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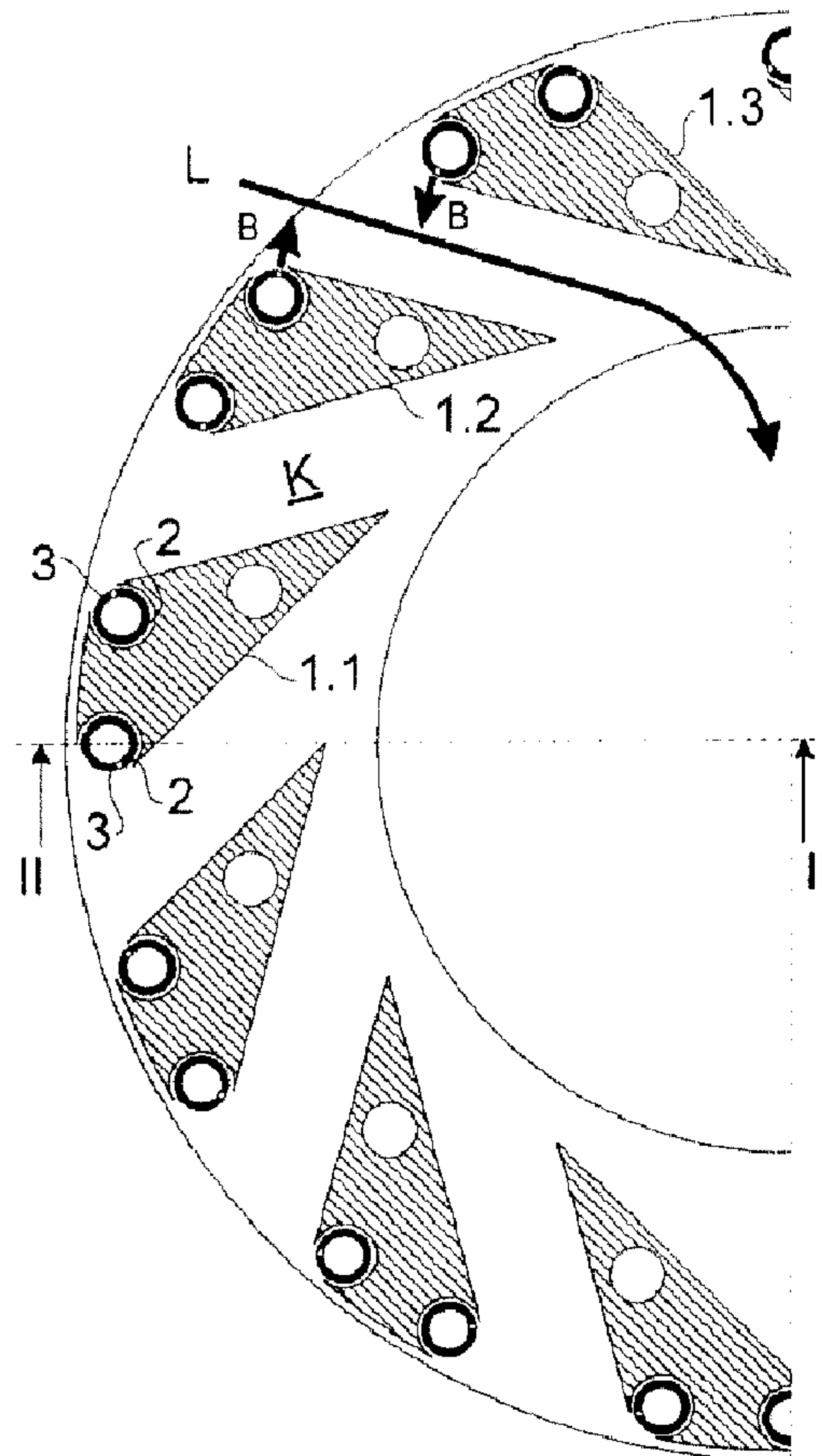
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(57) Abrégé/Abstract:

For injecting fuel (B) into a gas turbine, it is proposed that an injection of the fuel into a channel (K) of a swirl generator of the gas turbine is predetermined by the arrangement of a fuel injecting insert (2; 2') in a swirl generator segment (1.1, 1.2, 1.3).



Abstract

For injecting fuel (B) into a gas turbine, it is proposed that an injection of the fuel into a channel (K) of a swirl generator of the gas turbine is predetermined by the arrangement of a fuel injecting insert (2; 2') in a swirl generator segment (1.1, 1.2, 1.3).

(Fig. 1)

SWIRL GENERATOR

5 **Field of the Invention**

The present invention is directed to a swirl generator and to a method for injecting fuel into a gas turbine.

Background of the Art

10 Particularly for low-emissions combustion of gaseous fuels with air, it is known to impart a rotational momentum to the supplied combustion air through a swirl generator and to inject fuel into the air flow in this swirl generator in order to achieve an optimal premixing of fuel and air.

