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E. BERTRAND & O. THIEL.

PROCESS OF MANUFACTURING STEEL.

No. 559,253. Patented Apr. 28, 1896.

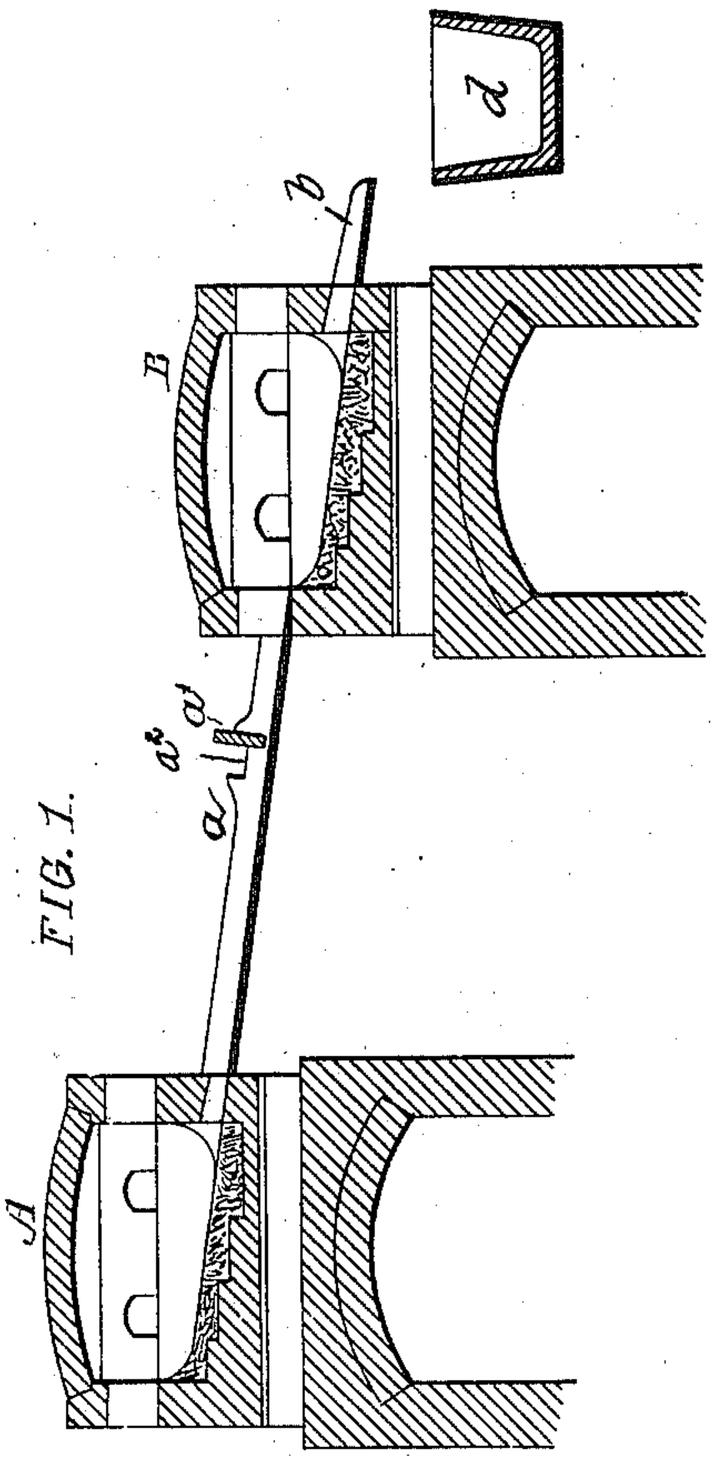

FIG. 1.

