No. 75240

John F. Bennett: Improved process for desulphurizing and purifying iron & other metals.

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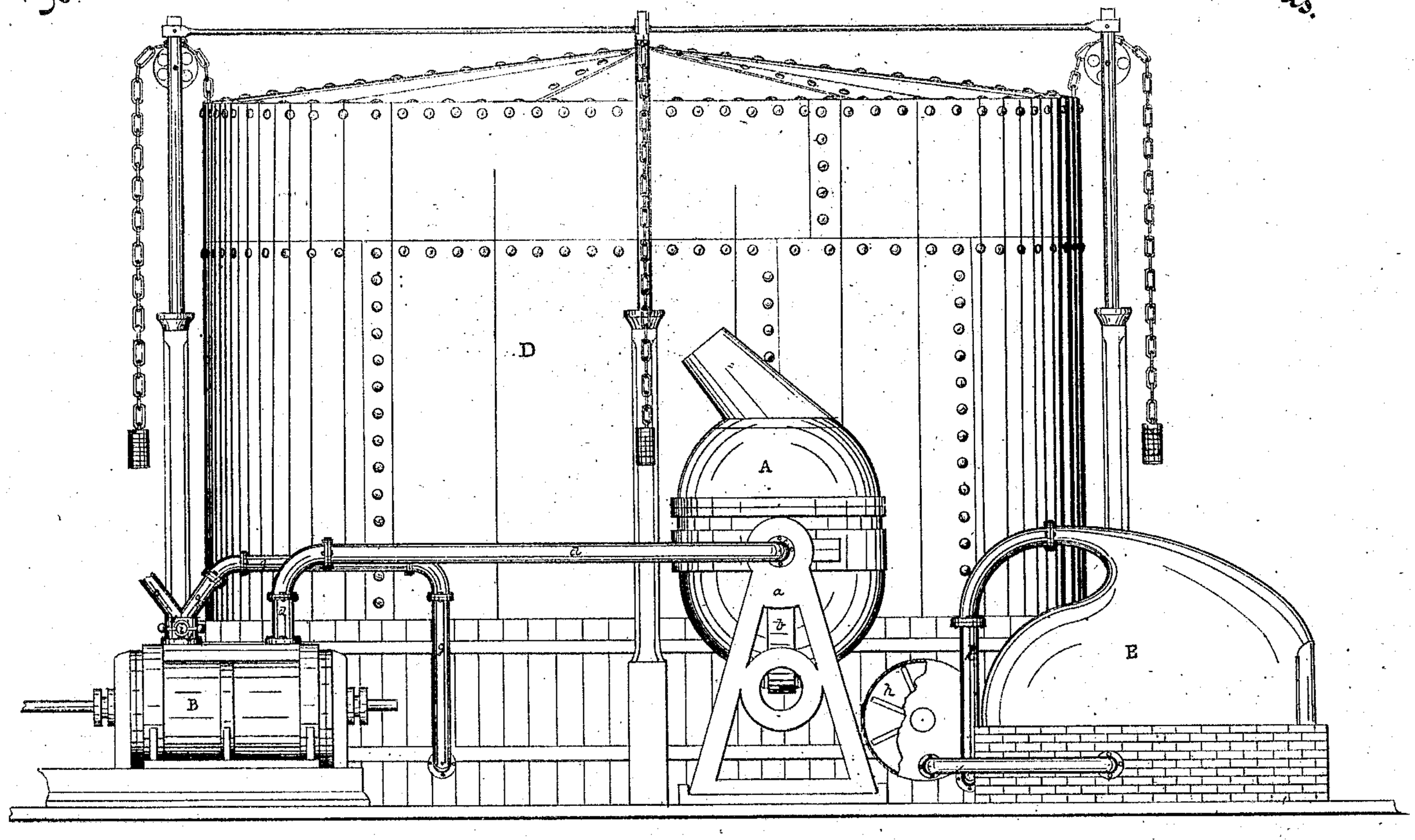
MAR. 10. 1868.



Witnesses:
W. D. Lewis.
C. B. Lushing

Inventor:
John F. Bennett
by his attys Bakewell & Christy.

UNITED STATES PATENT OFFICE.

JOHN F. BENNETT, OF PITTSBURG, PENNSYLVANIA.

IMPROVED PROCESS OF PURIFYING IRON AND STEEL.

