

UNITED STATES PATENT OFFICE

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CHROMIUM STEEL

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5 Claims. (Cl. 75—128)

This invention relates to ferritic chromium
steels that possess great toughness and excellent
resistance to corrosion and oxidation at elevated
temperatures.

When nitrogen is introduced into the ferritic
high-chromium steels a marked reduction in
grain size and an increase in strength are ob-
tained without loss of ductility. Nitrogen in-
creases the toughness of these steels without
seriously impairing their resistance to corrosion
or oxidation at elevated temperatures. In order
to obtain these results it is necessary that the
nitrogen be distributed substantially uniformly
throughout the steel, a condition that can read-
ily be obtained by adding the element, in the
form of a chromium nitride or other suitable
nitrides, to the molten steel. The marked effect
of nitrogen in improving the characteristics of
the high chromium steels is most pronounced in
steels that contain between about 15% and 35%
of chromium, and the nitrogen content should be
at least 0.10% and preferably at least 0.15%.

The present invention comprises improving the
toughness of the above-described high-nitrogen
chromium steels by introducing relatively small
amounts of copper or nickel or mixtures thereof.
The effectiveness of additions of these metals is
indicated in the following table of data obtained
on fully annealed steels:

Tensile tests

Analysis					Yield point pounds/ sq. in.	Max. strees pounds/ sq. in.	Per- cent el. in 2 in.	Per- cent red. of area	Izod impact, foot- pounds
Per- cent Cr	Per- cent C	Per- cent N ₂	Per- cent Cu	Per- cent Ni					
22.30	0.10	0.25	None	None	54,000	85,000	32	66	18
22.73	.09	.26	0.53	None	53,000	88,500	26	56	30
22.56	.09	.26	2.18	None	57,000	89,000	27	56	37
22.27	.12	.26	None	1.20	67,000	124,000	23	47	36
25.66	.12	.30	None	None	54,000	85,500	30	60	14
25.09	.10	.29	None	1.56	62,000	94,000	25	50	37

It is shown by this table of data that when
small amounts of copper or nickel are introduced
into ferritic chromium steels containing nitrogen,
there is obtained an appreciable improvement in
toughness as measured by the Izod impact test,
in fact, far more toughness than one would ex-
pect to obtain by the addition of such relatively
small percentages of either element. Further-
more, the other valuable physical characteristics
of the nitrogen-bearing steels, such as resistance
to heat and corrosion, are retained. The im-

provement in physical characteristics is most
marked in wrought steels of relatively low carbon
content; but a useful improvement is obtained
by applying the invention to castings produced
from higher carbon chromium steels.

The high-nitrogen chromium steels possess a
considerable resistance to grain growth at ele-
vated temperatures and additions of nickel or
copper, together or separately, impart some addi-
tional resistance to the grain growth that takes
place on heating at elevated temperatures.

The nitrogen-bearing steels of the invention
may be welded readily by either oxyacetylene or
electric processes, and welds of improved proper-
ties are obtainable.

Steels according to the invention contain about
12% to 35% chromium, at least 0.10% and not
over about 0.65% nitrogen, a carbon content no
greater than 1%, and a content of nickel or cop-
per, or both, between about 0.25% and about 3%.
If copper alone is used, it preferably does not
exceed about 2.5% of the steel. If the steel is to
be wrought, the carbon content is preferably be-
low about 0.3%. The nitrogen should be dis-
tributed substantially uniformly throughout the
steel and preferably exceeds 0.15%. The cus-
tomary fractional percentages of silicon and
manganese required to produce steel of good
quality are, of course, preferably added.

I claim:

1. Alloy steel having in the fully annealed state
an impact strength at least 30 foot pounds Izod,
and containing about 22% to 35% chromium,
carbon in amounts not exceeding 1%, at least
0.1% and not over 0.65% nitrogen distributed
substantially uniformly throughout the steel, and
at least 0.25% but not over 3% metal selected
from the group consisting of nickel, copper, and
mixtures of nickel and copper; the remainder
being substantially all iron.

2. Alloy steel having in the fully annealed state an impact strength at least 30 foot pounds Izod, and containing about 22% to 35% chromium, carbon in amounts not exceeding 1%, at least 0.1% and not over 0.65% nitrogen distributed substantially uniformly throughout the steel, and at least 0.25% but not over 3% nickel, the remainder being substantially all iron.

3. Alloy steel having in the fully annealed state an impact strength at least 30 foot pounds Izod, and containing about 22% to 35% chromium, carbon in amounts not exceeding 1%, at least 0.1% and not over 0.65% nitrogen distributed substantially uniformly throughout the steel, and at least 0.25% but not over 2.5% copper, the remainder being substantially all iron.

4. A wrought article of alloy steel having in the fully annealed state an impact strength of

at least 30 foot pounds Izod, and containing about 22% to 35% chromium, carbon in amounts up to about 0.3%, at least 0.15% and not over 0.65% nitrogen distributed substantially uniformly throughout the steel, and at least 0.25% but not over 3% nickel; the remainder being substantially all iron.

5. A wrought article of alloy steel having in the fully annealed state an impact strength of at least 30 foot pounds Izod, and containing about 22% to 35% chromium, carbon in amounts up to about 0.3%, at least 0.15% and not over 0.65% nitrogen distributed substantially uniformly throughout the steel, and at least 0.25% but not over 2.5% copper; the remainder being substantially all iron.

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