

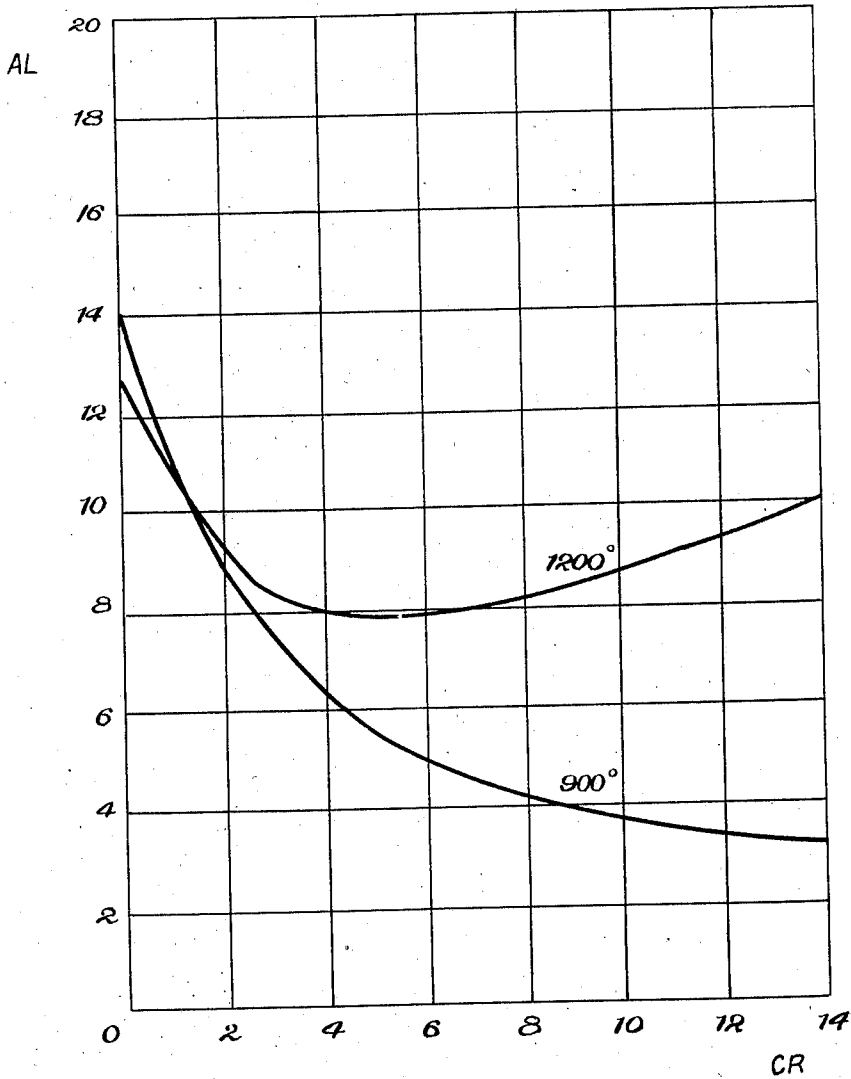
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CHROMIUM ALUMINIUM STEEL ADAPTED TO BE USED
FOR ARTICLES EXPOSED TO HIGH TEMPERATURES
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UPPER LIMIT OF THE SCALE-PROOF
RANGE AT 900° AND 1200°



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CHROMIUM-ALUMINIUM STEEL ADAPTED
TO BE USED FOR ARTICLES EXPOSED TO
HIGH TEMPERATURESErich Scheil, Dortmund, Germany, assignor to
the firm Vereinigte Stahlwerke Aktiengesell-
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5 Claims. (Cl. 75—124)

This invention relates to chromium-aluminum steels adapted to be used for articles exposed to high temperatures.

The present invention relates to chromium-aluminum steels of special composition, and especially to their employment for articles that are to be exposed to high temperatures and must therefore be free from tendency to scale.

In the ordinary sense, the term "scale proof" is applied to steels the surface of which does not, as is the case with acid-resisting steels, remain perfectly bright, but nevertheless forms only a very small amount of scale, this latter, moreover, soon diminishing, as the exposure is prolonged, owing to the formation of a special superficial film, so that the attacking action practically comes to a standstill after a short time.

