To all whom it may concern:

Be it known that I, DAVID I. MILLER, a citizen of the United States, residing at Birmingham, in the county of Jefferson and State of Alabama, have invented certain new and useful Improvements in the Manufacture of Ferrophosphorus; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to the manufacture of ferrophosphorus from natural com- pounds containing iron and phosphorus, and by a blast-furnace process.

So far as I am aware there are at present but two known and successfully practised methods of commercially producing ferrophosphorus, one of which, and the most expensive, requiring the use of an electrical furnace, the other and most practicable, as well as the least expensive, being by the use of the blast furnace. In both methods there are limitations as to the character of the materials that can be utilized for the manufacture of ferrophosphorus, and especially is this the case in the blast furnace process which, as heretofore practised, has deman- ed the use in the furnace charge either of a previously produced phosphorus-bearing material, such as phosphoric slag, or the selection of such iron ore and phosphatic rock as would jointly contain the proper content of phosphorus and silicious matter, or, in the absence of a proper content of silicious matter in the mixture of iron ore and phosphatic material, the addition of such further quantity of silica to the charge of iron ore and phosphatic material as will produce a slag of the proper composition for successful smelting.

The present blast furnace methods of pro- ducing ferrophosphorus demand the use of a large quantity of phosphorus-bearing materials of a grade well adapted to and available for the manufacture of fertilizers, to the exclusion of a large quantity of phosphorus-bearing material which is not available for the manufacture of commercial fer- tilizers, and which the blast-furnace process for the manufacture of ferrophosphorus as now practised, can not utilize.

Among the natural phosphorus-bearing materials at present useless in the manufacture of fertilizers and not available for the manufacture of ferrophosphorus by the present blast-furnace processes, may be enumerated as illustrative certain large sedimentary deposits of trisubphosphatic ironstone, which are so overlaid or agglomerated with highly silicious material as to be unprofitable to work for commercial fertilizer purposes; also large deposits of apatite occurring as intrusive veins in igneous rocks, these veins frequently varying in width from a few inches to many feet and the sur- rounding rock being acid in character, so that the large veins only can be profitably worked by present processes; also large de- posits of the phosphate of alumina and iron of which the essential components are phos- phorus, iron, alumina and silica, there being only a small amount, in some cases a mere trace of calcium or other basic material.

The object, therefore, of my present invention is the utilization, in a blast furnace process for the commercial production of ferrophosphorus of any desired phosphorus content, of phosphorus-bearing materials of the character above noted which are not now available for use by existing blast furnace processes, but which, for the reasons stated, it is desirable and economical to use.

To this end, generally stated, my inven- tion involves, in the manufacture commercially of ferrophosphorus by the blast furna- nce process, the addition to a charge of iron bearing material and phosphorus bearing material of a basic material in proper proportion to liberate the phosphorus required to combine with the iron, and sub- jecting the charge or mixture so constitu- ted to the smelting process in a blast furnace.

In carrying out my invention I take a given amount of a natural phosphate having the characteristics hereinafter noted, also given amounts of iron ore, and coke or other fuel to constitute the charge, and by analysis ascertain the relative proportions of phosphorus, iron, acids and bases con- tained therein, and to this charge or mixture is added sufficient basic material to produce the proper proportion of bases to acids in 105 the final mixture, which is then smelted by the usual blast furnace process.

For purposes of illustration I will assume that the ferrophosphorus to be produced is desired to contain fifteen (15) per cent. of phosphorus and to show on analysis a for- mula as follows: Fe 78.50%; P 15.00%; Mn...
0.16%; S 0.04%; C 3.30%; Si 3.00%. I will also assume that a phosphate rock is to be utilized which will on analysis be shown to contain: Fe 4.98%; P 18.20%; SiO₂ 18.09%; Al₂O₃ 24.00%; H₂O 16.49%; CaO-MgO 4.16%. I will also assume that the iron ore to be utilized on analysis will be shown to contain: Fe 39.15%; P 1.00%; Mn 0.10%; SiO₂ 80.00%; Al₂O₃ 3.42%; H₂O 5.71%; CaO-MgO 1.08%. And that the coke to be used in the charge will on analysis be shown to contain: SiO₂ 5.00%; Al₂O₃ 3.50%; H₂O 3.00%; CaO-MgO 3.50%; C 82.00%.

Experience has shown that the blast furnace charge should contain about 1.0 lbs. of coke for each pound of pig to be produced. Therefore, for the production of ferrophosphorus from the natural phosphate rock and iron ore referred to, for every 100 lbs. of pig to be produced containing fifteen per cent. of phosphorus, the charge should contain: iron ore 186.2 lbs.; phosphate rock 113.6 lbs.; limestone 134 lbs.; coke 190 lbs. If it were attempted to use such a charge for the manufacture commercially of ferrophosphorus by the present known and practised blast furnace processes, while a certain amount of the acids and bases would flux there would yet remain an excess of acid in the slag which would contain silica 57.65%; alumina 29.40%; lime and magnesia 9.80%, a character of slag that would render impossible the proper operation of the furnace.

To meet this condition I add to the mixture or charge a base, preferably limestone, though other suitable basic material may be used, in proper proportion to liberate the required percentage of phosphorus. Assume that limestone is to be used and that its contents as found by analysis are SiO₂ 0.66%; Al₂O₃ 0.90%; CaO-MgO 54.61%.

As the proper ratio of acids to bases in the slag is approximately as 1.4 to 1, the available bases in the limestone would equal about 53.54 lbs. in the hundred pounds, and, therefore, about 134 lbs. of the limestone base would be required for each 100 lbs. of the pig. The addition of this quantity of limestone would produce a final mixture, as follows: iron ore 186.2 lbs.; phosphate rock 113.6 lbs.; limestone 134 lbs.; coke 190 lbs. The approximate composition of the resultant ferrophosphorus pig produced by smelting this mixture will be Fe 78.50%; P 13%; Mn 0.16%; Si 3.00%; S 0.04%; C 3.20%. The approximate composition of the slag will be silica 37.90%; alumina 19.76%; lime and magnesia 41.29%.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

The process of producing ferrophosphorus, which consists in charging a blast furnace with a mixture of iron bearing material, a phosphorus-bearing material, and a basic material in proper proportion to liberate the percentage of phosphorus required to combine with the iron, and smelting said mixture.

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

DAVID I. MILLER.

Witnesses:
CHAS. F. HOGUE,
G. T. BRAZELTON.