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D E C I S I O N
of 17 May 1994

Case Number: T 0098/93 - 3.4.2

Application Number: 84115416.4

Publication Number: 0176625

IPC: G01N 21/63

Language of the proceedings: EN

Title of invention:
Method of laser emission spectroscopical analysis of steel and apparatus therefor

Patentee:
Kawasaki Steel Corporation

Opponent:
Fried. Krupp AG Hoesch-Krupp

Headword:
-

Relevant legal norms:
EPC Art. 100(a), 100(b), 56

Keyword:
"Disclosure of the invention (yes); inventive step (no)"

Decisions cited:
-

Headnote/Catchword:

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Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T 0098/93 - 3.4.2

D E C I S I O N
of the Technical Board of Appeal 3.4.2
of 17 May 1994

Appellant: (Proprietor of the patent)
Kawasaki Steel Corporation
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Respondent: (Opponent)
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Representative:
-

Decision under appeal:
Decision of the Opposition Division of the European Patent Office dated 13 November 1992 revoking European patent No. 0 176 625 pursuant to Article 102(1) EPC.

Composition of the Board:

Chairman: E. Turrini
Members: M. Chomentowski
M. Lewenton

Summary of Facts and Submissions

I. The Appellant is Proprietor of European patent No. 0 176 625 (application No. 84 115 416.4) concerning a method of laser emission spectroscopical analysis of steel and an apparatus therefor developed from techniques known from, in particular,

S2 = Patent Abstracts of Japan, Vol. 6, No. 188, (P-144) (1066), September 28, 1982 & JP-A-57 100 323, and

S3 = Patent Abstracts of Japan, Vol. 8, No. 75, (P-266) (1512), April 7, 1984 & JP-A-58 219 440.

II. The Respondent (Opponent) filed an opposition against the granted European patent on the grounds that the claims of the opposed patent lacked an inventive step having regard *inter alia* to the disclosure in

S5 = Patent Abstracts of Japan, Vol. 8, No. 5, (P-266) (1512), April 7, 1984 & JP-A-58 219 438, and

O2 = Transactions ISIJ, Vol. 24, 1984, pages 455 to 462, T. Ozaki et al, "Giant pulse laser spectrochemical analysis of C, Si, and Mn in solid steel", (which, according to a note at the bottom of page 455, had been originally published in "Tetsu-to-Hagané", Vol. 68 (1982), 863, in Japanese),

and that the claimed means of the invention for blocking analysis under predetermined conditions were not disclosed in a manner sufficiently clear and complete for the invention to be feasible.

III. The patent, which had been amended by the Proprietor, was revoked. The Opposition Division took the view that the Opponent's objection relating to feasibility was not

relevant because it concerned clarity of the claims, which is not a ground of opposition, but that the independent method and apparatus claims were obvious having regard to S5, O2 and to the experience of the skilled person.

IV. The Appellant lodged an appeal against this decision.

V. In a communication for inviting the parties to oral proceedings in accordance with their auxiliary requests, the Board of Appeal expressed the opinion that the subject-matter of the claims did not appear to involve an inventive step having regard in particular to S2, S3 and O2.

VI. During the oral proceedings of 17 May 1994 the Appellant submitted a new set of claims and requested that the decision under appeal be dismissed and the patent be maintained on said basis.

Claim 1 reads as follows:

"1. A method of laser emission spectroscopical analysis of steel, wherein
a surface of a steel sample (10) is irradiated by a pulsed laser beam (A) to convert part of the steel into a plasma,
light (B) emitted from the plasma is focused by an optical focusing means (12) onto the entrance slit (16A) of a spectroscope (16) for quantitative analysis of said light (B) after the occurence of a laser pulse and the light (B) emitted from the plasma is collected within a substantially cone-shaped beam,
the surface of the steel sample (10) is irradiated by a pulsed infra-red laser beam (A) producing an energy density of at least 2.0×10^9 W/mm^2 on the surface of the steel sample (10),

the cone angle θ of the cone-shaped beam is at least 16°,
a flow of an inert gas of at least 50 l/min is maintained in the path of the emitted light (B) between the surface of the steel sample (10) and the optical focusing means (12), and
the emitted light is only quantitatively analyzed after the lapse of a predetermined period of time upon generation of a laser pulse and when the intensity of a specified spectral line or the intensity ratio of a pair of specified spectral lines is within a predetermined range."

