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D E C I S I O N
of 13 January 1999

Case Number: T 0377/96 - 3.3.5

Application Number: 89201802.9

Publication Number: 0350136

IPC: C06B 47/10

Language of the proceedings: EN

Title of invention:
High-performance propellant combinations for a rocket engine

Patentee:
European Space Agency

Opponent:
Société Nationale des Poudres et Explosifs (SNPE) Société Anonyme

Headword:
Rocket propellant/ESA

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step - no"
"Obvious improvement"

Decisions cited:
-

Catchword:
-

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Case Number: T 0377/96 - 3.3.5

D E C I S I O N
of the Technical Board of Appeal 3.3.5
of 13 January 1999

Appellant: (Proprietor of the patent)
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Decision under appeal: **Interlocutory decision of the Opposition Division of the European Patent Office posted 19 February 1996 concerning maintenance of European patent No. 0 350 136 in amended form.**

Composition of the Board:

Chairman: R. K. Spangenberg
Members: G. J. Wassenaar
J. H. van Moer

Summary of Facts and Submissions

I. The appeal is from the decision of the Opposition Division to maintain European patent No. 0 515 478 in amended form on the basis of auxiliary request III, submitted on 12 October 1995 during oral proceedings.

II. In the decision, inter alia, the following prior art documents were cited:

D1: JP-A-62 265 192 (+ English translation)

D2: US-A-3 844 855

In the following, references to D1 relate to the English translation thereof.

III. With the statement of the grounds of appeal dated 24 June 1996 the appellant (proprietor) filed two sets of four claims as main request and auxiliary request. Claim 1 of the main request reads as follows:

"A solid propellant combination for a rocket engine, consisting essentially of a combination of polyglycidylazide (GAP) ($[C_3H_5N_3O]n$) or poly-3,3-bis-(azidomethyl)oxetane (BAMO) ($[C_4H_6N_6O]n$) with boron, aluminium, or aluminium hydride (AlH_3) and a compound selected from the group consisting of hydrazinium nitroformate ($N_2H_5C(NO_2)_3$), nitronium perchlorate (NO_2ClO_4) or ammonium perchlorate (NH_4ClO_4), together with other conventional additives."

Claim 1 of the auxiliary request reads as follows:

"A solid propellant combination for a rocket engine, characterized by being constituted by the following components:
$N_2H_5C(NO_2)_3$ (70-80%) + B (10%) + GAP or BAMO (10-20%);
NO_2ClO_4 (66-76%) + B (14%) + GAP or BAMO (10-20%);
NH_4ClO_4 (68-78%) + B (12%) + GAP or BAMO (10-20%);
$N_2H_5C(NO_2)_3$ (59-69%) + Al (21%) + GAP or BAMO (10-20%);
NO_2ClO_4 (61-71%) + Al (19%) + GAP or BAMO (10-20%);
NH_4ClO_4 (57-67%) + Al (23%) + GAP or BAMO (10-20%);
NO_2ClO_4 + AlH_3 + GAP or BAMO;
NH_4ClO_4 + AlH_3 + GAP or BAMO; together with other conventional additives."

In the following text complex compounds are cited by their acronyms. These which are not explained in claim 1 of the main request have the following meanings: HNF = hydrazinium nitroformate, NP = nitronium perchlorate, AP = ammonium perchlorate, HTPB = hydroxy-terminated polybutadiene, HMX = cyclotetramethylenetetranitramine.

The appellant further provided new evidence with respect to compositions comprising boron as fuel compound and to the relationship between experimental and theoretical specific impulses of compositions consisting of HNF/Al/GAP and AP/Al/HTPB. During oral proceedings, which took place on 13 January 1999, no new evidence was submitted, but attention was drawn to the technical report submitted with the letter dated 12 September 1995. If deemed appropriate, it was offered to provide new evidence within a month allowing a comparison under exactly the same conditions of the propellants according to the examples of the patent in suit and those disclosed in D1.

The appellant's arguments in favour of inventive step, put forward during the written and oral proceedings, which apply to both the main and the auxiliary request, can be summarized as follows:

The claimed propellants had a higher specific impulse (Isp) than comparable known propellants having the same fuel compound (Al, B or AlH_3). In particular, the claimed composition AP/Al/GAP, had a higher Isp than the closest comparable prior art composition AP-HMX/Al/GAP (see Comparative Examples 12 and 13 in Table 1 of D1). There was no obvious reason to replace HMX in said prior art examples totally with AP since the known combination had the best performance. It could not be foreseen that the Isp could be improved by replacing HMX with AP.