15 In this regard, WO 2004/057236 A2 shows fuel outlets in an upstream cover of the swirl generator, and EP 1 890 083 A1 shows fuel outlets in a downstream base of the swirl generator.

To enable the injection of fuel over the entire channel height of the swirl generator, EP 0 728 989 B1 and EP 0 718 550 B1 propose stationary fuel lances which are arranged in the channels between swirl generator segments and guide vanes of the swirl generator.

20 To prevent flow losses, it is also known, for example, from WO 2007/093248 A1, WO 2008/141955 A1, WO 2007/033876 A1 and EP 0 870 989 B1, to form fuel feed lines and outlets by means of bore holes in the swirl generator segments.

25 While the fuel outlets in these swirl generators are formed in lateral channel walls of the swirl generator segments, WO 2007/131818 A1 proposes front fuel outlets in axial shoulders of the swirl generator segments.

30 Finally, EP 1 892 469 A1 discloses a swirl generator according to the preamble of claim 1 with a plurality of wedge-shaped swirl generator segments in which are formed fuel-supplying axial bore holes and, parallel thereto, air-supplying axial bore holes. The air-supplying bore hole communicates with a bore hole in a side wall of the channel defined by the swirl generator segment, this bore hole opening into the air-supplying bore hole at right angles in order to inject additional combustion air into the channel. A hollow tube having a small diameter is inserted into this larger

bore hole so as to meet the fuel-supplying axial bore hole at right angles so that fuel is injected into the channel through this fuel injection insert in the interior of the annular additional-air feed.

In the above-cited prior art, the fuel injection through the fuel outlets is always
5 determined at the design stage. However, the mixing of fuel and combustion air which depends upon the injection of fuel is very sensitive, particularly with respect to the properties of the combustion gas, for example, its composition, density and calorific value, and also with regard to the air throughput which varies with different outputs of the gas turbine. Therefore, the solutions mentioned above, whose fuel
10 injections were designed to be optimized for certain boundary conditions and were then fixed, only work suboptimally when boundary conditions change, for example, when the fuel or the air throughput changes.

Summary

Therefore, it is the object of the present invention to improve the mixing of
15 fuel with combustion air in a swirl generator of a gas turbine.

It is proposed by the invention that the injection of fuel into a channel of a swirl generator of a gas turbine is defined by the variable arrangement of fuel injecting inserts in air-guiding swirl generator segments of the swirl generator. By changing the arrangement of fuel injecting inserts in the swirl generator segments, the
20 injection of fuel can be adapted to different fuel properties or air throughputs.

For this purpose, according to a first aspect of the present invention, diverse fuel injecting inserts having different fuel outlets can be arranged electively in a swirl generator segment. For example, two fuel injecting inserts which can be arranged alternatively in a swirl generator segment can differ with respect to the quantity,
25 shape, size, position and/or direction of one or more fuel outlets. A plurality of fuel outlets of a fuel injecting insert can be constructed identically or differently, can be equidistant or at different distances in direction of the channel height, and/or can be arranged so as to be offset relative to one another at an angle or one below the other on the lateral surface of the fuel injecting insert.

30 In a preferred construction, the fuel injecting inserts can be received in the swirl generator segments with a predetermined orientation in order to define an injecting direction of the fuel in which the fuel exits from the fuel injecting insert into

the channel, which injecting direction has a predetermined angle relative to a longitudinal axis of the swirl generator and/or relative to an air flow in the channel, i.e., in axial section or cross section, and which is oriented in a preferred construction substantially perpendicular to the longitudinal axis and/or to the air flow but which
5 can also have a component oriented in opposition to a through-flow direction of the channel to improve the mixing of the injected fuel with the swirled air by the formation of a stagnation point and resulting swirling of air. To this end, the fuel injecting inserts can be received in the swirl generator segments particularly so as to be fixed with respect to rotation relative to them, preferably by positive engagement.

10 According to a second aspect of the present invention, the injection of fuel into the channel can also be determined by the arrangement of the fuel injecting insert in the swirl generator segment in that the same fuel injecting insert can be received in a swirl generator segment with an orientation which can be variously defined.

To this end, the fuel injecting insert can be constructed, for example, in a
15 rotationally symmetrical manner and can be arranged in a corresponding hollow space of the swirl generator, where it can be secured permanently or detachably, for example, by frictional engagement or material bond, e.g., by welding, in an optional orientation or angular position with respect to its axis of symmetry. Similarly, the fuel injecting insert can also have a geometry with a break in the rotational symmetry
20 so that it can be inserted into the swirl generator segment in only one or more selected angular positions.

Both aspects can be combined in an advantageous manner in that one of a plurality of different fuel injecting inserts is alternatively inserted in a swirl generator segment electively in one of a plurality of possible orientations.

