No. 749,490. PATENTED JAN. 12, 1904.

H. W. LASH.

INGOT AND PROCESS OF FORMING THE SAME.

APPLICATION FILED OCT. 18, 1898. RENEWED OCT. 5, 1903.

NO MODEL. 2 SHEETS—SHEET 1.

Fig. 1.

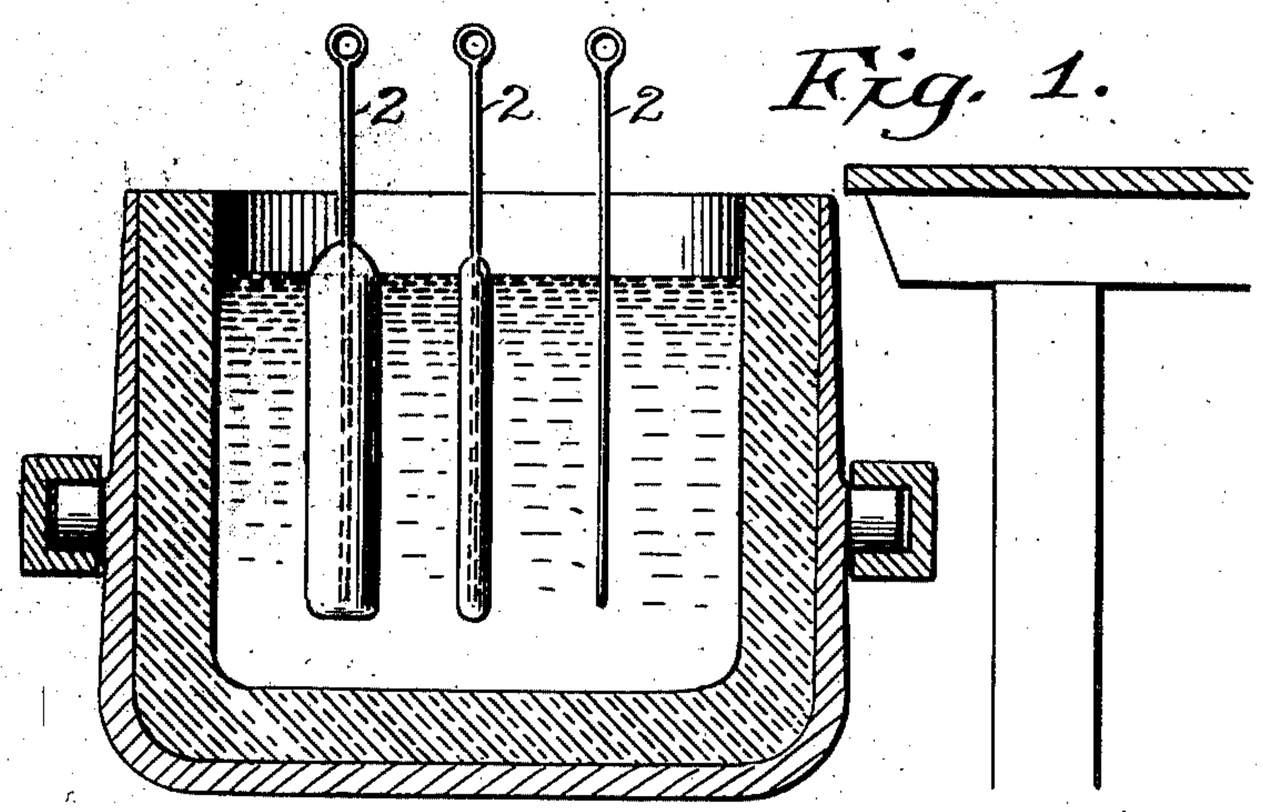


Fig. 4.

