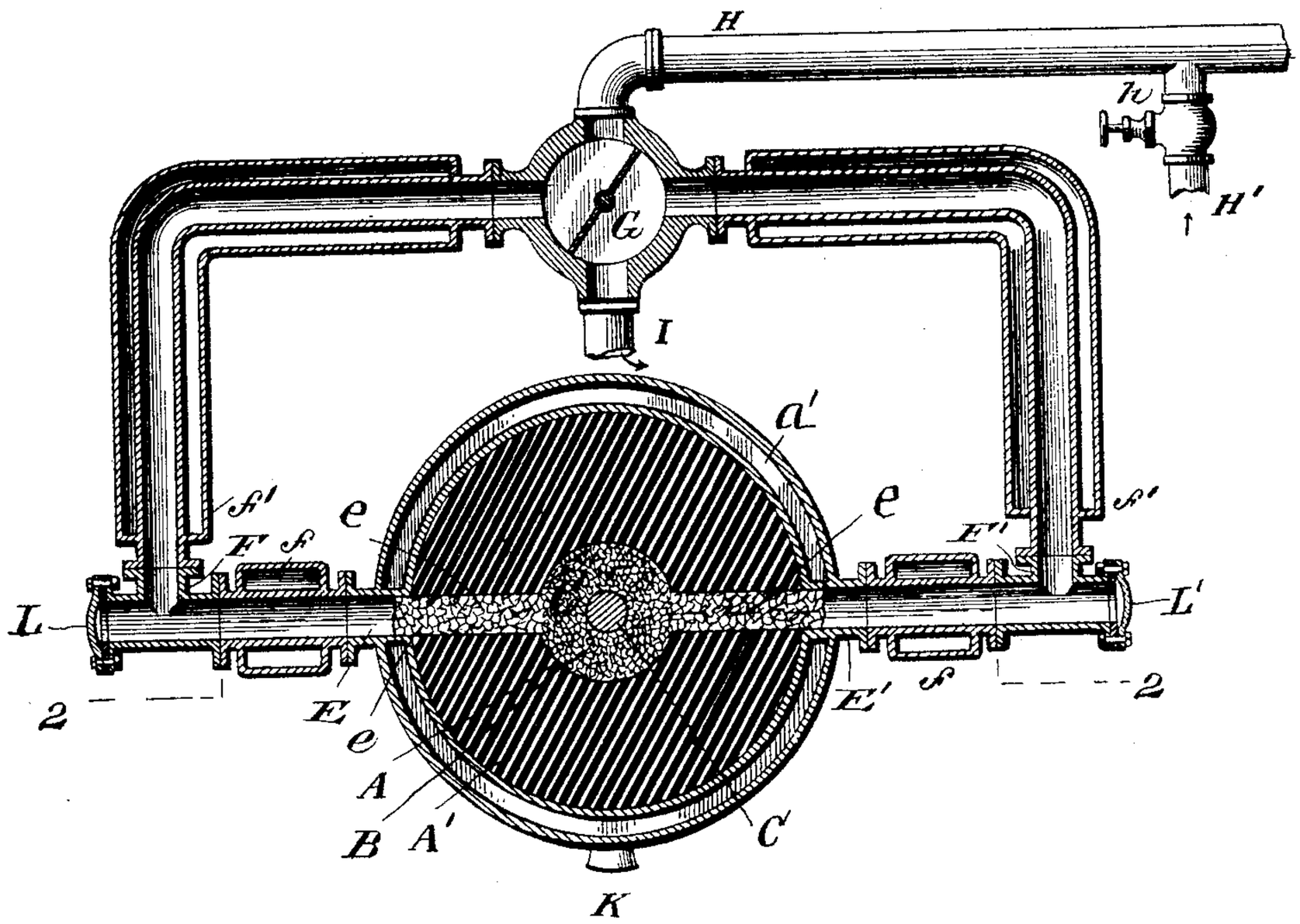
(No Model.) 2 Sheets—Sheet 1.

A. H. COWLES.

ELECTRIC FURNACE AND METHOD OF OPERATING SAME.

No. 583,249. Patented May 25, 1897.

Fig. 1.



Witnesses
John Dennie
Oliver H. Bailey.

Inventor
Alfred H. Cowles,
By Sewall B. Ford,
his Attorney

(No Model.) 2 Sheets—Sheet 2.

