No. 637,432.

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D. TSCHERNOFF.

GAS BLAST FURNACE.

(Application filed Feb. 16, 1898.)

(No Model.)

Fig. 5.

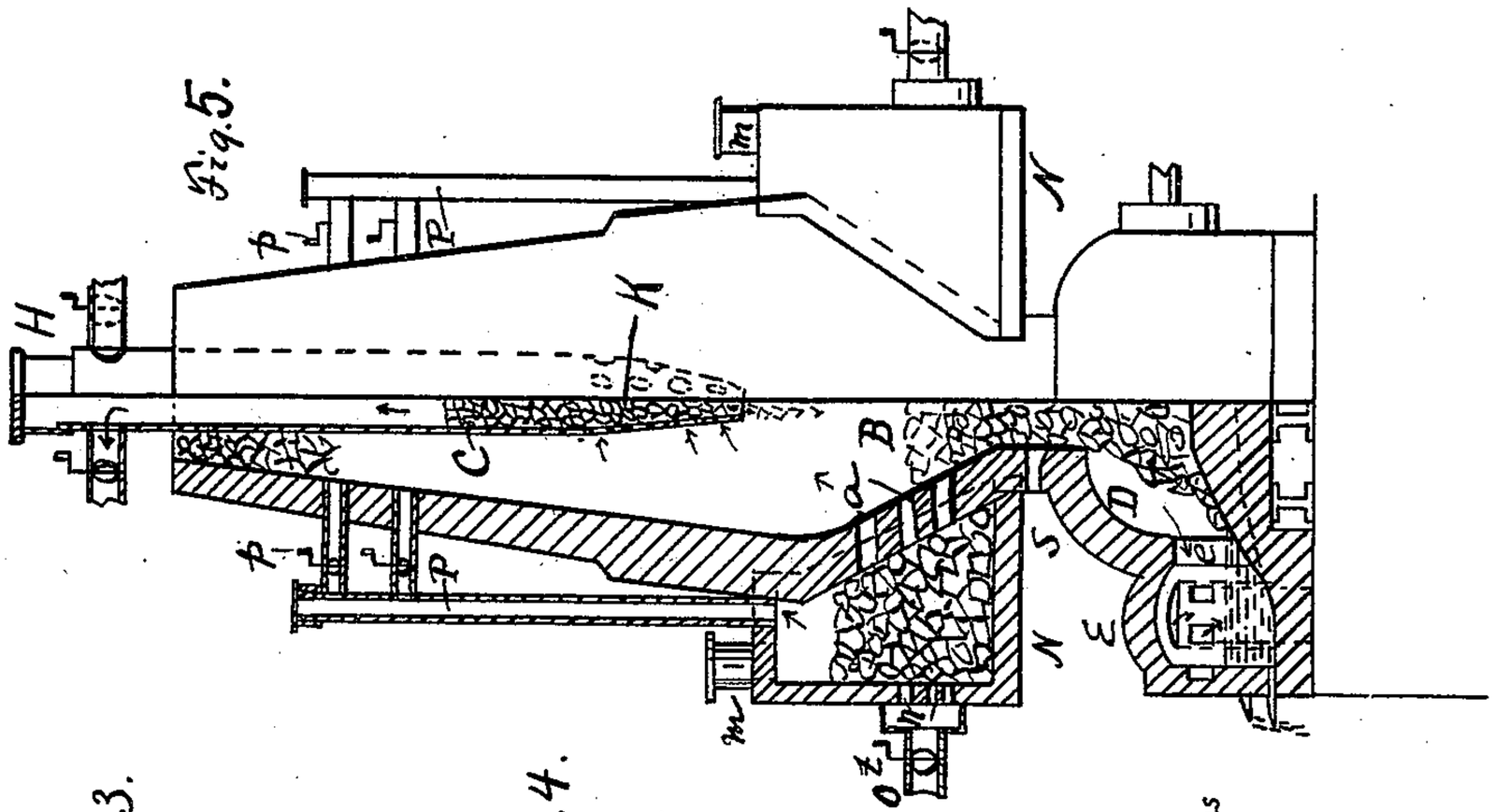


Fig. 3.

