No. 618,867. Patented Feb. 7, 1899.

J. K. GRIFFITH.

ART OF CASTING AND APPARATUS THEREFOR.

(Application filed Apr. 29, 1895. Renewed July 9, 1898.)

(No Model.)

3 Sheets—Sheet 1.

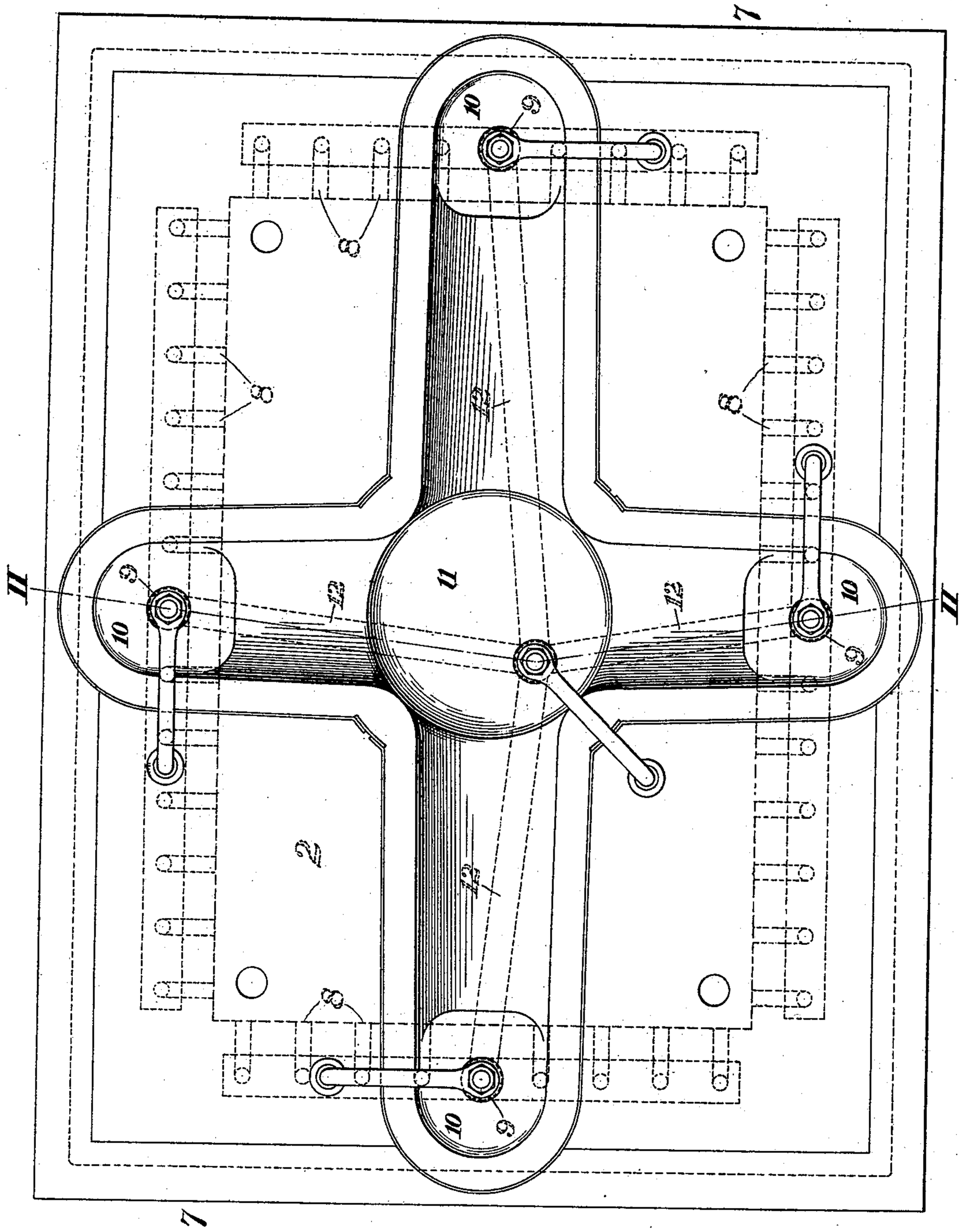

Fig. 1.

WITNESSES

A. Rife

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INVENTOR

Jacob K. Griffith.

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

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(No Model.) 3 Sheets—Sheet 2.

