

Internal distribution code:

- (A) [] Publication in OJ
(B) [] To Chairmen and Members
(C) [X] To Chairmen

D E C I S I O N
of 27 July 1999

Case Number: T 0402/97 - 3.2.4

Application Number: 94103897.8

Publication Number: 0623741

IPC: F02C 7/275

Language of the proceedings: EN

Title of invention:

Gas turbine starter assist torque control system

Applicant:

AlliedSignal Inc.

Opponent:

-

Headword:

-

Relevant legal provisions:

EPC Art. 56

Keyword:

"Main request - inventive step (no)"

"Auxiliary request - inventive step (yes) after amendment"

Decisions cited:

-

Catchword:

-



Europäisches
Patentamt

European
Patent Office

Office européen
des brevets

Beschwerdekammern

Boards of Appeal

Chambres de recours

Case Number: T 0402/97 - 3.2.4

D E C I S I O N
of the Technical Board of Appeal 3.2.4
of 27 July 1999

Appellant: AlliedSignal Inc.
101 Columbia Road
P.O. Box 2245
Morristown
New Jersey 07962-2245 (US)

Representative: Brock, Peter William
Urquhart-Dykes & Lord
1 Richfield Place
Richfield Avenue
Reading RG1 8EQ
Berkshire (GB)

Decision under appeal: Decision of the Examining Division of the
European Patent Office posted 26 August 1996
refusing European patent application
No. 94 103 897.8 pursuant to Article 97(1) EPC.

Composition of the Board:

Chairman: C. A. J. Andries
Members: H. A. Berger
C. Holtz

Summary of Facts and Submissions

I. The appellant (applicant) has lodged an appeal against the examining division's decision of 26 August 1996 to refuse European patent application No. 94 103 897.8 for grounds based on Articles 52(1) and 56 EPC. The appeal was received on 2 October 1996 and the appeal fee was paid simultaneously. The statement of the grounds of appeal was received on 24 December 1996.

II. The following prior art documents were cited during the examination proceedings:

D1: DATABASE WPI, Week 8432, Derwent Publication Ltd., London, GB; SU-A-1 059 236 (LENGD METAL WKS) 7 December 1983, abstract

D2: Patent Abstracts of Japan, vol. 14, no. 368 (E-0962) 9 August 1990 & JP-A-2/131 377 and its complete translation into English

D3: US-A-3 793 826

D4: US-A-4 043 119

D5: US-A-5 123 239

D6: US-A-4 119 861

The following further documents were cited in the European Search Report:

D7: US-A-5 172 543

D8: GB-A-587 527

D9: EP-A-0 234 055

The appellant filed with the letter of 20 December 1995 the following paper:

D10: Garrett Fluid Systems Division, Air Turbine Starter ATS 100-239, dated 9/90

The examining division came to the conclusion that the method of claim 1 and the apparatus of claim 8 did not involve an inventive step having regard to the prior art documents D2 and D6.

III. In response to a communication from the board, the appellant filed with the letter of 2 July 1999 claims 1 to 15 with further revised application documents as the main request.

Oral proceedings were held on 27 July 1999 during which the appellant deleted claims 6 and 7 of the main request and submitted new claims 1 to 7 as an auxiliary request.

IV. Claim 1 of the main request reads as follows:

"A method of accelerating a gas turbine engine (10) by means of a starter/motor along a predetermined schedule,

characterized by:

employing a starter/generator (17) as said starter

motor;

sensing engine speed; and

adjusting the torque output of said starter/generator (17) to the engine in response to said sensed speed, so that the starter/generator delivers only the torque necessary to keep the engine accelerating along said schedule."