This requirement in respect of non-scaling properties is only partly fulfilled by the scale formed, on pure ferro-chromium alloys containing up to about 30% of chromium and consisting substantially of Fe_2O_3 , even when the substitution of chromium for iron increases. In such case, even slight additions of aluminum do not produce any alteration at first, since the form of the black, velvety, lustrous Fe_2O_3 is retained even when part of the iron is replaced by chromium or aluminum.

If, however, the additions of aluminum be increased, the black scale is accompanied by a whitish scale consisting chiefly of alumina, and which does not form any mixed crystals with Fe_2O_3 . Experiments have shown that this whitish scale protects the steel, to a very considerable extent, from further attack. The efficacy of the white scale becomes particularly manifest when a range of concentration is maintained in which black scale is formed concurrently with the white scale, the parts covered with the black scale being somewhat extensively attacked, so that these steels cannot be ranked as particularly scale-proof. Reliable protection is not attained until sufficient aluminum is added for a pure white scale to be formed. As may be gathered from the accompanying diagram, a very considerable improvement in scale-proof properties is obtained when a certain proportion (about 8%) of aluminum is exceeded, even with relatively low proportions of chromium.

According to the results of experiment, a certain relation exists between the minimum amount of aluminum that must be employed to produce an effective scale-proofing, and the chromium content which must be employed in conjunction

with the said aluminum content. Whereas with an aluminum content of 5%, chromium to the extent of 6% is needed, this content becomes 4% when the aluminum is increased to 6.5%, falling to 3% with an aluminum content of 8%, to 2% with an aluminum content of 9%, and to 1% of chromium with an aluminum content of 11%.

Accordingly the present invention comprises objects which are exposed to high temperatures up to about 1100° C. consisting substantially of a steel alloy containing chromium in amounts between about 1% and 6%, aluminum in amounts between about 11% and 5% the sum of chromium and aluminum amounting to between about 10% and 12%, the balance of the alloy consisting predominantly of iron, said alloy showing under the action of gases containing oxygen a coating of a white oxide, the so-called white scale. It is to be understood that small quantities of other substances such as will not injuriously affect the nature of the alloys are comprised in the claims by the term "the balance consisting predominantly of iron".

In order that the steel may be forgeable, the carbon content must be kept below 0.1%. Alloys with this carbon content can be worked without any great difficulty.

It is important that the occurrence of an excessive amount of slag should be avoided in the production of the alloys. If the slag content is relatively high, black scale, in the vicinity of which the steel is attacked in a manner resembling the formation of cracks, forms in certain places. It has been ascertained that this phenomenon does not occur when the steel is melted in high-frequency induction furnaces, so that the method of production is an important factor in the preparation of scale-proof alloys.

Up to about one half of the aluminum content may be replaced by silicon, beryllium, titanium or vanadium, and up to about 50% of the chromium content may be replaced by tungsten, nickel, molybdenum, manganese or cobalt. Although these modifications cause a variation in the limits of the scale-proof range, the substantial point, even when the said metals are employed, is to remain within the white-scale range.

I claim:

1. Objects which are exposed to high temperatures consisting substantially of a steel alloy containing about 4% chromium and 6.5 up to 11% aluminum and the balance substantially all iron.

2. Objects which are exposed to high temperatures consisting substantially of a steel alloy con-

taining up to about 0.1% carbon and about 4% chromium and 6.5% up to 11% aluminium and the balance substantially all iron.

3. Objects which are exposed to temperatures up to about 900° C. consisting substantially of a steel alloy containing chromium in amounts between about 1% and 6%, aluminium in amounts between about 11% and 5% the sum of chromium and aluminium amounting to between about 10 to 12%, the balance of the alloy being substantially all iron, said alloy showing under the action of gases containing oxygen a coating of a white oxide, the so-called white scale.

4. Objects which are exposed to temperatures up to about 900° C. consisting substantially of a

steel alloy having a carbon content below about 0.1% and containing chromium in amounts between about 1% and 6%, aluminium in amounts between about 11% and 5%, the sum of chromium and aluminium amounting to between 10% and 12%, the balance of the alloy being substantially all iron, said alloy showing under the action of gases containing oxygen a coating of a white oxide, the so-called white scale.

5. An alloy of iron, chromium and aluminum in which the aluminum content is from 9 to 11 percent, and the chromium content is from 2 to 4 percent, and the balance being substantially all iron.

ERICH SCHEIL. 15