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**D E C I S I O N**  
**of 22 January 1997**

**Case Number:** T 0617/91 -3.2.2

**Application Number:** 87903375.1

**Publication Number:** 0268632

**IPC:** C21C 1/10

**Language of the proceedings:** EN

**Title of invention:**

Improvements in or relating to the production of iron

**Patentee:**

BRITISH STEEL PLC

**Opponent:**

-

**Headword:**

Production of Iron/BRITISH STEEL

**Relevant legal provisions:**

EPC Art. 56

**Keyword:**

"Inventive step - yes"

**Decisions cited:**

T 0110/92, T 1077/92

**Catchword:**

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Case Number: T 0617/91 -3.2.2

**D E C I S I O N**  
of the Technical Board of Appeal 3.2.2  
of 22 January 1997

**Appellant:** BRITISH STEEL PLC  
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**Representative:** Heath, Peter William Murray  
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**Decision under appeal:** Decision of the Examining Division of the  
European Patent Office posted 7 March 1991  
refusing European patent application  
No. 87 903 375.1 pursuant to Article 97(1) EPC.

**Composition of the Board:**

**Chairman:** H. Seidenschwarz  
**Members:** R. Lunzer  
C. Holtz

## Summary of Facts and Submissions

- I. European patent application No. 87 903 375.1, International Publication No. WO 87/07306, filed on 27 May 1987, claiming a priority date of 29 May 1986 derived from GB Application No. 8613106, was refused by a decision of the Examining Division dated 7 March 1991. That decision was based on a set of Claims 1 to 6 filed with the Appellant's letter of 30 May 1990, Claim 1 taking the following form:

"A process for the production of modified iron for casting with quasi-flake or spheroidal graphite comprising the steps of containing the iron in molten form, in a prepared state for modifying, in a containing vessel having a sliding gate valve mounted in the wall thereof at or adjacent the base thereof, the sliding gate valve having at least two openings passing therethrough, a first opening being connected to a source of modifying agent containing material and being selectively moveable into and out of alignment with an orifice through the wall of the vessel, and the second opening being selectively moveable into and out of separate alignment with an orifice through the wall of the vessel to enable the discharge of metal from the vessel therethrough; characterised by the steps of moving the gate of the valve to align said one opening with an orifice and injecting modifying agent containing material entrained in inert gas through said first opening therein and an orifice in the wall of the vessel for the formation of modified iron therein, and subsequently moving the sliding gate to align the second opening with an orifice in the wall of the vessel whereby to teem modified iron from the vessel."

II. The ground for the refusal was that the subject-matter of Claim 1, although novel, lacked any inventive step having regard to document:

(1) DE-A-2 800 684.

The Examining Division held that to solve the problem of introducing a relatively low boiling point metal such as Mg into molten iron, without undue loss of the Mg due to volatilisation and oxidation, the skilled worker would have referred to document (1), an earlier patent application of the present Appellant, regarded by the Examining Division as the closest prior art. That disclosed all the process features of Claim 1, save that it did not mention the production of quasi-flake or spheroidal graphite cast iron (hereinafter SG iron). As document (1) disclosed the introduction through a ladle gate valve of a considerable number of alloying, modifying, or inoculating agents for the treatment of all liquid iron melts, with the advantage that the reacting material was introduced directly into the melt, thereby bringing about improved yield of the agent added, and improved mixing of the melt, and as amongst the added agents mentioned there was specific reference to Mg, it would have been obvious to the skilled person to have applied that general teaching to the specific problem of making additions of Mg for the purpose of producing SG iron.

III. An appeal against that decision was filed on 1 May 1991, the appeal fee was paid on 6 May 1991, and the statement of grounds of appeal was filed on 3 July 1991. In that statement the Appellant contended essentially that the decision under appeal failed fully to take account of the importance of the alleged invention when seen against the background of the art in which it had been made. The invention provided an

economical, elegant and effective solution which overcame the fundamental difficulties of introducing the volatile metal Mg into molten iron, and at the same time securing a rate of recovery of Mg which was significantly better than the results attainable in the past. Thus the alleged invention achieved a major breakthrough in an art in which for some 40 years (cf. paragraph 4.4 below) there had been an endless search for a satisfactory mode of adding Mg or similar elements to achieve a SG structure in the solidified iron.

- IV. At the Board's suggestion, the Appellant introduced further background information directed to the history and the commercial development of SG iron, in order to substantiate its main arguments. Of this material, the Board has relied in particular on the the book entitled "Ductile Iron Production Practices" by Stephen Karsay, published in 1975 by the American Foundryman Society.
- V. The Appellant requested that the decision under appeal be set aside, and a patent granted on the basis of Claim 1 in accordance with its sole request.

### **Reasons for the Decision**

- 1. The appeal is admissible.
- 2. *Admissibility of amendments*

Claim 1 as filed during the examination procedure with a letter of 30 May 1990 is a combination of Claims 1 and 2 and paragraph one on page 1 of the description of the Application as filed. Similarly, dependent Claims 2

to 6 are disclosed in the application as filed, as explained in the Appellant's letter of 30 May 1990 in the penultimate paragraph on page 2. It follows that the requirements of Article 123(2) EPC are satisfied.

