J. F. BENNETT.
Blast-Furnace.

No. 197,010. Patented Nov. 13, 1877.

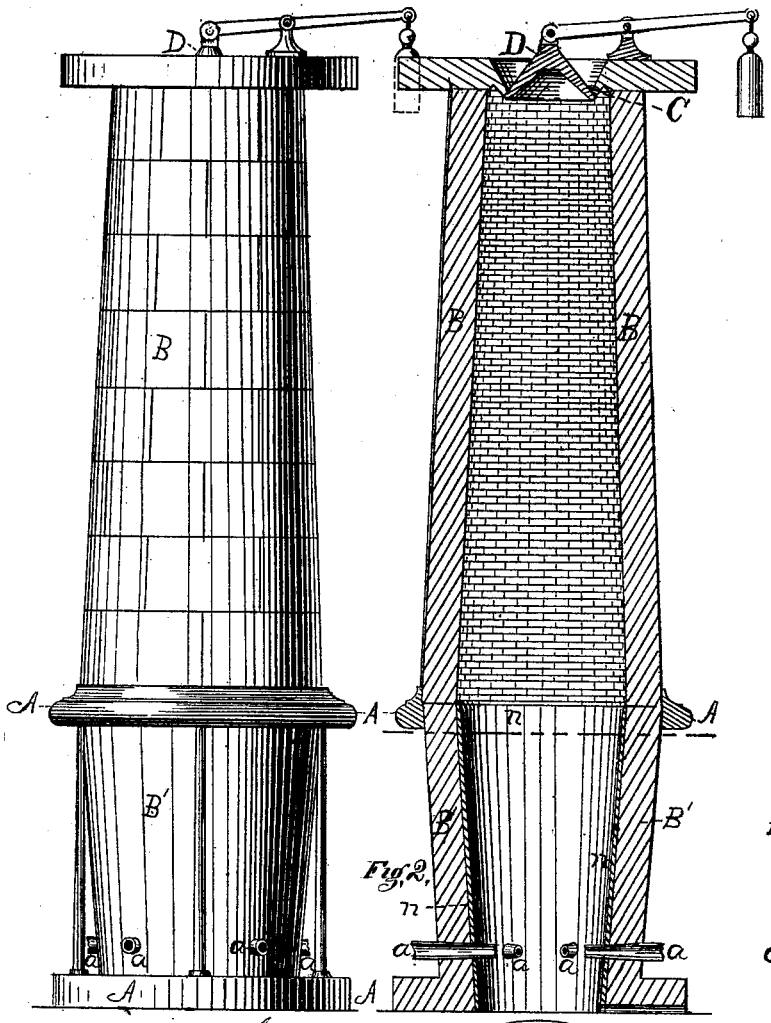

Fig. 1.

Fig. 2.

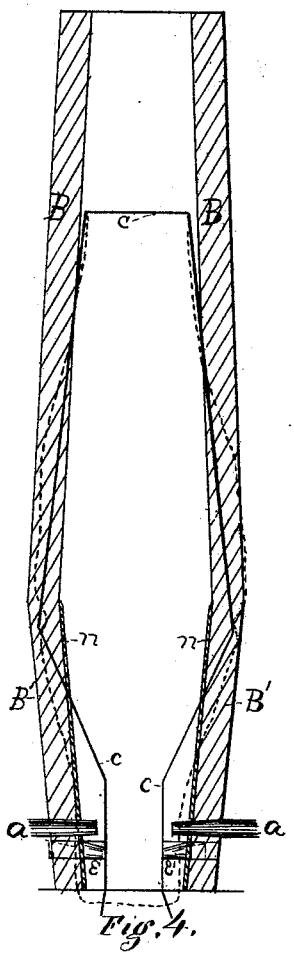

Fig. 4.

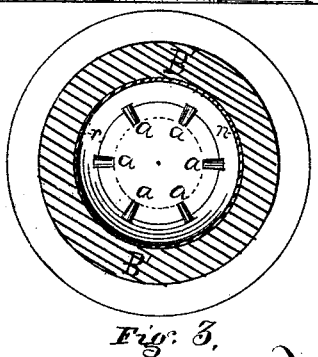

Fig. 3.

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JOHN F. BENNETT, OF PITTSBURG, PENNSYLVANIA.

IMPROVEMENT IN BLAST-FURNACES.

Specification forming part of Letters Patent No. **197,010**, dated November 13, 1877; application filed August 2, 1877.

To all whom it may concern:

Be it known that I, JOHN F. BENNETT, of Pittsburg, county of Allegheny, State of Pennsylvania, have invented or discovered a new and useful Improvement in Blast-Furnaces; and I do hereby declare the following to be a full, clear, concise, and exact description thereof, reference being had to the accompanying drawings, making a part of this specification, in which—like letters indicating like parts—

Figure 1 is an outside elevation of my improved blast-furnace. Fig. 2 is a vertical section of the same. Fig. 3 is a transverse section a little above the tuyeres; and Fig. 4 is also a vertical section of my furnace, having drawn thereon in full lines the outline figure of the interior walls of blast-furnaces as frequently constructed.

