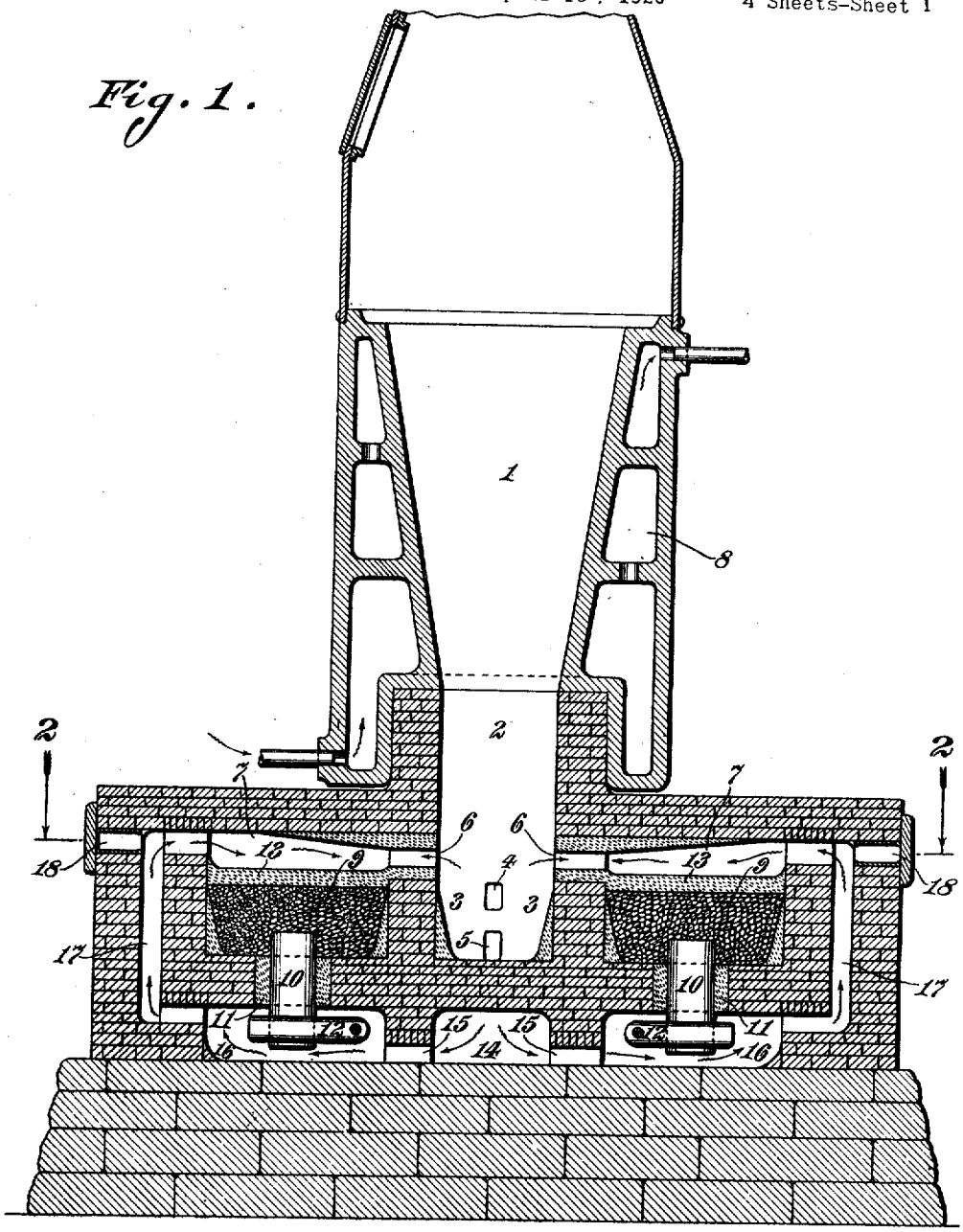
April 29, 1924. 1,492,086

J. F. SHAWHAN

ELECTRICAL SMELTING FURNACE

Filed April 15, 1920 4 Sheets-Sheet 1

Fig. 1.



