No. 742,441. PATENTED OCT. 27, 1903.

H. JOHNSON.

APPARATUS FOR THE MANUFACTURE OF STEEL.

APPLICATION FILED DEC. 27, 1901.

NO MODEL. 2 SHEETS—SHEET 1.

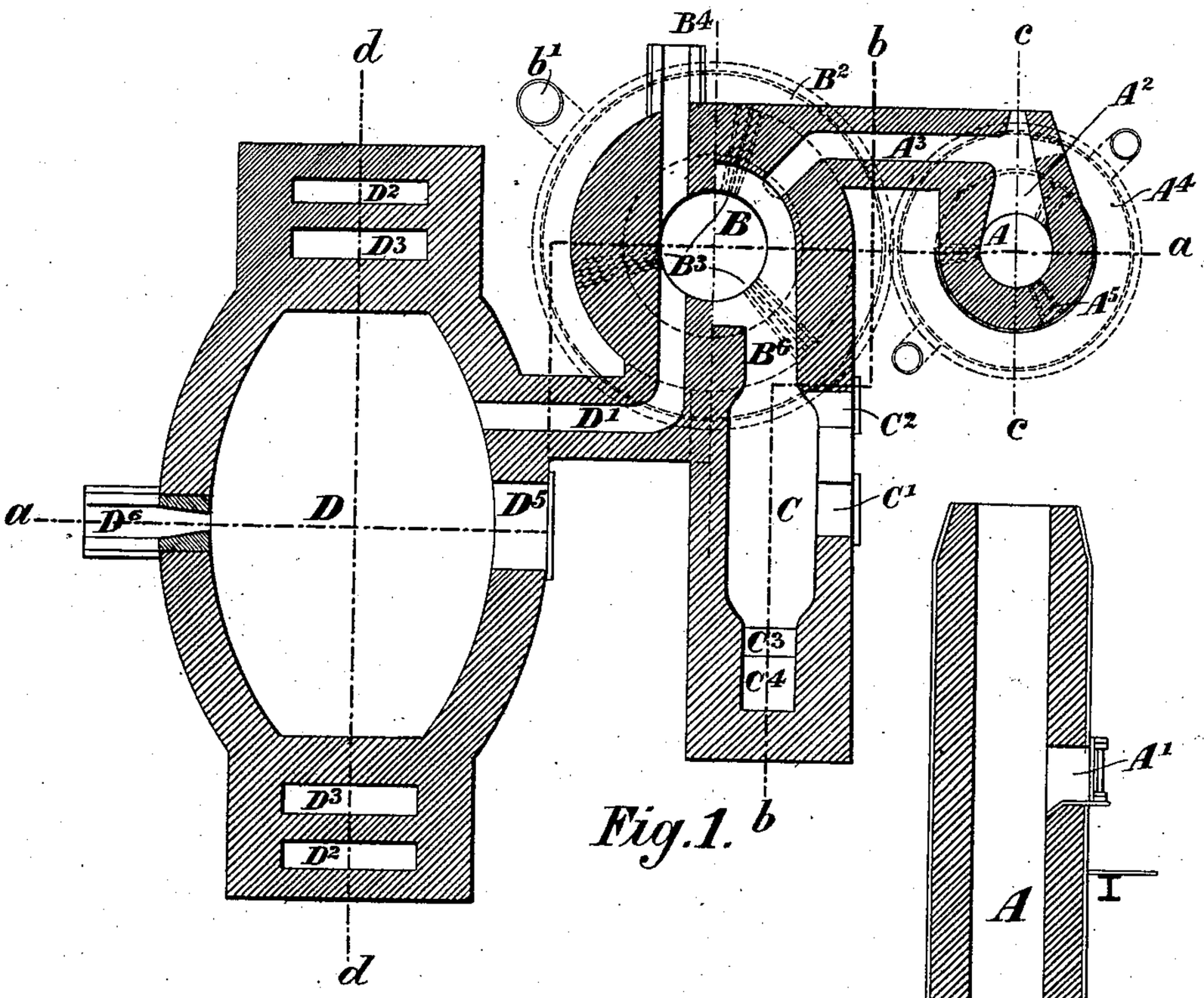

Fig. 1.

