

UNITED STATES PATENT OFFICE

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ALUMINO-THERMIC STEEL

No Drawing.

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The invention relates to an improved thermit steel involving high ultimate strength without the usual decrease in ductility, the improved qualities of the steel being due to the presence therein of manganese, carbon and aluminum within prescribed limits.

Alumino-thermic welding has been practiced for almost thirty years and the process has developed gradually from a very crude beginning, as the result of continued research, until the inherent defects in the welds, such as blow-holes, cleavage planes, and shrinkage cavities, which tended to produce inherent weaknesses in the thermit welds, have been eliminated and more attention has been given to improvement of the physical qualities of alumino-thermic steel.

Steel made by the reduction of metallic oxides by means of aluminum has in general very different properties from ordinary steels. In the first place, ordinary steels are the result of a refinement of metal reduced from impure iron ore and its refinement is carried on, not to completion, but to a point where commercially good results are obtained and, as a consequence, when these commercial steels are employed in casting operations, there are numerous impurities therein, which, as the metal cools, are thrown out to the grain boundary and introduce an element of weakness there. Alumino-thermic steels, on the other hand, are made by the reduction of exceptionally pure metallic oxides by means of pure aluminum, with the result that these steels are purer than even ultra refined steels made by the usual method. Cast steels made by the alumino-thermic process have, therefore, no such weaknesses at the grain boundaries and exhibit all of the physical properties of forged steels of the prior art, except that of appearance under a microscope.

The original thermit steel was, as a consequence of the method, a low carbon material produced by the reduction of pure iron oxide by means of aluminum, and this material was in effect a soft iron with carbon below .10% and practically no other impurity. It was soon found that this was too soft a material

for practical welding purposes, in that it lacked the requisite tensile strength, although it possessed a high degree of ductility. Succeeding developments introduced a percentage of mild steel punchings and gradual increasing quantities of manganese and carbon, until there was produced a material known in the trade as "railroad thermit", which is a steel containing approximately 10% to .15% carbon and .40% manganese. Further increases were made occasionally in the carbon content where greater strength or hardness was required, but any increase in the manganese content above .40% apparently greatly impaired the physical properties of the steel and rendered it unsuitable for welding purposes. It was known, of course, that manganese produced this undesirable effect in the ordinary steels, but usually this was not important until the steel contained more than 1% of manganese, but, in thermit steels, there is left invariably a fractional percentage of aluminum in the steel, which apparently materially changed the physical effects of manganese on the steel as compared to similar effects of like quantities of manganese employed in ordinary steels.

In developing the present invention, I made careful tests with increasing quantities of manganese, both with and without increasing percentages of carbon in the alumino-thermic steel, but always with a relatively small percentage of aluminum, varying from .01% to 1%, and discovered that with increasing quantities of manganese, the measurements of tensile strength and elongation showed that these thermit steels passed through a critical stage in which the manganese content varied from .40% to .50% and, in some cases, as high as .60%, and that immediately after this critical range, that is to say, with higher percentages of manganese, for example .65% to .70%, the physical properties were greatly improved, the ultimate strength increasing to as high a figure, for example, as 75,000 lbs. per square inch, without a corresponding decrease in ductility, which had always been experienced where the ultimate

strength had been increased by carbon additions alone. Ultimately there was developed a steel possessing the desired qualities of high ultimate strength and ductility of high ultimate strength and ductility
 5 aforesaid that was particularly well adapted for use in thermit welding and that produced better results than any hitherto known steel, the critical limits being between .55% and .80% manganese, between .20% and .40% carbon, and between .01% and 1% aluminum.

A typical alumino-thermic mixture that, upon reaction, will produce the new steel containing approximately Mn .67% and C .30% is as follows, the proportions indicated being by weight:

	Per cent
Pulverized aluminum-----	20.8
Roasted mill scale-----	64.7
20 Manganese ore (MnO ₂) -----	1.0
Mild steel punchings-----	12.8
Pulverized hard coal-----	.7

What I claim is:

1. Alumino-thermic steel containing from .55% to .80% manganese, from .20% to .40% carbon, and from .01% to 1% aluminum.

2. Alumino-thermic steel containing approximately .65% manganese, approximately .25% carbon and not less than .01% or more than 1% aluminum.

In testimony whereof I affix my signature.

JOHN H. DEPPELER.

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