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D E C I S I O N
of 18 January 2006

Case Number: T 0872/03 - 3.2.01

Application Number: 92101036.9

Publication Number: 0499815

IPC: B64G 1/26

Language of the proceedings: EN

Title of invention:
Triaxially stabilized satellite provided with electric propulsors for orbital maneuvering and attitude control

Patentee:
Finmeccanica S.p.A.

Opponent:
Astrium GmbH EADS Deutschland GmbH

Headword:
-

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step - main request (yes)"

Decisions cited:
T 0016/87

Catchword:
-

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Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T 0872/03 - 3.2.01

D E C I S I O N
of the Technical Board of Appeal 3.2.01
of 18 January 2006

Appellants: (Opponents)
Astrium GmbH EADS Deutschland GmbH
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Representative:
-

Respondents: (Proprietors of the patent)
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Decision under appeal:
Decision of the Opposition Division of the European Patent Office posted 26 June 2003 rejecting the opposition filed against European patent No. 0499815 pursuant to Article 102(2) EPC.

Composition of the Board:

Chairman: J. Osborne
Members: Y. Lemblé
G. Weiss

Summary of Facts and Submissions

I. The appeal is directed against the decision of the Opposition Division to reject the opposition against European patent No. 0 499 815. The patent had been opposed on the grounds that the subject-matter of the single claim extended beyond the content of the application as filed (Article 100(c) EPC) and lacked novelty and an inventive step (Article 100(a) EPC).

II. The Opposition Division held that the grounds for opposition mentioned in Article 100(c) and (a) EPC did not prejudice the maintenance of the patent unamended, having regard to the following prior art documents:

D1: Frank E. Marble et al. (eds): "Physics and Technology of Ion Motors", 1966, pages 393, 401, 405, 406, 415-418, Gordon and Breach Science Publishers, New York (USA)

D3: T. Duhamel et al.: "Design and Integration of an Electric Propulsion System on the Eurostar Spacecraft", DGLR/AIAA/JSASS 20th International Electric Propulsion Conference (AIAA 88), October 3-6 1988, Garmisch-Partenkirchen, West Germany

D6: T.G. Duhamel: "Implementation of Electric Propulsion for North-South Station Keeping on the Eurostar Spacecraft", AIAA/ASME/SAE/ASEE 25th Joint Propulsion Conference (AIAA 89), July 10-12, 1989, Monterey, CA

III. On 13 August 2003 the appellants (opponents) lodged an appeal against the decision and paid the required appeal fee. The statement setting out the grounds of appeal was filed on 23 October 2003.

IV. During oral proceedings held on 18 January 2006 the appellants requested that the decision under appeal be set aside and the patent be revoked. The respondents (patent proprietors) requested that the appeal be dismissed (main request) or, alternatively, that the patent be maintained in amended form on the basis of the claim filed during the oral proceedings.

V. Claim 1 as granted reads as follows:

"A triaxially stabilized satellite having a Cartesian axis system with mutually perpendicular axes, i.e. a roll axis X, a pitch axis Y and a yaw axis Z, a system of electric propulsors for orbital maneuvers and attitude control of said satellite, characterised in two electric propulsors (1, 2) having in their respective nominal orientations respective unit vectors (13, 14) including an angle between them and lying in an X-Y plane (12),the unit vectors (13, 14) being orientable away from their respective nominal orientations about the Z axis to include each a variable elevation angle a with said X axis and further being orientable away from the X-Y plane, so as to impart two degrees of freedom of movement to each of said electric propulsors (1,2), said electric propulsors (1, 2) generating thrust vectors (F) in line with said unit vectors (13, 14) and oriented in their respective nominal orientations away from the centre of gravity (CG) of the satellite (3) at an intersection of

said unit vectors, said electric propulsors (1, 2) being firable independently and for respective angles of arc in their displacement with said degrees of freedom to manoeuver said satellite (3) orbitally, control attitude of said satellite (3) and dissipate angular momentum of the satellite."