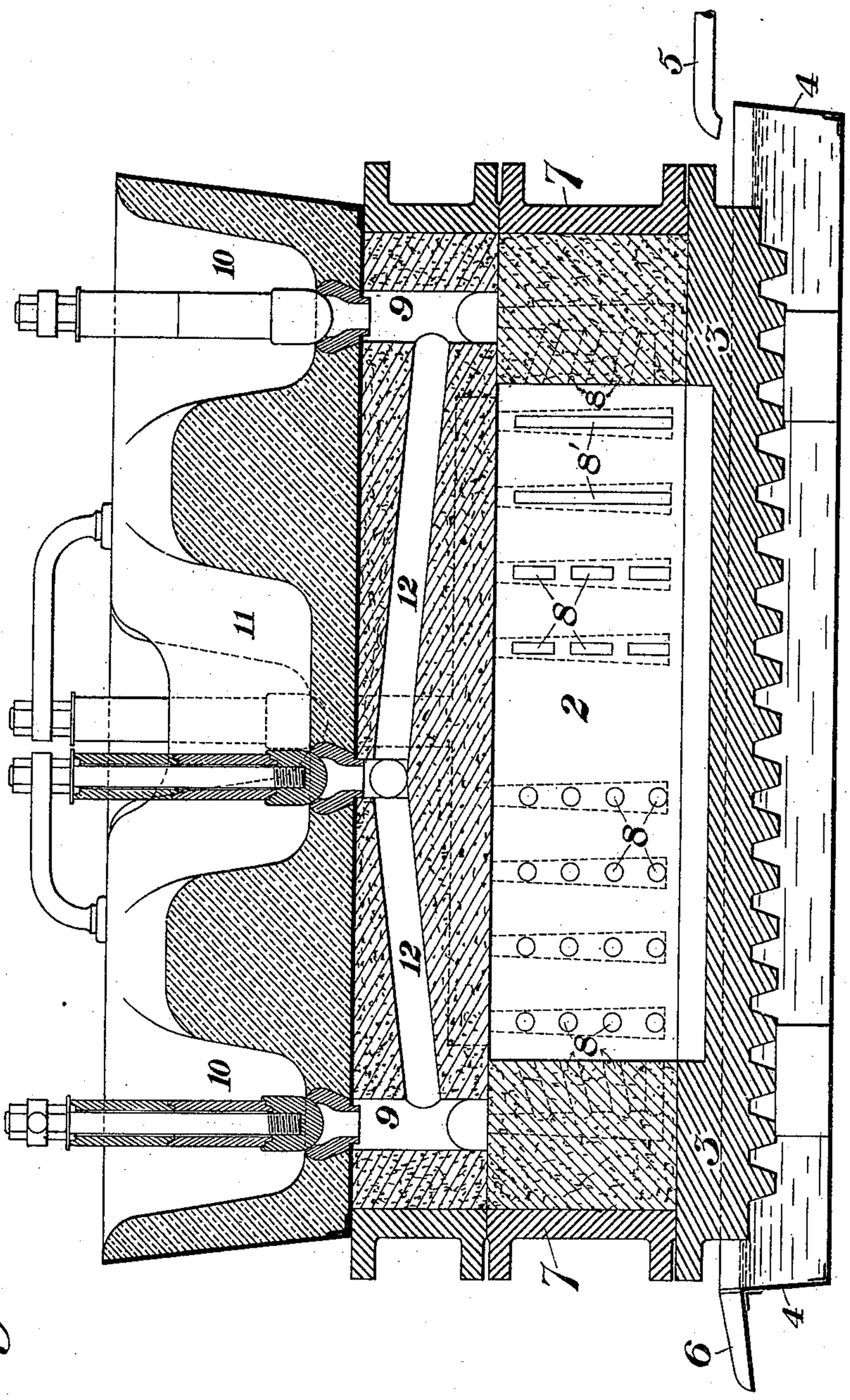

Fig. 2.

WITNESSES

A. Rife.

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(No Model.) 3 Sheets—Sheet 3.

Fig. 3.

