T. D. MACKIE & G. F. FORWOOD.

MANUFACTURE OF STEEL.

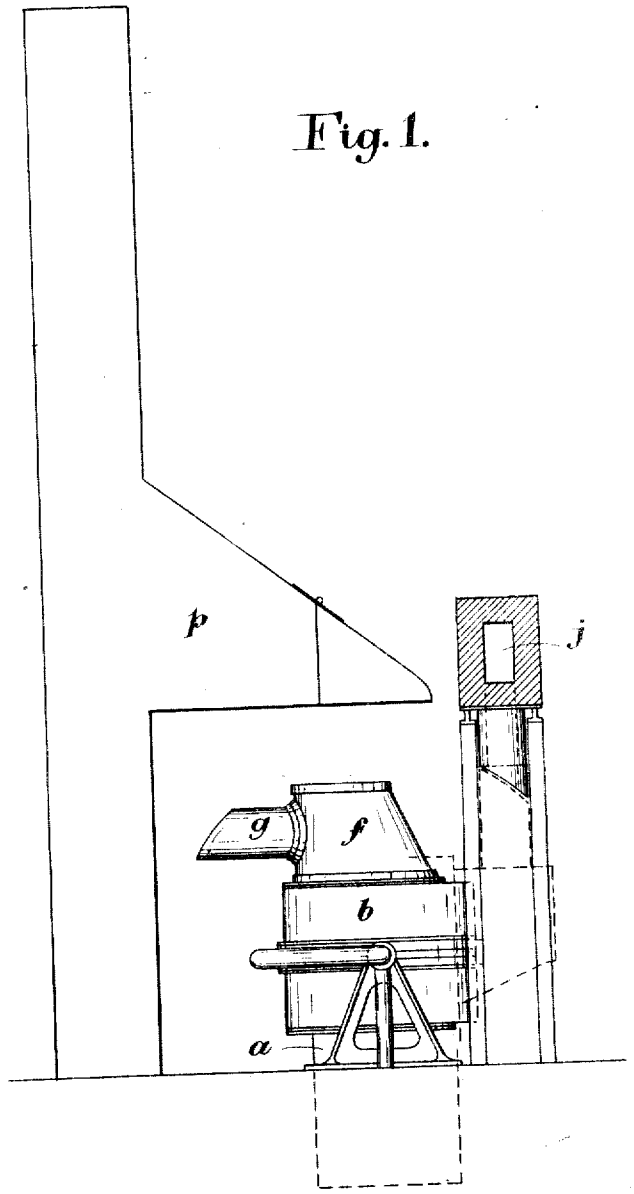
APPLICATION FILED NOV. 24, 1911.

1,024,999.

Patented Apr. 30, 1912.

4 SHEETS—SHEET 1.

Fig. 1.



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4 SHEETS—SHEET 2.

Fig. 2.

