(No Model.) 2 Sheets—Sheet 1.

H. S. BLACKMORE.

FURNACE FOR REDUCING METALS.

No. 478,908. Patented July 12, 1892.

Fig. 1.

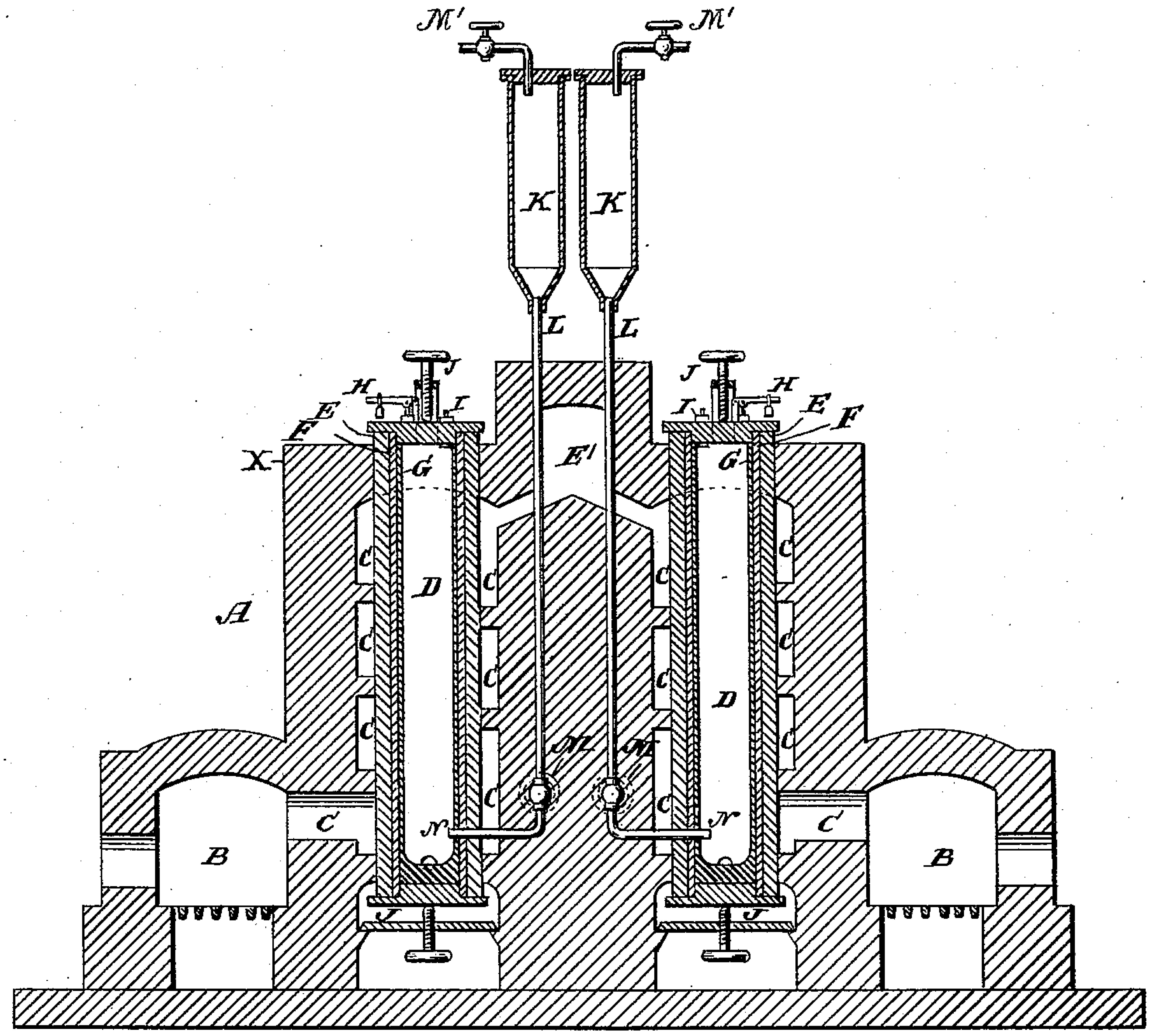
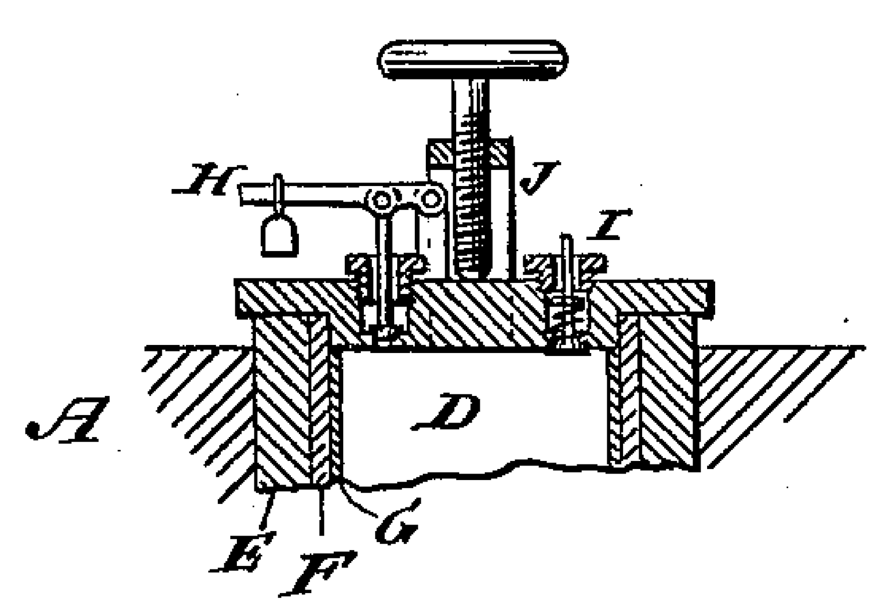