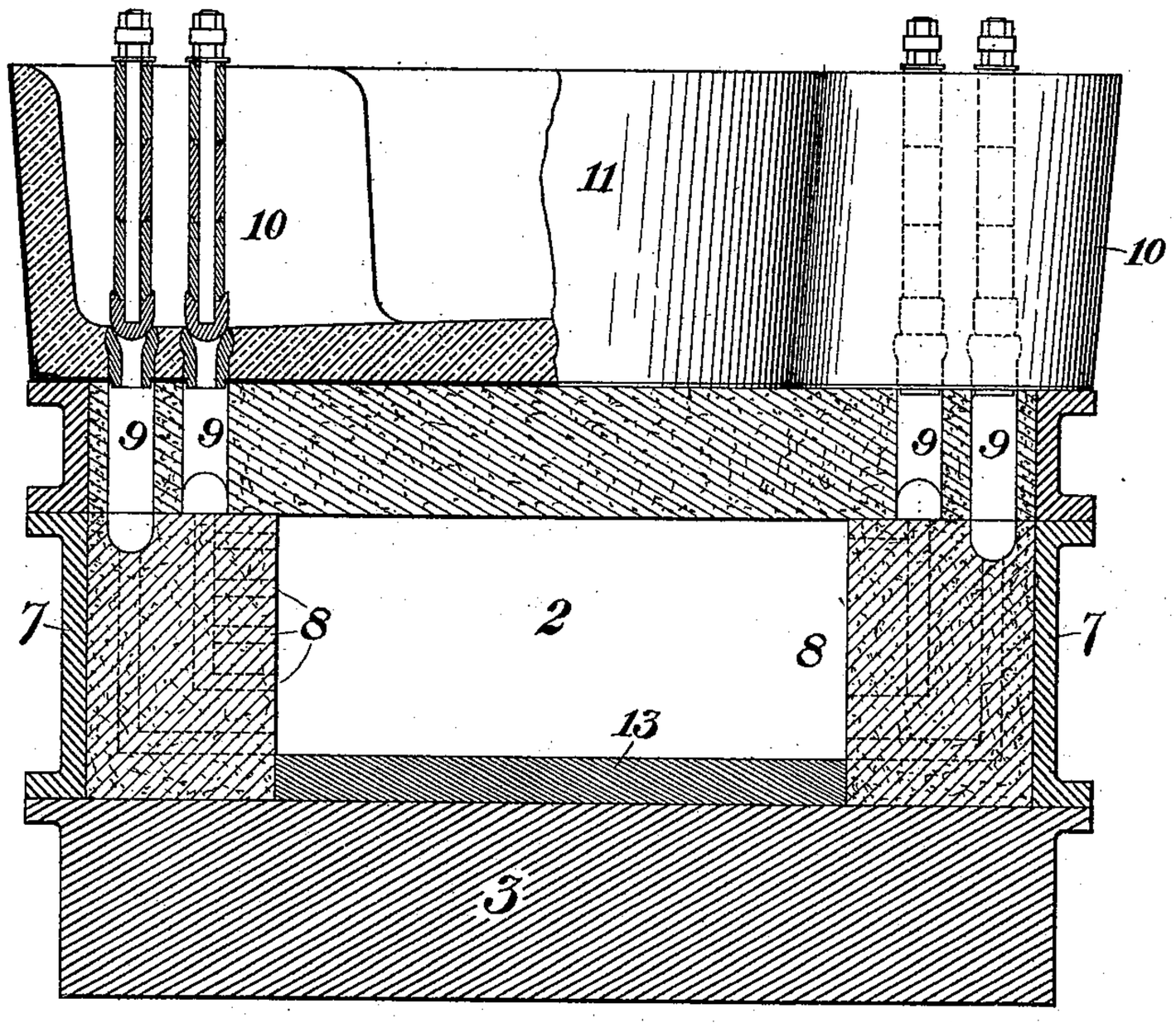
