(No Model.) 3 Sheets—Sheet 1.

J. A. POTTER.

METHOD OF CASTING.

No. 449,701. Patented Apr. 7, 1891.

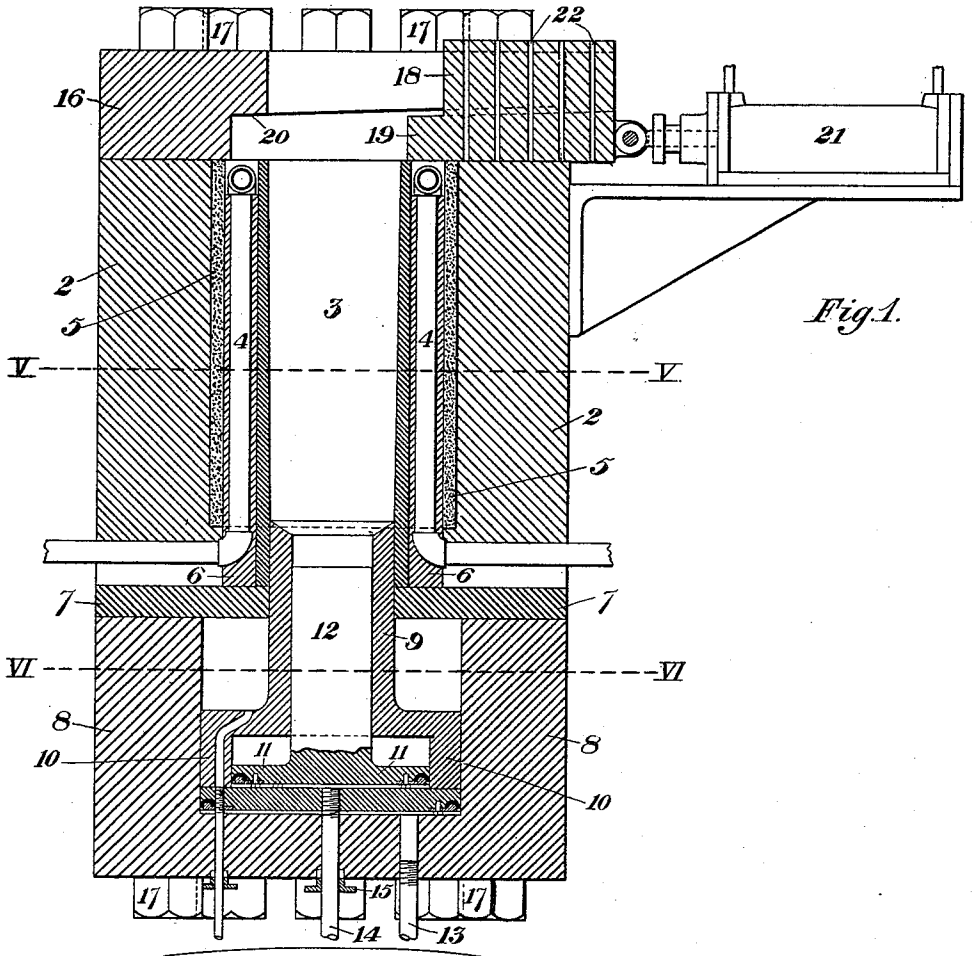


Fig. 1.

