N. WIKSTRÖM.

METHOD OF REDUCING ORES.

APPLICATION FILED JAN. 16, 1908.

914,622. Patented Mar. 9, 1909.

Fig. 1

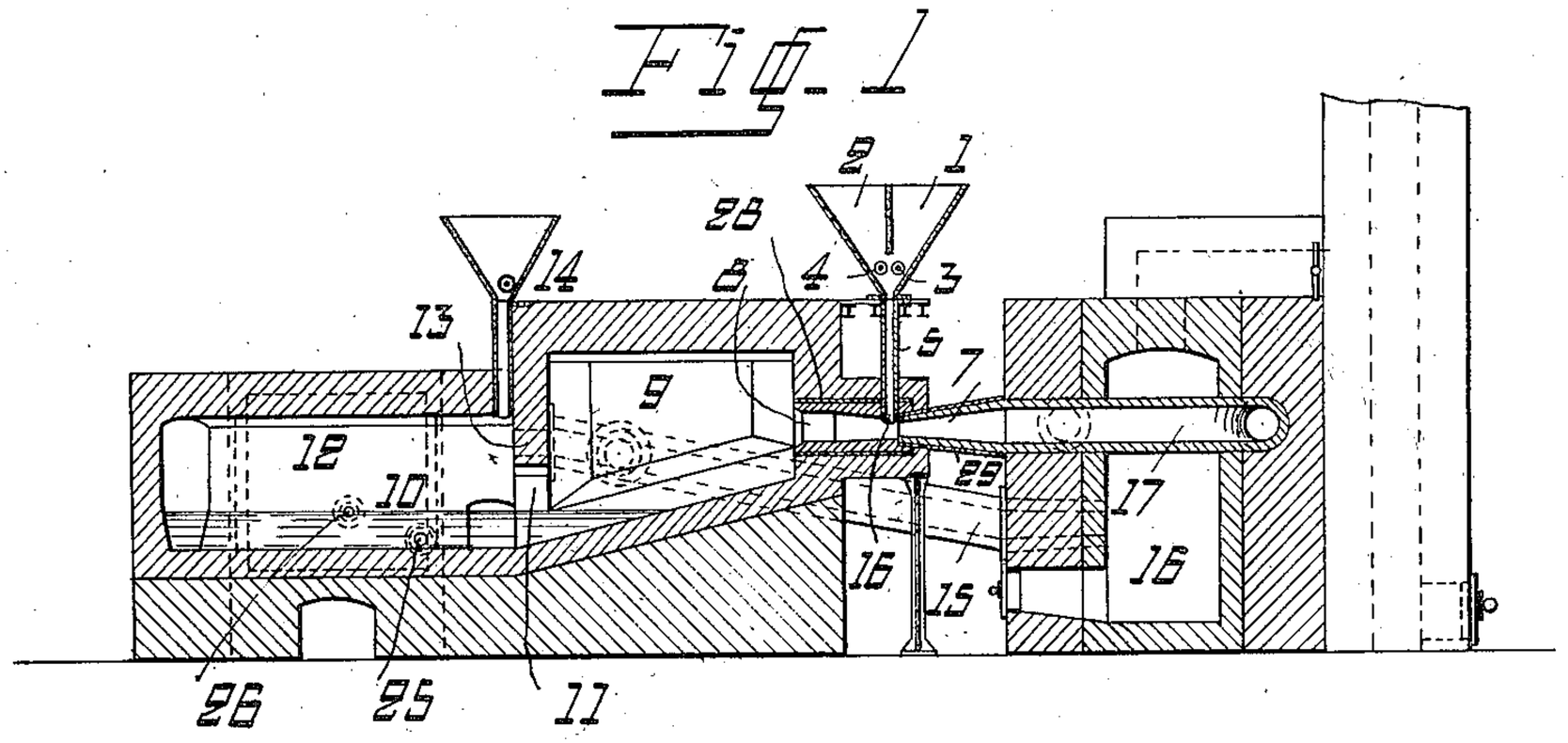



Fig. 2

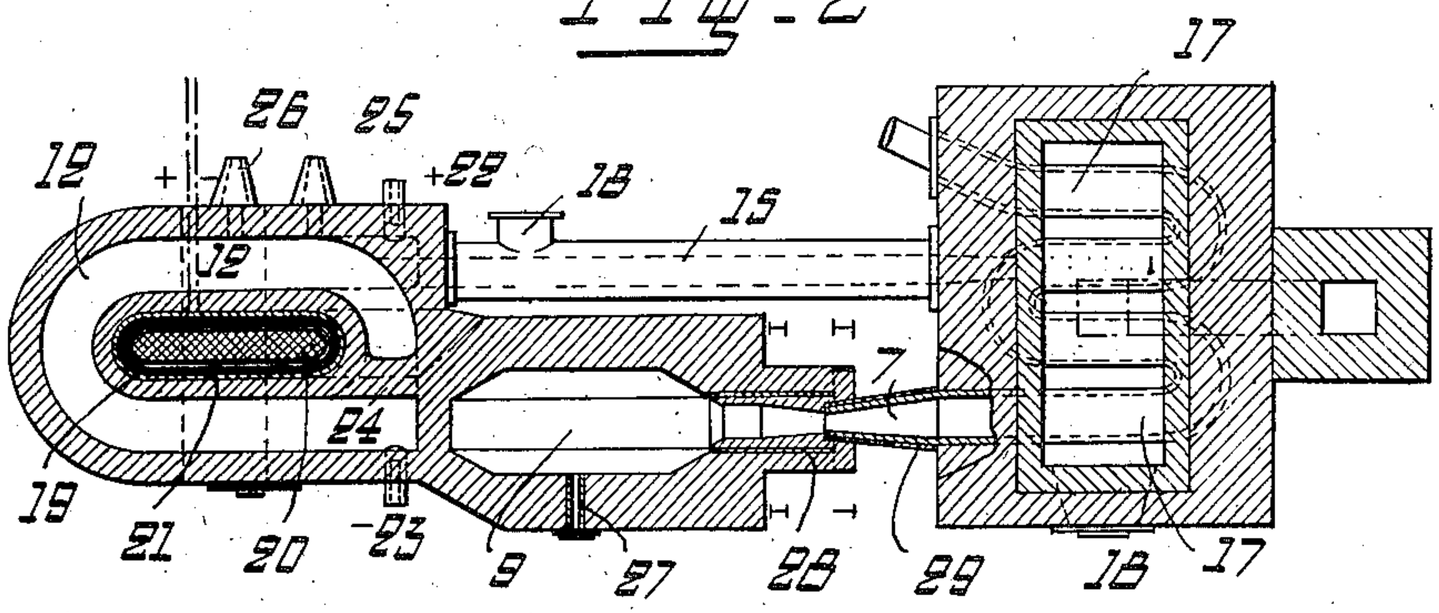



Fig. 3

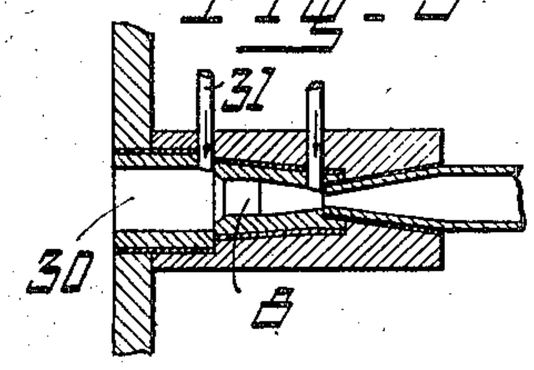
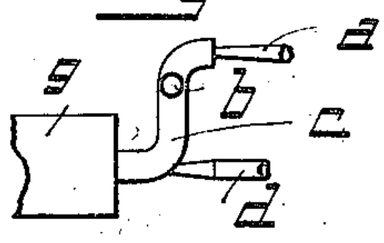



Fig. 4




Witnesses.

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# UNITED STATES PATENT OFFICE.

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## METHOD OF REDUCING ORES.

No. 914,622. Specification of Letters Patent. Patented March 9, 1909.

Application filed January 16, 1908. Serial No. 411,130.