Fig. 2.



WITNESSES:

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ATTORNEYS

(No Model.) 2 Sheets—Sheet 2.

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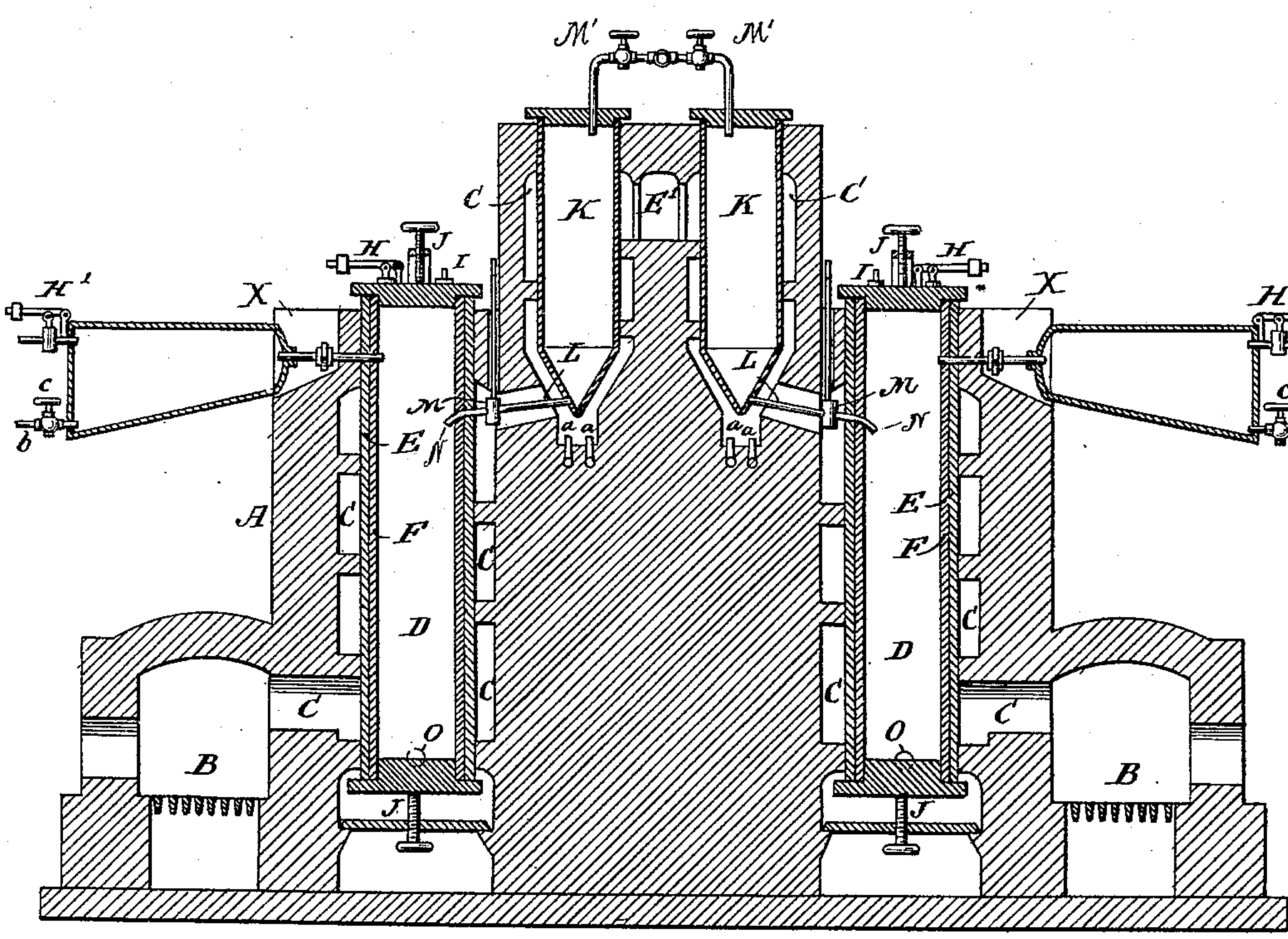
Fig. 3.