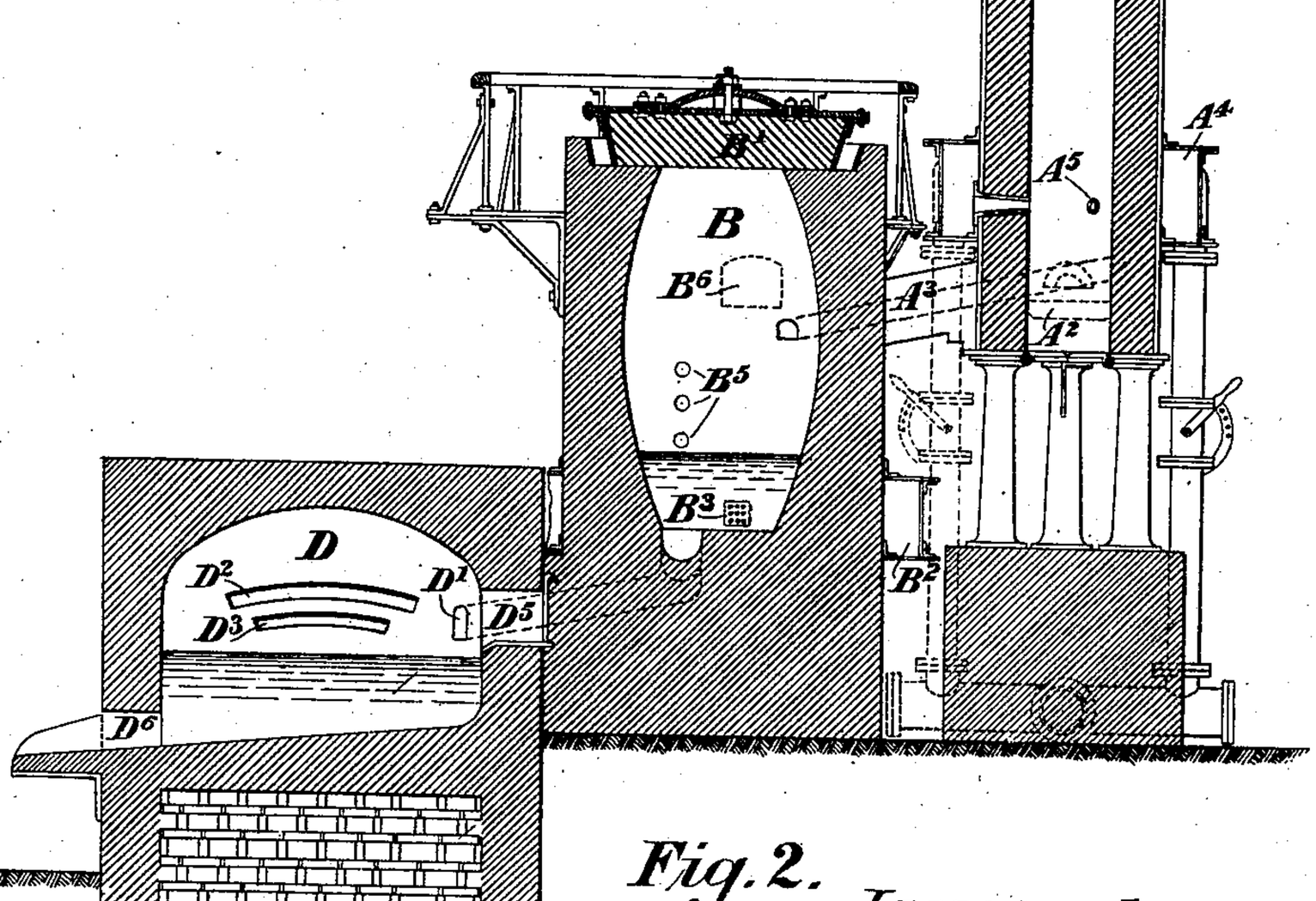

Fig. 2.

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Inventor:
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THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

