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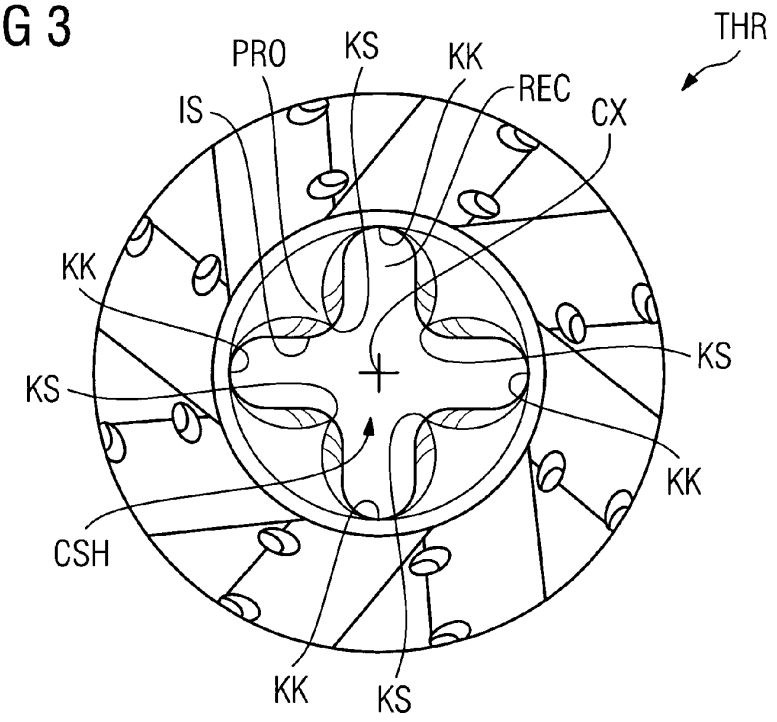
(71) Applicant: **SIEMENS AKTIENGESELLSCHAFT**
80333 München (DE)

(72) Inventors:
- **Karlsson, Andreas**
  602 26 Norrköping (SE)
- **Milosavljevic, Vladimir**
  60226 Norrköping (SE)

(54) Burner for a gas turbine

(57) The invention relates to a burner (B) for a gas turbine comprising a burner housing (BH) and a pilot combustor (PC) comprising a supply module (SM) providing pilot fuel (F) and pilot air (A) into pilot combustion room (PCR) being enclosed by a pilot combustor housing (PCH) comprising a tapered exit with a throat (THR) of a defined lengths into the resulting main flow direction, said throat (THR) discharging a concentration of radicals (R) and heat (H) generated in said pilot combustion room (PCR) into a main combustion room (MCR) enclosed by said burner housing (BH), wherein a burner axis (CS) is defined by a centre line of said throat (THR) extending in the direction of the resulting main flow through said throat (THR). To improve stability the invention proposes that the interior cross section area of said throat(THR) deviates from a circle by means of flow guiding elements (FGE) provided as protrusions (PRO) with a defined radial hight or as recesses (RCE) with a defined depth extending longitudinally along the direction of the burner axis (CX) to give the discharging flow a defined velocity distribution with regard to a circumferential direction.

FIG 3



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Description

[0001] The invention relates to a burner for a gas turbine, comprising:

- a burner housing and
    - a pilot combustor comprising a supply module providing pilot fuel and pilot air into a pilot combustion room being enclosed by a pilot burner housing comprising a tapered exit with a throat of a defined length into the resulting main flow direction, said throat discharging a concentration of radicals and heat generated in a pilot combustion zone into a main combustion room enclosed by said burner housing,
    - wherein a burner axis is defined by a center line of said throat extending in the direction of the resulting main flow through said throat.