V. Claim 1 of the auxiliary request reads as follows:

"A method of accelerating a gas turbine engine (10) by means of a starter motor along a predetermined schedule, which is a schedule of acceleration rate versus engine speed, stored in function generator (68), wherein

a starter/generator (17) is employed as said starter motor;

engine speed is sensed and a first signal indicative of said engine's actual acceleration is sent to an electronic control unit (50) programmed with said predetermined schedule; and

a second signal indicative of the predetermined acceleration for said engine as stored in function generator (68) is produced and

said first and second signals are combined to form an error signal;

said electronic control unit (50) controls acceleration

of said engine by continuously adjusting the torque output of said starter/generator (17) to the engine in response to said error signal, so that the starter/generator delivers only the torque necessary to keep the engine accelerating along said schedule,

said schedule including:

- (a) a first phase prior to ignition of said engine, in which said starter/generator provides power to said engine so as to accelerate said engine;
- (b) a second phase subsequent to said first phase in which said starter/generator halts the acceleration of said engine and holds it at zero for a preselected period of time;
- (c) igniting said engine during said second phase, and
- (d) a third phase subsequent to said ignition, in which said starter/generator provides power to said engine so as to accelerate said engine at a predetermined rate slower than the acceleration of step (a)."

Independent claim 4 of the same auxiliary request reads as follows:

"Apparatus for controlling a starter motor to accelerate a gas turbine engine (10) along a predetermined schedule, wherein

said starter motor is a starter/generator (17);

and in that said apparatus comprises means (52) for sensing engine speed; and

means for continually adjusting the torque output of said starter/generator (17) to the engine in response to said sensed speed, so that the starter/generator delivers only the torque necessary to keep the engine accelerating along said schedule,

and said schedule including:

- (a) a first phase prior to ignition of said engine, in which said starter/generator provides power to said engine so as to accelerate said engine;
- (b) a second phase subsequent to said first phase in which said starter/generator halts the acceleration of said engine and holds it at zero for a preselected period of time;
- (c) igniting said engine during said second phase, and
- (d) a third phase subsequent to said ignition, in which said starter/generator provides power to said engine so as to accelerate said engine at a predetermined rate slower than the acceleration of step (a), and said apparatus further comprising

means (64) for producing a first signal indicative of said engine's actual acceleration;

means (68) for producing a second signal indicative of a predetermined acceleration for said engine;

means (70) for combining said first and second signals to form an error signal; and

means for adjusting the torque to said engine in response to said error signal whereby said engine accelerates according to said predetermined schedule."

Claim 7 of the same auxiliary request reads as follows:

"A gas turbine engine (10) comprising: a compressor (26); a combustor (32) in fluid communication with said compressor; a turbine (34) in fluid communication with said combustor; a shaft (12) mounted for rotation and coupling said turbine to said compressor; a gearbox (14) having gears driving coupled to said shaft; a starter/generator (17) mounted on said gearbox and drivingly coupled to said gears; and apparatus (60) according to any one of Claims 4 to 6 for controlling said starter/generator."

VI. During the oral proceedings the appellant argued with regard to claim 1 of the main request that none of the prior art documents disclosed the acceleration of a gas turbine by means of a starter motor along a predetermined schedule. The appellant maintained that document D2 was concerned mainly with providing a constant supply of electrical power from a battery to a starter motor. The problem with which the inventor of the apparatus of document D2 was concerned was the situation that could arise if the power supply cable were changed to one having a different resistance from that of the cable whose use was intended when the starter motor and battery were first linked to each other. According to document D2, an alteration in the

cable, and hence in its resistance, could be compensated for by the addition or subtraction of appropriate resistors in the connection between the battery and the starter motor. There was no suggestion that the power supply could be changed in a programmed succession. The apparatus of document D2, which was provided with a DC motor, was therefore entirely different from that of claim 1 (main request).

The appellant further argued that, although disclosing the use of a starter/generator, document D6 did not disclose any indication of the provision of a closed loop control system and therefore could not lead to the method of claim 1 of the main request.

According to the auxiliary request the appellant deleted Figure 2a of the application and the part of the description related thereto. He also brought forward arguments on inventive step in respect to the method of claim 1 and the apparatus of claim 4 of this auxiliary request.

VII. Requests

The appellant requested that the decision under appeal be set aside and a patent be granted on the basis of the following documents:

Main request:

Claims: 1 to 5 and 8 to 15, filed with the letter of 2 July 1999.

Auxiliary request:

Claims: 1 to 7 submitted in the oral proceedings on 27 July 1999.

Description: Pages 1, 2, 2A, 4, 5 and 7 as filed with letter of 2 July 1999 and pages 3 and 6 as submitted in the oral proceedings on 27 July 1999.