Specification forming part of Letters Patent No. 75,240, dated March 10, 1868; antedated February 28, 1868.

To all whom it may concern:

Be it known that I, JOHN F. BENNETT, of the city of Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in the Process of Desulphurizing and Purifying Iron and other metals; and I do hereby declare the following to be a full, clear, and exact description thereof.

My invention consists in an improvement in the manufacture of iron and steel by what is known as the pneumatic process, the object being to carry off the sulphur, phosphorus, and other impurities from the metal, which are not removed by that process as ordinarily conducted. This result I effect while the metal remains in the converter, and without subjecting it to a process of reheating. Pig metal or crude iron, which results from the process of deoxidizing the iron ore by means of a blast-furnace, is highly-carbonized iron, with which are mingled silicon, sulphur, phosphorus, and other impurities.

The atmospheric pneumatic system consists in the removal of the excess of carbon from the metal by subjecting it, while in a molten condition, to the direct action of an atmospheric blast for the purpose of burning out the carbon, without the use of separate fuel for supporting combustion and producing the requisite heat.

The melted crude iron is poured into a receiver or converter at a temperature of about 3000° Fahrenheit, and a blast of atmospheric air, at a pressure of about twenty pounds to the square inch, is forced through the melted metal, entering at or near the bottom of the converter, and permeating the mass of molten metal therein. The mechanical effect of the passage of air through the metal is to produce violent ebullition and commotion, and the chemical effect is that the oxygen of the air unites with the carbon of the iron, generating a great increase of heat and causing a vivid combustion, the carbon of the iron serving, together with a portion of the iron, as the fuel, and the carbon being thus burned out and removed. During this process, which ordinarily takes about sixteen minutes, the heat of the metal rises rapidly to about 5000° Fahrenheit, and as soon as the carbon is all consumed the blast of air is stopped, as otherwise a rapid oxidation of the metal would ensue.

This process, which is successfully employed in the manufacture of steel from crude iron, does not effect the removal of the sulphur and phosphorus, which are eliminated, if at all, by a subsequent and distinct operation. I propose to effect the removal of the sulphur and phosphorus from the iron while it is yet in the converter, and before it has been allowed to cool, by means of carbonic-acid gas, either applied as a separate blast immediately after the cessation of the atmospheric blast in the pneumatic process, or by combining carbonic-acid gas with the atmospheric air in that operation.

In order to enable others skilled in the art to make and use my invention, I will proceed to describe the manner in which it is carried into operation.

The accompanying drawing represents the apparatus which I propose to employ, which is similar, in many of its details, to that used in the pneumatic process.

In the drawing, A is the converter, an egg-shaped iron vessel, exactly like that used in the atmospheric pneumatic process. It is supported on pillar-blocks *a* by trunnions placed above the center of gravity of the vessel, so as to incline it to preserve a vertical position and yet permit it to be tilted over in order to pour out the metal at the close of the operation. One trunnion, *c*, is hollow, and communicates externally with the blast-pipe *d* and internally with the interior of the converter by means of a passage, *b*, which conducts the blast to tuyere-holes in the bottom of the converter A. B is the blast-cylinder, of ordinary construction, by which a blast of air, or of carbonic-acid gas, or both, as the case may be, is forced through the blast-pipe *d* into the converter A. The inlet-pipe *e* admits atmospheric air into the blast-cylinder B through the valve-chest *f*, and the inlet-pipe *g*, connected with the gas-holder D, admits the carbonic-acid gas. The cock or valve *i* serves to regulate the supply of air or gas to the blast-cylinder, and also to shut off either or both, so that, by turning it properly, either gas or

air alone, or a mixture of the two, may be admitted into the blast-cylinder and forced into the converter.

The carbonic-acid gas employed in my process may be manufactured by the action of muriatic acid upon limestone, in a suitable apparatus, when it is desired to use the gas pure; but where it is employed in combination with the nitrogen of the air it may be conveniently procured by means of a generating-oven, E, which consists of a close-arched chamber furnished with grating, forming a bed for coke or charcoal, which being ignited, a stream of atmospheric air is forced, by a fan, *h*, into the closed space under the grating or fire-bed, and the air, passing through the ignited carbon, combines with it and is converted into carbonic acid mingled with nitrogen, which thence passes through the pipe *k* into the gas-holder D, which is of ordinary construction. The inlet-pipe *g* of the blast-cylinder B opens into the gas-holder D.

