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D E C I S I O N
of 17 October 2001

Case Number: T 0623/98 - 3.2.2

Application Number: 93306764.7

Publication Number: 0593158

IPC: C22C 38/58

Language of the proceedings: EN

Title of invention:
Austenitic stainless steel of the chromium-nickel-manganese type, and further containing copper and nitrogen

Applicant:
ALLEGHENY LUDLUM CORPORATION

Opponent:
-

Headword:
-

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

Keyword:
"Inventive step (no)"

Decisions cited:
-

Catchword:
-

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Case Number: T 0623/98 - 3.2.2

D E C I S I O N
of the Technical Board of Appeal 3.2.2
of 17 October 2001

Appellant: ALLEGHENY LUDLUM CORPORATION
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Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 6 February 1998 refusing European patent application No. 93 306 764 pursuant to Article 97(1) EPC.**

Composition of the Board:

Chairman: W. D. Weiß
Members: R. Ries
J. C. M. de Preter

Summary of Facts and Submissions

I. The appellant (applicant) lodged an appeal against the decision of the Examining Division to refuse the application No. 93 306 764.7.

The Examining Division held that the application did not meet the requirement of novelty (subject matter of claim 14) and that the subject matter of claim 1 lacked inventive step (Article 56) having regard to documents

D1 GB-A-1 070 317 and

D3 Brimacombe, J. K., "The Continuous Casting of Stainless Steel", Proceedings of the first International Chromium Steel and Alloy Congress (INSAC), 1992, Johannesburg, volume 2, pages 7 to 23

II. In a communication following summons for oral proceedings, the Board further referred to document

D5 US-A-3 615 365

and raised doubts whether the claimed steel composition meets the principles applied by the Boards of Appeal as part of their established case law on the novelty of selection inventions, and whether the claimed subject matter involves an inventive step vis-à-vis the closest prior art represented by document D5.

III. Oral proceedings took place on 17 October 2001. The appellant requested that

- the decision under appeal be set aside and

- a patent be granted on the basis of the main request or of one of the three auxiliary requests, all submitted at the oral proceedings.

IV. The wording of independent claim 1 according to the main request and three auxiliary requests is as follows:

"1. An austenitic stainless steel comprising the following elemental composition, on a weight percent basis:

about 17 % chromium;
6.4 to 8.0 % manganese;
2.8 to 4.0 % nickel;
2.0 to less than 3.0 % copper;
less than 0.15 % carbon;
less than 0.2 % nitrogen;
total carbon and nitrogen content not to exceed to 0.30 %;
less than 1 % silicon;
the balance iron and incidental impurities,

the steel having a delta ferrite forming potential less than 9% according to the formula:

$$\% \text{ delta ferrite} = 12.48 + 0.52(\% \text{manganese}) - 54.27(\%\text{nitrogen}) - 47.98(\%\text{carbon}) - 1.57(\%\text{nickel}) - 1.62(\%\text{copper}) + 0.69(\%\text{copper})^2."$$

First auxiliary request:

"1. An austenitic stainless steel comprising the following elemental composition, on a weight percent basis:

16.5 to 17.5 % chromium;
7.5 to 8.0 % manganese;
2.50 to 3.0 % nickel;
2.0 to less than 3 % copper, the amount of copper being in the range 2.0 to 2.75 when the chromium content is less than 17%;
less than 0.15 % carbon;
less than 0.2 % nitrogen;
total carbon and nitrogen content not to exceed 0.30%;
less than 1 % silicon;
the balance iron and incidental impurities,

characterized in that the composition of the steel is selected so that the steel has a delta ferrite forming potential less than 9% according to the formula:

% delta ferrite = 12.48 + 0.52(% manganese) - 54.27(%nitrogen) - 47.98(%carbon) - 1.57(%nickel) - 1.62(%copper) + 0.69(%copper)^2."

