F. G. GASCHE.

PROCESS FOR PERFECTING INGOTS.

APPLICATION FILED NOV. 14, 1916.

1,368,332. **Patented Feb. 15, 1921.**

2 SHEETS—SHEET 1.

Fig. 1.

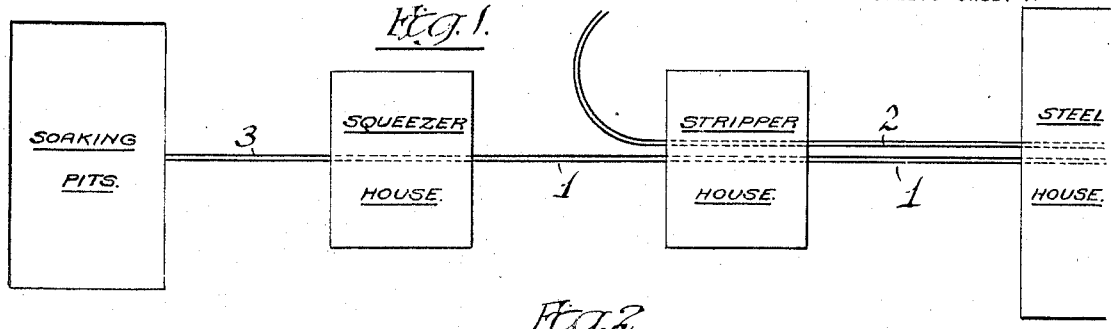


Fig. 2.

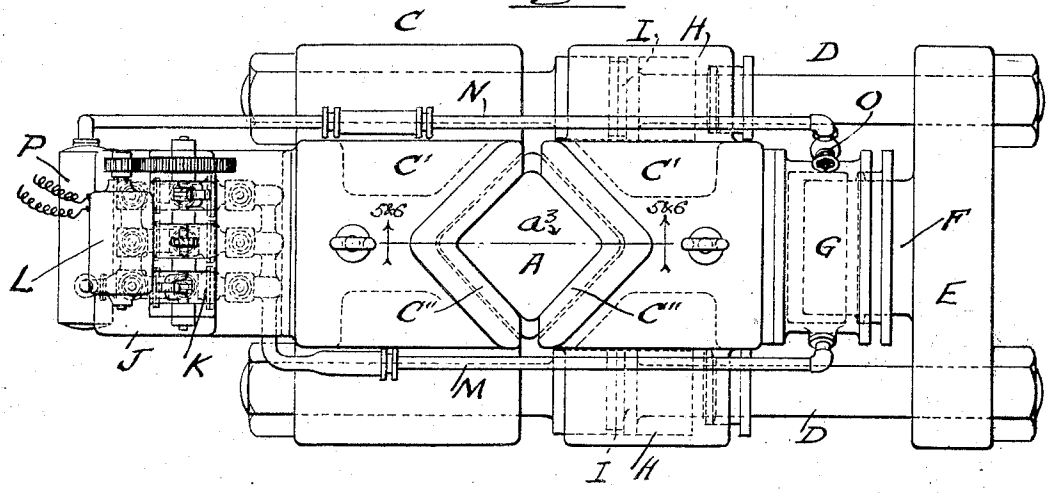
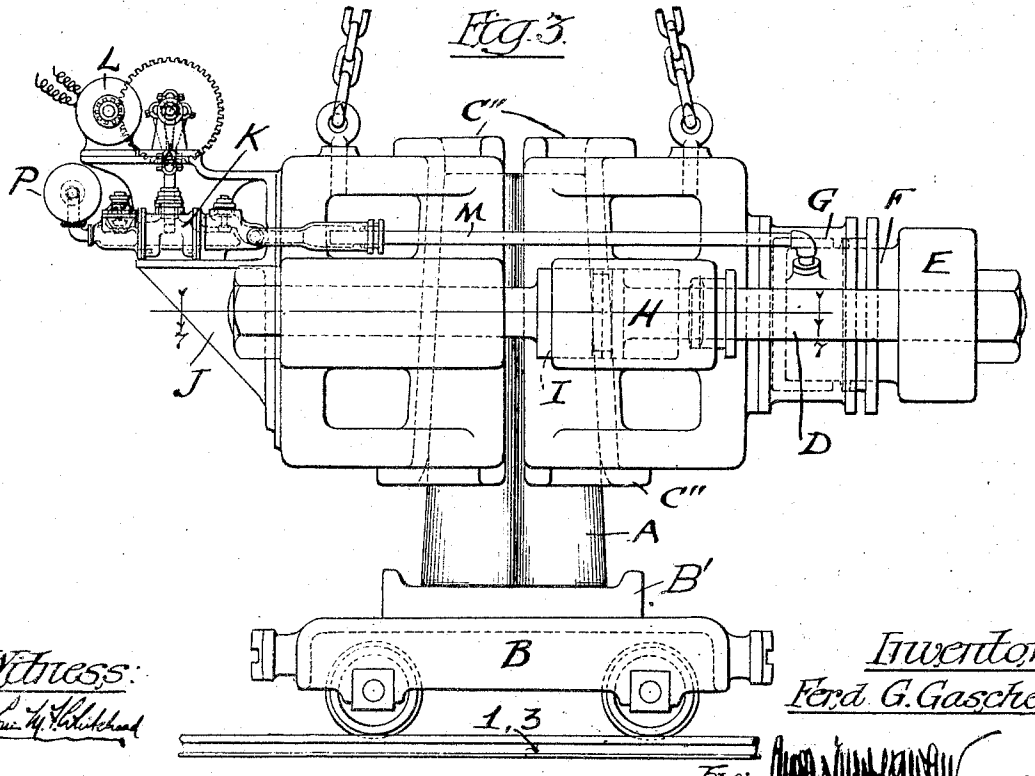