*To all whom it may concern:*

Be it known that I, NILS WIKSTRÖM, of Högfors, Finland, Russia, a subject of the King of Sweden, have invented certain new and useful Improvements in Methods of Reducing Ores; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to letters or figures of reference marked thereon, which form a part of this specification.

A furnace for effecting the present method of producing iron is illustrated on the annexed drawing where—

Figure 1 shows a vertical and Fig. 2 a horizontal section. Figs. 3 and 4 illustrate modifications of a detail.

Coke or charcoal is powdered quite finely, likewise iron-ore and lime or other suitable admixtures are ground to the required fineness. The finely divided ore with suitable admixture of lime is fed into compartment 1 of the charging-funnel and the coal-powder into compartment 2 of the charging funnel. By means of the feeding-wheels 3 and 4 coal and ore are charged into the feed-pipe 5 in suitable proportions. The feeding-wheels 3 and 4 rotate independent of each other so that the charging of coal and ore may be controlled as desired. When the admixture of ore and coal-powder leaves the lower end of tube 5 it is struck by a current of highly heated air or gas (temperature about 1000° C.) which comes by way of nozzle 7, so that the admixture of ore and coal is blown in through the burner 8 into the fore-furnace 9. In the burner 8, in which the mixture of ore, coal and the necessary admixtures are brought into intimate contact with the gas- or air-current, the temperature and the chemical processes may vary in proportion to the temperature of the said current and the quantity of fuel supplied and with due regard to whether the product is pig-iron or wrought-iron. In the fore-furnace 9 heat may for instance be supplied in electrical way, provided the temperature in the burner 8 is kept low. The iron collects on the bottom of the furnace to about the height indicated by 10 and runs through the opening 11 into the annular or V-shaped furnace 12. The communication between furnaces 9 and 12 is closed by means of bridge 13, so that a small opening 11 arises, through which both the iron as well as the gases may pass from furnace 9 to furnace 12, but owing to the superpressure existing in fore-furnace 9 in connection with the circumstance, that opening 11 is contracted, no return of the gases from furnace 12 to furnace 9 is possible. In both compartments such differently composed gases may thus be kept, as may be required by the various courses of the process.

In order to carburize or to refine the iron, according to the quality of iron ore blown into the burner 8, with part 9, coal-powder or finely divided iron-oxid may, if desirable, be fed in through another feeding device 14 before opening 11, so that the gases coming through fore-furnace 9 spread the iron- or coal-powder in furnace 12. A surplus of ore may also be introduced into furnace 9, so that a part of this ore passes along into the furnace 12, which is made so large that the speed of the gas is decreased to such a degree, that the powdered ore gets the opportunity of falling to the bottom in order to melt with the iron-mass flowing thereon. The exhaust gases from the furnace 12 are led by means of tubes 15 through the air-heating furnace 16 in order to burn there and heat the blast, which is by means of a suitable ventilator pressed through the heating-pipes 17 passing through furnace 16 so that the blast is highly heated on entering nozzle 7. The air may, of course, also be heated by any other ordinary heating-device for blasting-furnaces or glass-works. Those combustion gases which are not necessary for the heating are drawn off through side-outlets 18 and used for other purposes. The melted iron in the furnace 12 is further heated, if necessary, by means of electricity in such a manner, that an induction coil 19 with core 20 and cooling-mantle 21 is arranged in the middle of the furnace, or else, if the furnace is U-shaped, in the manner indicated in dotted lines in Fig. 2, contacts 22 and 23 are arranged, by which the current is led directly to the smelting-mass. The contacts are made hollow, so that they may be cooled by means of water-circulation. The contacts may even in U-shaped furnaces also be connected to an induction-circuit for heating the smelting-mass.

In annular furnaces a bridge 24 is arranged, which reaches nearly to the upper edge of the smelting-mass, so that the gases coming from 9 are compelled to pass in the right direction through the furnace and thus not enter directly into the exhaust-pipe 15.

The iron is drawn off through outlet 25 and the slag through an opening 26. The course of the operation may be observed through an observation-hole 27, which is kept closed by means of a plate of mica. The burner 8 and nozzle 7 are protected by cooling-mantles 28 and 29, in which water circulates. The length of the burner is chosen with regard to the properties of the ore.

