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

METHOD OF MAKING SULFURIC ACID FROM SMELTER GASES.

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962,493. Patented June 28, 1910.

Fig. 1.

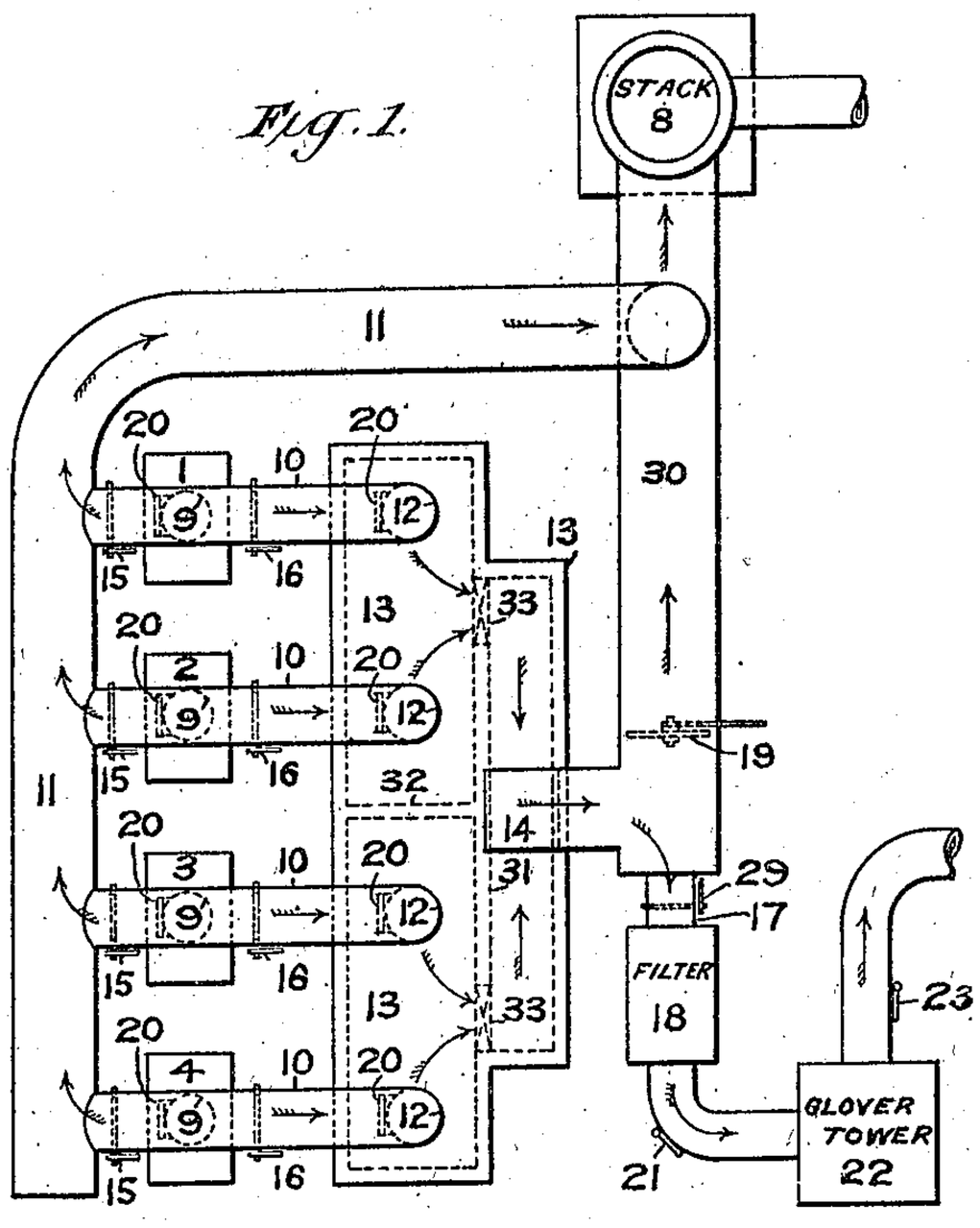
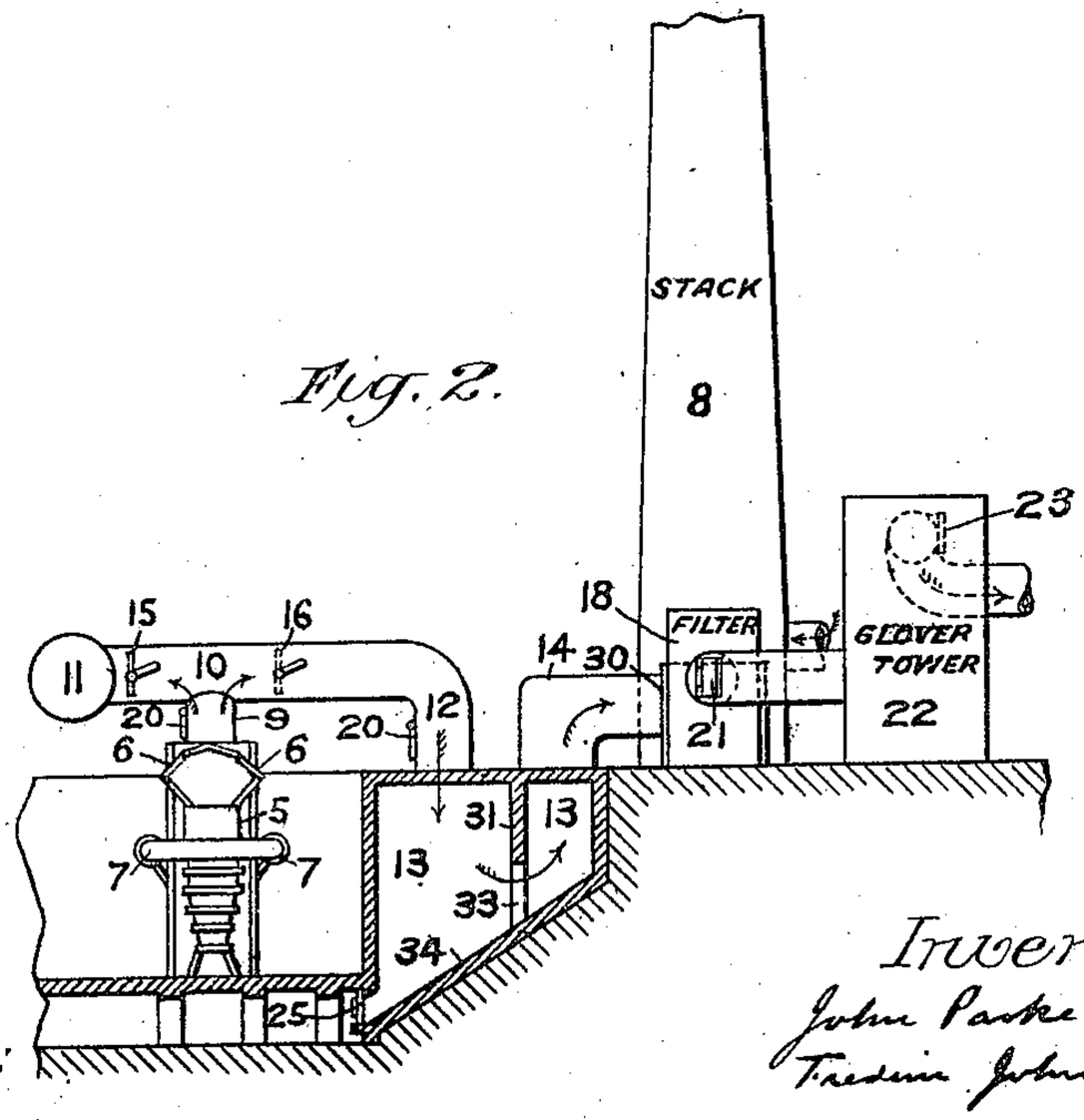