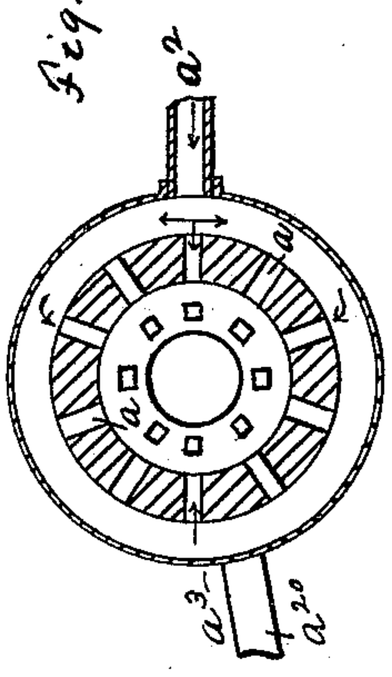


Fig. 4.

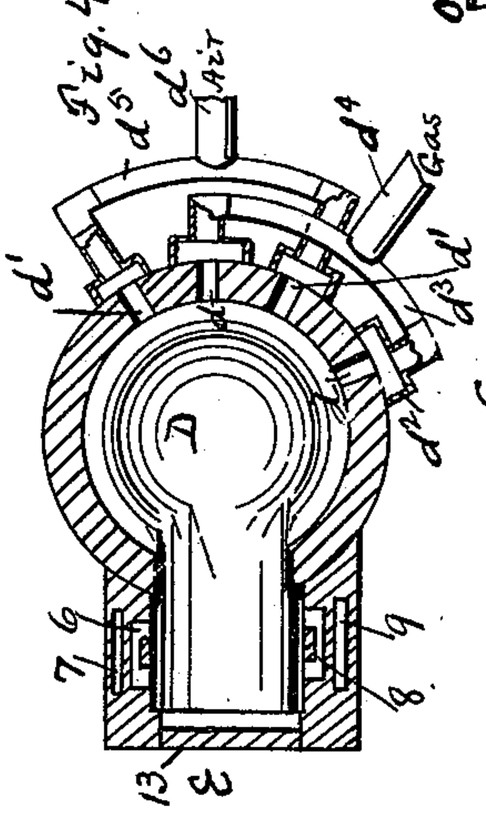


Fig. 2.