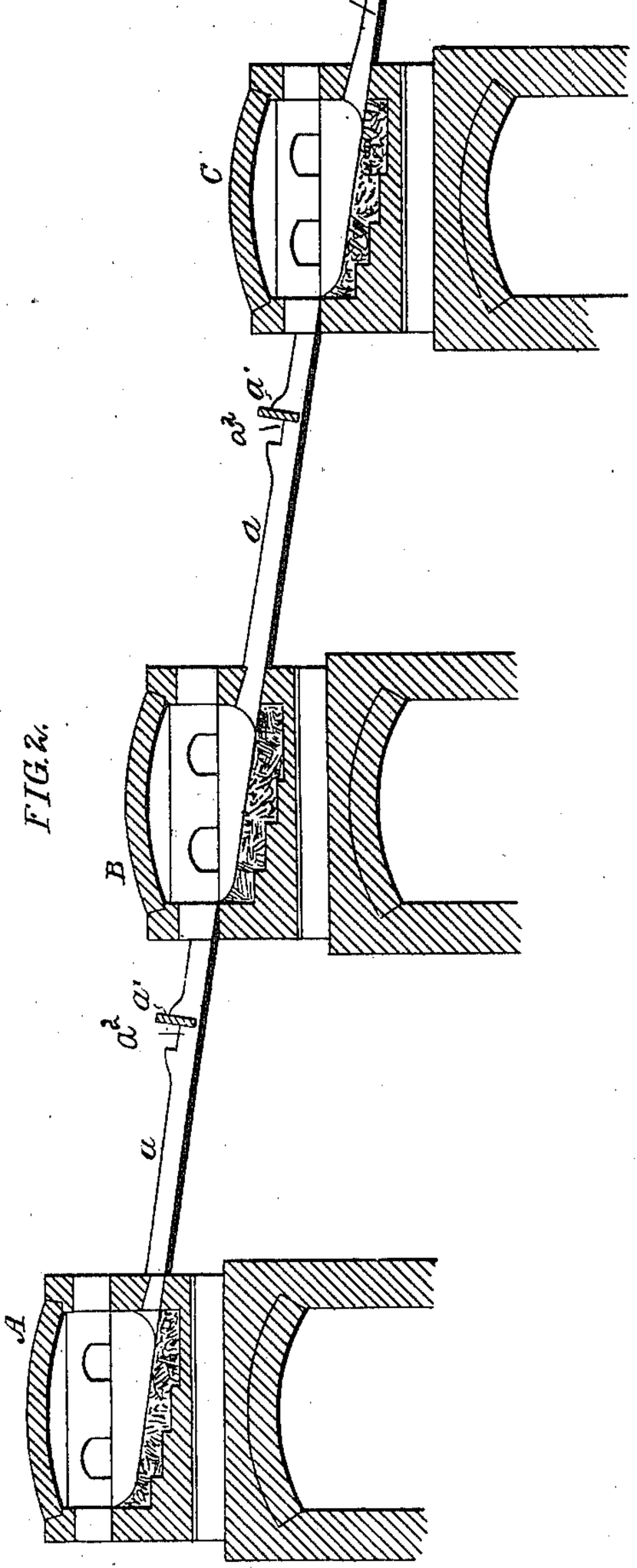

FIG. 2.

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FIG. 3.