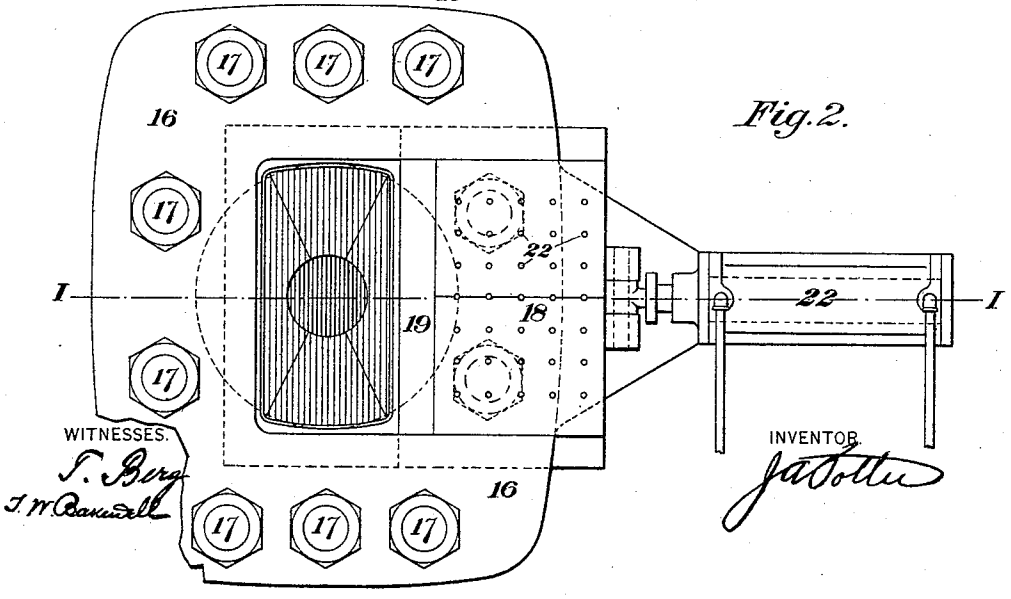


Fig. 2.

WITNESSES.
F. Berg
J. W. Bansell

INVENTOR.
J. A. Potter

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

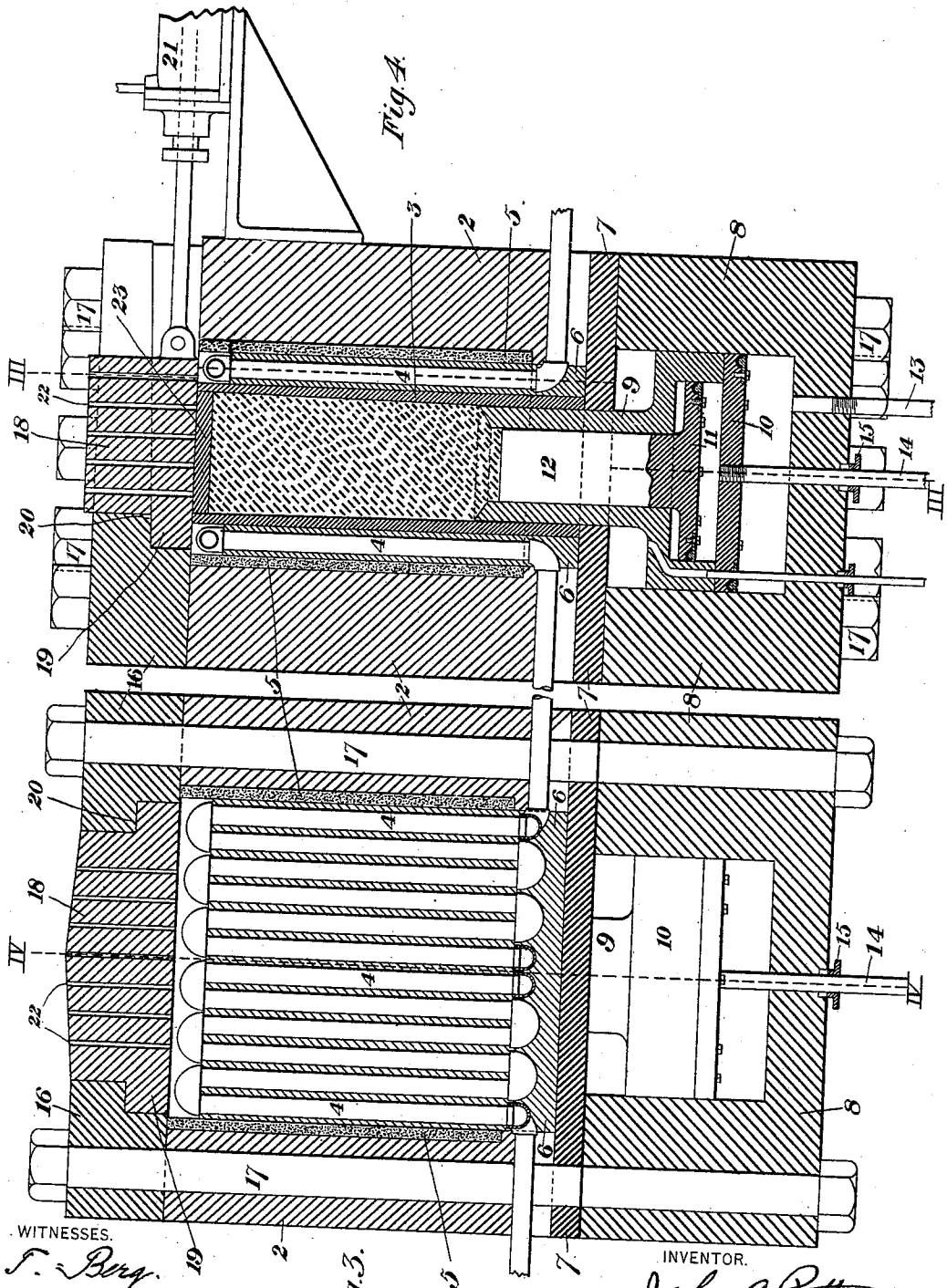
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3 Sheets—Sheet 2.

