

UNITED STATES PATENT OFFICE.

RALPH P. DE VRIES, OF MENANDS, AND HENRY A. DE FRIES, OF ALBANY, NEW YORK,
 ASSIGNORS TO LUDLUM STEEL COMPANY, OF WATERVLIET, NEW YORK, A COR-
 PORATION OF NEW JERSEY.

FERRO-ALUMINUM ALLOY AND METHOD OF MAKING IT.

No Drawing.

Application filed April 25, 1927. Serial No. 186,570.

Attempts have been made heretofore to make alloy steels containing substantial amounts of aluminum; but great difficulties are encountered, particularly when it is desired to have the aluminum present in a definite predetermined proportion. These difficulties arise from the fact that aluminum has a lower melting point than iron, is lighter than iron, and has great affinity for oxygen. When aluminum is added to a molten bath of steel, it will melt quickly, float on the surface, and rapidly oxidize. An uncertain part of the aluminum will, therefore, pass off as slag, and in addition another portion of the aluminum oxide may be held in the steel in a finely divided state. This latter condition is very objectionable and renders the steel unfit for commercial use. The impossibility of making the alloy to any definite specification in this way is obvious. The action of the aluminum just described has resulted in its use as a deoxidizer or preventive against oxidation of molten steel, and its use has been restricted to this purpose.

By our method, described below, it becomes possible to obtain alloys of aluminum and steel with the aluminum present in any desired proportion within very narrow limits; and the purpose of our invention may be stated as the provision of a method of producing such alloys:

Our invention is based on the fact discovered by us that the difficulties pointed out above are almost entirely absent if the aluminum is added to the steel bath in the form of a ferro-aluminum alloy of the composition as nearly as possible of 40% iron and 60% aluminum. The difficulty remains, however, of making such an alloy of the composition mentioned; and a part of our invention is the new method next described of preparing this 40-60 alloy.

To prepare this alloy of 40% steel and 60% aluminum we proceed as follows:

We first melt a steel scrap or pig-iron of suitable composition. An electric furnace is convenient for this purpose. The molten bath is then deoxidized by adding a small amount of aluminum, only a sufficient amount of this metal being added to form a very thin film of molten aluminum on the surface of the bath. Next sufficient molten or preheated aluminum is added to bring the percentage

up to the desired 60%. This procedure of introducing the aluminum in two stages as described makes it feasible to introduce the desired amount of aluminum without the difficulties which are otherwise experienced, as described above. It is important that neither too much nor too little of the aluminum be used in the deoxidizing step. If the amount is either too large or too small a scum or dross will form consisting principally of aluminum oxide which will make impossible the addition of the desired amount of aluminum or its forming the desired alloy. The formation of the dross or aluminum oxide on the top of the bath once started, its formation continues progressively as the further aluminum is added. The production of a ferro-aluminum of a definite chemical composition would under such conditions become impossible.

A typical alloy produced by our method within the range desired is as follows:

	Per cent.
Carbon.....	.055
Silicon.....	0.58
Iron.....	45.23
Aluminum.....	54.00

The proportions of 40% iron and 60% aluminum are based on the theoretical formula Al_3Fe , and it will be noted that the composition whose analysis is given approximates this closely.

Our method of preparing this alloy eliminates the loss of some undeterminable portion of the aluminum through oxidation, which would make it impossible to make the alloy of any definite aluminum content; and also eliminates the danger of the inclusion or occlusion in the finished product of any aluminum oxide which would render the steel unfit for uses we want to put it to.

This alloy of substantially 40% steel and 60% aluminum content is intended principally for use in connection with the preparation next to be described of alloys containing any smaller desired proportion of aluminum, although we do not wish to be understood as limiting ourselves in this respect.

We have found that the addition to a molten bath of steel of alloy of the composition indicated by the formula Al_3Fe , that is, of substantially 40% iron and 60% aluminum content, results in a melting of this alloy and

a uniform mixing of the aluminum content through the melt, without its floating to the surface and there oxidizing. The alloy, we have noticed, takes longer to melt, and this slower melting may have something to do with the good results obtained. We have found that adding aluminum to the steel in a combination of iron and aluminum in almost any proportion probably gives better results than adding the aluminum by itself; but the best results are obtained with the proportion of aluminum and iron described above. The results are markedly inferior when a departure from the proper proportion of about 7% plus or minus or more of either constituent is made. With an alloy containing iron in percentages of 10 to 20 and the balance substantially aluminum, the advantage, if there is any, has become so slight as not to be noticeable.

We claim:

1. In the preparation of a ferro-aluminum alloy the steps of melting iron, adding a small amount of aluminum thereby deoxidizing the iron, and then adding sufficient aluminum to

bring the aluminum content up to 60% of the mixture.

2. In the preparation of a ferro-aluminum alloy the steps of melting iron, adding just sufficient aluminum to form a thin film on the surface, and then adding sufficient heated aluminum to bring the aluminum content up to 60% of the mixture.

3. In the preparation of a ferro-aluminum alloy the steps of melting iron, adding just sufficient aluminum to form a thin film on the surface, and then adding sufficient melted aluminum to bring the aluminum content up to 60% of the mixture.

4. In the preparation of a ferro-aluminum alloy, the steps of melting some iron, adding a small amount of aluminum, thereby deoxidizing the iron, adding a sufficient amount of aluminum to bring the aluminum content up to 60% of the mixture, and adding such an amount of the alloy so formed to a batch of molten iron as will give the desired aluminum content to the resultant alloy.

RALPH P. DE VRIES.
HENRY A. DE FRIES.