(No Model.)

F. RIGAUD.

BLAST FURNACE FOR REDUCING ZINC.

No. 397,025. Patented Jan. 29, 1889.

Fig. 1

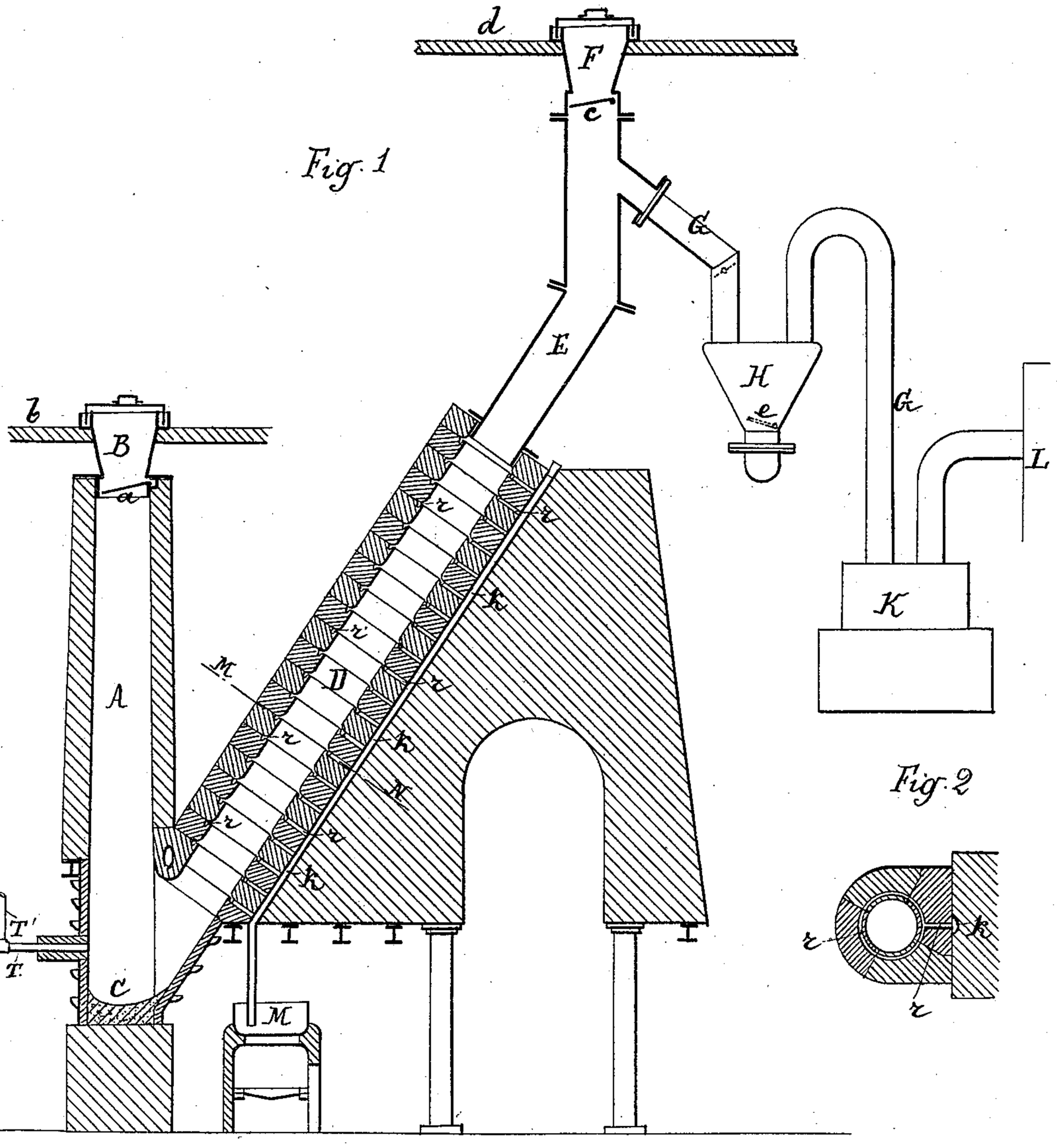

Fig. 2

WITNESSES:

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FERNAND RIGAUD, OF ALAIS, GARD, FRANCE.

BLAST-FURNACE FOR REDUCING ZINC.