Blast-furnaces, as heretofore constructed, consist in their main divisions of, first, the well, which is to contain the molten metal, and is usually of comparatively small area in cross-section; second, the boshes, which usually are made of the form of an inverted truncated cone with the sides diverging widely toward the top, to form what is commonly known as the belly of the furnace, which has an area in cross-section largely in excess of the well below, and usually, also, of the throat above; and, third, the stack or shaft of the furnace, which extends upward from the boshes any desired distance, according to the inclination of the builder. This upper shaft usually converges toward the top or throat, so as to give an opening somewhat smaller in area than the belly of the furnace, but still considerably in excess of the well, or of the point of junction between the well and boshes.

Tuyeres through which the blast is forced into the furnace have been inserted through the walls of the well, their nozzles terminating nearly even with the inner face of the wall. As the inner walls or lining wore away these tuyeres were moved back, so as still to keep their nozzles nearly even with the wearing-face. While furnaces in use differ from each other more or less in detail, yet they, as a rule, have substantially the parts and proportions given.

The difficulties which attend this form and construction, and which I effectually overcome by my improved furnace are, first, it is necessary to place the tuyeres pretty low down in order to produce sufficient heat in the lower part of the well to keep the metal and slags therein in a molten condition, and, the well being comparatively small in cross-section, such lowering of the tuyeres results in lowering and contracting the zone or belt of fusion, and reduces the efficiency of the furnace. Again, by placing the tuyeres with their nozzles even or nearly even with the inner face of the furnace-wall, the upward currents of the blast are brought near to the furnace wall or lining, which is thus subjected to intense heat. Such heat renders the material of the linings more or less plastic, so that it is easily worn away by the abrasion or attrition of the descending charge. In time this wearing away of the furnace-wall necessitates the pulling down and rebuilding of the same.

I have shown by dotted lines in Fig. 4 the form to which a furnace was worn by continuous use, the furnace being built originally of the internal form there shown in outline on the section-figure, and marked *c*. The tuyeres as used in such furnace are marked *e;* and, as already described, they were moved back as the furnace-wall wore away, so as to keep their nozzles about even with the inner face of the wall.

Another difficulty attending this arrangement of the tuyeres is, that the ascending gases, being brought thereby close to the side walls, tend to follow such walls in making their escape from the furnace, as the lumps and irregular pieces lying against the wall do not pack as densely as in the center of the furnace, and thereby offer an easier passage for such gases; but in so doing they do not act equally upon all parts of the charge, and their full effect is not realized, which results in lessening the production and increasing expense. To overcome this difficulty the boshes of the furnace have been widely expanded toward the belly; but such construction of the boshes interferes seriously with the uniform descent of the charge along the same, which is a very important consideration; and, again, the belly of the furnace being made so much larger than the throat, it is very difficult to

get an even and proper distribution of the materials when they reach the belly of the furnace in their descent.

In my improved furnace the inner walls constitute, substantially, two frustums of cones placed base to base, the lower one resting its smaller end upon the foundation or hearth and extending upward one-third the height of the furnace, or to the point of greatest area in cross-section, the upper cone beginning with its largest end at such point of greatest area and extending upward two-thirds of the height of the furnace.

The inner diameter of the furnace at the base or hearth is, by preference, two-fifteenths of the whole height of the furnace, and the area in cross-section at the belly or point of greatest diameter is not less than twice nor greater than three times the area at the base. The area of the throat is, by preference, the same as of the base, but may be increased by one-half when desired, as when the relative area at the point of greatest diameter is increased.

As shown in the drawings, B B′ represent the walls of my improved furnace, which are supported at the top of the boshes and at the base by any suitable frame-work, A. These walls are lined with fire-brick in the usual way. The cone or bell of the furnace is represented at D, and the opening in the throat, through which the furnace is charged in the usual way, is shown at C. The area of this opening is equal to one-half the area of the throat.

Furnaces, as ordinarily constructed, have a cone or bell much smaller in proportion to the throat than this, and the difficulty attending such small openings is, that the finer particles of the charge accumulate in the center of the furnace, and, becoming packed, prevent a free passage of the ascending gases through such packed portion. A few furnaces have been built having a much larger cone-opening than the one I employ, but with such large cones the charge becomes packed against the walls of the furnace. In no case has a cone of the relative dimensions given been used in a furnace having the described relative proportions of throat, belly, and base. By means of an opening and cone of the proportions given, I am enabled to secure a better and more even distribution of the charge, especially when it reaches the boshes, than could be done in the old form of furnace. Tuyeres *a* are inserted through the walls of the furnace at a height above the base equal to one-half the diameter of the base or one-fifteenth the height of the furnace. This position of the tuyeres is given as affording the best results with a blast of about five pounds to the square inch, and of a temperature of about 1,000° Fahrenheit. If the blast be weaker, say, one pound, giving a blast of four pounds to the square inch, then the tuyeres should be lowered a little, depending upon the capacity of the furnace, so as to keep the molten metal below sufficiently heated. The higher the tuyeres are placed, and at the same time a sufficient heat be maintained below, the more productive will be the furnace, for the zone or belt of fusion will thereby be increased. The dimensions which I have given to the base of my furnace provide for a much larger plane chamber or zone in which fusion takes place, and the heat from the same is correspondingly increased. This, of itself, enables me to place the tuyeres higher in the furnace than could be done in the old form, as such increased heat above assists in keeping the metal below properly heated.

