No. 792,440. PATENTED JUNE 13, 1905.

M. MOORE & T. J. HESKETT.

APPARATUS FOR TREATING FERRUGINOUS ORE FOR THE MANUFACTURE OF IRON AND STEEL THEREFROM.

APPLICATION FILED JAN. 25, 1904.

4 SHEETS—SHEET 1.

FIG. 1.

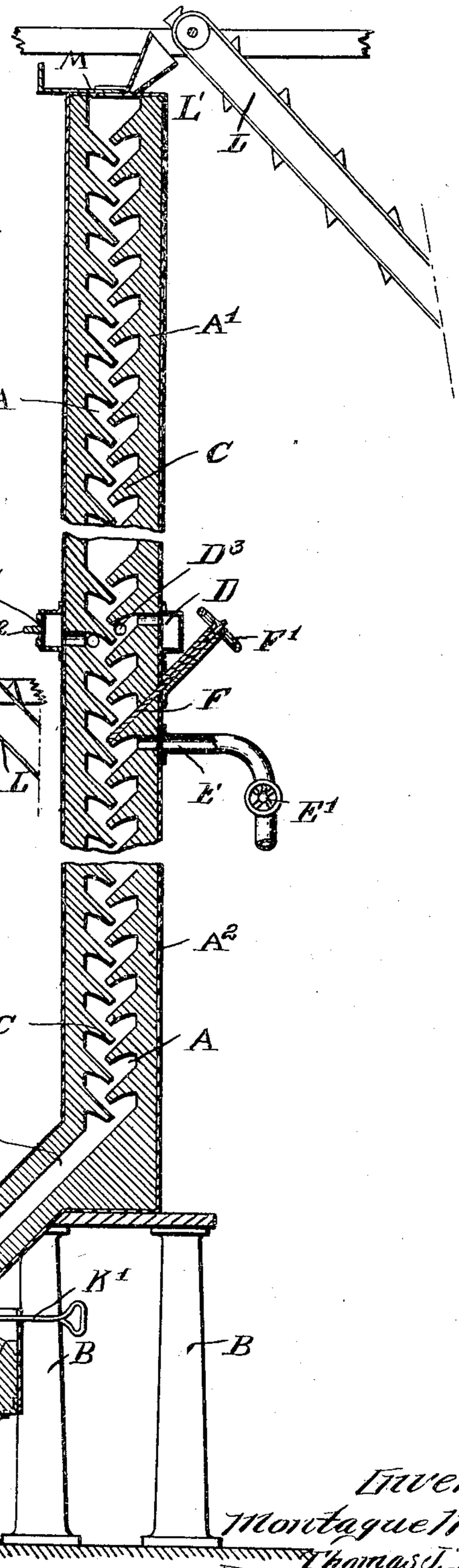
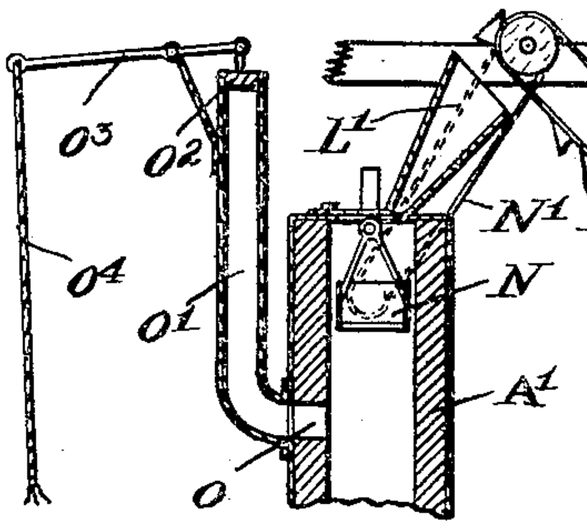


FIG. 2.



Witnesses:
C. L. Kesler,
James L. Norris, Jr.

Inventors
Montague Moore
Thomas J. Heskett
By James L. Norris.
Atty's

No. 792,440. PATENTED JUNE 13, 1905.

M. MOORE & T. J. HESKETT.

APPARATUS FOR TREATING FERRUGINOUS ORE FOR THE MANUFACTURE OF IRON AND STEEL THEREFROM.

APPLICATION FILED JAN. 25, 1904.

4 SHEETS—SHEET 2.

FIG. 3.

