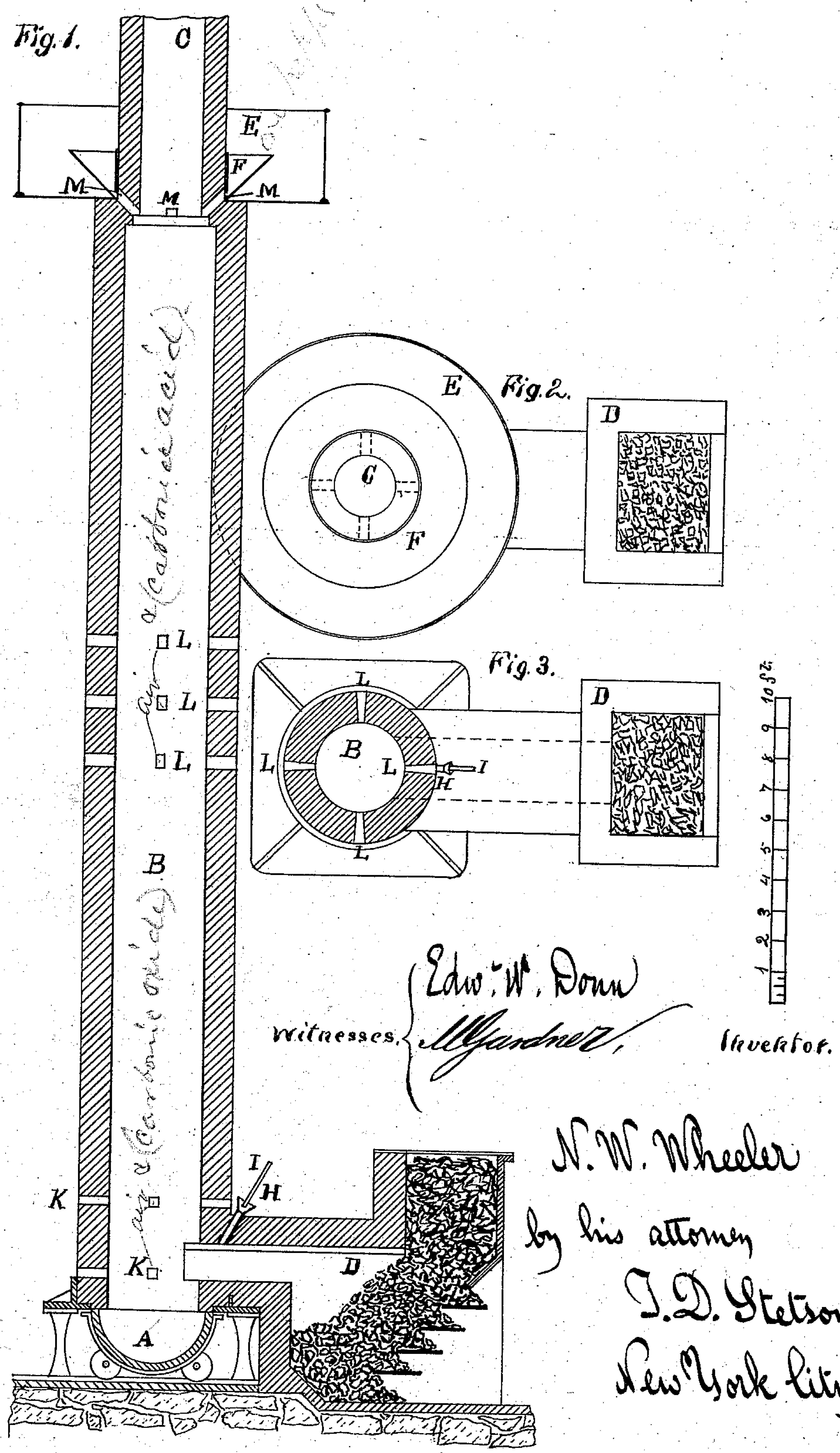
N. W. WHEELER.
Reducing-Ores.

No. 156,243. Patented Oct. 27, 1874.



Witnesses, Edw. W. Donn, M. Gardner.