Drawing: Figures 1, 2 and 3 as filed with letter dated 2 July 1999.

Reasons for the Decision

1. The appeal is admissible.
2. *Claim 1 of the main request*
 - 2.1 The closest prior art is disclosed in document D6, since the gas turbine engine described therein is provided with a starter/generator, i.e. the generator works during starting as an AC electric motor. Document D2 discloses a DC starter motor, which is different from the AC motor and which necessitates a different control device.
 - 2.2 Problem and solution:
 - 2.2.1 The technical problem with regard to claim 1 is to provide a method for a starter/generator that maintains a desired acceleration of the engine with minimum expenditure of energy.

2.2.2 According to claim 1 of the main request the problem is solved by sensing the engine speed and adjusting the torque output of the starter/generator to the engine in response to the sensed speed, so that the starter/generator delivers only the torque necessary to keep the engine accelerating along a predetermined schedule.

2.3 Inventive step:

2.3.1 Document D6 discloses a method of accelerating a gas turbine engine by means of a starter motor along a predetermined schedule (see column 4, lines 37 to 42 and column 5, lines 24 to 26) with the help of an open loop control system. The starter motor is a starter generator. Furthermore, document D6 discloses a fire detecting device, which is provided with a pulse generator coupled directly to the shaft of the turbine generator and which detects when the gas turbine ignites itself such as when the speed of the turbine-generator reaches at least 30% or more of the rated speed of the gas turbine (see column 4, lines 5 to 11), i.e. engine speed is sensed according to this method.

2.3.2 The method of claim 1 of the main request differs therefrom by adjusting the torque output of the starter/generator to the engine in response to the sensed speed, so that the starter/generator delivers only the torque necessary to keep the engine accelerating along the predetermined schedule.

2.3.3 It is generally known in the field of gas turbine engines that ignition must occur in a particular range of engine speed to guarantee flame propagation (see for

instance the translation of document D2, page 3, second and third paragraphs and page 7, first and second paragraphs and Figure 3) and it is part of the basic knowledge of the skilled person that a predetermined schedule can be followed more accurately with a closed loop control system than with an open loop control system. Therefore, there is no inventive step necessary for the skilled person, who wishes to maintain the acceleration schedule more accurately, to provide in the apparatus of document D6 a closed loop control unit which adjusts the torque output of the starter/generator to the engine, so that the starter/generator delivers only the torque necessary to keep the engine accelerating along the predetermined schedule. The only question which remains is the definition of a parameter which should be used as a feedback parameter for the closed loop control system.

2.3.4 In this respect document D2 discloses a method of accelerating a gas turbine engine by means of a starter DC motor. Engine speed is sensed by a speed detector 4. Resistors 9-11 are put into a series connection or are short-circuited "and the inflow of current to the starter 5 from the battery 6 is regulated in a manner such as to make the acceleration characteristic of the gas turbine 1 conform to a set acceleration characteristic. Therefore, it is possible to make the ignition time the optimum ignition time t_1 , and it is possible to avoid ignition failure" (see page 6, last two lines to page 7, line 5 of the translation).

2.3.5 Since it is already known in the same technical field (see D2) to use the engine speed as a feed-back parameter which indicates the obtained value [D2: $\dot{a}(t)$]

to be compared with the required value [D2: $\dot{a}(t)$]; and since furthermore in document D6, firstly there is already a pulse generator linked with the AC generator and secondly engine speed is presented as a map parameter for a proper ignition (see column 4, lines 36 to 42, 46 and 47; and column 5, lines 24 to 26), it is not inventive according to the board to use this parameter "engine speed" as the feed back parameter in a closed loop control system, when provided in the system of document D4.

The method of claim 1 therefore does not involve an inventive step.

2.4 The main request therefore is rejected

3. *Allowability of the amendments according to the auxiliary request (Article 123(2) EPC)*

3.1 The features of claims 1 to 7 are disclosed in the originally filed application, particularly in claims 1, 2, 4, 6, 7, 10 and 16; description page 4, lines 14 to 29; page 5, lines 1, 2 and 15 to 21 and page 7, lines 3 to 11 and 23 to 29 as well as in Figure 2.