Fig. 3.



Witness:

Inventor
Ferd. G. Gasche

By: Atty.

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2 SHEETS—SHEET 2.

Fig. 4.

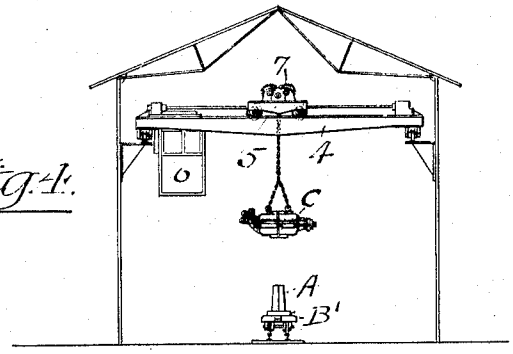


Fig. 5.

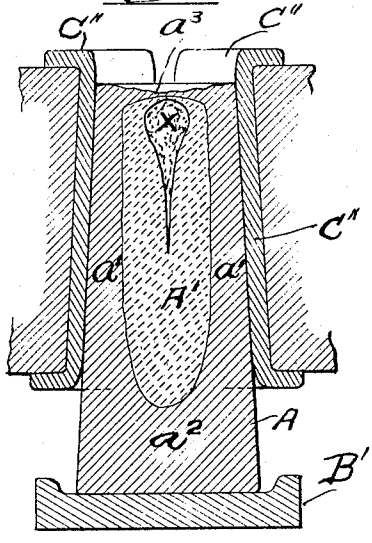


Fig. 6.

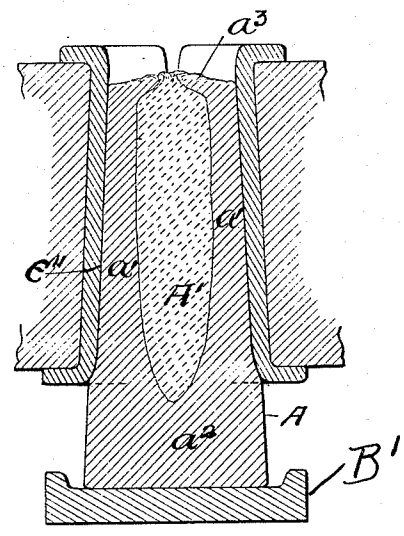
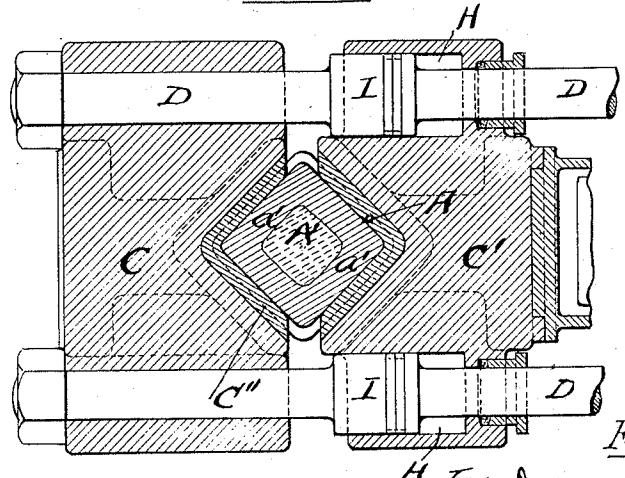


Fig. 7.



