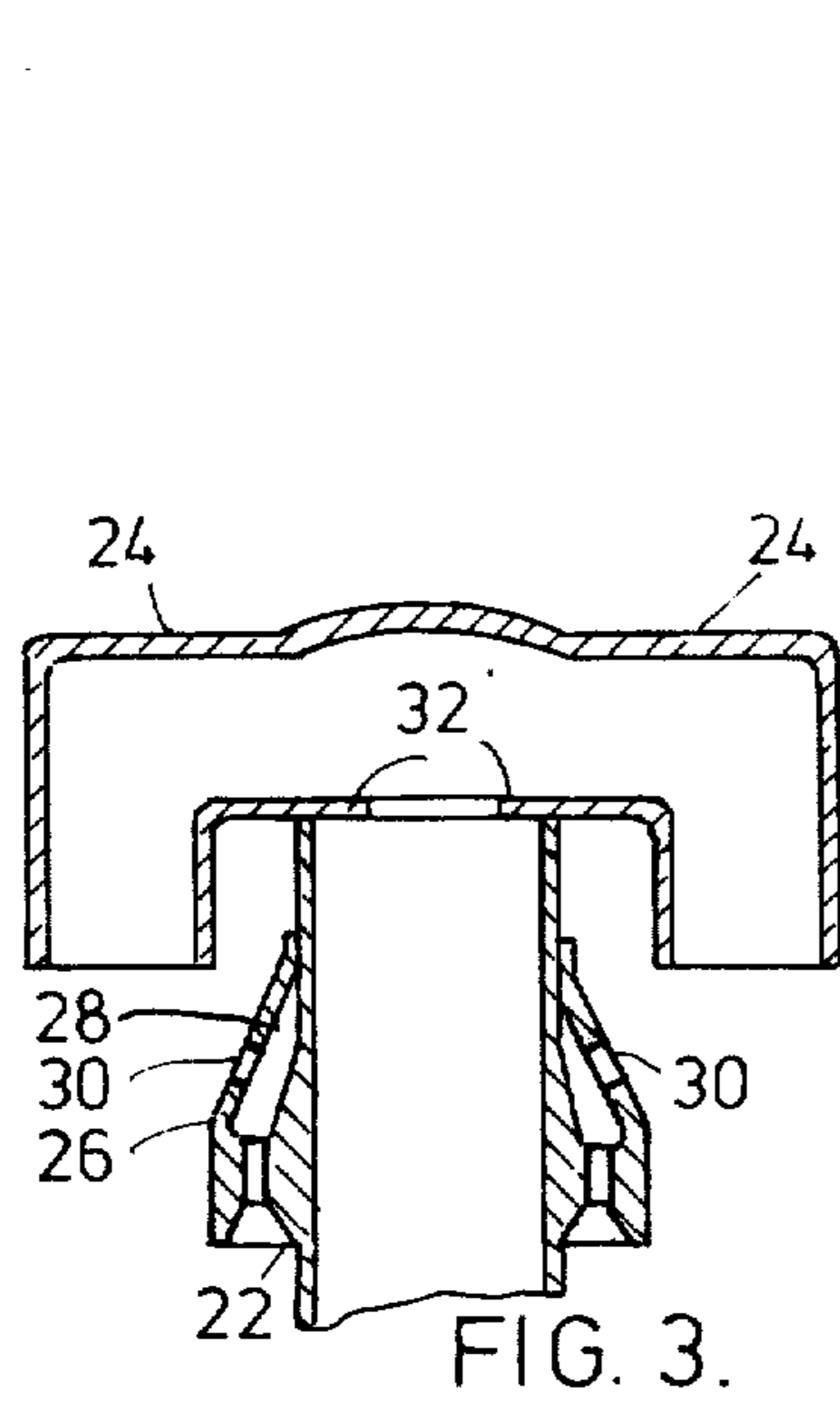
[57] ABSTRACT

A vaporizer for a gas turbine engine. The vaporizer has a shroud surrounding the stem and is used to provide a cooling air space. It is provided with holes from which the cooling air issues radially. The radial jets improve combustion efficiency and reduce smoke emission.

2 Claims, 5 Drawing Figures







GAS TURBINE ENGINE COMBUSTION EQUIPMENT

The present invention relates to fuel vaporizers for use in gas turbine engines. Fuel vaporizers, which are well known, have a hollow cylindrical stem which is adapted to be supplied with fuel and air at one end and to deliver a vaporized mixture of air and fuel from one or other ends.

The vaporizer may have one or more branches at the other end thereof which extend substantially radially of the stem and in order to cool such vaporizers in the past, the stem has been surrounded by a shroud which was spaced therefrom to provide an annular space for providing an air flow between the shroud and the stem, the air passing axially from the end of the space.

It has now been discovered that if the cooling air from said annular space is allowed to pass from the space substantially radially of the stem through holes in the shroud instead of axially of the stem from the annular space at the free end of the shroud, that this radial emission of cooling air improves the temperature distribution in the combustion chamber and leads to improved combustion efficiency. Furthermore, a problem of the burning out of the branches of a branched vapouriser which occurred with air passing from the shroud axially of the stem is overcome.

It is not necessary that all the air passes out of the shroud radially in order to achieve improved temperature distribution in the combustion chamber and improved combustion efficiency, these benefits could be gained while still allowing some of the air to pass axially from the end of the space but the problem of the burning out of the branches might occur.

Furthermore, the invention could be applied to an unshrouded vaporizer in that some of the air supplied to the vaporizer stem would, before mixing with the fuel, be allowed to pass substantially radially from the stem through holes in the stem.

According to the invention there is provided a vaporizer for a gas turbine engine and designed to receive air and fuel separately and to mix them together, said vaporizer having a hollow stem, into which the air and the fuel are separately delivered, and having means, which in operation of the vaporizer, allow air, but not fuel, to pass out of the vaporizer in a direction substantially radially of the stem.

