No. 683,107. Patented Sept. 24, 1901.

# L. S. DUMOULIN.

## SMELTING FURNACE.

(Application filed Oct. 13, 1899.)

(No Model.)

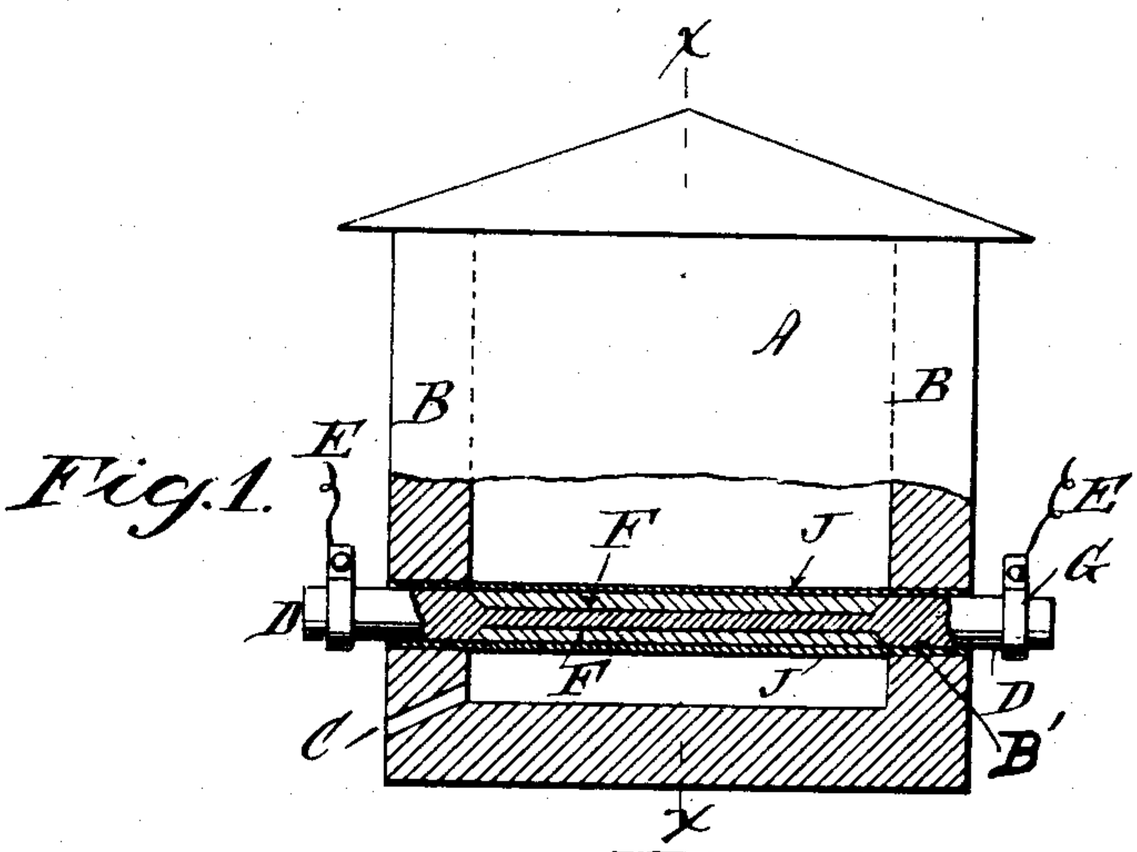



Fig. 1.

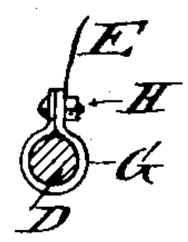



Fig. 2.