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Filed April 15, 1920

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Fig. 2.

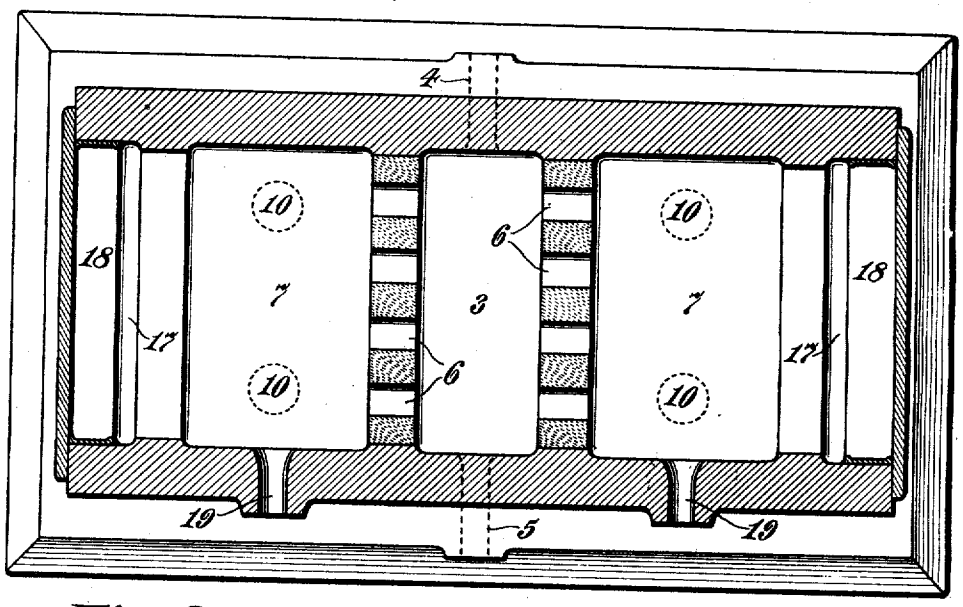


Fig. 3

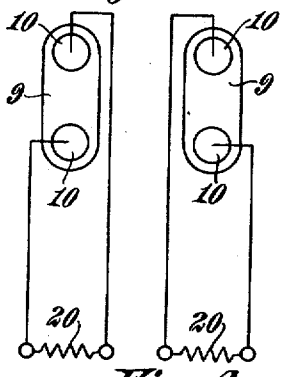


Fig. 5.

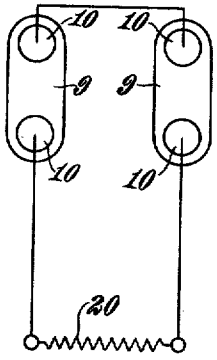


Fig. 6.

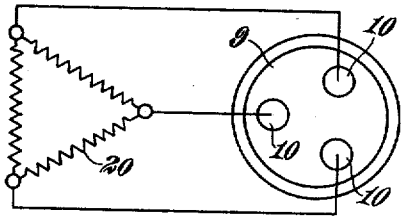


Fig. 7.

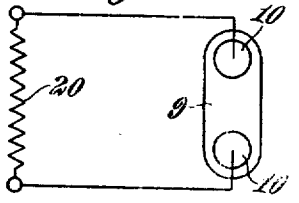
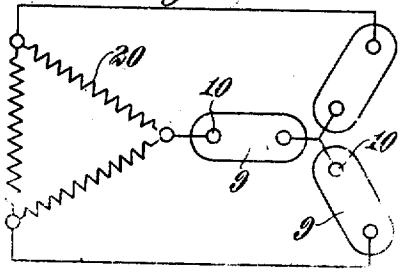


Fig. 4.



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ELECTRICAL SMELTING FURNACE

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Fig. 8.

