

# UNITED STATES PATENT OFFICE.

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## PROCESS OF REDUCTION OF ORES CONTAINING SULFUR AND IRON.

973,732.

Specification of Letters Patent.

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No Drawing.

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*To all whom it may concern:*

Be it known that I, ARNOLD WIENS, a subject of the King of Prussia, residing at 19 Lindenstrasse, Bitterfeld, Germany, have invented a certain new and useful Process of Reduction of Ores Containing Sulfur and Iron, of which the following is a specification.

The direct reduction of iron ores containing sulfur has hitherto not been possible as the products obtained were unusable because of the presence of sulfur. Even the conversion of ores containing sulfur into compounds of iron, such for example as ferro-silicon, has hitherto not been carried into effect.

When using sulfur ores for the production of ferro-silicon a product containing a large amount of sulfur is obtained even in electric furnaces, when the content of silicon is relatively low. It was therefore not to be assumed that this relationship would vary, if the content of silicon was increased. Numerous researches have however given the surprising result, that after the content of silicon has increased above a certain amount, the content of sulfur is decreased to a minimum, so that according to this process a product is obtained whose low content of sulfur meets the requirements of marketable goods in every manner. Naturally the process can only be carried into effect in electric furnaces.

It is sufficient, for the purpose of reducing the sulfur to a minimum, to add to the raw material so much silicic acid, that the resulting ferro-silicon contains 20% Si. If less quantities are used then the content of sulfur increases in the same proportion as the content of silicon, in the ferro-silicon formed, decreases. For example when obtaining a ferro-silicon—

With 6.4% silicon	3.1% sulfur is present.
“ 8.5% “	2.8% “ “ “
“ 12.0% “	2.4% “ “ “
“ 22.0% “	0.12% “ “ “
“ 31.4% “	no sulfur is present.

When carrying the process into effect care must be taken that a sufficient quantity of silicon is always formed to drive out or displace the sulfur in the ferro-sulfuret, or iron containing sulfur. It is immaterial whether the silicic acid is present in the ore used or whether this is added artificially. The sul-

fur displaced in the iron then escapes and if the process is carried out in a closed furnace it can together with the carbon dioxide, formed by the reaction be distilled over into receivers and there condensed or used for other purposes.

If the ores contain other metals besides iron such for example as zinc, which is very often the case in common iron pyrites, it is essential that the material should be first roasted; substances are then added thereto, with which the remaining sulfur that is set free combines without being additionally driven off either by carbon or by silicic acid. By these means the zinc is recovered in receivers in the metallic form or as oxide but without sulfur. Lime is generally used as such a sulfur-absorbing substance. It is immaterial whether it is previously contained in the ore or whether it is added afterward. Other non volatile metals can then be removed besides the ferro-silicon.

From the foregoing it will be seen that by means of this process ores, the reduction of which was hitherto impossible can now be converted into ferro-silicon and the like. The waste pyrites containing zinc and sulfur which remained from the manufacture of sulfuric acid was practically unusable and often involved a great loss.

According to this process an entirely marketable ferro-silicon is produced and zinc is obtained from the waste.

Zinc ores that are only reduced with difficulty can be added to the iron ores as in principle, it is immaterial whether oxidized or sulfurized ore predominates. Further it is of the greatest importance in the usefulness of the process that since the electric furnace is entirely closed a very pure carbonic acid gas is obtained under the circumstances.

What I claim as my invention and desire to secure by Letters Patent is—

1. The method of reducing ores containing iron and sulfur, which consists in smelting the ore to ferro-silicon in the presence of silica and carbon and at a high temperature by the aid of an electric current, the silica present being in such quantity as to substantially eliminate the sulfur from the ferro-silicon produced; substantially as described.

2. The method of reducing ores containing iron and sulfur, which consists in first

roasting the ore to partially desulfurize it, then smelting the roasted ore to ferro-silicon in the presence of silica and carbon and at a high temperature with the aid of an electric current, the silica being present in such quantity as to substantially eliminate the sulfur from the ferro-silicon produced; substantially as described.

3. The method of reducing ores containing iron and sulfur, and which likewise contain other volatile and non-volatile metals, which consists in smelting the ore to ferro-silicon in the presence of silica and carbon and at a high temperature with the aid of an electric current, the silica being present

in such quantity as to substantially eliminate the sulfur from the ferro-silicon produced, retaining the sulfur in the slag by a suitable sulfur absorbing element of said slag, recovering the volatile metals by distillation and condensation and recovering the non-volatile metals with the ferro-silicon; substantially as described.

In testimony whereof I have hereunto signed my name to this specification in the presence of two subscribing witnesses.

ARNOLD WIENS.

Witnesses:

JULIUS RUMLAND,

OSKAR SINGER.