[0002] A burner of the incipiently mentioned type is known from the document WO 2009/121777. An essential feature of this burner described in that document is that the pilot combustor is provided with its own combustion room enclosed by its own combustion housing and discharges a concentration of heat and radicals into a main combustion zone, which enables a stable combustion after ignition. In general major aims associated with gas turbine burner design are the enhancement of thermal efficiency, stabilization respectively elimination of pulsations and noise and the reduction of polluting emissions, especially nitrogen oxides, carbon monoxide and unburned hydrocarbons next to particle emissions. Some of these targets do have a contradictory tendency since an increase in thermal efficiency often goes along with an increase in temperature of the hot gas path, which can lead to a generation of a higher amount of emissions, especially nitrogen oxides. Further an especially lean combustion aiming to a complete oxidation of hydro carbons to avoid carbon monoxide or unburned hydro carbons influences stability negatively, which increases high frequency and low frequency fluctuations and noise. Since all parameters seem to be linked to each other an improvement for example in stability should enable also improvements with regard to thermal efficiency if an inventive step is claimed.

[0003] It is one object of the invention to improve stability and to avoid especially lower frequency fluctuations, which are often caused by fluctuations of the location of the flame front in the burner. It is a further object of the invention to reduce emissions and to increase thermal efficiency.

[0004] In accordance with the invention there is provided a burner of the incipiently mentioned type further comprising the feature of the characterizing portion of claim 1.

[0005] A conventional throat opening like described in the above mentioned WO 2009/121777 is of round respectively cylindrical shape with regard to the inner surface of the throat, wherein the pilot combustion room is tapered in the direction of the flow into the main combustion room. The main flow through the throat, which is at least partially cylindrical with a cylinder axisthe direction of the effective flow through the throat discharges into the main combustion room.

[0006] An essential feature of the invention is to give the discharging flow a defined velocity distribution with regard to a circumferential direction. Specifications like axial, radial and circumferential always refer to said burner axis, if not specified differently. Within the conventional burner according to WO 2009/121777 it was observed that relatively low frequency instabilities can occur due to entering of the flame front from the main combustion zone into the pilot burner housing through the throat. According to the invention it was recognized that the likely hood of the entering of the flame front through the throat of a pilot burner can be significantly influenced by giving the velocity flow distribution in the throat a circumferential component in a controlled and defined manner. This way the problem of the flame front entering the pilot burner room can be eliminated.

[0007] A very effective way according to a preferred embodiment of the invention to eliminate the likelyhood of entering the flame front through the throat into the pilot burner is to shape the protrusions or recesses in the throat to obtain a radial crosssection like a cross or a star.

[0008] Another preferred embodiment provides a radial cross section of the throat forming a triangle, a quadrangle, a pentagon or another polygon without being a circle.

[0009] Basically the aim of the invention can be reached by implementing a radial cross section in the throat, which inhibits a circumferential velocity component, which corresponds to the circumferential velocity component in the main burner room, which is given by the swirler discharging air and/or fuel into the main combustion room.

[0010] Good results with regard to the low frequency stability and also to the pressure loss through the throat can be obtained with a preferred embodiment provided with a radial crosssection in the throat comprising convex and concave portions of an inner surface of said throat.

[0011] Further improvement can be expected, when said protrusions and/or recesses are provided with a basically helical shape extending along the center line to give the flow through the throat a swirl. A different approach having a similar effect provides protrusions and/or recesses, which are basically parallel to said burner axis to give the flow a velocity distribution without a swirl respectively to reduce the circumferential velocity down to preferably nearly 0 in contrast to the velocity distribution in the main combustion room.

[0012] With regard to the helical shape of the protrusions and/or recesses it is advantageous if said burner comprises a swirler discharging air or/and fuel into said main combustion room establishing a main swirl in said

main combustion room of a first direction, wherein said protrusions and/or recesses are formed such that the flow exiting said throat is given a counter wise swirl. This design should inhibit any intrusion of a flame front through the throat from the main combustion room very efficiently.

[0013] Beneficial the efficiency can further be improved by providing nozzles in the throat for discharging fuel into the flow of heat and radicals through the throat. If at least a part of the fuel to be supplied to the pilot combustor by means of the supply module is instead injected through said nozzles the temperature in the pilot combustion room can be reduced resulting in lower levels of nitrogen oxide. On the other hand a significantly improved mixing of the fuel injected and the flow of radicals through the throat is established since the fuel is injected at a small diameter in the area of the throat, which eases the intrusion of a jet of fuel into this flow at the location of the nozzles. A further improvement of the mixing can be obtained, when the nozzles are provided on flanks or sidewalls of said protrusions and/or recesses in the throat. This way the fuel is injected at locations, where the potential start of a swirl is most likely resulting in a wide distribution of the fuel injected.