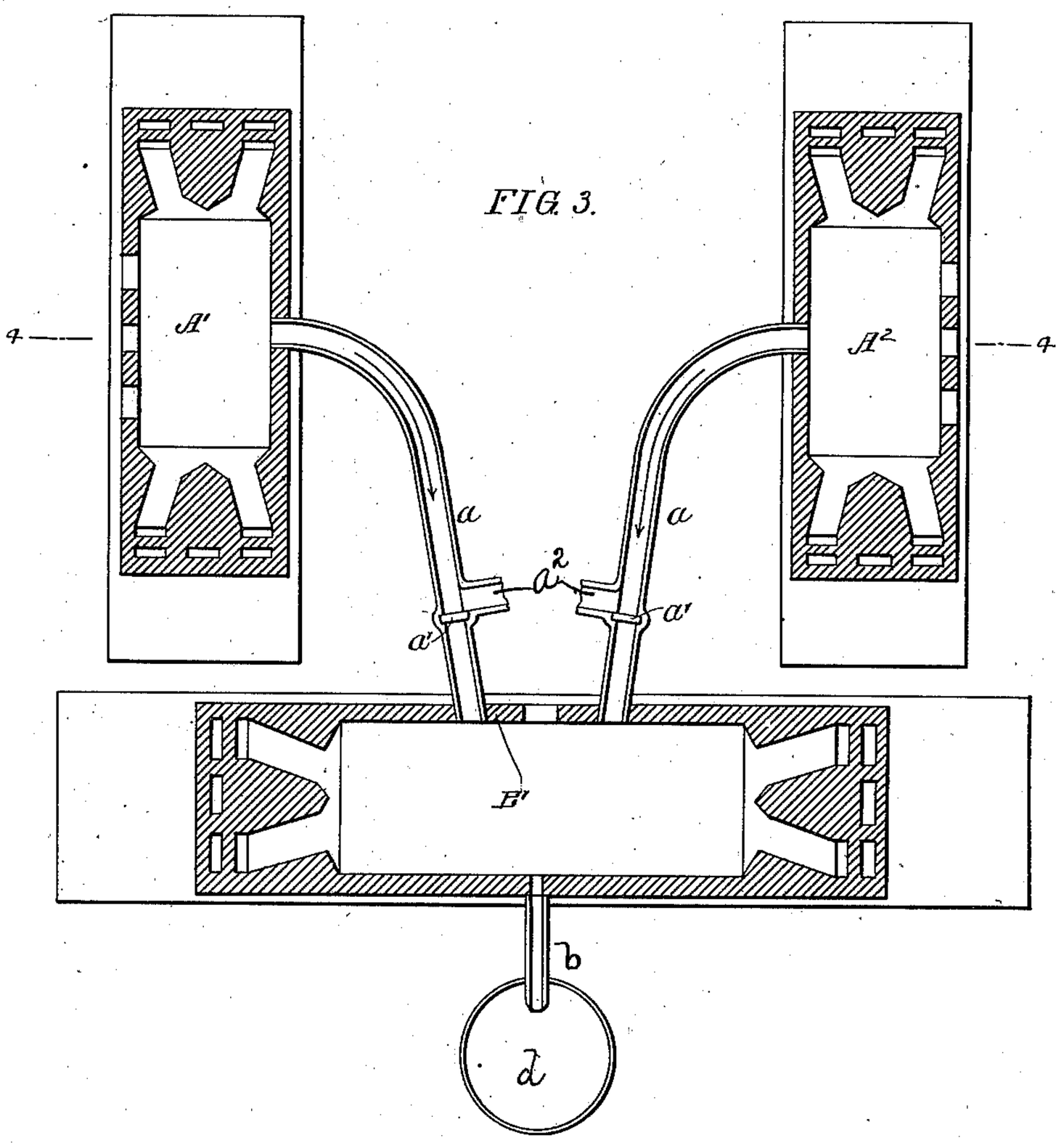
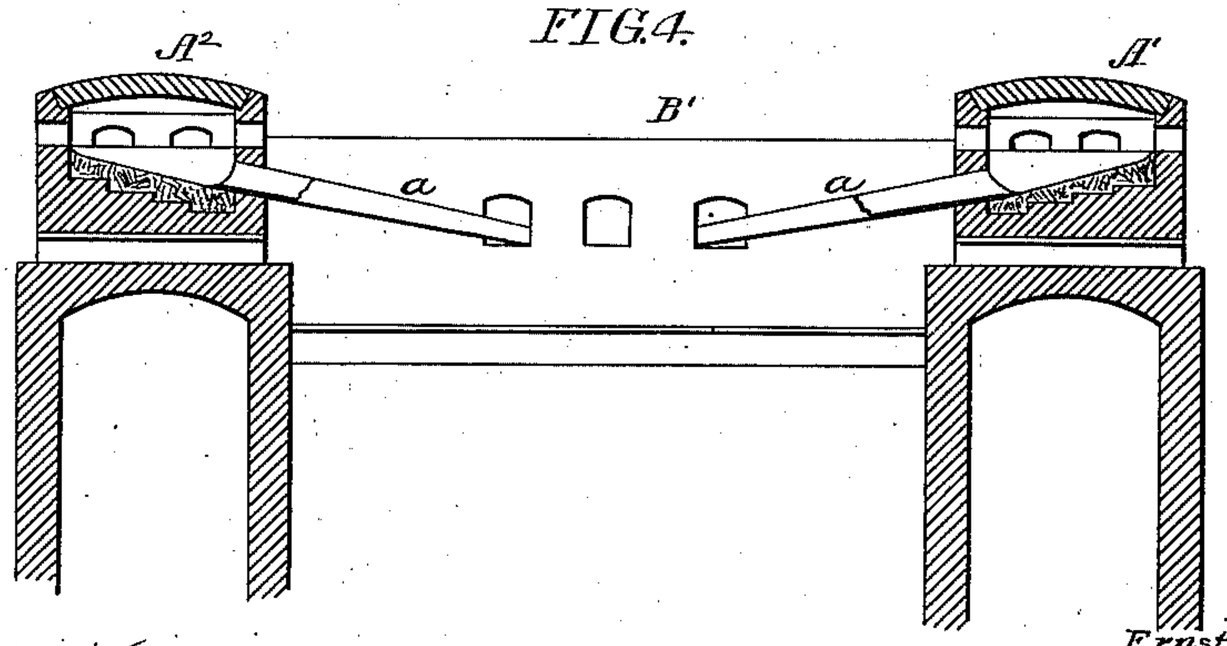