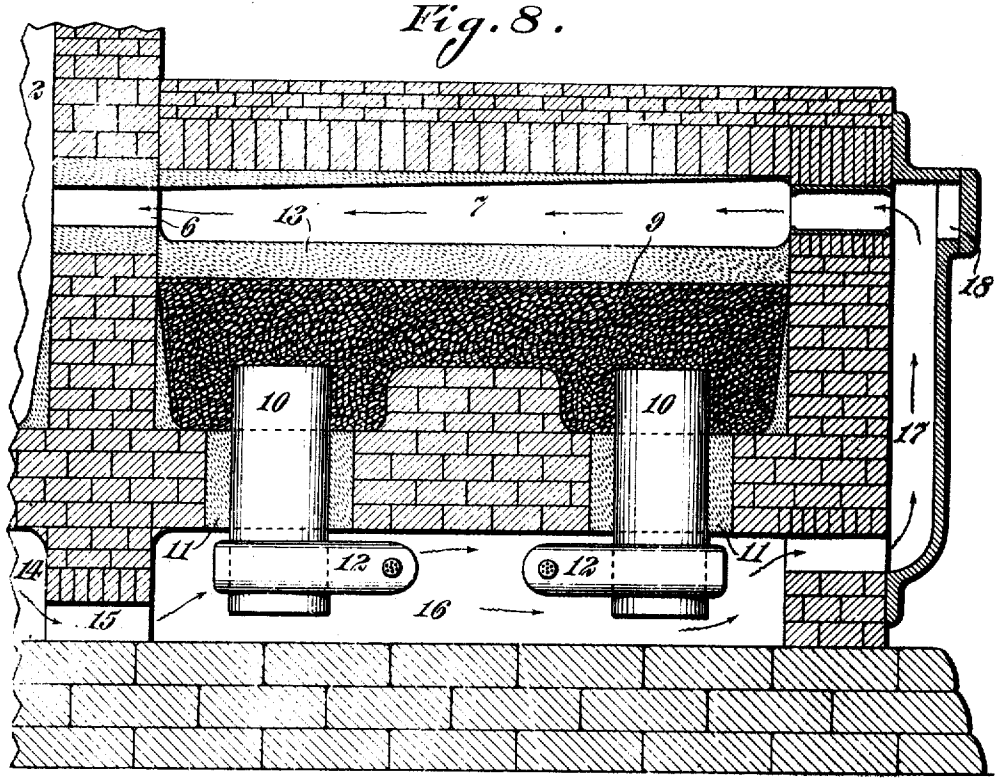
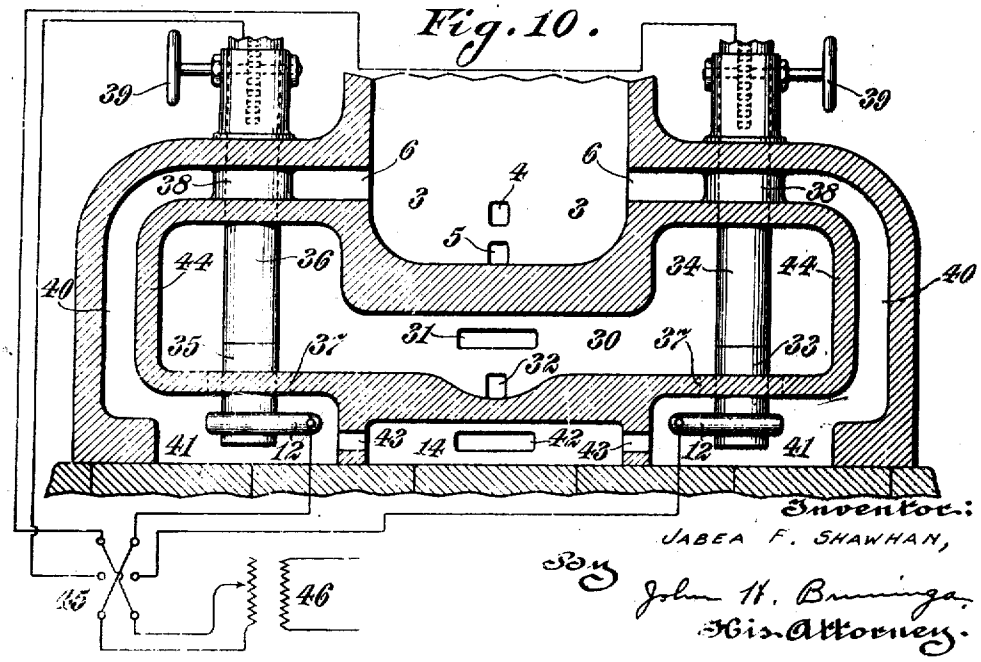