Besides the above mentioned and on the drawing illustrated details for controlling the charging of the ore, the coal and the lime, there must naturally be devices for controlling the volume, the temperature and the pressure of the air-current as well as the electrical heating.

As shown in Fig. 3 a tube 30 may eventually be placed in the prolongation of burner 8, said tube having a larger diameter than the burner and thereby causing an injector-like suction at the extra tube 31, arranged beside the burner 8, where thus ore, coal and air or gas may be introduced anew so that different components may be given the flame in tubes 8 and 30, that is, make the flame reducing or oxidizing as desired, and thus promote the continuity of the process.

As is diagrammatically shown in Fig. 4, two nozzles may also be used. Through the one nozzle —*a*— heated carbonic oxid is introduced for reducing the most easily reducible ore entering at —*b*—, said reduction taking place in the burner pipe —*c*—. Through the other nozzle —*d*— highly heated air or a gas-mixture is then blown in, whereby the heat in the burner-part —*c*— and fore-furnace 9 is increased for reducing the more difficultly reducible ore as well as partly for smelting the mass. The different proportions of air, other gases and ore and coal at the different places must be practically ascertained.

As is evident from the foregoing, the present method may advantageously be used in such places where there is an amplitude of power for the electric installation and for the crushing of the ore and the coal, but where the prices of coke and coal are high.

Claims.

1. The method of reducing ores, which comprises mixing granulated ore, granulated carbonaceous material and fluxes, feeding said granulated mixture in a stream, and injecting said stream by means of a blast of highly heated air through a contracted burner and into a closed chamber.

2. The method of reducing ores which comprises mixing fine ore, flux and fuel, feeding the mixture to a blast of air thereby thoroughly mixing the particles with the air and producing combustion in the mixture so formed at a burner to reduce the ore.

3. The method of reducing ore which comprises mixing fine ore, flux and fuel, feeding the mixture to a blast of air thereby thoroughly mixing the particles with the air and producing combustion in the mixture so formed at a burner in a closed chamber to reduce the ore.

4. The method of reducing ores which comprises mixing the fine ore, flux and fuel, feeding the mixture to a hot blast of air thereby thoroughly mixing the particles with the air, and producing combustion in the mixture so formed at a burner in a closed chamber to reduce the ore.

5. The method of reducing ores, which comprises mixing fine ore, flux and fuel, feeding the mixture substantially transversely to a hot blast of air thereby thoroughly mixing the particles with the air, and producing combustion in the mixture so formed at a burner in a closed chamber to reduce the ore.

6. The method of reducing ores, which comprises mixing fine ore, flux and fuel, feeding the mixture to a blast of air thereby thoroughly mixing the particles with the air, producing combustion in the mixture so formed in a closed chamber to reduce the ore, collecting the fused mass partly in said chamber and partly in a second chamber communicating therewith and supplying finely divided refining compounds to the metal by a blast of gases between the two chambers.

7. The method of reducing ores, which comprises mixing fine ore, flux and fuel, feeding the mixture to a blast of air thereby thoroughly mixing the particles with the air, producing combustion in the mixture so formed in a closed chamber to reduce the ore, collecting the fused mass partly in said chamber and partly in a second chamber communicating therewith, supplying finely divided refining compounds to the metal by a blast of gases between the two chambers and supplying the heat to the metal in said second chamber.

8. The method of reducing ores, which comprises mixing fine ore, flux and fuel, feeding the mixture substantially transversely to a hot blast of air thereby thoroughly mixing the particles with the air, producing combustion in the mixture so formed at a burner in a closed chamber to reduce the ore, collecting the fused mass partly in said chamber and partly in a second chamber communicating therewith, supplying finely divided refining compounds to the metal by a blast of gases between the two chambers and supplying heat other than that due to the combustion of the mixture in said first and second chambers.

In testimony, that I claim the foregoing as my invention, I have signed my name in presence of two subscribing witnesses.

NILS WIKSTRÖM.

Witnesses:

H. G. HEDBOM,

K. Y. LINDHOLM.