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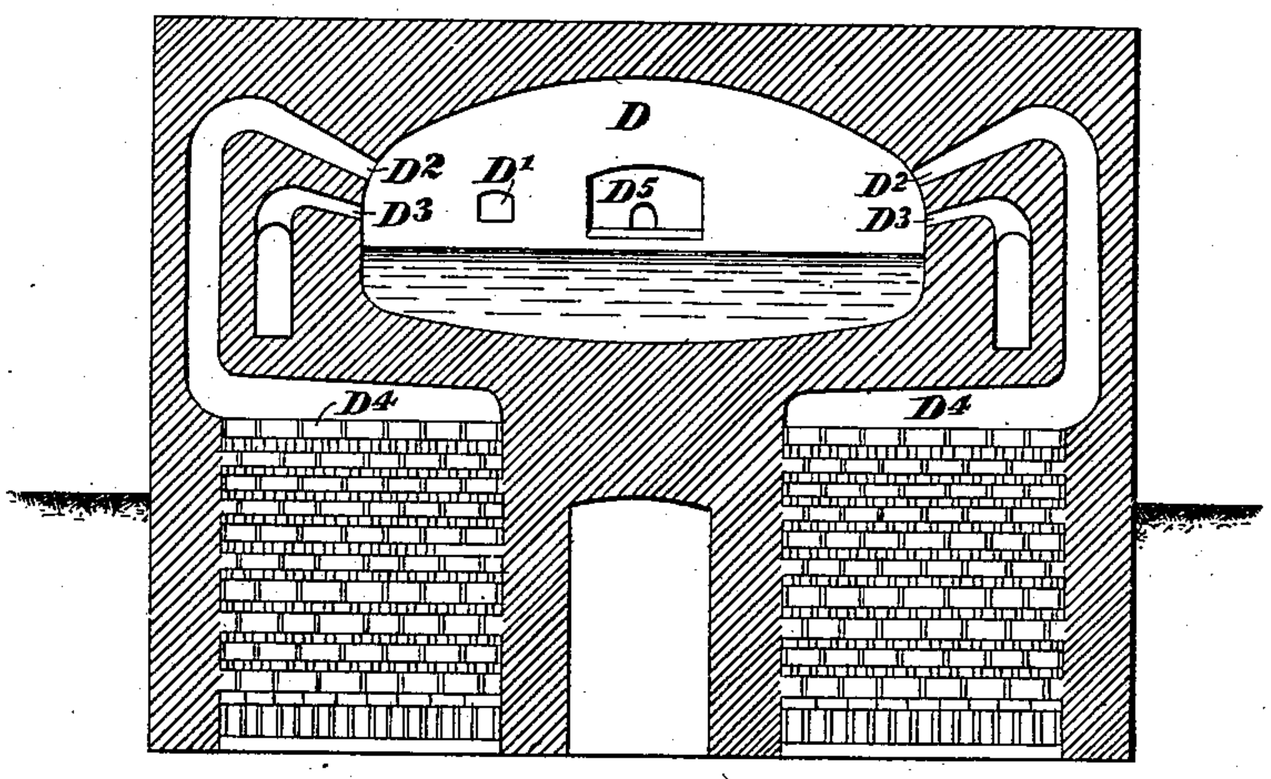

Fig. 5.

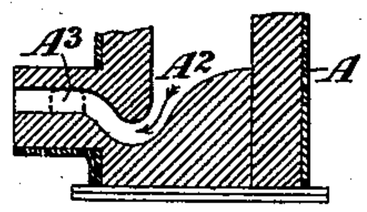

Fig. 4.

Fig. 3.

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No. 742,441. Patented October 27, 1903.

UNITED STATES PATENT OFFICE.

HENRY JOHNSON, OF BRUNSWICK, VICTORIA, AUSTRALIA, ASSIGNOR OF ONE-HALF TO GEORGE WILLIAM FRIER, OF GLENFERRIE, VICTORIA, AUSTRALIA.

APPARATUS FOR THE MANUFACTURE OF STEEL.

SPECIFICATION forming part of Letters Patent No. 742,441, dated October 27, 1903.

Application filed December 27, 1901. Serial No. 87,423. (No model.)

To all whom it may concern:

Be it known that I, HENRY JOHNSON, steel-founder, a subject of the King of Great Britain and Ireland, residing at No. 129 Blyth street, Brunswick, in the British State of Victoria, Commonwealth of Australia, have invented a new and useful Improvement in Apparatus for the Manufacture of Steel, of which the following is a specification.

This invention of improvements in apparatus for the manufacture of steel relates mainly to the class or quality of steel used for ordinary casting purposes and for the casting of ingots which are to be afterward manufactured into rails, plates, bars, and other articles, said steel, as is well known, being produced by the decarburization to the requisite degree of molten metal, consisting principally of pig-iron, preferably mixed with steel scrap or an alloy, the decarburization being effected by the injection of a strong blast into the molten metal.

In manufacturing steel according to this invention a cupola, a converter or refinery, a feed-metal-heating chamber or furnace, and an open-hearth regenerating or grading furnace is employed, said parts being so assembled and arranged that the molten metal leaving the one passes to the other by gravity through channels which are inclosed, by preference, and hence the metal needs no handling until such time as it is drawn off for use.

