

J. P. CHANNING & F. J. FALDING.

METHOD OF SMELTING PYRITIC ORES.

APPLICATION FILED MAY 4, 1909.

963,020.

Patented June 28, 1910.

Fig. 2.

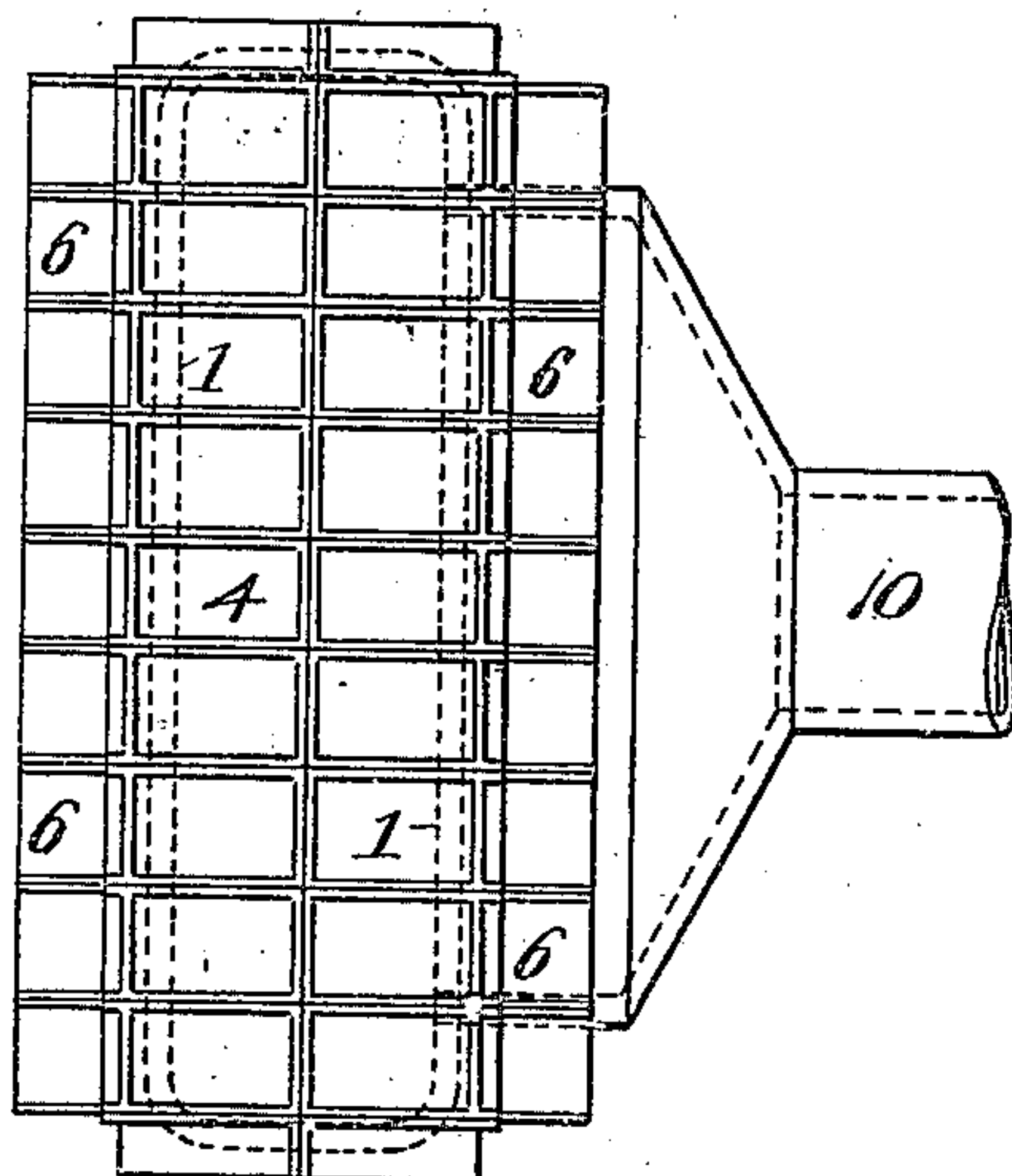
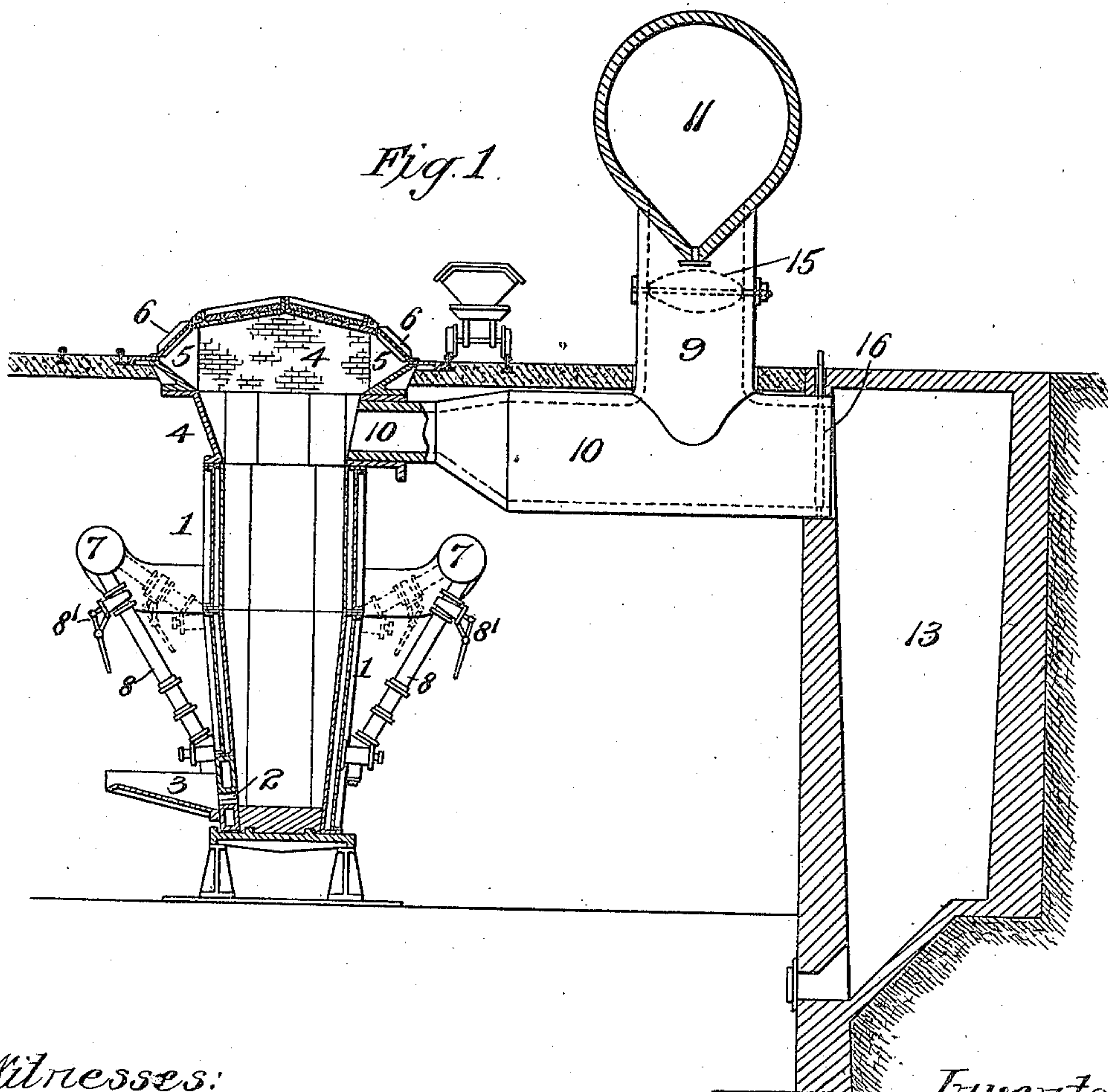