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UNITED STATES PATENT OFFICE.

HENRY S. BLACKMORE, OF MOUNT VERNON, NEW YORK.

FURNACE FOR REDUCING METALS.

SPECIFICATION forming part of Letters Patent No. 478,908, dated July 12, 1892.

Application filed June 18, 1891. Serial No. 396,732. (No model.)

To all whom it may concern:

Be it known that I, HENRY S. BLACKMORE, a citizen of the United States, residing at Mount Vernon, in the county of Westchester and State of New York, have invented new and useful Improvements in Furnaces for Reducing Metals, of which the following is a specification.

The object of my invention is to overcome the loss of metal by volatilization, oxidation, and contamination of the metal reduced, and to effect a saving of fuel, &c.

This furnace is specially adapted to the reduction of such metals as sodium, aluminium, magnesium, potassium, and other metals, which I reduce from their combinations in a fused state by means of a reducing agent in a like fused condition under pressure sufficient to force the same into or through the material reduced.

The construction of the furnace may be readily understood by referring to the accompanying drawings, forming part of this specification, in which—

Figure 1 represents a vertical section of a furnace constructed according to my invention. Fig. 2 is a vertical section through the head of one of the reducing cylinders or chambers. Fig. 3 is a vertical section of the furnace with modifications adapting it for operation with reducing agents of greater specific gravity than the material to be reduced.

The letter A designates a furnace provided with fire-boxes B B, from each of which proceeds a flue C, that is carried around a reducing cylinder or chamber D and discharges into the chimney E′, which is common to both flues. The reducing-chambers D are of similar construction with each other, their outer walls E, around which the spiral flues C are carried, being composed, by preference, of fire-clay, within which is a cylindrical vessel F, of wrought-iron, which is provided with a lining G, of carbon or of other material, depending on the metal to be reduced. If a sodium salt is to be reduced, the inside lining G can be omitted; but if a compound of aluminium is to be reduced the carbon lining is retained.

The cylinders D constitute what I call "reducing-chambers" and are duplicates of each other, so that a description of one answers for a description of the other. They are also independent of each other, as are the vessels containing the reducing agents, the apparatus being shown in duplicate with a common chimney for the sake of economy.

A quantity of the material to be reduced—say, for example, a salt of aluminium—being placed in one of the reducing-chambers D, it is fused or brought to a molten state by means of the heat generated in the adjacent fire-box B, passing up through the flues C, which are carried about the chamber D for that purpose. The air in the reducing-chamber is held under control by means of an ordinary pressure-valve H and a vacuum-valve I, both placed in the upper head J of the reducing-chamber. The vacuum-valve I is so arranged that the spring around its stem draws the valve proper up against its seat to close it, and when the pressure in the chamber D is less than the pressure of the atmosphere the valve will open and air will be admitted to equalize the pressure on both sides of the valve, as in the case of drawing the metal or slag from the chamber or retort D through the tap-hole O.