25 In a preferred construction, a fuel injecting insert is arranged in one or more inlet edges of a swirl generator segment. In this way, it is advantageously possible in particular to arrange fuel outlets in the vicinity of a channel inlet to improve mixing with the injected fuel through the swirling of the air taking place at that location and by making use of the entire channel of the swirl generator as a mixing section. For
30 this purpose, a fuel injecting insert can be inserted, particularly by positive engagement, into a cutout in the inlet edge of the swirl generator segment, which cutout opens outward toward the channel, so that the inlet contour of the channel or

the inlet edge of the swirl generator segment is formed at least partially by the inserted fuel injecting insert. By varying its orientation or exchanging it for a different kind of fuel injecting insert according to the first aspect and second aspect mentioned above, the inlet contour of the channel can also be adapted to altered
5 boundary conditions in this way. Further, by means of a fuel injecting insert arranged in an inlet edge of a swirl generator segment, this inlet edge can be constructed with a material, namely, that of the fuel injecting insert, which is different than the rest of the swirl generator segment whose walls define the lateral surfaces of the channel.

A fuel injecting insert is preferably received only partially in the swirl
10 generator segment, i.e., not along its entire lateral surface, and free areas of its lateral surface have fuel outlets and/or at least partially form an inlet edge of the swirl generator segment. To this extent, by fuel injecting insert received in a swirl generator segment is also meant, in particular, a fuel injecting insert which is only partially received in the swirl generator segment.

15 In a preferred construction, a fuel injecting insert is received in a swirl generator segment so as to be exchangeable in order to define the injection of fuel into a channel by reorientation or by exchanging with another fuel injecting insert. The exchangeable fuel injecting insert can be secured, for example, by frictional engagement, e.g., by screwing a cover on to the swirl generator segment, or also by a
20 material bond, e.g., by welding the fuel injecting insert to the swirl generator segment, in which case exchangeability is advantageously ensured by forming predetermined breaking points in the material bond connection.

In particular by means of a material bond connection of this kind and also, in addition to or as an alternative to this, by means of flexible sealing means, for
25 example, C-rings which are produced from metal in a preferred construction in view of the temperatures to which a swirl generator is exposed during operation of the gas turbine, a fuel injecting insert can be sealed relative to the swirl generator segment receiving it and/or relative to a cover in which a fuel feed to the fuel injecting insert can be formed.

30 According to a third aspect of the present invention which can preferably be combined with the first and/or second aspect, a swirl generator has a plurality of swirl generator segments for injecting fuel in a gas turbine, channels being formed between

the plurality of swirl generator segments for supplying swirled air to a combustion chamber of the gas turbine, and the swirl generator segments are arranged in the swirl generator so as to be exchangeable.

Accordingly, as was mentioned above with respect to the first aspect, the swirl generator can be adapted to different properties of the combustion gas or to an air throughput which varies with different outputs of the gas turbine by electively inserting different swirl generator segments which can differ from one another, for example, with respect to height, width and/or the shape of the channels of the swirl generator which are defined by them, quantity, shape, size and/or arrangement of fuel outlets provided therein or fuel injecting inserts received therein.

The present invention is applied in a particularly advantageous manner in stationary gas turbines, radial swirlers and/or for the injection of gaseous fuel.

Brief Description of the Drawings

Other advantages and features are indicated in the subclaims and the embodiment example explained in the following. The partially schematic drawings show:

- Fig. 1 a cross section through one half of a swirl generator according to a construction of the present invention along section line I-I in Fig. 2;
- Fig. 2 an axial section through one half of the swirl generator according to Fig. 1 along section line II-II; and
- Figs. 3A, 3B two different fuel injecting inserts for the swirl generator according to Fig. 1.

Detailed Description

Figs. 1 and 2 show one half of a radial swirl generator according to an embodiment of the present invention in cross section and axial section.

Channels K are formed between wedge-shaped swirl generator segments 1.1, 1.2, 1.3 having a substantially triangular cross section to supply combustion air L to a combustion chamber of a stationary gas turbine (not shown), this combustion chamber being situated (at bottom in Fig. 2) on the radially inner side, axially downstream of

the swirl generator. By means of the deflection, a rotational momentum is applied to the combustion air whose flow line is indicated by the bold arrows in Figs. 1 and 2.

Rotationally symmetrical bore holes which open outward are formed in the two radially outer corners of the swirl generator segments 1.1, 1.2, 1.3, respectively.

5 A cylindrical insert body 2.2 or 2.2' (compare Fig. 3) of a fuel injecting insert 2 or 2' is inserted into the bore holes in a positive engagement so that about three-fourths of its lateral surface is received in the complementary three-fourths circular bore hole. In a modification, not shown, the insert body can also be arranged deeper inside the swirl generator segment so that a larger portion of its lateral surface is received in the
10 complementary bore hole which can then extend over more than one three-fourths circle. In another modification which is not shown, the insert body can also be arranged at a lesser depth in the swirl generator segment so that a smaller portion of its lateral surface is received in the complementary bore hole which then extends over less than a three-fourths circle in a corresponding manner.