Fig. 2.



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METHOD OF MAKING SULFURIC ACID FROM SMELTER-GASES.

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To all whom it may concern:

Be it known that we, JOHN PARKE CHANNING and FREDERIC J. FALDING, 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 Making Sulfuric Acid from Smelter-Gases, fully described and represented in the following specification and the accompanying drawings, forming a part of the same.

This invention relates to an improved method of utilizing the furnace gases given off from smelting furnaces during the operation of smelting sulfid ores "pyritically", and it particularly relates to an improved method of controlling the furnace gases so as to obtain gases having a certain composition, and treating such gases to produce sulfuric acid therefrom.

In smelting sulfid copper ores "pyritically", as now carried out, the ore (not previously roasted) is treated in a blast furnace with an addition of 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, 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 therefrom. The sulfur dioxid (SO_2) passes through the furnaces in the form of a gas, together with certain other gaseous substances. While, theoretically, this oxidation of the iron and sulfur in the charge should furnish heat enough to smelt the charge, practically it is necessary to add certain carbonaceous material. This carbonaceous material is generally added in the form of coke, and this coke, during the smelting operation, is oxidized into carbon dioxid (CO_2). This mode of smelting is known in the art as "pyritic smelting", and by this method ore so low in sulfur that, treated by the ordinary methods, such ore will not produce gases suitable for the profitable production of sulfuric acid, can be treated to produce said gases profitably by our invention.

We have discovered that to successfully use these furnace gases in the manufacture of sulfuric acid, the relative proportion between the amount of sulfur in the charge and the amount of coke added thereto must be such, that sufficient free oxygen to convert the sulfur dioxid into the sulfur trioxid should be present in the gases. If too much coke is used, the gases are not suitable for manufacturing sulfuric acid, because so much of the oxygen in the air blown into the furnace is taken up in oxidizing the excess of coke into carbon dioxid that there is not enough oxygen left in the gases to convert the sulfur dioxid into sulfur trioxid, from which the sulfuric acid is obtained. Such oxygen cannot, 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 is present that the resulting gases are diluted to such an extent as to be unfit for use, being too weak in sulfur dioxid.

One part of our invention consists in keeping the carbonaceous material, or coke, used in the smelting furnaces, in a certain proportion to the sulfur content in the charge to be smelted, the proportion of said 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 dioxid.

In practice, we have found that about one per cent. of carbon to about four per cent. of available sulfur in the charge is a proportion which produces gases having sufficient oxygen therein to convert the sulfur dioxid into sulfur trioxid during the process of converting the sulfur dioxid into sulfuric acid. To give a concrete example, in an ore containing twenty-five per cent. of sulfur, about twenty per cent. of which will be oxidized or available, the balance of which will combine with the iron or copper to form the matte, we find that five per cent. 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 in the gases should be, to obtain the best results, considerably more than the amount theoretically required to convert the sulfur dioxid into sulfur trioxid. For example, assuming that the gases contain six per cent. of sulfur dioxid, such

gases would, theoretically, require three per cent. of free oxygen to convert them into sulfur trioxid. Gases containing such percentages of sulfur dioxid should, however, to obtain the best results carry seven to eight per cent. of free oxygen, or an excess of from four to five per cent. of free oxygen over that theoretically required.

The air entering the furnaces should be, as far as practicable, only that blown through the charge, the amount of which can be definitely determined. If air leaks into the furnace at the top and around the charging doors in any considerable quantity, the gases are made so weak or dilute as to be unsuitable for conversion into sulfuric acid, and such air should be excluded. If, however, the gases are too rich in sulfur dioxid, they may be diluted.

In addition to having sufficient oxygen in the gases to convert the sulfur dioxid into sulfur trioxid, the gases containing the sulfur dioxid supplied to the acid making apparatus must have a certain content or percentage of such sulfur dioxid. This content should be approximately from five to eight per cent. sulfur dioxid of the total gases supplied to the acid making apparatus. The gases should preferably be at least as rich as approximately five per cent. in sulfur dioxid, for if poorer than such percentage the reactions taking place in such apparatus are slow and not sufficiently intense, and the apparatus consequently has to be so extensive that its cost in maintenance precludes the possibility of making sulfuric acid profitably. The gases should not be richer in sulfur dioxid than approximately eight per cent., as a higher percentage of sulfur dioxid would preclude the possibility of there being sufficient free oxygen for the process. Again, whatever the particular percentage of sulfur dioxid in the gases, such percentage must be substantially constant, owing to the nature of the reactions which take place during the conversion of the sulfur dioxid into sulfuric acid, and owing to the physical conditions under which the reactions take place. The gases thus obtained from a furnace or furnaces working perfectly, and in which the carbon, sulfur and air are present in just the right proportions, and which gases contain the percentages of sulfur dioxid and oxygen indicated above, can be used for making sulfuric acid without further treatment by the well-known chamber or contact processes. Such ideal conditions, however, would seldom, in actual practice, be present, and if so, could not be practically maintained for any considerable length of time, as the gases from the furnaces vary constantly. Where a number of furnaces are used, gases having varying contents of sulfur dioxid and oxygen are given off, the content of each furnace being different from that of the others, and it would be extremely difficult to keep these contents sufficiently constant for use in making sulfuric acid.