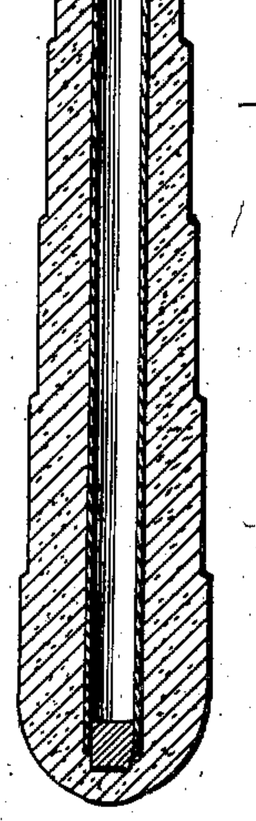
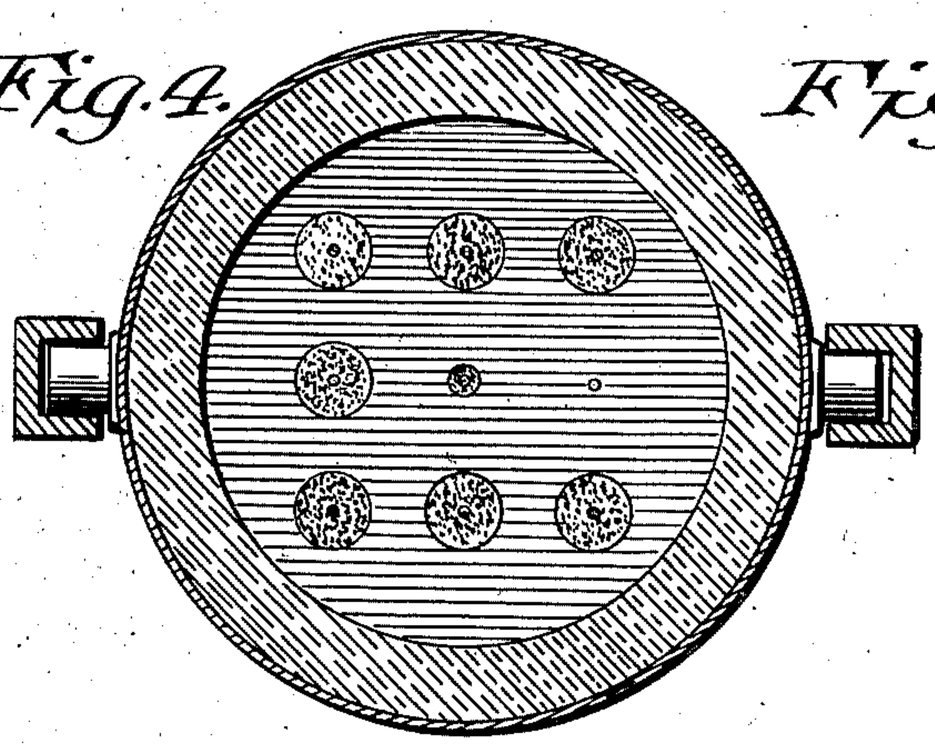


Fig. 2.



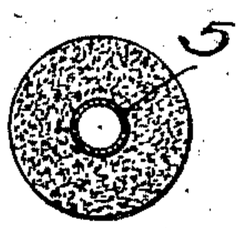


Fig. 5.

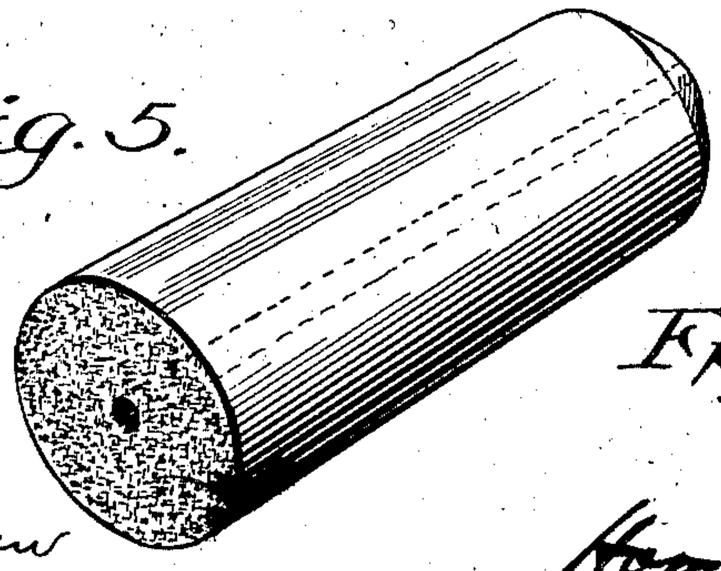


Fig. 3.