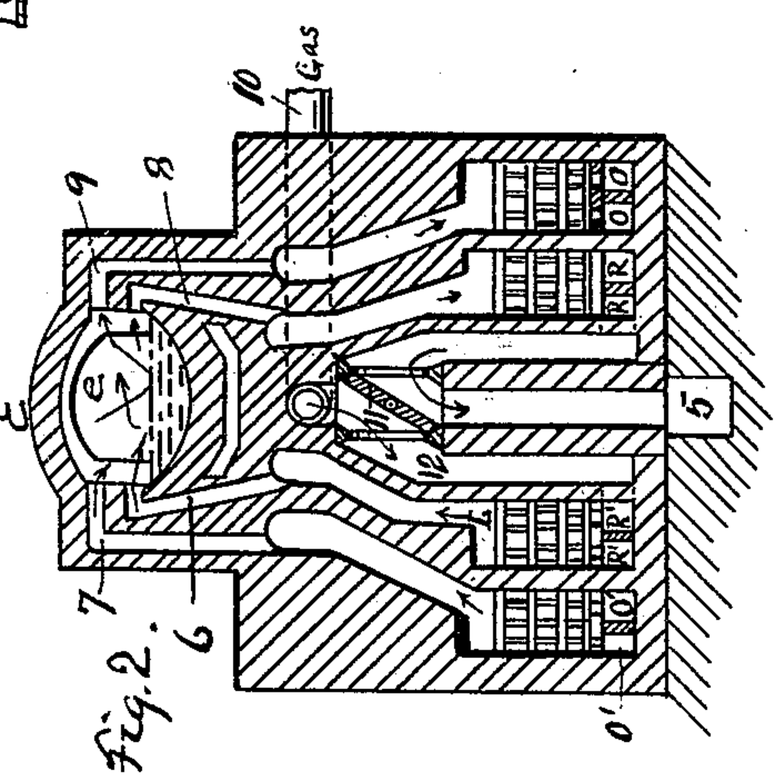
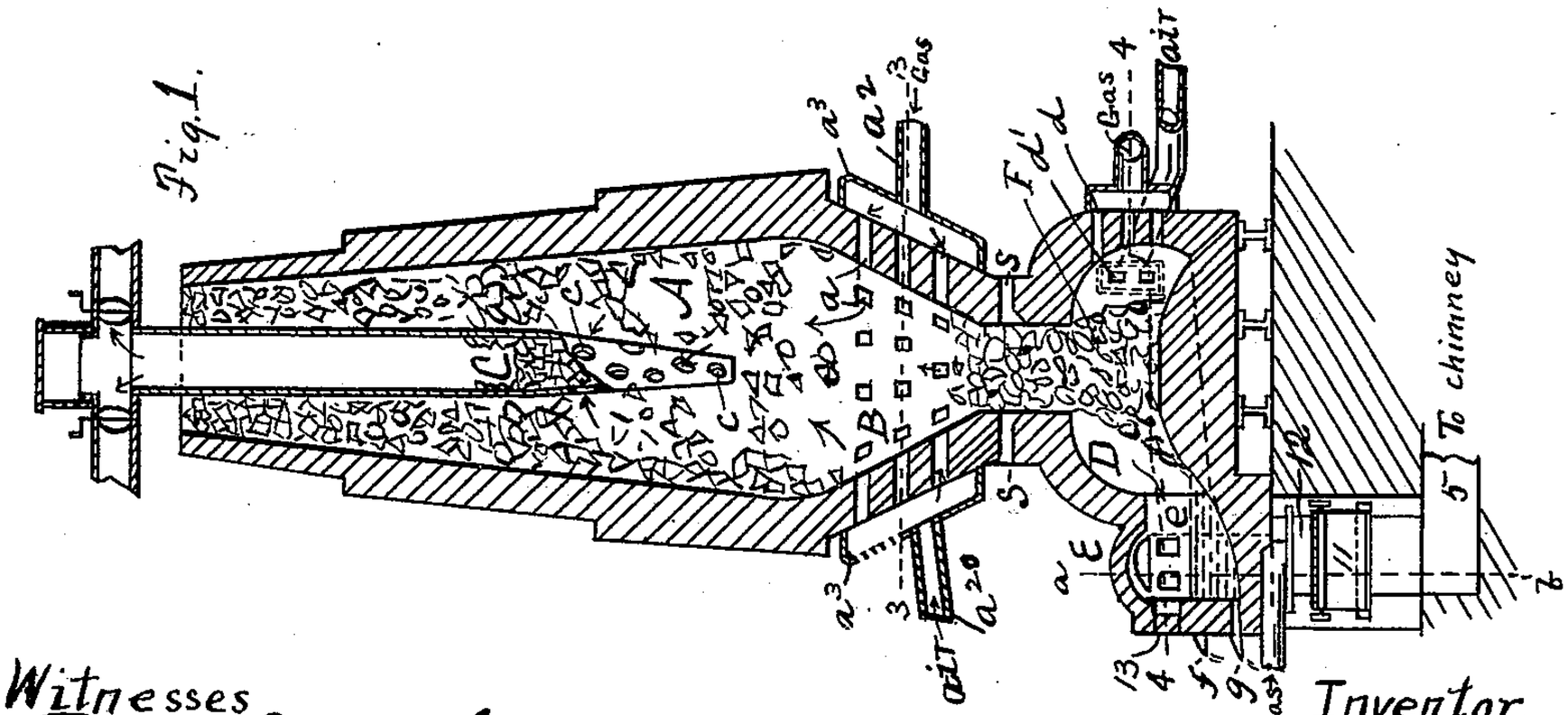


Fig. 1.



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DIMITRIS TSCHERNOFF, OF ST. PETERSBURG, RUSSIA.

GAS BLAST-FURNACE.

SPECIFICATION forming part of Letters Patent No. 637,432, dated November 21, 1899.

Application filed February 16, 1898. Serial No. 670,484. (No model.)

To all whom it may concern:

Be it known that I, DIMITRIS TSCHERNOFF, a subject of the Emperor of Russia, and a resident of St. Petersburg, Russia, have invented certain new and useful Improvements in Gas Blast-Furnaces, of which the following is a specification.

It is well known that numerous trials have been made to replace in the high or blast furnaces the dear carbonized fuel (charcoal, coke, &c.) by combustible gases and to control the action of the blast-furnaces in such a manner that in the lower hearth cast-iron, iron, or steel may be obtained; but till now these trials have never given satisfactory results.