Instead of placing the nozzles of these tuyeres even with the inner face of the wall, as has heretofore been done, I insert them into the interior of the furnace, by preference, until their nozzles reach an imaginary circle which will divide the area at that cross-section into two equal parts, or in any case I insert them to such distance that the reflex currents made by the mutual action of the several jets shall not return or strike back against the walls of the furnace, or until they shall have been converted into carbonic-oxide gas or carbonic-acid gas, in which condition they will not act destructively on the lining. By this arrangement the walls are subjected in a much less degree to the destructive action of the heat and gases of the furnace, and, in consequence of the diminished activity thus secured about the walls, particles of free, or nearly free, carbon settle upon and become attached to the walls. This accumulating carbon forms, in course of time, a coat or lining, *n*, closely resembling in its nature black lead or plumbago, and making, substantially, the lower part of the furnace a black-lead crucible, which practically never wears out, for it continually renews itself by the action of the furnace as worn away by the attrition of the descending charge or stock. And it is partly with a view to the formation of this coat or lining *n* that I have constructed my furnace with so great area in cross-section at the base, as I thus provide room for the same between the face of the wall and nozzles of the tuyeres, and also provide for free passage of the molten metal and slags through the space between the nozzles, which is always kept clear by the action of the blast.

I also secure an additional advantage by the enlarged size of this part of the furnace, as I thereby materially increase the area of the zone of fusion above the tuyeres, and, other things being equal, the productiveness of a furnace of given capacity depends upon the area of this zone; and, furthermore, the walls of the furnace being further removed, the ascending gases, which are generated near the center, do not as readily take to the walls for passage, but rather ascend up through the body of the charge and permeate the whole mass. This last result is also in a measure secured by the even distribution of the charge secured as before described.

By following the proportions given a greater

height is attained in a furnace of given capacity than in the old form, and this is a desirable feature, where, as in the case with my furnace, the form is such as to give the requisite strength and also preserve a uniform distribution of the charge through its whole descent. Still the height may be varied somewhat to adapt it to a companion furnace already built, retaining, however, as far as possible, the other features described.

By making the lower part of the furnace of a continuous conical form, I not only increase the area of the zone of fusion, as already described, but I also avoid the angle formerly made at the top of the well, or at the junction of boshes and well, and in so doing I secure a freer action of the furnace.

In the old form of furnace, with widely-expanded boshes, the ascending gases, having so much room for expansion, became cooler toward the walls, and did not operate upon the charge with the same effect as the hotter portion in the center; while in my furnace, the interior being more uniform in size, the charge will be more evenly affected.

I claim herein as my invention—

1. A blast-furnace composed interiorly of two frustums of cones, placed base to base, and having, first, its greatest area in cross-section not less than twice nor greater than three times the area of the base; second, the area of the throat equal to or not more than one-half greater than the area of the base; and, third, the lower frustum being about one-half the height of the upper, substantially as set forth.

2. In a blast smelting-furnace, the air-blast tuyeres *a*, two or more in number, projecting into the interior of the furnace, beneath the charge and above the space designed to contain the molten metal, substantially as and for the purposes set forth.

3. In combination with a blast-furnace having an interior form of two frustums of cones placed base to base, the tuyeres *a*, projecting into the interior, substantially as described, whereby a lining of carbon is deposited on the inner walls by the action of the furnace.

4. The tuyeres *a*, arranged so that a circle drawn through their nozzles shall divide the horizontal plane of the furnace at that level into two equal, or nearly equal, parts, in combination with a furnace having its greatest area in cross-section not less than twice nor greater than three times the area of the base, substantially as set forth.

5. The tuyeres *a*, arranged as described, in combination with a furnace having its greatest area in cross-section not less than twice nor greater than three times the area of the base, the area of the throat being not less than equal and not more than one-half greater than the base, and the cone or bell equal to one-half the area of the throat, substantially as described.

6. The combination, in a blast-furnace, of a throat having an area equal to or slightly in excess of the base, and a charging-hole and bell of about one-half the area of the throat, substantially as set forth.

In testimony whereof I have hereunto set my hand.

JOHN F. BENNETT.

Witnesses:

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