J. A. POTTER.

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

(No Model.) 3 Sheets—Sheet 3.

J. A. POTTER.

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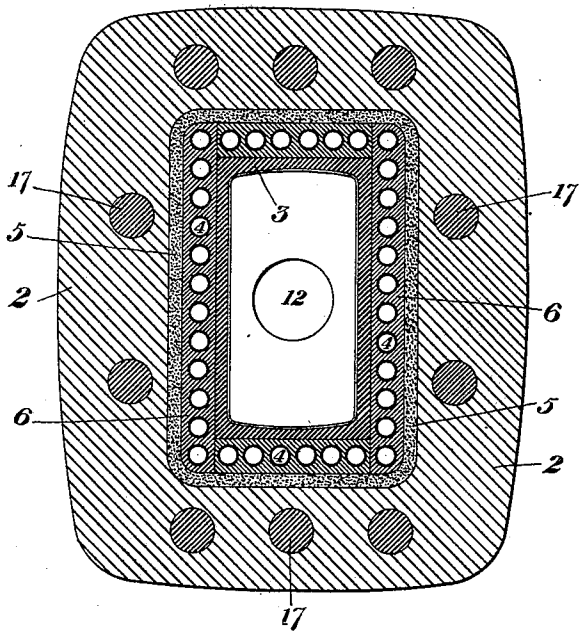


Fig. 5.

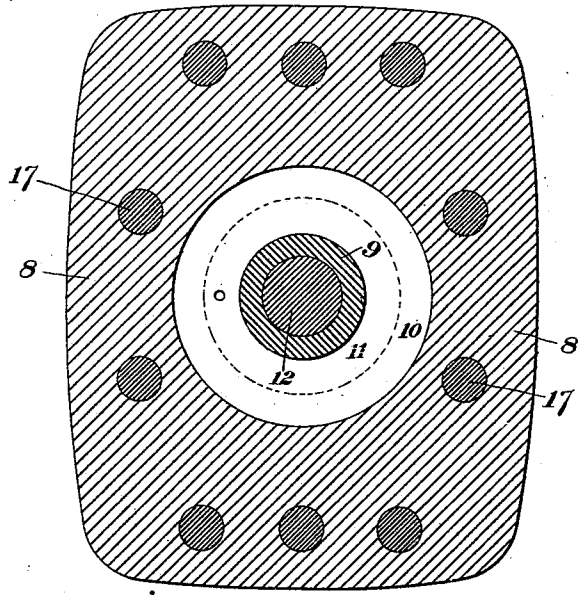


Fig. 6.

WITNESSES.

F. Berg.

J. W. Boxwell

INVENTOR.

John A Potter

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UNITED STATES PATENT OFFICE.

JOHN A. POTTER, OF MUNHALL, PENNSYLVANIA.

METHOD OF CASTING.

SPECIFICATION forming part of Letters Patent No. 449,701, dated April 7, 1891.