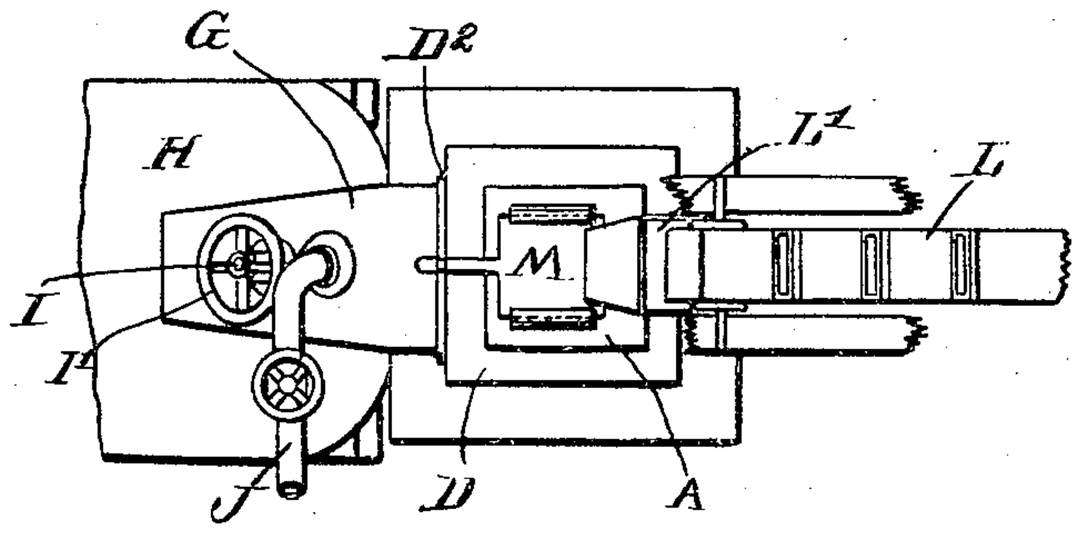
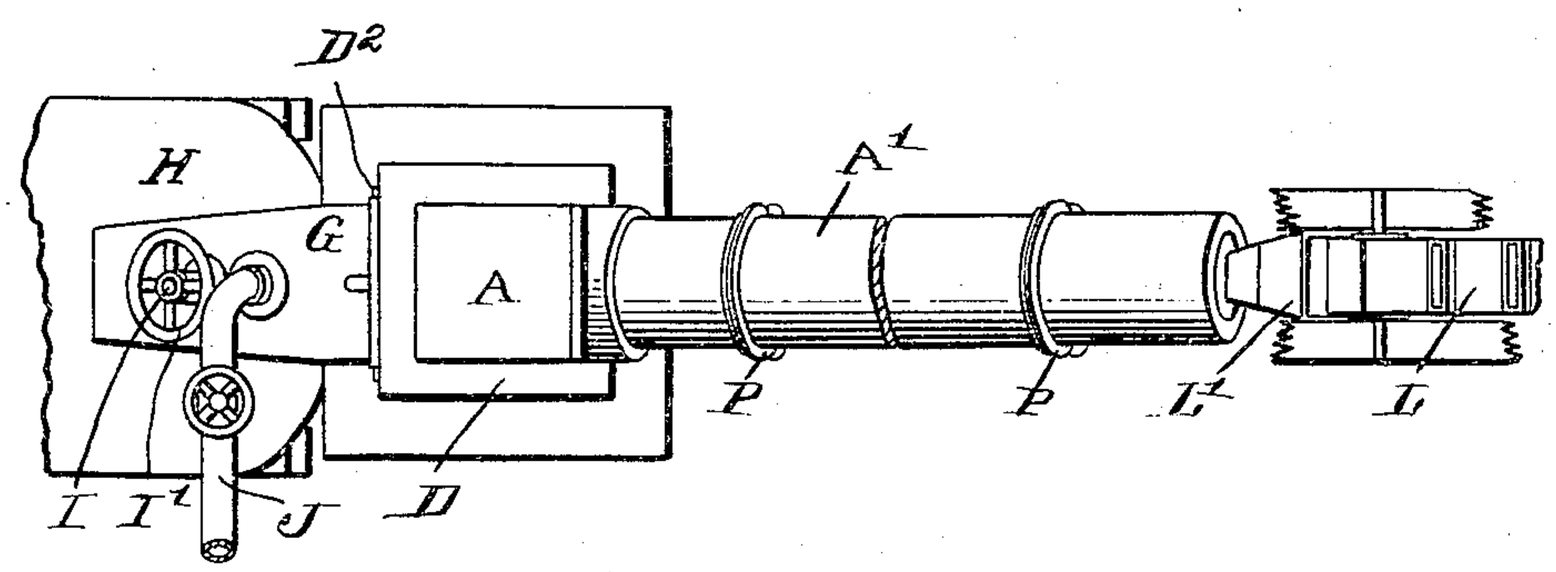


FIG. 6.



Witnesses,
C. D. Kesler,
James L. Norris, Jr.

Inventors
Montague Moore
Thomas J. Heskett
By James L. Norris.
Atty.