Fig. 1.



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# UNITED STATES PATENT OFFICE.

JOHN PARKE CHANNING AND FREDERIC JOHN FALDING, OF NEW YORK, N. Y.

## METHOD OF SMELTING PYRITIC ORES.

963,020.

Specification of Letters Patent. Patented June 28, 1910.

Application filed May 4, 1909. Serial No. 493,801.

*To all whom it may concern:*

Be it known that we, JOHN PARKE CHANNING and FREDERIC JOHN FALDING, both citizens of the United States, residing at New York city, county of New York, and State of New York, have invented certain new and useful Improvements in Methods of Smelting Pyritic Ores, fully described and represented in the following specification and the accompanying drawing, forming a part of the same.

This invention relates to an improved method of smelting pyritic ores and utilizing the gases therefrom, it being the object of the invention to produce a higher grade matte, or an iron slag available for the production of pig iron, and gases having such composition that they may be utilized, as for making sulfuric acid.

Some pyritic ores contain, in commercial quantities, copper or nickel or the precious metals, or several of these metals, while in other such ores they do not so exist.

In smelting sulfid copper ores pyritically, as carried out previous to our invention, the ore, not previously roasted, is treated in a blast furnace with a certain amount of carbonaceous material, the oxidation of the charge being accomplished by blowing certain quantities of air therethrough. This action results in an oxidation of a portion of the iron and sulfur content in the ore, which provides nearly all of the heat necessary for the process. The portion of the iron and sulfur which is not oxidized, theoretically combines with the copper and forms a substance known as matte, which is drawn off from the furnace and further treated to obtain the copper. The oxidized sulfur ( $\text{SO}_2$ ) passes from the furnace in the form of a gas, together with other gaseous substances. While this oxidation of the iron and sulfur in the charge, when they exist in sufficient quantities, theoretically should furnish heat enough to smelt the charge, in practice certain carbonaceous material has been added in the form of coke to furnish heat enough to smelt the charge, and this coke, during the smelting operation, is oxidized into carbon dioxide ( $\text{CO}_2$ ). This mode of smelting is known in the art as pyritic smelting. In this method of smelting, as practiced before our invention, considerable quantities of sulfur would leave the furnace with the gases unoxidized or sublimed, heat thus being lost, and, in addition, it frequently happened

that the iron was not sufficiently oxidized, thus producing an inferior grade matte. In addition, so much of the oxygen in the air blown into the furnace was taken up in oxidizing the excess of coke into carbon dioxide that there was not enough oxygen left in the gases to convert the sulfur dioxide into sulfur trioxide to obtain sulfuric acid therefrom, if it were desired to use the gases for this purpose. Such oxygen could not, under such conditions of excess of coke, be replaced by supplying more air to the gases, for the reason that in the air supplied so much nitrogen was present that the resulting gases were diluted to such an extent as to be unfit for such use, being too weak in sulfur dioxide.

If pyritic ores containing, in commercial quantities, nickel or the precious metals, or several of these metals, or pyritic ores in which neither they nor copper so exist, were smelted pyritically in the manner above described, there would be a similar loss of heat due to the escape of sulfur from the furnace, and an inferior grade matte would be produced with ores containing nickel or the precious metals; or, in the case of such ores in which copper or the other metals referred to do not exist in commercial quantities, the iron slag would be liable to contain sulfur in detrimental quantities. The resulting gases would also be diluted to such an extent as to render them unfit for use in obtaining sulfuric acid therefrom, if it were desired to use the gases for this purpose, for the reasons heretofore given.

Our invention consists in supplying air in sufficient quantity so that the sulfur and iron in ore containing copper or nickel or the precious metals is practically completely oxidized, except the sulfur and iron intended to combine with such metals in forming the final matte, and so that the sulfur and iron in ore in which copper, nickel or the precious metals do not exist in commercial quantities is practically completely oxidized, and so that the sulfur dioxide in the resulting gases may subsequently be converted from sulfur dioxide into sulfur trioxide, without diluting the gases so as to unfit them for making sulfuric acid. The sulfur and iron thus practically completely oxidized, we shall hereafter refer to as the available sulfur and iron.