15 A substantially circular disk-shaped insert head 2.1 or 2.1' which is flattened on a flat side 2.3 and 2.3', respectively, (Fig. 3) adjoins the cylindrical insert body 2.2, 2.2'.

Complementary circular cutouts with a flattened circle chord are formed in a cover ring 10 (compare Fig. 2) at which the swirl generator segments 1.1, 1.2, 1.3 are
20 formed integral therewith or, in a modification which is not shown, to which they are secured by a material bond or by frictional engagement, so that the fuel injecting inserts 2, 2' can only be inserted into the swirl generator segments 1.1, 1.2, 1.3 in an orientation that is predetermined by the flat side 2.3 and 2.3', respectively. They are attached in these swirl generator segments 1.1, 1.2, 1.3 by a weld seam so as to be
25 detachable again and, in addition, are sealed relative to the cover ring 10 by metal C-rings 60.

A cover 20 of the swirl generator is screwed to the cover ring 10, an annular fuel feed 50 which is open toward the insert heads 2.1 and 2.1', respectively (see Fig. 3) of the fuel injecting inserts being formed in the cover 20. To this end, screws 40
30 pass through the cover 20, the cover ring 10 and the swirl generator segments 1.1, 1.2, 1.3 and are screwed into a swirl generator base 30 which, together with the cover ring 10 and the side walls of the swirl generator segments 1.1, 1.2, 1.3, defines the air

supply channels K and into which the insert bodies 2.2 and 2.2' of the fuel injecting inserts 2 and 2' are inserted at the front (see Fig. 2). The cover 20 also secures the fuel injecting inserts by positive engagement and frictional engagement.

5 The fuel injecting inserts have an axial bore hole (see Fig. 2) which opens toward the insert head, radial bore holes 3 communicating with this axial bore hole. Gaseous fuel which is supplied to the fuel injecting inserts 2 via the fuel feed line 50 flows through the longitudinal or axial bore hole in the insert head and is injected into the channel K through the radial bore holes 3 functioning as fuel outlets.

10 Since the inserted fuel injecting insert is fixed with respect to rotation in the respective swirl generator segment with a predetermined orientation owing to the flattening of the insert head and the correspondingly complementary cutout in the cover ring 10 of the swirl generator segments, the position of the fuel outlets 3 relative to the flattened portion 2.3 and 2.3' of the insert head 2.1 and 2.1', respectively, determines an injection direction in cross section, i.e., relative to the air flow L, when
15 the fuel injecting insert is inserted into the swirl generator segment. In the fuel injecting inserts 2 (Fig. 3A), the fuel outlets 3 are arranged relative to the flattened portion 2.3 of the insert head 2.1 in such a way that, as is shown in Fig. 1, the fuel B is injected substantially perpendicular to the air flow L when the fuel injecting insert 2 is inserted.

20 In fuel injecting insert 2' (Fig. 3B), on the other hand, the fuel outlets 3' are offset relative to the flattened portion 2.3' of the insert head 2.1' in such a way that the injection direction of the fuel in the channel has a component that is oriented opposite the throughflow direction, i.e., radially outward, when fuel injecting insert 2' is inserted into a swirl generator segment so as to be fixed with respect to rotation
25 relative to it instead of fuel injecting insert 2 with the orientation predetermined by the flattened portion 2.3' and is attached by welding. This injection opposite the air flow of the combustion air can improve the mixing with the injected fuel, particularly at a lower air throughput, by stagnation points in the flow of the combustion air L which are formed in front of the fuel outlets 3'.

30 As is shown by comparing Figs. 3A and 3B, the fuel outlets 3, 3' differ not only in their angular position relative to the flattened portion 2.1 and 2.3', respectively, but also in the height at which they are arranged in the channel K.

Accordingly, by exchanging or electively inserting the fuel injecting inserts 2 or 2', the injection of fuel can be specified and adapted to changed properties of the combustion gas or to a varying air throughput. Instead of the fuel injecting inserts 2 and 2' which are shown in the drawing, it is also possible to use other fuel injecting
5 inserts, not shown, which have fuel outlets of a different shape, quantity and/or outlet direction so that, for example, an injection direction which is not horizontal with respect to Fig. 2 can be realized in that the fuel outlet axis forms an angle not equal to 90° with the longitudinal axis of the fuel injecting insert.

In a modification, not shown, the cutouts in the cover ring 10 for receiving the
10 insert heads of the fuel injecting inserts are formed so as to be completely rotationally symmetrical and accordingly allow the fuel injecting inserts to be received in the swirl generator segments with any predefinable orientation relative to their longitudinal axis or axis of symmetry. The fuel injection can also be predetermined in any desired manner in that the fuel injecting inserts are rotated in such a way when inserting them
15 into the swirl generator segments, or after inserting them into the swirl generator segments, that their fuel outlets 3 and 3' impart a desired injection direction and are subsequently fixed with respect to rotation in this angular position, e.g., by welding with the cover ring 10.

