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Fig. 1

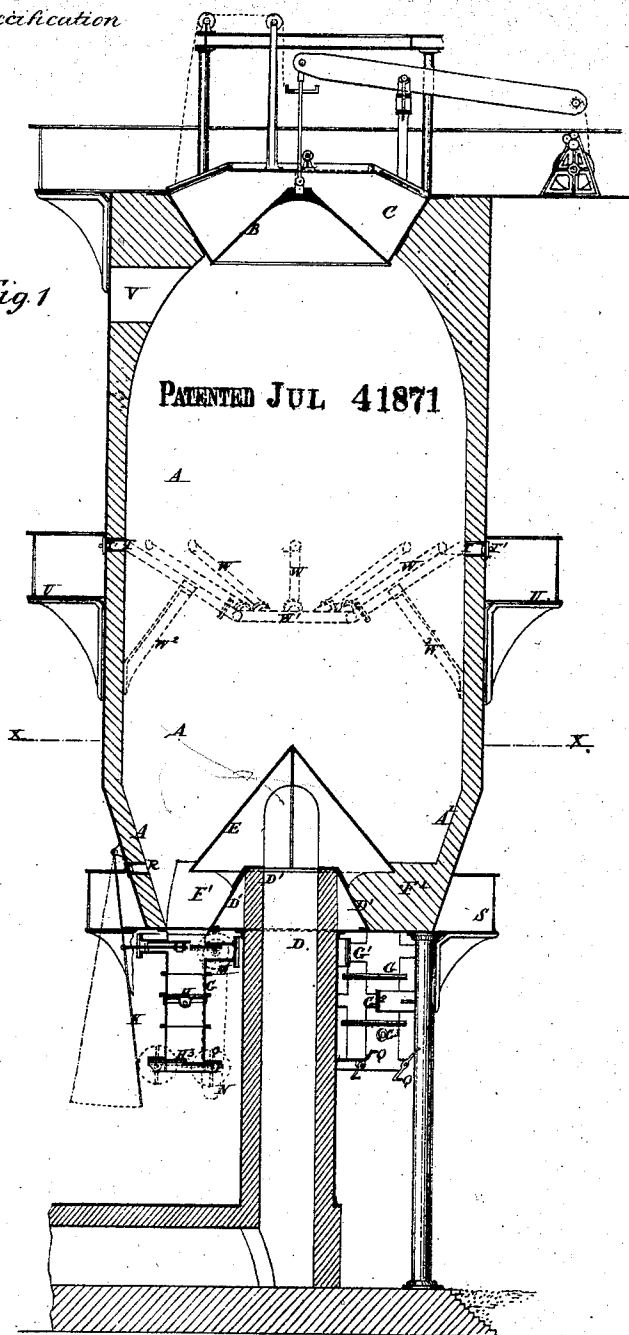
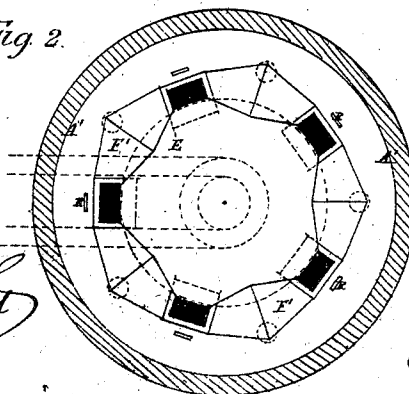