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APPLICATION FILED OCT. 18, 1898. RENEWED OCT. 5, 1903.

NO MODEL. 2 SHEETS—SHEET 2.

Fig. 6.

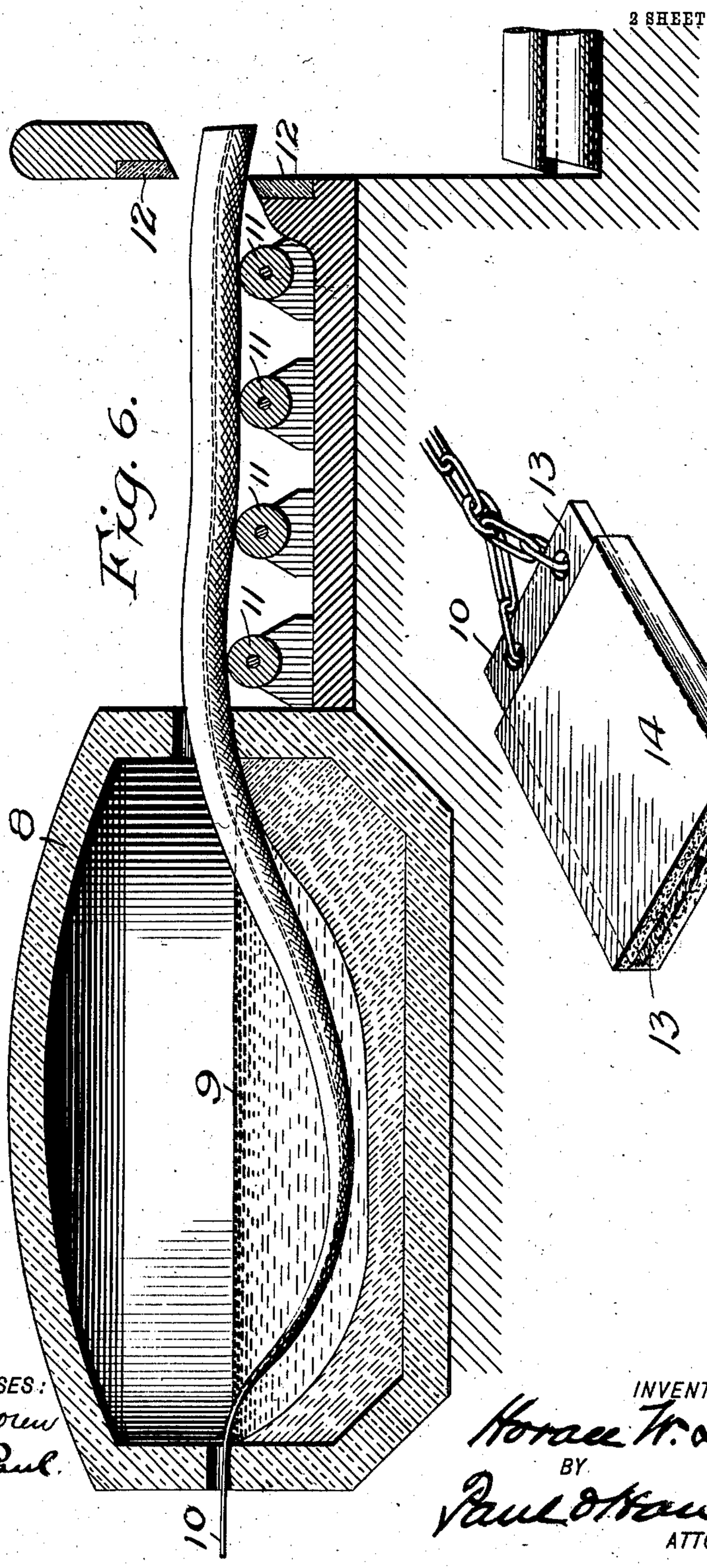

Fig. 7.