A. H. COWLES.

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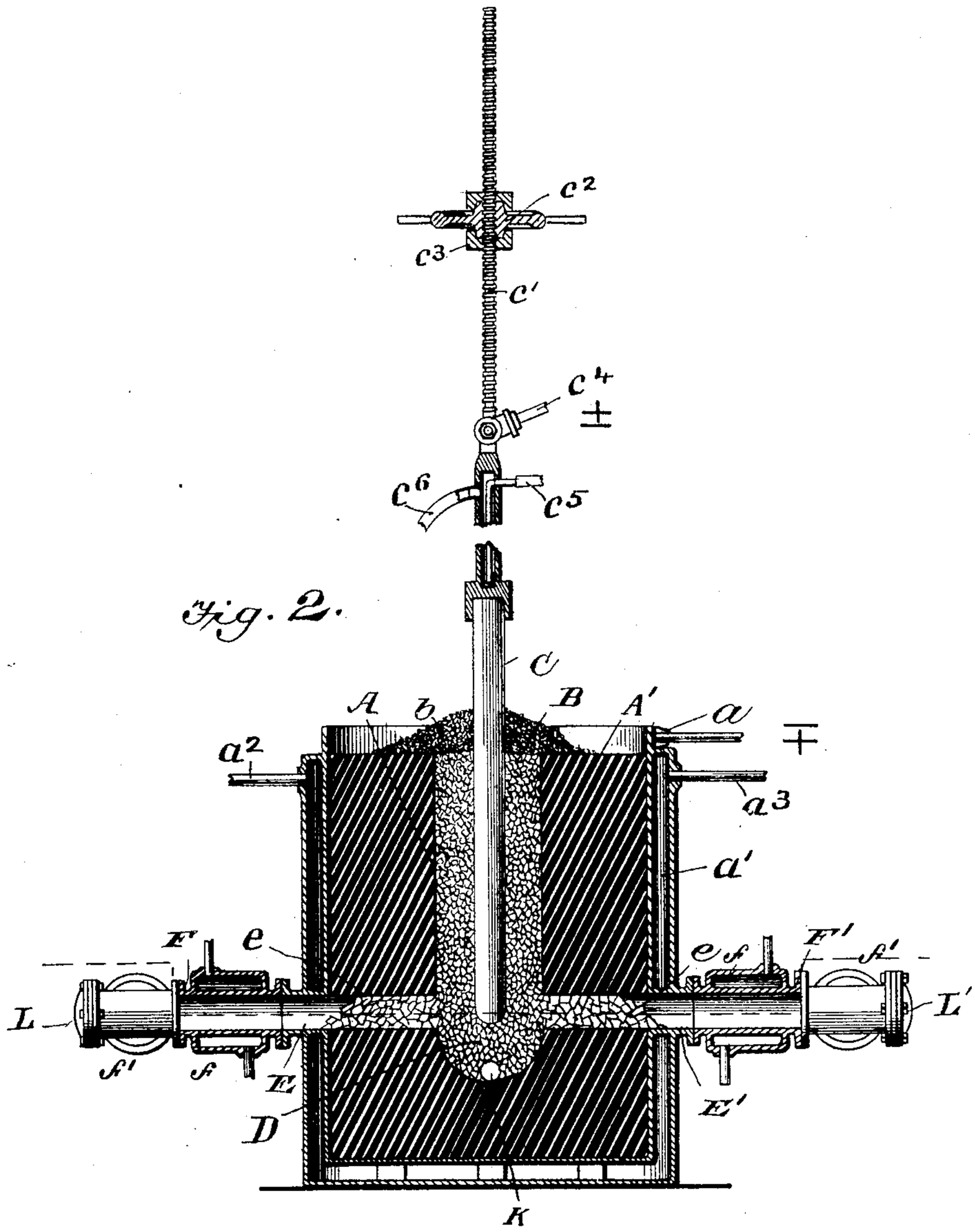
No. 583,249. Patented May 25, 1897.

Fig. 2.



Witnesses
John Dennie
Oliver W. Bailey.

Inventor
Alfred H. Cowles
By Stoughton B. Ladd,
his Attorney.

UNITED STATES PATENT OFFICE.

ALFRED H. COWLES, OF CLEVELAND, OHIO, ASSIGNOR TO THE ELECTRIC SMELTING AND ALUMINUM COMPANY, OF ILLINOIS.

ELECTRIC FURNACE AND METHOD OF OPERATING SAME.

SPECIFICATION forming part of Letters Patent No. 583,249, dated May 25, 1897.

Application filed July 6, 1895. Serial No. 555,115. (No model.)

To all whom it may concern:

Be it known that I, ALFRED H. COWLES, a citizen of the United States, residing at Cleveland, in the county of Cuyahoga and State of Ohio, have invented certain new and useful Improvements in Electric Furnaces and in Methods of Operating the Same and Controlling the Ore Reductions Therein; 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.

The object of the present invention is to effect the reduction and smelting of ores in an electric furnace or the reduction of any compounds capable of being treated in an electric furnace in a more uniform way than has been heretofore practiced and to secure more perfect reductions and results.