[0014] The above mentioned attributes and other features and advantages of this invention and the manner of attaining them will become more apparent and invention itself will be better understood by reference to the following description of the currently best mode of carrying out the invention taken in conjunction with the accompanying drawings, wherein

figure 1 shows a schematic depiction of a longitudinal cross section through a burner according to the invention,

figure 2 shows a three-dimensional schematic depiction of a throat according to the invention,

figure 3 shows a view through a throat according to the invention and shown in figure 2,

figure 4 shows a three-dimensional depiction of a different preferred embodiment of the throat according to the invention and

figure 5 shows a further preferred embodiment of the throat according to the invention in a longitudinal cross section.

[0015] Figure one shows a longitudinal cross section through a burner B according to the invention. The burner B comprises a pilot combustor PC and a main combustor MC. The pilot combustor PC supplies a flow of heat H and radicals R into a main combustion room MCR of the main combustor MC.

[0016] The main combustor MC comprises a burner housing BH enclosing the main combustion room MCR and the supply of air A and fuel F into the main combustor room and further in a non depicted manner the burner housing BH also encloses the pilot combustor PC. The pilot combustor PC discharges the heat H and the radicals R into said main combustion room MCR through a throat THR. A burner axis CX is defined by a center line extending in the direction of the resulting main flow through said throat THR.

[0017] The supply of air A and fuel F into the main combustion room MCR is provided by two annular channels, a first channel CH1 and a second channel CH2. The first channel CH1 is divided from the second channel CH2 by a splitter plate SP. Both openings of said channels CH1, CH2 into the main combustion room MCR have an annular shape, which is coaxial to the burner axis CX. Further, the openings of the channel CH1, CH2 succeed to each other in a staggered manner with regard to the burner axis CX, wherein the first channel CH1 opens upstream into the main combustion room with regard to the second channel CH2 and downstream with regard to said throat THR of the pilot combustor PC.

[0018] A main swirler MSW provided in the first channel CH1 and the second channel CH2 gives the mixture of fuel F and air A a defined swirl influencing significantly the flow distribution in the main combustion room MCR. The shape of the main combustion room MCR, the flow distribution of the mixture of fuel F and air A entering the main combustion room through channel CH1 and channel CH2 and the radicals R discharged into the main combustion room MCR by the pilot combustor PC establish a recirculation zone RCZ in the main combustion room MCR in training a portion or deburned combustion gas CG, which might contain unburned hydro carbons from an exhaust EXH of the burner housing BH. The velocity distribution in main combustion room MCR further establishes a stagnation point STP downstream said throat THR and on the burner axis CX. While in the centre of the recirculation zone RCZ the mixture is relatively lean and the temperature is high, the mixture is enriched at the openings of said first channel CH1 and said second channel CH2 into the main combustion room MCR, where a flame front FF is most likely to establish.

[0019] Upstream the main swirler MSW a main fuel injection MFI is provided in the first channel CH1 and the second channel CH2 injecting the major portion of fuel F to be burned in the burner B.

[0020] The pilot combustion PC is provided with a supply module SM supplying fuel F and Air A into a pilot combustion room PCR. The amount of fuel F and air A to be supplied into the pilot combustion room PCS is below 15% of the total mass flow of fuel F and air A into the burner B. The combustion in the pilot combustor room PCR is richer than in the main combustion room MCR, which results in a significantly higher temperature. The pilot combustion room PCR is equipped with an ignition module IGN, which ignites the combustion in the pilot combustor PC. The pilot combustor PC has its own pilot combustor housing PCH, which is cooled by a cooling air flow CAF. The cooling air flow CAF passes through a preferated? plate PP surrounding the pilot combustor housing PCH and afterwards enters the main combustion room MCR through an annular opening OP, being coaxial to the burner axis CX and being located directly next to

the opening of the said throat THR and upstream of said first channel CH1. A surrounding cooling cavity CCV channeling the cooling air flow CAF on the pilot combustor housing PCH passes a separate swirler SWP upstream entering the main combustion room MCR.

[0021] The fuel F and air A entering the pilot combustion room PCR through the supply module SM is premixed.