No. 792,440. PATENTED JUNE 13, 1905.

M. MOORE & T. J. HESKETT.

APPARATUS FOR TREATING FERRUGINOUS ORE FOR THE MANUFACTURE OF IRON AND STEEL THEREFROM.

APPLICATION FILED JAN. 25, 1904.

4 SHEETS—SHEET 3.

FIG. 4.

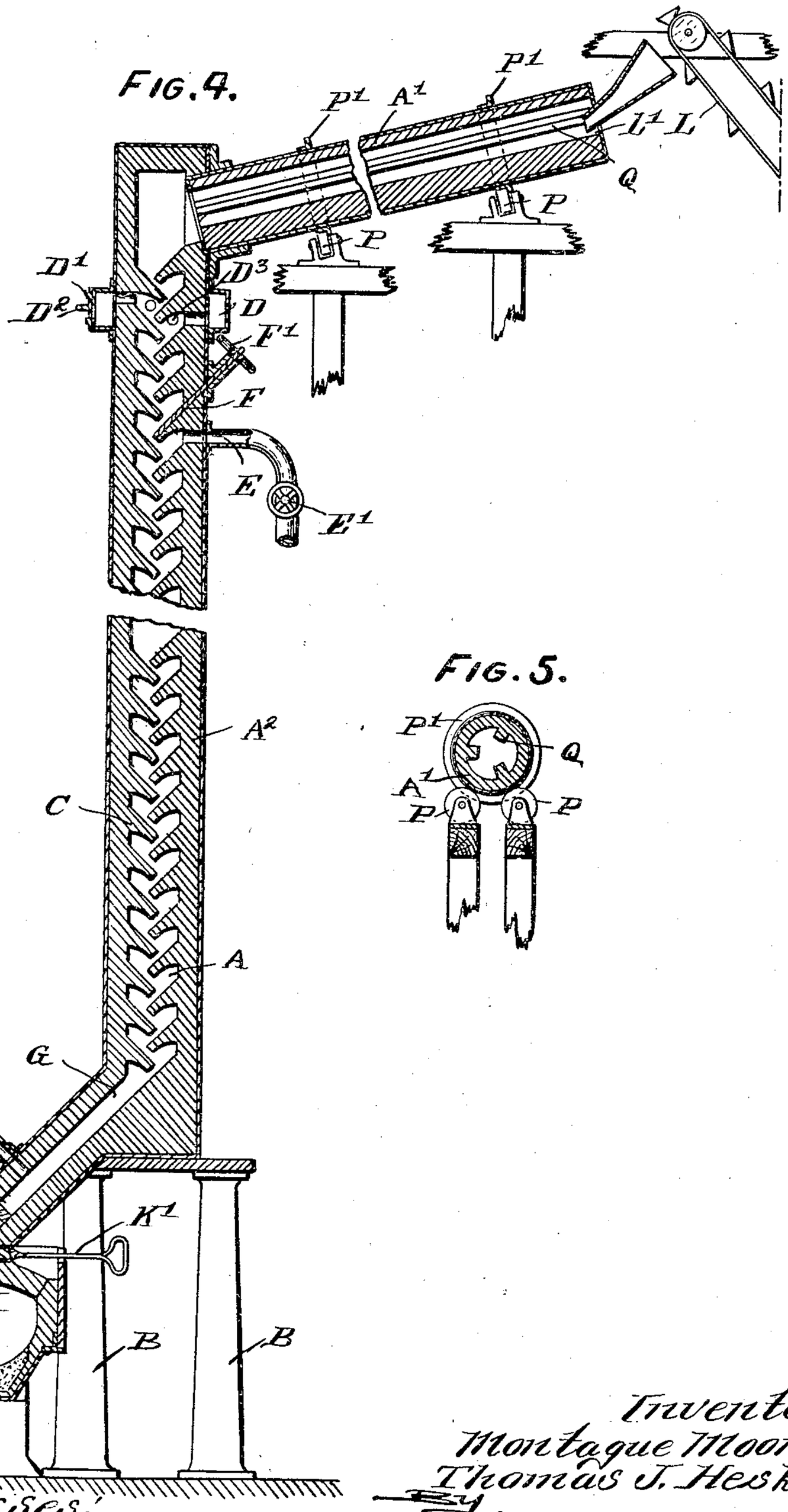


FIG. 5.

Witnesses,
C. D. Kesler
James L. Norris, Jr.

Inventors
Montague Moore
Thomas J. Heskett
By
James L. Norris
Attys.

No. 792,440. PATENTED JUNE 13, 1905.

M. MOORE & T. J. HESKETT.

APPARATUS FOR TREATING FERRUGINOUS ORE FOR THE MANUFACTURE OF IRON AND STEEL THEREFROM.