FIG. 4.



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PROCESS OF MANUFACTURING STEEL.

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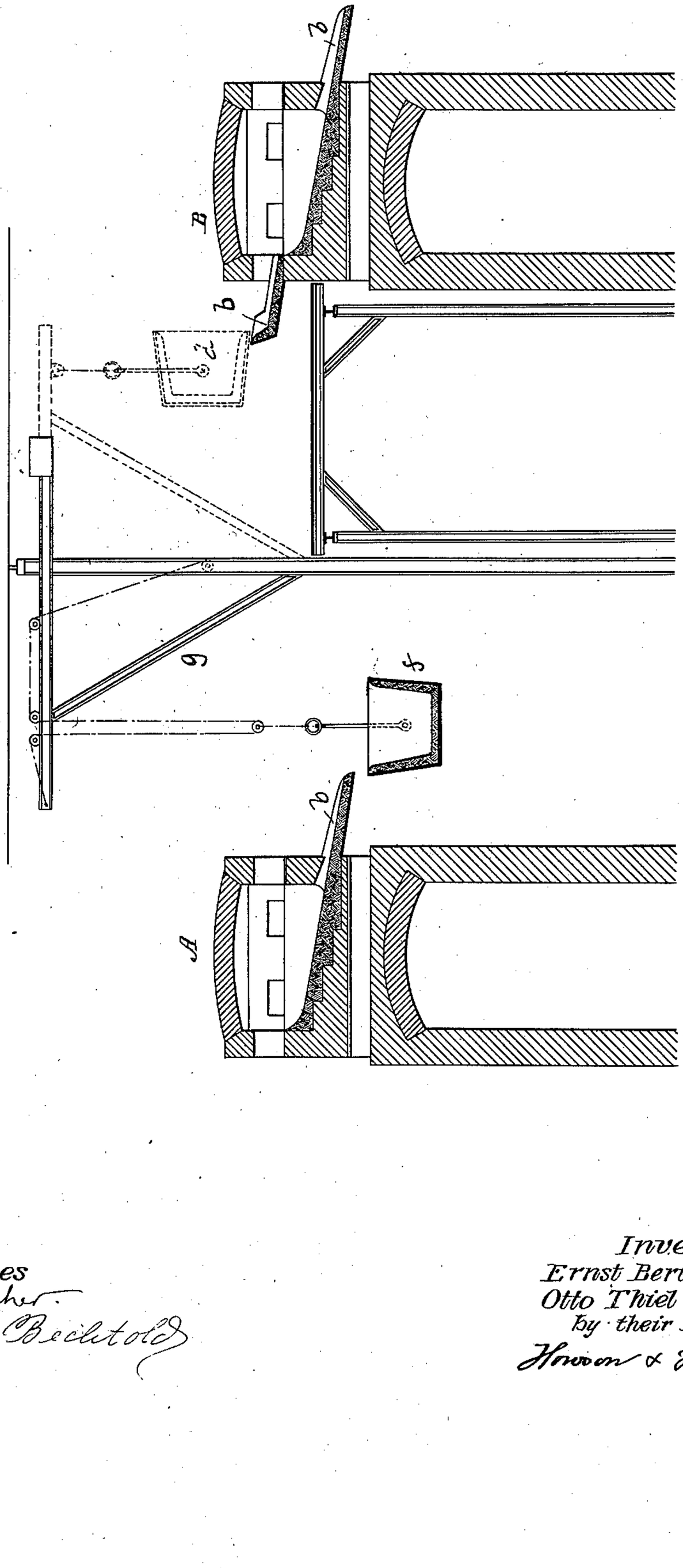
FIG. 5.