We have discovered that by mixing or commingling the varying gases given off from a number of smelting furnaces as before indicated, in a suitable receiving chamber or reservoir, a mixture of gases is obtained which contains a readily ascertainable content of sulfur dioxid and oxygen, such content being the average of the varying contents given off by the different furnaces. Where, therefore, a plurality of furnaces are operating, and the gases from the different furnaces vary in their content of sulfur dioxid and oxygen, we collect such gases from the furnaces in a chamber or reservoir and allow them to commingle or mix, and the resulting gases have a content of sulfur dioxid and oxygen which is the average of the varying contents given off by the different furnaces, such content being thus equalized. This final content is readily ascertainable, and can be readily obtained by suitable adjustment and control of smelting and collecting conditions to give the right percentage of sulfur dioxid and oxygen by admitting gases richer in sulfur dioxid or oxygen, or both, to the reservoir from a furnace producing such gases, if the average content is too weak in either. If such content has approximately the amount of sulfur dioxid and oxygen which should be present, as before indicated, the gases are then passed into a sulfuric acid making apparatus, either of the chamber process type, or the contact process type.

If the content of the gases from any furnace is too rich in sulfur dioxid, it may be diluted by admitting air to such gases before entering the reservoir, or if the average content of the gases in the reservoir is too rich in sulfur dioxid, it may be diluted by admitting air to such gases, either in the reservoir or after leaving the same, before entering the Glover tower of the apparatus of the chamber process type, or before entering the apparatus of the contact process type; or if the gases would be cooled too much for the concentration function of the Glover towers in the apparatus of the chamber process type, if such air were admitted before the gases enter the same, then the air may be admitted to them after they pass such Glover towers. The gases can in this way be maintained with a practically constant percentage of sulfur dioxid and oxygen, suitable for conversion into sulfuric acid. This treatment may be carried out in various apparatus, and we will now describe it in connection with one apparatus for carrying it out. The apparatus which will now be described is, we have found, a convenient one for such treatment of furnace gases, but

it will be understood that our invention is not to be limited to use with such particular apparatus.

In the accompanying drawings:—Figure 1 shows a diagrammatic plan view of an apparatus for treating furnace gases, and also a filter, and one Glover tower of the sulfuric acid making apparatus of the chamber process type; and Fig. 2 shows diagrammatically and partially in section an elevation of a portion of the same apparatus, or plant, shown in Fig. 1.

Referring now to said drawings, the apparatus shown comprises a plurality of smelting furnaces which are shown diagrammatically in Fig. 1, and are marked, respectively, 1, 2, 3 and 4. The number of such furnaces may be widely varied. The furnaces are of any usual or desired construction and, as shown, comprise (see Fig. 2) parts 5 in which the charge to be smelted is dumped; charging doors 6, which should be approximately air tight, located near the tops, also approximately air tight, and means such as 7, for blowing air in through the charge being provided. A stack 8, of suitable construction, for carrying off gases and giving the required draft, is also provided, as is usual, in suitable relation to the furnaces. As before indicated, by mixing or commingling the gases given off from a number of different smelting furnaces, more uniform gases are obtained, and to so mix or commingle the gases there is provided a chamber or reservoir, common to all the furnaces, in which the gases from the different furnaces are collected, and a certain flue construction for controlling the gases, and these constructions will now be described.

As shown, rising from the top of each of the furnaces is a short vertical flue or pipe 9. Each flue or pipe 9 communicates with a horizontal flue 10, one of which is provided at each furnace. These flues 10 communicate with a flue or passage 11, common to all of the flues 10. This flue 11 is a by-pass flue, the function of which will be hereinafter referred to. The horizontal flues 10 are, at their other end, in communication, through short vertical flues 12, with the chamber or reservoir 13, in which the gases from all the furnaces may be collected by means of the flues 9, 10 and 12, as described, and commingle or mix therein. This chamber or reservoir 13 is in communication with a flue or passage 14, which communicates with the flue 30 leading to the stack 8, the flue 30 being controlled by a damper 19. The flue 14 also communicates with the flue or pipe 17 connected with the acid making apparatus and controlled by a damper 29.

