(No Model.) 2 Sheets—Sheet 1.

H. SCHULZE-BERGE.

BLAST FURNACE.

No. 296,225. Patented Apr. 1, 1884.

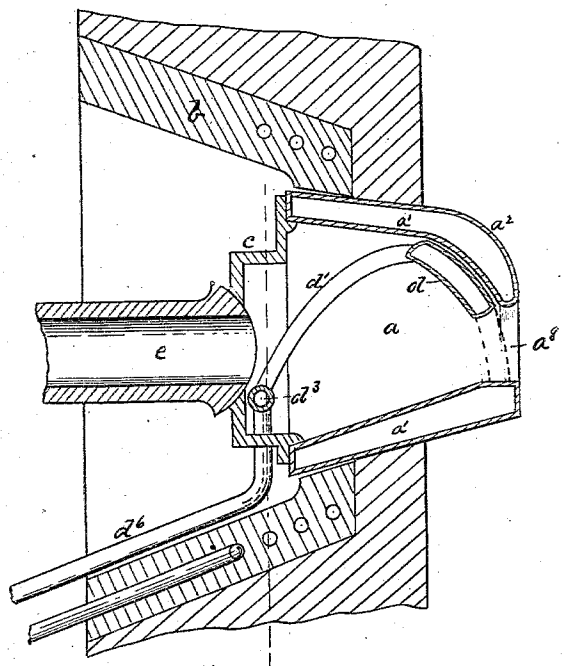


Fig. 1.

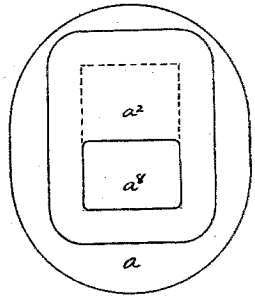


Fig. 2.

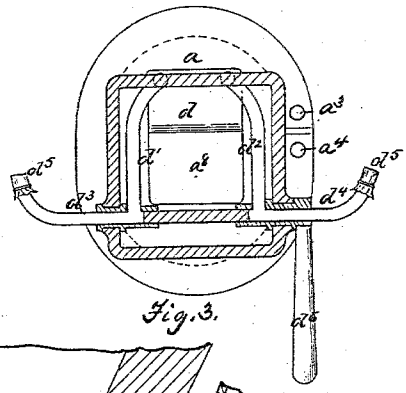


Fig. 3.

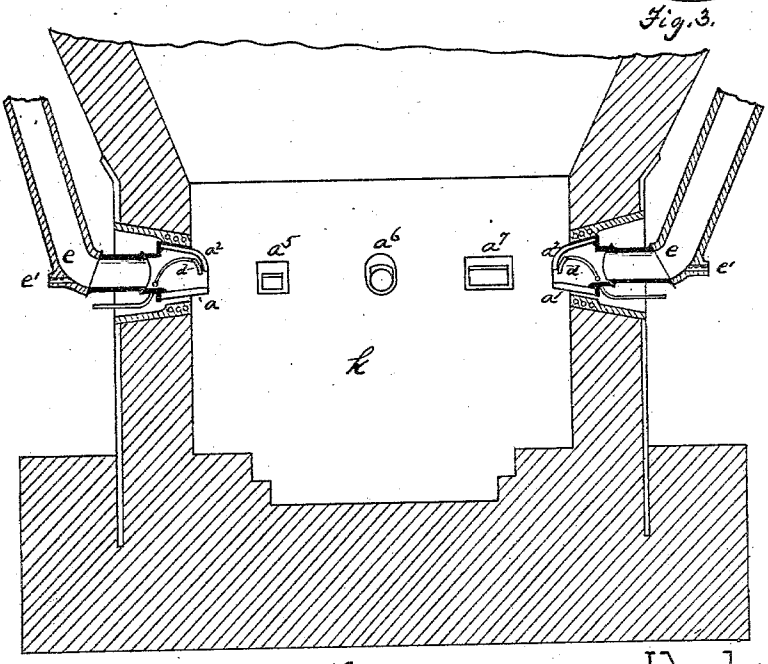


Fig. 4.