APPLICATION FILED JAN. 25, 1904.

4 SHEETS—SHEET 4.

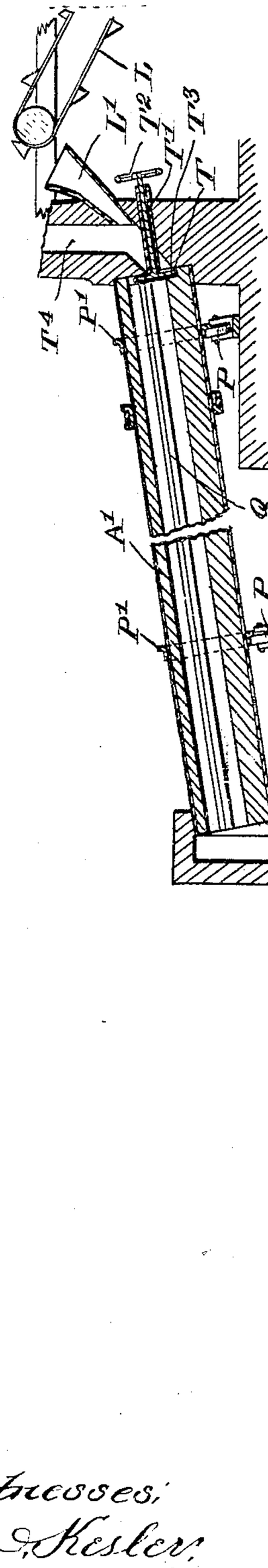


FIG. 7.

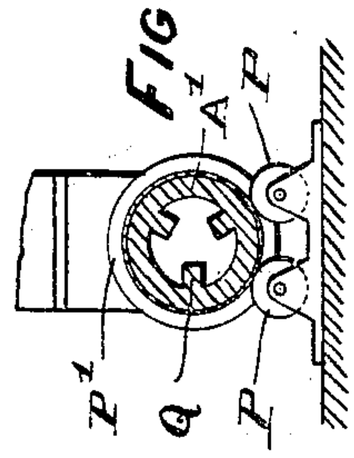


FIG. 8.

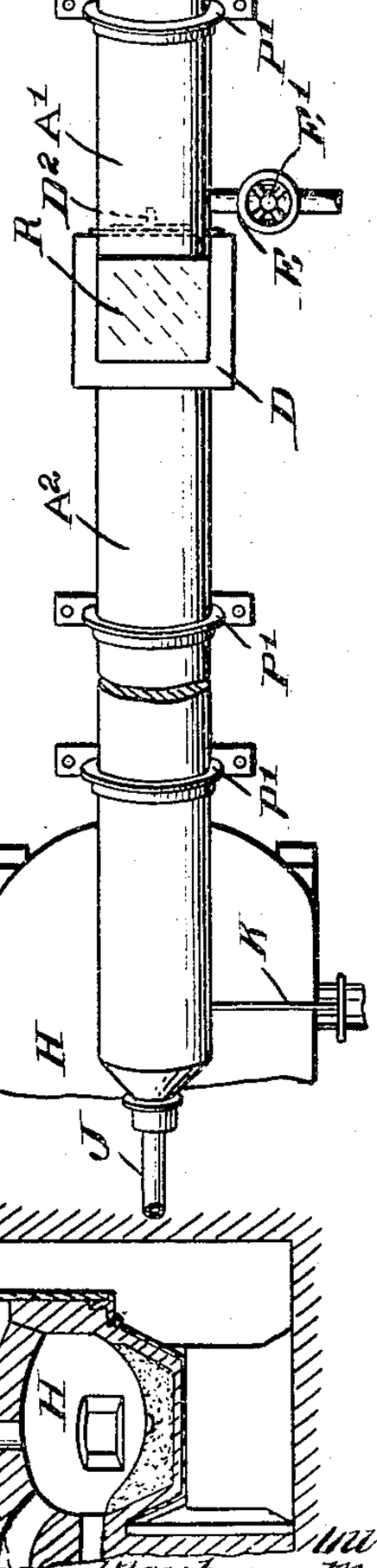


FIG. 9.

Witnesses:
C. F. Kester.
James L. Norris, Jr.

Inventors
Montague Moore
& Thomas J. Heskett
By James L. Norris
Attys.

No. 792,440. Patented June 13, 1905.

UNITED STATES PATENT OFFICE.

MONTAGUE MOORE, OF MELBOURNE, AND THOMAS JAMES HESKETT, OF BRUNSWICK, VICTORIA, AUSTRALIA.

APPARATUS FOR TREATING FERRUGINOUS ORE FOR THE MANUFACTURE OF IRON AND STEEL THEREFROM.