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PROCESS OF MANUFACTURING STEEL.

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FIG. 6.

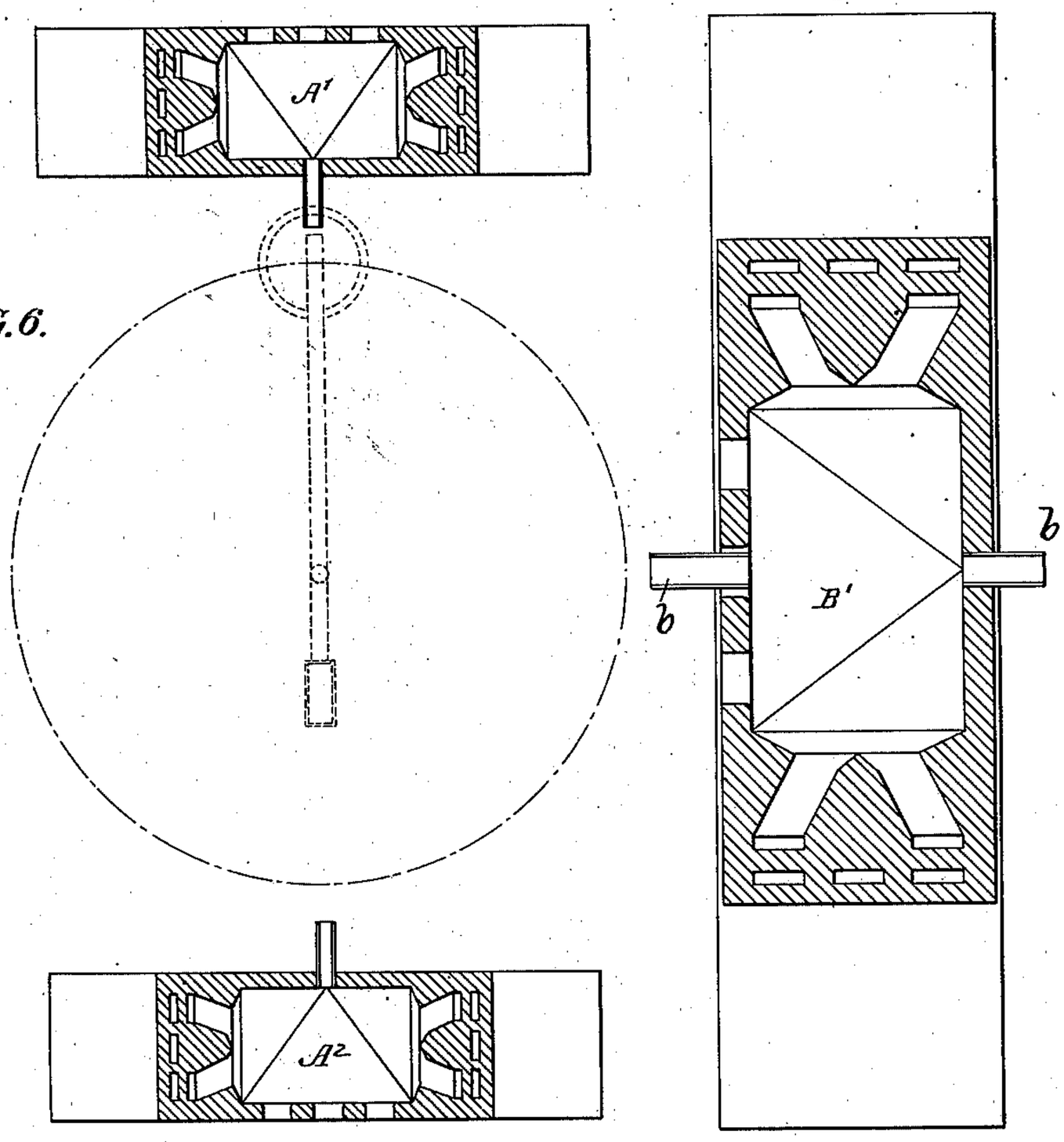
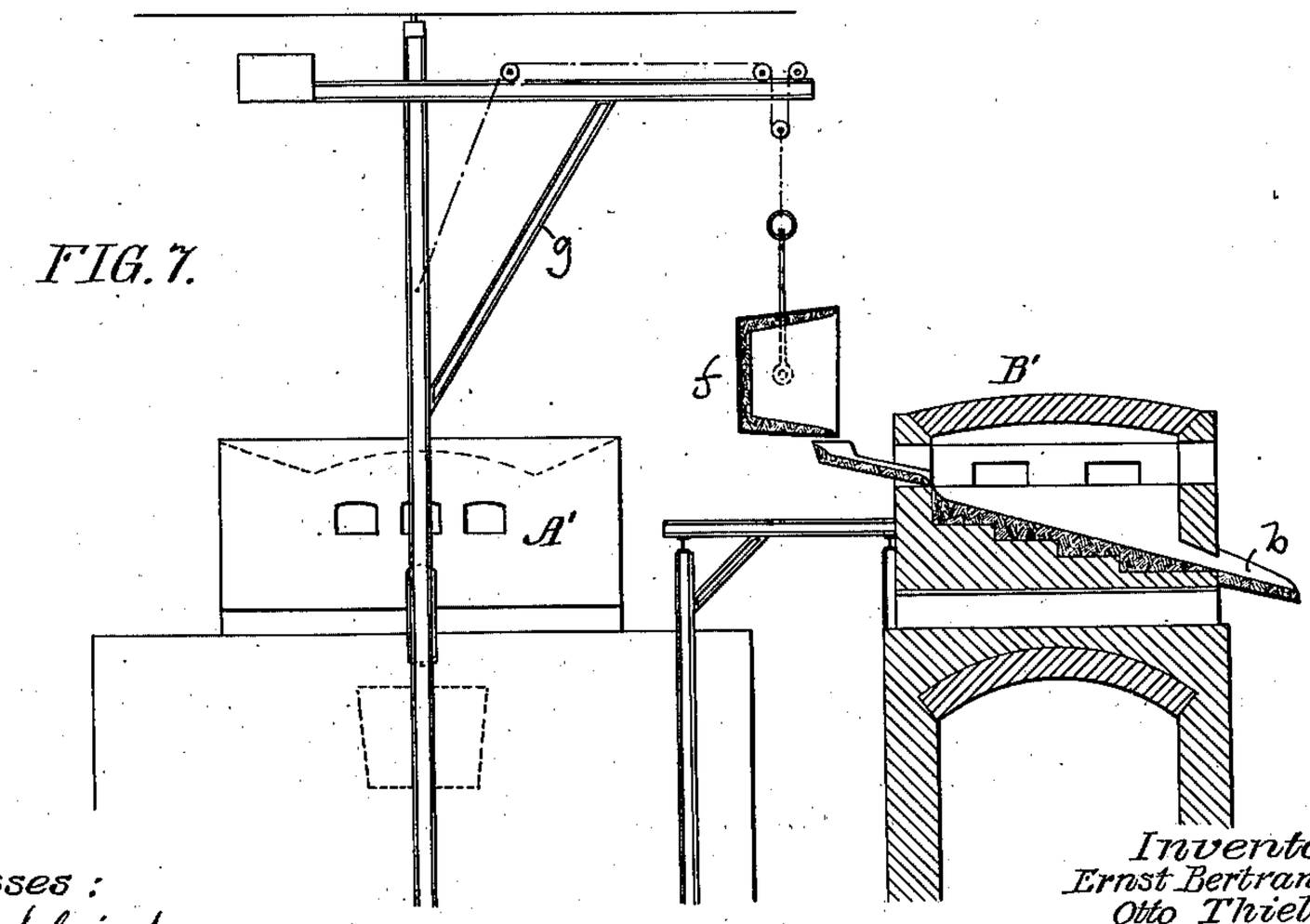


FIG. 7.



