Internal distribution code:

(A) [-] Publication in OJ
(B) [-] To Chairmen and Members
(C) [-] To Chairmen
(D) [X] No distribution

Datasheet for the decision of 16 December 2022

Case Number: T 1009/20 - 3.2.04

Application Number: 14712979.5

Publication Number: 2971750

IPC: F02P9/00

Language of the proceedings: EN

Title of invention:
CONTROLLED SPARK IGNITED FLAME KERNEL FLOW

Applicant:
Woodward, Inc.

Headword:

Relevant legal provisions:
EPC Art. 54

Keyword:
Novelty - main request (no) - auxiliary request (no)

Decisions cited:
T 1764/06

This datasheet is not part of the Decisior
It can be changed at any time and without notic

Catchword:

This datasheet is not part of the Decisior
It can be changed at any time and without notic

Europäisches Patentamt
European Patent Office
Office européen des brevets

Beschwerdekammern

Boards of Appeal

Chambres de recours

Boards of Appeal of the
European Patent Office
Richard-Reitzner-Allee 8
85540 Haar
GERMANY
Tel. +49 (0)89 2399-0
Fax +49 (0)89 2399-4465

Case Number: T 1009/20 - 3.2.04

D E C I S I O N
of Technical Board of Appeal 3.2.04
of 16 December 2022

Appellant: (Applicant)	Woodward, Inc. 1081 Woodward Way Fort Collins, Colorado 80524 (US)
Representative:	Fish & Richardson P.C. Highlight Business Towers Mies-van-der-Rohe-Straße 8 80807 München (DE)
Decision under appeal:	**Decision of the Examining Division of the European Patent Office posted on 3 December 2019 refusing European patent application No. 14712979.5 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman	S. Oechsner de Coninck
Members:	J. Wright
	K. Kerber-Zubrzycka

Summary of Facts and Submissions

I. The appellant (applicant) lodged an appeal against the decision of the Examining Division of the European Patent Office posted on 3 December 2019 refusing European patent application No. 14712979.5 pursuant to Article 97(2) EPC.

II. The examining division came to the conclusion that the subject-matter of claim 1 according to the main request and auxiliary request lacked novelty having regard to the state of the art as disclosed in document:
D2: US 2012/125287 A1

III. In a communication of 7 June 2022 following the summons to oral proceedings, the Board gave its provisional opinion.

IV. Oral proceedings were held on 16 December 2022.

V. The appellant requests that the decision under appeal be set aside and that a patent be granted on the basis of a main request, alternatively on the basis of a first auxiliary request, all requests re-filed on 1 April 2020 with the grounds of appeal.

VI. Claim 1 of the main request as now on file reads as follows:

"A method of facilitating combustion in operation of an engine, comprising: receiving air/fuel mixture from a combustion chamber (302) of the engine into an enclosure of a spark plug (306); igniting the received air/fuel mixture in a spark gap (314) within the enclosure; directing the ignited air/fuel mixture

through the spark gap predominantly away from a combustion chamber end of the enclosure at a peak flow velocity at least 10% of a peak flow velocity into the enclosure."

Claim 1 of the auxiliary request as now on file reads as follows:
"A method of facilitating combustion in operation of an engine, comprising: receiving air/fuel mixture from a combustion chamber (302) of the engine into an enclosure of a spark plug (306);
igniting the received air/fuel mixture in a spark gap (314) within the enclosure, wherein the ignition produces a flame kernel;
directing the ignited air/fuel mixture through the spark gap predominantly away from a combustion chamber end ofthe enclosure at a peak flow velocity at least 10% of a peak flow velocity into the enclosure; and
moving the flame kernel through the spark gap into a rearward portion of the enclosure."

VII. The appellant argues as follows:

The subject matter of claim 1 of the main and auxiliary requests is novel with respect to D2.

Reasons for the Decision

1. The appeal is admissible.

2. Technical background of the application

The application generally concerns a spark plug for internal combustion engines which has a pre-combustion chamber, or pre-chamber, used to enhance lean flammability limits, paragraph 005. This pre-chamber facilitates ignition of fuel mixtures having an excess of air beyond stoichiometric value, so called lean fuel mixtures, paragraph 004. In relation to the first embodiment of figures 1 to 8, paragraph 074, the pre-chamber comprises a central hole referenced 162 and periphery holes 164 that communicate with the engine piston chamber. Paragraph 083 explains that the central hole 162 is oriented to direct its flow into the interior of a velocity control tube 136. This velocity control tube channels a flow of air/fuel mixture to the spark gap where it is ignited by an electric spark. The velocity of the mixture causes the initial flame kernel to be transported to the back of the pre-chamber, called back chamber 106 (last sentence of paragraph 083).
All other embodiments of the pre-chamber disclosed in the application and depicted in e.g. figure 9, figure 15, figure 28A, 28C and figure 29 also include a central hole and a velocity control tube.

