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**STAINLESS STEEL WITH A HIGH BORON
 CONTENT**

Jean-Jacques de Cadenet, Ugine, and André Gueussier
 and Roland Tricot, Albertville, France, assignors to
 Pechiney Ugine Kuhlmann, Paris, France
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3 Claims

ABSTRACT OF THE DISCLOSURE

A stainless steel comprising from 20 to 30% by weight chromium, up to 5% nickel and from 2 to 6% boron which can be worked.

RELATED APPLICATIONS

This is a continuation-in-part of application Ser. No. 780,551, filed Dec. 2, 1968, having the same title, which claimed priority to French patent application No. PV. 130,934, filed Dec. 5, 1967.

Stainless steels with a high boron content are used in the nuclear industry as protection against radiation. Such steels are effective because boron presents a large absorption cross section, particularly for capturing neutrons. Moreover, in many instances it is desirable to use stainless steel as chemically corrosive environments will not cause rapid destruction of the metal. In the past, steels used in applications where they were subjected to both chemical corrosion and radiation comprised about 18% chromium and 10% nickel, or comprised about the same proportions of chromium and nickel to which a proportion of boron ranging from 2% to 4 or even 5% by weight was added.

Such steels have drawbacks. They are very difficult to forge due to the great amount of borides that they contain. In practice they are not forgeable when their boron content exceeds 2%. (This application relates to forgeable steels containing more than 2% boron.) Furthermore, these steels have reduced corrosion resistance. This is because the borides which are dispersed in the metallic matrix become very rich in chromium. Thus, the chromium in the metallic matrix is reduced. The content of

chromium in the matrix may even drop below 10%, which seriously impairs the corrosion resistance of the steels.

According to this invention, there are provided stainless steels with a high boron content which steels do not have reduced corrosion resistance and which can be forged.

The steels of the invention have the following general analysis:

Carbon (C) -----	Up to 0.2%.
Chromium (Cr) -----	From about 20 to about 30%.
Nickel (Ni) -----	Up to 5%, preferably only up to 1%.
Manganese (Mn) -----	Up to 3%.
Silicon (Si) -----	Up to 2%.
Boron (B) -----	From about 2 to about 6%.
Iron (Fe) and impurities --	The remainder.

Steels according to this invention are characterized by borides dispersed in a metallic matrix. Preferably, the matrix comprises more than 11% by weight, chromium. The invention pertains to steels fabricated in any manner, for example, cast or worked (rolled, forged or drawn).

In contrast to the conventional high boron stainless steels derived from the 18Cr-10Ni type steels, the steels of the instant invention have the following advantages. As shown by tests made by the applicants, they are very readily forgeable. Pieces of steel made in accordance with this invention and containing 3.4% boron have been forged, whereas this operation has been impossible for steels having the same boron content but derived from the 18Cr-10Ni type stainless steels. Like the steels having a high boron content and derived from the conventional 18Cr-10Ni type steels, the steels of this invention are formed of borides dispersed in a metallic matrix, but here the allotment of chromium between these two constituents is such that the metallic matrix remains relatively unoxidizable. And finally, the steels of the invention are less costly than the steels previously used for the same purposes.

By way of comparison, Table I gives the overall analysis, composition of dispersed borides and composition of metallic matrices for six known steels (Examples 1 to 6). Table II gives the same data for three steels made according to the teachings of this invention (Examples 7 to 9).

TABLE I

Example.....	1	2	3	4	5	6
Overall analysis:						
C.....	0.02	0.02	0.03	0.04	0.03	0.03
Si.....	0.38	0.96	0.55	1.1	1.1	1.1
Mn.....	0.26	2.3	8.2	0.24	0.35	0.29
Ni.....	9.6	9.9	10.0	8.9	15.6	15.8
Cr.....	19.2	19.5	19.4	19.7	21.3	24.2
B.....	2.5	2.7	2.8	4.2	3.9	3.7
Composition of the borides:						
Si.....	Traces	Traces	Traces	Traces	Traces	Traces
Mn.....	0.2	1.8	6.5	0.1	0.1	0.1
Ni.....	1.0	1.0	0.9	1.45	2.1	1.6
Cr.....	45	47	45.5	37.6	41.9	53.0
Composition of the metallic matrix:						
Si.....	1.50	1.0	0.7	1.55	1.50	1.50
Mn.....	0.33	2.5	8.8	0.25	0.40	0.35
Ni.....	14.0	14.5	14.5	16.6	23.8	28.0
Cr.....	9.1	10.0	9.5	5.3	5.7	7.0

TABLE II

Example	7	8	9
Overall analysis:			
C	0.02	0.03	0.03
Si	0.60	0.72	1.1
Mn	0.62	0.63	0.29
Ni	0.16	0.11	0.20
Cr	24.4	24.7	24.6
B	2.5	3.4	3.7
Composition of the borides:			
Si	Traces	Traces	Traces
Mn	0.45	0.40	0.20
Ni	Traces	Traces	Traces
Cr	54.0	30.5	47.0
Composition of the metallic matrix:			
Si	0.75	1.0	1.55
Mn	0.65	0.65	0.35
Ni	0.18	0.21	0.30
Cr	16.7	13.8	11.6

In Tables I and II only the alloying elements are given. The remainder of the overall analysis and composition of the metallic matrices are, of course, iron and impurities. The remainder of the boride compositions is boron.

Table I establishes that the chromium content of the metallic matrix of Examples 1 to 6 reaches a maximum of about 10%. On the other hand, Table II establishes that the chromium content of the matrices of Examples 7 to 9 according to this invention are always higher than 11%. Hence, these steels remain relatively chemically resistant or unoxidizable.

Having thus described our invention with the detail and particularly as required by the patent laws, what is desired protected by Letters Patent is set forth in the following claims.

We claim:

1. Forgeable, corrosion-resistant steels consisting essentially of up to 0.2% by weight carbon, from about 20 to 30% chromium, up to 5% nickel, up to 3% manganese, up to 2% silicon, from 2.0 to 6% boron, the remainder comprising iron and impurities, said boron being present as borides dispersed in a metallic matrix analyzing greater than about 11% by weight chromium.

2. Steels according to claim 1 comprising up to 1% nickel.

3. Nuclear radiation shields comprising forgeable, corrosion-resistant steels consisting essentially of up to 0.2% by weight carbon, from about 20 to 30% chromium, up to 5% nickel, up to 3% manganese, up to 2% silicon, from 2.0 to 6% boron, the remainder comprising iron and impurities, said boron being present as borides dispersed in a metallic matrix analyzing greater than about 11% by weight chromium.

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