The operation of my improvement is as follows: The atmospheric pneumatic process as ordinarily practiced is carried on substantially as before described, the valves *i* being set so as to force atmospheric air through the melted metal in the converter. This is continued until the carbon is nearly all removed, which will be usually in about sixteen minutes, the time varying in practice with each charge of metal according to its heat when poured into the converter, the quantity of carbon which it contains, the pressure of the blast, and other variable causes. As soon as the process of decarbonization is about completed I stop the blast of atmospheric air, and, by means of the valve *i*, force a blast of carbonic-acid gas from the gas-holder D through the melted metal in the converter A. This blast is continued for half a minute, more or less. I then again change the blast, admitting atmospheric air, which is continued for about fifteen seconds, when the blast is stopped, the operation being complete.

In order to preserve the distinctness and purity of each kind of blast, both the air and carbonic-acid gas being introduced through the same pipe *d* and trunnion *c* into the converter, I tilt the converter over on its trunnions, just before changing the blast, until the tuyere-holes are no longer covered by the melted metal, and allow the changed blast to pass through the converter without entering the metal until all traces of the former blast have disappeared, when the converter is restored to its upright position and the process is continued.

The result which I accomplish by my improvement may be briefly stated thus: The blast of atmospheric air being continued through the molten iron until nearly all trace of carbon has disappeared, on the introduction of the carbonic-acid gas a chemical union is formed between the two equivalents of oxygen and the sulphur present in the iron, forming sulphurous acid, which passes off as gas, depositing the carbon thereby set free, which may be expressed thus: $C O_2 + S = S O_2 + C$. A similar result takes place in respect to phosphorus present as an impurity in the iron. The oxygen of the carbonic acid combines with the phosphorus, evolving acid gases of phosphorus and depositing carbon, thus: $2 C O_2 + P = P O_4 + 2 C$, and carbon is deposited. This deposit of free carbon may be left in the iron, if preferred, in the manufacture of steel; or it may be burned out, after the sulphur and phosphorus are removed, by a repetition of the atmospheric blast for a few seconds, as before stated. The oxygen of the carbonic-acid gas will also combine with the iron, forming ferrous acid, thus: $C O_2 + Fe = 2 Fe O + C$, the formation of the protoxide of iron setting free and depositing the carbon.

In practice it will be found that the sulphur and phosphorus will first be expelled, and that what little carbon is deposited will either be blown off by the blast or current of air or gas, or will unite with the ferrous acid, reducing it to iron and forming carbonic oxide, which will be evolved as gas. While the blast of carbonic-acid gas is passing through the molten iron the temperature of the metal will fall somewhat, losing almost one-fourth of the additional heat gained during the passage of the atmospheric blast. This, however, is rather an advantage than otherwise, as it is found that by the atmospheric pneumatic process the iron is rendered almost too fluid by the extreme heat. If preferred, the carbonic-acid gas may be heated before entering the converter.

A modification of the process which I have described consists in allowing a small proportion of carbonic-acid gas to enter the blast-cylinder, together with the air, and thus subjecting the molten crude iron to a combined blast of atmospheric air and carbonic-acid gas. By this means the impurities are removed during the process of decarbonization. Other gases or fluids may also be introduced, together with the carbonic-acid gas, as may be desired.

I do not wish to confine myself to the exact mode of introducing the carbonic-acid gas hereinbefore described; nor to the use of the apparatus shown in the drawing, as this may be modified; or the gas may be generated between the blowing-cylinder and the converter and forced into the converter by means of the atmospheric blast, or by a separate blowing-cylinder.

Carbonic-acid gas may also be used to advantage in removing sulphur and other impurities from the sulphurets of copper, zinc, nickel, and other metals by passing it, as a blast or current, through the metals when in a molten state.

Having thus described my improvement,

what I claim as my invention, and desire to secure by Letters Patent, is—

The use of carbonic-acid gas, either alone or mixed with atmospheric air, or with other gases or vapors, when introduced into the body of molten iron or other metal, in combination with or immediately following the pneumatic process, for the purpose of removing sulphur, phosphorus, and any other impurities which will form chemical combinations with the oxygen of the carbonic acid and deposit the carbon, substantially as hereinbefore described.

In testimony whereof I, the said JOHN F. BENNETT, have hereunto set my hand.

JOHN F. BENNETT.

Witnesses:

A. S. NICHOLSON,

G. H. CHRISTY.