(No Model.)

A. DAUBER.

PROCESS OF MAKING IRON.

No. 502,482. Patented Aug. 1, 1893.

Fig: 1.

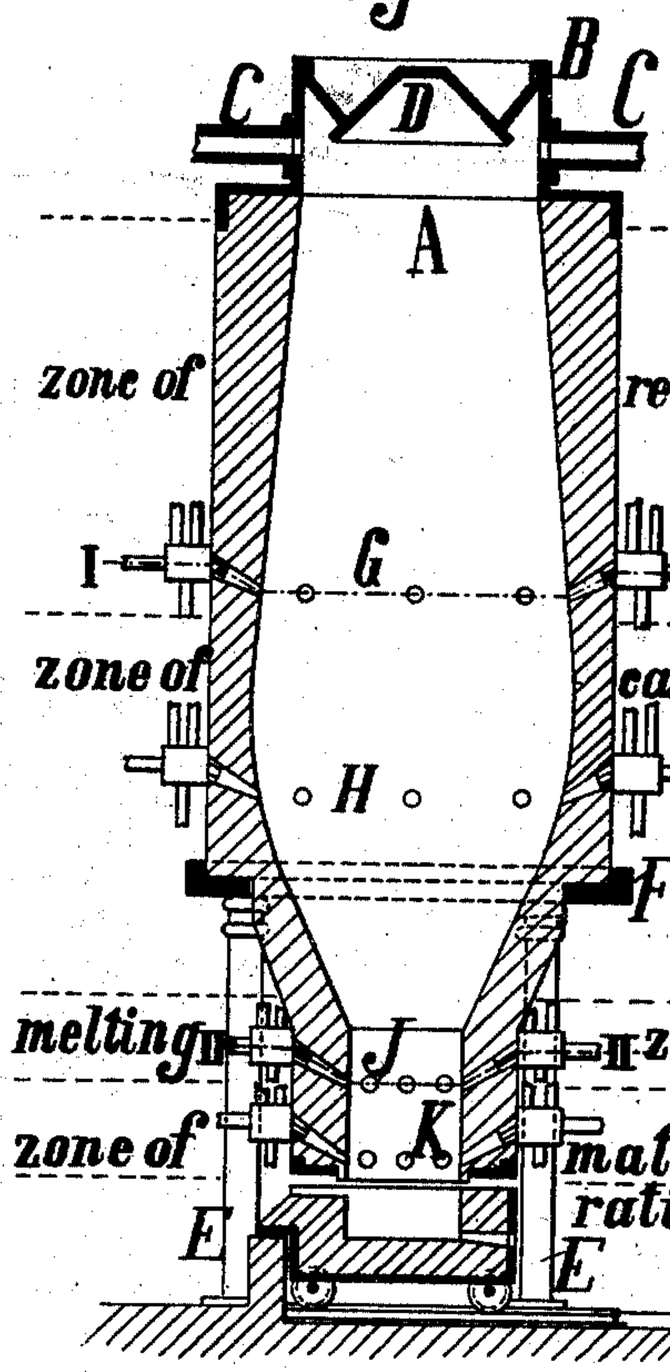


Fig: 4.

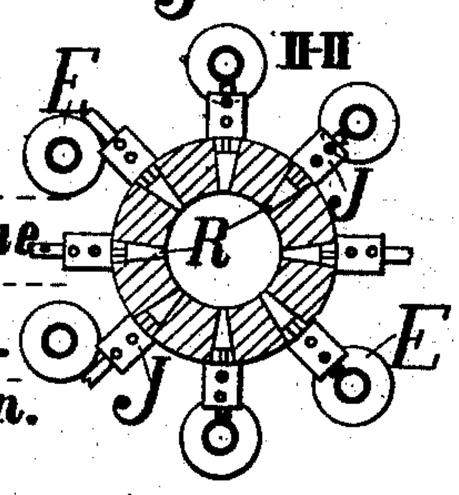


Fig: 2.