Fig. 2

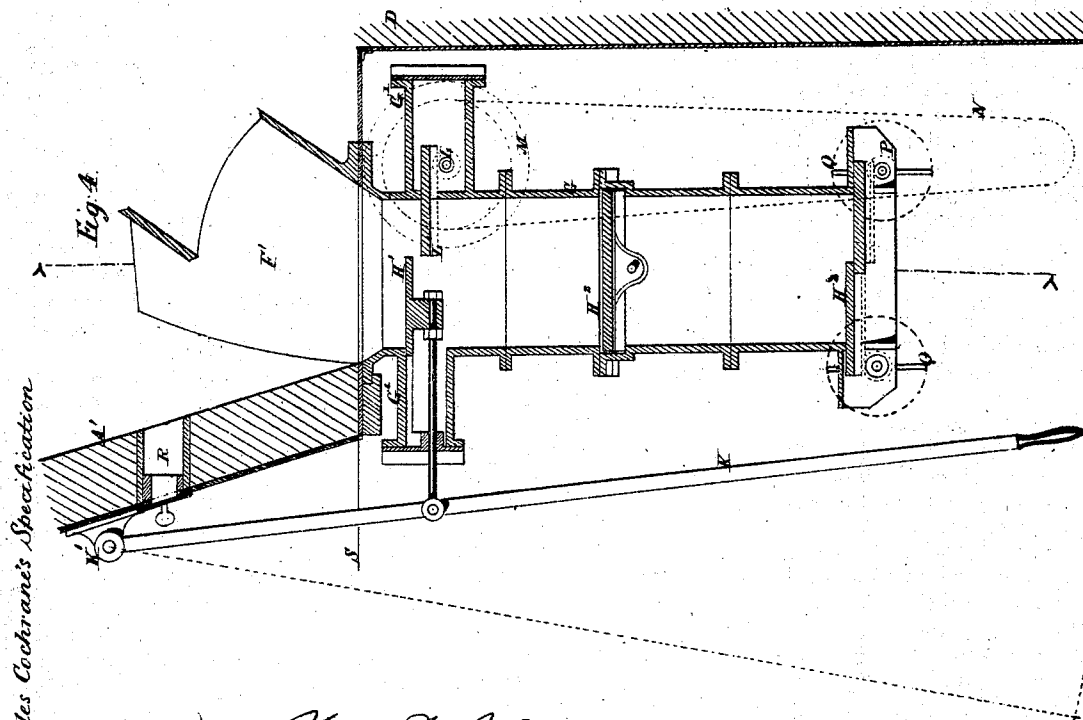
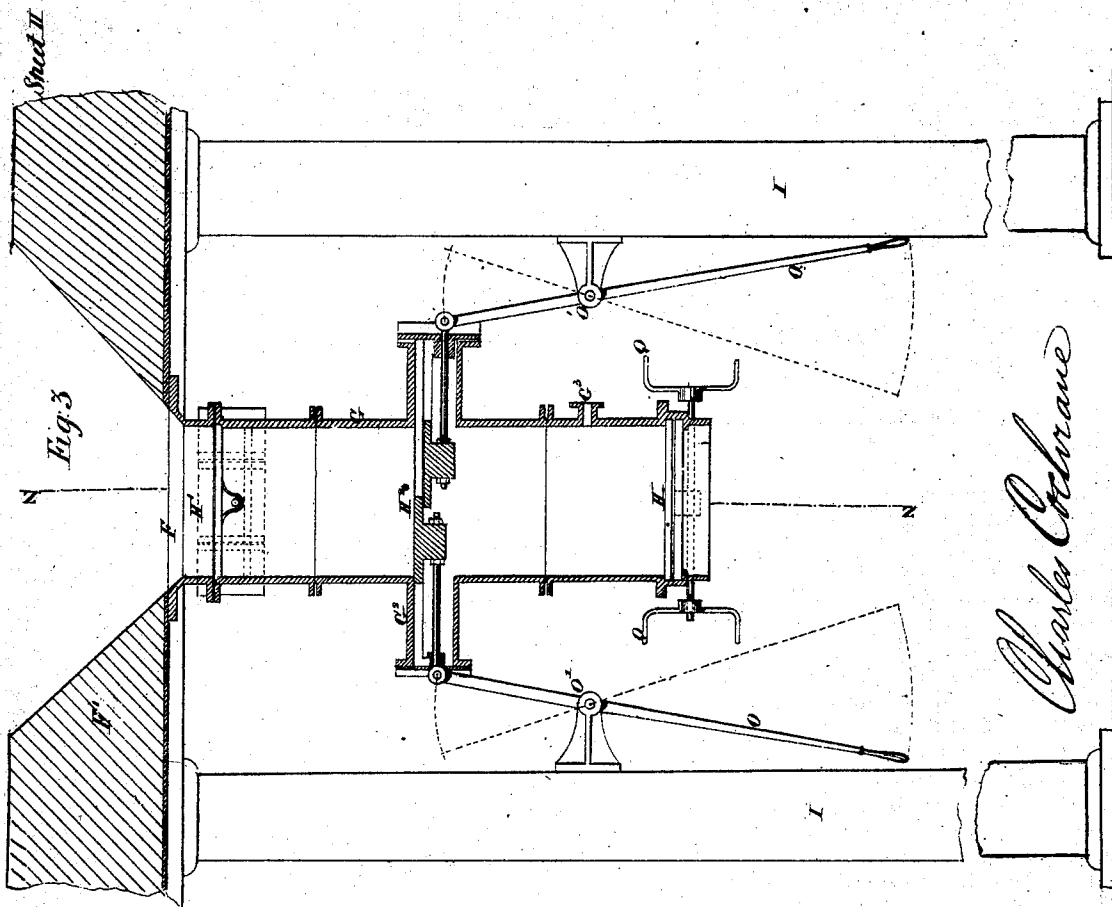


