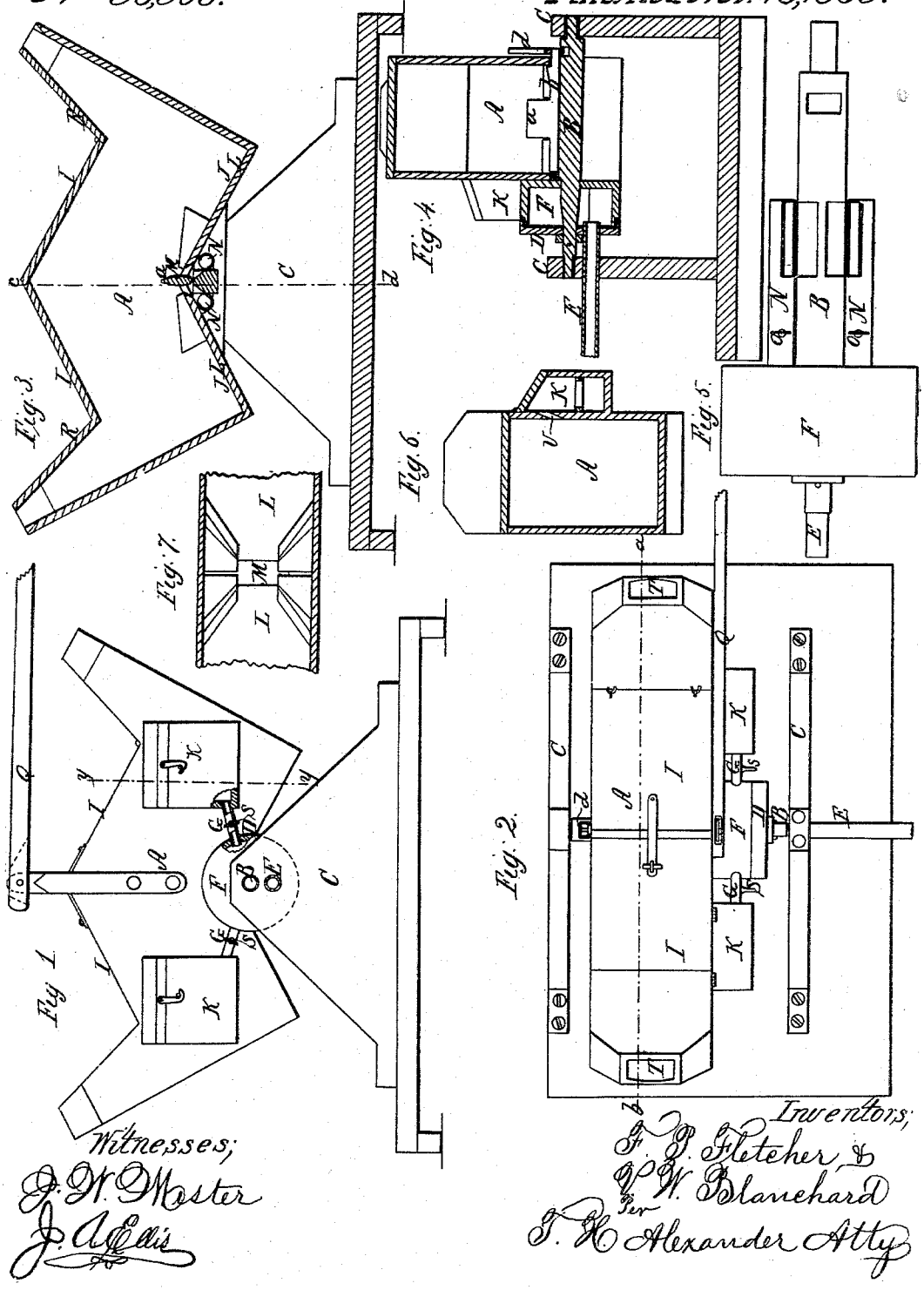
Fletcher & Blanchard.

Refining Metals.

No. 96,905. Patented Nov. 16, 1869.