Inventor. N. W. Wheeler by his attorney T. D. Stetson New York City.

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UNITED STATES PATENT OFFICE.

NORMAN W. WHEELER, OF NEW YORK, N. Y.

IMPROVEMENT IN REDUCING ORES.

Specification forming part of Letters Patent No. **156,243**, dated October 27, 1874; application filed February 28, 1874.

To all whom it may concern:

Be it known that I, NORMAN W. WHEELER, of New York city, in the State of New York, have invented an Improved Process for Reducing Iron or other Ores, and Apparatus for the Practice of the same, of which the following is a specification:

The ores suitable for treatment by this process are those oxides which are found in the form of sand, or those which have been crushed to a like form, and are reducible by deoxidation.

Take of such ores and shower them down the inside of a vertical shaft, which is so constructed and worked or operated that the upper part is filled with a rising column of oxidizing-flame or neutral flame, which I will, in this paper, term simply flame, and the lower part is filled with a rising column of carbon or hydrocarbon gases—for instance, such a mixture of gases as results from the partial combustion of coal. The height of that part of the shaft occupied by the flame should be such that each particle of ore will become greatly heated or fused during the time of its fall through the flame, and that part occupied by the carbon gases should have such a height that such particle of heated or fused ore will give up its oxygen to the carbon gas while it is falling through such gas to a crucible or other proper receptacle placed at the bottom of the shaft. By making the carbon-gas column of a greater or less height, the metal may be simply deoxidized or carbonized at will, so that, by regulating the height and richness of the carbon-gas column, neutral iron, steel, or carbonized iron may be obtained from oxide of iron at will. The desired gas-column may be produced and maintained in a reducing-shaft, as above indicated, by connecting the base of the shaft by a flue with a Treveray furnace or generator (that is to say, an apparatus in which a mixture of carbonic-oxide, hydrocarbon, and nitrogen gases is formed by the incomplete combustion of coal) in such a way that the reducing-shaft forms a chimney for the generator. The desired gas-column may also be produced and maintained through a suitable attachment to a gas-well, such as are developed by artesian borings in Pennsylvania and other parts of the world. The desired gas-column may also be produced and maintained by ejecting petroleum-vapor by means of a steam-jet or otherwise, or be derived from retorts fitted for the distillation of gas from coal or other fuel.

The desired flame-column may be produced and maintained by opening a series of air-holes through the walls of the reducing-shaft, at the proper height, so that the indraft of air through these holes will supply air for the complete combustion of the carbon gases as they rise to the level of the air-holes, and the ignition and complete combustion of the gases produce the desired column of flame.

Hydrogen gas may be substituted for or mingled with the aforesaid carbon gases with good effect, on account of its affinity for oxygen and the great heat evolved by it when burned.

A form of apparatus suitable for the practice of the above-described process is figured in the accompanying drawings, forming a part of this specification, in which—

Figure 1 is a vertical section of the entire apparatus. Fig. 2 is a plan view, and Fig. 3 is a horizontal section on the line S S in Fig. 1.

A is the crucible, capable of being lowered or otherwise removed; B, a hollow vertical shaft of refractory material, mounted upon supports so disposed as to allow of the removal and replacement of the crucible. D is a gas-generator or fire-place used for the generation of carbonic-oxide and hydrocarbon gases diluted with the nitrogen of the atmosphere by the incomplete combustion of coal or other fuel. The generator is connected to the shaft B by a flue in such a way that the reducing-shaft B forms a chimney for the generator D and carries upward the gases generated by it. At the lower part of the shaft B is a series of air-holes, K K, a sufficient number of which should be left open for the indraft of air to burn enough of the carbon gases to establish and maintain the requisite heat, which, however, will be partly produced by the combustion of the oxygen of the shower of ore with a part of the carbon gases. At the proper height, depending upon the fineness and quality of the ore under treatment, and also upon the richness of the carbon gases, is another

series of air-holes, L L, for the admission of enough air to complete the combustion of the carbon gases as they rise to and above the level of the air-holes L L. At a proper height above the level of the complete-combustion air-holes L L, depending upon the length of flame attainable and the character of the ore under treatment, is a series of inclined feed-holes M M, opening into the reducing-shaft B and into the hopper F, and below the hopper F is a platform, E, for workmen. Gates are fitted to each of the feed-holes wherewith to stop or regulate the supply of ore into the shaft. The reducing-shaft B is surmounted by a chimney, C, to carry the products of combustion above the heads of the workmen upon the platform E. The ore to be treated is to be elevated to the platform E and placed in the hopper F by workmen, from whence it will fall through the feed-holes M M down inside the shaft B in a shower, when the gates are open.