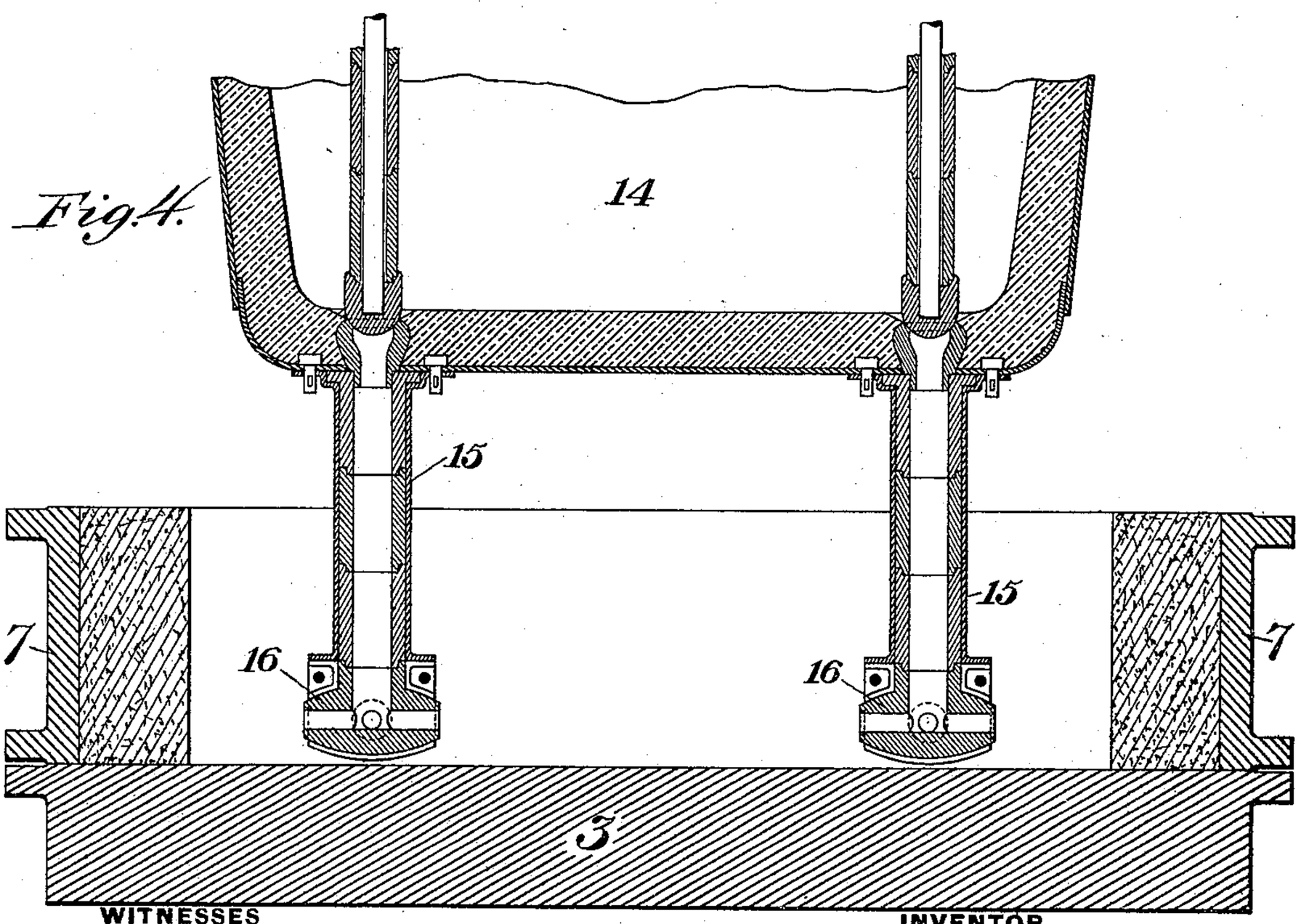