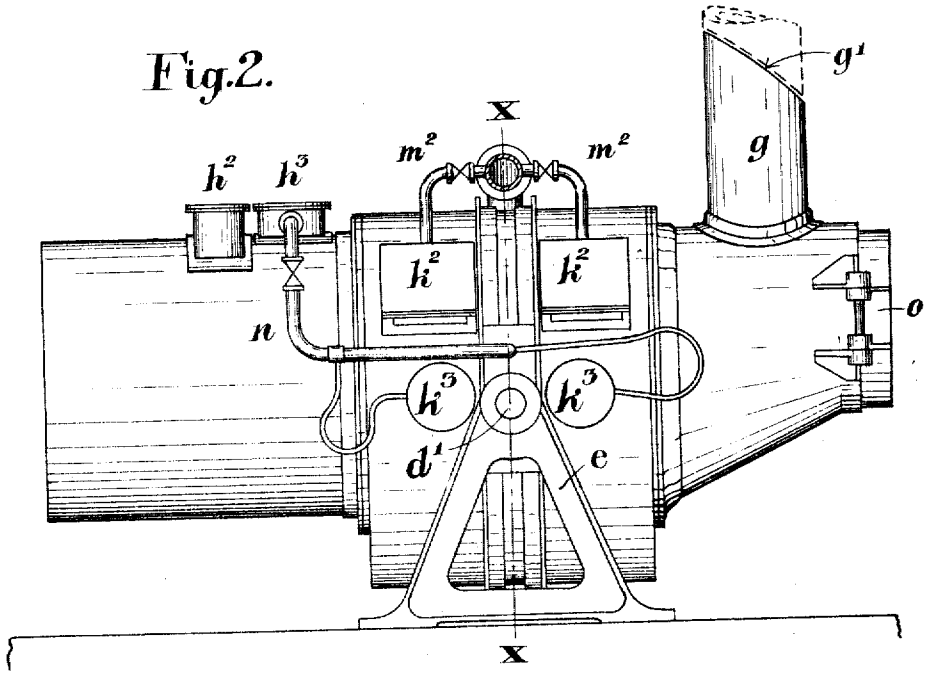
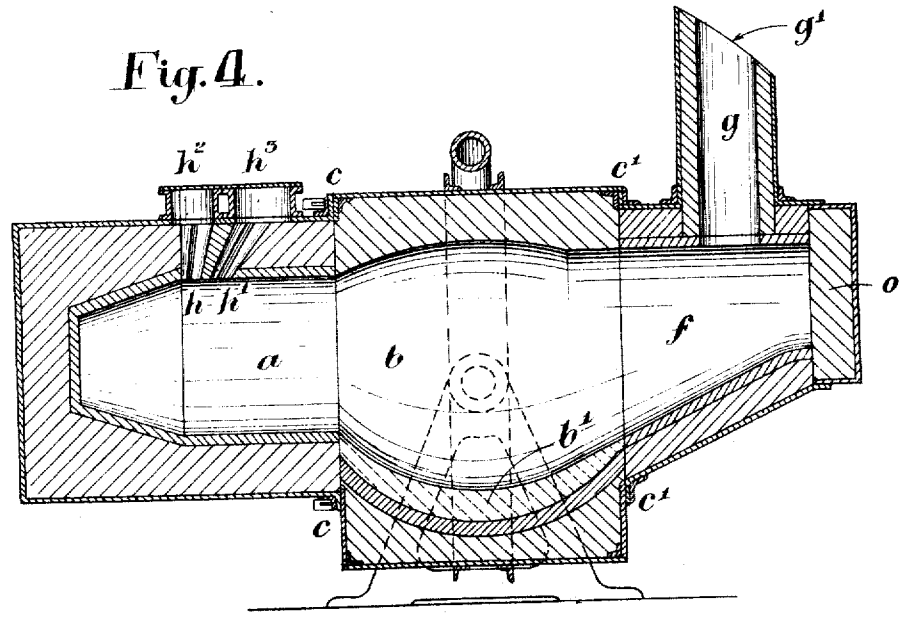


Fig. 4.



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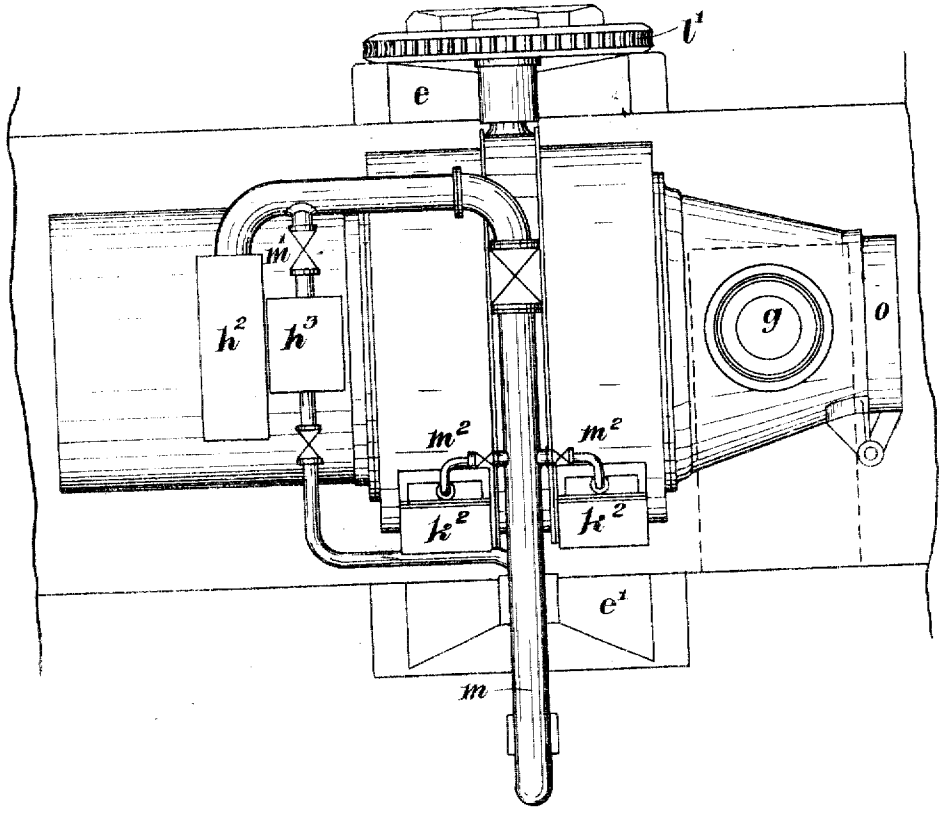
4 SHEETS—SHEET 3.

Fig. 3.