Fig. 10.



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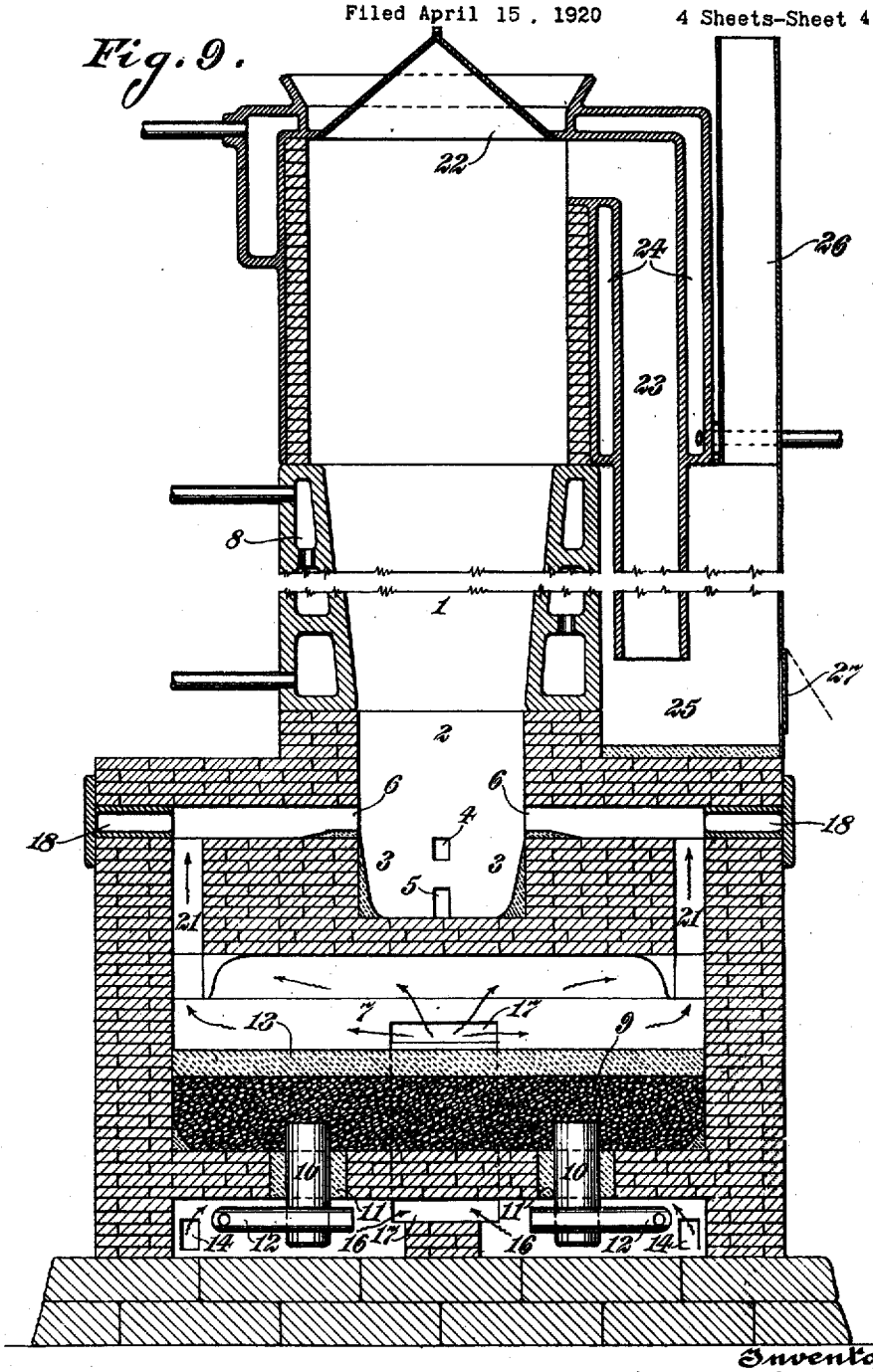
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ELECTRICAL SMELTING FURNACE