Application filed March 20, 1890. Serial No. 344,645. (No model.)

To all whom it may concern:

Be it known that I, JOHN A. POTTER, of Munhall, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in the Manufacture of Steel, of which the following is a full, clear, and exact description.

My invention relates to an improvement in the art of casting and compressing steel, especially steel ingots designed to be further treated by forging, rolling, or otherwise; but it should be understood that by suitable modifications the apparatus and method forming the subject of the invention may be applied to the direct manufacture of steel castings not intended to be subsequently worked, and that such application is within the scope of the invention as intended to be claimed by me herein.

The object of my invention is to improve the quality of steel by rendering it compact and dense in its nature, and also by preventing segregation of its non-metallic constituents—such as silicon, sulphur, phosphorus, carbon, &c.—to render it as nearly homogeneous in composition as possible.

I do not claim, broadly, to be the first inventor of the art of compressing steel ingots. Such compression, however, has been done heretofore by exerting on the steel in the mold a uniform compression on its entire cross-section; but as the exterior shell of the ingot cools and solidifies very much more rapidly than the inner portion a resistance is opposed to the compressing-plunger, which very much impedes its proper action and detracts from the efficiency of the operation, allowing the steel to shrink unevenly and internal strains to arise. If after casting an ingot or body of steel it be subjected to compression in the mold and its outer shell permitted to solidify, and then if local compression be applied to its inner more fluid portion, a denser casting is obtained, and if in addition to such operation the cooling of the metal while under compression be hastened by artificial means, as by the circulation of a cooling medium, the natural tendency of the non-metallic constituents to segregate or form pockets is restrained and a much more homogeneous product is had. The modes of treatment just referred to form the basis for the methods claimed in this application. For the practice of such methods I have devised certain improved apparatus, which I show and describe herein. It will be understood, however, that my claims relating to the methods of manufacture are not limited strictly by the said apparatus, since other mechanical devices may be devised, which may be used in accordance with invention.

I shall now proceed to describe my said invention with reference to the accompanying drawings, in which—

Figure 1 is a vertical sectional view of my improved apparatus, the section being on the line I I of Fig. 2. Fig. 2 is a plan view thereof. Fig. 3 is a vertical section on the line III III of Fig. 4. Fig. 4 is a vertical section on the line IV IV of Fig. 3. Figs. 5 and 6 are respectively horizontal sectional views on the lines V V and VI VI of Fig. 1.

In the drawings, 2 represents a box or frame, preferably of cast-iron, in which is set the mold 3, in which the steel is cast and compressed. Within this box or frame, around the position of the mold, is a series of coils of pipes 4, preferably cast in a metal casing 6, as shown in the several figures of the drawings, and on the exterior of said casing there is preferably an incasing layer 5 of refractory non-heat-conducting material, such as fire-clay. The parts 2, 3, and 6 rest on a removable plate 7, which forms the end of a hydraulic cylinder 8.

9 is a hollow plunger, which projects through the plate 7 and whose head 10 is within the cylinder 8. The head 10 is hollow and contains a plunger-head 11, whose plunger 12 extends through the hollow plunger 9, and is preferably of smaller diameter than its head, so that the pressure transmitted by its end is greatly intensified in degree. A pipe 13, which enters the cylinder 8, supplies motive fluid to actuate the plunger 9, and a pipe 14, which passes through a stuffing-box 15 in the head of the cylinder 8 and through the end of the hollow plunger-head 10, supplies motive fluid to actuate the plunger 12. The pipe 14 is capable of longitudinal motion through the stuffing-box, so as to permit motion of the plunger 9 within its cylinder 8.

The box 2 has an entablature 16, which is connected with the cylinder 8 by strong bolts 17, and which is provided with a removable section or cap 18, adapted to fit over and close an opening in the entablature directly above the cavity in said box. This cap is set in

suitable slideways in the entablature and has a lip or projecting portion 19, adapted to fit under and to interlock with a lip or shoulder 20 on the entablature. To move this cap I may employ any suitable mechanical means, preferably a double-acting hydraulic cylinder 21. The cap 18 is preferably provided with a series of holes 22, the function of which is stated hereinafter.