K is a vessel, which may be of iron and in which is placed the reducing agent, which is either fused or melted after it has been placed therein or is placed therein after it has been fused or melted elsewhere. The vessel K is provided with a removable head, as shown in the drawings, through which it is charged, and the said vessel K is connected with the interior of the chamber D by a tube L, which enters the lower part of the chamber at the point N, the discharge of the molten or liquid reducing agent from the vessel K to the chamber D being controlled by stop-cocks M.

When the material to be reduced—say double chloride of aluminium—and the reducing agent—say sodium—are fused or brought to a molten state in their respective chambers or receptacles D and K, pressure is applied to the reducing agent in its vessel K by means of compressed gas admitted through a pipe connected with the head of said vessel or receptacle K and supplied with a valve M′, and the same is forced through the tube L into the reducing-chamber D after the valves or cocks M M have been opened. The valves H and I are so adjusted that when the pressure in the reducing-chamber D exceeds five pounds to the square inch the pressure-valve H opens and the air contained in the reducing-chamber above the molten material therein escapes, while the reducing agent entering the reducing-chamber at N increases the liquid contents of said chamber. As the reducing agent enters the reducing-chamber in a small stream under pressure through the tube L, the reducing agent rises gradually through the fused material to be reduced, quietly reducing it to its metallic state and liberating the small globules of metal contained in it, which, being thus freed from the other matters present, readily combine and settle in a mass or button at the bottom of the reducing-chamber, whence it is finally drawn off through the discharge-opening O and cast into ingots.

It is obvious that in a case where the reducing agent is heavier or of greater specific gravity than the material to be reduced the same should be discharged or forced into the material to be reduced at the top in small streams, instead of at or near the bottom, when a similar result will be attained by the gradual settling or passage downward of the reducing agent through the fused material in the reducing-chamber. In such case provision is made for discharging the molten or liquid reducing agent into the reducing-chamber at its top or upper part through suitable openings in it, as shown in Fig. 3.

When reducing agents of comparatively light specific gravity are to be employed—such, for example, as sodium or potassium—it is advantageous to place some aluminium, magnesium, or other metal a salt or compound of which is to be reduced in the bottom of the reducing-chamber D, enough to cover the discharge-opening N, in order to prevent the flux or fused material in the reducing-chamber from clogging the mouth of tube L at N.

Where aluminium is to be reduced, a compound—such as cryolite or the double chloride of aluminium and sodium or a similar compound—is fused or melted in the reducing-chamber D and sodium or some similar reducing agent is melted in the chamber or vessel K in any convenient manner by the heat generated in the furnace. When both materials are properly fused or melted, pressure is applied to the reducing agent in the chamber or vessel K in any convenient manner—say by means of compressed hydrogen—the valves or cocks M being thrown open, and the sodium or other reducing agent in its molten state is forced into the fused cryolite or other material at N and gradually rises through the fused material and quietly reduces the same, while the aluminium thus reduced gradually settles and combines at the bottom of the reducing-chamber and is drawn off through opening O.

In case sodium is to be reduced the sodium salt—such as caustic soda—is fused or melted in the reducing-chamber D, as above explained, and the process carried out, as described in the reduction of aluminium, with the exception that for this purpose the chamber K, instead of being composed of iron and outside of the walls of the furnace, as shown in the drawings, Fig. 1, is composed of some refractory material and situated within its walls, so as to be exposed to the direct heat of the furnace, and the molten reducing agent, which is preferably iron, is forced therefrom into and near the top of the molten mass in the reducing-chamber in small streams, and instead of drawing the metallic sodium off, as in the case of aluminium, it is allowed to distill and is condensed in a condensing-chamber connected with the outside of the furnace or placed near thereto, as shown in Fig. 3, where the furnace is shown with slight modifications adapting it for operation with the reducing agents, which are of greater specific gravity than the material to be reduced, and when the soda becomes saturated or filled with oxide of iron it is drawn from the reducing-chamber through the tap-hole O and fresh soda supplied, while the oxide of iron is separated from the soda thus drawn by lixiviation, the liquor soda being afterward evaporated and fused and the oxide of iron reduced to its metallic state. Both are used over again in future operations.