Fig. 4.



WITNESSES

Abr. Rife

Warren H. Swartz.

INVENTOR

Jacob K. Griffith

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

UNITED STATES PATENT OFFICE.

JACOB K. GRIFFITH, OF LATROBE, PENNSYLVANIA.

ART OF CASTING AND APPARATUS THEREFOR.

SPECIFICATION forming part of Letters Patent No. 618,867, dated February 7, 1899.

Application filed April 29, 1895. Renewed July 9, 1898. Serial No. 685,533. (No model.)

To all whom it may concern:

Be it known that I, JACOB K. GRIFFITH, of Latrobe, in the county of Westmoreland and State of Pennsylvania, have invented a new and useful Improvement in the Art of Casting and Apparatus Therefor, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming part of this specification, in which—

Figure 1 shows in top plan view casting apparatus constructed in accordance with my invention. Fig. 2 is a vertical cross-section on the line II II of Fig. 1. Figs. 3 and 4 are vertical cross-sections showing modified constructions of apparatus.

Like symbols of reference indicate like parts in each view.

In the casting of steel ingots as heretofore practiced much difficulty has been experienced from segregation, which renders the metal heterogeneous in composition, and from piping, which is due to the contraction of the interior of the ingot after the solidification of the exterior shell. These causes result in loss to the steel manufacturer, detract from the commercial value of the product, and make it necessary to shear off as waste a considerable portion of the metal.

The objects of my invention are, first, to obviate the difficulties above mentioned, and, second, to provide efficient means for casting compound ingots—*i. e.*, ingots composed of layers of steel of different composition or of layers of different metals or alloys.

I have made the following discoveries: that, especially in the casting of large ingots, if in addition to the use of a bottom chill the gates or passages for entrance of the metal be located at the sides of the mold-cavity at successively higher levels, or if provision be made otherwise so that the metal shall first flow laterally into the mold at the base and shall then flow laterally thereinto at the upper gates constantly at the surface of the metal as the levels of the latter are reached successively by rise of the metal within the mold, the mold being kept free from agitation and the streams of metal caused to enter in different directions, danger of segregation and piping is diminished, and by introducing the metal in lateral streams, so as to prevent the later portions of the cast from disturbing the metal first introduced, the formation of a compound ingot having strata of different composition is made easy and practicable.

Chills have been used heretofore to harden and to change the properties of the metal cast against them. This, however, is not my object. By chilling the ingot uniformly over the entire bottom from below and causing the solidification of the metal to proceed from the bottom to the top the occurrence of solidification in parallel planes upwardly prevents segregation, or at least causes any heterogeneity which takes place to occur in horizontal strata, so that it does not materially injure the plate, and it prevents piping in the center of the ingot, for as the chilling and solidification extend from the bottom in planes or strata parallel to the face of the chill there is no opportunity for the contraction of the interior of the metal within a rigid shell, which is the cause of piping. Any defects which may result are therefore at the surface of the ingot and can be planed off readily, if desired, or if they be left their location on the surface prevents them from weakening the strength of the body of the metal plate formed therefrom. The mode of casting above described also makes it possible to feed the casting with a much smaller sinking-head than is otherwise necessary to secure good results. It also prevents the formation of surface-cracks, which in the method of casting heretofore employed are caused by the chilling of the sides of the ingot and the contraction of the shell thus formed upon the incompressible molten interior of the ingot. By placing the chill at the bottom of the mold the gravity of the molten metal above keeps the metal constantly in contact with the chill and secures the best results.

When a chill is used in the manner which I have described in the manufacture of compound ingots by casting two or more superposed strata of different metals or metals of different composition, the action of the chill will cause a rapid solidification of the metal first poured sufficient to preserve its identity, but will, if desired, permit the adjacent surfaces of the strata to blend to such extent as

to prevent the occurrence of a sharply-defined line of demarcation. A better and stronger union is thus produced.

The results of the invention which I claim herein are much better secured when the mold in which the metal is cast is less in its depth than in its horizontal dimensions, for the chilling action is then exerted more completely in a vertical direction.

It will be apparent that in the manner above indicated I can make ingots the face or bottom of which shall be of high carbon grading upwardly into low carbon or softer steel, and which can be forged or rolled into rails the heads or portions of the heads of which shall be of hard steel and the web and foot of soft steel, armor-plates, deck-plates, plates for burglar-proof safes, &c., and which can afterward be hardened or tempered by known processes, if desired, and that chromium, tungsten, manganese, nickel, or other alloying materials may be introduced into the steel or into strata thereof; further, that I may make castings for the protection of floating batteries, forts, &c., where heavy weight of the cast plates is not a disadvantage. In such case the plate is cast initially in the shape in which it is to be used. The face may be made of chilled charcoal-iron, manganese steel, chrome steel, tungsten steel, nickel steel, or any like steel or steel alloy of high elastic limit, the back and body portion being formed of one or more softer strata, the elastic limit gradually diminishing toward the back. I may also use metals or alloys other than steel in like manner provided they are of such nature that they will weld together, and I may make castings of other forms than plates.

The discoveries above mentioned form the bases of the subject of the present specification, in which I claim as an improvement in the art the method of casting above stated and also certain apparatus which I have devised and which I deem preferable for the putting of the same into practice.

In the drawings, Figs. 1 and 2, 2 represents the cavity of a mold for casting ingots which is of less depth than width and the bottom of which is constituted by a chill-plate 3, either a heavy metal plate or, as shown in these figures of the drawings, a plate uniformly and regularly cooled by the passage of water through it or in contact with it, the purpose being that the chill shall be of proper construction to abstract the heat from the bottom of the liquid metal very rapidly by conduction. The conduction of heat is constant and uniform from all parts of the bottom of the ingot until the surface of the ingot is frozen.