The cupola or blast-furnace may be of any known and approved construction designed to smelt the metal, the molten metal being run therefrom through a channel to a closed converter or refinery which is provided with twyers fed with the necessary blast from an air-compressor or blowing-engine. The opening from the cupola to said channel is provided with a siphon-shaped trap in order to prevent the slag being carried with the molten metal to the refinery or converter, and such trap also prevents the combustible gases and waste heat arising from the molten metal in the converter passing to the cupola.

The refinery or converter has a feed-metal-heating chamber or furnace combined with it, the mouth of said chamber or furnace entering the converter or refinery at its upper part or at a position just above the height to which the molten metal rises during its ebullition within the chamber, and into said feed-metal-heating chamber or furnace the whole of the heated gases and products of combustion developed within the refinery or converter are fed or passed in order to heat the metal placed therein preparatory to its being pushed from the hearth of said chamber into the converter or refinery, or when the converter has developed such a degree of heat or temperature that the gases emitted from it will melt pig-iron then such metal is melted in the feed-metal-heating chamber or furnace and flows therefrom to the converter, and at such period in the working of the process the cupola can be dispensed with, said feed-metal-heating chamber or furnace when combined with the converter or refinery constituting an important feature in the invention.

The open-hearth regenerating or grading furnace is supplied with refined metal in a molten state from the refinery or converter, and this furnace is made of a capacity sufficient to receive any desired number of full charges from the refinery or converter, so that when the hearth is fully charged a large body of metal will be under the control of the assayer in order that he may bring it to any desired grade by the well-known regenerative air-and-gas process, aided by the addition of highly carburized or decarburized metals supplied from the refinery and by the addition of the requisite alloy. The regenerating or grading furnace is charged with molten metal by the provision of a channel between it and the tap-hole of the converter or refinery.

In order that the improvements in the manufacture of steel may be well understood, drawings are attached hereto which illustrate a suitable plant or set of furnaces for the purpose.

Figure 1 shows a sectional plan of the connected cupola, refinery, or converter, feed-metal-heating chamber or furnace, and the grader or regenerator; Fig. 2, a vertical sectional view on line *a a*, Fig. 1, of the connect-

ed cupola, refinery, or converter and the grader or regenerator; Fig. 3, a vertical sectional view on line *b b*, Fig. 1, showing the connected feed-metal-heating chamber or furnace and the refinery or converter. Fig. 4 is a section on line *c c*, Fig. 1, showing the siphon-shaped trap in the mouth of the cupola-delivery channel; Fig. 5, a vertical section on line *d d*, Fig. 1, through the grader or regenerator.

In the drawings, A is the cupola, A′ its feed-opening, and A^2 the siphon-shaped trap arranged in its molten-metal-delivery mouth leading to channel A^3, which conveys the metal to the refinery or converter B.

A^4 is a blast-jacket fed from any suitable air-supply source, such as from a Roots blower, and A^5 represents the twyers.

The converter or refinery B has a movable brick-lined cover B′, which is capable of being secured down while it is in use.

B^2 is a blast box or chamber fed with compressed air from a pipe *b*′, leading from a receiver or blowing-engine, and B^3 represents the twyer-holes through which the air passes to the metal in the converter.

B^4 is a tap-hole.

B^5 represents slag-holes, and B^6 the mouth of the feed-metal-heating chamber or furnace C, which, as shown, is provided with feed-holes C′ and C^2, through which to place metal in the chamber, and outlet-flue C^3, leading to the chimney C^4. The floor or hearth of this chamber or furnace preferably inclines downward toward the converter in order to assist in feeding the metal thereto. If so desired, the waste heat from feed-metal-heating chamber or furnace may be utilized to heat the blast prior to its reaching the refinery or converter.

The open-hearth regenerating-furnace D is connected with the converter tap-hole by the channel D′, which thus allows the molten metal to run direct to the hearth of grading-furnace. D^2 represents the air flues or ports, and D^3 the gas flues or ports, the former leading from the regenerator-chambers D^4 and the latter being fed with gas from any gas-supply source or from gas-producers of any known and suitable type. The heat produced by the combustion of gas in this furnace is of a neutral character and is utilized mainly to retain the metal in a molten condition.

D^5 is a doorway for use when withdrawing samples for assay and for the introduction of the alloy as the metal may require, and D^6 the tap or discharge hole or chute for drawing off the finished steel.

In the furnaces glass or mica sight-holes are provided to allow the furnace-man to view the condition of the twyers and the metal. Further, acid lining may be provided in the converter or refinery and a basic lining in the grader or regenerator.