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Fig. 9.



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Patented Apr. 29, 1924.

1,492,086

UNITED STATES PATENT OFFICE.

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ELECTRICAL SMELTING FURNACE.

Application filed April 15, 1920. Serial No. 374,080.

To all whom it may concern:

Be it known that I, JABEA F. SHAWHAN, a citizen of the United States, and residing at Dayton, county of Montgomery, and State of Ohio, have invented the new and useful Improvement in Electrical Smelting Furnaces, of which the following is a specification.

This invention relates to smelting furnaces, and more particularly to that type of furnace used for smelting pyritic ores.

In the process of pyritic smelting, the heat required for the smelting process is obtained by combustion of materials contained in the ores themselves, particularly sulphur and iron in the case of pyritic ores. In order to carry on such a process, pure air in a heated condition must be supplied to the charge to cause oxidation of the sulphur and iron. The charge can, of course, first be brought to a sufficiently high temperature so that the oxidation will be carried on automatically, by rapid oxidation of the iron and sulphur, but once this condition has been attained, the process goes on of itself so long as the proper supply of heated air and ore is maintained.

One of the objects of this invention, therefore, is to provide a smelting furnace adapted to carry on such a smelting process continuously by providing an adequate supply of properly heated air upon the charge.

In a great many cases, facilities for smelting by ordinary methods are not on hand at the mine and ores must be shipped to a distance to be smelted. As the ores in the mine usually carry only about 10% of their weight in valuable metals, a great saving can be effected by carrying on the smelting operation at the mine, thereby saving the cost of transporting the bulky ores and the necessary fuel for heating the air and the charge. As water power is usually available in mining districts, and when transformed into electrical energy, can be used for heating purposes, this invention provides means for carrying on a smelting process at the mines.

Another object of this invention, therefore, is to provide means for utilizing materials and sources of energy available at or near the mine location for the smelting process.

Another object of this invention is to provide electric means for heating the air used in such a process.

Further objects will appear from the detailed description taken in connection with the accompanying drawings in which:

Figure 1 is an elevation in cross section of a smelting furnace embodying this invention;

Figure 2 is a section taken on the line 2—2, Fig. 1;

Figure 3 shows the electrical connections for the air heating furnace, having two heating elements, when used on a two phase system of electrical distribution;

Figure 4 shows the electrical connections for a furnace having three heating elements when used on a three phase system;

Figure 5 shows the connections for a furnace with two heating elements when used on a single phase system.

Figure 6 shows the electrical connections for a furnace having one heating element when used on a three phase system;

Figure 7 shows the connections for a furnace having one heating element when used on a single phase system;

Figure 8 is a cross sectional view showing another arrangement of the air heating furnace;

Figure 9 is a sectional view in elevation of a smelting furnace showing another embodiment of this invention; and

Figure 10 is a sectional view in elevation showing still another embodiment of this invention.

Referring now to Figs. 1 and 2, 1 designates the ore stack, 2 is the contracted portion thereof or smelting chamber, and 3 is the crucible. The crucible 3 is provided with an outlet 4 for the slag and an outlet 5 for the matte. Opening into the crucible at the sides are tuyères 6. These may be all of the usual construction. The lower part of the furnace, including the crucible, and the smelting chamber are usually constructed of brick and lined with refractory material, while the ore stack 1 may be of cast iron and may be provided with a water jacket 8 to keep it cool.