The admission of a gas or of a gas or vapor producing fluid into an electric furnace has heretofore been practiced, but the gas or the fluid or material producing the gas within the chamber has always been introduced and passed through the furnace-chamber in a uniform direction, and the flow of the gas within the chamber where the latter is charged with a body of ore or of a material or mixture of different materials to be treated has always been constant whenever it has been given any direction, and the effect of the steady flow of gas through such a mass in a uniform direction tends to elevate the temperature of the mass on the side of the outflow of the gas and to lower it on the side of the inflow.

I will not in the present case consider in detail the special effects of the reversal of the gas flow within an interstitial mass, but will present the particular features incident to the present application of the invention.

In the accompanying drawings, Figure 1 is a vertical sectional view of an electric furnace; and Fig. 2, a horizontal section of the same, taken on the line 2 2.

A is a furnace-chamber filled with a charge B of mixed broken granulated ore and carbon or ore alone or other material or mixture capable of being reduced or treated in the furnace. For the purpose of the present invention it matters not what the charge may be so long as it is a charge of material to be subjected to electric heat and to the action of the gas flowing through or over its mass.

C is an electrode leading down into the mass, the bottom of the furnace-chamber or the reduced material forming the other electrode. This electrode is adjustably supported in any preferred way. For example, the upper end c' of the holder is screw-threaded and engages with a hand-wheel nut c^2, properly supported in a girder c^3. One of the electric cables is attached to the holder at c^4. Provision is made for cooling the carbon-holder by means of a flow of water therethrough. The lower part of the holder is made hollow and provided with a water-pipe c^5, leading into the bottom of the hollow chamber within the rod, and with a water-discharge pipe c^6 at the upper end of the same. The furnace-chamber or crucible is also provided with a water-jacket a' and with water-pipes a^2 a^3 for the inflow and outflow of water therefrom. The structural features of the water-cooled carbon-holder above described are made the subject of a divisional application hereof. Electrical connection is shown as made with the outer iron shell of the furnace at a, the current passing through the carbon filling or block A′ to the charge in the furnace-chamber. Extending out laterally on opposite sides of the furnace-chamber, and at a sufficient distance above the bottom of the same to form a sump D below, there are the lateral flues, passages, or pipes E E′, diametrically opposite and leading outward through the furnace-walls, and these flues are filled with coarsely-granulated or broken carbon e, the interstices of the same forming carbon-lined passages for the gas. Connected with these flues E E′ are the gas-pipes F F′, respectively, properly protected by water-jackets f f', said gas-pipes leading into the reversing-valve chamber G, which chamber has a gas-supply pipe H and a discharge-pipe I. The latter may, for example, lead to a gas-holder, or to such apparatus as may be proper for the subsequent treatment or handling of the product. Connected with the gas-supply pipe H there is an air-supply pipe H′, which admits air under pressure to the gas, and the supply of air can be regulated and controlled by the valve h.

The furnace-chamber, as indicated, is filled to the top with the charge of ore and carbon, with the top covered over with a surface covering of fine carbon *b*. This is a sufficient closing in of the furnace-chamber for cases where the gas-pressure is light, but the chamber may be completely closed in and sealed when necessary.

K is a tap for drawing off the molten material collected in the sump. Access is gained to the flues E E′, for cleaning them out and for filling them with coke, by removing the caps K′ K′ on the ends of the pipes.

In operation, a furnace having been charged and heated up to a working temperature by means of the electric current, the gas is turned on and the air-valve *h* is opened to a proper extent to feed into the gas a requisite amount of air for action in the furnace-chamber. A current of gas flows through the passage F E, for example, into the furnace-chamber, passing through the interstices of the ore-body and through the central field of heat, where the reduction of the ore, or the chemical change in the charge of the furnace, takes place, or the major portion of the same is effected, that being the field of the greatest electrical energy.

The mixing of air with the gas produces a combustible mixture which burns within the interstices of the ore-body and adds to the heated field the heat due to the combustion of the gas, and in this way the electric heat is supplemented and increased by the heat of combustion.

A current of gas passing through the furnace-chamber flows outward through the passage E′ and the interstices of the carbon *e*, filling the same, and through the pipe F′ and the proper channel in the reversing-valve G and the discharge-pipe I. The current of hot gasses passing through the central intensely-heated field to and through the flue E′ gradually extends the field of heat in the direction of this point of exit, while the inflowing current of gas cools the opposite side of the chamber, and if the flow of gas is long continued in one direction it gradually works the side of the sphere or zone of heat inward toward the center of the mass. The center of the zone of highest heat, barring an arc center, by reason of the carrying inward of the heat on the inflowing side and the carrying outward of heat on the outflowing side, is being gradually moved toward the point of exit of the gas or products of combustion from the chamber. The particles of soot, dust, and sublimated matter picked up and carried along by the gas-currents are, on the inflowing side, carried inward toward the center of greatest electrical activity and the region most favorable for chemical changes and reductions in the ore-bodies, thus clearing out and opening up the channels for the free passage of the gas through the mass on that side. On the side of exit the gas-currents as they get away from the heating-field deposit within the interstices of the mass and of the exit-passage the dust, soot, and sublimated powders carried by them. After the gas has been flowing through the furnace for a proper interval of time the reversing-valve G is shifted, making connection of the gas-supply pipe H with the pipe F′ and of the pipe F with the gas-discharge pipe I. The flow of gas is now through the furnace-chamber from the flue F′ to the flue E in the opposite direction from what it has been flowing and in an opposite direction through the interstices of the ore-body.