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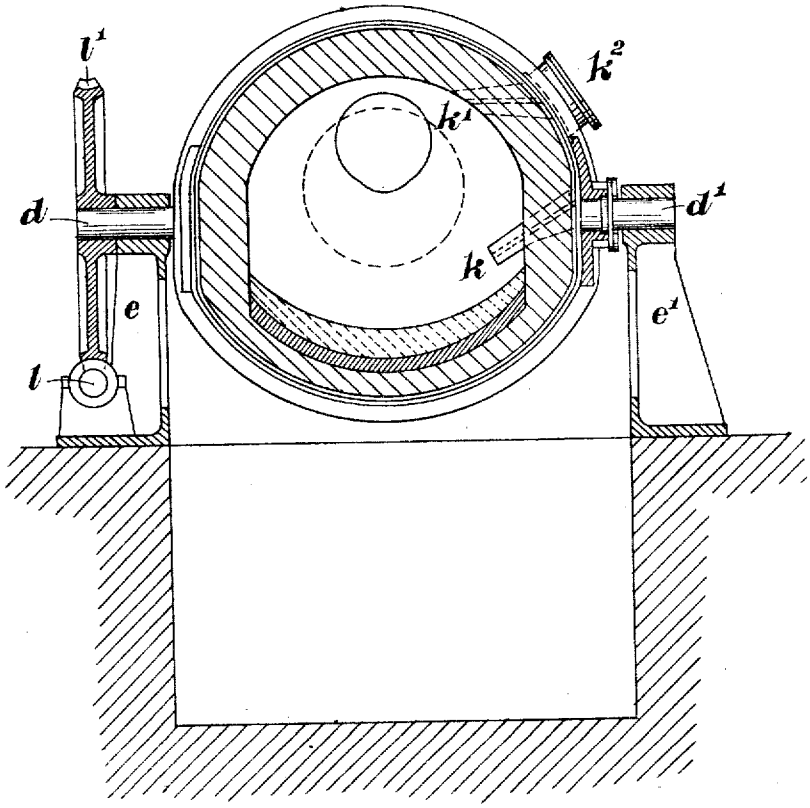
4 SHEETS—SHEET 4.

Fig. 5.



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UNITED STATES PATENT OFFICE.

TOM DARKE MACKIE, OF BOWES PARK, AND GEORGE FREDERICK FORWOOD, OF LIMPSFIELD, ENGLAND.

MANUFACTURE OF STEEL.

1,024,999. Specification of Letters Patent. Patented Apr. 30, 1912.

Application filed November 24, 1911. Serial No. 662,200.

To all whom it may concern:

Be it known that we, TOM DARKE MACKIE, a subject of the King of Great Britain and Ireland, and a resident of "Southwood," Palmerston Road, Bowes Park, in the county of Middlesex, England, and GEORGE FREDERICK FORWOOD, a subject of the King of Great Britain and Ireland, and a resident of West Chart, Limpsfield, in the county of Surrey, England, have invented certain new and useful Improvements in the Manufacture of Steel, of which the following is a specification.

This invention relates to the manufacture of steel by an expeditious process adapted for being carried out in a special apparatus of the character hereinafter described, and is designed to insure the production of castings free from imperfections of the kind commonly known as "blowholes."

It is well known that one of the objections to the employment of pneumatic processes—such for example as Bessemer's—for the production of steel castings, is that, during the removal of the metalloids by oxidation with excess of air, there is a tendency for the iron to become oxidized, with the result that blowholes occur in the finished article.

According to our improved method of manufacture—particularly when the production of steel castings is in view—the oxidized metal and slag from the converter (which may be of any known type) are transferred to the hearth of a reverberatory furnace, and, after the removal of the slag, the metal is subjected to the action of a reducing gas, such as hydrogen, blue water-gas or the like, with the result that it becomes deoxidized. On reaching the upper portion of the furnace the reducing gas meets with air, becomes ignited and burns, with the effect that the metal is exposed to the heat generated by the combustion, but is protected from its oxidizing influences, such reverberatory furnace treatment constituting an essential feature of our invention.

Apparatus adapted for carrying our improved process into effect is represented in the accompanying drawings, whereof—

Figure 1 is a side elevation of the apparatus in a vertical position, and Fig. 2 a side elevation (to an enlarged scale) of the apparatus in a horizontal position; Fig. 3 is a plan of the apparatus, Fig. 4 a longitudinal vertical section, and Fig. 5 a transverse vertical section on the line x x Fig. 2.

According to our preferred method of construction, illustrated in the accompanying drawings, the converter a and reverberatory furnace b are parts of one and the same apparatus; but for convenience in construction and for facilitating the repair of the linings or other parts, are made separable at the joints c, c^1. The operation of transferring the metal from the converter a to the furnace b is effected by simply tilting the bi-part structure, the latter being, with this object, mounted on trunnions d, d, carried in supports e, e. It will be seen that the converter a is in direct communication with the reverberatory furnace b, and the latter with an extension f whence branches a flue g for conveying the escaping gases to a regenerator where they are employed for heating the air-blast hereinafter referred to.