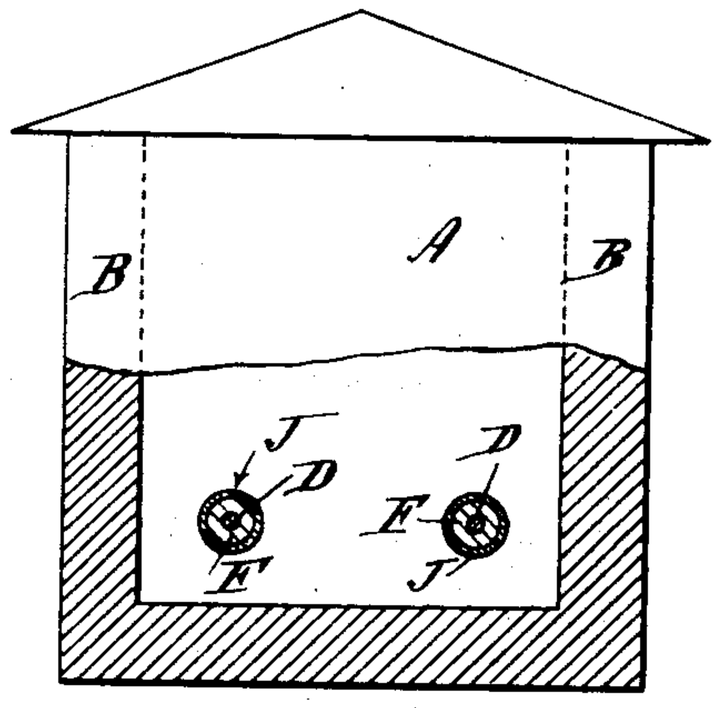
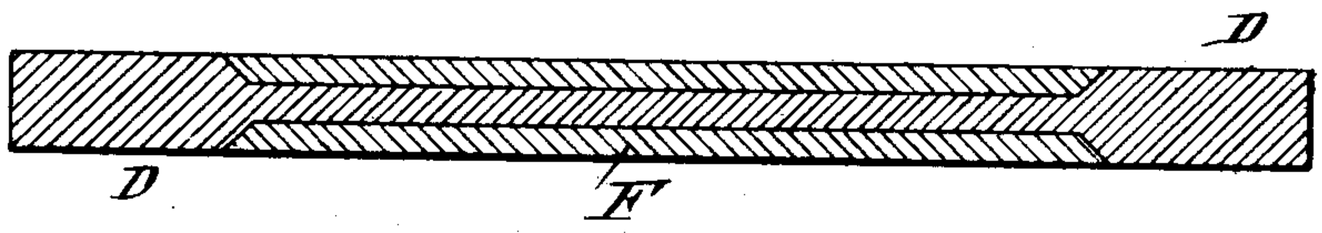



Fig. 3.




Witnesses:
Ernest B. Fahnestock.
Charles D. Daley

Inventor:
Leonard S. Dumoulin
by Walter S. Logan
Attorney

# UNITED STATES PATENT OFFICE.

LEONARD S. DUMOULIN, OF FLUSHING, NEW YORK.

## SMELTING-FURNACE.

SPECIFICATION forming part of Letters Patent No. 683,107, dated September 24, 1901.

Application filed October 13, 1899. Serial No. 733,456. (No model.)

*To all whom it may concern:*

Be it known that I, LEONARD S. DUMOULIN, a subject of the Queen of Great Britain, and a resident of Flushing, in the county of Queens, in the State of New York, have invented a new and useful Smelting-Furnace, of which the following is a description, reference being had to the accompanying drawings and to the letters of reference marked thereon.

My invention relates to improvements in heat-producing devices for the smelting of ore and the fusing of minerals in furnaces, and in particular to that class of smelting or fusing devices in which the electric current is used to produce the high degree of heat required; and it consists in the covered and insulated smelting-rod hereinafter described and the means by which it is rendered operative.