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UNITED STATES PATENT OFFICE.

FRIEND P. FLETCHER AND V. W. BLANCHARD, OF BRIDPORT, VERMONT.

IMPROVEMENT IN THE MANUFACTURE OF IRON AND STEEL.

Specification forming part of Letters Patent No. 96,905, dated November 16, 1869.

To all whom it may concern:

Be it known that we, FRIEND P. FLETCHER and VIRGIL W. BLANCHARD, of Bridport, in the county of Addison and State of Vermont, have invented a new and useful Improvement in the Manufacture of Steel and Malleable Iron; and we do hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, and to the letters of reference marked thereon, which form a part of this specification, in which—

Figure 1 is a side elevation; Fig. 2, a plan view; Fig. 3, a vertical longitudinal section through line *a b*, Fig. 2; Fig. 4, a cross-section through line *c d*, Fig. 3; Fig. 5, a plan view of axle, &c.; Fig. 6, a cross-section through line *y y*, Fig. 1; and Fig. 7, a broken plan of the bottom of vessel.

To enable others skilled in the art to make and use our invention, we will now describe its construction and operation.

A represents the converting-vessel, mounted upon its axle B. The axle B is firmly supported by the frame C. By means of its axle B a tilting, rocking, or revolving motion may be given to the converting-vessel A. Surrounding the axle B of the converting-vessel A, and connected to that vessel, is seen the circular apartment F. Fitted by a suitable bearing-surface to the circular apartment E is seen the stationary disk D. Connected with the disk D and opening into the apartment F is the blast-pipe E. Connected by one extremity with the apartment F is seen the air or blast pipes G G. The open extremity of the air or blast pipe E may be connected by any suitable conductor with a receiver or reservoir containing the compressed gaseous element or elements required in the process of reducing and purifying the molten metal. It will be observed that whatever may be the position of the converting-vessel A the passage is always free between the air or blast pipe E and the air or blast pipes G G. Let K K represent two symmetrical apartments or pockets of the converting-vessel A. These apartments or pockets serve several important uses in the invention: first, as vessels to hold the molten metal during the process of convertion or purification; second, as vessels in which the process of atomizing or globularizing is carried on; third, as puddling-vessels in which the process of converting the carburet of iron into steel and malleable iron may be completed with a puddling-tool, if desired; fourth, they serve as vessels or crucibles for melting wrought-iron or cast-iron, or any variety of iron ore or any substance that will aid in the production of the desired product; and, lastly, as vessels in which the recarbonizations of the molten metal may be effected, if desired.

L L represent the bottom or floor of the converting-vessel A. This bottom or floor consists of two planes, which terminate near the center of the vessel and slope or form inclined planes extending downward and outward toward its extremities.

Directly over the axle B, in a central position between the apartments or pockets K K, at the point where the planes forming the floor of the converting-vessel nearly meet at an obtuse angle, is seen the depression M.

Extending upward at a greater or less angle, and terminating or opening in each wall of the depression M, opposite or facing the pockets K K, are the blast-pipes N N. These pipes are connected, through the apartment F, with the blast-pipe E, and are provided with the valves O O, to bar or regulate the passage of the gaseous element or elements through them.

Connected with apartment F are the pipes G G. These pipes are furnished with the valves S S, to regulate the passage of the gaseous elements through them. Working in the depression M is seen the valve *a*. Directly over the axle B of the converting-vessel A is the extremity of the rod *b* to which the valve *a* is attached.

d represents a lever attached to rod *b*, by means of which the valve *a* can be worked outside of vessel A. The office or use of the valve *a* is to close the extremity of the blast-pipes N N, opening into the depression M. It will be observed that while the extremity of one of the blast-pipes N is closed by the valve *a*, the extremity of the other will be open. By this means the molten metal may be prevented from entering the open extremity of either of the blast-pipes N N, while the jet of gaseous elements is issuing from the pipe on the opposite side of the depression M during the process of reduction or purification of the molten metal. We would, however, remark that we

do not consider the use of the valve *a* indispensable in the process, but only as a valuable auxiliary.