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No. 749,490. Patented January 12, 1904.

UNITED STATES PATENT OFFICE.

HORACE W. LASH, OF MINNEAPOLIS, MINNESOTA.

INGOT AND PROCESS OF FORMING SAME.

SPECIFICATION forming part of Letters Patent No. 749,490, dated January 12, 1904.

Application filed October 18, 1898. Renewed October 5, 1903. Serial No. 175,895. (No model.)

To all whom it may concern:

Be it known that I, HORACE W. LASH, of the city of Minneapolis, county of Hennepin, State of Minnesota, have invented certain new and useful Improvements in the Art or Process of Forming Metal Ingots, of which the following is a specification.

My invention relates to a novel process of forming or producing steel ingots wherefrom various articles may be manufactured by the usual forging, pressing, or rolling methods. At present steel ingots are formed or cast in molds, and owing to the cost of molds and the expense of handling the same the practice has been to make the molds and ingots as large as possible to be handled with profit, with the result that the ingots produced are large and unwieldy and require heavy and expensive machinery for cogging or reducing the ingots to sizes suitable for rolling into finished material. By employing large molds and heavy machinery it has been possible to produce steel in large quantities at a cost so small as to prohibit competition by small plants using small molds and light machinery. It is generally acknowledged that small steel ingots cannot be produced in competition with large ingots, for the reason that the cost of producing a tonnage of small ingots is much greater than that of producing the same tonnage of large ingots. This is because of the excessive cost of small ingot-molds, the short life thereof, the extra labor required for placing the molds in ratio to the product and for removing the ingots from the molds, the excessive scrap that is produced in handling small ingots, and because it is almost impossible to cast the entire contents of a large converter into small ingots, owing to the rapid cooling of the molten steel after it is taken from the converter.

The object of this invention is to enable the production of steel ingots of comparatively small weight and cross-section at a low cost, and the particular object is to dispense with the use of molds entirely in the mauufacture of ingots, and thereby greatly reduce the cost of casting or forming the ingots.

Another object of my invention is to produce steel ingots that shall be perfectly uniform in composition, solidity, and weight throughout and, further, to enable the manufacture of hollow and tapered ingots without molds.

Another object of my invention is to enable the cheap production of compound steel ingots direct from molten steel and in general the production of ingots that shall be free from blow-holes and air-cells.

A general fault with ingots cast in molds arises from segregation during the cooling of the metal, the fault being a center or core of very impure and weak metal within the ingot, making some thereof wholly useless and renderingall objectionable; and the particular object of this invention is to avoid internal segregation during the formation of the metal to the end that the ingot produced shall be perfectly sound and uniform.

My invention resides generally in the improvement in the art of forming steel ingots that consists in preparing a mass of molten metal, inserting a piece of cold metal into said mass, and thereby causing said molten steel to form or settle upon the exterior of said piece, thereby forming an ingot, and withdrawing such ingot from the molten mass prior to the general solidification of said mass.

The invention will be more readily understood by reference to the accompanying drawings, forming part of this specification, and in which—

Figure 1 illustrates my process of forming or growing metal ingots. Fig. 2 is a plan view of Fig. 1. Fig. 3 illustrates a fractured round ingot. Fig. 4 is a longitudinal section of a tapered ingot which is also hollow. Fig. 5 is a cross-section thereof. Fig. 6 illustrates a continuous process of forming ingots, and Fig. 7 illustrates a fractured compound grown ingot.