VI. The appellants did not pursue the opposition ground under Article 100(c) EPC in appeal. They only maintained that the subject-matter of claim 1 lacked an inventive step. Their submissions made in writing and at the oral proceedings in support of their request can be summarised as follows:

The decision of the opposition division did not take into account the fact that the person skilled in the art of satellite technology, when designing a satellite and its propulsion system, would always consider the very limited number of alternatives in choosing a design for the basic function of the satellite such as thruster arrangements for manoeuvring and attitude control, even if he would subsequently reject them. D3 clearly disclosed two configurations implementing ion thrusters on a triaxially stabilised satellite of the type defined in the claim. According to the first configuration, mentioned on page 218, left-hand column, 2nd to 5th paragraphs and shown in Figure 1 of D3, the electric propulsors were located in the pitch-roll plane. Among the combination of thrusters used in connection with that pitch-roll plane configuration, paragraphs 2 and 3 clearly mentioned the possibility of firing the electric thrusters independently. Since claim 1 did not define a value for the angle between the thrusters in the X-Y plane, the thrusters shown in

Figure 1 of D3 were also covered by the wording of the claim. In the part entitled "Impacts on the attitude control subsystem" on page 222 of D3, it was suggested to use a two-axis mechanism to redirect the thrust vector through the centre of mass of the satellite and, thus, reduce the torques disturbing the attitude of the spacecraft when the ion thrusters were actuated. Document D6, which stemmed from one of the authors of D3, described on page 3 such a two-axis mechanism, called thruster pointing mechanism (TPM), to redirect the thrust vector through the centre of mass. The TPM mechanism generated torques both about the roll and yaw axes and was utilized as an attitude control actuator, the realignment of the thrusters being here nothing else than a correction of the orientation of the respective thruster vectors away from the nominal orientation thereof. Consequently, two degrees of freedom of movement were imparted to the thrusters of the embodiments described in D3/D6, these embodiments being identical. The person skilled in the art of satellite technology knew that such two-axis compensating mechanisms were equally applicable to thrusters in the roll-pitch plane as to thrusters in the pitch-yaw plane, since the physics which acted on the satellite were the same. Furthermore, expressions of the claim like "to dissipate angular momentum" or "to control its attitude" were merely indicative of an intended use and not limiting. They could not be interpreted as a method since they were not claimed as such. Hence, the obvious application of the known two-axis mechanisms to the thruster configuration in the roll-pitch plane described in the paragraphs 2 or 3 on page 218 of D3 would lead to a satellite having all the features of granted claim 1. Therefore, the claim did not involve an inventive step over the disclosure of these documents.

VII. The arguments presented by the respondents in support of inventive step may be summarized as follows:

The merit of the present invention was in the teaching that two electric propulsors, which were first orientable in the X-Y pitch-roll plane about the Z axis, thus defining a first degree of freedom, and further orientable away from the X-Y plane, so as to impart a second degree of freedom, allowed all types of orbital manoeuvres to be performed and also permitted to control the attitude and to dissipate angular momentum of the satellite by firing these electric propulsors independently and for respective angles of arc in their displacement with said degrees of freedom. Such a teaching was not disclosed in the prior art cited by the appellants.

Reasons for the Decision

1. The appeal is admissible.

2. *Inventive step*

2.1 Construing the claim.

As mentioned in paragraph [0001] of the European patent specification the object of the present invention is to propose a satellite design which relies on a limited number of propulsors in order to effect all manoeuvres which are required for the orbital movements of the satellite and permit the control of its attitude and the dumping of momentum absorbed by the satellite. This object is especially achieved by the last feature of

the granted claim according to which the electric propulsors are "firable independently and for respective angles of arc in their displacement with said degrees of freedom to manoeuvre said satellite orbitally, control attitude of said satellite and dissipate angular momentum of the satellite".

It is observed that, as is well established by the jurisprudence of the Boards of Appeal, the provision of Article 69(1) EPC stipulating that the description and the drawings be used to interpret the claims, also applies when an objective assessment of the content of a claim has to be made in order to determine whether its subject-matter is novel and non-obvious, see e.g. T 16/87 (OJ EPO 92, 212).

The description indicates clearly how the following three distinct functions mentioned in that last feature of claim 1:

- to manoeuvre the satellite orbitally,
- to control its attitude,
- to dissipate angular momentum of the satellite,

have to be understood within the context of the invention.

The expression "to manoeuvre the satellite orbitally" refers to any manoeuvre which has to do with the correction or the change of the orbit of the satellite (see column 1, lines 2 to 4; column 1, lines 36 to 37; column 3, lines 15 to 17). It can be observed that this expression is not limited to any specific orbital manoeuvre.