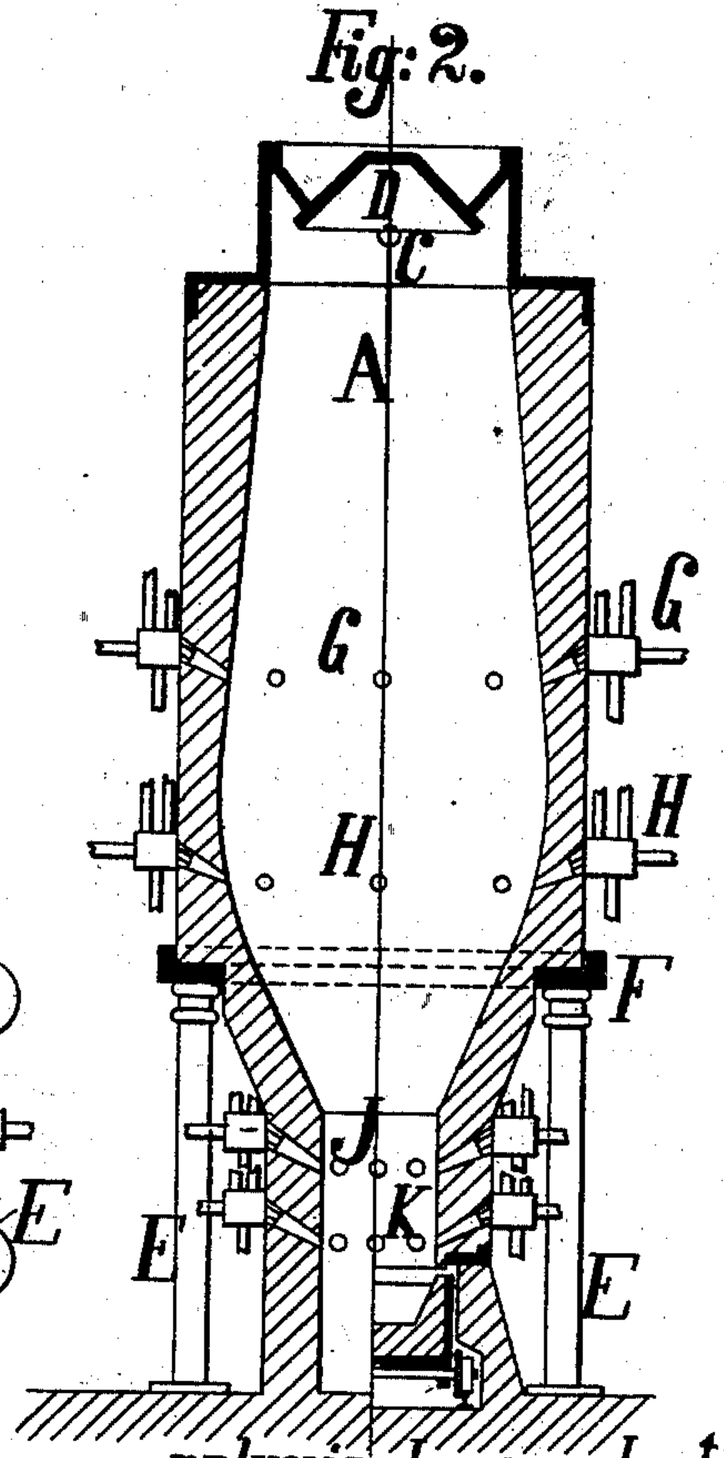


Fig: 3.

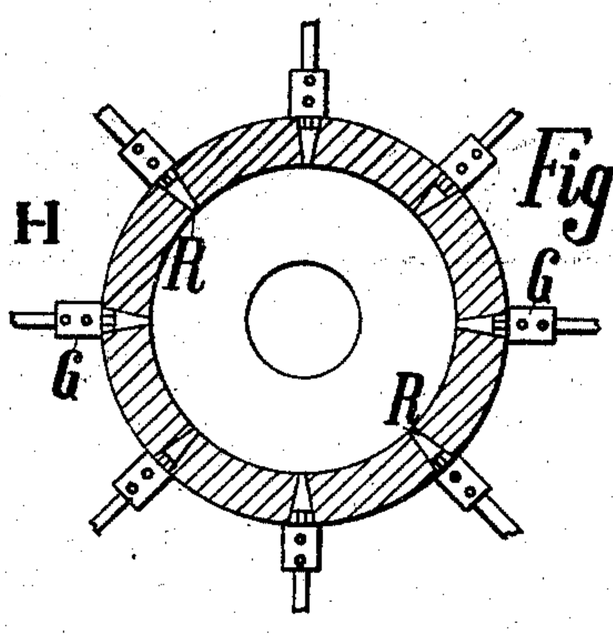
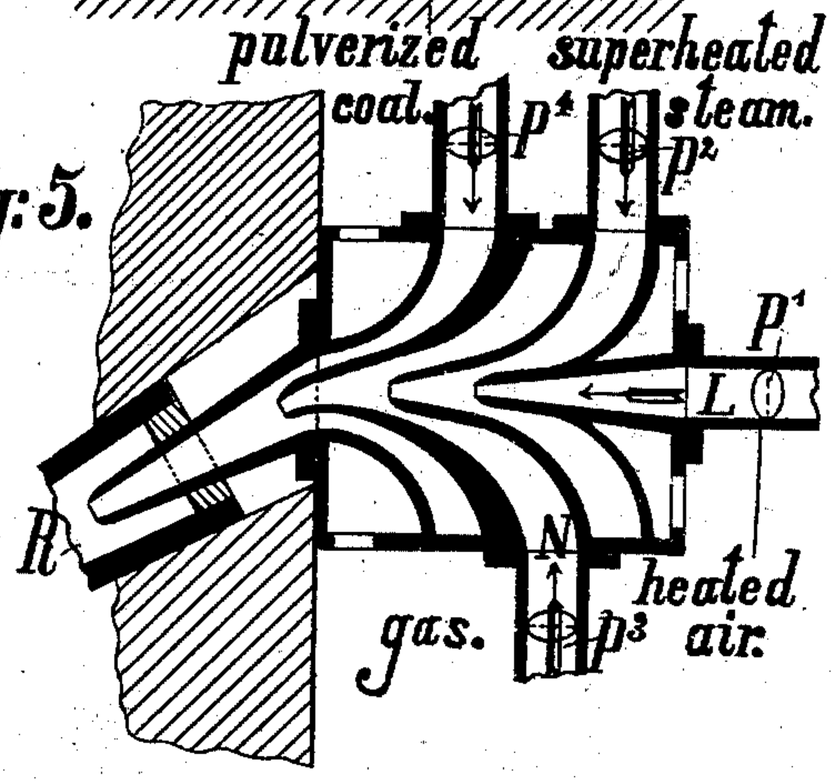