In another modification which is not shown in the drawings, the insert heads
20 2.1 and 2.1' of the fuel injecting inserts 2 and/or 2' and the cutouts in the cover ring 10 which receive them are constructed in such a way that they allow the fuel injecting inserts to be received in the swirl generator segments with different discrete orientations which are offset relative to one another at an angle around their longitudinal axis. For this purpose, for example, the insert heads and the cutouts
25 receiving them can have a cross section in the shape of a regular polyhedron, e.g., a regular 36-sided polyhedron, so that they can be received so as to be offset by 10° , respectively, and fixed with respect to relative rotation.

In the preferred construction shown in the drawings, the fuel injecting inserts are arranged in the radially outer inlet edges of the swirl generator segments. This
30 advantageously combines a rounded channel inlet through the cylindrical insert body 2.1 and 2.2' of the fuel injecting inserts, protection of the inserts against mechanical environmental influences, a favorable thermal impact upon the inserts, and an

advantageous injection of the fuel at, or – depending upon the angular position – in front of, the edge inlet so that the entire channel is used as a mixing section.

Accordingly, the fuel injecting inserts arranged in the inlet edges of a swirl generator segment advantageously form a portion of the surface of the swirl generator segment and accordingly likewise make it possible to integrate the fuel injecting inserts in the swirl generator segments in a compact manner and to vary their outer contour. For example, like the insert head, the insert body of another fuel injecting insert, not shown, can have a flattened portion in which the fuel outlets are formed. By inserting these fuel injecting inserts instead of the inserts with cylindrical insert bodies 2.2 and 2.2' shown in Figs. 3A, 3B, the inlet edges of the swirl generator segments can be represented by a run-in bevel which is formed by the flattened portion of the insert body and takes the place of the run-in radius which is formed by the lateral surface of the cylindrical insert body 2.2 and 2.2'.

Instead of the cover ring 10 and the swirl generator segments 1.1, 1.2, 1.3 which are originally formed, e.g., cast, with them, another cover ring, whose swirl generator segments differ from the swirl generator segments 1.1, 1.2, 1.3 shown in Figs. 1 and 2 with respect to the shape of the lateral surfaces of the channel, the channel height, the arrangement of fuel injecting inserts, or the like, can be screwed to the cover 20 and the swirl generator base 30 so that the channel shape, channel height, and/or quantity of channels in the swirl generator can also be varied like the fuel injection.

Reference Numbers

	1.1, 1.2, 1.3	swirl generator segment
	2; 2'	fuel injecting insert
	2.1; 2.1'	insert head
5	2.2; 2.2'	insert body
	2.3; 2.3'	flattened portion
	3; 3'	fuel outlet
	10	cover ring
	20	cover
10	30	swirl generator base
	40	screw
	50	fuel supply line
	60	C-ring

Patent Claims

1. Swirl generator, in particular radial swirl generator, for the injection of fuel (B) in a gas turbine, with a plurality of swirl generator segments (1.1, 1.2, 1.3), channels (K) being formed therebetween for supplying swirled air (L) to a combustion
5 chamber of the gas turbine, and with fuel injecting inserts (2; 2') for injecting fuel into the channels in order to premix air and fuel, wherein these inserts (2; 2') are received in swirl generator segments, characterized in that an injection of fuel into a channel can be predetermined by the arrangement of a fuel injecting insert in the swirl generator segment.
- 10 2. Swirl generator according to claim 1, characterized in that an injection direction of the fuel in a channel is oriented at a predetermined angle to, particularly substantially perpendicular to, a longitudinal axis (A) of the swirl generator and/or an air flow (L).
3. Swirl generator according to claim 2, characterized in that the injection
15 direction of the fuel in the channel has a component oriented in opposition to a through-flow direction of the channel.
4. Swirl generator according to any one of claims 1 to 3, characterized in that different kinds of fuel injecting inserts (2; 2') having different fuel outlets (3; 3') can be received in a swirl generator segment.
- 20 5. Swirl generator according to any one of claims 1 to 4, characterized in that a fuel injecting insert (2; 2') has swirl generator segments (1.1, 1.2, 1.3) at a predetermined height and/or with a predetermined nozzle orifice.
6. Swirl generator according to any one of claims 1 to 5, characterized in that a fuel injecting insert (2; 2') can be received in a swirl generator segment with at
25 least one predetermined orientation.
7. Swirl generator according to claim 6, characterized in that a fuel injecting insert can be received in a swirl generator segment with different orientations.