SPECIFICATION forming part of Letters Patent No. 792,440, dated June 13, 1905.

Application filed January 25, 1904. Serial No. 190,587.

To all whom it may concern:

Be it known that we, MONTAGUE MOORE, a resident of No. 408 Collins street, Melbourne, and THOMAS JAMES HESKETT, a resident of No. 86 Donald street, Brunswick, in the State of Victoria and Commonwealth of Australia, subjects of the King of Great Britain, have invented a new and useful Improved Apparatus for Treating Ferruginous Ore for the Manufacture of Iron and Steel Therefrom, of which the following is a specification.

Our improved apparatus has been devised for the purpose of carrying out a process for treating ferruginous ore for the purpose of manufacturing iron and steel from what are known as "magnetic iron sands," such as those found in New Zealand and elsewhere; but it is equally applicable for treating any ferruginous ore which has been crushed or ground to a state of comminution.

The process in question forms the subject of an application for Letters Patent filed by us contemporaneously herewith; and it consists in first concentrating and separating from such ferruginous ore any silica, earthy, or other deleterious matter contained therein. The ore is then subjected while passing through a chamber to the action of heat, preferably produced by the admixture of air with waste carbonic-oxid or hydrocarbon gas issuing from another chamber, and subsequently to the progressive reducing action of such gas or gases alone while passing through said latter chamber, the result being that all the oxygen is removed from the ore, which is thereby converted into the metallic state, but being still in a finely-divided condition. It is then allowed to pass without coming into contact with an oxidizing atmosphere into a Siemens or other gas-furnace, where it is fused and "balled up" as wrought-iron or converted into molten steel. The keeping of the heated reduced ore from contact with an oxidizing atmosphere during the operation of delivering it from the deoxidizer to the gas-furnace is an essential feature of our process.

Our improved apparatus for carrying out the process above described consists of a vertical brick tower containing a number of shelves arranged in series one above the other and approximately at an angle of forty-five degrees below the horizontal. At or about a point midway between the bottom and top of the tower we provide inlets for air, the supply of which can be regulated as desired. At the base of the tower we also provide an inlet for reducing-gas, such as carbonic-oxid or hydrocarbon gases, the supply of which can also be regulated at will. The tower is supported on piers, and at the side of and below the base-line of the tower is a Siemens or other gas-furnace and gas-producers from which the supply of gas for the tower is obtained. The top of the gas-furnace is connected to the base of the tower by means of an inclined passage, and in the latter is a valve to regulate the supply of reduced ore from the tower to the gas-furnace. The entrance to the said gas-furnace is closed by means of a fire-brick valve. The gas for the Siemens furnace is supplied from the producers before referred to. At the side of the tower is an elevator for raising and delivering to the top thereof the ore to be treated.

Instead of the shelves in the tower we may use a shaking-sieve or riddle, in which case the top of the tower is closed by an iron plate from which the riddle is suspended, motion being conveyed to it in any approved way from the elevator-shaft. A hole is provided in the plate in order to permit of the elevator delivering the ore to the tower. To provide for the escape of the products of combustion, a port is provided in the upper part of the tower below the riddle leading to a chimney at the side.

A modification of our apparatus consists in considerably reducing the height of the tower by dispensing with that portion which constitutes the heating-chamber and substituting therefor a revolving cylindrical chamber in which the heating of the ore is effected. This chamber is arranged at an angle of about ten degrees with the horizontal and is arranged at a point just above the air-inlets. In this modification the elevator delivers the ore into the upper end of the revolving chamber.

In lieu of using either a tower or the

modification last described for effecting the heating and subsequent deoxidation of the ore we may, if found desirable, use what is known as a "Bruckner two-cylinder roaster." We, however, dispense with the furnace for heating it and provide means for supplying air to the passage between the two cylinders. We prefer also that the cylinders instead of being horizontal should be set slightly at an angle. The lowermost cylinder is arranged so that its contents can be delivered into the Siemens or other gas-furnace. The gas is delivered into the latter cylinder, which constitutes the deoxidizing-chamber, and combustion takes place when it meets the air entering the passage above referred to. The heat then passes up into the upper chamber, in which the heating of the ore takes place.

We are aware that attempts have been made to manufacture iron from ferruginous ore in a fine state of division by subjecting it to the deoxidizing action of carbonic-oxid or other gases and subsequently bringing it to a state of fusion in a Siemens or other gas-furnace; but so far as we know such ore has not previously been subjected to a preliminary heating and certainly not to a preliminary heating by the complete combustion of waste gases from the reducing or deoxidizing chamber with air before being deoxidized by such gases, nor has it been kept from contact with an oxidizing atmosphere during the delivery of the reduced ore from the deoxidizer and its subsequent treatment in the furnace.

