(No Model.)

T. SOUTHAN.

Process of and Furnace for Reducing Oxides to the Metallic State.

No. 233,568. **Patented Oct. 19, 1880.**

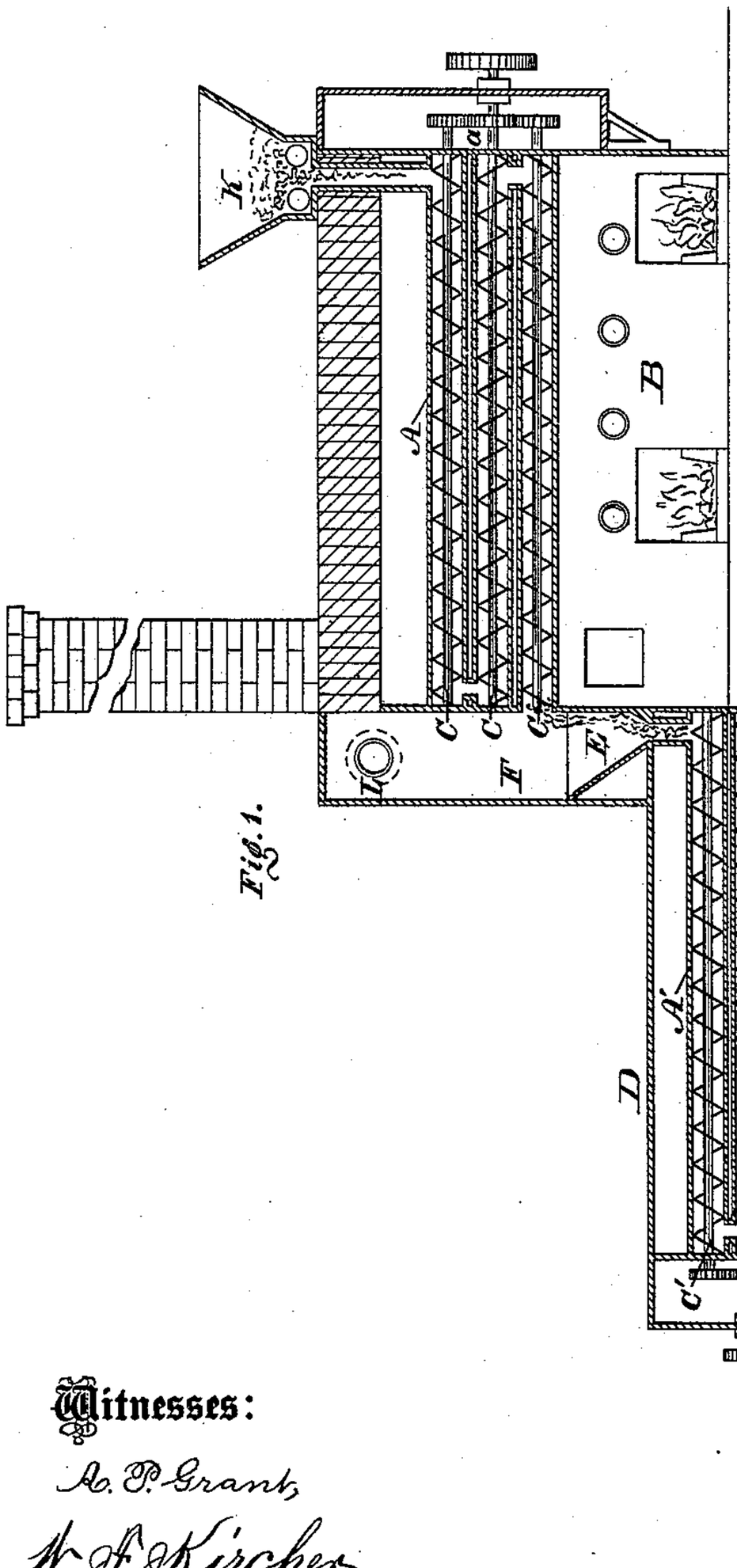

Fig. 1.