Witnesses.
W. B. Cowin
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(No Model.) 2 Sheets—Sheet 2.

H. SCHULZE-BERGE.

BLAST FURNACE.

No. 296,225. Patented Apr. 1, 1884.

Fig. 5.

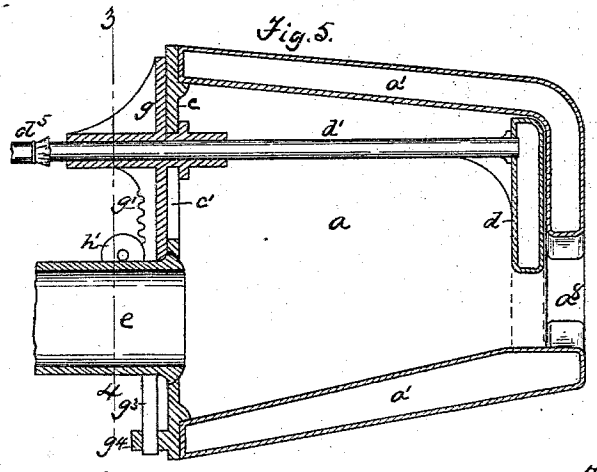


Fig. 10.

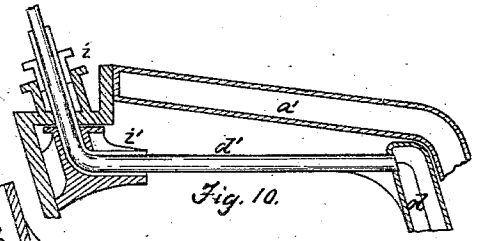


Fig. 8.

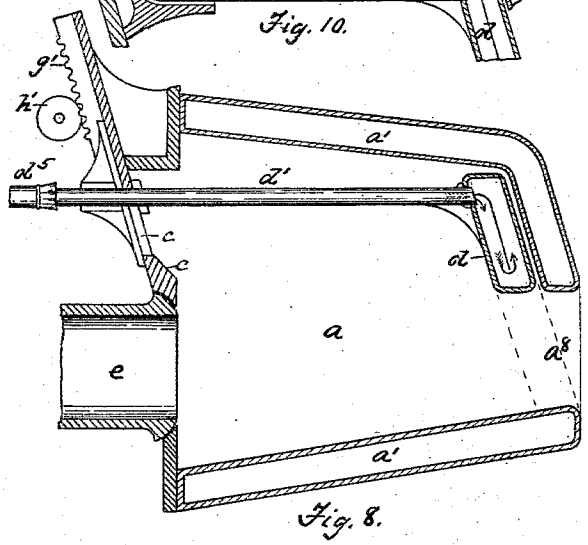


Fig. 6.

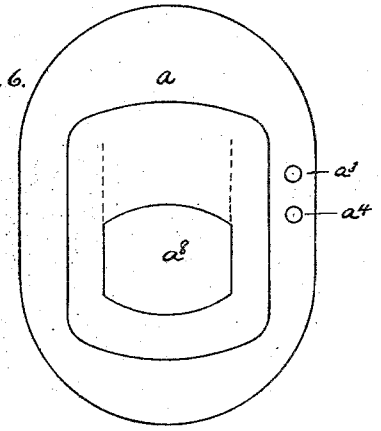


Fig. 7.