IV. In reply, the respondent (opponent) maintained that the subject matter of the independent claims of both the main and auxiliary request lacked an inventive step over the available prior art, in particular over D1 in combination with D2.

The respondent's arguments can be summarized as follows:

The claimed compositions differed from the compositions according to comparative Examples 12 and 13 of D1 only in that HMX was replaced with AP. The evidence put forward by the appellant was not suitable to demonstrate an improved Isp for the claimed compositions. HMX and AP were both known oxidants for propellants comprising an energetic binder and a fuel compound such as Al, B and AlH_3. From D2 it was known that in such propellants AP was preferred over HMX. It was therefore obvious to replace HMX with AP.

V. The appellant requested that the decision under appeal be set aside and that the patent be maintained on the basis of claims 1 to 4 (main and auxiliary requests) submitted with letter of 24 June 1996.

As a further auxiliary request, he requested the opportunity to file additional evidence.

The respondent requested that the appeal be dismissed.

Reasons for the Decision

1. The appeal is admissible.

2. *Main request*

2.1 The Board considers, in agreement with both parties, that D1 represents the closest prior art. This document relates to high energy binder type composite propellants. D1 proposes to replace the known high energy polymeric binder GAP with a modified form of said polymer in order to improve the mechanical properties of the propellant. Such propellants contain an oxidizing agent. Five such agents are mentioned, among which AP and HMX are mentioned in the first place (page 9). The propellants may also contain fuel compounds (combustion improvers) such as Al and B (page 10). Propellants containing modified GAP have been compared with propellants containing unmodified GAP. Specifically disclosed are comparative examples 12 and 13, comprising GAP as an energetic binder, a mixture of AP and HMX as oxidizer and Al as fuel compound. Of the comparative examples, example 12 has the highest specific thrust (239 kgf.s/kg; Table 3).

The specific thrust was measured on a standard small-size rocket motor with an adjusted pressure of about 5 MPa and a nozzle opening ratio of 6 (page 15; the cited pressure of 50 kgf/m^2 must be a clerical error and should read 50 kgf/cm^2).

In respect of this state of the art the problem existed to provide a solid propellant combination for a rocket engine having an improved specific impulse. The patent in suit proposes to solve this problem by the solid propellant combinations according to claim 1. The respondent disputed that this technical problem had in fact thereby been solved, since the appellant had failed to present an exact comparison with the propellant representing the closest state of the art. In the Board's judgment, however, a comparison under exactly the same conditions, which in many cases is not possible without undue burden, is not an absolute requirement for accepting that the stated problem has actually been solved. It is sufficient that the available evidence shows on the balance of probabilities that it is much more likely than not that the stated problem has been solved. In the present case the specific thrust measured under the conditions set out in D1 cannot be directly compared with the calculated max.Isp for equilibrium flow of the propellant combinations indicated in Table 1 of the patent in suit. These calculations were made on the basis of a pressure of 10 MPa and an opening ratio (A_e/A_t) of 100. However, the appellant has also calculated the theoretical I(vac) for eq. flow at a pressure of 5 MPa and an opening ratio of 60 for comparative example 12 of D1 and has found a value of 3198.9 m/s (pages 2 and 5 of the technical report filed with the letter dated 12 September 1995). Taking into consideration the same reduction of 92% as used in the patent in suit to get a realistic value for the specific impulse this amounts to a max.Isp at eq. flow