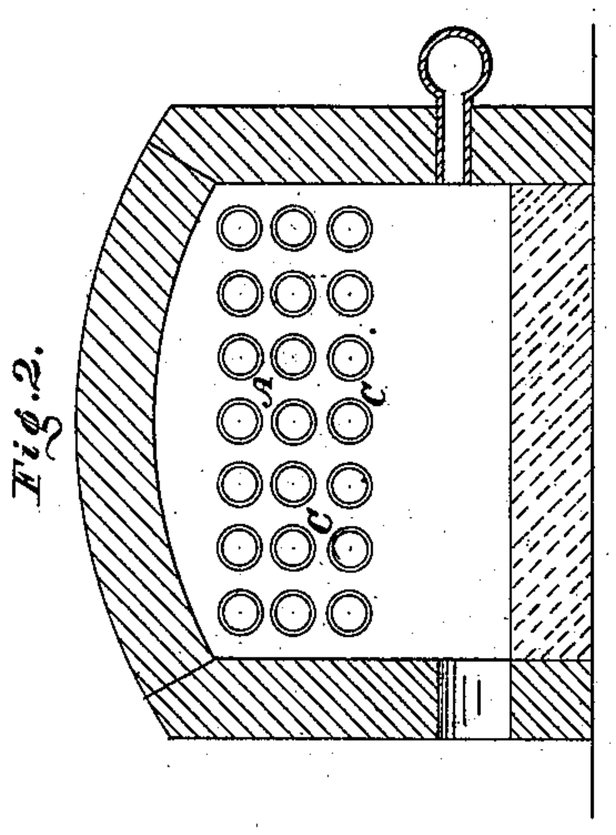

Fig. 2.

Witnesses:

A. P. Grant,

W. F. Kircher

Inventor:

Thomas Southan,

by John A. Wiedersheim

ATTORNEY.

UNITED STATES PATENT OFFICE.

THOMAS SOUTHAN, OF WELLINGTON, ENGLAND, ASSIGNOR TO HENRY A. BROGNARD, OF PHILADELPHIA, PENNSYLVANIA.

PROCESS OF AND FURNACE FOR REDUCING OXIDES TO THE METALLIC STATE.

SPECIFICATION forming part of Letters Patent No. 233,568, dated October 19, 1880.

Application filed April 14, 1880. (No model.)

To all whom it may concern:

Be it known that I, THOMAS SOUTHAN, a subject of the Queen of Great Britain, and a resident of Wellington, Shropshire, England, have invented a new and useful Process of and Furnace for Reducing Oxides to the Metallic State; and I do hereby declare that the following is a full, clear, and exact description of the invention, which will enable others skilled in the art to which it appertains to make and use the same.

It has long been known that oxygen may be dissociated from the iron with which it is combined by placing oxide of iron in contact with carbon in the presence of a suitable degree of heat and preventing the access of air to the mixture, as the oxygen under such conditions will combine with the carbon and leave the iron in a metallic state.

It has also long been well understood that iron in such metallic state while at a red heat will absorb the oxygen of the atmosphere with avidity, but does not readily combine with it at the ordinary temperature; but although contact at a red heat of oxide of iron and carbonaceous matter, cooling the metallic iron to the temperature of the atmosphere, and isolation from the oxygen of the air until the cooling is completed are conditions exceedingly simple in theory, attempts to reduce these conditions to practice have heretofore proved unsuccessful and impracticable on account of the imperfect reduction of the ore from the want of a suitable apparatus for conducting the heat to all parts of the mass under treatment, and the exposure of the metallic iron to reoxidation for want of a proper apparatus for excluding the atmosphere therefrom until the cooling thereof.

The object of my invention is the practical realization, in an inexpensive manner, of these theoretical conditions; and to that end it consists both in certain processes for treating the ore in the manufacture of metallic iron from the oxides of that metal and also in certain improvements in the furnace made use of for successfully and economically carrying out the said processes.

In order that my invention may be clearly understood I propose, first, to describe the construction and operation of the apparatus or furnace and afterward the process to which the furnace is adapted.

This furnace is illustrated in the accompanying drawings, in which Figure 1 is a longitudinal, and Fig. 2 a transverse, section.

A number of sets or series of retorts, A, are arranged within a chamber constructed of any suitable refractory material. In the example given each set is represented as composed of three retorts, arranged the one above the other; but the number is immaterial, and it is not absolutely necessary that they should be arranged in the same vertical plane, although this arrangement is deemed preferable. The number of sets of retorts employed will, of course, depend upon the capacity of the furnace, and any number of sets may be used without departing from the mode in which my invention operates.