I am aware that extensive use of the electric current, although not upon any large individual scale, has been heretofore made in furnaces by forming an arc within the furnace between two electrodes. In this use of the current the heat generated is intense and uncontrollable, and the practical results have been found to be unsatisfactory. Attempts have also been made to smelt ores by means of a bare rod or coil or series of rods or coils placed within the furnace and heated to incandescence by passing the current through them. No practically successful results have been or can be attained in this way, because the admission of the oxygen, which occurs invariably to some extent, rapidly destroys such bare rods or coils. I am also aware that rods of carbon or other conducting material insulated and covered with a refractory substance adapted to be heated to incandescence by contact with the rod are known in the art; but a convenient and practicable means in said devices for producing and maintaining the required degree of heat in the furnace without danger of destroying the carbon rods or other conductors and of removing and replacing broken or disintegrated rods without materially cooling down the furnace has not heretofore, so far as I am aware, been known in the art.

In the drawings, Figure 1 is a side view, partly sectional, of a furnace in which my invention is embodied. Fig. 2 is a view, partly in section, at right angles to Fig. 1 on the line $x\ x$. Fig. 3 is an enlarged sectional view of my conductor.

A is the furnace, of any convenient size or shape, having walls B, of ordinary fire-brick or other material refractory to heat, having at opposite points openings B′, lined with non-conducting material, and a tap-hole C.

D is a cylindrical bar of carbon or other electrically-conducting substance, passed through the furnace from side to side and having its ends resting in the openings B′. The ends of bar D are of larger diameter than the portion within the furnace and are connected with the electric circuit by wires E E. Between the ends and the reduced portion the bar is preferably tapered, as shown.

G G are metal bands clasping the bar D at each end and secured thereon by means of bolt and nut H and electrically connecting the bar D and wires E. The bar D, if passed through the furnace without any covering and heated sufficiently to smelt ore, would be quickly destroyed. In order to protect it from the air, and thus from its own destruction, I cover that part of it within the furnace with a covering F of non-conducting refractory material, such as fire-clay, capable of transmitting the heat of the bar to the material to be fused or smelted and at the same time completely protecting the bar when heated from access of air or contact with the material to be treated. This covering F is preferably applied to the bar in a plastic condition and covers the reduced portion of the bar between the enlarged ends only, preferably extending, however, onto the tapered portions above described and is of such thickness that when in use, resting at its ends upon these tapered portions, it forms a support for the reduced portion of the bar to prevent its injury from the pressure of the material within the furnace. The thickness of the covering F is preferably such that the bar as a whole, including the covering, is of substantially uniform diameter throughout, as shown in Fig. 3. The portion of the bar D which is within the furnace being, as stated, of reduced diameter offers such resistance to the passage of the electric current that it will be heated to a temperature sufficiently high to effect the

fusing or smelting of the material to be acted on, while its ends being of larger diameter offer comparatively small resistance and not being covered will radiate heat freely, and thus remain comparatively cool and will not be subject to expansion and contraction to any material degree. The size of the bar D and the relative proportions of its reduced portion and ends can be readily calculated by an electrician for the size of furnace and for the degree of heat which it is desired to produce by following these rules: The reduced part of the bar D within the furnace must be of such diameter that with a given current the resistance will be increased sufficiently to yield the heat needed, and the enlarged ends of the bar D must be of such size that they will fit snugly within the openings B′ or the tubes J, hereinafter described, if these tubes are used. For a small furnace capable of smelting one ton of ore (copper, for example) per day I would use two carbon bars D twelve feet long, with a diameter of two inches at their enlarged ends and with a diameter at their reduced portions within the furnace of three-fourths of an inch, using a current of five thousand watts. The material F, covering the bar D within the furnace, must be heat-transmitting, so that the heat may pass through it. It must be indestructible by the heat. It must be a non-conductor of electricity, so that the necessary resistance will be obtained in the reduced part of the bar D. With such a covering the bar D within it may even disintegrate under the heat without affecting the operation of the furnace.