[0022] The throat THR is provided with flow guiding protrusions PRO to give the flow entering the main combustion room MCR a defined circumferential velocity distribution.

[0023] A further fuel injections happens in the throat THR trough side walls of the protrusions PRO, which are provided with nozzles NOZ ejecting a jet of fuel F into the flow of heat H and radicals R discharging into the main combustion room. The nozzles NOZ connect the flow channel of the throat THR with an inner cavity CV provided in the protrusion PRO, which is supplied with fuel F through channels provided in the adjacent wings of said swirler SWP. In a non depicted manner the wings of the swirler SWP receive the fuel F from channels through a side wall of said first channel CH1.

[0024] Figure 2 shows a three dimensional picture of a throat THR according to the invention. The throat THR is provided with basically round shape extending coaxially along said burner axis CX. The same throat THR is also depicted in figure 3 shown in a different perspective. Protrusions PRO are provided with a symmetry, which results in a cross shape CSH of the opening of the throat THR. An inner surface IS is provided with convex KS and concave KK portions. As well the radial cross section depicted in figure 3, comprises concave KK and convex KS portions of the inner surface IS of the throat THR. The protrusions PRO and the recesses REC in figure 3 are basically parallel to the burner axis CX.

[0025] Figure 4 shows a preferred embodiment of the throat THR according to the invention in a three-dimensional simplified depiction. Said protrusions PRO and recesses REC follow basically a helical path arranged coaxially around a burner axis CX. The swirl of the flow given by this helical shape is counterwise with regard to the swirl in the main combustion room MCR.

[0026] Figure 5 shows a throat THR provided with fuel injection by means of nozzles NOZ provided on flanks respectively side walls of the protrusions PRO respectively recesses REC. The nozzles NOZ connect an inner cavity CF inside said protrusions PRO, which is supplied with pressurized fuel F to be injected into the flow through nozzles provided in the throat THR. In a non depicted manner the inner cavity CV receives the flow of fuel F through a non depicted channel provided in swirler wings of the pilots swirler SWP.

Claims

1. Burner (B) for a gas turbine comprising
- a burner housing (BH) and
- a pilot combustor (PC) comprising a supply module (SM) providing pilot fuel (F) and pilot air (A) into pilot combustion room (PCR) being enclosed by a pilot combustor housing (PCH) comprising a tapered exit with a throat (THR) of a defined lengths into the resulting main flow direction, said throat (THR) discharging a concentration of radicals are and heat (H) generated in said pilot combustion room (PCR) into a main combustion room (MCR) enclosed by said burner housing (BH),
- wherein a burner axis (CS) is defined by a centre line of said throat (THR) extending in the direction of the resulting main flow through said throat (THR), **characterized in that**

the interior cross section area of said throat (THR) deviates from a circle by means of flow guiding elements (FGE) provided as protrusions (PRO) with a defined radial hight or as recesses (RCE) with a defined depth extending longitudinally along the direction of the burner axis (CX) to give the discharging flow a defined velocity distribution with regard to a circumferential direction.

2. Burner (B) according to claim 1,
wherein said cross section protrusions or recesses form a cross or a star shape of said radial crosssection of the throat (THR).

3. Burner (B) according to claim 1,
wherein said crosssection forms a triangle, a quadrangle, a pentagon or another polygon without being a circle.

4. Burner (B) according to claim 1 or 2,
wherein said crosssection comprises convex or concave portions of an inner surface (IS) of said throat (THR).

5. Burner (B) according to claim 2 at least 1 of the preceding claims,
wherein said protrusions (PRO) and/or recesses (REC) are provided with a basically helical shape extending along the centre line (CX) to give the flow through the throat (THR) a swirl.

6. wherein said protrusions and/or recesses are basically parallel to said burner axis (CX) to give the flow a velocity distribution without a swirl.

7. Burner (B) according to claim 5,
wherein said burner (B) comprises a swirler (MSW) discharging air (A) or/and fuel (F) into said main combustion room (MCR) establishing a main swirl in said main combustion room (MCR) of a first direction, wherein the protrusions (PRO) and/or the recesses

(RCE) are formed such that the flow exiting the throat (THR) is given a counterwise swirl with regard to the swirl in the main combustion room (MCR).