The retorts are represented in the drawings as being heated by the products of combustion and flame of the fire-place B; but any other mode of heating now known and which is applicable may be used. They may be constructed of any suitable refractory material and of cylindrical, semi-cylindrical, or any other appropriate form. Each retort is provided with a conveyer, which, in the example given, is what is known as a "screw-conveyer," or, in other words, a shaft provided with spiral projections revolving within, and in proximity to the inner surface of the retort. The form of the conveyer is not material, however, as any other conveyer now in use which will cause the particles composing the mass within the retort to be thoroughly intermixed and travel from one end of the retort to the other may be substituted for the spiral flange illustrated in the drawings.

In the example given, the lowest retort of each set being nearest the fire is subjected to a higher degree of heat than the retorts above it. The mass conveyed through the retorts from the moment of its entrance into the first retort to the time of its exit from the last will be subjected to a gradually-increasing degree of heat; but these conditions may be changed by changing the relative arrangements of the retorts and the source of heat.

The mass to be treated may be introduced into the upper retort of each set by means of

a hopper, K, or any other known method for feeding ore or similar substances, and the feed or flow of the mass may be regulated or adjusted by a valve or other suitable device. The hopper may be so constructed that it may be made to supply each and all of the retorts at the same time.

The conveyers within the retorts may be rotated at a uniform degree of speed by proper gearing for that purpose; or, if the steps of the process require it, the actuating mechanism or gearing may be so arranged that the mass to be heated will be conveyed more rapidly through one of the retorts than the other or others.

A number of sets or series of cooling-cylinders, A′, similar in construction and operation to the heating-retorts hereinbefore described, are arranged within a water-tank, D, in such a manner that the uppermost cylinder of each set arranged in the tank communicates with the lowermost retort of each series in the heating-chamber. The alternate ends of the retorts or cylinders of each set communicate with each other, and the rotation of the conveyer is so regulated that the mass to be treated is delivered at one end of the retort or cylinder and conveyed to the opposite end thereof, from whence it is again delivered to the retort or cylinder below; or, in other words, each retort or cylinder communicates at one end with the retort or cylinder from which it receives the mass, and at its opposite end with the retort or cylinder into which it delivers the mass.

The lower cooling-cylinder of each set, arranged within the tank D, communicates, by means of the passage G, with the trough H. By allowing the water to rise in the trough H above the mouth of the passage G, a hydraulic seal is formed which excludes the outer air from the cooling-cylinders.

Access of the outer atmosphere to the chamber or hopper with which the heating-retorts or cooling-cylinders communicate may be prevented by any of the known devices made use of for such purposes, or any outlet which permits of the egress of the gases evolved but prevents the inflow of the outer air.

It is obvious that the apparatus above described may be applied to various uses other than those mentioned in this specification, none of which need be particularly described, as they will be apparent from the above description of its operation.

The apparatus is applied to my process of deoxidizing iron ores, iron oxides from the heating-furnaces and puddling-furnace, or the manufacture of metallic iron from the oxides of that metal in the following manner: The retorts A are maintained at a temperature by the flame and products of combustion from the furnace B, which will impart a cherry-red heat to the contents thereof. The ore or oxide of iron is pulverized to a granulated state, intermixed with about fifteen per cent. of fine charcoal, and charged into the hopper K. I prefer that the particles of ore thus granulated should be of the size of grains of coarse sand; but the process may be applied to larger particles, although in the latter case a longer treatment will be required. The amount of fine charcoal may be somewhat varied, according to the chemical composition of the ore to be treated or the amount of oxygen it contains, as the percentage of carbon used should be in proportion to the amount of oxygen contained. An excess of carbon will do no harm, as, owing to the low degree of heat at which the reduction is effected, the metalized ore will not be carbonized by cementation during the short time it is exposed to the carbon. Charcoal is used in preference to substances containing much hydrogen, but other carbonaceous matter may be employed. The charge of carbon and ore having thus been prepared, intermixed, and charged into the hopper K, care should be taken to keep the hopper full, or partially full, as the charge descends into the uppermost retort. The charge is caused, by the screw, spiral flange, or other suitable conveyer, to travel gradually and uniformly from one end of the retort to the other, the particles thereof being made to circulate continuously among themselves and occupy constantly-changing relations to each other, thus subjecting each and every part of the mass to an equal and uniform temperature, and obviating difficulties which have hitherto prevented the production of metallic iron from its oxides in closed retorts—as, for instance, the difficulty of deoxidizing the center of the mass, and the liability to carbonize the outer surface thereof, owing to the mass not being thoroughly and uniformly heated.