The manner of use of the apparatus when thus constructed, is as follows: When the parts are in the position shown in Fig. 1, the molten steel is teemed into the mold 3 until the latter is filled to or nearly to the top. A refractory brick 23, made of asbestus or other porous gas-permeable material, is placed over the mold 3, and the cap 18 is moved into position over the mold, as shown in Fig. 4. Water is then admitted into the cylinder 8, so as to force the plunger 9 and the contained plunger 12 against the metal in the mold, thus compressing it to a high degree and expelling the gases, which escape through the porous brick and through the holes 22 in the cap 18. The metal, being forced by the compression firmly against the sides of the mold, chills rapidly on its exterior, the cooling being hastened by the action of the pipe-coil 4, through which the circulation of a cooling medium—such as air, water, or steam—is maintained. When the exterior shell has cooled somewhat and has set so as to form a crust inclosing the hotter and more fluid metal in the middle of the ingot, water is admitted into the hollow head 10, so as to force the plunger 12 upward within the hollow outer plunger 9, and as said plunger 12 is opposite to the central portion of the ingot its effect is to press inward the metal in the hollow open end of the plunger 9 and to compress the central portion of the ingot within the solidified outer shell. The pressure thus exerted is direct and independent of the pressure applied to the whole body of steel by the plunger 9, and being concentrated in position is very intense and by forcing the fluid metal in all directions and causing it to press laterally against the outer shell a firm contact of the ingot with the sides of the mold is maintained. The solidified shell acts to resist this pressure and prevents it from being exerted with full force directly on the mold. This causes the ingot to cool very rapidly, and by such rapid cooling and compression segregation of the metal is prevented, and I secure a compact ingot of substantially homogeneous composition throughout. This operation is continued until the entire ingot has solidified, and as the central portion is the last to become solid a constant pressure throughout the period of solidification is maintained. The particles of metal are thus compacted as they shrink and all internal strains which result from the natural process of shrinking are prevented. When the ingot has cooled sufficiently to stand removal, the cap 18 may be retracted and the ingot removed, or the plunger 9 may be employed to eject the ingot partially from the mold, its removal being completed by suitable tongs or lifting devices.

It will be understood by those skilled in the art that the apparatus is susceptible of modification in form and structure in divers ways without essentially changing its principle, and such modifications I intend to cover, broadly, in the following claims, each of which expresses a distinct item of my invention unqualified by the conditions and limitations contained in the other claims.

My invention is applicable not only to cast-steel, but also to cast-iron, and I desire to cover in the following claims its application to such use.

I claim—

1. In the art of casting steel, the improvement which consists in casting an ingot or body of steel, compressing the steel, hastening its cooling by artificial means, and when the exterior shell has partially cooled compressing the inner more fluid portion of the metal within such shell by a direct and independent pressure, substantially as and for the purposes described.

2. In the art of casting steel, the improvement which consists in casting an ingot or body of steel, compressing the steel, and when the exterior shell has partially cooled compressing the inner more fluid portion of the metal within such shell by a direct and independent pressure, substantially as and for the purposes described.

3. In apparatus for casting steel, the combination, with a mold, of a hollow compressing-plunger, and a second inner intensifying-plunger to which the first-named hollow plunger serves the function of a cylinder and which exerts a greater pressure, substantially as and for the purposes described.

4. In apparatus for casting steel, the combination, with the mold, of a mold-receptacle having an inner casing provided with channels for the circulation of the cooling medium, a refractory lining between the walls of the receptacle and said casing, and compressing mechanism, substantially as and for the purposes described.

5. In apparatus for casting steel, the combination, with a mold, of a compressing-plunger adapted to operate on the steel within the mold and an inner plunger adapted to operate independently and to impart to the steel a separate compression, the end of the inner plunger being normally situated within the compressing-plunger at some distance from the end thereof, whereby a space is afforded at the end of the plunger for the reception of the molten metal, substantially as and for the purposes described.

In testimony whereof I have hereunto set my hand this 15th day of March, A. D. 1890.

JOHN A. POTTER.

Witnesses:
W. B. CORWIN,
THOMAS W. BAKEWELL.