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Charles Cochran's Specification

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UNITED STATES PATENT OFFICE.

CHARLES COCHRANE, OF "THE ELLOWES," UPPER GORNAL, ENGLAND.

IMPROVEMENT IN SMELTING IRON ORES.

Specification forming part of Letters Patent No. 116,558, dated July 4, 1871.

To all whom it may concern:

Be it known that I, CHARLES COCHRANE, of "The Ellowes," Upper Gornal, in the county of Stafford, England, have invented an Improved Mode of, and Apparatus, Kiln, or Furnace for, Preparing Iron Ores for Smelting; and do hereby declare that the following description, taken in connection with the accompanying drawing, hereinafter referred to, forms a full and exact specification of the same, wherein I have set forth the nature and principles of my said improvement, by which my invention may be distinguished from others of a similar class, together with such parts as I claim and desire to secure by Letters Patent—that is to say:

My invention has reference to the process of deoxidizing iron ores, before introduction into the blast-furnace, by subjecting the same to the action of carbonic-oxide gas; and consists of an improved method, whereby, instead of acting upon cold-iron ore with highly-heated carbonic-oxide or blast-furnace gas, as described in the specification to another patent for which I am applying, or instead of simultaneously heating the ore and the carbonic-oxide gas, as is effected to a certain extent in the blast-furnace, and as has also otherwise been proposed, the iron ore is first heated to the requisite degree in one part of a special furnace or kiln, and then in another part of such kiln is subjected to the action of carbonic-oxide or blast-furnace gas, which has not been specially heated for this purpose.

Various arrangements may be employed for carrying this invention into practice. Thus in one arrangement I introduce the ore into a chamber or kiln, at or near the lower end of which cool carbonic-oxide or blast-furnace gas is made to enter, which gas, after ascending through the lower strata of the ore, is, in the upper part of the kiln, (constituting a combustion-chamber which may or may not be separated from the lower part or reducing-chamber of the kiln,) brought into contact with jets of atmospheric air, and, in entering into combustion therewith, is caused to heat the ore contained in such combustion-chamber to the requisite degree before it descends into the reducing-chamber of the kiln, where it is acted upon by the carbonic-oxide gas, and whence it afterwards issues through chutes at the bottom. By this arrangement the heat contained in the ore is utilized by being taken up