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UNITED STATES PATENT OFFICE.

ERNST BERTRAND AND OTTO THIEL, OF KLADNO, AUSTRIA-HUNGARY, ASSIGNORS OF ONE-THIRD TO JOSEPH HARTSHORNE, OF POTTSTOWN, PENNSYLVANIA.

PROCESS OF MANUFACTURING STEEL.

SPECIFICATION forming part of Letters Patent No. 559,253, dated April 28, 1896.

Application filed October 3, 1894. Serial No. 524,778. (No model.) Patented in England June 5, 1894, No. 10,923.

To all whom it may concern:

Be it known that we, ERNST BERTRAND, a citizen of the United States, and OTTO THIEL, a subject of the Emperor of Germany, residing at Kladno, Bohemia, Austria-Hungary, have invented certain Improvements in the Manufacture of Steel by a Combined Open-Hearth Process, (patented in England, No. 10,923, dated June 5, 1894,) of which the following is a specification.

Our invention consists in combining several open-hearth furnaces in such a manner that the charge may be divided, each part of the same being treated in a separate furnace for the purification, or partial purification, of the same, and the charges being then run into one furnace for the completion of the process and the making of the necessary additions, the slag being removed from the charge of the first furnace while the same is exposed on its way to the second furnace, or from the charges of a series of primary furnaces while the same are exposed on their way to a finishing-furnace.

In the accompanying drawings, Figure 1 represents one arrangement of a furnace in accordance with our invention. Fig. 2 represents another embodiment of the invention in which three furnaces are used. Fig. 3 represents, in sectional plan, another arrangement of three furnaces, which is preferable in some cases to that shown in Fig. 2. Fig. 4 is a transverse section on the line 4 4, Fig. 3; and Figs. 5, 6, and 7 are sectional views illustrating modifications of the invention.

In the arrangement of furnaces shown in Fig. 1, a portion of the charge may be treated in a furnace A and another portion of the charge in the furnace B, and when the charge in the furnace A is purified, or partially purified, it is run into the furnace B through the inclined trough *a*, the furnace B being on a slightly-lower level than the furnace A to provide for the desired inclination of said trough. In the furnace B the two charges are combined and the operation is completed and the required additions are made to the charge. During the flow of the metal through the trough *a* from the furnace A to the furnace B the slag may be removed therefrom in any available way—as, for instance, by means of a vertically-adjustable partition-bar a', which can be so set as to stop the flow of slag and direct the same into a branch trough a^2, the metal flowing beneath the partition. The metal, after the completion of the operation, can be withdrawn from the furnace B through a spout *b* into a ladle *d* or other suitable receptacle.

Fig. 2 represents an arrangement of three furnaces A B C, providing for a division of the charge into three parts, each separately treated in one of the furnaces, and all then combined in the furnace C for the completion of the process and the making of the necessary additions, provision being made for removing the slag from the charge from each of the furnaces A and B on its way to the furnace C, or with this arrangement of furnaces the charge may be divided into two parts, treated independently in the furnaces A and B, the furnace C serving to receive these two charges after treatment, and providing for the completion of the process.

A preferable arrangement of three furnaces is that shown in Figs. 3 and 4, each of the primary furnaces A' A^2 in this case discharging into a secondary furnace B', this arrangement also providing for a division of the charge into either two or three parts, as desired.

The use of the trough as a means of conveying the partially-treated charge from one furnace to the other, while a simple and therefore preferable means of effecting this result is not absolutely essential to the proper carrying out of our invention. For instance, a ladle *f*, mounted upon a crane *g*, as shown in Fig. 5, may be used for the purpose, the slag being removed from the metal while the same is exposed on its way from the furnace A to the furnace B.