In a preferred form of the invention the vaporizer is provided with a cylindrical shroud surrounding, and radially spaced from, the stem thereof to define an annular space for receiving a supply of air, and wherein said means are holes provided in the cylindrical surface of the shroud through which air passes out of the annular space in a direction substantially radially of the stem.

In a further preferred form of the invention all of the air supplied to the annular space passes out of the space through said holes in a direction substantially radially of the stem.

In another preferred form of the invention said means are holes provided in the surface of the stem and through which some of the air supplied to the hollow stem passes out of the stem, before mixture with the fuel, in a direction substantially radially of the stem.

In yet a further preferred form of the invention the vaporizer may have one or two branches at one end of the stem and which extends substantially radially of the stem, the vaporizer thus having an L- or T-shape.

Three examples of the invention will now be more particularly described, by way of example only, with reference to the accompanying drawings in which:

FIG. 1 is a diagrammatic view of a gas turbine engine, FIG. 2 is a section through the combustion chamber of the engine of FIG. 1 showing the vaporizers in more detail,

FIG. 3 is a sectional plan view of a vaporizer of FIG. 2,

FIG. 4 is a sectional plan view of a second vaporizer, and

FIG. 5 is a sectional plan view of a third vaporizer.

Referring now to the drawings, there is shown in FIG. 1 a gas turbine engine having a compressor 2, combustion equipment 4, a turbine 6 and a propulsion nozzle 8 all in flow series.

The combustion equipment comprises an outer casing 10 and an annular flame tube 12 (FIG. 2). Air is supplied to the flame tube from a compressor delivery duct 3, some of the air passing directly into the flame tube through vaporizers 14, whilst the majority of the air supplied passes into the space 16 between the flame tube and the outer casing, and from there passes into the flame tube through apertures 18 into the wall thereof. Fuel supply pipes 20 supply fuel to the vaporizers where it is mixed with the air and vaporized due to the heat in the surrounding gas in the flame tube.

The vaporizers 14 are of substantially T-section, each of which has a cylindrical stem 22 which is connected to the flame tube at one end and radial branches 24 at the free end thereof.

Surrounding the stem of each vaporizer is a shroud 26 which is radially spaced from the stem to define an annular passage 28 which is supplied with air from the compressor delivery duct 3. The downstream end of the annular passage is blocked and holes 30 are formed in the shroud to allow the air to emerge substantially radially of the stem as shown by arrows 29.

The effects of this are two fold:

a. The radial flow of air, although relatively small promotes further mixing of fuel and air in the primary combustion zone, and this improves the temperature distribution in the combustion chamber, and the combustion efficiency.

b. Cooling air is prevented from flowing axially over the radial branches of the T vaporizer, and this prevents a flame from stabilizing of the vaporizer downstreams of the radial branch in the air flow.

The holes 30 are positioned, so that there is no impingement of the air flowing through them on the branches.

In addition, weirs 32 are provided within the stem at the junctions with the radial branches of the vapouriser for creating turbulence in the fuel/air mixture in the branches. This promotes cooling of the branches.

The vaporizer 40 shown in FIG. 4 is similar to the one shown in FIGS. 2 and 3 except that the radial arms 24 are replaced by an umbrella 37 which is supported from the stem 22 by struts 38 to form an annular outlet 39. The effect of the umbrella is similar to that of the radial branches 24 in that the air and fuel mixture is emitted from the annular outlet 39. The radial flow of air through the holes 30 promotes further mixing of fuel and air in the primary combustion zone. The vaporizer 40 is mounted from the flame tube 12 in the same manner as is shown in FIG. 2.

The vaporizer 31 shown in FIG. 5 is similar to the vapouriser 14 shown in FIGS. 2 and 3 except that it is not provided with a shroud 26 and there is a substantially radial outflow of air through the holes 35 in the stem 22. The fuel supply pipe projects into the stem a sufficient distance downstream of the holes 35 in order that fuel and fuel vapor does not flow out of the holes 35. The radial flow of air through the holes 35 promotes further mixing of fuel and air in the primary combustion zone. In operation there is a pressure drop across the wall of the stem which promotes a radial outflow of air through the holes 35 and this pressure drop could be increased by the weir 32 or other known means such as converging outlets at the exits to the radial branches 24. The holes 35 are so positioned that there is no impingement of the air flowing through the holes 35 on the branches 24.

The vaporizers 14 and 40 shown in FIGS. 2, 3 and 4 may instead have one radial branch 24 and be L-shaped.

The embodiment shown in detail in FIG. 2 illustrates an annular combustion chamber. However, the invention is applicable to other forms of combustion chamber, such as a reverse flow combustion chamber or a chamber of the type known as can-annular which in-

cludes an array of cylindrical combustion chambers or "cans" disposed in an annular array.

What we claim is:

1. A vaporizer for a gas turbine engine for receiving air and fuel separately and mixing them together, said vaporizer comprising a hollow stem to which air and fuel are delivered separately, at least one radial branch connected to the hollow stem and through which in operation there passes a flow of a mixture of the air and fuel delivered to the hollow stem, and a cylindrical shroud surrounding and radially spaced from the hollow stem to define an annular space for receiving a supply of air but not fuel, the cylindrical shroud having means defining holes provided in the wall thereof through which in operation air passes out of said annular space in a direction substantially radially of the stem to mix with the mixture of air and fuel discharged from the radial branch of the hollow stem immediately downstream of the discharge from said radial branch.

2. A vaporizer as claimed in claim 1 and having a general T-shape comprising said hollow stem which constitutes the leg of the T and two transverse radial branches connected to said hollow stem.

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