BESCHWERDEKAMMERN DES EUROPÄISCHEN PATENTAMTS

BOARDS OF APPEAL OF THE EUROPEAN PATENT OFFICE

CHAMBRES DE RECOURS DE L'OFFICE EUROPEEN DES BREVETS

A		B		C	X

File No.: T 0786/90 - 3.2.2

Application No.: 80 104 709.3

Publication No.: 0 027 165

Classification: C22C 38/60

Title of invention: Free machining steel with bismuth

D E C I S I O N
of 13 July 1993

Applicant:

Proprietor of the patent: INLAND STEEL COMPANY

Opponent: I: Thyssen Stahl AG
II: Saarstahl AG

Headword:

EPC: Art. 56

Keyword: "Inventive step (no)"

Headnote
Catchwords

Europäisches Patentamt | European Patent Office | Office européen des brevets

Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T 0786/90 - 3.2.2

D E C I S I O N
of the Technical Board of Appeal 3.2.2
of 13 July 1993

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Decision under appeal: **Interlocutory decision of the Opposition Division of the European Patent Office dated 16 August 1990 concerning maintenance of European patent No. 0 027 165 in amended form.**

Composition of the Board:

Chairman: G.S.A. Szabo
Members: W.D. Weiß
M.K.S. Aúz Castro

Summary of Facts and Submissions

I. European patent No. 0 027 165 was granted with effect from 28 November 1984 on the basis of European patent application 80 104 709.3, filed 11 August 1980.

II. Two oppositions were filed against the patent on the grounds of lack of novelty and inventive step (Article 100(a) EPC) in the light of numerous documents. On 26 June 1986 one of the opponents additionally cited a case of prior public use which originally had been cited in the opposition proceedings against patent No. 0 027 510 of the same proprietor.

The prior public use was seen in the delivery of billets of a free cutting steel (cast No. 9971/2) by British Steel Corporation Limited to Von Moos Stahl A.G. Copies of the following documents were filed as a proof for this prior use:

(D23) (a) Invoice, Cost A.C. No. 0099147, Customer Order No. 08-1225/WW/70369, dated 26 May 1978, and

(b) "Certificate of Physical Tests and Analysis" No. 728, Customer Order No. 08-1225/WW/70369, dated 2 June 1978.

III. In the course of the opposition proceedings, an amended version of the patent in suit was submitted which the Opposition Division by its Interlocutory Decision, dated 16 August 1990, has found to meet the requirements of the EPC.

The independent Claim 1 in this version reads as follows:

"1. A free machining cast steel shape comprising in wt%:

carbon	0.06-1.0
manganese	0.3-1.6 maximum
silicon	0.30 maximum
sulphur	0.03-0.50
phosphorous	0.12 maximum
bismuth	0.05-0.40
lead	0-0.3
tellurium	0-0.06
iron and incidental impurities	the balance

wherein said bismuth is present in bismuth containing inclusions having a mean size less than 5 microns and wherein the total amount of impurities which lower the wetting ability of bismuth, said impurities comprising copper, nickel, tin and zinc, is less than the bismuth content."

The dependent Claims 2 to 5 refer to particular embodiments of the free machining cast steel shape according to Claim 1.

IV. In its decision, the Opposition Division has found that the steel according to the public prior use as documented by (D23) disclosed a steel the composition of which was fully covered by the composition indicated in Claim 1, but that this state of the art was silent about the size of the inclusions present in this steel. The other documents either, when stating small particle sizes of Bi containing inclusions, referred to alloys of different basic compositions, or, when concerning alloys of similar basic compositions, were at least vague about the particle size of the inclusions. The Opposition Division attributed a particular importance to the fact that the document:

(D9) US-A-3 705 020

taught "that the size of the inclusions of certain elements including Pb and Bi have a remarkable influence on machinability and recommends a size range of 10 to 100 microns" and concluded "that this will obviously lead the skilled man away from the teaching of the contested patent".

V. Two Appeals were filed on 12 October 1990 (Appellant I/Opponent II) and on 16 October 1990 (Appellant II/Opponent I). The appeal fees were paid on 15 October 1990 and on 16 October 1990, respectively. The respective Statements of Grounds were both filed on 17 December 1990.

VI. In a communication dated 1 April 1993, the Board cited the general textbook

(T1) "The Making, Shaping and Treating of Steel", 9th Edition (1971), page 493,

stating that residual alloy elements such as copper, nickel or tin were usually considered undesirable in low carbon steels and that the generally high consumption of hot metal used in the basic oxygen process therefore resulted in a low residual alloy which was normally introduced by the addition of scrap. Moreover, the attention was drawn to the fact that another Board, in case T 839/90 (2 April 1992, unpublished) the subject-matter of which (EP-B-0 027 510) was closely related to the subject-matter of the patent in suit, had finally concluded that it was the normal practice of the steel worker to keep the level of these residual elements low and in particular below the relatively high content of bismuth (point 8.3 of this previous decision).

