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Datasheet for the decision of 20 November 2017

Case Number: T 1166/13 - 3.2.04

Application Number: 02018282.0

Publication Number: 1286031

IPC: F02C9/50

Language of the proceedings: EN

Title of invention:
Gas turbine control apparatus and gas turbine system using the same

Patent Proprietor:
MITSUBISHI HEAVY INDUSTRIES, LTD.

Opponent:
Siemens Aktiengesellschaft

Headword:

Relevant legal provisions:
EPC Art. 84, 123(2), 54(1), 56

Keyword:
Amendments - allowable (yes)
Novelty - (yes)
Inventive step - (yes)

Decisions cited:
G 0003/14, G 0010/91

Catchword:

Europäisches Patentamt
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Beschwerdekammern

Boards of Appeal

Chambres de recours

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Case Number: T 1166/13 - 3.2.04

D E C I S I O N
of Technical Board of Appeal 3.2.04
of 20 November 2017

Appellant: (Opponent)	Siemens Aktiengesellschaft Werner-von-Siemens-Straße 1 80333 München (DE)
Respondent: (Patent Proprietor)	MITSUBISHI HEAVY INDUSTRIES, LTD. 5-1, Marunouchi 2-chome, Chiyoda-ku Tokyo (JP)
Representative:	Henkel, Breuer & Partner Patentanwälte Maximiliansplatz 21 80333 München (DE)
Decision under appeal:	**Interlocutory decision of the Opposition Division of the European Patent Office posted on 21 March 2013 concerning maintenance of the European Patent No. 1286031 in amended form.**

Composition of the Board:

Chairman	A. de Vries
Members:	J. Wright
	C. Heath

Summary of Facts and Submissions

I. The appellant-opponent lodged an appeal, received 15 May 2013 against the interlocutory decision of the Opposition Division posted on 21 March 2013 concerning maintenance of the European Patent No. 1286031 in amended form. The appellant paid the appeal fee on the same day. Their statement setting out the grounds of appeal was filed on 12 July 2013.

II. Opposition was filed against the patent as a whole and based on Article 100(a) together with Articles 52(1), 54 and 56 EPC, lack of novelty and inventive step.

III. The division held, inter alia, that the patent as amended according to an auxiliary request met the requirements of the European Patent Convention, inter alia because the subject matter of claim 1 did not add subject matter extending beyond the application as filed, and was new and involved an inventive step having regard to, amongst others, document D1: US6205765 B1.

IV. Oral proceedings before the Board were duly held on 20 November 2017.

V. The appellant-opponent requests that the decision under appeal be set aside and that the patent be revoked.

VI. The respondent-proprietor requests that the appeal be dismissed, in the alternative that the decision under appeal be set aside and the patent be maintained based on Auxiliary Request 1A filed with letter dated 20 October 2017, or one of Auxiliary Requests 1 - 3 filed with letter dated 28 November 2013.

VII. Claim 1 of the main request (claim 1 as upheld) reads as follows:

"A gas turbine control apparatus comprising:
a frequency analyzing section (12) which analyzes the frequency of at least one pressure oscillation in combustors of a gas turbine and acceleration oscillation of each of said combustors and outputs a first frequency analysis result as the result of frequency analysis for a plurality of predetermined frequency bands; and
a control unit (11,21,24,27,30,33,34) which controls at least one of a first fuel flow rate of fuel and a first air flow rate of air based on said first frequency analysis result for said plurality of frequency bands, said fuel and said air being supplied to said gas turbine;
wherein said control unit comprises:
a control section (11) which outputs process data indicating an operation state of said gas turbine and control signals for controlling said gas turbine; and a correcting section (21,24,27,30,33,34) which, when said first frequency analysis result shows that an intensity of the oscillation exceeds a threshold value in any of said plurality of frequency bands as an abnormal frequency band, determines correction data for said abnormal frequency band based on said abnormal frequency band and said process data from said control section (11) and controls at least one of said first fuel flow rate and said first air flow rate based on said determined correction data and said control signals,
wherein, for controlling said first fuel flow rate under the control of the control section, a fuel flow rate control valve (113,114) is used which is coupled at its one side to a pipe for supplying fuel from

outside to the combustors, and which is coupled at its other side to a pipe coupled to a plurality of fuel supply valves (115-1 to m) respectively used to control a flow rate or fuel supplied to a respective one of the combustors under the control of the control section".