8. Swirl generator according to any one of claims 1 to 7, characterized in that a fuel injecting insert is received in a swirl generator segment so as to be fixed with respect to rotation relative to it, particularly by positive engagement.

5 9. Swirl generator according to any one of claims 1 to 8, characterized by a cover (20) in which a fuel feed (50) to fuel injecting inserts (2) is provided, wherein a fuel injecting insert is sealed relative to this cover (20) and/or relative to the swirl generator segment (1.1, 1.2, 1.3) receiving it.

10. Swirl generator according to any one of claims 1 to 9, characterized in that a fuel injecting insert is arranged in an inlet edge of a swirl generator segment.

10 11. Swirl generator according to claim 10, characterized in that the fuel injecting insert at least partially forms the inlet edge of the swirl generator segment.

12. Swirl generator according to any one of claims 1 to 11, characterized in that fuel outlets (3; 3') are arranged in front of or at a channel inlet.

15 13. Swirl generator according to any one of claims 1 to 12, characterized in that a fuel injecting insert is received in a swirl generator segment so as to be exchangeable.

14. Swirl generator in particular according to any one of claims 1 to 13, characterized in that the swirl generator segments (1.1, 1.2, 1.3) are arranged in the swirl generator so as to be exchangeable.

20 15. Fuel injecting insert (2; 2') for a swirl generator according to one of the preceding claims, with an insert body (2.2; 2.2'), particularly a rotationally symmetrical insert body, for receiving in a hollow space of a swirl generator segment (1.1, 1.2, 1.3) opening toward the channel, wherein the insert body has a longitudinal bore hole and at least one fuel outlet (3; 3') communicating with the latter.

25 16. Fuel injecting insert according to claim 15, characterized by an insert head (2.1; 2.1') for receiving in the swirl generator by positive engagement, particularly so as to be fixed with respect to relative rotation.

17. Swirl generator segment (1.1, 1.2, 1.3) for a swirl generator according to one of the preceding claims 1 to 14, with a hollow space opening toward the channel for receiving a fuel injecting insert (2; 2'), wherein an injection of the fuel (B) by a fuel injecting insert into a channel can be predetermined by the arrangement of the fuel injecting insert in the swirl generator segment.

18. Swirl generator segment according to claim 17, characterized in that it has a substantially triangular cross section, wherein two corners form inlet edges.

19. Gas turbine, particularly stationary gas turbine, with a swirl generator according to one of the preceding claims 1 to 14.

20. Method for injecting fuel (B) into a gas turbine according to claim 19, characterized in that an injection of the fuel into a channel (K) of the swirl generator of the gas turbine is predetermined by the arrangement of a fuel injecting insert (2; 2') in a swirl generator segment (1.1, 1.2, 1.3).