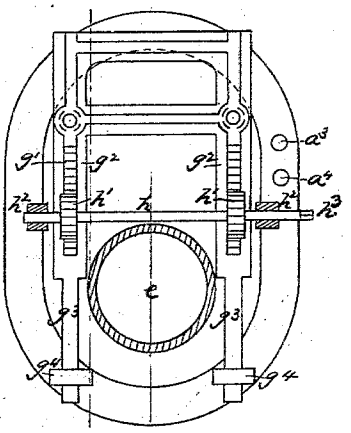
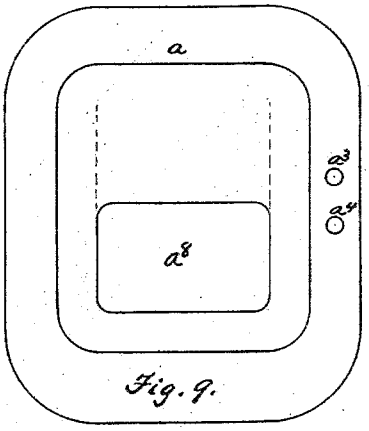


Fig. 9.



Witnesses.

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UNITED STATES PATENT OFFICE.

HERMANN SCHULZE-BERGE, OF ROCHESTER, PENNSYLVANIA.

BLAST-FURNACE.

SPECIFICATION forming part of Letters Patent No. 296,225, dated April 1, 1884.

Application filed December 21, 1883. (No model.)

To all whom it may concern:

Be it known that I, HERMANN SCHULZE-BERGE, of Rochester, in the county of Beaver and State of Pennsylvania, have invented a new and useful Improvement in Blast-Furnaces; and I do hereby declare the following to be a full, clear, and exact description thereof.

The process of smelting ores in a blast-furnace depends, chiefly, upon the heat produced by combustion of fuel, and this again depends, to a certain degree, upon the quantity and pressure of blast. The amount of oxygen required to complete the combustion of a certain amount of carbon is the same whether the air be forced through it quickly—say in one minute—or when allowed to pass through it in two minutes, and the amount of heat produced in both cases is equal when expressed in units of heat. However, the pyrometrical effect is quite a different one, the degree of heat varying proportionately to the time in which the carbon is consumed. In metallurgical processes the melting or other chemical reactions take place only when a certain degree of heat is reached, and from this it may be inferred that two furnaces working under absolutely equal conditions, except that one furnace is supplied with blast twice as quickly as the other, and the first furnace is producing pig-iron, the heat in the second one may not even come up to the degree necessary to do so, notwithstanding the fact that in both cases complete combustion of fuel may ensue. The pyrometrical effect of combustion can be raised at will by increasing the amount of blast in a given time. If the degree of heat which is necessary for the smelting of the ores is reached, a further increase of the pyrometrical effect of combustion causes an acceleration of the process, and as, by such accelerated working, the loss of heat is less than if working over the same product a longer time, there is a saving of fuel attainable by bringing the pyrometrical effect of combustion to its highest pitch. Such is the result by using hot-blast over cold-blast, the amount of units of heat carried along by the hot-blast is but secondary to its chief action of producing an accelerated combustion of fuel, and by this an increase of the pyrometrical effect of the combustion of the fuel. The variation of the amount of fuel used in different furnaces is, to a great extent, due to the fact that in many cases the best pyrometrical effect of the combustion of the fuel is not reached. The same quantity of blast of equal temperature forced into the same furnace in a given time can be blown in at a lower pressure with a wide tuyere-nozzle, or at a higher pressure with a narrower tuyere-nozzle. In both cases the same amount of heat-units is produced in the same time; but notwithstanding this the pyrometrical effect can be a different one in the same oven. This depends upon the way in which the heat is produced, as well as in which it is applied. A furnace, when the blast has been taken off, has a strong draft; yet a certain blast-pressure is needed to overcome the obstructions in the blast-furnace and reach the center of the hearth. Such obstructions are independent of the moving solid materials and the larger or smaller diameter of hearth. The swelling in bulk of the blast itself, it being forced into a higher temperature, where it expands two or three times in reciprocal proportion to the temperature at which it was forced in, and the volume of gaseous carbonic acid and carbonic oxide generated from the combustion of the fuel, exert their influence upon the blast-pressure inside of the furnace. All such resistances which are to be overcome by the blast-pressure vary with the inner shape of the furnace and with the state of the solid or melting substances in parts above the tuyere level. Placing these obstructions for two furnaces upon an equal footing, and following up the question how it affects a furnace when the same quantity of air of equal temperature is forced into the furnace by a stronger or by a lower blast-pressure, it will be found that when the blast-pressure is so low that it just balances the obstructions, and a small quantity of air is blown in through a wide-mouthed tuyere, the heat will pass upward to the bosh, and the pyrometrical effect of the combustion will be very small, because the amount of heat-units which are generated in a certain length of time are spread and dispersed through a large space and a large amount of stock. By careful management this amount of heat may be partly regained by bringing the stock more highly heated into the hearth. It more fre-