The tuyères 6 communicate with heating chambers 7. Each chamber 7 comprises a bed formed in the brick work, which may

be lined with refractory material, and is filled with granulated carbon, chrome ore or other suitable resistance material 9. Electrodes 10 are introduced into this bed, suitably insulated by means of refractory material 11 and provided with connectors 12 for connection to the electric circuit. By means of the electrodes 10, electric current may be passed through the beds of resistance material for the purpose of heating them.

The beds are filled with granulated resistance material nearly to the top and over this are placed insulating layers 13 to separate the hot carbon from the air in the heating chamber 7 so as to prevent both oxidation of the resistance material and the extraction of oxygen from the air. It is, of course, evident that to extract a portion of the oxygen from the air while it is in the heating chamber would seriously reduce its efficiency as a supporter of combustion in the smelting chamber. The insulating layer 13 is preferably composed first of a layer of pure silica quartz crushed to a size of about one-fourth inch, then a layer of quartz sand and then a second layer of pure silica quartz crushed to about one-half inch size. The grains of this top layer are sufficiently large that they will not be disturbed by the air blast passing over them.

When the resistance bed is heated up, the temperature will usually reach a sufficiently high value to melt the layer of silica on top, thus forming a complete coating over the top of the resistance material to prevent contact of the air therewith, and providing at the same time a highly heated surface against which the air impinges. The air will, therefore, be heated to a high temperature in the heating chamber 7 so as to be ready for combustion when it reaches the smelting chamber 2.

The air enters from the outside of the furnace into the chamber 14, passing thence through the ducts 15 into the chamber 16 where it is warmed by contact with the hot electrodes 10, thence through the ducts 17 into the heating chamber 7, and then out through the tuyères 6 into the smelting chamber. Openings 18 are provided for access to the heating chamber 7 for cleaning and similar purposes. Outlets 19 are provided for drawing off the molten layer of quartz 13 when the furnace is shut down. Upon resuming operation, the quartz may again be broken up and replaced to form a new layer 13.

Each chamber 7 may have a separate heating element comprising a resistance bed 9 and a pair of electrodes 10. These may be connected to the electrical circuit in any suitable manner, a number of alternative arrangements being shown in Figures 3 to 7 inclusive. In Figure 3, in a furnace having two heating elements each element is connected across one leg of a two phase circuit, the secondary winding of the usual transformer being represented at 20. In Figure 4, the three beds of the furnace are arranged for connection to a three phase circuit. In Figure 5, two elements are connected in series on a single phase circuit. In Figure 6, a heating element having three electrodes arranged in the same resistance bed is arranged for connection to a three phase circuit. In Figure 7, a single heating element is arranged for connection to a single phase circuit.

Figure 8 shows another arrangement of the heating chamber and resistance bed, which may be used, for instance, in a furnace having three heating elements using the connection shown in Figure 4. In this furnace, the ducts 17 are formed by metal caps attached to the side of the brick work.

Figure 9 shows another embodiment of this invention, in which the heating chamber 7 is located underneath the smelting furnace. The arrangement is otherwise similar to that described except that the air passes from the heating chamber 7 to the tuyères 6 through additional air ducts 21; and except that the air enters at the ends of the chamber 14, passes in contact with the electrodes and is led from chamber 16 to chamber 7 by vertical ducts rising vertically outside of the layer 9 of resistance material.

In this figure is also shown an arrangement for condensing the flue gases. Connected with the upper end of the stack 1 underneath the hopper 22, is a downwardly directed flue 23. This flue is surrounded by a water jacket 24 adapted to cool the flue 23, thereby condensing any volatilized metal in the flue gases, which metal is deposited in the form of dust at the bottom of the chamber 25 into which the flue 23 opens. Such gases as are not condensed pass out of the chamber 25 upwardly through the stack 26. The clean out door 27 is provided for access to the chamber 25 for removal of the deposited metal which can be recovered by any suitable treatment, such as by sintering and subsequent resmelting.