The converter a is furnished with two twyers h h', while in the horizontal position (Fig. 4), air, preferably hot, is admitted through twyer h, and producer gas or equivalent gas through the twyer h'; the mixture being fired in the usual manner. The supply of air and gas is maintained until the entire apparatus has been thoroughly heated; whereupon the air and gas supplies are shut off, the apparatus swung into a vertical position (Fig. 1) and a charge of molten metal is admitted from an ordinary cupola. The converter having been swung to such an angle as to enable the twyers h h' to blow most advantageously upon the surface of the metal, a blast of hot air is admitted through the twyer h' or through both the twyers h h' and the oxidation of the impurities proceeds in the usual manner. The blowing of the metal is not, however, carried so far as in the Bessemer process, but (as in the Swedish method) until the percentage of silicon and manganese required in the finished material is approximately reached. The air-blast being now shut off, the converter is turned to a horizontal position, with the effect that the metal and slag flow from the converter a to the hearth b' of the reverberatory furnace b. The air and producer gas supplies to the twyers h h' are now again opened, and, owing to the heated condition of the fur-

nace, ignition takes place; the air and producer gas supplies being so adjusted as to produce a long flame over the surface of the metal on the hearth b' of the reverberatory furnace b. The waste gases escape by way of the flue g which latter is in communication with a main flue j (Fig. 1); the joint g' in the flue g being struck from the center of the trunnions d d'. The flue j is connected to a regenerator (not shown) provided with a chimney shaft adapted to produce the necessary draft throughout the apparatus. The charge on the hearth b' is now treated with oxid of iron, in the usual manner, as in an open hearth furnace, and is brought down slightly below the percentage of metalloids required in the finished product. The slag having been thickened by the addition of suitable material, the apparatus is slightly tilted on its trunnions with the object of facilitating the removal of the slag; it being important for the next stage of the process that the molten metal be left with a clean surface. The apparatus having been restored to a horizontal position, the metal is exposed to a reducing atmosphere obtained by the employment of "blue" water-gas or the like, containing 50% hydrogen or thereabout; this deoxidizing gas being introduced through the twyer k arranged at a level slightly above the surface of the metal, while a suitably restricted air-supply enters through twyer k' placed at a higher level. In the heated condition of the furnace, the gaseous mixture ignites at the top of the furnace, where the air enters; thus maintaining, by radiation, the temperature of the bath; while the metal on the hearth at the bottom of the furnace is subjected to the reducing action of the gas entering the furnace by way of the lower twyer k before referred to.

It will be perceived that, under conditions such as those described, although an oxidizing atmosphere exists in the upper portion of the furnace, a stream of deoxidizing gas impinges upon and bathes the surface of the metal, thus maintaining a deoxidizing atmosphere in the neighborhood thereof. Such oxygen as may be present in the metal having, by these means, been removed and the usual additions of carbon, manganese, silicon or other metals or metalloids, made, the charge is ready for pouring, and may forthwith be used for the production of castings.

The combined converter and reverberatory furnace is rotated on its trunnions d d' by means of a worm l and worm-wheel l'. m is the hot-blast conduit leading to the twyer-box h^2 and having branches m' for supplying the twyer-box h^3, and m^2 m^2 for supplying the twyer-boxes k^2 k^2. n is the main for supplying the twyer-box h^3 with producer gas, or the twyer-boxes k^3 k^3 with "blue" water-gas, according to the stage of the process in operation; the last mentioned twyer-boxes being connected by means of flexible pipes in order that the twyers k k' may if desired be removed during the conversion stage; dummy plugs being substituted in their places.

o is a hinged door for closing the extension f.

p is a hood for collecting and conveying away the waste gases which escape during the initial stages of the process.

What we claim as our invention and desire to secure by Letters Patent is:—

1. The process for the conversion of iron into steel which consists in treating the charge on the hearth of a furnace with oxid of iron, removing the slag from said charge, then blowing the charge with a reducing gas in order to deoxidize the same while a gaseous mixture in a state of combustion is maintained exclusively in the upper portion of the furnace.

2. In the process for the conversion of iron into steel, the steps which consist in maintaining a supply of deoxidizing gas in contact with a surface of the metal, and a suitably restricted supply of a combustion supporting gas in the upper portion of the furnace out of contact with the metal, the former serving to protect the metal from oxidation, and ultimately on reaching the upper portion of the furnace, mingling with the combustion supporting gas and there burning, substantially as set forth.

In testimony whereof we have signed our names to this specification in the presence of two subscribing witnesses.

TOM DARKE MACKIE.
GEORGE FREDERICK FORWOOD.

Witnesses:
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C. P. LIDDON.