4 represents a water channel or passage having an inlet 5 and an outlet 6. This channel is preferably formed by an open pan, within which the plate 3, preferably formed with a corrugated bottom to give greater surface of contact with the water, is set. The sides of the mold-cavity are constituted of fire-brick, fire-clay, sand, or other molding composition contained within a suitable box or flask 7, and there are gates 8 for the entrance of the metal, which are formed in the sides at successively higher levels and which communicate by way of stopper-controlled passages 9 with fountains or basins 10, into which the molten metal may be poured. In casting an ingot in the mold so formed molten steel is poured into the basins 10 and, flowing through the passages 9, enters through the lowest gate or gates 8 into the bottom of the mold, where it is rapidly chilled by contact with the plate 3. When the metal rises above the level of the lowest gate, it begins to enter through the gates next above, chilling as it enters by reason of the cooling influence of the plate 3, and so on the metal enters in succession through the gates until the mold has been filled. Instead of forming the gates into the mold-cavity of series of separate openings 8 at different levels they may be constituted by vertical continuous slots 8′ with the same result, the difference being simply that all the gates of each vertical series are merged, the metal in both instances entering laterally the base of the mold and then entering at successively higher levels at the surface of the metal as the same rises.

Within the scope of my broader claims the steel may be cast in a shallow mold, with metal sides and of much less depth than horizontal dimensions, so that the chilling of the liquid metal shall progress much more rapidly from the bottom upwardly than from the sides and so that by far the greater portion of the metal shall be chilled by the action of the bottom chill than by the action of the sides of the mold, the chilling action of the latter being comparatively insignificant.

If it is desired that the ingot shall not be homogeneous, but shall be constituted of strata of different composition—for example, if it be desired to produce an ingot having a face of very hard steel and a body of steel of softer composition—the harder steel, which may be steel containing a greater percentage of carbon, is first poured, and when a short interval has elapsed to permit the first stratum of steel to set partially the second layer is poured, the proper time for the second pouring being determined, if desired, by a pyrometer. The cooling effect of the chill-plate is such that the harder steel is rapidly cooled and loses its fluidity, and the lateral direction of the inflowing softer steel being divided into small streams prevents it from stirring up the harder steel and mixing with it to a material extent. By pouring into the mold in succession more than two varieties of steel an ingot of several different strata may be cast, or by pouring successively different metals or alloys I may obtain a composits ingot having a face of one metal or alloy and a body of a different material.

I show in Figs. 1 and 2 an excellent arrangement for casting steel ingots which may be caused to vary gradually and uniformly in

the proportion of carbon or other element which they contain from the face of the ingot to the back. In the middle of the basins 10 I form a second basin 11, having a stopper-controlled discharge communicating through a passage or passages 12 with the passages 9 and having dams separating it from the basins 10, over which the metal can overflow. The first portion of the metal to be cast—say steel having a high percentage of carbon or containing a hardening alloying substance—is poured into the basin 11 and, overflowing into the basins 10, is then discharged into the mold through the passages 9. Additions of softer metal are then made to the metal in the basin 11 until the diluted metal overflows into the basins 10 and is discharged into the mold, and by successively increasing the proportion of softer metal added to the middle basin a body of metal of gradually-lessening hardness may be introduced through the lateral gates. The contents of the basin 11 may at any time be emptied into the mold through its stopper-controlled opening, and afterward, if desired, a homogeneous softer stratum may be poured therethrough.

Instead of constituting all the strata of the ingot of cast metal I may proceed, as illustrated in Fig. 3, by placing a plate 13, of wrought metal, heated to or above a welding heat, at the bottom of the mold upon the chill and then teeming the fluid metal upon it through the lateral ports, as above described. The wrought plate is held upon and in close contact with the chill by the weight of the superincumbent metal, and the chilling action of the chill is exerted by conduction through the plate upon the molten metal above. The consequence is that a compound ingot is formed, the cast metal adhering and welding perfectly to the wrought plate and being itself prevented from segregation and piping by the action of the chill, as above described.