Claims 2 to 5 are dependent method claims and Claim 6 concerns an apparatus for laser emission spectroscopical analysis of steel for carrying out the method according to Claim 1, with means therefor.

VII. The Appellant submitted the following arguments in support of his request: The invention in dispute can be carried out, since in particular the spectroscopical means are working continually and outputting measurement values which can be used to determine whether the predetermined spectral intensities values are met, so that the gate means input said values to the processing section. The invention in suit concerns a combination of features which are indeed known *per se* from a plurality of prior art documents, but which are combined in such a way that they solve the problems of the prior art. In particular, the skilled person would be incited by **O2** not to use energy densities of the laser beam as high as 2.0×10^9 W/mm^2 because they are derivable as providing no result or negative results; from the same document, he would also be incited to use values of the flow of inert gas lower than 50 l/min. Therefore, the technique in dispute is inventive.

VIII. The Respondent requested that the appeal be dismissed and that the patent be revoked. He argued as follows in support of his request: In the technique in dispute, the emitted light is only quantitatively analyzed after the lapse of a predetermined period of time upon generation of a laser pulse and when the intensity of a specified spectral line or the intensity ratio of a pair of specified spectral lines is within a predetermined range; however, to meet these last conditions, a measurement beforehand is necessary, which according in particular to the text of the claim is impossible. Therefore, the technique in dispute cannot be carried out. Moreover, all the features of the technique in dispute are known in the relevant technical field and are working accordingly. In particular, S5 discloses most of them, but also **O2** and **S2** provide clear indications in this sense. Concerning the high energy densities used and which are known per se, the indications in **O2** would not incite the skilled person to avoid them. The same applies to the range of inert gas flow, which can be adapted to said high energy densities. Therefore, the technique in dispute is not inventive.

Reasons for the Decision

1. The appeal is admissible.

2. *Disclosure of the invention*

The Respondent has submitted that the feature that the emitted light is only quantitatively analyzed after the lapse of a predetermined period of time upon generation of a laser pulse and when the intensity of a specified spectral line or the intensity ratio of a pair of specified spectral lines is within a predetermined range

cannot be carried out because, indeed, these last conditions can be determined only by quantitative analyzing beforehand, but said quantitative analyzing beforehand is not allowed as long as said intensity conditions are not met. However, as credibly argued by the Appellant, in the method of the patent in suit (see column 9, line 47 to column 12, line 23; Fig. 15), the gate means (30) controls the inputting of signals of the spectroscope (16) to the signal processing section (32) and does not control the spectroscopical means of the spectroscope (16), i.e. the photoelectric transducing elements (16C) and the output terminals (16D) of the spectroscope working continually, whereby some of said output terminals (16D) are continually outputting signals corresponding to the measured intensities which are transmitted to the spectral line intensity monitor (28) which determines whether the gate circuit (30) is actuated or not. Therefore, the technical conditions for the invention in dispute are met and the patent in suit discloses it in a manner sufficiently clear and complete for it to be carried out by a person skilled in the art (Art. 100(b) EPC).

3. *Novelty*

The novelty of the claims has not been objected (Art. 54 EPC).

4. *Inventive step*

4.1 S2 (see the abstract) is cited in the patent in suit (see column 1, line 55 to column 2, line 2) and is a suitable starting point for the invention in dispute; in the known method of laser emission spectroscopical analysis of steel, a surface of a steel sample (22) is irradiated by a pulsed laser beam to convert part of the steel into a plasma, light emitted from the plasma is

focused by an optical focusing means (6) onto the entrance slit (24) of a spectroscope (8) for quantitative analysis of said light emitted from the plasma after the occurence of a laser pulse, i.e. for the period of 1 µsec to about 16 µsec after the irradiation: the light emitted from the plasma is collected within a substantially cone-shaped beam. However, contrary to the method in dispute, in the known method, in particular,

- the surface of the steel sample is not derivable as being irradiated by a pulsed infra-red laser beam producing an energy density of at least 2.0×10^9 W/mm^2 on the surface of the steel sample, and

- no flow of an inert gas of at least 50 l/min is maintained in the path of the emitted light between the surface of the steel sample and the optical focusing means.