Fig. 1

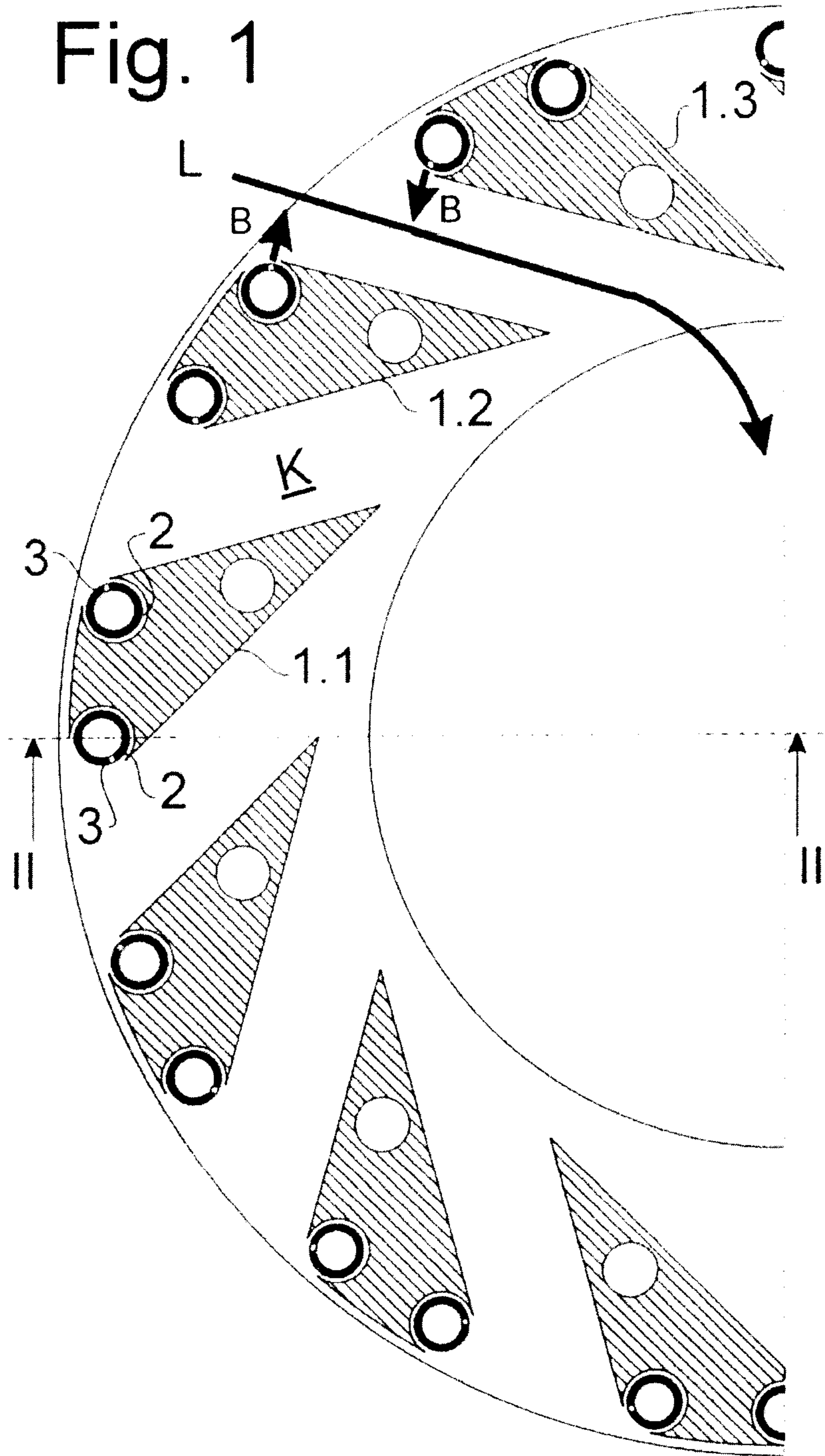


Fig. 2

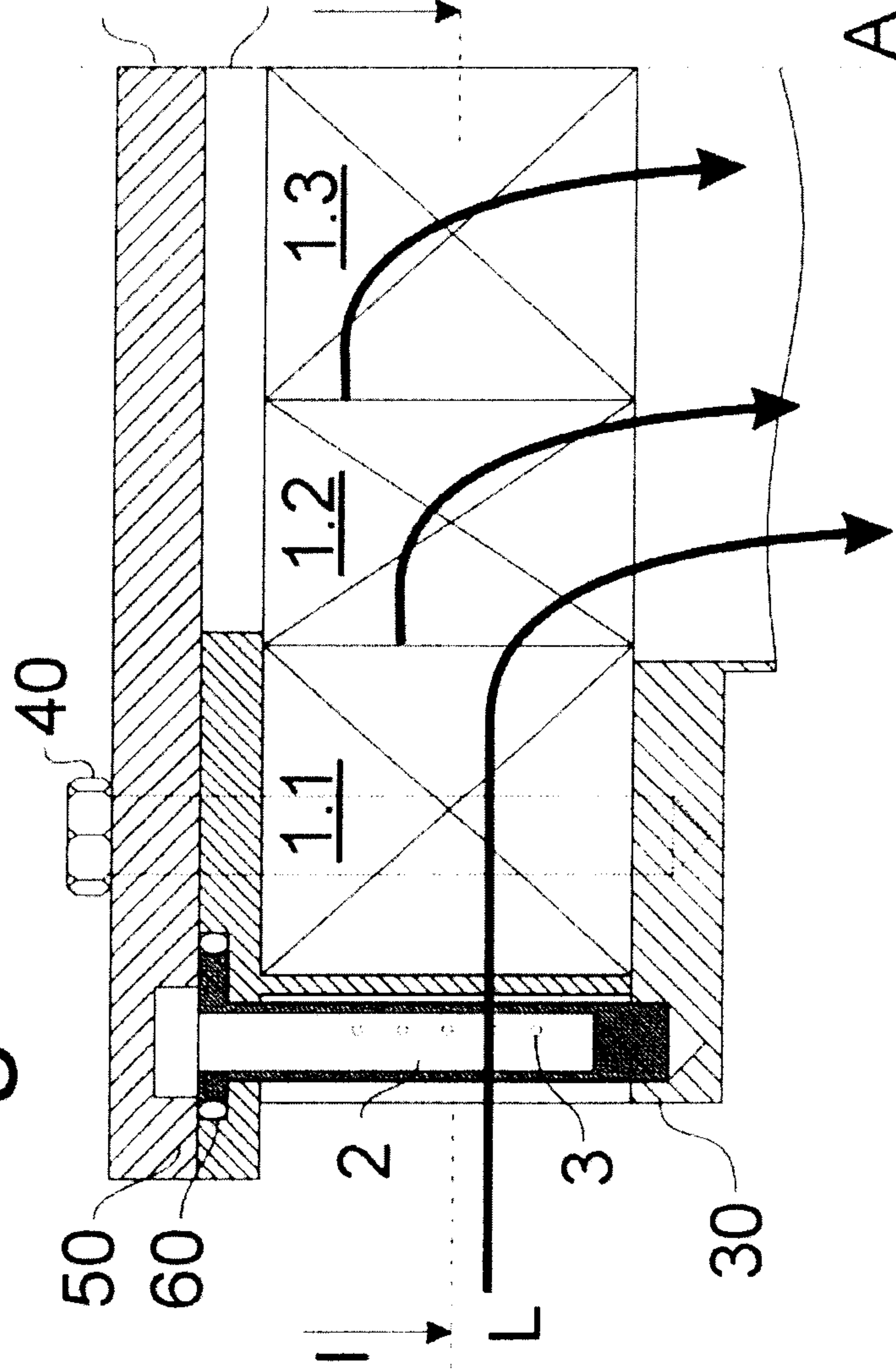