Witness:-
Geo. H. Whitehead

Inventor:-
Ferd. G. Gasche

Fig.-

Attys.

UNITED STATES PATENT OFFICE.

FERDINAND G. GASCHE, OF CHICAGO, ILLINOIS.

PROCESS FOR PERFECTING INGOTS.

1,368,332. Specification of Letters Patent. Patented Feb. 15, 1921.

Application filed November 14, 1916. Serial No. 131,261.

To all whom it may concern:

Be it known that I, FERDINAND G. GASCHE, a citizen of the United States, and a resident of Chicago, Cook county, Illinois, have invented a new, useful, and Improved Process for Perfecting Ingots, of which the following is a specification.

My invention relates to improvements in the art of, and machinery for use in, manufacturing metal ingots, and especially steel ingots, from which billets, bars, rods, rails, sheets, plates, and the like are rolled and forged.

While my invention might profitably be employed for and upon ingots of other metals, its primary intendment and its chief value appertain to the steel industry. I shall therefore describe my invention in that relation.

As well known, commercial steel ingots are poured and cast in molds, which generally are in the form of metal shells rectangular or square in cross section, and open at top and bottom. In practice the mold rests upon a metal plate which closes the bottom of the mold while it is being filled with molten steel, and until the steel has sufficiently solidified to retain the shape given it by the mold. The mold is then stripped, or drawn off, the ingot; and the latter is allowed to cool until ready for the soaking or heating pit; where the ingot by long exposure to heat slightly below the melting temperature is prepared for the rolls, hammers or presses in which the metal is finally reduced or worked to commercial form.

The molds are prepared by being placed upright on small cars or buggies. In that condition they are filled with molten steel at the converter house or the open hearth house, as the case may be. The filled molds are then drawn away to the open air, and stand until the ingot is solid enough to permit the stripping off or removal of the mold. This is done at the stripper house, and leaves the hot ingot standing upon its car.

To say that the steel cools and solidifies in the mold, is equivalent to saying that the steel shrinks therein. The first cooling obviously occurs in the metal which is in direct contact with the walls of the mold, and thus quite solid walls are soon formed. These are thicker at the bottom than at the sides and thinnest at the top. Being at the first quite thin the walls inclose a cubically greater portion of still molten steel. The shrinking of the relatively solid walls frees the ingot from too tight contact with the mold and enables the ultimate removal of the mold. Further radiation of heat and consequent further solidification of the central portion of the ingot gives the ingot walls strength to sustain themselves against the bursting tendency of the molten column within, and the pressure of contained gases, and then it is that the ingot is stripped of its mold.

The early formation of the form-retaining walls results in the complete inclosure of a large quantity of metal which has not yet solidified. And thus, there arises a difficulty which has long withstood solution. The self-sustaining walls, obviously, fix the dimensions of the hot ingot and hence the molten remainder must solidify within the relatively rigid envelop which they form. As stated, solidification is accompanied by shrinkage. As solidification progresses from the sides toward the center, it follows that the shrinkage of the metal at the center of the ingot takes effect outwardly, that is, away from the center; and, almost inevitably, a shrinkage cavity or "pipe" is formed in the upper central portion of the ingot. The appearance of the pipe is often accompanied by the appearance of blow holes in other parts of the ingot, these more especially depending upon the quantity of the gases which are occluded in the metal. The pipe is occupied by segregated gases and to the still greater detriment of the ingot, the walls of the pipe are covered with segregated impurities or metalloids which prevent the welding together of those walls in any later stage of manufacture.

So common is this piping of ingots that it is now the general practice to cut off and discard the metal comprising the top of every ingot, which metal, however, is usually cut off after the ingot is rolled into a bloom, billet or slab. The loss so suffered is rarely less than one-quarter of the whole weight of the ingot, and in exacting industries such as munition works the loss rises to a full third of the metal originally poured into the molds.

The object of my invention it to obviate these tremendous losses, and this I accom-

plish by subjecting the stripped ingot, still molten within, to external lateral compression, while in an upright position. I apply such pressure and movement until the molten contents of the ingot shell is displaced to the extent, at least, of the cubical contents of the pipe and blow holes in the ingot.