4.2 According to the patent in suit (see column 1, line 55 to column 2, line 2; see also column 2, lines 19 to 31) the intensity of white noises generated by the light emitted initially is higher than the line spectrum intensity; thus, without a satisfactory intensity of the line spectra, no effective improvement in accuracy can be attained; the invention in dispute tries to avoid in particular the above-described disadvantage of the prior art and has as its object the provision of a laser emission spectroscopical analysis of steel and an apparatus therefor, which are practicable and usable under an adverse environment on the site, wherein light excited and generated by a laser beam is caused to fall into a spectroscope with a satisfactory intensity and

various methods of improving the accuracy having been proposed by the Applicant are additionally used with great effect.

4.3 The two distinguishing features mentioned here above have been stressed by the Appellant as the most relevant to the invention in dispute. However, one part of the first distinguishing feature, i.e. the use of an infra-red laser beam, and, incidentally, two further features of the method in dispute not mentioned here above in relation to **S2**, are considered as providing no contribution to an inventive step of the method in dispute, for the following reasons:

A method wherein a laser beam which is an **infra-red** pulsed laser beam irradiates a sample is acknowldeged in the patent in suit (see column 2, lines 3 to 10) in relation with Japanese Patent Laid-Open No. 76744/83. Incidentally, the use of a ruby laser having a wavelength of 694.3 nm, i.e. of the same type as the one disclosed in the patent in suit (see column 5, lines 25 to 28), is also known from **O2** (see the title and page 456, Table 1), which concerns giant pulse laser spectrochemical analysis of C, Si, and Mn in solid steel. Thus, this part of the first feature is generally known in the relevant technical field and can be implemented in an obvious way in the method of **S2**.

Moreover, the cone angle θ of the cone-shaped beam is to be at least 16°. This is not specifically mentioned in **S2**; however, the cone angle derivable from the Figure of the abstract of **S2** is not substantially distinguished from the angles θ disclosed in the patent in suit (see Fig. 4, 8 and 15) having angle values between about 15° and 30°; thus, even by keeping in mind that values derived from drawings are not to be considered "*a priori*" as exact, a value of the cone angle of 16° or

more is a value which the skilled person can derive from **S2**; indeed, no improvement as compared to the prior art is mentioned in the patent in suit (see column 11, line 44 to column 12, line 23) in respect of said feature. In any case, even if this feature were to be considered as a distinguishing feature, the only related effect derivable from the patent in suit (see column 6, lines 12 to 30; Fig. 5 and 6) is an improvement in the coefficient of variation of the emission spectrum intensity, which the skilled person starting from the incomplete teaching of **S2** can arrive at by mere routine work.

Further, in the method in dispute, the emitted light is only quantitatively analyzed (a) after the lapse of a predetermined period of time upon generation of a laser pulse and (b) when the intensity of a specified spectral line or the intensity ratio of a pair of specified spectral lines is within a predetermined range. However, the feature (a) is already in the method known from **S2** (see the abstract) because the plasma light is spectrally measured with a photodetector (26) only for the period of 1 µsec to about 16 µsec after the irradiation, i.e. for a period starting 1 µsec after the irradiation. Concerning the method feature (b) it is to be noted that in the method of the patent in suit (see column 9, line 47 to column 12, line 23 and in particular column 11, line 44 to column 12, line 12; Fig. 15), as admitted by the Appellant, the gate means (30) controls the signal processing section (32) and thus the further indication section (34) but does not control the spectroscopical means of the spectroscope (16), i.e. the photoelectric transducing elements (16C) and the output terminals (16D) of the spectroscope working continually; an advantage resulting from this feature of non inputting the respective spectrum intensity signals to the signal processing section (32)

is mentioned as being an improvement in the coefficient of variation of 5,3% as compared with 9% without this feature; however, an improvement of the calculated coefficients is in no way surprising since the spectrum intensity monitor (28) actuates the gate means (30) only when said measured intensity is within a preset range and thus excludes other measured values of said intensity for further processing in the signal processing section (32), so that the coefficient of variation can only be reduced; in any case, a method for spectroscopical analysis using laser light is known from **S3** (see the abstract), wherein a spectral intensity monitor (32) and a gate circuit (34) are provided and, when the intensity of the spectral line of the light from the sample or an intensity ratio of specified pairs of spectral lines is within a specified range, the gate (34) is opened and the analysed value is displayed in a display part (36), whereby a highly accurate analysis can be performed regardless of the fluctuation in laser output intensity. Therefore, this feature (b) is obvious.