Second auxiliary request:

"1. An austenitic stainless steel comprising the following elemental composition, on a weight percent basis:

16.5 to 17.5 % chromium;
7.5 to 8.0 % manganese;
2.50 to 3.0 % nickel;
2.0 to less than 3 % copper, the amount of copper being in the range 2.0 to 2.75 when the chromium content is less than 17%;
less than 0.15 % carbon;
less than 0.2 % nitrogen;
total carbon and nitrogen content not to exceed 0.30%;
less than 1 % silicon;

the balance iron and incidental impurities,

characterised in that the steel is selected so that both hot rolled and cold rolled products of the steel have a delta ferrite forming potential less than 9% according to the formula:

% delta ferrite = 12.48 + 0.52(% manganese) - 54.27(%nitrogen) - 47.98(%carbon) - 1.57(%nickel) - 1.62(%copper) + 0.69(%copper)^2."

Third auxiliary request:

"1. An austenitic stainless steel comprising the following elemental composition, on a weight percent basis:

about 17 % chromium;
7.5 to 8.0 % manganese;
about 3.0 % nickel;
about 2.5 % copper;
about 0.07 % carbon;
about 0.11 % nitrogen;
about 0.35 % silicon;
the balance iron and incidental impurities,

characterised in that the composition of the steel is selected so that the steel has a delta ferrite forming potential of less than 9% according to the formula:

% delta ferrite = 12.48 + 0.52(% manganese) - 54.27(%nitrogen) - 47.98(%carbon) - 1.57(%nickel) - 1.62(%copper) + 0.69(%copper)^2."

VI. The appellant essentially argued as follows:

The application addresses the problem of providing a Ni-Cr-Mn-Cu-nitrogen alloy having a reduced amount of nickel, a low delta ferrite content, acceptable corrosion resistance and mechanical properties as well as a satisfactory resistance to forming martensite upon plastic deformation. Given that controlled amounts of delta ferrite in the range of 2 to 6% are known in the art to improve the hot working characteristics of austenitic steels, see document D3, page 12, left hand column and page 13, right hand column, a certain amount of delta ferrite is desirable. As is apparent from the examples given in Tables I, II, VIII and IX, the claimed composition always comprises delta-ferrite phase in amounts lower than 10%, but none exhibits a fully austenitic microstructure which is aimed at for the alloys disclosed in the prior art D1 and D5.

Having regard to document D5 the Board has extrapolated too far from the teaching given therein. Although the delta-ferrite potential is limited to 10% at maximum, calculating the delta-ferrite potential of the alloy compositions disclosed in D5 and the present application gives different results, and it remains also unclear whether the examples given in D5 actually satisfy the claimed condition. Even though the broad elemental ranges of the alloy disclosed in D5 overlap the claimed ranges, none of the examples of D5 completely falls within the claimed composition. On the contrary, the exemplifying compositions HN86B, HN86A and 55743 given Table 1 of D5 exhibit much higher amounts of nickel and lower amounts of manganese compared to the examples given in the application. Consequently, the technical teaching according to D5 leads away from the claimed alloy composition which has been modified by shifting the manganese content towards a higher end and the nickel content towards a lower end, thus balancing the composition differently from that disclosed in D5. The formula describing the delta ferrite forming potential according to the application represents a previously undisclosed calculation and the claimed ranges are narrow vis-à-vis the broad elemental ranges given in document D5. The alloy composition designed as claimed results in an improvement of a combination of properties including good processability, corrosion resistance, and acceptable mechanical properties, ie a match in properties generally obtained only with more expensive alloys such as AISI 304. Hence, the claimed alloy composition is novel and involves an inventive step.

Reasons for the Decision

1. The appeal complies with Rule 65(1) EPC and is, therefore, admissible.

2. *The patent application*

Austenitic stainless steels, such as AISI 304, having a microstructure at room temperature substantially comprised of a single austenite phase, are highly valued because of their favourable mechanical properties, increased corrosion resistance and good formability. A disadvantage of these alloys is that the large amounts of nickel which are necessary to stabilize the austenitic phase at room temperature increase the cost of the steel. Consequently, substitute alloy compositions have been developed to replace a part of Ni by such elements as C, Mn or N. Also the present application relates to an austenitic Cr-Ni stainless steel composition comprising reduced amounts of nickel. However, reducing nickel entails the drawback of forming the undesirable delta-ferrite phase which promotes slivers, hot tears and cracking if present in amounts higher than 10%. Moreover, appreciable work hardening occurs in the cold forming process as a result of the partial transformation of the austenitic phase into the martensitic phase. Although either delta-ferrite or martensite are generally undesirable phases, it has been found that up to about 10% of each phase can be tolerated without substantially impairing the properties of the alloy (cf. the application as filed, pages 1 to 3).