Displacement downwardly is prevented by the more solid and thicker wall constituting the bottom of the ingot. Hence, the displaced molten metal is forced toward the top; and the cavity or pipe, if any exists, is thus filled.

The pipe is confined to the top center of the ingot and the cubical capacity of the pipe (and blow holes) is relatively small. Hence, relatively slight compression of the ingot in the manner described is sufficient to effect the complete filling of the same. And thus the ingot, containing actually the same quantity of metal, is restored to solid or perfect condition, and the whole ingot, unreduced (not diminished in weight) may be safely passed to the soaking pit and mill.

The continuance of compression results in rupturing or bursting the top or thin crust of the ingot, letting out the gases, and evidenced by an overflow chiefly composed of the objectionable metalloids in a molten state. These being of a non-welding character are easily removed after the crust again solidifies, and before the ingot goes into the soaking pit, or more desirably the expelled impurities are removed by the action of the first rolls.

The bursting and overflow of the top crust is the signal for releasing the upright ingot from external pressure. The compressor, or as I have named it, the squeezer, is then removed and the hot perfected ingot is allowed to pass on to the soaking pit or mill.

At this point, I wish it understood that one of the advantages of my process resides in the important fact that by thus subjecting the almost, or even wholly, solidified hot ingot to compression, I readjust the metal and its internal stresses to such an extent that in many branches of the steel industry the expensive soaking process may be omitted and the hot ingot may pass directly to the manufacturing or fabricating mill. When desired a short reheating may be resorted to; but, as indicated in many cases the long soaking process is wholly unnecessary.

Another great advantage of my process is that the "bleeding" of the ingot is entirely avoided. The act of ridding the ingot of its segregated impurities is in no sense a bleeding of the ingot, for no valuable metal is lost. Furthermore, the compression of the molten central portion of the ingot tends to so far solidify it that the ingot, ordinarily, will not thereafter burst or bleed even when accidentally or intentionally thrown upon its side immediately after removal from the squeezer.

Accompanying this specification and forming part hereof are drawings which depict and explain the several steps of the above described process. The drawings illustrate the best apparatus that I have thus far devised for carrying out my process; this apparatus I also claim, as a part of my invention.

In said drawings:—Figure 1 is a diagram depicting the course of the ingot, from the steel house to the mill; Fig. 2 is a plan view of my preferably suspended novel ingot perfecter or squeezer; Fig. 3 is a side view thereof, in action upon an ingot; Fig. 4 is a small sectional elevation of the squeezer house, showing the squeezer suspended therein; Fig. 5 is a sectional view depicting the position of the squeezer jaws and the condition of the ingot, at the moment when the squeezer is about to act upon the latter viewed substantially along the line 5 & 6—5 & 6 of Fig. 2; Fig. 6 is a like view depicting, in a somewhat exaggerated degree, the action of the jaws and their metal displacing effect upon the hot ingot viewed substantially along the line 5 & 6—5 & 6; and Fig. 7 is a horizontal section on the line 7—7 of Fig. 3.

As will be readily understood, though the ingot is intensely hot and still molten within, a pressure mounting to many tons is required to compress the ingot walls. Hence all parts of the apparatus are heavy and very strong. The ingots reach the squeezer house upon trains of cars or buggies which cannot always be stopped at a given point, and I prefer not to attempt to make the squeezer a stationary object. Instead I prefer to make it movable. Not only do I gain the advantage of being able to treat successive ingots wherever they stop within the house, but also I am able to treat the ingots in any desired order. On viewing the incoming stripped ingots, it is not difficult to detect those which are less solid than others and I prefer to treat first the more solid ones, lest the solidification advance too far to allow the effective, though not actually essential, expulsion of the impurities in the manner before described. Because of its weight I find it necessary to suspend the squeezer and to move it through the agency of a traveling crane.

Fig. 1 is self-explanatory. The ingot cars move along the track 1. The ingots stand between the steel house and the stripper house upward of, or more than an hour, depending upon their size. They stop in the stripper house; and the molds are removed and placed on other cars by which the molds are reconveyed to the steel house over the return track 2. The distance between the

stripper house and the squeezer house need not to be so great as indicated by the diagram, Fig. 1; indeed the squeezer may be operated under the same roof with the stripper. Here operates the squeezer or ingot perfecter, and thence the cars move on over track 3, toward the soaking pits or the mill.