VIII. The appellant-opponent argued as follows:

Claim 1 lacks clarity. The amendment to claim 1 after grant adds subject matter extending beyond the application as filed.

Claim 1 lacks novelty vis-à-vis D1. In particular the statements in D1 pertaining to modulating global fuel control (column 4, lines 52 to 58 and column 5, lines 4 to 7) mean that the gas turbine control apparatus of D1 is the same as that claimed.

If the subject matter of claim 1 is new with respect to D1, it lacks inventive step starting from D1 and considering the skilled person's general knowledge. In particular, when seeking an alternative way of suppressing combustion disturbances in the gas turbine control apparatus of D1, the statements regarding global fuel control would lead the skilled person to implement a scheme based on comparison to a threshold and to use valves as claimed, without making an inventive step. In this respect, the skilled person would use fuel supply valves leading to individual combustors because they know that control should be implemented as close as possible to the individual combustor where the instability occurs.

IX. The respondent-proprietor argued as follows:

The subject matter of claim 1 is clear and does not add subject matter.

The subject matter of claim 1 is new with respect to D1. D1 does not disclose a control apparatus that suppresses combustion instability by comparing frequency banded pressure data to a threshold as claimed, rather it uses a frequency cancelling technique. Nor does D1 disclose a plurality of control valves as claimed.

The subject matter of claim 1 involves an inventive step vis-à-vis D1 and the skilled person's general knowledge. Central to D1 is a noise cancellation scheme, which the skilled person would not change when seeking to modify the apparatus of D1 to suppress combustion instability in an alternative way.

Reasons for the Decision

1. The appeal is admissible.

2. Background

The patent relates to a gas turbine control apparatus. Flow rates of air and fuel to a combustor are predetermined for optional operation. Gradual degradation of compressors and blocking of filters may cause combustion oscillations (specification, paragraph [0002]). An object of the invention is to overcome these oscillations, so achieve combustion stability (specification, paragraph [0004]). To this end, oscillation frequencies are analysed for a plurality of predetermined frequency bands and for those bands exceeding a threshold value, correction data is

generated that corrects signals controlling at least one of a first fuel flow rate of fuel and a first air flow rate (specification, paragraphs [0006], [0011] and [0012] and claim 1 as upheld by the opposition division).

3. Main request, claim 1, clarity

3.1 The appellant-opponent raised two clarity objections:

a) that claim 1 is unclear because the subject matter of the claim is to a "gas turbine control apparatus" - independent of the gas turbine, however, the claim also requires that fuel and air must be supplied to the gas turbine ("said fuel and said air being supplied to said gas turbine"), which are not part of the control apparatus.

b) that the claim defines "a control unit which controls at least one of a first fuel flow rate of fuel and a first air flow rate of air", but goes on to define "for controlling said first fuel flow rate under the control of the control section, a fuel flow rate control valve (113,114) is used...". So the argument goes, in the case where the control unit only controls the air flow rate then the reference to controlling fuel flow rate makes no sense.

3.2 Regarding the first objection (a), whether or not this renders the claim unclear, these features were all in claim 1 as granted. Since clarity is not an opposition ground, the Board does not have the power to question the clarity of claim 1 in this respect (cf. G3/14, reasons 85).

3.3 With respect to the second objection (b), this objection concerns matter added from the description, so must be examined by the Board (cf. G10/91, reasons 19). In the Board's view, this feature does not render the claim unclear.

3.4 It is true that the claim defines a gas turbine control apparatus which controls at least one of a first fuel flow rate with correction data to correct control setting data (see for example figure 1, where pilot fuel rate is so adjusted) and a first air flow rate again with correction data to correct control setting data (see for example figure 4, where bypassed air flow rate is adjusted). Thus the claim presents an alternative in which the first fuel flow rate is not controlled using correction data.

3.5 However, the Board notes that, whether or not fuel supply to a gas turbine is controlled using correction data, it must always be controlled, the contrary would mean that no fuel could be supplied at all.