R R indicate the sloping portions of the roof of the vessel A, the interior surface of which serves as inclined planes against which the atom or globule of molten metal is flattened or reflected while the process of atomizing or globularizing is going on.

T T designate two openings, situated one at or near each extremity of the vessel A. These openings serve in several important uses: First, through them the metal, molten or otherwise, is introduced into the converting-vessel; second, through them the products of combustion escape during the process of conversion or purification; third, by them the process of skimming the molten metal or the removal of scoria or slag takes place; fourth, through them the process of puddling is carried on; fifth, by means of them the recarbonization of the molten metal may take place by the introduction of certain suitable substances into the converting-vessel; and also by them the molten metal is poured from the vessel when the process of conversion or purification is complete.

J J represent two reverberatory furnaces, connected each with the converting-vessel A, about midway its extremities.

U designates the passage by which the reverberatory furnace is connected with the apartment or pocket K of the vessel A. This passage is inclined downward, so as to deflect the flame or products of combustion issuing from said furnace against the bottom or floor of apartment K. Fuel is introduced into the reverberatory furnaces J J by means of their lids I I. The reverberatory furnaces are furnished with blasts by means of the pipes P P. It may be here remarked that the connection, arrangement, construction, and operation of each reverberatory furnace, as respects the converting-vessel A, are identical. These furnaces perform several important offices—such as affording means of melting cast or wrought iron or any variety of iron ore within the apartments K K; for keeping the metal in a sufficiently fluid or molten state while the process of atomizing or globularizing or while the process of puddling is going on; for carbonizing or decarbonizing or otherwise purifying the molten metal contained in the pockets K K, according as the flames or products of combustion issuing from them are charged with carbonizing or decarbonizing or other purifying or eliminative gases or vapors.

Q represents a lever, by means of which the vessel A may be depressed, elevated, tilted, rocked, or revolved to a greater or less degree required in the introduction, conversion, and pouring of the metal. We would have remarked that we do not confine ourselves to the mechanism described, but to any means substantially the same by which the same effect is produced. In the practical operation of our invention, fuel is first introduced into the reverberating furnaces T T, and kindled. The valves O O in the blast-pipes P P, connecting these furnaces through the apartment F with the blast-pipe E, are opened. The flame or products of combustion are thrown by this means, through the openings U U, into the apartments or pockets K K of the converting-vessel A, pointing to the floor or bottom of the same. When the pockets K K are heated to a sufficient degree of intensity, the converting-vessel may, by means of the lever Q, be rocked or revolved or tilted to a suitable degree to conveniently introduce at one of the openings S molten cast-iron direct from a blast, or any other form of furnace, or wrought or cast iron in the form of scrap or pig. In case the molten cast-iron is alone introduced, the process of conversion or purification will commence at once, while if the wrought or cast iron is singly introduced, or introduced mixed with molten metal, the process will be more or less delayed, according to the time required to melt the same in the heat afforded by the reverberating furnaces. We would here remark that the different varieties of iron ore are not introduced into the converting-vessel to be melted, except in combination with the melted metal, before the process of conversion or purification commences, but may be added after such process has begun, in such quantities as may be deemed desirable. Such addition we do not, however, consider indispensable in the process.

By the addition of wrought or cast iron or iron ore, in suitable quantities, to the molten metal after the process of conversion or purification has begun, any surplus heat beyond what is required to keep the metal in a liquid or molten state may be utilized, and by such means a proper quantity of iron ore or wrought or cast iron scraps may be economically converted into the desired product. When the metal introduced into the pocket K of the vessel is in a sufficiently liquid state from previous heat, or from the effects of such heat combined with that of the flame or products of combustion from the reverberating furnace, the extremity of the vessel A, containing the molten metal, is raised, tilted, or revolved by means of the lever Q, so that the molten metal in a stream flows over the central portion of the floor of the vessel A into the depression M, situated above its axle B. Previous to this, however, the valve O in the blast-pipe N, situated upon the half of the converting-vessel, is opened, while its fellow in the blast-pipe N, situated upon the opposite half of the converting-vessel, is closed. At the same time, by means of the lever *d* the valve *a* in the depression M is actuated so as to close the extremity of one of the pipes N N, opening into the depression M, opposite to its fellows, from which the jet of gaseous elements issues into the converting-vessel. Then, as the melted metal falls into the depression M, the jet or blast of gaseous elements issuing from the open extremity of the blast-pipe N, with a

greater or lesser force and velocity, strikes the stream of melted metal and forcibly carries or projects it in a globular or atomic condition over the depression M into the opposite apartment or pocket K of the vessel A.