Fig: 5.



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UNITED STATES PATENT OFFICE.

AUGUST DAUBER, OF BOCHUM, GERMANY.

PROCESS OF MAKING IRON.

SPECIFICATION forming part of Letters Patent No. 502,482, dated August 1, 1893.

Application filed June 18, 1890. Serial No. 355,889. (No specimens.) Patented in Germany September 19, 1889, No. D4,005; in France October 4, 1889, No. 201,107; in Luxemburg April 25, 1890, No. 1,281, and in Belgium April 25, 1890, No. 67,709.

To all whom it may concern:

Be it known that I, AUGUST DAUBER, a subject of His Majesty the Emperor of Germany, residing at Bochum, in the Province of Westphalia, Germany, have invented certain new and useful Improvements in Processes of Making Iron of any Quality, Pig-Iron, Wrought-Iron, Cast-Steel, and Rough Steel, (for which I have obtained patents in Germany, provisional No. D4,005, dated September 19, 1889; in France, No. 201,107, dated October 4, 1889; in Luxemburg, No. 1,281, dated April 25, 1890, and in Belgium, No. 67,709, dated April 25, 1890;) and I do hereby declare that the following is a full, clear, and exact description of the invention, which will enable others skilled in the art to which it appertains to make and use the same.

It is a well known fact that in burning carbon in gaseous state in combination with oxygen over one hundred per cent. of calorics or units of heat more are obtained than when the combination of the oxygen with the carbon in a solid state takes place. For this reason many trials have been made of late years to use gaseous combustibles instead of such in a solid state for heating purposes of any sort. If anywhere, this extraordinary gain must prove profitable in the iron industry, the largest consumer of coal, provided that it will be possible to introduce the easily obtainable gas in place of coal and coke into the high furnace in a practicable manner and at the proper place. Combined with this gain obtained by using gaseous fuel there is another, which is the absolute consequence of the use of gaseous fuel in blast and similar furnaces, namely the space gained in a furnace which otherwise is occupied by the coal or coke and which now will be free. All that space formally occupied by the coal or coke, about one-third of the whole volume of a furnace, is now available for ores and lime stone or flux. The production of a blast and similar furnace worked by gaseous fuel as compared with one where coal or coke or other solid fuel is used, therefore must be larger in proportion to the space gained in the first case, or a furnace of the first class may be built so much smaller from the beginning to give out the same quantity of iron as in the other case, and the first costs of building will therefore be reduced considerably also.

The object of my invention is to realize the gains named by the use of gaseous fuel or carbon in a fluid or pulverized state which is blown into the furnace at certain stages in such combinations with or without heated air and superheated steam and in such proportions as will correspond to the reaction going on in the furnace at that stage in that place and at that time; injector like tuyeres being used for regulating the quantities of each gas so as to obtain the proper mixture required. The success will be assured if the zones of preparation, of reduction, of carbonization, of melting and of maturation so created will be placed at the right place in the furnace and if the reactions taking place there are caused at the proper time and in the proper proportions to the fuel blown into the furnace. In order to secure this result I introduce the gases into the furnace at those places in such a state that answers the reactions having to take place there by means of adjustable injector like combined tuyeres. The gases used, superheated steam and hot air, each for itself or in combination with the others in adjustable proportions are produced in separate generators so as to have them always ready in sufficient quantities and in proper condition.