3. *Novelty*

Novelty was not in issue. Having reviewed all the documents brought to light in the course of examination, the Board is satisfied that the subject-matter of Claim 1 is novel for the purposes of Article 54 EPC.

4. *Background to the alleged invention*

4.1 Gray cast iron, one of the oldest engineering materials used by man, is so called because the surface of a newly fractured casting has a gray colour due to the prevalence in its microstructure of graphite flakes. Its advantages when compared with cast steel, are its lower melting temperature, relative ease of casting, and relative cheapness. Its drawback lies in its brittleness, which is due to the presence of the graphite flakes.

4.2 Malleable cast iron had long been made industrially, inter alia by processes involving careful control of the composition and rate of cooling during casting, followed by lengthy heat treatment, so as either to precipitate the carbon in nodular form (black heart malleable iron) or to largely eliminate the carbon through oxidation at the surface of the castings (white heart malleable iron). Such processes were slow and costly, with the consequence that only a small proportion of cast iron was so treated.

4.3 At a conference held in Düsseldorf, Germany in 1936 it was demonstrated that under suitable conditions an as cast spheroidal graphite structure could be produced. From that time onwards, the race was on to find a commercially effective method of so doing.

4.4 The race was won by workers of the International Nickel Company Inc. who in 1943, while seeking to include Mg as an alloying substituent in place of Cr in Cr-Ni containing alloys, encountered a more than five-fold increase in tensile strength in a cast structure, and observed that the improvement was due to the modified shape of the graphite. Research continued from 1943 to 1947 when the basic patent application for SG iron was filed.

4.5 Although other additions, such as of cerium in the form of mischmetal, are known alternatives to Mg for the production of SG iron, for reasons of economy Mg is the most widely used addition.

4.6 From 1950 onwards, the use of SG iron developed worldwide, reaching 5m. tons by 1970, and increasing since then.

5. *The problems of introducing Mg into molten iron*

5.1 Cast iron, when in the molten state, is normally held at a temperature in the range of 1250 to 1500°C. In contrast Mg metal boils at atmospheric pressure at 1107°C, is only sparingly soluble molten iron, has a specific gravity of 1.7 contrasted with the 7.0 of molten iron, and in its volatilised state is capable of reacting with air with explosive violence. Over the years an enormous number of proposals have been made for overcoming the problems of introducing Mg into molten iron.

5.2 One solution used from the outset was to form an alloy such as 85:15 Ni:Mg, which has the advantage that it does not float due to its increased specific gravity. Such alloy additions were found to be effective in the commercial production of SG iron, but on cost grounds it is undesirable to add Ni other than when a high strength Ni alloyed iron is required. In general, addition of Mg metal in an unalloyed condition was found to be more economical, but the recoveries of Mg, i.e. the proportion of Mg remaining in the iron after making allowance for that consumed by reaction with residual sulphur, was normally in the range of 35 to 50%. There is an enormous patent literature dealing with methods for introducing Mg, including methods which rely on enclosing the ladle in a pressure vessel, capable of maintaining a pressure above the vapour pressure of the molten Mg, and other methods which introduce the Mg metal in one form or another deep into the ladle, so that the supernatant head of liquid metal produces a pressure in excess of the Mg vapour pressure. This ensures that the Mg when molten has the maximum opportunity of being absorbed into the metal bath as it floats towards the surface due to the big difference of specific gravity between molten Mg and molten iron. A paper read by John Powell at a one day seminar held by BCIRA on 22 November 1990 under the title "The Metallurgy and Production of Ductile Iron" refers to some 30 methods for introducing Mg into iron, but these are regarded as being merely the best known methods amongst many others which have been proposed.

5.3 Thus there has long been a demand for a method of adding Mg which is safe, controllable, and affords a high rate of recovery into the iron of the Mg added.



6. *The prior art*

The Board agrees with the Examining Division in regarding document (1) as being the closest prior art document. It discloses a method of treating metals, including but not limited to molten iron, by blowing a stream of a gas, which may be air, nitrogen, argon, carbon monoxide, carbon dioxide, natural gas, a hydrocarbon gas, or a mixture of such gases, through a jet located in a gate valve in the base of metal containing vessel. A long list of possible reagents, which may be intended as desulphurising agents, deoxidisers, alloying additions, or modifying agents, is given at page 5, lines 17 to 29, amongst which Mg is mentioned by name at line 18.

7. *Inventiveness*

7.1 In dealing with the issue of inventiveness, the Examining Division referred in particular to the passage in document (1), page 8 last paragraph, mentioning the treatment of liquid iron melts. The process there disclosed offered the advantage that the reacting material was introduced directly into the melt, thereby bringing about improved yield of the agent added, and improved mixing of the melt. The Examining Division went on to reason that as it was well known that SG iron could be made by the addition of Mg and other elements, no inventive step was needed for a person skilled in metallurgy, faced with the problem of making SG iron by adding graphite modifying agents, to use a process which had already proved to be effective for adding the same agents, even if in the past the additions had been made for a different purpose, such as for desulphurisation and deoxidation.