The chamber or reservoir 13 is preferably divided by a longitudinal partition 31 having two openings 33, and by a transverse partition 32, to cause the gases to more thoroughly commingle or mix in passing, than if the chamber was not so divided. Said partitions may, however, be dispensed with. The gases pass through the pipe or flue 17 and, if desired, through a filter 18, to the acid making apparatus of the chamber process type, one Glover tower 22, of this type being indicated in the drawing; or to the purifying and cooling apparatus and then to the other parts of the apparatus of the contact process type. As the apparatus of both types, and the processes and reactions which the gases undergo therein, are well known, it will not be necessary to describe them. The flues 10, or anyone of them, are connected to or disconnected from the by-pass flue 11 by dampers 15, these dampers being located in the flues 10 between the short vertical pipes 9 rising from the tops of the furnaces and the by-pass flue 11. In the flues 10 are provided dampers 16, by means of which each of the flues 10 may be disconnected from, or connected with, said reservoir or chamber 13.

As before stated, all the flues 10 leading from the furnaces are arranged to be in communication with the flue or by-pass 11. This by-pass flue 11 is closed at one end, and at the other end communicates with the flue 30 leading to the stack 8, so that if desired the gases from all or any one of the furnaces may be passed therefrom without entering the reservoir or chamber 13. With this arrangement of a mixing chamber common to all of the furnaces, and the system of flues thus described, the gases produced from the furnaces may be led into this chamber and mixed and commingled, and the varying contents of sulfur dioxid obtained from the different furnaces equalized, the resultant gases, having a content of sulfur dioxid and oxygen which is the average of the varying contents of the sulfur dioxid and oxygen from the different furnaces. If, for any reason, one or more furnaces is not in operation, or if the gases produced from any one of the furnaces is too poor in sulfur dioxid or in oxygen, or otherwise unsuitable to be run into the mixing chamber, the gases from such furnace may be directed away therefrom by closing the damper 16, and such gases permitted to enter the by-pass flue by opening the damper 15, the gases from the other furnaces passing into the chamber.

If the gases from any one of the furnaces are too rich in sulfur dioxid, and the gases from the other furnaces are not poor enough in sulfur dioxid to reduce the resultant mixture to the required percentage, air may be introduced at any part of the apparatus between the dampers 15 and the Glover towers of the apparatus of the chamber process type, or the purifying apparatus of the contact process type: Or, it may be introduced

after the gases leave the Glover towers in the apparatus of the chamber process type, or it may be introduced at the charging doors 6 of the furnace, or by increasing the amount of blast. We have indicated doors 20 in the flues 9, 10 and 12, and a door 21 in the flue leading to the Glover tower, and a door 23 in the flue leading from the Glover tower for controlling the admission of such air for reducing the mixture to the desired percentage of sulfur dioxid. By these means the control of the sulfur dioxid and free oxygen in the gases is permitted, and a certain relative percentage of each can be obtained and kept approximately constant.

By raising and lowering the damper 19 in the flue 30, the draft to the stack 8, and the pressure and consequent tension of the gases up to the damper 29, is controlled, and the excess of gases, beyond what is required for the acid making apparatus, is carried to the stack 8. The gases required for the acid making apparatus are drawn forward through the flue 17 by reason of the partial vacuum in the acid making apparatus caused by the cooling and condensation of the gases therein, or by auxiliary fans, aspirators, or other apparatus, or both, as is well known, which partial vacuum is in excess of the partial vacuum existing in the chamber 13 caused by the connection of such chamber and the flue 14 with the flue 30. By raising and lowering the damper 29 in the flue 17 the tension of the gases in the filter, if it is used, and in the acid making apparatus, is also controlled. The mixing reservoir or chamber 13, also, serves as a dust chamber, and is preferably formed as shown in Fig. 1, with a sloping wall 34, so as to catch flue-dust and other matter which may pass through the apparatus with the gases, the door 25 being provided to permit the removal of such dust or other matter.

As the heat of the furnace gases is employed in concentrating the acid made in the Glover towers of the apparatus of the chamber process type, the pipes and flues leading from the furnaces to the chamber 13 and the pipe leading from such chamber to such Glover tower should be made as short as possible and covered by some heat non-conducting material, and the chamber 13 itself should be likewise protected as much as possible to prevent the radiation of heat in order that the gases may reach the Glover towers as hot as possible.