by the gas on its way to the combustion-chamber, the ore passing away from the kiln in a comparatively cool state, and thus the loss of heat arising in the before-mentioned processes through the passing away of the ore in a highly-heated condition is prevented. In this arrangement a sufficient quantity of carbonic-oxide or blast-furnace gas must be introduced into the reducing-chamber to afford the requisite surplus of unconverted gas after passing through the ore for producing the necessary heat by combustion with the air in the combustion-chamber. In another arrangement the necessary quantity of combustible gas is introduced directly and separately into the combustion-chamber, and only such a quantity of carbonic-oxide or blast-furnace gas is passed into the reducing-chamber as is requisite for deoxidizing the ore. The heat of such gas, if any is left after passing from the reducing-chamber, may, if desired, be utilized by causing the gas to pass in contact with the pipes or flues conducting the air or combustible gas, or both, into the combustion-chamber, or the hot gas may be allowed to rise up among the ore in the combustion-chamber.

Having thus set forth the nature of my invention, I will now proceed more particularly to describe the manner in which it is to be performed, for which purpose I shall refer to the accompanying drawing, showing one of the various arrangements of kilns or furnaces by which my invention may be carried into effect.

Figure 1 on Sheet I shows a vertical section of the kiln. Fig. 2, Sheet I, shows a sectional plan of the same on line X X, Fig. 1. Figs. 3 and 4, on Sheet II, show, respectively, an enlarged section on line Y Y Fig. 4, and a section on line Z Z, Fig. 3, of one of the discharging-boxes.

Similar letters of reference indicate similar parts in each of the figures.

The furnace or kiln consists of a chamber, A, of fire-brick, inclosed in an iron casing, which chamber is closed at its upper end by a bell-valve, B, above which is a closed feeding-hopper, C, for the introduction of the ore, for the construction of which Letters Patent for Great Britain and Ireland have been granted to me, bearing date 21st February, 1868, No. 579. The lower end of the chamber A is supported by columns I I, and is contracted to a funnel-shape at A', into the center of which rises the passage for

carbonic-oxide or blast-furnace gas D, terminating in a conical orifice, D', covered by a conical hood, E, so that the gases passing from the passage D issue into the kiln from under the edge of the hood E. The annular space formed between the sloping sides A' of the chamber A and the surface of the conical orifice D' has a number of outlet-apertures, F, communicating with the iron discharge-boxes G, fixed by their upper ends in an air-tight manner to and suspended from the iron casing of the kiln. Between the outlet-apertures F are formed ridges F' to prevent the lodging of ore in the spaces between the apertures. The construction and mode of operating the discharge-boxes G will be more readily understood on reference to the enlarged views thereof shown on Sheet II. In order to discharge the reduced ore from the kiln without at the same time allowing atmospheric air to enter the kiln through the discharge-boxes, each box is provided with three sets of slides, H¹ H² H³, of which those H¹ serve to cut off the communication between the kiln and the box, while those H² cut off the communication between the upper part and the lower part of the box, and those H³ close the lower end of the box. By this arrangement, if the slides H¹ are opened, (H² being closed,) a quantity of reduced ore will fall from the kiln into the upper part of box. If, now, the slides H¹ are closed and those H² are opened, (H³ being closed,) the ore contained in the upper part of the box will fall into the lower part, and after the slides H² have been closed, and those H³ are open, the ore is discharged into the trucks or onto the ground. The slides H¹ H² are opened and closed in opposite directions, respectively, by means of the lever K, having its fulcrum at K', and by means of a pinion, L, in gear with the rack L' on the slide, the spindle of the pinion being rotated by a grooved pulley, M, fixed on the same, worked by an endless chain, N. The slides H² are actuated in a direction at right angles to H¹ by means of the levers O O working on fulcrums O' O' fixed to the columns I. The slides H³ are worked by pinions P in gear with racks on the slides, and rotated by means of crank-handles Q. In order to prevent any escape of carbonic-oxide gas at the slides H¹ H² these are made to work backward and forward inside closed casings G¹ G² projecting from the discharge-box G; also, in order to prevent as much as possible the entrance of air into the lower part of the discharge-box, when the slides H³ are opened for discharging the reduced ore, carbonic-oxide gas may be introduced into such lower space through the aperture G³. Should it be found at any time that the ore does not descend readily into the discharge-boxes from the kiln, stoppered apertures R R are provided, through which prizing-bars may be introduced, and to which access is gained from the gallery S. At some height above the inlet D', for the carbonic-oxide gas, side apertures T T are formed round the kiln for the inlet of atmospheric air, or in order to effect the combustion of the unconverted portion of the carbonic-oxide gas rising up from below. The air-holes are capable of being closed

by stoppers T', so as to regulate the inlet of air to the exact extent required. Access is gained to the air-holes from the gallery U.