Observing Fig. 3, the receptacles K and the reducing agent therein are subjected to heat from oxyhydrogen-jets *a a*, arranged beneath the receptacles, whereby the reducing agent employed is melted or fused, so that it can be forced through pipe L into reducing-chamber D on opening the valve M. The condenser X for condensing the sodium may be supported near the outside of the furnace, as shown in Fig. 3, and is provided with a pressure-valve H′, which is so weighted that it will open at a less pressure than the pressure-valve H, so as to allow the gases to escape that are generated in chamber D during the process of reduction of the metal. The lower end of the condenser is provided with a discharge-pipe *b* and valve *c* for drawing off the condensed metal which has collected in the condenser from the reducing-chamber. The pressure-valve H acts as a governor to relieve the pressure in case the tube that connects the chamber D with the condenser should become clogged.

In cases where sodium or potassium are used as a reducing agent the heat arising from the furnace heats the receptacle K, Fig. 1, sufficiently to melt the contents, as these elements fuse at a temperature of about 200° Fahrenheit, so that it is unnecessary to place the same in brickwork. In cases where iron or other less fusible reducing agents are used the receptacle may be set within the walls of the furnace by placing it lower and heating it by carrying the flue C around it, or by oxyhydrogen flame in any convenient manner, as shown in K, Fig. 3.

The vacuum and pressure valves I and H in the heads of the retorts or chambers D control the passage of air in said chambers, because the fused or melted material to be reduced which is in the chambers D is under pressure, the pressure being communicated from the fused or melted reducing agent in the retort or receptacle K through tube L, the valve M being open. The material in the retorts or chambers D being under pressure, it can be readily understood that the pressure will keep the vacuum-valve closed, so that no air can be admitted through it, and the air contained in said receptacle D above the fused salt cannot escape until the pressure exceeds that of the pressure-valve, so that no air is admitted into receptacle D while the reducing action is going on.

The object of the vacuum-valve is to allow the air to enter the receptacle D after the metal has been reduced and the pressure lessened, so that the air admitted can take the place of the metal or slag when they are drawn from the retort or chamber D through the tap-hole O.

My furnace prevents loss by volatilization of either the reducing agent or of the material to be reduced or by oxidation by being entirely inclosed and protected from free passage of air by a five-pound pressure-valve and a vacuum-valve, which admits air only after the metal has been reduced and is being drawn off from the furnace. It also prevents contamination of the metal reduced by having the reducing-chamber lined with a material specially adapted to the same—as, for instance, in the case of aluminium, (where care must be taken not to have it contaminated with silicon, which it would obtain from a fire-clay lining, or iron, which it would obtain from an iron vessel or receptacle,) a carbon lining is employed, and in the case of sodium the ordinary iron cylinder without the lining is preferred.

The cylinders or reducing-chambers are composed of wrought-iron, having a fire-clay covering and lined with a material especially adapted to the metal to be reduced, as above explained.

What I claim as new, and desire to secure by Letters Patent, is—

1. In a furnace for the reduction of metals, the combination of a fire-box B, a suitable heating-flue C about chamber or receptacle D for the purpose of melting or fusing the material to be reduced, the receptacle D, the receptacle K for containing the reducing agent in a fused or melted state and situated within or above the furnace, so as to be heated by it or its flue C and so that said reducing agent therein shall always be above the level of the fused material in chamber or receptacle D, tube L, connecting the receptacles D and K, valve M in the tube L for controlling the flow of the reducing agent from receptacle K into receptacle D, receptacle D being provided with a pressure-valve H for keeping the fused materials therein under pressure, and a vacuum-valve I for admitting air to take the place of the metal or slag when drawn from the receptacle D through the tap-hole O, substantially as shown and described.

2. In a furnace for the reduction of metals, the combination, with a fire-box and a heating-flue C, of a retort or chamber D for containing the material to be reduced in a fused or molten state, the retort or receptacle K, in which the fused or molten reducing agent is contained, it being situated so that said reducing agent therein shall always be above the level of the fused material in chamber or receptacle D, the pressure and vacuum valves H I in the reducing-chamber, and the valve M for controlling the discharge of the reducing agent into the reducing-chamber D, substantially as described.

In testimony whereof I hereunto set my hand in the presence of two subscribing witnesses.

HENRY S. BLACKMORE.

Witnesses:
J. VAN SANTVOORD,
W. C. HAUFF.