Fig. 3A

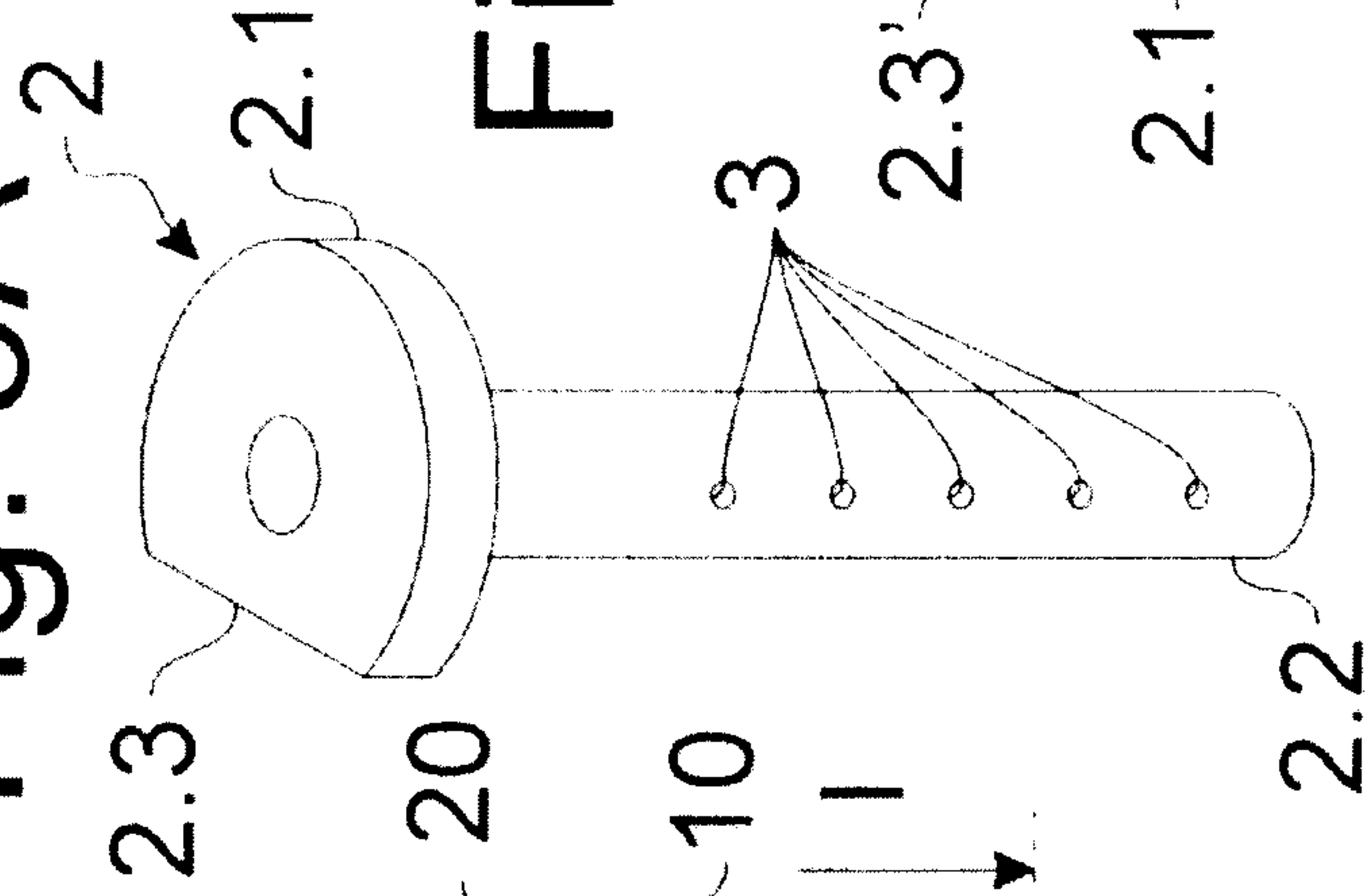


Fig. 3B