Thus, when the skilled person with their mind willing to understand and using normal reading skills reads the last claim feature, with its particular arrangement of valves for controlling fuel supply under control of the control section, far from seeing a contradiction (for the case that only the first air flow rate is controlled with correction data), they merely read the feature as explaining the particulars of how the flow of fuel from outside to inside the gas turbine is controlled, a control aspect they know to be present in a gas turbine, be that with or without control data correction.

Therefore, for the above reasons, in as far as the Board has the power to examine clarity of claim 1, the arguments put forward by the appellant-opponent have not convinced the Board that the claim lacks clarity.

4. Main request, claim 1, added subject matter

4.1 Claim 1 is based on granted claims 1 and 2 with the addition of a final feature ("wherein, for controlling said first fuel flow rate under the control of the control section, a fuel flow rate control valve (113,114) is used which is coupled at its one side to a pipe for supplying fuel from outside to the combustors, and which is coupled at its other side to a pipe coupled to a plurality of fuel supply valves (115-1 to m) respectively used to control a flow rate or fuel supplied to a respective one of the combustors under the control of the control section"). This feature is said to be based on the description.

In first instance proceedings the opposition ground of added subject matter under Article 100(c) EPC was not invoked against the granted claims. Therefore the only consideration under Article 123(2) EPC is whether there is a basis for including this last claim feature added vis-a-vis granted claims. In summary, the feature defines a fuel flow rate control valve which controls fuel flow to the gas turbine and, downstream thereof, fuel supply valves controlling fuel supply to individual combustors, all valves being controlled by the control section.

4.2 The wording for this feature largely corresponds to the description as filed (page 16, lines 17 to 24) explaining valves controlling a main fuel flow rate and repeated (page 17, lines 9 to 16) for valves

controlling a pilot fuel flow rate. Both passages set out a fuel flow rate control valve 113 / 114 coupled to a pipe supplying fuel from outside at one end and to a pipe coupled to a plurality of fuel flow rate control valves 115-1 to m / 116-1 to m at the other ends [sic]. The arrangement, for a single combustor 111, is shown in figure 11. Furthermore, original claim 5 sets out that the claimed "first flow rate" can either be the main or the pilot fuel. Thus, other than slight differences in syntax, the only remaining difference between the feature added to the end of claim 1 and these two passages is that the claim has both types of valves defined therein (the upstream first fuel flow rate control valve and the plurality of fuel supply valves downstream) "under the control of the control section", whereas in the above passages the valves are said to be "under the control of the gas turbine control section 3".

4.3 The gas turbine control section 3 is shown in figures 1, 4, 5, 6 and 7. There it is directly and unambiguously shown that the control section 11 is a part of the gas turbine control section 3. Furthermore, although an adder section (e.g. adder 23 in figure 1) may add correction data to the signal from the control section 11 (in figure 1 for controlling pilot fuel flow), it is always the control section 11 which generates the basic fuel flow rate control signal (be that for the main or pilot fuel).

4.4 The description tells the same story. There, main and pilot fuel rates are always adjusted by controlling the single upstream control valve and respective individual downstream flow rate control valves according to a command issued by the control section 11 (see for example application as filed, figure 1 with page 22,

lines 4 to 5 and lines 14 to 16, page 24, lines 16 to last line). Where an adjustment is made (see for example application as filed page 26, lines 2 to 7) the description confirms that correction data is added to the control signal from the control section 11. In other words, the correction data determining section and adder sections do not generate the original control signals, they correct control signals generated by the control section 11. Thus, with or without any correction, the upstream and downstream valves are always under the control of the control section. Although the above has been explained for the embodiment of figure 1, it also applies to the other embodiments (see for example the application as filed, page 38, line 19 to page 39, line 8, page 47, lines 2 to 17, page 55, lines 15 to last line, page 57, lines 16 to 27).

4.5 From the above the Board is of the opinion that the skilled person, reading the above mentioned passages on which the amendment to claim 1 is based, in the context of the remaining application, will understand that, where the "gas turbine control section 3" is mentioned, it is actually the control section 11 within the section 3 that (with or without a correction) controls the various fuel supply valves.

