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PROCESS FOR IMPROVING ALUMINO-
GENETIC IRON

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This invention relates to a process for improving aluminogenetic iron.

In the known aluminothermic welding process, no particular value was formerly attached to the mechanico-technical properties of the iron formed in the process, inasmuch as the so-called butt-welding was preferably employed in which the rails to be welded were set close together at the ends, coated over with the fused product of the aluminothermic reaction (iron and slag) and then immediately pressed together, so that only the high temperature of the reaction was utilized for raising the rails to the requisite temperature and weld them together. The introduction of other welding processes, especially the so-called inter-casting, necessitated greater attention to the properties of the aluminogenetic iron, since, in some of these processes, the said iron fills up the space between the rails to be welded, and thus becomes a rail constituent. The requirements to be filled by the aluminothermally produced iron increased in the same proportion as the consolidation of the rail material itself. In order to obtain a satisfactory weld by inter-casting, the iron must be of such a character as to approximate, as closely as possible, in mechanical properties, to the rail material itself, when welded.

It is known that iron can be extensively consolidated by adding carbon, but the amount of added carbon is restricted within certain limits, because carbon increases the fragility of the aluminogenetic iron, with unfavorable results, especially in respect of impact stresses on the welded joint. Attempts have also been made to improve aluminogenetic iron by the addition of manganese, and also of small amounts of silicon, but without obtaining the substantial improvement desired.

Experiments have now shown that the aluminogenetic iron can be greatly strengthened by the addition of certain other high melting metals, especially nickel, cobalt, chromium, molybdenum, titanium, tungsten and vanadium.

It has also been found that nickel and cobalt are best employed in association with chromium for addition to the iron formed in the aluminothermic reaction, whereas vanadium, molybdenum and tungsten are preferably used in association with titanium. Titanium has only a slight consolidating effect on aluminothermally produced iron, being mainly consumed as an excellent deoxidizer and remover of nitrogen. This effect, however, constitutes a favourable condition precedent for the consolidation of the iron

by the metals molybdenum, tungsten and vanadium, which can now be introduced in larger quantities into the iron refined by the titanium, whereas, otherwise they themselves would be largely consumed in deoxidizing the iron. The alloys formed in situ from the iron set free in the reaction and the alloying metals added have a composition quite different from that of the ordinary carbon steel rails usually required to be welded, but the physical properties of the welding alloy are similar to those of the steel of the rails. The result is a union of greatly improved strength and an evenly wearing rail joint.

No definite data can be given with regard to the amounts in which these metals can be added, because the optimum amount depends substantially on the carbon content of the aluminogenetic iron, and also on the aluminium always present, in small quantity, therein. The quality of the rails to be welded is also a decisive factor. The most suitable composition of the iron, in respect of the said additions, for the rail material concerned, must be ascertained by preliminary experiment in each case. So far as nickel, cobalt and chromium are concerned, it may be stated generally that the aggregate amount of these metals should not exceed about 3-4 per cent, the content of nickel and cobalt being about 1 to 4 times that of the added chromium. For rail materials of present day quality, the aggregate addition of molybdenum, tungsten and vanadium is about 1 to 2 per cent. They may be added jointly or separately to the iron. The amount of added titanium may be up to 3 per cent, only a fraction of this usually passing into the iron as an alloying component, whilst the remainder acts as deoxidizer and denitrifying agent and thus, as already mentioned, establishes the optimum preliminary condition for the action of the metals molybdenum, tungsten and vanadium.

The aforesaid additional metals can be incorporated with the iron in various ways, for example by adding the pure metals to the aluminothermic mixture (ferric oxide and aluminium powder). As a matter of convenience, however, the pure metals are replaced by suitable pre-alloys, preferably in a crushed condition, and especially ferro-alloys, such as ferro-tungsten, ferro-vanadium or the like, or multiple alloys such as ferro-tungstovanadium, ferro-chromium-nickel or the like. Moreover, these alloys may also contain other components such as manganese, carbon and silicon. In order to utilize the high temperature of the aluminothermic re-

action, these ferro-alloys may have a high content of iron, because, owing to its high temperature, the aluminothermally produced iron is capable of dissolving considerable amounts of such alloys. If the high iron content of the added ferro-alloys causes difficulties in the crushing of same, they can suitably be added in granular form. The alloys may be added to the reacting mass during the reaction or if stress be laid on a maximum content of the additional components in aluminogenetic iron, it will be advisable to add the metals, or pre-alloys, to the resulting iron as soon as the aluminothermic reaction has terminated, because, otherwise, a considerable portion will have a deoxidizing action and thus retard their introduction into the iron. This is particularly the case with the metals having a strong affinity for oxygen, such as titanium, molybdenum, tungsten and vanadium. The metals in question, however, may be mixed, in the form of their oxides, (e. g. titanium dioxide, nickel oxide or vanadium pentoxide), with the corresponding amount of aluminium powder, and added to the aluminothermal mixture prior to the reaction. This manner of introduction is especially applicable if titanium is to be introduced. In this manner, a very thorough deoxidation and denitrification of the aluminogenetic iron is obtained, since the the nascent metallic titanium is able to act immediately on the oxide and nitride impurities in the iron.

It is often advisable to place the mixture of the additional metals, their pre-alloys or oxides, and aluminium, in the mould surrounding the material to be welded, and then pour the aluminogenetic iron into the mould. This measure not only refines the iron thoroughly, but also effects the introduction of a considerable amount of the additional components into the iron.

Vanadium, molybdenum and tungsten improve more particularly the resistance of the iron to impact and abrasion, whilst at the same time the bending strength of the iron alloyed in this manner is considerably increased in consequence of the very remarkable reduction in the grain texture of the material. The metals nickel, cobalt and chromium increase the chemical resistance of the resulting ferro-alloys and have a particularly favourable influence on its tenacity.

What I claim is:

1. In the improvement of properties of the aluminogenetic iron joints produced in the aluminothermic process of welding rails and other steel parts, the process of improving the tenacity and chemical resistance of such a welded joint which comprises incorporating with the aluminogenetic iron, chromium and at least one high melting point metal selected from a group consisting of nickel and cobalt, the total of these added components not exceeding 4 per cent by weight of the iron, the content of the nickel and cobalt being from 1 to 4 times that of the chromium; and of simultaneously improving the tensile strength, resistance to impact, tenacity and density of said welded joint by also incorporating with the aluminogenetic iron, titanium in an amount up to 3 per cent by weight of the iron present and in addition at least one high melting point metal selected from a group consisting of tungsten, molybdenum and vanadium, the total of these components not exceeding 2 per cent by weight of the iron present.

2. In the improvement of properties of the aluminogenetic iron joints produced in the aluminothermic process of welding rails and other steel parts, the process of improving the tenacity and chemical resistance of the welded joint which comprises incorporating with the aluminogenetic iron, chromium and at least one high melting point metal selected from a group consisting of nickel and cobalt, the total amount of these added components not exceeding 4 per cent by weight of the iron, the content of nickel and cobalt being from one to four times that of the chromium.

3. In the improvement of properties of the aluminogenetic iron joints produced in the aluminothermic process of welding rails and other steel parts, the process of improving the tensile strength, resistance to impact, tenacity and density of the welded joint which comprises incorporating with the aluminogenetic iron at least one high melting point metal selected from a group consisting of tungsten, molybdenum and vanadium, the total amount of these components not exceeding 2 per cent by weight of the iron present, and also incorporating in said aluminogenetic iron titanium in an amount up to 3 per cent by weight of the iron present.

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