My process of forming ingots from and in a mass of molten steel comprises the following steps: first, starting with the liquid metal already converted into steel and ready for casting and permitting the same to cool to within a few degrees above the melting-point either in the furnace or in a suitable receptacle wherein the steel is placed while in the liquid condition; second, while the mass is still mol-

ten, though too cool to cast into ingots, causing or producing in the mass a local reduction of temperature, whereby a local growth or crystallization, accretion, or coalescence is set up within the mass, forming a solid body, unit, or ingot which may be withdrawn from the molten mass at will. This process of growth, which is a logical deduction from the tendency to local accretive coalescent action or solidification in molten steel, is dependent largely for utility upon the temperature of the mass, and particularly upon the means employed to excite such local action or growth within the molten mass.

For starting the crystallization or formation of an ingot in the molten steel I prefer to use a bar, rod, plate, or block of metal, preferably iron or steel. Such a bar is cooler than the molten steel, and when it is placed in the molten mass the surrounding metal will instantly begin to grow, coalesce, or solidify upon the rod, thus forming the beginning of the ingot, which will continue to grow and increase in size as long as it is allowed to remain in the molten mass. A few minutes only are required to thus create, form, or grow an ingot several inches in diameter upon a small rod as a base or to form an ingot of uniform solidity and of any desired thickness from or upon a relatively small plate or piece of metal. In all cases the resultant ingot will possess substantially the same shape as the original bar or plate or "mold-pieces," as it may be termed. Ingots of irregular dimensions may be readily formed by varying the period of immersion of different parts.

I apply the name "grown" ingot to the product of my process as best describing its manufacture and its nature. This ingot possesses several important qualities not hitherto obtained in steel ingots—to wit, the quality of perfect consistency, uniformity, and density throughout—the ingot being absolutely without blow-holes or air-cells, a naturally-finished unchilled surface, and uniformity of composition in all its parts. In all ingots that are cast in molds there is found a center or core of chemically-imperfect metal, the same being an alloy of iron and the various impurities contained in the molten mass and which through the natural process of segregation are forced to the center from the outer parts of the ingot, which cool first. This hard, brittle, or rotten center is very objectionable in the ingot and in all articles made therefrom, as it greatly reduces the theoretical strength of the mass or bar and for many uses must be bored out, as in steamship-shafts,

In my process segregation takes place, but not within the ingot, the impurities instead being eliminated from the metal as it cools and left in the molten mass or upon the surface of the ingot.

In Fig. 1 of the drawings I have shown a pot, ladle, or well in which the metal is prepared or is poured after preparation in a suitable furnace. 2 2 represent rods of iron or other metal the ends of which are thrust down into the molten mass of steel. These rods promote or excite solidification or accretion to the metal surrounding the same, and in a few minutes a solid mass or ingot will coalesce or grow upon the rod, and when the mass is sufficiently large it is withdrawn by means of the rod. The free end of the rod is then cut off, and the ingot is ready for the rolls or for any reducing process. The greater part of the steel in ladle will be removed in growing a number of ingots therefrom, and the material which is left, which will contain all the impurities, will be replaced in the furnace for reconversion or to be added to raw material. For convenience the ladle is preferably arranged upon trunnions, so that the metal that is left after a number of ingots have been made may be easily poured out. The original metal rod or molding-piece remains in the ingot, the surrounding metal being firmly contracted and welded thereon. The center rod will show, as indicated in Fig. 3, when an ingot is fractured or broken, and the surface surrounding the rod at the fracture will possess the granular or crystalline appearance common to cast-steel. Tubular ingots may be readily formed, as indicated in Fig. 4, a tube 5 being substituted for a solid rod, as shown in the preceding figures. The lower end of the tube is plugged to prevent the metal from flowing upward therein. In this manner hollow ingots to be manufactured into hollow shafts, car-axles, &c., may be manufactured much more cheaply than under the old methods.

A taper casting is readily made by gradually raising the ingot after a sufficient quantity of metal has accumulated or grown thereon to give the proper dimensions to the upper end of the ingot. Such taper ingots are adapted for various purposes, particularly in the construction of ordnance. In Fig. 6, which illustrates the continuous operation of my process, 8 represents a suitable furnace, in which 9 is the molten metal. This furnace has openings in opposite sides for the rod or strip 10, which is slowly forced or drawn through the bath of molten metal. The growth of the ingot is gradual during the passage of the rod through the furnace, and I prefer that the rod and the ingot should be drawn away from the furnace by a gang of live-rolls 11, arranged before the door thereof. At the end of the live-rolls I prefer to place powerful shears 12 for cutting the ingot into lengths.