It may here be observed that the blast-pipes N N are placed at such an angle that the jets of gaseous elements issuing from them and striking the molten metal causes the globules, atoms, or particles into which such stream becomes dispersed or divided, to forcibly strike against the inclined planes R R, formed by the roof of the converting-vessel. Then, as the jet of gaseous elements may consist of air, superheated steam, free oxygen, hydrogen, ammoniacal or chlorine gas, or any mixture of the same, or any hydrocarbon vapor, or any volatile or gaseous element or elements that may be required to effect the conversion and purification of the molten metal, it is clearly seen that every atom, globule, or particle of the melted metal may be brought into free and immediate contact with the gaseous elements required to effect its conversion and purification. The atom, globule, or particle of molten metal forcibly striking the inclined plane R, formed by the roof of the vessel A, becomes flattened or reflected, thereby presenting a new surface to the action of the gaseous elements by which it may be surrounded. The atom, globule, or particle of molten metal, after striking or being reflected from the incline plane, passes or falls directly into the flame from the furnace T, that points to the floor of the vessel A. By this means every atom, particle, or globule of the melted metal that passes from one apartment to the other on the opposite side is exposed to the direct action of the flame issuing from the reverberating furnaces. It will be observed that the heat of these furnaces is used and applied most economically.

We would remark here that we do not confine ourselves to the precise means just described, but that we claim any means substantially the same, whereby the molten metal in a globular or atomic condition is exposed to the action of the heat from a reverberating or other form of furnace. As the process of atomizing or globularizing the molten metal separates the slag or scoria from it to a great degree, this direct exposure of the latter to the heat of the reverberating furnace, together with the heat generated by the combustion of carbon contained in the molten metal, operates favorably in effecting its combustion and elimination. We would here remark that the blasts for supplying the reverberating furnaces are shown as desired in common with those used for atomizing or globularizing purposes, from the apartment F, connected with the blast-pipe E.

We would be understood that we do not confine ourselves to this arrangement. If necessary, separate blasts may be provided for the said furnaces. It may be found, in certain varieties of metal, expedient to have the blasts of the reverberating furnaces consist of a different gaseous element or elements from those used in the atomizing or globularizing process. We would be understood to claim this variation.

By elevating, tilting, rocking, or revolving the vessel A to a certain degree the molten metal will all pass over in a globular or atomic condition into the opposite apartment or pocket. Then, by continuing the same process to a still greater degree, the slag or scoria or other impurities on the top of the melted metal may be poured off through the opening S, near the extremity of the vessel A, or removed with a suitable instrument. We would here remark that during the process of removing the slag or scoria from the molten metal, or any other necessary operation pertaining to its conversion or purification, the valve O in the pipe P of the furnace T may be closed, which will allow any such necessary operation to be performed without difficulty. At this point in the process a portion of the molten metal may be removed from the vessel and tested, if desired, to ascertain its quality. At this point the valve O in the blast-pipe N, that has furnished the jet of gaseous elements by which the process of atomizing or globularizing the melted metal has been carried on, should be closed and its fellow in the pipe N be opened. Also at the same time the lever *d* should be actuated so as to change the position of the valve *a*, so that the extremity of the blast-pipe that has been closed during the operation just described may be opened and its fellow on the opposite side of the depression be closed. This pipe will afford a jet or blast of gaseous elements on the opposite side of the depression M to that whose effects have just been described. Then, by tilting, rocking, or revolving that extremity of the vessel A which contains the molten metal, in the manner previously described, such metal in a globular or atomic state may be passed back into the apartment or pocket of the vessel A into which it was first introduced. The process of skimming or testing the molten metal may then again be performed in the manner hereinbefore described. Thus the melted metal may be passed, in a globular or atomic condition, a greater or less number of times from one apartment to its fellow on the opposite side, and the process of skimming or testing performed as often as desired. We would here observe that we do not limit ourselves to the precise method shown for repeatedly converting or purifying the melted metal, but that we claim any manner or method whereby a stream of molten metal is repeatedly reduced or dispersed to a globular or atomic state by the same jet or jets of a gaseous element or elements by means of which its conversion or purification is effected. By the means above specified, a small degree of force on the part of the jet or jets of gaseous ele-