SPECIFICATION forming part of Letters Patent No. 397,025, dated January 29, 1889.

Application filed February 2, 1888. Serial No. 262,786. (No model.) Patented in France December 22, 1887, No. 187,763; in England December 27, 1887, No. 17,809; in Belgium December 27, 1887, No. 80,068; in Italy January 3, 1888, XXI, 22,850, XLV, 157; in Norway January 11, 1888, No. 743, and in Spain March 22, 1888, No. 7,739.

To all whom it may concern:

Be it known that I, FERNAND RIGAUD, a citizen of the French Republic, and a resident of Alais, (Gard,) France, have invented certain Improvements in Blast-Furnaces for Reducing Zinc, &c., (for which I have been granted Letters Patent in France, No. 187,763, dated December 22, 1887; in Great Britain, No. 17,809, dated December 27, 1887; in Belgium, No. 80,068, dated December 27, 1887; in Spain, No. 7,739, dated March 22, 1888; in Italy, No. XXI, 22,850, XLV, 157, dated January 3, 1888, and in Norway, No. 743, dated January 11, 1888,) of which the following is a specification.

My invention relates to a double-cupola blast-furnace for reducing the ores of zinc and other metals, and especially those of a volatile character.

It is well known that in passing through a blast-furnace ores containing volatile metals—such as zinc and mercury—mixed with a suitable flux a complete separation and distillation of the metals is effected; but at the same time great difficulty is experienced in their recovery without excessive loss or injurious transformations. In order to profit by the enormous economic advantages due to the use of the cupola-furnace in connection with the apparatus commonly employed in the extraction of these metals, Messrs. Lesainne, Lencauchez, Müller, and other metallurgists made some important experiments about the year 1860; but they failed by reason of not discovering any suitable means of condensing the metallic vapors, which could be adapted for employment industrially. I have found a practical construction for effecting the desired result, and this forms the subject of the present application.

My apparatus comprises a double cuve or cupola, which can be primarily constructed as a whole, or the second cupola applied to blast-furnaces such as are now used, or to a Raschette furnace already installed, by annexing to the cupola already in use another applied according to my invention.

My apparatus is illustrated in the accompanying drawings, wherein—

Figure 1 is a vertical section or sectional elevation of the apparatus, and Fig. 2 a transverse section of the second cupola in the plane indicated by line M N in Fig. 1.

As hereinbefore stated, my apparatus employs two cuves or cupolas. The first is the ordinary reducing-cupola, A, of a blast-furnace or cupola-furnace having a circular, square, trapezoidal, or rectangular cross-section and of variable height and dimensions, according to the nature of the ores to be treated and the importance of the product to be obtained. This cupola A is provided with a tuyere, T, for the blast, with or without water-circulation. A hot blast is usually employed. This cupola A is furnished at its top with a hopper, B, or some like charging device, fitted so as to prevent the escape of gas and provided with a valve, *a*. A platform, *b*, is arranged around the hopper B. After the usual period of firing, a charge of ore mixed with a suitable flux—coal and wood or coke—necessary to produce a good and somewhat basic slag entirely free from precious metals, is introduced.

The second cuve or cupola, D, which extends obliquely upward from the melting-pot C of the first cupola, A, has its axis considerably inclined, in order to facilitate the descent of the combustibles contained in it. Its section is proportionate to that of the vertical cupola A and is circular or polygonal in form and is of such length that the gas which traverses it issues at a temperature lower than the point of ebullition of the metal to be recovered. This cupola D, which is generally prolonged by a metal tube, E, should serve for the condensation of metallic vapors in its main part, and especially for the condensation of vapors of zinc. For mercury perhaps the condensation will be effected throughout the entire course to the outlet-passage.

The upper orifice of the cupola D is furnished with a hopper, F, provided with a valve, *c*. A platform, *d*, is arranged around this orifice. Suitable charging devices will be employed for introducing the charge of coal, charcoal, metallurgic coke, or gas-coke. Below or in front of the hopper F the gas-outlet

pipe G taps the extension-pipe E and extends down into a dust box or catcher, H, provided with a valve, *e*. Thence the gas-pipe extends to a dust-washer, K, and finally to a dust-chamber, L.

