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TREATING INHERENTLY AGING CHROMIUM-NICKEL STAINLESS STEEL

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1 Claim. (Cl. 148—12)

This invention is concerned with treating inherently aging chromium-nickel stainless steel for the purpose of enhancing its aging characteristic when its composition is such that the steel has a structure incompletely amenable to aging.

As disclosed in a copending application Serial No. 414,194, filed jointly by this inventor and another, aging characteristics are inherently possessed by a carbon-containing chromium-nickel stainless steel of the type containing at least one of the stronger-than-chromium carbide formers such as titanium, columbium, zirconium, etc., when its components that are ferrite formers, other than the named carbide formers, are proportioned to those that are austenite formers to provide the steel with a structure that transforms at relatively low temperatures to stress-laden ferrite. That is to say, when such a steel is cooled from an elevated temperature, where it is predominantly austenitic, to a lower temperature producing the stress-laden ferrite, the steel may be aged, without its being previously cold worked, to a higher hardness and strength. The aging occurs naturally or may be artificially induced by the use of elevated temperature sufficient to shorten the time required but insufficient to return the steel to a predominantly austenitic condition.

If the composition of the steel is such that the ferrite formers overbalance the austenite formers to a degree producing a structure that is approximately all stress-laden ferrite, then the steel has a maximum aging characteristic. If the ferrite formers overbalance the austenite formers so far that the steel practically entirely transforms to ferrite at too high a temperature to result in ferrite that is stress laden, the steel is not inherently aging. Therefore, it is natural, in commercially producing the steel, to tend to produce a steel having a structure that transforms to ferrite relatively close to room temperature, the result being that, at times, steel is produced having a structure that incompletely transforms the stress-laden ferrite required for aging, the untransformed structure being austenite which is not inherently aging. In such instances it is impossible to develop the same high hardness and strength that would have been possible had the steel been produced with a structure that was practically all stress-laden ferrite.

The present invention is concerned with enhancing the aging characteristic of the described steel under the above discussed circumstances, namely, when its ferrite formers are proportioned to those that are austenite formers to provide the steel with a structure that only partly transforms, at relatively low temperatures, to stress-laden ferrite, so it retains an appreciable amount of austenite.

This invention comprises treating the steel by cold straining it to a sufficient degree to convert all or a substantial amount of the described, retained austenite to stress-laden ferrite, the enhancement of the aging characteristic depending on the amount of cold strain placed in the steel since this, in turn, determines the amount of retained austenite transformed to stress-laden ferrite so as to be converted from a nonaging material to a material that is inherently aging. Heretofore, it has not been known that cold working would perform the function described, it being known only that austenitic, chromium-nickel stainless steel of the stabilized type, containing titanium, columbium, etc., could be rendered aging by cold working after the steel was first given a stabilizing thermal treatment, such as normally used to fix the carbides to prevent intergranular corrosion by preventing intergranular carbide precipitation. However, the practice described herein works with the defined steel regardless of whether the steel is first thermally stabilized.

As a specific example of the invention, steel was produced, in sheet form, containing .08% carbon, 18.52% chromium, 7.1% nickel, and .84% titanium, which retained 65% austenite upon cooling from a temperature where it was austenitic to a temperature normally resulting in the production of practically all stress-laden ferrite in the case of a steel having the somewhat higher proportion of ferrite formers, respecting the austenite formers, required to produce a steel having the maximum aging characteristic. Aging this steel at 950° F. for one-half hour, followed by air cooling, increased the hardness of the steel from Rockwell B84 to B91. When the same steel was cold strained by a 17% cold reduction in its thickness, the same aging treatment increased its hardness from Rockwell C28.5 to C33.5; while 50% cold reduction resulted in the aging increasing it from Rockwell C38 to Rockwell C46.5.

As the amount of austenite retained at room temperature increases towards 100%, it becomes increasingly difficult to make the steel aging in the manner described, a fully austenitic steel remaining practically nonaging regardless of the amount of cold strain induced in its structure, unless it is first given a stabilizing thermal treat-

ment such as is usually used in the interest of intergranular corrosion prevention.

As explained in the previously mentioned co-pending application, an inherently aging steel results by following the following percentage composition range:

Carbon	.03 to .15
Chromium	12.0 to 20.0
Nickel	2.0 to 10.0
Manganese	.25 to 10.0
Aluminum	0.0 to 1.0
Titanium	.40 to 2.0
or	
Columbium	.50 to 3.0

Balance, iron.

These percentage composition ranges may be narrowed to obtain a critically more vigorous response to aging as follows:

Carbon	.05 to .08
Chromium	15 to 18
Nickel	4 to 7
Titanium	.2 plus 5 to 12 times the carbon content
Aluminum	.03 to 1.0
Manganese about	.50 for 7% Ni
Or	1.00–2.5 for 5% Ni
Or	3.00–6.0 for 3% Ni

Balance, iron.

It is to be understood that the present invention is not concerned with those instances where the ferrite formers are proportioned sufficiently high respecting the austenite formers to produce a steel that is, practically speaking, 100% stress-laden ferrite. The invention is applicable to those instances where the compositional balance is such that substantial amounts of austenite are retained at room temperature, the invention providing a means for converting practically all, or any portion, of this retained austenite to stress-laden ferrite, depending on the amount of cold strain used, so as to, thereby, enhance the inherent aging characteristic of the steel, as required. It is to be further understood that in all instances the stronger-than-chromium carbide former is held to sufficiently low values to produce a steel having adequate ductility to adapt it for structural use, it being the chromium and, generally, aluminum, particularly, that are to be considered as the ferrite formers whose proportion is increased respecting the austenite formers, although the proportioning must be carried out in conjunction with the ferrite forming effect of the stronger-than-chromium carbide former.

I claim:

A method of enhancing the inherent aging characteristic of carbon-containing chromium-nickel stainless steel of the type containing at least one of the stronger-than-chromium carbide formers such as titanium, columbium, zirconium, etc., with its components, other than said carbide former, that are ferrite formers proportioned to those that are austenite formers to provide said steel with a structure that partly transforms at relatively low temperatures to stress-laden ferrite while retaining an appreciable amount of austenite, said method comprising cooling said steel to produce said ferrite, and cold straining the steel to an extent transforming an appreciable amount of said austenite to said ferrite.

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