Claims 1 to 7 of the auxiliary request therefore do not contravene Article 123(2) EPC.

3.2 The description has been adapted to the present claims and the relevant prior art documents cited therein. The drawings were revised by adding missing reference signs and cancelling Figure 2a.

These amendments do not contravene Article 123(2) EPC

either.

4. *Novelty (auxiliary request)*

None of the prior art documents discloses a method of accelerating a gas turbine engine and an apparatus for controlling a starter motor with all the features of claim 1 or claim 4 of the auxiliary request, particularly the ignition during a second phase where the acceleration is kept at zero. The method of claim 1 and the apparatus of claim 4 therefore are novel in the meaning of Article 54 EPC. This is also true for the gas turbine of claim 7, since it includes the apparatus of claim 4.

5. *Closest prior art, problem and solution with regard to claims 1, 4 and 7 of the auxiliary request*

5.1 The closest prior art with regard to claims 1, 4 and 7 of the auxiliary request is again document D6.

5.2 The technical problem addressed by the invention with regard to the claims 1, 4 and 7 of the auxiliary request is to provide a method and an apparatus for a starter/generator and a gas turbine engine with such an apparatus, which maintain a desired acceleration of the engine with minimum expenditure of energy and with the guarantee of a reliable starting of the engine.

5.3 *Solution*

This problem is solved by sensing the engine speed and adjusting the torque output of the starter/generator to the engine in response to the sensed speed keeping the

engine accelerating along a predetermined schedule, which includes a second phase subsequent to a first phase, during which second phase the starter generator halts the acceleration of the engine, holding it thereby at zero for a preselected period of time, and during which the engine is ignited. The predetermined schedule further includes a third phase subsequent to the ignition, in which the starter/generator provides power to the engine so as to accelerate the engine at a predetermined rate slower than the acceleration of the first phase.

6. *Inventive step (auxiliary request)*

6.1 Claim 1:

Although document D6 discloses a method of accelerating a gas turbine engine by means of a starter motor which is a starter/generator and although it is generally known that ignition must occur in a particular speed range of the engine (see document D2), there is no indication in any one of the cited prior art document to have firstly a schedule with a second phase, wherein the starter/generator halts the acceleration of said engine and holds it at zero for a preselected period of time during which said engine is ignited, and secondly a schedule with a third phase subsequent to said ignition, in which said starter/generator provides power to said engine so as to accelerate said engine at a predetermined rate slower than the acceleration during the first phase. Even if the skilled person were to slow down engine acceleration during the phase of the ignition event in order to guarantee proper ignition of the engine, he would have no reason to accelerate the engine after the ignition phase less than in the acceleration phase before the ignition. None of the cited prior art documents gives any hint thereto.

The method of claim 1 therefore involves an inventive step (Article 56 EPC).

6.2 The apparatus of claim 4 comprises means with the schedule of claim 1, including the first, second and third phase defined in this claim 1. As already explained with regard to claim 1 in paragraph 6.1

above, there is no indication in any one of the cited prior art documents to provide such a predetermined particular schedule for starting a gas turbine engine. Therefore, the apparatus of claim 4 also involves an inventive step (Article 56 EPC).

- 6.3 Claim 7 is related to a gas turbine engine, which comprises an apparatus with all the features of claim 4. Therefore, the engine of claim 7 also is inventive for the same reasons as explained in paragraphs 6.2 and 6.1 above (Article 56 EPC).
7. In view of the above claims 1, 4 and 7 are patentable under Article 52(1) EPC. Claims 2, 3, 5 and 6, the description and the drawings also meet the requirements of the EPC.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.
2. The main request is refused.
3. The case is remitted to the first instance with the order to grant a patent in accordance with the auxiliary request submitted during the oral proceedings on 27 July 1999 on the basis of the following application documents:

Claims: 1 to 7 as submitted in the oral proceedings on 27 July 1999.

Description: Pages 1, 2, 2A, 4, 5 and 7 as filed with letter of 2 July 1999 and pages 3 and 6 as submitted in the oral proceedings on 27 July 1999.

Drawing: Figures 1, 2 and 3 as filed with letter dated 2 July 1999.

The Registrar:

The Chairman:

N. Maslin

C. Andries