When constructing such apparatus I provide air-holes at various heights, and furnish means of closing such as are not required for use, so that varying qualities of ore may be treated in the same apparatus, and different kinds of fuel be used.

When sulphurous ores are to be treated it will be well to open larger areas of air-holes than will be necessary for complete combustion simply, so that the flame may be rich in oxygen, and capable of burning away the sulphur or other oxidizable impurity before the ore shall have fallen into the carbon gases. An additional series of air-holes near the top of the reducing-shaft B will be of use in such cases, to furnish the required amount of oxygen without cooling the whole body of flame by over admission of air.

When it is desirable to reduce ferruginous zinc ores the reducing-shaft should be arranged as for the treatment of sulphurous ores, and such collectors attached to the chimney as are now used with roasting-kilns for the purpose of collecting the zinc-white. The first action upon the ore will be by the oxidizing part of the flame, whereby the zinc will be burned to peroxide and carried into the collectors, and the subsequent action upon the iron ore will be as hereinbefore described, so that the complete reduction and utilization of the metals may be accomplished by one heat and operation.

Should refractory ores require a greater height of flame-column than is readily attainable by the means hereinbefore described, the reducing-shaft should be increased in height, and additional supplies of carbon gases and air may be introduced above the primary flame; or a mixture of air and pulverized fuel may be forced into the reducing-shaft to supplement and extend the effect of the primary flame. The gases and air may be heated by well-known means previous to the entrance thereof into the reducing-shaft.

If the ore under treatment requires the use of fluxes they may be finely divided, mingled with the ore, and showered down the shaft with it, or placed directly in the crucible A, and be reduced to, and kept in, a state of fusion by means of a blast of air through the pipe H, directed downward upon whatever may be in the crucible through the intervening carbon gases, care being taken that the mixed air and gas be ignited.

If a steam-jet, through the pipe I, be used to induce the air-blast, it is thought that the hydrogen resulting from the decomposition of the steam will be of benefit, the oxygen combining with carbon and leaving the hydrogen free to combine with the oxygen of the ore at a lower temperature, which will obtain above the blast-jet.

The finely-divided or comminuted ore may be heated before its introduction into the hopper F, if desired.

It will now be understood that finely-divided ore may be placed in the hopper F and showered down the shaft B, so as to fall first through a rising column of flame, and afterward through a rising column of carbon gases.

It is also obvious that carbon gases, such as described, may be made to pass from the generator into the base of the shaft B, rise to a determinate height therein, and made to undergo combustion by admission of air through the air-holes L L, so that when the apparatus is properly worked the reducing-shaft B will have its upper part filled with a body of flame, and its lower part filled with a body of carbon gases, thus furnishing the requisite means for practicing the hereinbefore-described process.

This process differs from those heretofore known for the roasting of ores by shower exposure to homogeneous hot gas, or to flame simply, and from those where the ore traversed through flues or ovens in a direction coincident with the current of gases, in that, to accomplish the object sought, the ore shower must fall, first, through a flame, and, second, through carbon gases, so as to be reduced during the time of its fall, and not simply roasted, desulphurized, or chlorinated.

I claim—

The process herein described for obtaining metals from the ores thereof, namely, the showering of granulated ore downward through a double atmosphere, consisting of a column of heating, or heating and oxidizing, flame of adequate height for the preheating of the ore, over a column of reducing-gas of adequate height for the reduction of the greater part thereof, substantially in the manner and for the purposes set forth.

In testimony whereof I have hereunto set my hand this 24th day of February, 1874, in the presence of two subscribing witnesses.

NORMAN W. WHEELER.

Witnesses:

ARNOLD HORMANN,

WILLIAM C. DEY.