8. Burner (B) according to at least one of the preceding claims, wherein the throat (THR) is provide with nozzles (NOZ) for discharging fuel (F) into the flow through the throat (THR).

9. Burner (B) according to claim 8, wherein said nozzles are located on flanks of said protrusions (PRO) and/or recesses (RCE).

10. Burner (B) according to 1 of the claims 8, 9, wherein said nozzles (NOZ) are made for gaseous fuel (F) to be injected into said flow through said throat (THR).

FIG 1

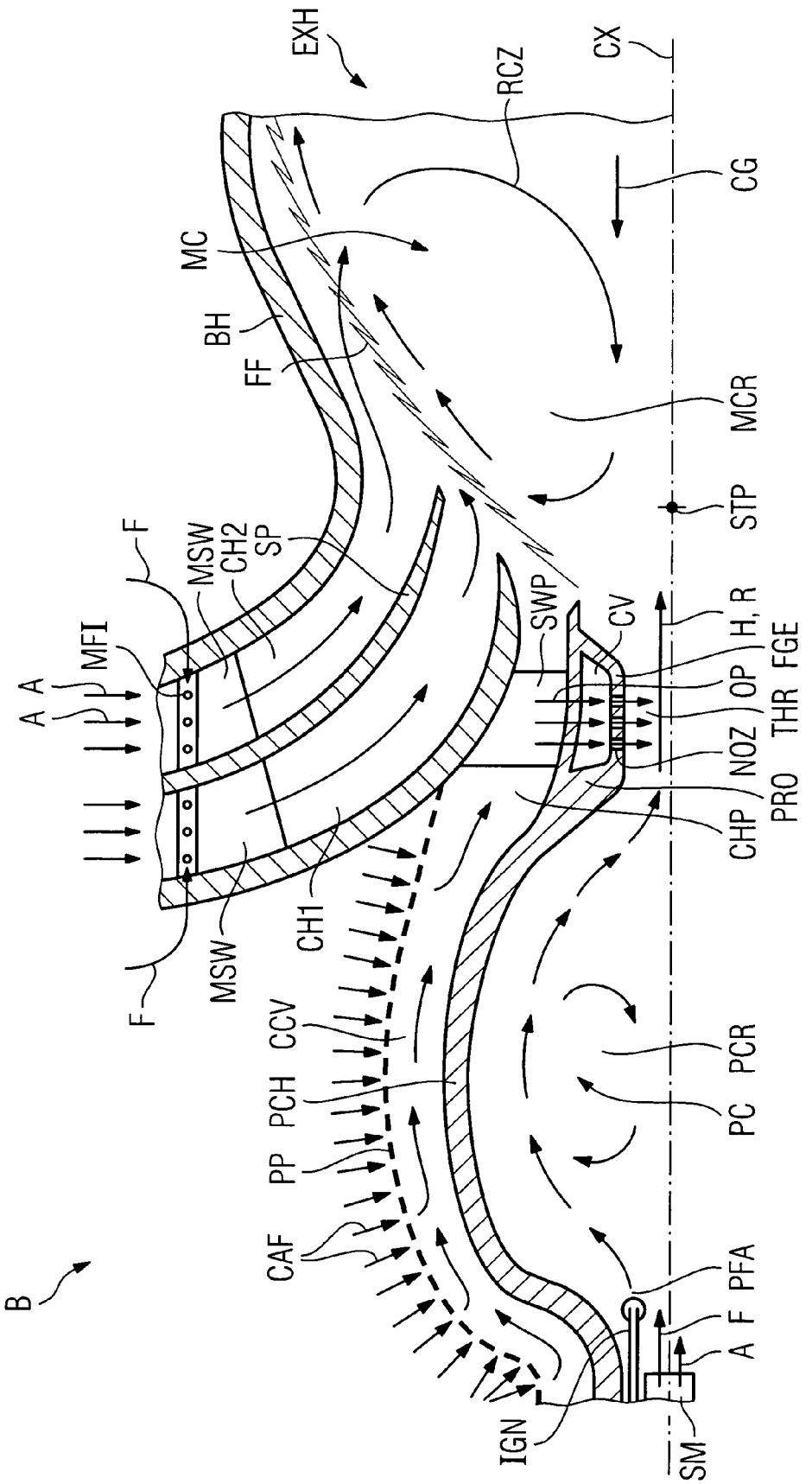

EXH
RCZ
CX
CG
MC
BH
FF
MCR
STP
F
MSW
CH2
SP
SWP
CV
MFI
A A
H, R
OP
NOZ
THR
FGE
CHP
PRO
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PCR
PC
PFA
A F
B
IGN
SM