For the sake of following the process going on in a furnace designed to correspond to my method of iron making let us suppose the furnace be at work. The starting having to be done as usual with solid fuel and only when the work is going on in regular order, the new method is being introduced gradually by reducing by degrees and replacing the solid fuel—coal or coke—by at first gradual and then continuous charges of gases and carbon which are blown into the furnace. At the bottom of the zone of preparation or as near as this place can be fixed, I arrange a row of tuyeres by means of which superheated steam or heated air is blown in, in order to dry and roast the charges, ore and flux, and to free them from the humidity contained therein and from other volatile materials and to prepare them so for the reception of oxide of carbon and to make them loose and open. In

the zone of carbonization I arrange a similar row of tuyeres, the object of which is to introduce carbon and to mix it with the ores so as to prepare them for the melting process. The blowing in of carbon may be done by the use of gaseous carbon or in a fluid or in a pulverized state, or any of these combined with the other. In the melting zone I arrange tuyeres by means of which I blow into the furnace a mixture of heated gas and air to which superheated steam may be added, in order to produce the high temperature which is necessary to reduce into a fluid state also the earthen material and so to separate completely the iron from the slag and cinders in consequence and according to the difference of their specific weights.

In order to be able to vary the composition of the produce or its quality in the hearth at will so as to receive spiegeleisen, for instance, with a high percentage of carbon down to mottled iron containing but traces of carbon, as well as steel of any sort, I here provide a zone of maturation by arranging a similar row of tuyeres through which I blow into the furnace at this place a mixture of gas and superheated steam and hot air, which may be varied as desired so as to reduce the carbon in the iron to the required degree.

It may be added here that my method differs materially from that used for a short time in England and America by Glay Bull who blew the gas and air into the furnace each at opposite sides and only at the bottom of the furnace, for which reason his furnaces after a short period were "blown cold."

The furnace used with my process is shown on the annexed drawings in which—

Figure 1 is a vertical section of the furnace with a movable hearth. Fig. 2 is a similar section at right angles to Fig. 1, the left side showing a fixed hearth or crucible, the left half having a movable crucible. Fig. 3 is a cross section along line I—I of Fig. 1. Fig. 4 is a cross section along line II—II. Fig. 5 shows a section on an enlarged scale of the combination tuyere used.

The blast furnace A is in its main part of ordinary construction. At the head of the same it is provided with the hood or cap B with the pipes C C branching off for leading away the gases, a bell cover D serving for closing the top as in ordinary furnaces. The upper part of the furnace is mounted on six pillars E and supported by a strong iron plate F. The hearth may be fixed as shown on the left side of Fig. 2 or it may be movable on wheels as shown in Fig. 1 and on the right side of Fig. 2. This is however immaterial and may be made in the one way or the other, as it is not peculiar to my process or to the furnace. So far as described the furnace is not distinguished from ordinary blast furnaces. But I differ from ordinary constructions in the arrangement of tuyeres. I arrange special tuyeres in the zones of reduction of carbonization and in the melting zones, G, H and I respectively by means of which I blow into the furnace the necessary gases as stated in describing the process above. The mixture of these gases or the proportions in which they are mixed vary according to the nature of the ores and flux used, and they also depend upon the process going on in the furnace. The melter regulates this process by altering the mixtures so that a regular going will be maintained. Below the melting zone I also have a row of combined tuyeres K and I thus form what I call the zone of maturation or the crucible, because it is here, where I complete the process by reducing the contents of carbon, so as to obtain either wrought iron, steel or cast iron in its various shades and according to the quality or the nature of the product desired. I vary the mixture of the gas by means of the combined tuyeres. Fig. 5 shows the arrangement of such a combined tuyere.

L is the central tube for hot air. By M superheated steam may be added and by N the carbon gas is introduced and the tube O serves for blowing in carbon in a pulverized or fluid state. Every one of these tubes may be shut off by valves P', P^2, P^3 or P^4 respectively. They are arranged concentrically to each other and they all blow into a common tube R which leads into the furnace.

Having now particularly described the nature of my invention, what I claim, and desire to secure by Letters Patent, is—

The process of reducing iron which consists in charging into a blast furnace, a mixture of ore and flux, without carbon, and introducing into the furnace at the zone of preparation a heated gas containing oxygen, at the zone of carburization, carbon superheated steam and heated air; at the zone of melting, a heated combustible gas, superheated steam, air and carbon, and into the crucible containing molten metal a mixture of gas, superheated steam and air.

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