What we claim is:—

1. The method of controlling and utilizing the furnace gases given off in smelting furnaces during the operation of smelting sulfid ores "pyritically," which consists in keeping the percentage of the carbonaceous material used in the smelting of such ore low proportionately to the percentage of sulfur in the ore, so as to obtain gases having certain relative contents of sulfur dioxid and oxygen, said oxygen being in excess, and treating the same to produce sulfuric acid.

2. In the art of producing sulfuric acid, the method of controlling and utilizing the furnace gases given off in smelting furnaces during the operation of smelting sulfid ores "pyritically," which consists in keeping the percentage of the carbonaceous material in the proportion of about one per cent. of such material to about four per cent. of sulfur in the ore, so as to obtain gases having certain relative contents of sulfur dioxid and oxygen, and treating the same to produce sulfuric acid.

3. The method of controlling and utilizing the furnace gases given off in smelting furnaces during the operation of smelting sulfid ores "pyritically," which consists in maintaining a certain proportion between the sulfur in the ore and the carbonaceous material used in the smelting of such ore so as to obtain gases having certain relative contents of sulfur dioxid and oxygen, collecting such gases from a plurality of such furnaces, in a chamber where they commingle or mix together, and treating the same to produce sulfuric acid.

4. The method of controlling and utilizing the furnace gases given off in smelting furnaces during the operation of smelting sulfid ores "pyritically," which consists in maintaining a certain proportion between the sulfur in the ore and the carbonaceous material used in the smelting of such ore, so as to obtain gases having certain relative contents of sulfur dioxid and oxygen, collecting such gases from a plurality of such furnaces, mixing or commingling them so that the content of sulfur dioxid is from about 5% to 8% of the mixture, maintaining such percentage of sulfur dioxid constant, and treating the same to produce sulfuric acid.

5. In the art of producing sulfuric acid, the method of treating furnace gases produced in smelting furnaces during the operation of smelting sulfid ores "pyritically," which consists in collecting such gases in controlled proportions from a plurality of such furnaces in a chamber where they may commingle or mix together, and treating the same to produce sulfuric acid.

6. In the art of producing sulfuric acid, the method of treating furnace gases produced in smelting furnaces during the operation of smelting sulfid ores "pyritically," which consists in collecting such gases from a plurality of such furnaces in a chamber mixing or commingling said gases under controlled conditions until a certain content of sulfur dioxid and oxygen is present, and treating the same to produce sulfuric acid.

7. In the art of producing sulfuric acid, the method of treating furnace gases pro-

duced in smelting furnaces during the operation of smelting sulfid ores "pyritically," which consists in collecting such gases from a plurality of such furnaces in a chamber, mixing or commingling said gases under controlled conditions until a certain content of sulfur dioxid and oxygen is present in the mixture, maintaining such content constant, and treating the same to produce sulfuric acid.

8. In the art of producing sulfuric acid, the method of treating furnace gases produced in smelting furnaces during the operation of smelting sulfid ores "pyritically," which consists in collecting such gases from a plurality of furnaces in a chamber, mixing or commingling said gases under controlled conditions until a certain content of sulfur dioxid and oxygen is present in the mixture, adding air after such gases have passed the Glover tower of the acid making apparatus of the chamber process type if the content of sulfur dioxid is too rich, and treating the same to produce sulfuric acid.

9. In the art of producing sulfuric acid, the method of treating furnace gases produced in smelting furnaces during the operation of smelting sulfid ores "pyritically," which consists in collecting such gases from a plurality of smelting furnaces in a chamber, mixing or commingling said gases under controlled conditions so that the content of sulfur dioxid is from 5% to 8% of the mixture and that the oxygen is from 7% to 9%, maintaining such percentage of sulfur dioxid constant, and treating the same to produce sulfuric acid.

10. In the art of producing sulfuric acid, the method of treating furnace gases produced in smelting furnaces during the operation of smelting sulfid ores "pyritically," which consists in collecting such gases from a plurality of such furnaces in a chamber where they may commingle or mix together, and from which they are delivered to the Glover towers of the acid making apparatus of the chamber process type, and maintaining their heat from the time they leave the furnaces until they enter such Glover towers, 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:
M. B. PHILIPP,
T. F. KEHOE.