FIG 2

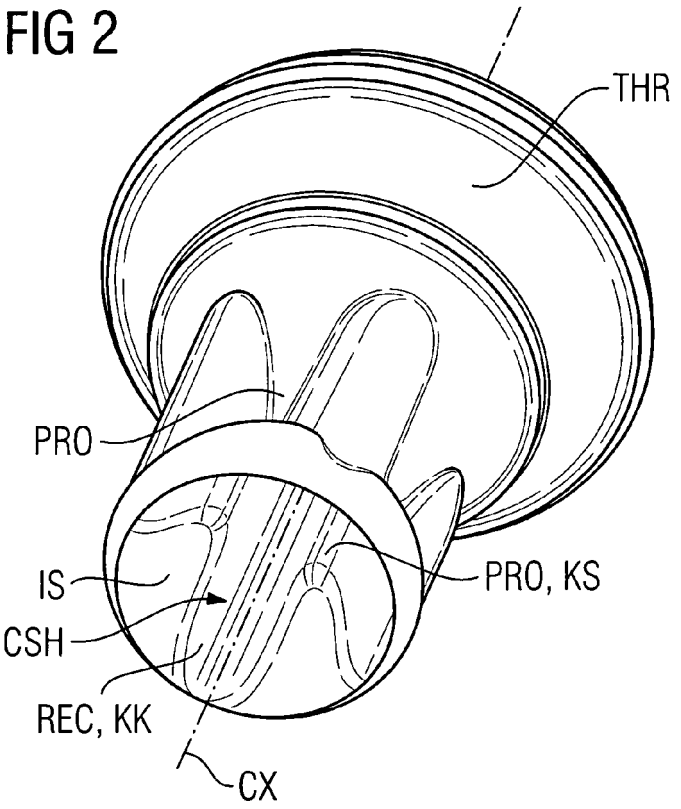

THR
PRO
IS
CSH
REC, KK
CX
PRO, KS

FIG 3

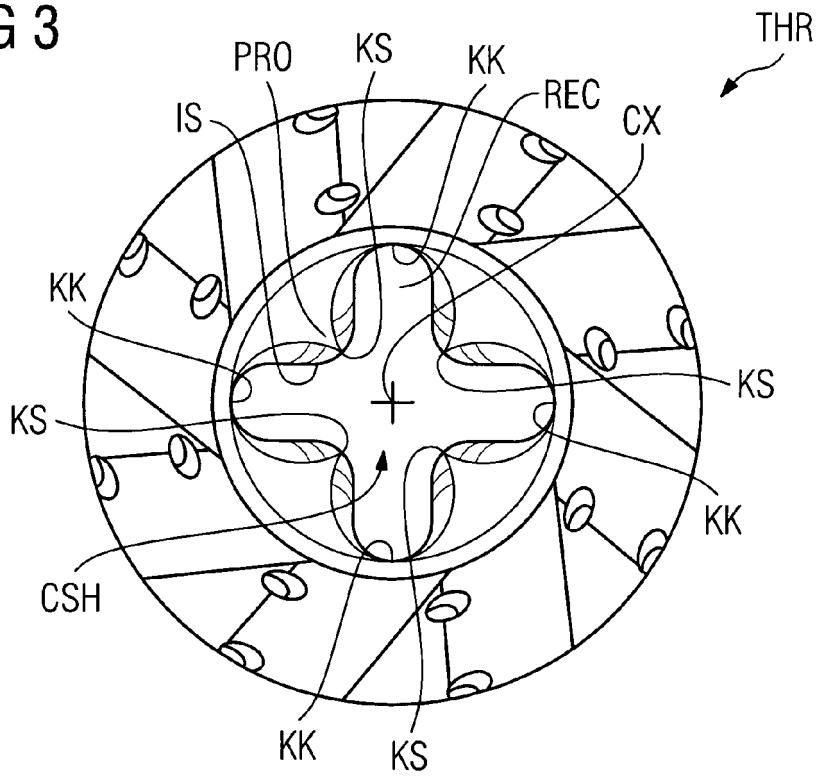

THR
PRO
KS
KK
REC
IS
CX
KK
KS
KS
KK
CSH
KK
KS

FIG 4

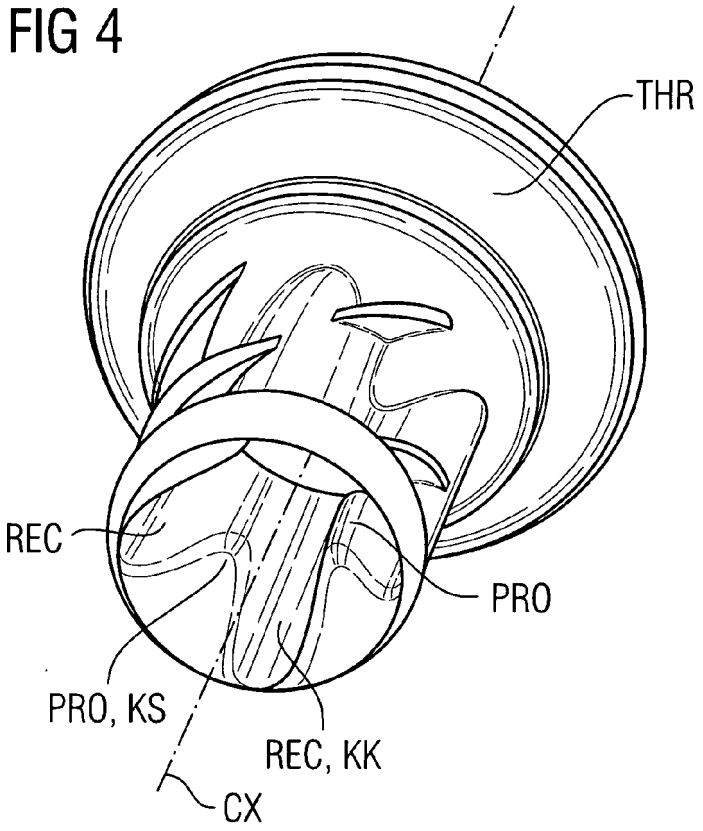
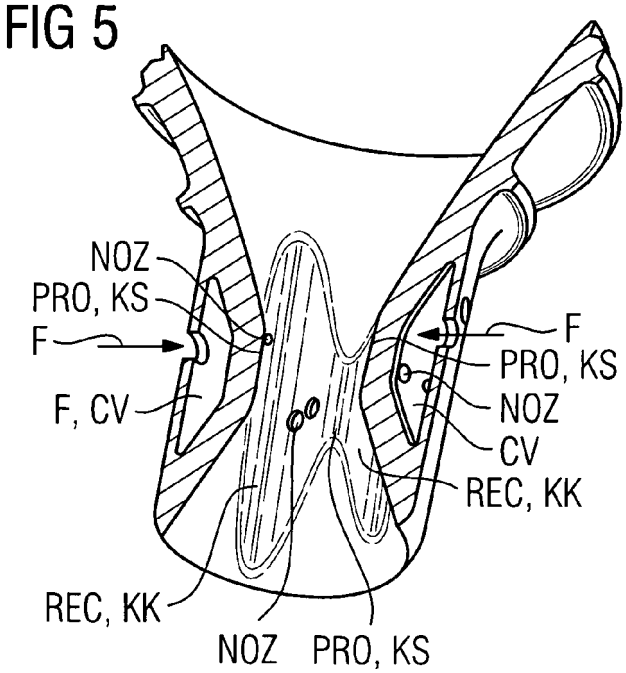

THR
REC
PRO
PRO, KS
REC, KK
CX

FIG 5


NOZ
PRO, KS
F
F, CV
F
PRO, KS
NOZ
CV
REC, KK
REC, KK
NOZ
PRO, KS

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EUROPEAN SEARCH REPORT

Application Number
EP 10 18 4134

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	16 February 2011	Gavriliu, Costin

CATEGORY OF CITED DOCUMENTS

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