4.6 In this context, the Board notes that it does not share the appellant-opponent's interpretation of claim 1, according to which the first fuel rate is only controlled by the upstream "fuel flow rate control valve", not by the downstream plurality of fuel supply valves. The last two lines of claim 1 define that this plurality of fuel supply valves are used to control flow rate of fuel supplied to a respective one of the combustors under the control of the control section.

The skilled person, with their mind willing to understand and reading this feature using their normal reading skills, understands that these valves are to be controlled under control of the control section when supplying fuel, whether or not correction data is added, just as the upstream "fuel flow rate control valve" is defined as being controlled under the control of the control section in the preceding feature.

Nor does the Board see this plurality of fuel supply valves as being merely referred to in the claim in order to explain the location of the the upstream fuel flow rate control valve, without being defined as playing a role in flow control themselves. Since the claim defines that they are used to control a flow rate of fuel to respective combustors under the control of the control section, the skilled person understands them, without ambiguity, to be part of the claimed gas turbine control apparatus. For all these reasons, the Board sees no disparity between the originally filed application, in which, as explained above, both (upstream and downstream) valves are controlled by the control section, and claim 1 as amended.

4.7 Therefore the appellant-opponent's arguments have not convinced the Board that claim 1 as amended adds subject matter extending beyond the application as filed.

5. Main request, claim 1, novelty

According to established jurisprudence, a prerequisite for lack of novelty is that the claimed subject-matter is "directly and unambiguously derivable from the prior art". In other words, it has to be "beyond doubt - not merely probable - that the claimed subject matter

was directly and unambiguously disclosed in a patent document" see Case Law of the Boards of Appeal, 8th edition, 2016 (CLBA), I.C.4.1, and the decisions cited therein.

5.1 D1 discloses a control apparatus for gas turbine (title). It also discloses a frequency analysing section which analyses pressure oscillations in combustors and outputs the result for a plurality of predetermined frequency bands (column 2, lines 42 to 44 and column 4, lines 41 to 47, column 6, lines 1 to 6 with figure 4).

5.1.1 Likewise D1 discloses a control section 54 that outputs process data indicating an operating state: for example, minimum/maximum levels for each frequency band are used to generate alarms that indicate operating status (see figure 4, references 54c and 60 with column 4, lines 40 to 58). Furthermore, part of the control section 54 output control signals for controlling the gas turbine (see for example column 4, line 59 to column 5, line 18 and column 6, lines 13 to 24, with figures 2 and 3): in figure 2, control section 54 controls a pressure driver 64, whereas in figure 3, the control section 154 controls a small fuel-bypass valve 158.

5.2 Whether or not D1 discloses an upstream fuel flow rate control valve (cf. the prior art D1 describes, column 3, lines 24 to 28 with figure 1, fuel control valve 26), in order for D1 to take away novelty of claim 1, it must directly and unambiguously disclose a correcting section as claimed (based on a threshold in a frequency band being exceeded), and a plurality of fuel supply valves, each used to control flow rate supplied to a combustor under the control of the

control section as claimed. The Board considers that D1 does not disclose these features.

5.3 D1 has a control system for a gas turbine (see column 1, lines 16 to 27, column 4, lines 59 to column 5, line 17, column 6, lines 13 to 24) working on the principle of combustion pressure disturbance cancelation, like an active noise cancellation system. The detected pressure oscillations for particular frequency bands are filtered then inverted (figure 4, 54 D and 54 E) to generate a disturbance cancelling negative pressure impulse in the gas turbine inlet nozzle, for example with a speaker 58 (figure 2) or a small bypass valve 158 (figure 3) that injects high pressure fuel into the captured response volume 148 within the nozzle (column 6, lines 13 to 24). D1 refers to this as active dynamic feedback/combustion) control" (see for example column 3, lines 1 to 9, column 5, lines 7 to 13). In summary, this active control uses pressure disturbance cancelling without comparison to a threshold (as claimed) to counteract combustion instability. Furthermore, this feeding back of negative pressure pulses does not involve controlling fuel flow rate or air flow rate, it merely requires generating cancelling pressure pulses, either by using speaker 58 or by selective discharge from the bypass. Thus here D1 does not disclose a correcting section for generating correction signals as claimed.