The effects above set out occur now in the opposite direction. The area of intense heat, which extended laterally toward the flue E′, now moves inward and travels toward the new point of exit—the flue E—and the deposit of fine matter in the interstices of the mass is carried back into the heated field, while the formation of new deposits in the interstices of the mass on the opposite side and in the flue E may be going on. Thus with a proper periodical reversal of the gas-valve it will be seen that there is secured a perfect control of the field of heat in the furnace, and it can be either held central, by making the reversals of the flow sufficiently frequent, or it can be caused to move from side to side at command. Moreover, the regenerative principle comes into play. With each successive reversal of the gas-flow the material through which the gas passes before it enters the zone of electrical heat becomes hotter and hotter and the inflowing gas enters the field of action at a constantly increasing temperature. The electric heat is thus supplemented not only by the heat of combustion but by what would otherwise be waste heat recovered and utilized by the reversal of the gas-flow.

The movement of the field of heat is the most marked in an incandescent furnace where there is no fixed arc center. The heat can then be bunched and the center of greatest heat moved along the line of the flow of the gas through the mass to the point of exit and then caused to travel back again. If a charge of ore is of an elongated form with the gas inlet and exit passages at the ends, the field of concentrated heat or bunch of highest heat can be made to travel toward the point of exit and to concentrate close up to that point, and then by the reversal of the direction of the flow of the gas through the charge the bunch of highest heat can be made to traverse the length of the charge to the other end, and thus travel back and forth. The electrical heat action on the ore charge and the action or reduction due to the gas is thus under control, and more perfect results are obtainable than is possible when such control is wanting.

I am aware that in combustion-furnaces it has been proposed to pass a flow of gas through a body of incandescent fuel for the purpose of changing the composition of the gas, and also to reverse the flow of the gas

through the fuel, but this is not done for the purpose of controlling a heat center produced otherwise than by the gases themselves, nor is there any other heat present.

What I claim as my invention is—

1. The method of treatment of ores or other compounds or mixtures of material of low conductivity herein described, which consists in passing an electric current and generating within the mass of the material electrical heat, and in periodically passing gas therethrough in opposite directions, as and for the purpose set forth.

2. The combination in an electric furnace, of an electric-furnace chamber with gas inlet and outlet flues or passages and a reversing valve connected with the said inlet and outlet flues or passages and adapted to change the direction of the flow of gas through the electrically-heated field of the furnace-chamber, as and for the purpose set forth.

3. In an electric furnace, a furnace-chamber adapted to be charged at the top and having a central adjustable electrode extending down into the chamber, lateral gas inlet and outlet flues or passages, opening into the furnace-chamber and filled with granulated or broken carbon, together with gas connections with said inlet and outlet flues or passages for the supply of gas to the furnace-chamber and the removal of the same therefrom, as and for the purpose set forth.

4. In an electric furnace, a furnace-chamber, adapted to be charged at the top, and having a central adjustable electrode extending down into the chamber, lateral gas inlet and outlet flues or passages opening into the furnace-chamber and filled with granulated or broken carbon, together with gas connections with said inlet and outlet flues or passages for the supply of gas to the furnace-chamber and the removal of the same therefrom, and means for reversing the flow of gas through the inlet and outlet flues, as and for the purpose set forth.

5. The combination in an electric furnace of an electric-furnace chamber, having electrical connections for the passage of an electric current through the same, of pipes connected therewith for the inflow of gas and air and for the outflow of gas, and means for the reversal of the direction of the flow of gas through the electrically-heated field of the furnace-chamber, as and for the purpose set forth.

6. The combination in an electric furnace of an electric-furnace chamber, having electrical connections for the passage of an electric current through the same, of pipes connected therewith for the inflow and outflow of gases, a reversing-valve in operative relation to said pipes to reverse the flow of gas through the electrically-heated field, and an air-pipe connected with the gas-supply pipe outside of the reversing-valve, as and for the purpose set forth.

In testimony whereof I hereto affix my signature in presence of two witnesses.

ALFRED H. COWLES.

Witnesses:
CHAS. M. VORCY,
WM. G. TAYLOR.