The interior part or lining of the cupola D, especially when zinc is the metal treated, should be constructed of refractory materials and have transverse or helicoidal grooves *r*, with contracted openings, arranged in such a manner as not to retard too much the descent of the fuel, yet still so as to catch and recover the little drops of liquid metal and to conduct them by a special channel, *k*, to the receiving-basin M, where they can be recovered. One part of this cupola D, and notably the upper part, of a vaulted form, may in certain cases be constructed of cast-iron or be protected by a metallic casing. The gases issuing from this cupola are deprived of smoke and matter in suspension in passing through cuvettes, dust-chambers, and washers, and they may be afterward utilized for calcination, roasting, heating air, the production of steam, and other useful purposes.

Operation: The furnace being fired up or heated, the mixture of ore, &c., is introduced into the ore-hopper B and the coal or fuel into the fuel-hopper F at regular intervals. The mineral when it descends to the tuyere-zone is fused and volatilized, the slag forms and descends into the melting-pot C, whence it is drawn off in the usual way. The metals not volatile under ordinary furnace temperatures fuse and collect at the bottom of pot C, and may be freed, either in combination or separately, from speiss and matt. The volatile metals are drawn in the form of vapors into the cupola D by the gases, and are completely reduced by the combustibles therein. The vapors of the metals that are least volatile flow along the walls or lining of the cupola D, where they encounter the grooves *r*, which gather and condense them and carry them to the receptacle M. The vapors of the more volatile metals and the dust are recovered in the manner hereinbefore stated.

It is necessary to say here that the cupola A may in some cases be arranged obliquely as well as the cupola D, but that this arrangement, which is necessary for the latter, is not necessary for the former. For fuel anthracite as well as soft coal may be used, and also shales. If solid combustible material is more expensive than liquid, the quantity of the former required may be considerably diminished by annexing to the tuyere T a suitable pipe, as T′, for introducing into the melting-pot C organic liquid combustibles—such as petroleum, coal-tar, &c.—or combustible gases—such as natural gas—may be so introduced. Combustible hydrocarbons may also be introduced into the top of the reducing-cupola; but in all cases there must be solid fuel in the cupola D.

The cupola D may be modified in arrangement somewhat according to circumstances, sometimes constructed interiorly of refractory materials, as in the drawings, which form is necessary for extensive production; sometimes reduced to a semi-cylindrical form interiorly for a part of its length and partially covered with an envelope of sheet or cast iron. The grooves or channels *r* may occupy only a part of the section, and they will often be confined to the inferior part of the cylinder or prism of the cupola D.

I am aware that the mere employment of a fuel-cupola alongside of a reducing-cupola and connected with the latter at the fire-pot is not new. A furnace has been proposed wherein the said fuel-cupola is substantially, if not quite, vertical, and the vapors of zinc pass up through it as through a flue and are condensed therein. In operating such a furnace the temperature of this upright fuel-cupola is maintained at a point above that at which the vapors condense. In my furnace the cupola D is considerably inclined and entirely distinct from the cupola A, except where they join at the melting-pot, and in my furnace the cupola D is the vapor-condenser, its temperature being kept below that at which zinc vaporizes. Thus I condense the vapors of zinc entirely within the furnace, where they are fully protected against oxidation.

Having thus described my invention, I claim—

1. A furnace for the reduction of volatile metals, comprising an ore cupola or reducer and a fuel-cupola connecting with said ore-cupola at the melting-pot in the bottom of the latter, said fuel-cupola being inclined and having suitable grooves in its inner surface for the recovery of the vaporized metal condensed within said cupola, substantially as set forth.

2. In a furnace for reducing the ores of volatile metals, the combination, with the ore cupola or reducer, of the inclined fuel-cupola D, connected with the lower part of the ore-cupola, said cupola D being provided with grooves and channels *r k* for the recovery of the vaporized metal, substantially as set forth.

3. The combination, with the ore-cupola A, provided with a melting-pot, C, and tuyere, of the inclined cupola D, connecting with the cupola A at its lower end, the dust-box H, the washer K, the chamber L, and the pipes G, connecting said box, chamber, and washer with the elevated part of cupola D, substantially as set forth.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

FERNAND RIGAUD.

Witnesses:
ROBT. M. HOOPER,
JULES ARMENGAUD, Jeune.