In cases where hydrocarbon gases are used as the deoxidizing agent more heat would be generated when such gas is mixed with air than would be required, and for the sake of economy we provide means by which a portion of this surplus gas can be taken after it passes through the deoxidizing-chamber and fed to the Siemens or other gas-furnace for heating it.

Referring to the drawings hereto annexed, in which similar letters refer to similar parts throughout the several views, Figure 1 is a sectional elevation of an apparatus for carrying out our process in which the heating and subsequent deoxidation of the ore is effected in a vertical tower. Fig. 2 is a sectional elevation of certain modifications in the construction of the tower. Fig. 3 is a plan of Fig. 1. Fig. 4 is a sectional elevation of a modified form of apparatus in which that portion of the tower which in Fig. 1 constitutes the heating-chamber is dispensed with and a revolving cylindrical chamber is substituted therefor. Fig. 5 is a cross-section of said revolving chamber. Fig. 6 is a plan of Fig. 4. Fig. 7 is a sectional elevation of another modified form of apparatus. Fig. 8 is a cross-section of the cylinders illustrated in Fig. 7. Fig. 9 is a plan of Fig. 7.

Referring now to Fig. 1 of the drawings, A is a vertical square brick tower incased with iron and supported on four piers B, said tower containing a number of shelves C on either side thereof and arranged in series one above the other and approximately at an angle of forty-five degrees below the horizontal, those on one side alternating with those on the other. D is a hollow casing around the tower A at about a point midway of its height. D′ is a slot in one side of said hollow casing, and D^2 is a sliding door to regulate the supply of air passing through said slot to the casing, if and when required. D^3 represents inlets in the tower A to permit of the air passing from the casing D to the interior of the upper portion A′ (hereinafter called the "heating-chamber") of the tower A. E is a pipe for the purpose of withdrawing from the top of the lower portion A^2 (hereinafter called the "deoxidizing-chamber") of the tower surplus gas when hydrocarbon gas is used as the deoxidizing agent and conducting it to the gas-furnace H. E′ is a cock in said pipe E. F is a valve, and F′ is a wheel by which said valve can be operated to regulate the passage of gas from and ore through the lower or deoxidizing chamber A^2. G is an inclined passage from the base of the tower A to the top of a Siemens or other gas-furnace H. I is a valve for the purpose of stopping the flow of reduced ore through the passage G until a sufficient quantity has collected to form a charge. I′ is a wheel to operate said valve I. J is a pipe for supplying gas from the producers. (Not shown.) K is a fire-brick valve for closing the opening to the gas-furnace H. K′ is a handle for operating said valve K. L is an elevator which delivers the ore to be treated into a chute L′ at the top of the tower. M is a sliding door at the top of the tower to regulate the draft and to prevent ingress of air in any large quantity to the tower. This door can be operated in any approved way.

In lieu of using a tower constructed as described and as illustrated in Fig. 1 we may dispense with the internal shelves and substitute therefor, as shown in Fig. 2, a sieve or riddle N, suspended in the upper portion of the tower. Motion is supplied to said sieve N by means of belt N′ from the elevator-shaft. O is a port to permit of the products of combustion passing from the upper portion A′ of the tower A to a chimney O′ at the side of the tower. O^2 is a valve to regulate the draft in the chimney O′, and O^3 is a lever to open or close said valve by means of rope O^4.

When the apparatus illustrated in Fig. 1 is used, the mode of operation is as follows: The Siemens gas-furnace is first heated in the ordinary way, the fire-brick valve K being closed, and at the same time a reducing-gas, such as carbonic-oxid or hydrocarbon gas, is admitted through pipe J to the passage G, leading to the base of the tower A. The gas passes up the tower, and when it comes in contact with the air which enters through slot D′ and holes D^3

combustion ensues and the upper portion A′ of the tower becomes a heating-chamber. The concentrated and separated ore is fed to the top of the tower A by the elevator L and falls upon the topmost shelf C, and so on from shelf to shelf, every particle being thereby exposed to the heat. By the time the ore reaches the air-inlets D^3 it has become red-hot. In its further passage down the tower the ore passes through the body of gas in the deoxidizing-chamber A^2, and by the time it reaches the passage G it is completely deoxidized and reduced to fine particles of metallic iron. As soon as a charge has collected in the passage G valves I and K are opened and the reduced ore passes into the gas-furnace H, where it is fused and "balled up" as wrought-iron or converted into steel in the usual manner.

When the modification of the apparatus illustrated in Fig. 2 is used, motion is imparted to the sieve or riddle N and the ore which passes through it falls down the tower in the form of a shower. In other respects the operation is the same as already described in connection with the apparatus illustrated in Fig. 1 of the drawings, save and except that the products of combustion pass away by means of the chimney O′ instead of through the tower A.