As indicated in Fig. 4 the stripper building is equipped with a traveling crane, 4, which may move longitudinally over the track 1, 3, and bears a trolley, 5, which is transversely movable. The operator is carried in the cage, 6, and from thence controls the movements of the trolley, 5, and of the hoisting engine or motor, 7, thereon. The stripped ingot, A, is shown on its car, B, resting upon supporting plate or stool B'. Above it, suspended from the crane trolley, is the squeezer, C; which, obviously, may be raised, lowered, and moved both longitudinally and transversely by means of the traveling crane. The squeezer, as presently will be explained, is essentially two normally open jaws together containing a space large enough to admit the upright ingot. On the arrival of an ingot in the stripper house, the open squeezer is first positioned directly above it, and is then lowered until the top of the ingot appears through the top of the squeezer. Thereupon, power is applied to close the squeezer jaws upon the ingot to compress it. After the compressing action, the squeezer is opened and raised clear of the ingot, to permit the latter to be drawn away. As before stated, any one of the row of ingots in the house may be thus treated, irrespective of the order of their entrance.

My novel squeezer, though large and heavy, is of very simple construction. Its chief elements are the two heavy jaws or clamps, C', which bear on the sides of the ingot, and preferably over a large part of the side surfaces thereof. These clamps reciprocate and preferably have a motion along the diagonal of a square or rectangular ingot, and when in action confine nearly all of the plastic surfaces thereof against the bursting tendency induced by a liquid interior under compression. In their completed form it is contemplated that the confining surfaces of the jaws, C', shall be constituted by removable gibs or plates, C'', capable of adaptation to any special contour or form of ingot which is to be compressed. These liners or gibs are clearly shown in Figs. 5, 6 and 7. The jaws are held in proper relation and are guided by heavy connecting or tie rods, D. At one end, the rods, D, are connected by a yoke, E. This in turn is connected to or formed with a large plunger, F. The latter works in a cylinder, G, secured on the adjacent jaw, C'. By injecting water or oil under heavy pressure, the plunger may be expelled from the cylinder, and by that action the jaws, C' C', are closed together to squeeze the ingot which they contain. A pair of "pull back" cylinders, H, on the jaw, which carries the cylinder, G, co-act with pistons, I, on the tie rods, D, and are utilized to forcibly separate the jaws, C' C', as required to release an ingot which has been compressed. Most conveniently, the liquid pressure applying mechanism is arranged upon a bracket, J, on the end opposite cylinder, G. This mechanism may comprise a relatively small hydraulic pump, K, and an electric motor, L, therefor. A telescoping pipe, M, leads from the pump to the cylinder, G, and may be in open connection therewith. A second telescoping pipe, N, contains a valve, O, adjacent to the cylinder, G, and returns from said cylinder to a surge tank, P. The latter is supported on the bracket, J, and is the source of liquid supply for the pump, K. The advantage of this mechanism is that it is subject to easy electrical control, and obviates the necessity for heavy flexible pipe connections, which would be required if the squeezer were operated from a stationary pump or pressure reservoir. As shown, the tie rods are provided with nuts at their ends whereby the spaced relation of the jaws on the tie rods may be varied, thus enabling the length of movement of the jaws to be changed when necessary.

The operating position of the squeezer is accurately shown in Fig. 3, with the exception that, for clear illustration, the carrier car is shown paralleling the longitudinal axis of the squeezer, whereas in usual practice the longitudinal axis of the squeezer should be transverse to the track 3. It will be noted that I prefer that the ingot shall occupy a diagonal position on the car rather than its usual square position thereon. This is to enable the use of the very simple form of squeezer jaws which is shown in Fig. 2, and which best adapts itself to the covering of a maximum area of the ingot with the least tendency to stick when the jaws are released and elevated.

From the foregoing description it will be understood that the squeezer is lowered into the position of Fig. 3, while open, and is then closed against the ingot by means of the hydraulic mechanism which the squeezer carries.