The action of the kiln takes place as follows: The kiln being charged with ore, the lower portion of which may be introduced either in a heated or cool state, and the valve B and hopper C closed, carbonic-oxide gas or blast-furnace gas, or other suitable reducing-gas, is introduced through the passage D into the bottom of the kiln, and in rising up through the heated lower portion of the ore it acts upon and deoxidizes the same more or less completely, at the same time taking up the heat therefrom and becoming itself converted into carbonic-acid gas. The reducing-gas is, however, introduced in such quantity as to be in excess of the amount required for reducing the ore, so that the unconverted portion thereof, in rising up in a heated state to the level of the air-holes T, enters into combustion with the air passing in, and thereby heats the ore in the upper part of the kiln to the requisite degree before it is made to descend into the lower part, in order in its turn to be reduced by the incoming carbonic-oxide gas. The deoxidation of the lower portion of the ore having thus been effected it is discharged in a comparatively cool state into the discharging-boxes G, as before described, and fresh ore is introduced into the kiln through the valve B at top. The carbonic-acid and other gases, in rising up through the mass of ore above the air-holes T, impart their heat to the same, and finally escape through the side aperture V into a flue, in which a draught is produced, either by a chimney or by an exhaust-fan, or by both. Should it be found that the air entering through the apertures T does not penetrate sufficiently through the mass of ore to effect the equable heating of all parts of the same, this may be facilitated by causing it to pass in through perforated radial pipes W, shown in dotted lines in Fig. 1, leading from the apertures T to a central annular pipe, W¹, connecting all the radial pipes, and supported by means of stays W².

As before stated, the arrangement of the furnace or kiln may be variously modified for carrying my invention into practice. Thus the upper part or combustion-chamber of the kiln may be separated from the lower part or reducing-chamber, and be furnished with a separate supply of combustible gas for raising the ore to the requisite temperature; or one or more heating-chamber or chambers or retorts may be arranged at the top of the kiln and the heated ore be discharged thence into the kiln. Also, the reducing-gas may be made to enter the kiln through several side apertures instead of through one single central passage, and the discharge of the reduced ore may be effected in any other convenient manner, whereby the inlet of the atmospheric air into the lower part of the kiln is practically prevented.

Having thus set forth the nature of my invention, and in what manner the same is to be performed, I wish it to be understood that I do not limit myself to the precise means or apparatus for carrying the same into effect, as hereinbefore described, with reference to the accompanying draw-

ing, as these may be variously modified, as already stated, without departing from the nature of my invention; neither do I claim as part of my invention the various details of construction of apparatus hereinbefore described, except when used in combination for the purposes of my invention. Also, I am aware that kilns have before been constructed with a central inlet for combustible gases, covered by a conical hood, but for totally different purposes, namely, for calcining minerals and other substances—that is to say, for subjecting the same to an oxidizing flame; whereas, by my invention, the ore is subjected to the action of reducing-gases, and the introduction of oxidizing-gases, as in calcining operations, is carefully avoided; but

What I claim is—

Deoxidizing or reducing iron ores before their introduction into the blast-furnace by first raising the ores to the requisite degree of heat, and then subjecting the same to the action of carbonic-oxide or blast-furnace gas, which has not been specially heated for that purpose, substantially as hereinbefore set forth.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses this 13th day of April, 1870.

CHARLES COCHRANE.

Witnesses:

CHAS. D. ABEL,
JNO. BN. MILLARD.