quently happens, however, that this manner of working is a cause for scaffolding and for a direct loss of heat by the gases leaving the furnace with a higher temperature. When the same amount of air is applied with a strong pressure, requiring a smaller size of tuyere-mouth, an entirely different result is produced. The blast forces its way through the stock toward the center of the hearth, and the amount of heat-units concentrates in a smaller space and upon a smaller amount of stock, producing a better pyrometrical effect of the combustion of the fuel. In running a blast-furnace it frequently happens that it works too cool, either by reason of too heavy burdening or too strongly forced working, or other causes. To remedy such faults the furnace is slackened, which is done by giving it less blast. This can be done in two ways—either by decreasing the pressure of the blast, or by decreasing the number of the tuyeres blowing into the furnace. The latter method causes an irregular distribution of blast in the hearth of the furnace, while decreasing the blast-pressure results, as explained above, in a reduction of the pyrometrical effect of the combustion of the fuel.

In the accompanying two sheets of drawings I show a novel construction of water-cooled blast-furnace tuyeres, by which the size of their nozzle-openings can be adjusted so as to cause the blast to enter into the furnace with a stronger or lower pressure, which can be varied at will, thus enabling the keeper to slacken the furnace down and yet keep up the pressure unchanged, attaining by this a better pyrometrical effect of the combustion of the fuel, and consequently a saving of fuel.

To enable others skilled in the art to make and use my invention, I will now describe it by reference to the accompanying drawings, in which—

Figure 1 is a vertical section of my improved blast-furnace tuyere. Fig. 2 is an end view of the nozzle of the tuyere shown in Fig. 1. Fig. 3 is a vertical cross-section on the line 1 2 of Fig. 1. Fig. 4 is a vertical section of the hearth of a blast-furnace provided with my improved tuyeres, several different forms of nozzles being shown. Fig. 5 is a vertical section of a modified form of tuyere. Fig. 6 is a front end view, and Fig. 7 is a vertical section on the line 3 4, of the tuyere shown in Fig. 5. Fig. 8 is a vertical section of another modification, and Fig. 9 is a front end view of the same. Fig. 10 is a partial section of another modification.

Like letters of reference indicate like parts in each.

The tuyere *a*, (shown in Figs. 1, 2, and 3,) is water-cooled by means of the chamber *a'*, which has suitable inlet and outlet water-connections at a^3 and a^4, as will be understood. It is held in place in the water-cooled casting *b* by the box-plate *c*, and has a sliding stopper, *d*, preferably hollow, and provided with a water inlet and outlet through its arms d' d^2, made hollow for that purpose. These arms are supported by hollow journals d^3 d^4, having couplings d^5. The stopper is moved by a handle or lever, d^6. In connection with the tuyere is a blast-pipe, *e*, leading from the blast-trunk in the usual way. The size of the opening a^8 at the tuyere-nozzle is regulated by moving the stopper *d* by means of the handle d^6, which may be secured in its regulated position by a suitable tally board or rack. The sides between which the stopper moves are parallel. The other sides may be tapering. The blast will preserve the direction of the plane of the side to and from which the stopper approaches and recedes. The upper side of the projecting nozzle end of the tuyere *a* is curved downward, as at a^2, so that no drops of iron can settle on it and alloy with or burn through the bronze, as is often the case with an ordinary conical tuyere, especially when scrap-iron is charged into the furnace. When such a thing happens with a water-cooled tuyere, not only is the latter destroyed, but the water flows into the furnaces with injurious results.