4.4 The following is to be noted in relation with the two remaining distinguishing features:

No value of the energy density of the laser beam is derivable from **S2**. An energy density on the surface of the irradiated sample which becomes 2.0×10^9 W/mm^2 or more is acknowldeged in the patent in suit (see column 2, lines 3 to 10) in relation with the above-mentioned Japanese Patent Laid-Open No. 76744/83. The Appellant has argued that this value of the energy density is known "*per se*" but is not related to the other prior art documents; in particular, in the above-mentioned method of **O2** (see the title; page 455, right-hand column, last paragraph to page 457, left-hand column, second paragraph; Fig. 1 and 2, and in

particular Table 1), the peak power is 50 MW and the half width of the pulse is 20 nsec; by assuming that the number of pulses per second is one and the diameter of the crater created at the surface of the sample is 2 mm, this leads to an energy of about 10^7 W/mm^2, i.e. more than 100 times smaller than in the method in dispute; the person skilled in the art would not be incited to use higher energy densities, especially since it is not practical to increase the laser energy because it is expensive and generally renders the laser unstable, while it is derivable from **O2** (see page 458, left-hand column, third paragraph; see also page 459, left-hand column, third paragraph, lines 1 to 5; Fig. 6) that the increase in energy does not result in an increase in spectral intensities. However, these arguments are not considered as relevant for the following reasons: although it is derivable from these text locations of **O2** that the spectral intensities for some constituents (FeII and MnII) of the sample, after increasing with laser energy, inversely fall with higher energy values, this is not the case for the other constituents shown, for which the slope of the spectral intensities vs. energy only becomes slower. Moreover, it is also derivable from the same text locations of **O2** that it is suitable to set laser energy on the average above 0.3 J for the apparatus shown, from the point of view of signal-noise ratio and smaller variation with laser energy. Therefore, although **O2** alone does not incite using higher values of energy density, there can be seen in this document no indication for disregarding, for all constituents, the energy density values of 2.0×10^9 W/mm^2 or more known from the above-mentioned Japanese Patent Laid-Open No. 76744/83.

A spectrochemical analysis method using laser light and comprising a flow of inert gas is known from **S5** (see the abstract and in the Japanese document, Fig. 2) and,

independently, from the above-mentioned **O2** (see page 456, left-hand column, second complete paragraph; page 457, left-hand column, third paragraph to page 458, left-hand column, first paragraph; page 461, right-hand column, "Conclusion", paragraph (2); Fig. 2, 4 and 5); for instance, in **C2** a flow of inert gas is provided in the path of the emitted light between the surface of the steel sample and the optical focusing means located above it; flow rates of the inert gas (Argon) above 10 l/min are mentioned as "necessary"; reported values of 20 l/min and measurements having been effected up to about 50 l/min (derivable from Fig. 5) are also mentioned. Therefore, values of said flow rate of inert gas of at least 50 l/min either do not differ from the limit of measurements effected in **O2**, or result from an extrapolation of these values within the limit "above 10 l/min" stressed therein.

4.5 Therefore, the method in dispute results from a combination of features known and used in the same technical field. No surprising effect resulting from the claimed combination can be seen; in particular, the comparative results mentioned in the patent in suit (see column 11, line 44 to column 12, line 23) concern the comparison of a conventional method (with a coefficient of variation of 11,4%) with a series of partial combinations of two features (with respective coefficients of 9%, 7,3%, 5,9% and 5,3%); a last mentioned result concerning the cumulative combination (coefficient of 3,2%) is indeed smaller than that of the partial combinations but cannot be considered as surprising since all the partial combinations of features have an effect in the same sense of reducing the coefficient of variation.

4.6 Therefore, the subject-matter of Claim 1 in dispute does not involve an inventive step in the sense of Article 56 EPC and, thus, Claim 1 is not allowable (Art. 52(1) EPC).

4.7 It is to be noted that Claim 6 concerns an apparatus for laser emission spectroscopical analysis of steel for carrying out the method according to Claim 1 and is not allowable for the same reasons.

5. Therefore, the grounds of opposition mentioned in Article 100(a) EPC prejudice the maintenance of the amended European patent (Art. 102(3) EPC).

Order

For these reasons, it is decided that:

The appeal is dismissed.

The Registrar:

P. Martorana

The Chairman:

E. Turrini