7.2 The Board cannot fault the reasoning of the Examining Division insofar as it is an analysis of the purely technical considerations divorced from the background facts. However, in determining the issue of obviousness, unlike the issue of novelty, every tribunal, whether it be an Examining Division, Board of Appeal, or Court of law dealing with validity, is bound to look at all the relevant facts, in order to give a realistic answer to the question of whether an alleged invention involved any inventive step or not.

7.3 In reaching its contrary conclusion, that the alleged invention is not obvious, the Board has taken particular account of the following facts:

(a) Document (1) is a very general teaching. It relates to substantially all additions to all metals for almost any purpose by injection through a gate valve of a metal-containing vessel. It follows that there may be scope for inventive selection of one particular kind of injection, i.e. the injection of Mg, not in the small quantities suitable for desulphurisation, which process is mentioned at page 4, line 17 and at page 5, line 17 of document (1), but in the significantly larger quantities required for the totally different purpose of producing SG iron.

(b) Document (1) was published on 12 July 1979, while the priority date of the alleged invention is 29 May 1986, almost seven years later. In a rapidly developing area of technology such as the production of SG iron, where active research continues on a worldwide scale, seven years is a relatively long time.

- (c) In some industries, and in particular in the iron and steel industry, a delay in introducing new processes is often explicable on cost grounds. A new method or apparatus may be technically superior and more economical, but nonetheless its wide adoption has to await the amortisation of existing plant, and fresh investment in new plant. Here, in contrast, all that is needed for carrying out the invention is a conventional sliding gate ladle, a piece of apparatus commonly either available on site, or readily obtainable from plant suppliers. Such a ladle could be provided with additional gas injection means either by the plant supplier, or as an on site modification.
- (d) It could have been expected that there would have been a strong incentive to modify the teaching of document (1) by applying the method and apparatus there disclosed to the production of SG iron as now proposed by the invention. In particular, it ought to have been foreseeable that such a process would have afforded a method of introducing Mg which overcame the problems normally associated with making SG iron, which would permit very accurate control over the amounts of Mg introduced, and which inherently could be expected to result in exceptionally high recovery rates of Mg, and that all those objectives could have been attained without the need for investment in costly specialised plant. Thus it was reasonable to have been expected that upon the publication of document (1), many producers of SG iron, including the Appellant who had published document (1) and who had been in possession of the ideas there disclosed from at least the application date of January 1978, could have been expected to have adopted its proposals for the production of SG iron with a minimum of delay.

(e) The results obtained by the Appellant confirm the above-mentioned technical expectations. The process can be accurately controlled to the extent that, with modern means of analysis, it is possible to ensure that no more and no less than the optimum amount of Mg is added, so as to secure consistency of results without waste of Mg, and the recoveries of Mg in excess of 70% are among the best experienced with any method of Mg addition.

8. *Evaluation*

8.1 Given the facts set out above, the Board is compelled to confront the question which is sometimes asked, if it was obvious, why was it not adopted sooner? In the decision T 0110/92 (12 October 1994, not reported in OJ EPO) at point 5.6 of the decision, the comment was made that:

"The question of why no person skilled in the art has hit on the idea of combining the teachings of ..... before the priority date of the patent in suit can be asked with regard to any invention that satisfies the requirement of novelty. The reasons why can be many and various."

8.2 However, instead of going on to declare that the question was irrelevant, on that occasion the Board was able to find a credible answer to that question, which did not involve postulating that inventive ingenuity was needed.

8.3 In contrast, in its earlier decision T 1077/92 (5 December 1995, not reported in OJ EPO) this Board faced the unusual situation of a problem and its ready solution having co-existed for 100 years in general, and more recently in a field of intensive research, and

still the seemingly obvious step was not taken. The Board concluded that as no other explanation could be found, this must have been because inventive insight was needed (Reasons points 5.5 to 5.7).

- 8.4 The 100 years in that earlier case is a more extreme situation than the 7 years in the present case. Nevertheless the fact remains that throughout that time interval there was a strong incentive amongst SG iron makers throughout the world to look for better methods which would be more safe, and more economic, both in terms of plant cost and in terms of Mg recovery in the melt, and throughout that interval the teaching of document (1) was ignored. Consequently, although document (1) seen in hindsight might seem to suggest a solution, the Board draws the inference that the generality of its teaching was such that it remained unnoticed, and would have remained so but for the inventive insight of the Appellant.

9. *Conclusion*

The subject-matter of the amended Claim 1 in issue involved an inventive step, and the essential requirement of Article 56 EPC is therefore satisfied.

**Order**

**For these reasons it is decided that:**

1. The decision under appeal is set aside.
2. The case is remitted to the Examining Division with the order that a patent be granted on the basis of Claims 1 to 6 filed with the Appellant's letter of 30 May 1990, the description and drawings still to be adapted.

The Registrar:



S. Fabiani

The Chairman:



H. Seidenschwarz