The Board is also not convinced that elsewhere in D1 a correcting section as claimed is directly and unambiguously disclosed, as the appellant-opponent has argued. As already touched on, D1 discloses (see column 4, lines 40 to 58 with figure 4) generating frequency signature data for individual frequency bands, filtering the same with a minimum/maximum filter 54C

for each frequency band and determining when the level is outside the minimum/maximum level for each band, thus a comparison to see if an oscillation exceeds a threshold value is carried out. However, the result of this comparison is not used for generating correction signals but sent to the main turbine control panel 60 for failure detection and alarms (high and high/high levels), thus this section is not a correcting section as claimed. Nor, in the Board's view, does the statement following this passage disclose a correcting section as claimed (column 4, lines 52 to 56): "With a magnitude and frequency (Hz) for each given frequency band supplied to the main controller, global or total fuel control could be modulated in addition to the individual fuel nozzles active dynamic control". This proposed global fuel modulation is not to be based on the result of comparison to a threshold but on magnitude and frequency (of pressure oscillations) in a frequency band. Thus it is not a direct and unambiguous disclosure of a correcting section that detects when oscillations exceed a threshold in order to determine correction data.

5.4 The Board is also not convinced that D1 discloses a plurality of fuel supply valves used to control a flow rate of fuel supplied to respective ones of the combustors as claimed.

5.4.1 The Board first notes that it is not implicit that all gas turbines will have such valves on the supply lines to individual combustors. For example, the prior art D1 discusses (see D1, column 3, lines 13 to 28 with figure 1) has a global fuel supply valve 26, but fuel to individual combustors 10 is directly supplied to fuel nozzles 20 from a fuel manifold 28, not via intervening valves.

5.4.2 Nor, in the Board's opinion, is the presence of such valves implied by the statement discussed above (column 4, lines 54 to 56 - global fuel control could be modulated in addition to the individual fuel nozzles active control). At most, controlling the global or total fuel supply might suggest, but not directly and unambiguously disclose, some control of the main fuel line, such as a main inlet fuel supply valve leading from the outside perhaps (cf. D1's explanation of the prior art, column 3, lines 13 to 28 with figure 1). However, such a suggestion is not a direct and unambiguous disclosure of any valve, let alone a plurality of fuel supply valves, each respectively supplying an individual combustor as claimed. Furthermore, as already explained, the active dynamic control of D1 involves pressure modulation (with a speaker 58 for example cf. figure 2), not fuel supply modulation, so it does not require, in other words imply, the presence of (adjustable) fuel supply valves. At most the active dynamic control of D1 may use small fuel bypass valves 158, leaving the bulk of the fuel to pass directly into the combustor via orifice 144 (see column 6, lines 13 to 24 with figure 3), but not fuel supply valves for controlling the rate of fuel supplied to respective combustors as claimed.

5.4.3 By the same token, the Board does not consider that such individual fuel supply valves are implied by the statement (D1, column 5, lines 4 to 6) "This mixing of both global fuel control and single can fuel control in combination is a more unique application of active dynamics control". Here the pronoun "this" can but link the statement to the one that precedes it. There (column 4, lines 54 to 56), individual nozzles have active dynamic control. Thus, the "single can fuel

control" refers to a form of pressure disturbance cancelation that modulates pressure in the combustor nozzle. At most this "single can fuel control" might use a small fuel-bypass valve (D1, figure 3, valve 158 again), but not fuel supply valves supplying respective combustors as claimed.

5.5 The Board concludes that D1 does not disclose a correcting section, nor a plurality of fuel supply valves as claimed. Therefore it cannot take away novelty of claim 1.

6. Main request, claim 1, inventive step

Following on from the discussion of novelty, inventive step depends, at least, on whether, starting from D1 and applying their general knowledge, the skilled person would arrive at a gas turbine control apparatus having a correcting section and a plurality of (downstream) fuel supply valves as claimed in an obvious manner. In the Board's opinion, they would not.

6.1 An object of the invention is to suppress combustion oscillations in a gas turbine (see specification, paragraphs [0004]).