ments is sufficient to convert or purify a large body of melted metal, and the process may also by this means be indefinitely prolonged for the removal of the slag or scoria and other impurities. During the process of conversion or purification the addition of suitable quantities of wrought-iron or iron ore will shorten the process of converting the carburet of iron into steel or malleable iron. By passing the molten metal, in a globular or atomic state, a greater or less number of times from one apartment of the vessel A to its fellow on the opposite side it may be reduced to any desired grade of steel or malleable iron.

It will be observed that by the elevating, rocking, or revolving, tilting, and depressing motion of the converting-vessel, and by means of the valves in the air or blast pipes that furnish the atomizing or globularizing jets, the size or volume of the stream of molten metal and the size or volume of the jet or jets of gaseous element or elements are completely under the control of the operator. Thus, by increasing or diminishing the size of the stream of molten metal with a given size to the jet or jets of gaseous elements, or by increasing or diminishing the size of the jets of gaseous elements with a given size to the stream of molten metal, a greater or less amount of the carbon, sulphur, or phosphorus, or any impurities contained in the molten metal, for which the gaseous elements contained in the jets may have a chemical or elective affinity, may be removed or eliminated from the molten metal at pleasure; also, by charging the blasts of the reverberating furnaces T T to a greater or less degree with a surplus gaseous element or elements that have an elective or chemical affinity with the deleterious substance or qualities contained in the molten metal, such substances or qualities may be to a greater or less extent removed or eliminated from the molten metal at pleasure.

It will here be particularly observed that by the process heretofore set forth different grades of steel may be produced from the carburet of iron by several different modes or methods, which the quality of the iron to be converted and the quality of steel to be produced must determine. The skill and judgment of the operator must determine the proper method. The molten metal may be passed from one apartment or pocket K of the vessel A, in a globular or atomic condition to its fellow on the opposite side of the vessel, and this process continued till the desired product is obtained. The molten metal may be reduced, in the manner just described, to a state approximating pure malleable iron, after which the proper quantity of speigeleisen, spathic ore, or carburet of iron, or any other proper substance containing carbon, may be added to the molten metal to produce the desired product; or the atomizing or globularizing jets and the blasts of the reverberating furnaces may be charged with hydrocarbon vapors or gaseous or volatile elements containing carbon, and the atomizing or globularizing processes continued till the desired product is obtained. The molten metal may be reduced by the atomizing or globularizing process to nearly the desired degree, after which the process may be completed with a puddling-tool introduced into the opening S near each of the extremities of the vessel A. By this mode puddled steel or iron may be produced at the close of the operation in precisely the same manner as in ordinary puddling-furnaces, with but little labor. We do not in this connection confine ourselves to the precise method shown; but we claim any method by means of which the molten metal is partially converted or purified by the atomizing or globularizing process, the process being completed with a puddling-tool or its equivalent.

We would here observe that we do not limit ourselves to the means and processes described in this specification to the production and manufacture of steel or malleable iron, but that we do claim by such means and processes the manufacture or production of any grade or quality of metal intervening between the carburet of iron or cast-iron and steel. We would here also remark that we do not confine ourselves in this invention to the conversion or purification of iron alone, but that we claim the process of atomizing and globularizing, and all of the features embodied in this invention, applied to any other metal besides iron by means of which such metal may be purified or refined. The purification of silver containing lead as an impurity or alloy may be effected by this process with great facility.