The object of my invention is to construct a blast-furnace which will accomplish both these results. This furnace differs substantially from all known furnaces of the same kind in this feature, that the current or flow of gas, which is generally single, is in my blast-furnace divided into two separate flows: First, the reducing flow, which is let in the furnace at the height of the cementation-zone of the former blast-furnaces, this flow of incandescent gas being led from said zone up through the ore in the shaft of the furnace between said zone and the gas-outlets and serving to reduce the ore, and, second, the melting flow, which is led to the hearth of the blast-furnace together with air indispensable for the combustion. This gas being ignited melts the reduced metal and the cinders or slags, which reduced material moves down in the shaft and is directed horizontally through a side port. The combustion-gases pass through the covered hearth to exhaust-openings and through the regenerators of this side hearth, together with the exhaust-gases of this side hearth, to a separate chimney.

The blast-furnace forming the subject of this invention is shown on the accompanying drawings, of which Figure 1 represents a vertical section of my blast-furnace; Fig. 2, a vertical section of a gas-regenerative furnace in line *a b* of Fig. 1. Fig. 3 is a section on line 3 3 of Fig. 1. Fig. 4 is a section on line 4 4 of Fig. 1. Fig. 5 is a partial vertical section of a modified furnace.

The shaft A of the furnace is supplied with ore and flux, to which small quantities of charcoal or coke may be added when the nature of the ore treated requires it. At the zone B ports or holes *a* are provided through which incandescent gas entering through tube a^2 passes and also air which may be introduced through pipe a^{20} to casing a^3 and into the furnace along with the gas. Said tube communicates with a casing a^3, which surrounds zone B, as shown most clearly in Fig. 3. The gas should have a temperature of about 1,000° to 1,200° Celsius and comes from any suitable generator. (Not shown.) This gas passes upwardly through the ore, rendering it incandescent, and reduces the ore to metal, the flow of gas continuing to and through ports *c* in the exhaust-conduit C. The reduced ore, with the flux, continuously descends to the enlarged hearth D and there is melted by the combustion heat of gas admitted through the ports *d*, while air is admitted through the ports *d'*. As indicated in Fig. 4, the ports *d* may be provided with connected coverings d^2, connected by a pipe d^3, to which the gas-supply pipe d^4 is connected. The ports *d'* are likewise connected through a pipe d^5 and to air-pipe d^6. The flames of the gas which is admitted when melted metal falls to hearth D surrounds the ore-column F in the enlarged hearth D and are drawn through the port *e* into the covered front hearth E, which communicates with a separate chimney through the chimney-passage 5. The hearth E is arranged as a gas-regenerating furnace, with this peculiarity, that in addition to its own ordinary gas and air supply from its regenerators through passages 6 7, respectively, it is traversed by the flames from the central hearth D, due to combustion around the column F of reduced material, the flames entering through port *e*. All these gases are exhausted through the regenerators into the common chimney, as already stated. One arrangement of regenerator, to which the passages 6 7 and 8 9 may be connected, is indicated in Fig. 2, in which 10 is a pipe conducting gases from any suitable generator (not shown) to the regenerator. When the valve 11 is in the position shown, such gas descends through passage 12 to passages R', thence up through the heated regenerator L. At the same time air rises through the passages O' through the section of regenerator above the same to the furnace.

The gases resulting from the flames entering through port *e* and the air and gas entering through the regenerator and acting on the metal in the side hearth pass downward through passages 8 9, through the right side of the regenerator, and to the chimney-passage 5. When this side of the regenerator becomes heated and the other side cooled, valve 11 is reversed, thereby, together with suitable valves (not shown) in the air and gas pipes, reversing the flow through the regenerator in the manner and for the purpose well understood. Through the port *e* flows the metal reduced in the large hearth D to the side hearth E, together with cinders and slags, which may be removed through the port 13. The metal on the bottom of hearth E may be treated as in the Martin process—that is to say, the metal may be stirred and mixed with spiegel-iron, ferromanganese, ferrosilicium, or other similar materials, according to the nature and purpose of the metal. As soon as sufficient metal is formed it is removed through the tap-hole *g* and cast as usual. Thus my blast-furnace can be worked without interruption so long as it does not require any fundamental repairs.