As already discussed, the gas turbine control apparatus of D1 controls combustion oscillations by active dynamic feedback control (similar to active noise cancelation systems, cf. D1, column 4, line 66 to column 5, line 6). Therefore D1 already achieves the object of the present invention.

6.2 Furthermore, the patent does not state any particular advantage or technical effect associated with the above identified differences: The correcting section with

threshold comparison is merely said to determine correction data (see specification, paragraph [0017]), whereas the specification explains that a fuel supply valve controls fuel flow rate to an individual combustor (see for example specification, paragraphs [0042] and [0044]).

6.3 Thus in the Board's opinion the objective technical problem can be formulated as how to modify the gas turbine control apparatus of D1 to provide an alternative way of suppressing combustion oscillations.

6.4 As already explained, D1 discloses comparing oscillation intensity in respective frequency bands to thresholds for alarm purposes (column 4, lines 40 to 52) and directly follows up this statement (column 4, lines 52-58) with the information that "with a magnitude and frequency for each given frequency band supplied to the main controller, global or total fuel control could be modulated in addition to the individual fuel nozzles active dynamic control". In the Board's view, faced with the objective problem, this statement would not lead the skilled person to a scheme that involved a correcting section based on comparing to a threshold. At best, the statement might suggest the skilled person apply their general knowledge to implement a global, that is a total, fuel modulation scheme based on magnitude of oscillations in frequency bands, perhaps controlling a main fuel valve (cf. D1, figure 1 again) in addition to active dynamic control of individual combustors. So the statement, even considering the skilled person's general knowledge, would not lead the skilled person to suppress combustion oscillations by using the available alarm signalling information (resulting from comparison to thresholds), nor one controlling valves feeding

individual combustors as the appellant-opponent has speculated.

6.5 Nor does the Board agree with the appellant-opponent's view, that when seeking a modification to D1 to achieve an alternative combustion disturbance suppression, the skilled person would abandon D1's active dynamic control of individual combustors, with its filtering and inversion of a frequency banded detected pressure signal in combustors (column 4, lines 59 to 65 with figure 4, elements 54d and 54e). D1 describes this as a basic idea, demonstrated, in other words proven, in other applications such as in pilot's noise canceling headsets (column 4, line 66 to column 5, line 4). Thus this basic idea is central to D1's approach to combustion disturbance suppression.

Even where D1 (see column 4, lines 52 to 58 and column 5, lines 4 to 6) suggests modulating global fuel control, and however the skilled person might implement this when applying their general knowledge, this global fuel control is consistently presented in combination with D1's basic idea of "active dynamic control". Thus, in solving the objective problem, although the skilled person might modify the control apparatus of D1 to provide some global fuel supply control, perhaps with a global fuel supply valve, they would not replace, for example, the pressure modulating speaker 58 of figure 2 or the small bypass valves 158 of figure 3 that active dynamic control uses, with individual fuel supply valves leading to each combustor. Thus, even if the skilled person knows to place control means as close as possible to the element to be controlled from their general knowledge, as the appellant-opponent has argued, they would not arrive at the valve arrangement as claimed.

By the same token, given D1's basic idea of dynamic feedback control filtering and inverting frequency banded pressure disturbances to produce a pressure cancelling signal, the skilled person would not replace this with a threshold comparison scheme controlling fuel supply to individual combustors as claimed. All the more so, given that D1 already teaches to generate threshold-compared frequency banded signals, but neither uses nor suggest using this for countering combustion disturbances, but rather limits its application to the generation of alarms and failure detection (column 4, lines 48 to 52).

6.6 For these reasons, starting from D1 and applying their general knowledge to solve the above problem (alternative combustion disturbance suppression), the Board does not consider that the skilled person would arrive at the subject matter of claim 1 as a matter of obviousness.

7. For all the above reasons, the arguments presented by the appellant-opponent have not convinced the Board that the impugned decision (see sections 3 and 4) was wrong in finding the claims of the present main request (then auxiliary request II) to meet the requirements of the EPC. Thus the Board must dismiss the appeal.

Order

For these reasons it is decided that:

The appeal is dismissed

The Registrar: The Chairman:

G. Magouliotis A. de Vries

Decision electronically authenticated