The chemical action which takes place in the retort under these conditions is well known. The charcoal employed is, at a high temperature, a well-known reducing-agent, or, in other words, a substance which readily extracts oxygen from ores or other substances with which it is brought in contact. The retort, therefore, having been heated to a proper degree for the chemical action required, the affinity of the carbon for the oxygen of the ore causes it to combine therewith, forming a compound which escapes as a gas, while the metallic iron remains in the retort. As the gas thus generated has a tension exceeding ordinary atmospheric pressure the outward flow of the same from the retorts will prevent the inflow of the air into the retorts or the chamber or chimney communicating with them.

Although this reduction of the ore may be effected according to my invention in a single retort, provided it is made of sufficient length, I prefer to use a set of retorts arranged, the one above the other, as shown in the drawings, in which the mass, after traveling to the end of the first retort, falls, by its own gravity, through a properly-constructed passage into the second retort, immediately below, through which it is conveyed in the same manner, but in an opposite direction, to a passage leading

to a third retort arranged below the second, and so on through any number of retorts which it may be deemed desirable to use.

As much of the reducing action which commonly is ascribed directly to carbon is really effected through the mediation of the protoxide, or "carbonic oxide," as it is sometimes called, and as this gas possesses, at a high temperature, the power of reducing the oxides of iron and other metals, it is evident that it may be substituted in the retorts, in whole or in part, under certain conditions for the fine charcoal hereinbefore mentioned. The reducing-gas thus used may be carbonic oxide, or may be a gas consisting of carbonic oxide and nitrogen principally, such as is produced by a Siemens producer, and it may be introduced into the retorts by means of tubes or other devices, which, either alone or in combination with the conveyer, will bring it into intimate contact with the heated ore.

If such a reducing agent as sawdust or like substance is employed in the retorts, a certain amount of reducing-gas would be evolved by the heating of the same.

If the reduced ore or metallic iron after having been passed through the retorts should be taken therefrom in a heated state, the exposure to reoxidation would be inevitable. It therefore becomes necessary to devise some method of reducing its temperature to that of the atmosphere without interfering with the continuous reduction of the ore in the retorts. I effect this object by means of a set of cooling-cylinders, A′, provided with conveyers similar in construction to the reducing-retorts hereinbefore described, but surrounded with a water-tank. The heated and reduced material drops from the lowermost retort into the hopper E, from whence it passes through the series of cooling-chambers A′ in the manner hereinbefore described with reference to the retorts A, to the passage G, and trough H. The water in the trough H forms, with the passage G, a hydraulic seal, which excludes the air from the cooling-cylinders.

It will be observed that my process and apparatus differ from those heretofore described in that the ore and carbonaceous matter is continuously intermixed, and the air is excluded from the retorts during the entire process.

Having thus described my invention, I claim, and desire to secure by Letters Patent—

1. The process of reducing oxides of iron to the metallic state, which consists in subjecting them, in contact with carbonaceous matter, to a red heat in a retort or retorts from which air is excluded, and in which the ore and carbonaceous matter are continuously intermixed, substantially as described.

2. The process of producing metallic iron from oxides of iron by causing the oxides in contact with carbonaceous matter to pass through a reducing retort or retorts at a red heat, from which the air is excluded, into a cooling chamber or chambers from which the air is also excluded, and then continuously intermixing the particles for uniformly cooling them, as described.

3. In the production of metallic iron from oxides thereof, the process of thoroughly and uniformly deoxodizing the pulverized ore mixed with carbonaceous matter, which consists in causing the mixture to be continuously intermixed and conveyed through a red-hot retort from which the air is excluded.

4. The combination of a set of communicating reducing-retorts having screw-conveyers arranged within a heated chamber with a set of cooling-cylinders having screw-conveyers arranged within a water-tank, as and for the purposes described.

5. The air-tight cooling-cylinders communicating with each other at their alternate ends and provided with screw-conveyers, as and for the purposes described.

6. The cooling-cylinders A′, placed within tank D, having a water-sealed passage, G, and the tank H, combined together, as and for the purposes described.

7. The combination of the air-tight reducing-retorts from which the air is excluded, communicating with each other at alternate ends, and having in each a rotating conveyer, with the air-tight cooling-retorts communicating with each other at alternate ends, and having in each a screw-conveyer, as and for the purposes described.

THOMAS SOUTHAN.

Witnesses:
JOHN A. WIEDERSHEIM,
A. P. GRANT.