In Figs. 5, 6, and 7 I show a modified form of regulable tuyere. Here the stopper *d* moves vertically, its supporting-arms d' d^2 being mounted on a frame, *g*, which slides vertically on the face of the plate *c*. The frame *g* is provided with two racks, *g'*, in which mesh the two pinions *h'*, mounted on the shaft *h*, which is journaled in boxes h^2 on the outer end of the tuyere. The side plates, g^2, of the frame *g* cover the slots *c'* in plate *c*, through which the arms d' d^2 project, to prevent the escape of the blast. The frame *g* is provided with guide-rods g^3 at its lower end, which extend through guides g^4 on the outer end of the tuyere. The shaft *h* has a hub, h^3, upon which a lever or handle may be placed to turn it, and thereby raise or lower the plate *g*, and thereby the stopper *d*.

In Figs. 8 and 9 I show another modification, which differs from that shown in Figs. 5 to 7 only in giving a diagonal or inclined movement to the stopper *d*. In Fig. 10 the stopper is moved by working the arms d' d^2 through stuffing-boxes *i*, the elbows of the pipes having guide and support pieces *i'*, resting and moving on the box-plate *c*.

In Fig. 4 I show tuyeres with different forms of nozzles, as at a^5, a^6, and a^7, projecting into the hearth *k* of the furnace.

I am aware that blacksmiths' tuyeres having means for regulating the size of the nozzle-opening were devised before my invention; but the use of such tuyeres in a blacksmith's forge and other places does not anticipate my invention, for the reason that my method of increasing the pyrometrical effect of the combustion of the fuel, which is accompanied by the saving of fuel, prevention of scaffolding and chilling, and ability of better regulating the operation of a blast-furnace, was not apparent from such use, and could be discovered

only by a thorough knowledge of the conditions of the smelting operations in a blast-furnace, and also for the reason that the existence of such tuyeres did not render apparent the means of curing these evils, which have long existed in blast-furnace practice, and which blast-furnace engineers have as long sought to remedy. The conditions of the blast-furnace are peculiar to itself and totally different from those of a blacksmith's forge. The functions of the combination claimed by me are such as do not result from any other use of regulable tuyeres.

I am aware that prior to my invention cupola-furnaces for remelting pig metal having slides placed at the outer ends of the tuyeres for closing them had been devised; also converters for treating molten metal having stoppers at the outer ends of the tuyeres, and also a converter having conical tuyere-stoppers arranged at the inner ends of the tuyeres, the latter having been patented to me on March 4, 1884. These prior devices differ in construction from my present invention, in that the two first mentioned do not regulate the size of the nozzle-openings, and the last changes the direction of the blast, which is a serious objection to its use in a blast-furnace. Moreover, none of these things anticipate my invention, because they had no relation to a blast-furnace and were not used under the conditions found therein. Furthermore, they did not, and could not, have the functions due to my invention.

Having thus described my invention, what I claim, and desire to secure by Letters Patent, is—

1. A blast-furnace for smelting ores, provided with tuyeres having stoppers for regulating the size of the nozzle-openings, substantially as and for the purpose described.

2. A water-cooled tuyere having a water-cooled sliding stopper for regulating the size of the discharge-opening, substantially as and for the purposes described.

In testimony whereof I have hereunto set my hand this 10th day of December, A. D. 1883.

HERMANN SCHULZE-BERGE.

Witnesses:
W. B. CORWIN,
THOMAS W. BAKEWELL.