J is a tube within the furnace having its ends secured in the furnace-walls and is composed of fireproof material, such as fire-clay. This tube J is not essential to the operation of the furnace; but it forms a protection for the bar D additional to that afforded by the non-conducting covering F, and also allows the bar D to be readily withdrawn, if necessary, without interrupting the operation of the furnace. The contact between the covering F and the bar D is close, so as practically to exclude all air from that part of the bar when the bar D and its covering F are expanded by heat; but the tube J is made a little larger than the bar D, so as to allow of the easy insertion and removal of the bar D. The material of which the tube J is made must be refractory and heat-conducting, but it is not absolutely necessary that it should be non-conducting. The bar D should be placed near enough to the bottom of the furnace so that everything below it will be reduced to the liquid state. In the furnace of the proportions mentioned above I would place the bar D two inches from the bottom. Fig. 2 shows two similar conductors side by side, and it is obvious from the drawings and previous description that any number of tubes and bars can be placed in the furnace in the manner above indicated, according to the size and shape of the furnace and the results desired, and that the bars can be connected in multiple or series or placed singly in circuit.

In operation insulated and covered rods D D are passed into the tubes J J, connected, as hereinbefore described, with any sufficient source of electric power and connected at their opposite ends by suitable electric connections. The current is then turned on. The resistance of the bars D D along their reduced diameter to a sufficient current generates the desired degree of heat, which heat is transmitted through the covering F and the walls of the tubes J J to the mineral charge of the furnace A. Owing to the insulation of the bars D D by means of the covering F a high degree of heat, amply sufficient for smelting purposes, can be maintained for many hours. The enlarged ends of the bars D D, although uninsulated, will not burn out, owing to their large size, and consequently low resistance, and owing also to the fact that, as shown, they extend outside the furnace-wall and are without covering, free radiation being thus permitted. When the life of the carbon is finally used up or a breakage in the covering F or the bar D occurs, the bar D can readily be disconnected, withdrawn, and replaced with a fresh insulated bar.

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

1. In heat-producing devices for the smelting of ores and the fusing of minerals in furnaces, an electric furnace, a conductor consisting of a bar of high resisting material extending through the furnace-chamber having the portion thereof within the furnace of less diameter than its ends and a covering of insulating refractory material surrounding the reduced portion, of sufficient thickness and strength to support the reduced portion of the rod, the ends of the rod being without covering and supporting the ends of the covering of the reduced portion; substantially as described.

2. In heat-producing devices for the smelting of ores and the fusing of minerals in furnaces, an electric furnace, a conductor consisting of a bar of high resisting material extending through the furnace-chamber having the portion thereof within the furnace of less diameter than its ends, the rods being tapered between its ends and the reduced portion, and a covering of insulating refractory material surrounding the reduced portion of sufficient thickness and strength to support the reduced portion, and having its ends extending onto and supported by the tapered portions; substantially as described.

3. In heat-producing devices for the smelting of ores and the fusing of minerals in furnaces, an electric furnace, a conductor consisting of a bar of high resisting material extending through the furnace-chamber, having the portion thereof within the furnace of less diameter than its ends and a covering of insulating refractory material surrounding the

reduced portion, the exterior diameter of the covering being substantially the same as that of the ends of the bar; substantially as described.

4. In heat-producing devices for the smelting of ores and the fusing of minerals in furnaces, an electric furnace, a conductor-bar of high resisting material extending through the furnace-chamber, having a portion thereof covered by non-conducting refractory material, and a tube of refractory material having its ends secured in the walls of the furnace, and having its interior diameter corresponding substantially with the exterior diameter of the covering of the conductor-bar; substantially as described.

5. In heat-producing devices for the smelting of ores and the fusing of minerals in furnaces, an electric furnace, a conductor consisting of a bar of high resisting material extending through the furnace-chamber, having the portion thereof within the furnace of less diameter than its ends, a covering of insulating refractory material surrounding the reduced portion, the exterior diameter of the covering being substantially the same as that of the ends of the bar, and a tube of refractory material having its ends secured in the walls of the furnace and surrounding the conductor, the interior diameter of the tube being such that the conductor may be readily inserted therein; substantially as described.

In witness whereof I have hereunto set my hand this 9th day of October, 1899.

LEONARD S. DUMOULIN.

Witnesses:
MYRA B. MARTIN,
CHARLES S. DALEY.