In carrying out our invention, we employ a blast smelting furnace, the twyers of which



are sufficiently large to enable the proper amount of air to be forced therein, which amount is controlled by valves in the pipes leading to the twyers. Such furnace is constructed so as to prevent, as far as practicable, any air entering therein except through the twyers. If air leaks into the furnace at the top and around the charging doors in any considerable quantity, there is danger that the gases will be made so weak or diluted as to be unsuitable for conversion into sulfuric acid, and such "false" air should be excluded. If the ore does not contain enough available sulfur and iron to produce, by oxidation, the heat necessary for the smelting operation, or if the ore does contain enough available sulfur and iron for this purpose, carbonaceous material, such as coke, may be added. In either case, this should be in a certain proportion to the sulfur content in the charge to be smelted, the proportion of such carbonaceous material to be maintained as low as possible, and yet not interfere with the smelting operation, in order to obtain gases containing sufficient oxygen relatively to the sulfur dioxide. In practice we have found that as low as about  $\frac{1}{2}\%$  of carbon to about 4% of available sulfur in the charge is a proportion which produces gases having sufficient oxygen therein to convert or oxidize the sulfur dioxide into sulfur trioxide. To give a concrete example, in a sulfid copper ore containing 25% of sulfur, about 20% of which will be oxidized or available, the balance of which will combine with the iron and copper to form the matte, we find that as low as  $2\frac{1}{2}\%$  of coke is sufficient to allow for the proper operation of a smelting furnace, and at the same time to obtain gases sufficiently rich in oxygen. It is found in practice, furthermore, that the amount of free oxygen should, to obtain the best results, be considerably more than the amount theoretically required to convert the sulfur dioxide into sulfur trioxide. For example, assuming that the gases contain 6% of sulfur dioxide, such gases would, theoretically, require 3% of free oxygen to convert them into sulfur trioxide. Gases containing such percentages of sulfur dioxide should, however, to obtain the best results, carry from 7% to 8% of free oxygen, or an excess of 4% to 5% of free oxygen over that theoretically required. In addition to having sufficient oxygen in the gases to convert the sulfur dioxide into sulfur trioxide, the gases should preferably be as rich as approximately 5% in sulfur dioxide, but not richer than approximately 7%, as a much higher percentage of sulfur dioxide would preclude the possibility of there being sufficient free oxygen to oxidize the sulfur dioxide into sulfur trioxide. If the resulting gases, whether carbonaceous material is used or not, are too

rich in sulfur dioxide, they can be diluted by admitting more air through the twyers referred to than is necessary to practically completely oxidize the available sulfur and iron in the ore, or such additional air can be admitted through extra twyers, with which the furnace can be provided, located above those before referred to, and below the top of the charge, the amount of air so admitted being controlled by valves in the pipes leading to the twyers, or such air can be introduced into the top of the furnace, or at any point after the gases leave the furnace, between the furnace and the Glover towers (not illustrated), if the chamber process of making sulfuric acid is employed; or, if the gases are cooled too much for the concentrating function of the Glover towers (if such air were admitted before the gases enter the same) then such air may be admitted after such gases pass such Glover towers; or, if the contact process is employed, then such air may be admitted to such gases between the furnace and the apparatus of such contact process, the amount of air so admitted being controlled by suitable devices, as valves. If the ore is deficient in silica, an ordinary quartz flux is added for the smelting operation.

If a plurality of furnaces is employed, and the gases therefrom have varying contents of sulfur dioxide and oxygen, the content of each furnace being different from that of the others, they can be treated as set forth in a co-pending application filed by us May 14, 1908, serially numbered 432,781.

In the drawings we have illustrated a blast smelting furnace, in which—

Figure 1 shows such furnace partly in vertical section, the apparatus for introducing and regulating the quantity of air forced into the furnace being shown in elevation; and Fig. 2 shows a plan view of the top of the furnace, the apparatus for introducing and controlling the quantity of air forced into the furnace not being shown.

Referring to these drawings, the sides and end of the furnace are shown as made up of water jacketed sections 1, with a suitable base, and near the latter is an opening 2, through which the slag or the matte and slag pass into a spout 3 from which it is delivered into the proper receptacle. Above these water jacketed sections is a furnace top 4, also made in sections, having openings 5 through which the charge to be smelted is dumped, said openings being closed by hinged charging doors 6, which should be approximately air tight. A bustle pipe 7 is connected by pipes 8, having air controlling valves 8', leading to the twyers, near the bottom of the furnace, there being preferably two of these pipes 8 and air controlling valves 8' and twyers, for each of the lower water jacketed sections of the furnace, the



valves 8' enabling the regulating of the quantity of air forced into the furnace burden through the twyers for the smelting operation. We have indicated in dotted lines another similar set of pipes connected with the bustle pipe 7, such pipes leading to twyers located above those first referred to, and below the top of the charge, for introducing air for diluting the resulting gases if they are too rich in sulfur dioxid, said pipes having valves for regulating the quantity of air introduced through such twyers.