Having thus described our invention, what we claim as new, and desire to secure by Letters Patent, is—

1. The use and employment of a tilting, rocking, or revolving converting vessel or bath for the purpose of exposing the melted metal contained therein in a globular or atomic state a greater or less number of times to a jet or jets of gaseous element or elements, substantially as and for the purposes set forth.

2. The repeated forcible reduction or dispersion of the molten metal into a globular or atomizing condition by the same jet or jets of a gaseous element or elements, substantially as and for the purposes specified.

3. The introduction into the blast of a reverberating furnace, when such furnace is combined with a converting vessel or bath in which the molten metal is reduced to a globular or atomic state, any gaseous or volatile element or elements that will by chemical affinity eliminate or remove any deleterious element contained in the molten metal, or assist in the production of the desired product.

4. The use and employment of a tilting, rocking, or revolving converting vessel or bath

containing two apartments or pockets for holding the molten metal during the process of conversion or purification.

5. The exposure of the molten metal in a globular or atomic condition to the flame or the products of combustion from a reverberating furnace, substantially as and in the manner specified.

6. A puddling-vessel, with its reverberating furnace, in combination with the converting vessel or bath in which the molten metal may be reduced to a globular or atomic condition, substantially as and for the purpose set forth.

7. The introduction of wrought or cast iron, or any variety of iron ore, into a converting vessel or bath in which the molten metal is reduced to a globular or atomic condition within the effect or in the presence of a flame or products of combustion from a reverberating furnace, substantially as and for the purposes described.

8. The arrangement of blast-pipes, with their necessary valves, connected with the apartment of the converting-vessel, in combination with such vessel and the reverberating furnaces, for the purpose of supplying and regulating the jet of gaseous elements required to reduce the metal to a globular or atomic state, and to supply and regulate the necessary blast for the reverberating furnaces, substantially in the manner specified.

9. The introduction of spiegeleisen, spathic ore, or any suitable substance containing a greater or less per cent. of carbon, into a converting vessel or bath combined with a reverberating furnace, and in which the molten metal is reduced to a globular or atomic condition by a jet or jets of gaseous elements, substantially as and for the purpose set forth.

10. The introduction of any hydrocarbon vapor, or any gaseous or volatile element containing a greater or less per cent. of carbon, into the jet or jets by which the molten metal is atomized or globularized within the converting vessel or bath, substantially as and for the purposes described.

11. The openings at each extremity of the converting-vessel, for the purpose of the exit of the products of combustion, and for the introduction of any suitable instrument for the removal of the scoria or slag from the molten metal, or for working the metal with a puddling-tool, substantially in the manner set forth.

12. The lever Q, or its equivalent, for tilting, rocking, or revolving the converting-vessel, substantially as and in the manner specified.

13. The forcible dispersion of a stream of molten metal into a globular or atomic state, in the production of any desired grade or variety of product between the carburet of iron, or what is commonly known as "cast iron and steel," substantially as and in the manner described.

14. Rising and falling pockets or apartments for holding the molten metal during the process of conversion or purification, substantially as and for the purpose set forth.

15. The use of the valve *a* in the depression M of the converting-vessel A, substantially as and for the purpose specified.

16. The use of the stationary disk D, in combination with the apartment F, and blast-pipe E, when used in connection with a converting-vessel in which the molten metal is reduced to a globular or atomic state, substantially as and in the manner set forth.

17. In a tilting, rocking, or revolving converting-vessel to which are attached reverberating furnaces, and in which the molten metal is repeatedly reduced or dispersed into a globular or atomic state by the same jet or jets of a gaseous element or elements, the purification or refinement of any other molten metal besides iron, substantially as and for the purposes specified.

In testimony that we claim the foregoing as our own we hereby affix our signatures in the presence of two witnesses.

FRIEND P. FLETCHER.
VIRGIL W. BLANCHARD.

Witnesses:
N. S. BENNETT,
C. W. EARL.