The simple or compound ingot or plate (shown in Fig. 7) comprises the thin original plate 13, upon which the body 14 of the ingot is formed by the process of growth.

Aside from the better quality of material produced by my invention the principal advantage lies in the cheapness of the process,

and by the aid of the invention a plant producing from fifty to one hundred tons of steel daily may manufacture small ingots and compound ingots as cheaply as if producing a much larger tonnage and may be operated at points where the market is not sufficiently large to warrant the investment in a large mill of a thousand or more tons capacity daily, as required for the cheap production of steel under old methods.

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

1. The improvement in the art of forming metal ingots that consists in preparing a mass of molten steel, then inserting a piece of cold metal into said mass, thereby causing the molten steel to form or settle upon the exterior of said piece and thus form an ingot and then withdrawing such ingot from the molten mass prior to the general solidification of said mass, substantially as described.

2. The improvement in the art of forming metal ingots that consists in placing a piece of metal plate in molten steel or the like, allowing a large quantity thereof to solidify thereon and then withdrawing said bar or plate with the resultant ingot formation thereon before said mass as a whole solidifies, substantially as described.

3. The improvement in the art of forming steel ingots that consists in cooling molten steel to a temperature below that of conversion, then exciting or creating a local solidification or growth in the molten mass by the introduction of a bar or piece of metal, permitting said solidification or growth to continue until an ingot of several times the weight of the original bar or piece of metal is formed and then withdrawing said ingot from the mass of steel before the mass as a whole solidifies, substantially as described.

4. The improvement in the art of forming ingots that consists in inserting a single piece of cold steel into a mass of molten steel and thereby causing said molten steel to form or settle wholly upon the exterior of said piece and thereby forming an ingot, substantially as described.

5. The improvement in the art of forming ingots from molten metal that consists in inserting one end of a cold piece of metal into a mass of molten metal, thereby chilling the molten metal upon the cold metal and causing a large accretion and growth thereon and then withdrawing the original piece, with the ingot accretion, from the molten metal, substantially as described.

6. The improvement in the art of forming hollow steel ingots from molten steel that consists in inserting the end of a closed metal tube into the mass of molten metal and thereby causing the molten metal to chill or form upon the exterior of said tube and form an ingot, substantially as described.

7. The method of shaping metallic articles, consisting in lowering a former into a metallic bath and lifting the same gradually therefrom; substantially as described.

8. A new article of manufacture, comprising the herein-described ingot, composed of a metal core or mold piece and an inclosing mass of ingot metal, formed by inserting said core or mold piece in a mass of molten metal, allowing a quantity of the metal to solidify on said core and then withdrawing said core, with the resultant ingot formation thereon, before said mass, as a whole, solidifies, substantially as described.

9. The product of the herein-described process, comprising the central metal bar or mold-piece and the ingot-body formed thereon, by the insertion of said mold-piece in a mass of molten metal and permitting the molten metal to solidify on said core-piece until the resultant ingot reaches the desired dimensions, and then withdrawing the ingot from said mass while the latter is still molten.

10. The herein-described tapered ingot, comprising a core or mold piece, and the ingot-body formed thereon by inserting said core in a mass of molten metal and then gradually withdrawing the same from said mass, sufficient time being allowed for extensive solidification of the metal on said core, and the ingot being wholly withdrawn from said mass while the latter is still plastic, substantially as described.

11. A steel ingot having a core and a non-molded body portion coalesced thereon, such body portion being uniformly dense, homogeneous, and centrally free from segregated impurities.

In testimony whereof I have hereunto set my hand, this 7th day of October, 1898, at Minneapolis, Minnesota.

HORACE W. LASH.

In presence of—
C. G. HAWLEY,
M. E. GOOLEY.