Moreover, the Board pointed to the fact that according to document:

(D1) Drahtwelt 59 (1973), No. 8, pages 346 to 352,

manganese sulphide inclusions were considered as being good for the machinability when their size was in the range of about 10 to about 60 microns.

VI. The Appellants, in their written submissions and during the oral proceedings of 13 July 1993, presented, based on the documents

(D5) Thyssen Technische Berichte, (1977), pages 59 to 65,
(D6) DE-B-2 051 406,
(D8) Technical Digest No. 9 1967, pages 616 to 620,
(D17) GB-A-0 519 572, and
(B1) US-A-3 876 422,

the following essential arguments:

The composition of the steel included in Claim 1 was not novel with respect to the composition of the steel the public prior use of which was proved according to documents (D23). Therefore, the only difference with respect to this prior art was the feature that the grain size of the bismuth containing inclusions should be less than 5 microns.

The documents (D17) and (B1) disclosed that, whenever lead had been used to form inclusions in free machining steels, great efforts had been undertaken to warrant their uniform and microscopically fine dispersion. Document (D8) proved that the experts in this field of technology had always understood sizes of less than 5 microns as being "microscopically small". Document (D6)

disclosed a typical method to produce such a microscopically fine dispersion. Since lead and bismuth were completely miscible, no reason could be seen why inclusions consisting of an lead-bismuth alloy, like in the steels disclosed for instance in the documents (D23) and (D5), should have another grain size. Consequently, the subject-matter of Claim 1 did not involve an inventive step.

VII. The Respondent presented essentially the following arguments:

The alloy according to the public prior use, which was not principally contested, had to be seen as an accidental anticipation and not as a common prior art of greater significance which could be used as a starting point for assessing inventive step. Starting from such common prior art, the invention of the patent in suit had to be seen in the teaching that bismuth was particularly effective as a liquid metal embrittler, when, in combination, the mean size of the bismuth containing inclusions was less than 5 microns and the total amount of impurities which lower the wetting ability which comprise copper, nickel, tin and zinc was less than the bismuth content. This combined teaching was not contained in any of the cited documents. On the contrary, document (D9) had to be considered as the prevailing prior art teaching regarding the size of bismuth inclusions which taught those skilled in the art that to enhance machinability due to bismuth, the bismuth inclusions should have a size in the range 10 to 100 microns (and preferably 20 to 60 microns).

VIII. The Appellants request that the decision under appeal be set aside and the patent be revoked in its entirety.

The Respondent requests that the appeal be dismissed.

Reasons for the Decision

1. The appeal is admissible.

2. *Novelty*

The subject-matter of Claim 1 is novel, because none of the cited documents discloses a steel having bismuth containing inclusions having a mean size less than 5 microns.

3. *Closest Prior Art*

The public prior use according to documents (D23) is uncontested prior art in the sense of Article 54(2) EPC. The analysis according to document (D23)(b) fully meets the proportions regarding the composition specified in Claim 1.

Free machining steels of this type serve for the production of machine elements which are to form parts of complex machinery and, therefore, have to reliably warrant the mechanical characteristics required by the respective customer. The main source of residual impurities such as copper, nickel and tin, which heavily affect certain mechanical characteristics, is scrap which is used during the production of the steel (document (T1), page 493). Consequently, the hot metal/basic oxygen process will be used by the steel mill, whenever the steel to be produced has to warrant narrow specifications. The low level of the impurities chromium, nickel, cobalt, copper and tin indicated in document (D23)(b) is typical for the hot metal process. Zinc has not to be considered as an impurity in steel,

because it will boil away at the temperatures occurring during the steel making process.

Following the above considerations, the Board is convinced that the low level of the impurities copper, nickel, tin and zinc of this known steel is the result of deliberate production and not an accidental singular event. There is, therefore, no obstacle for not rating the steel disclosed by the prior use according to document (D23) as the closest state of the art which forms the basis for considering the question about the inventive step.

4. *Problem and Solution*

One factor which favours the free machinability of steels is a high chip brittleness which is achieved by the uniform distribution of numerous inclusions in the iron structure. These requirements are met by nonmetallic components which are soluble in the liquid steel but form insoluble compounds in the solid state of the steel. The manganese sulphides are the major components used for this purpose (document (D5), page 60, penultimate paragraph).

The free machinability is also favourably influenced by the addition of metallic elements like lead and bismuth which solve in iron in the liquid but not in the solid state. Standard steels (document (D5), Table 2, e.g. 9 SMnPb36 and 9 SMnPbBi36) were already known before the effective date of the patent in suit which contain manganese sulphide inclusions together with inclusions of lead of lead/bismuth, respectively. Whereas the function of nonmetallic inclusions, like manganese sulphide, is mainly to reduce the length of the chip, the low melting metallic inclusions like lead and bismuth principally act as a lubricant which reduce the

frictional and ripping work ((D5), pages 64/65). Accordingly, bismuth, in addition thereto, reduces surface energy with respect to the steel matrix.