In Fig. 4 of the annexed drawings the height of the tower is preferably reduced by about one-half—that is, by dispensing with that portion which in Fig. 1 constitutes the heating-chamber. In lieu thereof we use as the heating-chamber a revolving cylindrical chamber A′. This heating-chamber is placed at an angle of about ten degrees with the horizontal and is arranged to it at a point just above the air-inlets D^3. P represents rollers upon which the heating-chamber revolves. P′ represents angle-iron hoops or bands to keep the heating-chamber A′ in its proper position and prevent it pressing too much against the tower. Q represents projections running longitudinally the whole length of the interior of the heating-chamber A′. These projections are for the purpose of keeping the ore well stirred, so that every particle thereof may be subjected to the heat in the chamber. The mode of operation when this modification is used is identically the same as described in connection with the apparatus illustrated in Fig. 1, with the exception that the ore instead of being delivered by the elevator to and heated in the upper portion A′ of the tower A is delivered to the upper end of and heated in the revolving cylindrical chamber A′ and enters the tower A at a point just above the air-inlets D^3.

We will now refer to Figs. 7, 8, and 9, where another modified form of apparatus is illustrated. In this arrangement instead of, as previously explained, using a vertical tower or a revolving cylindrical chamber and a vertical tower for heating and deoxidizing the ore we use two revolving cylindrical chambers each set approximately at an angle of about ten degrees, the heating-chamber being at a higher elevation than the deoxidizing-chamber. The lower end of the former is connected to the upper end of the latter by means of a vertical passage. The latter cylinder is connected at its lower end with the Siemens or other gas-furnace. A′ is the heating-chamber, and A^2 the deoxidizing-chamber. P represents rollers upon which the chambers revolve. P′ represents angle-iron hoops which run on the rollers P and prevent the chambers from moving downwardly. R is the vertical passage connecting the two chambers A′ and A^2. The inlets for air are situated about midway of the height of said vertical passage R and are constructed in the same way as described and illustrated in Fig. 1. J is the pipe for supplying gas to the deoxidizing-chamber, and E is the pipe through which any surplus gas is conveyed from the deoxidizing-chamber to the gas-furnace. E′ (see Fig. 9) is a cock for controlling the flow of gas through such pipe E. S is a rod, and S′ is a plate at one end thereof for the purpose of closing more or less the entrance to the deoxidizing-chamber A^2 when desired, so as to control the supply of gas to chamber A′ and the supply of heated ore to chamber A^2. S^2 is an opening in said plate by means of which ore can pass from the vertical passage R to the deoxidizing-chamber A^2. S^3 is a wheel for operating said plate S′. In the center of the plate S′, opposite to the mouth of the pipe E, are a number of holes (not shown) to allow the gas to pass into said pipe E when the plate S′ is closed tightly against the entrance to the vertical chamber R. G is a pipe formed integral with and leading from the lowermost end of the deoxidizing-chamber A^2, with which it is free to revolve. G′ is another pipe leading upward from the top of the Siemens or other gas-furnace. These two pipes are in a vertical line when it is required to pass the accumulated reduced ore from chamber A^2 into the Siemens or other gas-furnace H. I is the valve which when open allows the reduced ore to pass to the gas-furnace, and K is the fire-brick valve in the top of the gas-furnace. Q represents projections in the interior of both the heating and deoxidizing chambers similar to those described in connection with Figs. 4 and 5 of the drawings. L is the elevator, and L′ the chute through which the ore to be treated passes to the upper end of the heating-chamber. To prevent air from entering this chamber A′ and to regulate the draft therefrom, a circular plate T, carried on the end of a rod T′, is so placed that by turning a wheel T^2 on the other end of the rod the opening T^3 to the chimney T^4 is opened or closed, as desired.

The mode of operation is as follows: The gas-furnace is first heated and gas is then admitted to the deoxidizing-chamber A^2 through

the pipe J and at the same time air is admitted to the vertical chamber R. Combustion takes place in this chamber R, and the resulting heat passes into the heating-chamber A′. Motion is then given to both the revolving chambers A′ and A^2, and the ore to be treated is supplied to the upper end of the former, and in its passage therethrough it becomes heated and is delivered to the top of the vertical chamber R, from whence it passes to the deoxidizing-chamber A^2, and on the revolution of the chambers being stopped and valves I and K being opened, pipes G and G′ being then in line, it falls into the gas-furnace H, where it is fused and "balled up" as wrought-iron or converted into steel.

Although we have described the chamber A′ as being heated by the admixture of air with waste carbonic-oxid or hydrocarbon gas from chamber A^2, it is obvious that it may be heated by other means; but this would be much more expensive.