Leading from the furnace top 4 is a flue 10 for conveying the gases from the furnace. This flue 10 is connected with a chamber 13 from which the gases, entering therein from such flue, are, if it is desired to use them for making sulfuric acid, conducted to an apparatus for making such acid. The flue 10 has a pipe 9 connecting with a flue or by-pass 11. The pipe 9 is provided with a damper 15, and the flue 10 is also provided with a damper 16 beyond the pipe 9, so that such flue may be connected with the chamber 13 and disconnected from the by-pass 11, or disconnected from the chamber 13 and connected to the by-pass 11, as and when desired.

If a plurality of furnaces is employed, as before referred to, each of these furnaces will be provided with a flue 10 connected with the chamber 13 and having a damper 16, and with a pipe 9 provided with a damper 15 connecting with the by-pass 11, so that the gases from the different furnaces can be controlled and commingled, and treated in apparatus as set forth in said co-pending application.

In treating ores according to our invention containing copper or nickel or the precious metals in commercial quantities, it may sometimes be preferable at first to leave more sulfur and iron in the matte than is desirable to combine with such metals in forming the final matte, when there is a likelihood of such metals being oxidized and being lost in the slag. In such case, after such lower grade matte is produced, it is again treated in the same furnace or in another furnace and air supplied thereto in sufficient quantity so that the sulfur and iron remaining therein are practically completely oxidized, except the sulfur and iron intended to combine with the copper and nickel or the pre-

cious metals in forming the final, higher grade matte. In such second treatment, the proportion of the carbonaceous material, (if employed), to the sulfur is maintained as low as possible and the air may be supplied as heretofore described, so that the sulfur dioxid in the resulting gases may be converted from sulfur dioxid into sulfur trioxid without diluting the gases so as to unfit them for making sulfuric acid, or the proportion of such carbonaceous material to the sulfur and the resulting gases may be ignored for the purpose of making sulfuric acid. This treatment in several steps is to be regarded as the equivalent of the treatment in one step for the purposes as stated.

The result produced by our invention is that a higher grade matte in case copper or nickel or any of the precious metals exist in commercial quantities in the ore treated may be produced, or in case they do not so exist in the ore treated, then the resultant iron slag will be available for the production of pig iron in an ordinary blast furnace; a saving in carbonaceous fuel, such as coke, if it be used; sublimed sulfur will either not substantially pass off with the gases, or a less amount will pass off than prior to our invention, and the gases may be profitably used in the production of sulfuric acid whether ores so low in sulfur, that treated by the ordinary methods, such ores will not produce such gases profitably are treated, or whether ores rich in sulfur are treated.

What we claim is:—

In the art of smelting pyritic ores pyritically, and utilizing the gases therefrom, the improvement which consists in supplying air in sufficient quantity so as to practically completely oxidize the available sulfur and iron in the ore, and produce a matte, and also produce a gas of such composition as will enable the sulfur dioxid contained therein to be oxidized into sulfur trioxid, in a condition to be used for making sulfuric acid, substantially as described.

In testimony whereof, we have hereunto set our hands in the presence of two subscribing witnesses.

JOHN PARKE CHANNING.

FREDERIC JOHN FALDING.

Witnesses:

P. B. PHILIPP,  
J. A. GRAVES.

It is hereby certified that Letters Patent No. 963,020, granted June 28, 1910, upon the application of John Parke Channing and Frederic John Falding, of New York, N. Y., for an improvement in "Methods of Smelting Pyritic Ores," were erroneously issued to said inventors; whereas they should have been issued to said *John Parke Channing as sole owner of said invention*, as shown by the record of assignments in this office; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 19th day of July, A. D., 1910.

[SEAL.]

F. A. TENNANT,  
*Acting Commissioner of Patents.*