Figures 10, illustrates another embodiment in which the air is heated by means of an electric arc furnace. Only the lower part of the smelting furnace is shown, namely, crucible 3, with the outlets 4 and 5 and the tuyères 6. The upper portion of the furnace which is broken away may, however, be the same as that illustrated in Figure 1.

Underneath the smelting furnace is a chamber 30 in which are mounted electrodes 33, 34, 35 and 36, adapted to form in this case, two arcs for heating this chamber. One, two or more arcs may be used, according to circumstances. These electrodes pass

through the walls of the chamber and are insulated by bushings of refractory material 37 and 38. The lower electrodes 33 and 35 are provided with connectors 12 for connection to the electric circuit. The upper electrodes 34 and 36 are each provided with an elevating device 39 including a rack and pinion movement. These electrodes are further equipped with connectors, not shown, for connection to the circuit.

Surrounding the heating chamber 30 is a series of air passages 40 communicating at the lower end with the air heating chamber 41 and at the upper end with the tuyères 6. The air supply enters the chamber 14 at the inlet 42 and passes through the ducts 43 to the heating chamber 41 where it is heated by contact with the hot electrodes 33 and 35, passing thence up through the passages 40, being heated by contact with the hot walls 44 of the heating chamber 30 to the tuyères 6. This arc-heated chamber may be put to double use by using it as a refining furnace. To this purpose it may be provided with an inlet 31 and an outlet 32. The material to be operated upon is spread over the floor to be acted upon by the arc heat. If said material is a conductor of electric current it may be heated by passing the current directly through it.

The electrical connections of the furnace to the supply circuit may be made as shown in Figure 10. The electrodes are connected through the double throw switch 45 to the secondary of an adjustable transformer 46 connected to the supply line. With this arrangement, the furnace can be used either as an arc furnace or as a resistance furnace. By throwing the switch 45 to the upper position, the electrodes 33 and 35 are connected to one side of the circuit and the electrodes 34 and 36 to the other side of the circuit. It is evident that with this connection either or both of the electrodes may be used as an arc furnace by touching and separating the electrodes by means of the controlled device 39. It is convenient to use a furnace in this way as an arc furnace when starting up on a new charge, as heat can be generated more rapidly. When the charge has melted down, the switch 45 may be thrown to the lower position whereby the electrodes 33 and 35 are connected to opposite sides of the circuit. With this connection, the furnace operates as a resistance furnace establishing a circuit through the molten charge. With this connection, it is immaterial whether the upper electrodes are or are not in contact with the lower electrodes, since each pair is short circuited by the switch 45.

It will, therefore, be seen that the invention accomplishes its objects. The electrical resistance is entirely enclosed and covered with a refractory material, which is nonoxidizable by air. Accordingly, an ordinary granular material (which, while economical, is ordinarily rendered unfit for use on account of being readily oxidizable) can be used. Accordingly, the furnace is not only economical in requiring renewal of the resistance material only at long intervals, but it is also efficient in that the entire oxygen in the air can be utilized for smelting purposes. The resistance material electrodes or heating elements are entirely enclosed and the air is circulated therearound, so that subsequently all of the heat generated by the current is utilized, thereby resulting in maximum economy of electrical energy used.

It is obvious that various changes may be made in the details of construction without departing from the spirit of this invention; it is, therefore, to be understood that this invention is not to be limited to the specific details shown and described.

Having thus described this invention, what is claimed is:

1. A pyritic smelting furnace, comprising, a furnace chamber adapted to receive a charge to be oxidized, tuyères adapted to deliver air to said chamber in order to oxidize the charge, a heating passage through which the air passes preparatory to delivery, an oxidizable electric heat generating medium, and a heat conducting envelope for said medium adapted to provide a wall for said passage in order to heat the air but protect said medium against oxidation thereby.