What we claim as our invention, and desire to secure by Letters Patent, is—

1. The combination of a gas-furnace H, an inclined revolving cylindrical heating-chamber A′, an inclined revolving cylindrical deoxidizing-chamber A^2, and a vertical chamber R connecting the lower end of the former chamber with the upper end of the latter chamber, said vertical chamber R being provided with air-inlets D^3, and said chamber A^2 with means such as J for supplying gas thereto, substantially as herein described.

2. An apparatus for treating ferruginous ore for the manufacture of iron and steel therefrom, involving a heating-chamber adapted to receive the material in a continuous stream, a deoxidizing-chamber isolated from said heating-chamber, adapted to communicate therewith and receive the material therefrom, in a heated condition, means for supplying a deoxidizing gas to said deoxidizing-chamber to convert the heated material into metallic particles, means for supplying air solely to the heating-chamber to support combustion, and a gas-furnace isolated from said deoxidizing-chamber, adapted to communicate therewith and receive the material therefrom.

3. An apparatus for treating ferruginous ore for the manufacture of steel and iron therefrom involving a revolving heating-chamber adapted to receive the material in a continuous stream, a deoxidizing-chamber communicating with said heating-chamber and adapted to receive the material therefrom in a heated condition, means for supplying a deoxidizing gas to said deoxidizing-chamber to convert the heated material into metallic particles, means for supplying air to the heating-chamber to support combustion, and a gas-furnace communicating with said deoxidizing-chamber and adapted to receive the material therefrom.

4. An apparatus for treating ferruginous ore for the manufacture of iron and steel therefrom involving a revolving heating-chamber adapted to receive the material in a continuous stream, a revolving deoxidizing-chamber communicating with the heating-chamber and adapted to receive the material therefrom in a heated condition, means for supplying deoxidizing gas to said deoxidizing-chamber to convert the material into metallic particles, a regulatable air-supply means adapted to supply air to the heating-chamber to support combustion, and a gas-furnace communicating with said deoxidizing-chamber.

5. An apparatus for treating ferruginous ore for the manufacture of iron and steel therefrom, involving a heating-chamber adapted to receive the material in a continuous stream, a deoxidizing-chamber isolated from said heating-chamber, adapted to communicate therewith and receive the material therefrom in a heated condition, means for supplying a deoxidizing gas to said deoxidizing-chamber to convert the heated material into metallic particles, a regulatable air-supply means for supplying air solely to the heating-chamber to support combustion, and a gas-furnace isolated from said deoxidizing-chamber, adapted to communicate therewith and receive the material therefrom.

6. An apparatus for treating ferruginous ores involving a revolving heating-chamber, a revolving deoxidizing-chamber, a conduit for establishing communication between the lower end of said heating-chamber and the upper end of said deoxidizing-chamber, a regulatable air-supply means carried by said conduit and adapted to supply air to said heating-chamber to support combustion, means communicating with one end of the deoxidizing-chamber for supplying a deoxidizing medium thereto, and a gas-furnace communicating with the lower end of said deoxidizing-chamber.

7. An apparatus for treating ferruginous ore involving a revoluble heating-chamber, a closable-inlet supply means for one end of said heating-chamber, a revoluble deoxidizing-chamber, a conduit opening at one end into the lower end of said heating-chamber and at its other end opening into the upper end of said deoxidizing-chamber, a regulatable air-inlet supply carried by said conduit adapted to cause a supply of air to said heating-chamber to support combustion, adjustable means for closing the upper end of said deoxidizing-chamber, means communicating with the lower end of said deoxidizing-chamber for supplying a deoxidizing medium thereto, and a gas-furnace adapted to communicate with said deoxidizing-chamber.

8. An apparatus for treating ferruginous ore involving a revoluble heating-chamber, a closable-inlet supply means for one end of said heating-chamber, a revoluble deoxidizing-

chamber, a conduit opening at one end into the lower end of said heating-chamber and at its other end opening into the upper end of said deoxidizing-chamber, a regulatable air-inlet supply carried by said conduit adapted to cause a supply of air to said heating-chamber to support combustion, adjustable means for closing the upper end of said deoxidizing-chamber, means communicating with the lower end of said deoxidizing-chamber for supplying a deoxidizing medium thereto, an outlet-valve for said deoxidizing-chamber, a gas-furnace provided with an inlet, said inlet adapted to communicate with said deoxidizing-chamber, and a valve for closing said inlet.

In testimony whereof we have hereunto set our hands in presence of two subscribing witnesses.

MONTAGUE MOORE.
THOMAS JAMES HESKETT.

Witnesses:
WALTER S. BAYSTON,
FRANK BAYSTON.