Referring now to Figs. 5, 6 and 7, it will be seen that I have therein represented the squeezer in operation upon an ingot which contains a central pipe or cavity, X. In Fig. 5 the squeezer jaws, C' C', are shown as at the instant when they begin to press upon the side walls a' of the ingot A. At that moment, the central portion A' of the ingot is still molten or not completely solidified, and within the body of molten metal is found the shrinkage cavity, X. The bottom

a^2 of the ingot, as will be noted, is much thicker than the top crust, a^3. This is because the heat of the ingot tends to prevent the solidification of the top of the ingot. By lateral compression, amounting in practice to approximately one-eighth of an inch, on all surfaces within the range of the jaws, the upper portion of the ingot is so compressed as to displace the molten or less solid central portion A', and thus the ingot is brought to the stage indicated in Fig. 6; that is, the molten metal is placed under such pressure that it elevates and finally bursts through the top crust a^3. Obviously, the gases are thereby vented and the still liquid metalloids are floated and discharged upon the top of the ingot. It will be understood that the ingot walls, which before were of sufficient strength to retain their form, are further strengthened by the compression of the ingot. Therefore the jaws may be immediately released, once the crust has been broken, without danger of a return or sinking of the metal within the ingot. Upon releasing the jaws, I immediately elevate them, and thus completely free the ingot, so that it may be carried away from the squeezer house to the mill. The crust reforms very quickly after the release of the ingot, and after leaving the squeezer house it may be handled with the same freedom, and indeed greater freedom, than is the case with an ingot produced in the old manner.

In saying that the desired result may be accomplished by decreasing the diameter of the ingot to the extent of one-fourth of an inch, I do not wish it understood that that particular amount of compression is an essential of my invention; on the contrary it will be apparent that the degree of compression should in all cases substantially equal the cubic contents of the cavity or cavities within the ingot under treatment. I prefer that this shall be ascertained by squeezing the ingot until its top crust bursts, and overflows slightly, and that compression shall cease at that moment. This is the safer guide, and should be followed in practice. To continue compression after the bursting of the crust would be likely to result in a waste of metal, and to stop short of the bursting of the crust would leave doubt as to the presence or non-presence of an internal cavity.

I have not deemed it necessary to illustrate the same, but my invention comprehends the carrying out of the described process by means of preferably vertical-pass rolls which are collared or deeply V cut in order that they may restrain all sides of the ingot while progressively compressing the ingot from bottom to top. The crust bursting point is not so readily regulated in such rolls and some waste of metal is likely to result from their employment; hence I much prefer the reciprocating squeezer above detailed, the same being subject to close and easy regulation by the operator who stands in view of the ingot top.

The use of my process does not entail a heavy outlay for machinery and as the operation of the squeezer is neither expensive nor difficult to those skilled in the art, it will be apparent that the invention effects a tremendous saving in the steel industry inasmuch as it enables every ingot, and all of every ingot, to be utilized.

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

1. The herein described improvement primarily in the manufacture of steel which consists in placing the molten metal in a mold arranged in a predetermined position, moving the mold and metal to a position spaced from the pouring position and there stripping the mold from the ingot, thence moving the ingot on its stool to a different position and there laterally compressing portions of the sides of the ingot to the point of rupturing its crust, and thereafter moving the ingot to soaking pits spaced from the squeezing position.

2. The herein described improvement primarily in the manufacture of steel which consists in pouring the molten metal into a mold mounted upon a car, moving the car and mold to a position spaced from the pouring position, and there removing the mold from the partially solidified ingot, thence moving the car and ingot resting upon its stool to another spaced position, and there subjecting the upper portion of the ingot to lateral compression to an extent sufficient to rupture its top, and thereafter moving the ingot to soaking pits spaced from the squeezing position.

3. The herein described improvements, primarily in the manufacture of steel which consists in pouring the molten metal into a mold, resting upon a metal supporting plate, stripping the mold from the ingot when the ingot has solidified sufficiently to sustain itself on said metal supporting plate, and compressing said ingot while resting upon its supporting plate, in a substantially complete encompassing manner cross-sectionally considered, to an extent sufficient to rupture its top and expel the impurities.

4. The herein described improvement, primarily in the manufacture of steel which consists in substantially completely encompassing the upper portion of a stripped hot ingot while resting on its metal supporting plate and in laterally compressing the ingot, through the medium of said encompassing means, to the point of rupturing its top.

5. The herein described improvement, primarily in the manufacture of steel which consists in treating a hot ingot, resting

upon the metal supporting plate upon which it is poured, by permitting the ingot to solidify to an extent to be self supporting on said metal plate, and in then compressing the upper side superficial portions of the ingot to the point of rupturing its top crust and expelling the segregated impurities while said ingot is resting upon its supporting plate.

In testimony whereof, I have hereunto set my hand this 7th day of November, 1916.

FERDINAND G. GASCHE.