of 2943.0 m/s. This value is 84.4 m/s lower than the corresponding value for the AP/Al/GAP propellant given in Table 1 of the patent in suit. Since the conditions for the calculations of the comparative examples of D1 (pressure 5 MPa and opening ratio 60) were again not exactly the same as those used in the examples of the patent in suit (pressure 10 MPa and opening ratio 100) the comparison is still not exact. Nevertheless, taking into account that the calculated difference between the two I(max) values is not negligible, as has been pointed out by the appellant, the Board finds it reasonable to assume, on the balance of probabilities, that a calculation on the basis of identical pressure and opening ratio would also have resulted in a higher specific impulse for the composition according to the patent in suit. In this situation it is not sufficient for the respondent simply to state that the comparison was not made on exactly the same basis, without providing evidence or at least sound arguments to the effect that for the comparative examples of D1 a substantially different value would have been obtained if the calculations had been made under the conditions mentioned in the patent in suit. The respondent has, however, not provided such evidence. With the comparative examples comprising boron as fuel compound, filed with the statement of grounds of the appeal, the appellant has shown that boron containing propellants according to the patent in suit have a higher specific impulse than boron containing propellants with a HTPB binder known in the art. The Board therefore accepts that propellants according to present claim 1 have a higher specific impulse than comparable propellants, based on the same fuel compound, according to D1 and is thus satisfied that the stated problem underlying the invention has actually been solved.

2.2 It remains to be decided whether it was obvious to a person skilled in the art to solve the said problem by providing a propellant combination according to claim 1. In this respect, the Board considers that, although in D1 AP and HMX were treated as equivalent oxidizing agents, it was known in the art that they were in fact not completely equivalent. D2, related to solid composite propellants comprising Polytaz (condensated triaminoguanidinium azide) as binder, not only discloses that AP and HMX are suitable oxidizing agents in combination with Al but also that AP together with NP and HNF has been found to be particularly effective oxidizers for use in the formulation of high energy compositions (column 2, lines 5 to 22). Polytaz is, like GAP, a high energy, azide containing polymer.

On the basis of this disclosure a skilled person would therefore have had good reasons to expect that AP, NP and HNF would be more effective oxidizers than HMX also in combination with GAP and Al. It was therefore obvious to a skilled person trying to improve the specific impulse of compositions based on Al and GAP to calculate the specific impulse of such compositions with any oxidizer chosen from said preferred group of AP, NP and HNF, since, as indicated in the description of the patent in suit and confirmed during oral proceedings, a computer programm enabling the skilled person to calculate the specific impulse of any propellant composition in dependence on the rocket geometry and the combustion conditions belonged to the state of the art. More particularly, the skilled person trying to improve the performance of the propellant according to comparative example 12 of D1, which already contained AP as an oxidizer, was provided with a clear incentive to calculate the specific impulse for

an analogous composition wherein the HMX was completely replaced by AP. The improved specific impulse thereby found by the appellant is therefore no more than a confirmation of the skilled person's reasonable expectation by a routine calculation.

2.3 In this context, the Board is unable to agree with the appellant's argument that a skilled person would have been prevented from performing this calculation by the fact that comparative example 12 of D1 had the highest specific thrust, so that he would not have expected that a further improvement could be obtained by modifying the composition. Said example is only a comparative example which happens to have the highest specific thrust of the comparative examples tested in D1. It cannot be inferred from this fact that the composition of comparative example 12 of D1 was disclosed as having the highest possible thrust of compositions comprising Al and GAP. Therefore, D1 did not suggest that the calculations mentioned in the preceding paragraph would be useless, or that they were unlikely to give the desired result.

The subject matter of claim 1 lacks therefore an inventive step within the meaning of Article 56 EPC.

3. *Auxiliary request*

Claim 1 of the auxiliary request differs from claim 1 of the main request by limiting the propellant combination to more specific compositions. One of these compositions comprises 57-67% AP, 23% Al and 10-20% GAP. For the reasons given above, it was obvious to the skilled person trying to improve the specific impulse of propellant combinations to investigate in detail compositions of AP, Al and GAP, and to calculate the specific impulse of such compositions. There is no

evidence, nor did the appellant argue, that it required more than routine work to select, after having selected the desired components, the optimal amounts indicated in claim 1 as a result of performing routine calculations. Furthermore, in the calculations made in D2 for similar compositions comprising Al and AP, these compounds were taken in the range of 8 to 30% and 38 to 65% respectively (Table VI, runs 29 to 38), thereby providing the skilled person with additional guidance in respect of suitable concentration ranges. Thus at least one of the compositions according to claim 1 lacks an inventive step.

4. It follows from the Board's considerations set out in point 2.1 above that it was accepted that an improved specific impulse was in fact obtained. It was therefore not necessary to give the appellant an opportunity to provide further evidence, more convincingly demonstrating such an improvement. The request for the opportunity to provide further evidence is therefore refused.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

S. Hue R. Spangenberg