

# UNITED STATES PATENT OFFICE.

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## PROCESS OF SMELTING IRON OXIDS.

No. 924,677.

Specification of Letters Patent.

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*To all whom it may concern:*

Be it known that I, HORACE W. LASH, a citizen of the United States, residing at Cleveland, in the county of Cuyahoga and State of Ohio, have invented a certain new and useful Improvement in Processes of Smelting Iron Oxids, of which the following is a full, clear, and exact description.

My invention relates to the reduction of iron oxids either into finished steel or into a partially refined condition suitable for the making of castings or finished iron or steel by further treatment.

In carrying out my invention I prepare a smelting mixture comprising finely ground or comminuted oxid of iron, such as iron sand or scale, and finely divided cast or pig iron and a carbonaceous material as coke. For the preparation of this mixture the several ingredients may be separately ground or, if preferred receive their final comminution during the mixing process by being ground together during the mixing.

The iron oxid which I employ in the smelting mixture may be obtained from any of the suitable sources; such as the sand ores of the St. Lawrence or New Zealand. The essential thing is that the iron oxid shall be in a finely divided condition in the mixture. The finely divided cast or pig iron of the smelting mixture may be obtained from any suitable source, such for example as iron turnings or borings, but it is necessary that this portion of the mixture shall be distinctly of that quality of iron commonly designated as cast or pig iron, as distinguished from the ordinary run of scrap, wrought iron or steel, since it is important that it contain a high percentage of metalloids or easily oxidizable metals, such as manganese, capable of uniting with the oxygen of the iron oxid.

The carbonaceous material above mentioned as forming part of the mixture, is preferably in the form of ordinary coke, and is finely ground, as are the other portions of the charge mixture.

In addition to the above mentioned ingredients, I find it advantageous in many cases to add to the smelting mixture a small proportion of readily combustible material, such as crushed bituminous coal or sawdust. This addition is for the purpose of rendering the mass porous, an end which is easily accomplished owing to the combustion of the sawdust taking place at an early stage of the process, thus leaving unfilled interstices

throughout the mass. The carbon of the sawdust coats the particles of the iron oxid, and probably for this reason assists in the reduction. I may also add flux of the ordinary kind, such as lime and fluorspar varied to suit the different grades of ore. It is, however, customary to add fluxes to smelting mixtures, and I do not claim any novelty for this feature. If it is found desirable to handle the mixture in the form of briquets, a suitable binder, such as coal tar pitch, may be employed. This mixture may be varied as to the proportions of its constituent elements. The following, however, I find to be an effective mixture when used in the smelting process below described:—

Ore .....	54%	
Cast iron borings .....	27%	
Crushed coke .....	8%	75
Coal tar pitch .....	4%	
Sawdust .....	4%	
Crushed limestone .....	3%	

The exact percentages above named need not be followed. In fact different operators will always be found to use different proportions, for reasons of their own, on account of individual notions as to the manner in which the heat should be handled. The general characteristics of the mixture, however, will be found to be set forth in my U. S. patent thereon No. 862,978, August 13, 1907. In the smelting of this mixture by the process forming the subject of this application for patent, I place a certain quantity of pig iron upon the hearth of a metallurgical furnace of the type commonly designated as the open hearth, which receives its heat from above. This pig iron may be in the form of cold pigs or any other solid form extending over the sole of the furnace and preferably up near the edges of the bowl shaped hearth. The pig metal, however, may be molten in condition instead of solid, but the solid metal is preferable in most cases by reason of it being more easily handled and distributed. The smelting mixture which I have above described is then charged into the furnace on top of the layer of pig iron and the charge raised to smelting heat. If, for any reason, the smelter desires to make use of scrap metal, he may charge this into the furnace in addition to the aforesaid smelting mixture, as its use is not inconsistent with my procedure and it ordinarily accumulates around most steel plants. As heat is now applied to the charge, the smelt-



ing mixture will ultimately be observed to "sweat", apparently, on the surface and the charge will, about the same time, settle somewhat, so, that in the event the full furnace charge has not been added at the beginning of the operation the remaining portion may be subsequently thrown in. As the mass rises in temperature, and before the smelting temperature of the mixture is reached, the pig metal in the lower portions of the furnace will, if solid, fuse and become liquid, and for the purpose of facilitating and quickening this liquefaction the cold pig metal used to form the lower portion of the charge may be spread, as above stated, up around the edges of the furnace hearth close to the surface so that the heat of the flame may be transmitted to it quickly. Also, solid pig may be distributed in pockets in the mass of the smelting mixture where the charge is very thick, the pigs thus distributed fusing and trickling down through the mass and thus facilitating the early reduction of the smelting mixture. As soon as the pig metal in the bottom of the charge becomes molten, the smelting mixture resting thereon is rapidly dissolved by the molten bath, the necessary reactions taking place much more readily than if the smelting mixture were subjected to heat without contact with such a metallic bath.

While the smelting mixture may be smelted alone under certain conditions, to an advantage, and the reduction will take place as set forth in my prior patent above mentioned, the present procedure involving the use of solid or molten pig iron in the lower part of the charge is of the greatest advantage in practical operation.

While the continued application of heat to the mixture would, as stated, eventually result in the reduction of the oxids, nevertheless, the obtaining of a bath of the pig metal capable of dissolving the adjacent particles of the smelting mixture and itself assisting through its carbon and other metalloids, in the reduction, quickens the process to a great extent. This procedure is effective, further, by reason of the fact that while the reduction of the oxid in the smelting mixture is taking place in the lower portion of the charge, the molten bath containing its high percentage of carbon is protected against the oxidizing atmosphere above the charge by the overlying smelting mixture itself, which as the

process proceeds, floats somewhat like an island in the bath, receiving the heating flame directly. The oxidizing atmosphere over the charge, will take out considerable of the carbon from the surface of the charge mixture, which surface will, under the combined influence of the heat and the oxygen, become reduced to the condition of almost pure iron, but the carbon losses in this way are small. It will thus be seen that not only is the process of smelting a rapid one, but the carbon of the bath, which is formed during the smelting process, is effectually protected so that when the reducing process is completed the bath will be still fusible, by reason of being protected against any material loss of its carbon due to the oxidizing flame. The bath finally obtained may be refined in the furnace or tapped, according to the desire of the smelter.

I found in practice that an economical proportion of materials to be used in forming the charge may be produced by employing enough of the smelting mixture to comprise about eighty per cent. of the total charge, the remaining twenty per cent. being made up of pig metal which is charged into the lower portion of the furnace. Of course, if scrap be added to the charge, the proportion will vary somewhat.

Having thus described my invention, I claim:

1. A process of smelting iron oxids which involves charging into a furnace a smelting mixture containing finely divided oxid of iron, finely divided cast iron and carbonaceous material, and also disposing in said furnace a quantity of pig metal in proper manner to form a bath beneath the smelting mixture and applying a smelting heat to the charge.

2. A process of smelting iron oxids which involves charging into a furnace a smelting mixture containing finely divided oxid of iron, finely divided cast iron and carbonaceous material, and distributing in the mass of the smelting mixture chunks or masses of pig metal and applying a smelting heat to the charge.

In testimony whereof, I hereunto affix my signature in the presence of two witnesses.

HORACE W. LASH.

Witnesses:

H. R. SULLIVAN,  
E. B. GILCHRIST.