The appellant has pointed in this context to the basic metallurgical knowledge given in document D3, pages 12 and 13 indicating that controlled amounts of delta-ferrite in fully austenitic stainless steel have been observed to refine the size of columnar grains, to reduce the directionability of the columnar structure, which beneficially affects the hot working characteristics. The appellant, therefore, concluded that a certain minimum amount of delta-ferrite is always aimed at in the claimed alloy which distinguishes it from the substantially or fully austenitic stainless steel alloys disclosed in documents D1 and D5.

It is, however, apparent from the application as a whole that delta-ferrite resulting from the steel composition merely represents an undesirable structural component which - although tolerable within certain limits - should be kept as low a possible or even be avoided. Reference is made to the application page 10, Table II and to the paragraph below, saying that a "ferrite number FN of 4 or lower" is preferred. Moreover the delta ferrite content in the examples was found to be "acceptable" which in fact means "tolerable" rather than desirable as alleged by the appellant (cf. e.g. the application page 12, lines 1 and 2 from the bottom; page 19, the text above Table IX). There is no indication anywhere in the application for concluding or implying that the properties of the steel are beneficially affected by the presence of the delta ferrite phase within the austenitic matrix and, to this end, specific amounts of delta-ferrite above a minimum limit are envisaged. The appellant's reasoning in this respect is, therefore, not convincing.

3. *The closest prior art*

The object of document D5 - like the one of the application - is to provide a relatively inexpensive, stable austenitic stainless steel which forms little martensite upon severe cold working (cf. D5, column 1, lines 22 to 28; the application page 4, lines 1 to 13). This known austenitic Cr-Mn-Ni stainless steel alloy composition is balanced to contain reduced amounts of costly nickel and specific amounts of C, Mn, Cu and N within proportions ensuring that the amounts of martensite and delta ferrite are kept below specific maxima and good workability is maintained. In its broadest aspect, the steel composition consists of up to 0.12% C, up to 2% Si, 5 to 8.5% Mn, 15 to 17.5% Cr, 3.0 to 6.5% Ni, 0.75 to 2.5% Cu, up to 0.05% N, the remainder being iron and incidental impurities, the steel exhibiting both a delta-ferrite and martensite forming potential of less than 10% (cf. D5, column 2, lines 33 to 45; claim 1). In view of its dealing with the same type of alloy and the same problem underlying the present application, the Board considers document D5 to represent the closest prior art.

4. *Main request*

As can be seen, an overlap exists between the elemental ranges of the alloy set out in claim 1 of the present application and the alloy disclosed in D5. In many examples given in document D5 (e.g. HN86B, HN86A, 55743) the chromium content is 16.55, 16.70; 16.40% Cr which corresponds to "about 17% Cr" as claimed.

However, the teaching of a prior art document is not confined to the detailed information given in the examples. Even though initially the skilled person would focus his attention on the examples and the claims of a relevant document, he would not restrict his study of the document solely to them, but would also direct his attention to the general description in his search for technical teaching relevant to the technical problem he is confronted with. Such technical information about the effects associated with the reduction of nickel in the claimed type of alloy is given in detail in document D5.

Turning to the range for manganese, on the one hand at least 5% is necessary since less than this would require higher amount of expensive nickel or excessive amounts of copper making the alloy hot short (cf. D5, column 6, lines 14 to 19). On the other hand, an upper limit of 8.5% Mn is recommended having regard to the balance between manganese and copper which must be maintained to prevent hot shortness (cf. D5, column 5, lines 31 to 49; column 6, lines 19 to 22). The examples in Table I of D5 HN86B, HN86A and 55743 exhibit 6.37, 6.28 or 6.78% Mn, respectively, which either come close to the lower limit of 6.4% Mn or even fall within the claimed range of 6.4 to 8% Mn.

According to document D5 column 6, lines 23 to 32, higher amounts of nickel or manganese are required unless at least 0.75 Cu% are added in order to stabilize the alloy against the formation of martensite during deformation, but adding more than 2.5% Cu entails the drawback of hot shortness. The exemplifying alloys mentioned in document D5 exhibit copper contents of 1.97% and 1.88%, respectively, which come close or even may be considered to comply with the lower limit of 2.0% Cu as claimed.