The walls of the furnace are provided with eyeholes *s s* for watching the process and through which to assist the moving down of the charge. These holes may also be utilized in case of need for introducing into the furnace required substances—as, for instance, alkaline silicates, fluor-spar, or the like—for enhancing the fluidity of slags, &c. The control of the reduction of the metal and the degree of its carburization are obtained in this last furnace partly by mixing with the charge a required quantity of carbonaceous matter (charcoal, coke, anthracite, resin, &c.) and partly by greater or less intensity of firing in the lower central hearth and the volume of reducing-gas injected into the furnace through the ports *a*. Thus for obtaining cast-iron about five per cent. of charcoal or coke, by weight, must be added to the charge of ore and the temperature and volume of the injected gas must be increased. For obtaining wrought-iron the admixture of coal can be dispensed with and the temperature of the reducing must be lowered, but the temperature in the lower central hearth must be raised. In this manner the reduction and carburization are retarded, and the melting and consequently the charge are hastened. For obtaining steel of greater or less softness intermediate measures must be taken.

I will now describe certain features of my invention more particularly.

The gas obtained from solid or liquid fuel by means of any suitable generator before it is supplied through ports *a* must have a temperature of about 1,000° to 1,200° Celsius, as above stated. For this purpose the gas is led through brickwork or other heating apparatus, placed as near as possible to the blast-furnace; or instead of this arrangement gas-generators N for this purpose can be arranged close to the walls of the furnace between the standards (not shown on the drawings) supporting the brickwork of the shaft and of the corbeling out of the blast-furnace. The working of the generators N presents this feature, distinguishing them from ordinary generators, that the products of destructive distillation and the wet vapors which are developed by the fuel are exhausted separately from the combustible gases, which are consequently more rich in carbonic oxid, poorer in nitrogen, and dryer and hotter than the gases of ordinary generators.

In Fig 5, O is an air-pipe provided with a controlling-valve *t*, which leads air from a suitable blowing apparatus (not shown) to generator N through ports *n*. Here the air penetrates the bed of incandescent fuel almost in a horizontal direction, the carbonic oxid produced with a part of nitrogen passes through the ports *a* to the blast-furnace, and the products of distillation and also the wet vapors from the fresh charge of fuel, which is inserted through the inlet *m*, ascend in the pipe P and pass through the branch pipes *p* to the upper part of the blast-furnace. Here these products traverse the upper beds of the charge in the shaft, and after having transmitted their heat are exhausted as products almost without value through the mouth of the furnace. The pipe *p* can be made of brickwork in order to prevent the cooling of the gases. The bulk of the products exhausted through the pipe P on the generator can be controlled by means of valves *p'* in said branch pipes *p*.

As the reduction of iron from its oxid by means of the carbonic oxid is performed without expense of external heat, the whole heat brought to the furnace by the incandescent gases will be expended only in heating the ore and the flux. Consequently the gases, arriving at the furnace at a temperature of about 1,000° to 1,200° Celsius, will enter the conduit C at a temperature of at least 800° Celsius. This circumstance permits the regeneration of these gases by placing in the conduit C a quantity of charcoal K, Fig. 5, which is introduced through the top H. A part of this coal will go out through the lower end of the conduit C with the ashes and will follow the column of ore in its downward movement to the lower hearth D. The generators N can be arranged at some distance from the walls of the blast-furnace, in which case the generated gas will be led to the inlets *a* from the generators by tubular passages, which may be iron tubes with refractory linings.

I claim—

1. A furnace having a shaft A, a contracted zone B with openings *a* therein, means for introducing hot gas to said contracted zone; a pipe C in said shaft having openings for the escape of said gases, pipe C extending to the top of the shaft and having a suitable outlet,

an enlarged hearth below the contracted zone, onto which material descends from the shaft, inlets for air and gas to said enlarged hearth, a side hearth slightly lower than the enlarged hearth and connected therewith by a passage, whereby melted metal from the enlarged hearth will pass to the side hearth, as set forth.

2. A furnace having a shaft A with openings *a* near the base of the shaft, a chamber on the exterior over said openings, a pipe P from the upper part of the chamber to the interior of the shaft toward the top thereof, and a perforated pipe C in the shaft.

3. A furnace having a shaft A, an enlarged hearth below said shaft, means for introducing air and gas into the shaft at zone B, means for introducing air and gas to the enlarged hearth, a side hearth E communicating with the enlarged hearth below the shaft, there being regenerating-passages for admitting air and gas to the hearth E, and exhaust regenerating passages from said side hearth.

Signed at St. Petersburg, Russia, this 27th day of January, 1898.

DIMITRIS TSCHERNOFF.

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