2. A pyritic smelting furnace, comprising, a furnace chamber adapted to receive a charge to be oxidized, tuyères adapted to deliver air to said chamber in order to oxidize the charge, a heating passage through which the air passes preparatory to delivery, a bed of granulated and oxidizable resistance material, and a heat conducting envelope for said medium adapted to provide a wall for said passage in order to heat the air but protect said medium against oxidation thereby.

3. A pyritic smelting furnace, comprising, a furnace chamber adapted to receive a charge to be oxidized, tuyères adapted to deliver air to said chamber in order to oxidize the charge, a heating passage through which the air passes preparatory to delivery, an oxidizable electric heat generating medium, and a non-oxidizable heat conducting envelope for said medium adapted to provide a wall for said passage in order to heat the air but protect said medium against oxidation thereby.

4. A pyritic smelting and refining furnace, comprising, a smelting chamber adapted to receive the charge and provided with tuyères, a refining chamber, an oxidizable electric heat generating medium for said refining chamber, a heat conducting enve-

lope for said medium, and means for passing the air over said envelope preparatory to its delivery to said tuyères.

5. A pyritic smelting and refining furnace, comprising, a smelting chamber adapted to receive the charge and provided with tuyères, a refining chamber, an oxidizable electric heat generating medium for said refining chamber, a heat conducting envelope for said medium, and means whereby the air is heated as generated by said medium before passing to said tuyères.

6. A pyritic smelting and refining furnace, comprising, a smelting chamber adapted to receive the charge and provided with tuyères, means for delivering air to said tuyères, a refining chamber adjacent said smelting chamber, heating means therefor including cooperating electrodes, means for controlling said electrodes in order to adapt them selectively for arc or resistance heating, and means for utilizing the heat of said refining chamber to heat the air delivered to said tuyères.

7. A pyritic smelting and refining furnace, comprising, a smelting chamber adapted to receive the charge and provided with tuyères, means for delivering air to said tuyères, a refining chamber adjacent said smelting chamber, heating means therefor including cooperating electrodes, means for selectively connecting said electrodes in order to adapt them selectively for arc or resistance heating, and means for utilizing the heat of said refining chamber to heat the air delivered to said tuyères.

8. A pyritic smelting furnace, comprising, a furnace chamber adapted to receive the charge and provided with tuyères, means for delivering air to said tuyères, and means for heating said air including a heating chamber, and means for circulating said air over the walls of said chamber adapted to heat said air.

9. A pyritic smelting furnace, comprising, a smelting chamber adapted to receive a charge and provided with tuyères, means for delivering air to said tuyères, and means for heating said air including a horizontally disposed bed of granulated resistance material and electrodes entering said bed from the bottom thereof.

10. A pyritic smelting furnace, comprising, a smelting chamber adapted to receive a charge and provided with tuyères, means for delivering air to said tuyères, and means for heating said air including a horizontally disposed bed of granulated resistance material covered with a layer of refractory material and electrodes entering said bed from the bottom thereof.

11. A pyritic smelting furnace, comprising, a smelting chamber adapted to receive a charge and provided with tuyères, means for delivering air to said tuyères, and means for heating said air including a chamber containing a horizontally disposed bed of granulated resistance material and electrodes entering said bed from the bottom thereof.

12. A pyritic smelting furnace, comprising, a smelting chamber adapted to receive a charge and provided with tuyères, means for delivering air to said tuyères, and means for heating said air including a chamber containing a horizontally disposed bed of granulated resistance material covered with a layer of refractory material, and electrodes entering said bed from the bottom thereof.

13. A pyritic smelting furnace, comprising, a smelting chamber adapted to receive a charge and provided with tuyères, means for delivering air to said tuyères, and means for heating said air including a chamber containing a horizontally disposed bed of granulated resistance material covered with a layer of refractory material, adapted to form a part of the lining of said chamber, and means for passing an electric current through said resistance material to heat said bed.

In testimony whereof, I affix my signature this 27th day of February, 1920.

JABEA F. SHAWHAN.