It will be observed that the various parts hereinbefore described—to wit, the cupola-furnace, converter, feed-metal furnace, and open-hearth furnace—are all made as an integral structure, and by this arrangement and the direct covered passages between the parts loss of heat by radiation is reduced to a minimum and the economy of the apparatus greatly increased.

In working the apparatuses the regenerating or grading hearth is first heated to the requisite temperature in the usual way by burning gas within the furnace. Then a wood fire is made in the refinery or converter and a light blast applied thereto through the twyers until a good heat has been obtained. Then the brick-lined cover is placed on top of the converter and it is bolted down. The smelting hearth or cupola is then charged with coke and pig-iron in the usual way and the blast applied. Also a light blast is kept up in the refinery or converter until sufficient molten metal has run thereinto from the cupola, when the blast in the converter may be increased to its full pressure in order to start refining or converting the metal. By providing the before-described trap in the discharge-mouth of cupola no slag will be present in the metal when it reaches the converter. The feed-metal-heating chamber or furnace is now charged with scrap-steel, which will be heated by the waste heat from refinery or converter as said heat passes through it on its way to the chimney C^4, the metal being pushed forward when heated into converter as desired, and the said chamber or furnace is then recharged with metal, which is heated therein, as just described. By charging the converter from the feed-metal-heating chamber or furnace the scrap-steel is heated without its coming into contact with coke, and which latter, as is well known, makes it unfit for the purpose of steel ingots and steel castings. Also the refinery or converter by receiving fresh metal from the feed-metal-heating chamber or furnace is prevented from working too hot, which effects a great saving in the life of its linings. When a sufficient quantity of metal has collected in the refinery or converter from the cupola and from the feed-metal-heating chamber or furnace and the refining or converting has been carried far enough, which will be determined by tapping off small quantities of metal and testing same, the whole or any given quantity of the molten metal is allowed to flow through the channel D′ into the grading-furnace, to be finished off by the assayer for distribution, and while the latter is being done another supply is being prepared in the converter.

When required to deal with large quantities of steel, the grading-furnace is made of the requisite capacity, and should it be designed to hold, say, fifty tons, then such quantity will be obtained by successive tappings from the refinery or converter. Again, when the waste heat from refinery or converter has arisen to a temperature sufficient to heat steel scrap and melt pig-iron, then the cupola will be stopped and all the metal will be fed

to the feed-metal-heating chamber or furnace, and thus steel will be produced without the aid of artificial fuel, the metal itself containing all the heating agents or combustible matter that is required to maintain the requisite temperature.

For some classes of steel—for instance, such as is used for casting purposes—the regenerating and grading furnace will not be necessary, as the steel can be sufficiently refined and drawn direct from the converter.

When it is desired to manufacture steel direct from iron ore with the herein-described combination of apparatuses, a blast-furnace will be employed instead of the cupola, and when the apparatuses are to be worked continuously the converter and the feed-metal-heating furnace will need to be duplicated.

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

1. An apparatus for the manufacture of steel, consisting of an integral structure and comprising a converter, a melting-furnace having a covered passage connecting it directly to said converter for supplying molten metal thereto, and a feed-metal-heating furnace also having a covered passage connecting it directly with said converter, substantially as described.

2. An apparatus for the manufacture of steel consisting of an integral structure and comprising a converter, a melting-furnace having a covered passage connecting it directly with said converter, a feed-metal-heating furnace having a covered passage connecting directly to said converter, and a regenerative open-hearth furnace having a covered passage connecting it with said cupola, substantially as described.

3. An apparatus for the manufacture of steel consisting of an integral structure and comprising a converter, a melting-furnace having a covered passage leading directly to said converter, an inclined feed-metal furnace communicating directly with said converter at one end, a chimney or stack connected to the opposite end of said feed-metal furnace, and a regenerative open-hearth furnace connected directly to said converter and receiving the metal therefrom, substantially as described.

4. An apparatus for the manufacture of steel consisting of an integral structure and comprising a converter having a closed top, a melting-furnace having a covered passage connecting it directly to said converter, an inclined feed-metal furnace connected directly with said converter at one end, a chimney or stack connected to the opposite end of said feed-metal furnace, and a regenerative open-hearth furnace of much larger capacity than said converter connected directly to the converter, substantially as described.

In witness whereof I have hereunto set my hand in presence of two witnesses.

HENRY JOHNSON.

Witnesses:
BEDLINGTON BODYCOMB,
N. J. S. THOMPSON.