Moreover, the skilled reader finds detailed information in document D5 about the effect upon the alloy displayed by low nickel contents. Reducing nickel below 3% has to be compensated for by increasing the amounts of manganese and/or copper to prevent the formation of martensite and excessive delta-ferrite (cf. D5, Figure 2; column 6, lines 4 to 8). Concurrently, Mn and Cu amounts are to be balanced in order to safeguard against hot shortness as is depicted in Figure 1 of document D5. This overall information has been followed in the present application by limiting nickel according to claim 9 to a preferred range of 3 to 4% Ni that, according to claim 1, can be further reduced to 2.8% minimum. In doing so, it is obvious to the metallurgical expert that the manganese and copper contents have to be shifted to the upper region of the allowed Mn- and Cu range, ie to about 8% Mn and to 2 to 2.5 Cu, to assure sufficient stability and a good combination of the mechanical and corrosion properties compatible with cost. It is true that the formulae for calculating the δ-ferrite and martensite forming potential in document D5 differ from those set out in claim 1 of the application. Notwithstanding that it is rendered obvious by the technical teaching of document D5 that controlled amounts in both phases, though undesirable, could be tolerated. Moreover, the composition of examples HN86B, HN86A and 55743 which come close the claimed ranges satisfy the proviso set out in claim 1 of the application, and they exhibit a tensile strength between 80 to 100 ksi, a yield strength between 35 and 50 ksi and an elongation between 40 to 60% as claimed in dependent claims 3 to 6 (cf. D5, Table II, examples HN86B, HN86A, 55743).

In view of these considerations, the implementation as claimed amounts, in the light of the detailed technical information given in document D5, to no more than an obvious choice so that no inventive step can be considered to be involved in the subject matter of claim 1 of the main request.

5. *First and second auxiliary request*

In claim 1 of the first and second auxiliary request, the nickel content of the alloy has been restricted to a range between 2.5 to 3%. According to the application as filed, nickel is to be added in amounts ranging (a) from 2.50 to 5.0% (claim 1), or (b) preferably from 2.8 to 4.0% (claim 3) or (c) most preferably from 3 to 4% (claim 13). It is, however, not disclosed in the application as filed that a composition restricted to 2.5 to 3% Ni according to claim 1 of both requests is a particular preferred embodiment of the claimed composition which provides an improved match in the corrosion and mechanical behaviour or any other property. The subject matter of claim 1 of the first and second auxiliary request, therefore, does not satisfy the requirements of Article 123(2) EPC.

6. *Third auxiliary request*

Claim 1 of the third auxiliary request contains the preferred embodiment of the austenitic stainless steel alloy disclosed in the penultimate paragraph on page 25 of the application as filed. With respect to inventive step, the same considerations arising forward with respect to claim 1 of the main request apply to this preferred essentially punctual composition. In replacement for nickel which is reduced to "about 3%" (which corresponds to the lower limit for nickel specified in D5), manganese has been increased to be in the range of 7.5 to 8%, ie towards the higher end of manganese range disclosed in D5. According to document D5, column 5, lines 31 to 49, a balance between manganese and copper must be maintained in order to prevent hot shortness, described by the expression: $\%Cu_{max} \le 3.85 - 0.18(\%Mn)$. Consequently, for the claimed range of 7.5 to 8.0% Mn the copper content should not exceed 2.41 to 2.5% which meets the claimed limitation of copper being "about 2.5%". It has further been noted that the claimed nitrogen content of about 0.11% N is above the maximum limit of 0.05 % N specified in document D5. However, having regard to the basic knowledge of the metallurgist that nitrogen additions markedly affect the stability of austenitic stainless steels and that the resulting austenite forming tendency can be used to replace some nickel, increasing the nitrogen content to about 0.11% N does not amount to a distinguishing technical feature upon which an inventive step of the subject matter of claim 1 can be based.

7. In view of the foregoing, the subject matter of independent claim 1 according to all the requests cannot be considered as involving an inventive step within the meaning of Article 56 EPC.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

V. Commare W. D. Weiß