The steel according to the closest state of the art (D23) belongs to this class of steels which contain inclusions of manganese sulphide together with inclusions consisting of a lead-bismuth alloy.

Bismuth like lead, which has already been used since the fourth decade of this century to improve the free machinability of steel (see (D17)), has a fusion temperature which is much lower (271°C and 328°C, respectively) than the temperature at which liquid steel is treated and cast (above 1500°C). BiPb alloys may have fusion temperatures which lie even considerably below the fusion temperature of bismuth. This difference of the melting temperatures involves a considerable loss of the PbBi alloy by evaporation unless particular care and technique is taken for its avoidance.

The problem to be solved by a skilled practitioner, who starts from the prior use according to document (D23) as the closest state of the art and who is asked by a subsequent customer's order of a steel with the same quality as the batch 9971/2 (document (D23)(a)), is which alloying technique he should use to avoid the above mentioned evaporation when aiming at the same target analysis and to warrant a uniform distribution of the PbBi inclusions and the same free machining characteristics of the final steel.

This problem is solved by the distinguishing feature of the subject-matter of Claim 1, namely by choosing a method which warrants that the bismuth is present in bismuth containing inclusions having a mean size less than 5 microns.

5. *Inventive Step*

The same problem had persisted since the late 1930's, when the metallurgists had been challenged by the problem to incorporate pure lead into a steel to improve its free machinability.

It had been found already in 1938 that lead had the most favourable effect on the free machinability of manganese sulphide containing steels, when 0.1 to 0.478% of it were "uniformly distributed" throughout the steel in form of inclusions "of microscopically small size" (document (D17), page 2, line 89, to page 3, line 44; page 5, lines 18 to 37). In 1938, the problem to produce such a uniform distribution of microscopically small lead inclusions in steel had obviously been solved only on a laboratory scale, because the author of document (D17), in 1975, was still facing the problem to reliably produce such a distribution at a commercial scale, in particular continuous cast, ingots (see document (B1), column 1, lines 19 to 60; column 3, lines 3 to 28). When seen out of context, the expression "microscopically small size", may be relative and ambiguous in its meaning. It is, however, unambiguous to a person skilled in the relevant field that it means here "as small as possible" and refers to sizes on the level of microns.

This interpretation is, in particular, confirmed by document (D8) (page 416, second paragraph) which is a report about research on the lead alloying technique originating from the author of documents (D17) and (B1). Document (D8), reports that, using this "Inland Steel method" in a modified form, lead inclusions of a size of 1 micron and below are achieved and this "more uniform lead distribution, and the much finer lead particles, contribute to the physical and chemical homogeneity which is essential, when the material is to have a good

and uniform machinability" (pages 617 to 619, first paragraph). The documents (D17). (D8) and (B1), which, in this sequence, represent subsequent stages of development of the same technology, give the consistent teaching that lead inclusions should be as small in size as possible to achieve a good machinability. This is interpreted as commonly known by the skilled practitioner.

Document (D9) (1972), which historically was published between the documents (D8) (1967) and (B1) (1975), obviously concerns a different technical development project which has not been referred to in any of the other documents cited. Consequently, this singular document would not be apt to prove the presence of a general prejudice against the above described consistent teaching even when its disclosure were contradictory thereto. The Board cannot, however, see that this is the case. (D9) refers to "inclusions" in general irrespective of their chemical (inorganic or metallic) nature and, therefore, solely tries to influence the machinability via the length of the chip, neglecting the lubricating or surface energy effects attributed to certain metallic inclusions (see point 4. above, first and second paragraph). It is, therefore, only consequent, that all the examples of document (D9) concern manganese sulphide. Manganese sulphide inclusions, however, typically have had a size of between 10 to 100 micron (see document (D1), Figure 2) in commercially available free machining steels and may have this size in the steels according to the closest prior art as well as according to the subject-matter of Claim 1.

Following the above considerations and having in mind the well established close chemical similarity of lead and bismuth (document (D1) page 250, paragraph 6.6.;

(D5), the paragraph bridging pages 64 and 65), a person skilled in the art who has to incorporate a Pb-Bi alloy in to a steel would first try the methods which, according to the state of the art, have been developed for the incorporation of lead alone and which result in and aim at PbBi inclusions of a size of less than 5 microns. It should be noticed that the claim also covers embodiments wherein there is six times as much lead for the purpose as bismuth.

Consequently, the subject-matter of Claim 1 does not involve an inventive step.

6. In summary, the Board comes to the conclusion that Claim 1 lacks one of the requirements for a patentable invention according to Article 52(1) EPC.

Order

For these reasons, it is decided that:

1. The decision under appeal is set aside.

2. The patent is revoked.

The Registrar: The Chairman:

S. Fabiani G. Szabo