To control the attitude of the satellite means to control its orientation about the three axis coordinate system. This may play an important role e.g. for the orientation of the solar panel arrays (see paragraphs [0017], [0026] to [0028] of the patent).

In the field of satellite technology the term "momentum dump" used in paragraph [0001] of the patent has a clear meaning and relates to the momentum wheels which are control gyros which counteract periodic torque on the satellite. The torques are primarily periodic in nature but some constant components are included which in time will saturate the wheels; in a satellite with conventional propulsion systems a jet pulse to desaturate the system is required from time to time (see also column 1, lines 37 to 39; column 5, lines 44 to 45 of the patent). Hence, the use of the expression to "dissipate angular momentum".

The above mentioned feature when interpreted in the light of the description clearly means that the two electric propulsors can be actuated independently for respective angles of arc in their displacement with said degrees of freedom and are able to perform the three above-mentioned distinct functions.

Contrary to the opinion of the appellants and owing to the fact that a satellite is an automatic device having the capacity to independently move in space using only its on-board control devices and systems, the last feature of the claim implies some limitations on the satellite itself and its control system. In particular, it requires that the satellite be equipped with

adequate means enabling it to perform the claimed functions.

2.2 In support of their ground that the subject-matter of the granted claim lacked an inventive step the appellants rely on the contention that the obvious application of the known two-axis mechanisms to the thruster configuration in the roll-pitch plane described in the paragraphs 2 or 3 on page 218 of D3 would lead to a satellite having all the features of granted claim 1.

In the absence of the knowledge of the invention the Board does not see any reason for the person skilled in the art to start from the thrusters configuration in the roll-pitch plane described in the paragraphs 2 or 3 on page 218 of D3. The authors of D3 and D6 do indeed teach the advantage of having independently firing thrusters, which place less demands on the thermal and power subsystems of the satellite. They emphasise, however, that independent actuation of such electric thrusters in the pitch-roll plane would either create inadmissible longitudinal drift or unacceptably increase the eccentricity of the orbital trajectory and they clearly recommend the pitch-yaw plane configuration in connection with independently fired thrusters.

Moreover, the thruster pointing mechanism (TPM) described in D3/D6 is continually aiming at pointing the thrust vectors of the electrical propulsors towards the centre of mass of the satellite. The purpose of the TPM is to cancel the undesirable disturbing torques generated by the ion thrusters and thus eliminate their effects on the attitude of the satellite. Even if it

were assumed that the skilled person would provide each of the independently firing electric thrusters lying in the pitch-roll plane with a two-axis TPM of the type shown in D6, this combination would not lead to the claimed subject-matter. The electric propulsion system described in D6 still does not perform orbit and attitude control functions other than North-South station keeping, the former still being performed by the conventional propulsion system using chemical bi-propellants (see D3, page 217, last paragraph of left-hand column). The electric propulsion system of D3/D6 cannot purposely produce disturbance torques to unload momentum wheels, or otherwise positively adjust spacecraft attitude. Neither document D3 nor document D6 indicates that the electric thruster arrangement therein described could be used for any other purpose than North-South station keeping and that it could have any utility for other manoeuvres like orbit raising, unloading momentum or attitude control. In the case of an automated vehicle such as a satellite, it is not sufficient that the mounting of propulsors with two degrees of freedom would permit them to theoretically perform all other manoeuvres. It is necessary that the skilled person would also provide for them to do so.

The concept of D3/D6 is to exclusively perform North-South station keeping with the ion thrusters while eliminating the disturbance induced thereby on the attitude of the spacecraft and leaving the other orbit and attitude control functions performed by the conventional propulsion system. In the Board's view, there is an inventive step involved in departing from that concept in favour of the idea of using only two electric propulsors, which are provided with two

degrees of freedom, to perform any type of orbital manoeuvres, to positively control the attitude and to dissipate the angular momentum by firing these electric propulsors independently and for respective angles of arc in their displacement. The claimed satellite system is thus provided with control functions that the prior art satellite propulsion systems, and especially that of D3/D6, neither perform nor render obvious.

The Board concludes that the subject-matter of claim 1 as granted involves an inventive step (Article 56 EPC).

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

A. Vottner J. Osborne