The application focuses on the velocity in the spark gap and compares the velocity distribution obtained by computational fluid dynamics analysis in the pre-chamber according to an embodiment of the application shown in figure 28a and the same pre-chamber lacking a velocity control tube shown in figures 27a (paragraph

0137). Paragraph 0139 explains that the peak velocity of the incoming fresh air/fuel mixture from the combustion chamber is nearly the same in both instances, however in paragraph 0140 the core effect of the velocity control tube is described to capture the incoming flow by its walls and direct it rearward into the spark gap. The velocity control tube further maintains enough velocity for the mixture to flow through the entire spark surface and to the rear of the pre-chamber, sweeping out any residuals that might be in the spark gap. When the spark plug is fired, the flame kernel produced by the electrical spark is moved quickly through the spark gap and into the [rearward] portion of the pre-chamber to reduce the tendency of the kernel to quench on the spark surfaces (page 32, lines 28 to 30).

This concept of establishing enough velocity in the spark gap common to all embodiments is the basis of the application and is expressed in claim 1 by the corresponding step of directing the ignited air/fuel mixture through the spark gap predominantly away from a combustion chamber end of the enclosure at a peak flow velocity at least 10% of a peak flow velocity into the enclosure.

3. Main request - Novelty with respect to D2

3.1 D2 stems from the same family of US patent applications as the present application and is a US continuation in part of the application US 2013042599. The present application claims priority of the application US 2013 833226 itself also a US continuation in part of US 2013042599. D2 discloses several embodiments of a spark plug with a pre-chamber equipped with a velocity control tube. The first embodiment is depicted in

figures 1 to 8 and explained in paragraphs 039 to 048, a second embodiment is disclosed in figure 9 in relation to paragraphs 058 and 059 and a third one in figures 10 to 13 is explained in paragraphs 061 to 076. All these embodiments exhibit the same appearance as the embodiments depicted in figures 1 to 8, figure 9 and figures 15 to 17 of the application.

In relation to the first embodiment, paragraph 048 of D2 explains that the air/fuel mixture is drawn into the pre-chamber spark plug 100 through a center hole 162, then through the velocity control tube 136 to the spark gap to be ignited. The velocity of the air/fuel mixture causes the initial flame kernel to be transported into the back chamber 106. Thus because of the provision of the velocity control tube, the flow of ignited mixture occurs through the spark gap away from a combustion chamber end of the enclosure with a certain velocity. The same operation is also expressed in relation to the second embodiment of figure 9 in the first sentence of paragraph 059. The corresponding movement of the flame kernel through the spark gap into the back of the pre-chamber is also explained in paragraph 071 in relation to the embodiment of figures 11 to 13. Thus, reading the whole content of D2, the skilled person directly and unambiguously derives that the velocity control tube provides the effect common to all embodiments of directing an ignited flame kernel from an upstream side closer to the central hole through the spark gap into the back of the pre-chamber.
The disclosure of the step of directing the ignited air/fuel mixture through the spark gap predominantly away from a combustion chamber end of the enclosure at at a velocity according to claim 1 is not disputed.

3.2 The appellant disagrees that the embodiments disclosed in D2 are identical to those of the present application, and that they have the same purpose or effect that peak flow velocity in the park gap is at least 10% of a peak flow velocity into the enclosure.

3.2.1 The Board comes to the opposite conclusion. The minimum peak velocity of the flow in the spark gap according to claim 1 is obtained in all the embodiments described in the present application in particular the embodiments shown in figures 1 to 8 in figure 9 and in figures 15 to 17. These embodiments exhibit the same configuration as in D2. The skilled person, using its normal technical understanding has to infer that all these embodiments that exhibit minor shape variations of the common velocity control tube all achieve exactly the same channelling effect on the flow of mixture with a corresponding commensurate if not identical velocity level.

3.2.2 Taking the third embodiment of figures 11-13 in D2 to assess novelty, paragraph 069 discloses that the aerodynamic ram 316 gathers the primary flow 328 - from the central hole - around the spark gap 314 and achieves a velocity of this flow into the spark gap of between 1 and 100 meters per second (during the compression stroke of the engine mentioned in paragraph 068). The application also contains the very same statement in paragraph 0112 in relation to the same embodiment of figures 15 to 17 and refers to the same range of absolute velocities. It is therefore clear that for that embodiment and at least for the upper part of the range of absolute velocities, it largely exceeds 10% of the velocity at the outlet of the central hole, taken as the peak velocity in the enclosure.