Figs. 6 and 7 illustrate the same idea in connection with the combination of three furnaces A', A^2, and B', such as shown in Fig. 3.

If the removal of phosphorus is not contemplated, the linings of the furnaces may be of acid material; but where the metal contains sulfur or phosphorus in any quantity the linings of the furnaces, or of those, at least, in which the preliminary treatment of the metal is effected, should, in all cases, be of a basic material. By performing the different operations of the process in the sepa-

rate furnaces and freeing the metal from the resulting slag after the completion of the first operation it is evident that each operation can be carried on with much greater perfection and precision than usual, the quality of the finished product being consequently materially improved. Furthermore, it will be clear that since the slag is separated from the metal on its way from one furnace to the other each furnace will contain much less slag and, as a consequence of this, less lime, limestone, or other additions will be necessary, comparatively speaking, to make the slag sufficiently basic, which fact also tends to reduce the quantity of slag made. Since the metal in the furnaces is covered by a materially thinner layer of slag the flame will naturally be able to act more energetically upon the bath, thereby causing the process to proceed more rapidly and effecting a material saving of fuel and a correspondingly-increased output for the plant.

The diminished quantity of slag in the furnace and the shorter duration of the operation will also result in a proportionate saving of furnace-lining material and in the reduction in the amount of metal lost, and there will be a saving in the amount of ferromanganese, spiegel, &c., required to deoxidize and recarburize the bath, since the decreased quantities of slag will take up proportionately smaller quantities of the oxids of iron and manganese.

The management of the different furnaces will naturally depend upon the natural and chemical compositions of the pig-iron and scrap which is to be treated, more especially upon the amounts of silicon and phosphorus which they contain.

The three-furnace arrangement shown in Fig. 3 is especially available when part of the metal to be treated contains a large percentage of phosphorus and another portion contains a large proportion of silicon. In this case one of the primary furnaces would be used for working the iron containing the silicon and the other for working the iron containing the phosphorus, the metal, after the silicon and phosphorus are removed in the respective furnaces, being run into the furnace B′ and the operation being finished in the usual way.

Under certain circumstances it is possible to remove comparatively large amounts of silicon and phosphorus by means of the arrangement shown in Fig. 1—that is, by employing two furnaces only. In this case the pig-iron containing silicon and phosphorus may be charged into the furnace upon the upper level, while scrap and pig iron containing but little silicon are charged into the lower furnace. After the silicon and a large part of the carbon and phosphorus have been removed from the metal in furnace A on the upper level the metal is run down into the lower furnace, the phosphorus and sulfur still remaining in the mixed metals is then worked out, and the operation is finished in the usual manner.

Naturally this arrangement of a combined open-hearth process using a series of furnaces will permit of modifications too numerous to mention in detail, the modifications given being sufficient to show the principles upon which the process is based.

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

1. As an improvement in the open-hearth process of making steel, the mode herein described of dividing the charge, removing impurities from each portion of the charge in an independent furnace, uniting the charges for the completion of the operation and making of the necessary additions, and removing slag from the metal while the same is exposed on its way from one furnace to another.

2. As an improvement in the open-hearth process of making steel, the mode herein described of first removing impurities from a portion of the charge in a primary furnace, melting another portion of the charge in a second furnace, withdrawing the charge from the primary furnace, removing the slag therefrom while the charge is exposed on its way to said second furnace, and introducing the metal into the second furnace and there effecting the removal of the remaining impurities from the charge and making the required additions.

3. As an improvement in the open-hearth process of making steel, the mode herein described of first removing impurities from a portion of the charge in one furnace, removing impurities from another portion of the charge in a second furnace, tapping the charges from said furnaces, removing the slag from the charges so tapped off, introducing the two supplies of metal into a third furnace containing the remainder of the charge, and completing the operation in said third furnace.

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

ERNST BERTRAND.
OTTO THIEL.

Witnesses:
ADOLPH FISCHER,
JOSEF SCHÖBL.