In the apparatus shown in Fig. 4 the lateral introduction of the fluid metal into the mold at successively higher levels is effected by means of a vertically-movable ladle 14, suspended by a lifting-crane or otherwise and having a discharge constituted by a vertical stopper-controlled pipe or pipes 15, provided at the ends with nozzles 16, having lateral discharge-openings. In pouring the first portions of the metal the ladle is lowered so as to bring the nozzles to the base of the mold. On raising one or more of the stoppers the metal flows out in lateral jets, and by elevating the ladle or lowering the mold the level of the metal streams can be raised as the filling of the mold progresses, thus causing it to enter constantly at the surface. This ladle can be used for casting compound ingots by gradually diluting its contents with softer steel during the pouring operation. The ladle may be stationary and the mold arranged to be movable downwardly.

In the case of the apparatus of Fig. 4, as I use an open-top mold, I prefer, after teeming the first stratum of molten metal, to cover the same with a substantial layer of easily-fusible non-oxidizing flux or slag, the purpose of which is to confine the heat and to compel the top of the ingot to chill last. The flux or slag retards the cooling of the surface and prevents the formation of surface shrinkage cavities, and in cases where it is desired to make the first stratum of metal unusually thick the surface is kept sufficiently hot to weld with the next stratum, while its base is being chilled. The second layer of metal is poured when the surface has reached a a semiviscous condition, and the slag being of less fusing-point than the metal and of less specific gravity rises to the surface of the second layer and serves to it the same function as it did to the first. The slag or flux can be used as above described not only with the open mold of Fig. 4, but with the closed-top mold of the other figures.

The apparatus and method above described may be modified in various ways without departure from the essential principles of the invention as defined in the following claims, and parts of the invention may be used without others. For example, within my broader claims the bottom chill may be used for casting homogeneous ingots in which the metal is poured vertically from above, the flux being used to protect the surface, the mold being shallow, and the metal being quickly poured.

By the statement in claim 5 that the mold has ports arranged to conduct the metal in a certain manner I intend to cover the ports arranged in this manner whether they are in the sides of the mold proper or in the nozzle of the ladle, which is lowered into the mold.

I claim—

1. The method of casting, consisting in pouring the molten metal into a mold, chilling it therein through the bottom more rapidly than from the sides and top, and maintaining a fused floating protective layer upon the surface of the metal from at least near the beginning of the pour throughout the same; substantially as described.

2. The method of casting, consisting in pouring the molten metal into a mold on lines parallel with the bottom, chilling it therein through the bottom more rapidly than from the sides and top, and maintaining a fused floating protective layer upon the surface of the metal from at least near the beginning of the pour throughout the same; substantially as described.

3. The method of casting consisting in pouring the molten metal into a mold through lateral ports in streams directed in different directions, but on lines parallel with the bottom of the mold, chilling it therein through the bottom more rapidly than from the sides and top, and maintaining a fused floating protective layer upon the surface of the metal from at least near the beginning of the pour throughout the same; substantially as described.

4. The method of casting, consisting in pouring the molten metal in successive strata differing in composition into a mold in lines parallel with the bottom, chilling it therein through the bottom more rapidly than from the sides and top, and maintaining a fused floating protective layer upon the surface of the metal from at least near the beginning of the pour throughout the same; substantially as described.

5. A mold for casting steel having a mold-cavity with a bottom chill adapted to abstract the heat uniformly from the base of the metal cast thereon, and having sides of less heat conductivity, said mold having ports arranged to conduct in different directions streams of metal into the mold in lines parallel with the chill and at the surface of the metal as the same rises in the mold-cavity, whereby the metal is caused to solidify in parallel horizontal strata; substantially as described.

6. A mold for casting steel having a mold-cavity with a bottom chill adapted to abstract the heat uniformly from the base of the metal cast thereon and having sides of less heat conductivity, and ports entering laterally opposite sides of the cavity respectively at the same levels, affording a series of inlets for the simultaneous entrance of the metal in lines parallel with the chill and at the surface of the metal as the same rises in the mold-cavity, whereby the metal is caused to solidify in parallel horizontal strata; substantially as described.

7. Apparatus for casting comprising a pouring-ladle having a mixing-basin, with an auxiliary basin or basins connected therewith by overflows, said mixing-basin having also a stopper-controlled discharge-opening; substantially as described.

In testimony whereof I have hereunto set my hand.

JACOB K. GRIFFITH.

Witnesses:

JOS. C. HEAD,

JOHN V. TONER.