Thus taking this particular embodiment, the Board is unable to identify a difference in geometry or configuration of the velocity control tube and spark gap, that would prove operation with different velocities, in particular velocities below 10% of a peak flow velocity through the central hole into the enclosure in all circumstances.

3.3 The appellant emphasizes that there has been no evidence provided by the examining division or by the Board that D2 implicitly discloses a minimum velocity for the flow through the spark gap, less so that this minimum reaches 10% of a peak velocity in the pre chamber.

3.3.1 The Board however concurs with the examining division that the velocity expressed with reference with a peak velocity is an unusual parameter, in which case the onus is on the applicant to establish any difference. In such situation the applicant does not have the benefit of the doubt. The assessment of an implicit disclosure in the context of parameters has been relied upon by the examining division in item 1.2.6 of the decision by reference to the guidelines for examination G-VI 6, which quotes decision T1764/06. The guidelines rely on the jurisprudence of the Boards, cf. Case Law of the Boards of Appeal, 10th edition 2022, I.C.5.2.3 for a difference in parameters.

In its appeal grounds, the appellant merely contended that the claim 1 does not make use of unusual parameters (page 11 third paragraph). However no reason or evidence in support of this assertion has been submitted. The appellant further asserts that velocity distribution would be a known parameter for characterising the flow in a pre-chamber, and that

comparing it with a reference value such as a peak value of the velocity would be difficult to avoid.

The Board does not consider the fact that a parameter is unknown or undisclosed to be a precondition for qualifying a parameter as unusual. Instead the use of known parameters in a particular technical field or context where it is not regularly used or measured can be qualified as unusual. In the present case it is not necessarily the velocity of the fuel air mixture as such which is unusual, but instead its relation to a peak velocity in the enclosure, which location is not further defined in the claim.

Despite the lack of comparative tests mentioned in the first paragraph of page 6 of the decision to support novelty of unusual parameters, the appellant failed to provide any such tests or other CFD calculations to support its case in appeal. Therefore the Board fails to recognise why any of the embodiments of D2 might result in velocities in the spark gap below 10% of the inflow velocity through the central hole. Furthermore, the Board fails to see how such tests or calculations could ever show any difference between the flow in the third embodiment of D2 and the corresponding embodiment in the present application, as the configuration of the tube, electrode and pre chambers are the same in D2 and in the application.

3.4 Additional arguments

3.4.1 The further observation of the appellant that the disclosure of paragraphs 068 and 069 explains the behaviour in operation of the primary and secondary flows does not affect the particular operation of the aerodynamic ram 316 to receive the primary flow from

the central hole gather it around the spark gap and impart it a certain velocity. Again that flow should be identical both in this embodiment of D2 as in the corresponding embodiment of the present application.

3.4.2 The appellant also relies on the ignition delay expressed in paragraph 059 in relation to the embodiment of figure 9 that should imply a reduction of the velocity of the flow in the spark gap, compared to the required minimum velocity. This embodiment explains a further advantage on ignition when the length of the velocity control tube is extended into the back chamber. This produces an earlier ignition of the mixture when the pressure in the piston is lower. This embodiment is also presented in the present application in paragraph 094 in relation to the same embodiment of figure 9 and explains the same further advantage without indicating that an earlier ignition changes the peak velocity in the tube.

3.5 The Board thus confirms the decision's finding that the subject-matter of claim 1 of the main request lacks novelty in view of D2.

4. Novelty - first auxiliary request

4.1 Claim 1 has been amended by adding that ignition produces a flame kernel, and moving the flame kernel through the spark gap. The formation of a flame kernel is seen by the Board as a direct consequence of the ignition step, and its rearward motion in the enclosure is also a direct consequence of the velocity into the spark gap. Thus the added features are inherent when the step of claim 1 of the main request is realised and are thus known from D2 (paragraph 048, last sentence).

4.2 The appellant considers that the velocity of the flow has an impact on how the flame kernel moves through the spark gap. The fact that according to paragraph 059 of D2 the ignition is delayed indicates a low velocity of the flame kernel into the spark gap.

4.3 For the same reasons as explained above in 3.4.2, the Board finds that this statement made in paragraph 059 in the context of the embodiment of figure 9, that is explained with the same explanation in lines 3 to 19 of paragraph 094 in the present application removes any doubt that the velocity of the flow of ignited mixture and thus of the flame kernel might be different in each embodiment.

4.4 The Board thus also confirms the decision's finding that the subject-matter of claim 1 of the first auxiliary request lacks novelty in view of D2.

5. In view of the above, the Board confirms the examining division's conclusion of lack of novelty of all requests and its decision to refuse the application pursuant to Article 97(2) EPC.

Order

For these reasons it is decided that:

The appeal is dismissed

The Registrar: The Chairman:

G. Magouliotis S.Oechsner de Coninck

Decision electronically authenticated