No. 653,133. Patented July 3, 1900.

J. H. CARPENTER.

APPARATUS FOR TREATING INGOTS OF STEEL.

(Application filed Mar. 14, 1895.)

(No Model.)

Fig. 1.

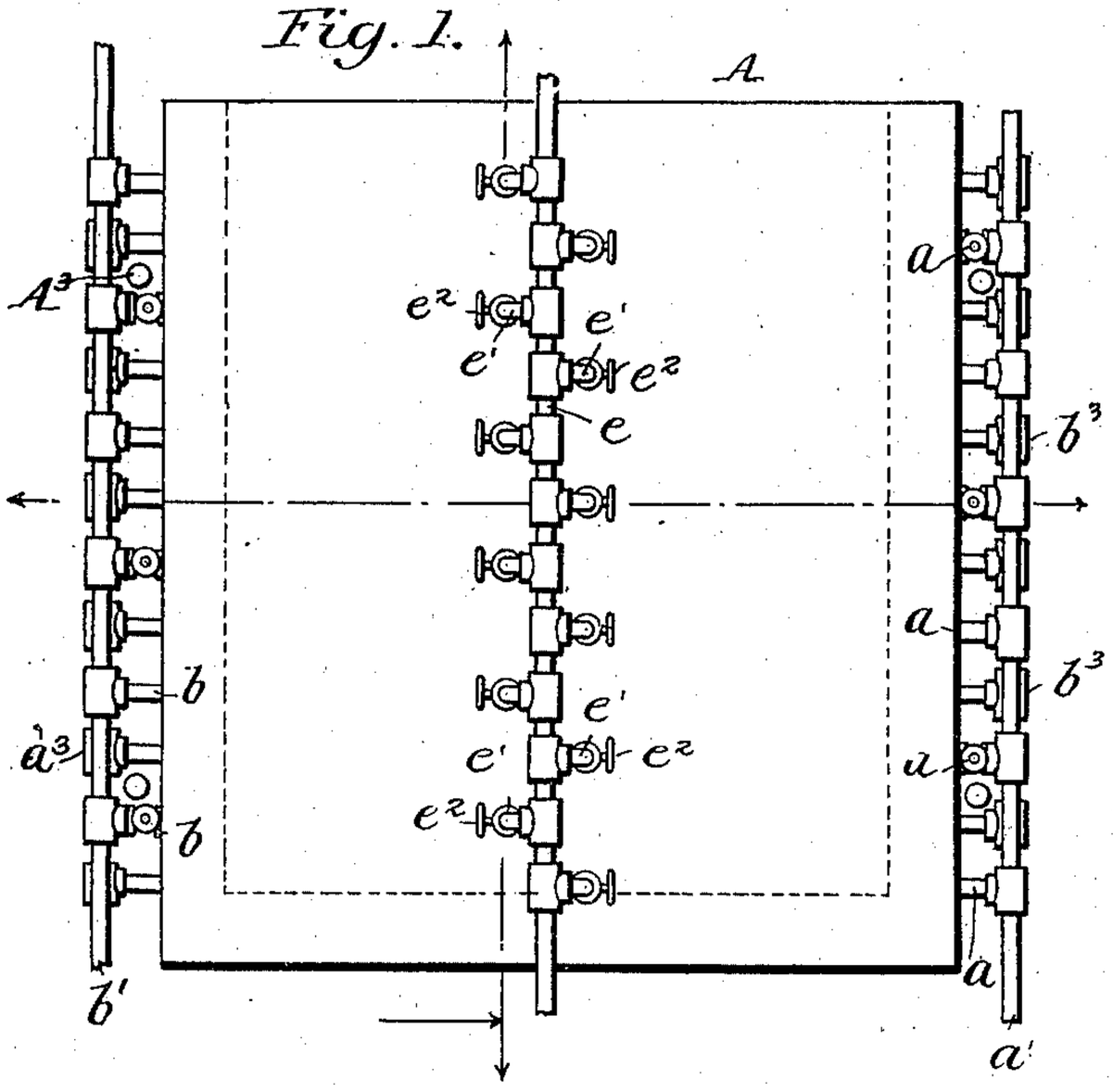


Fig. 2

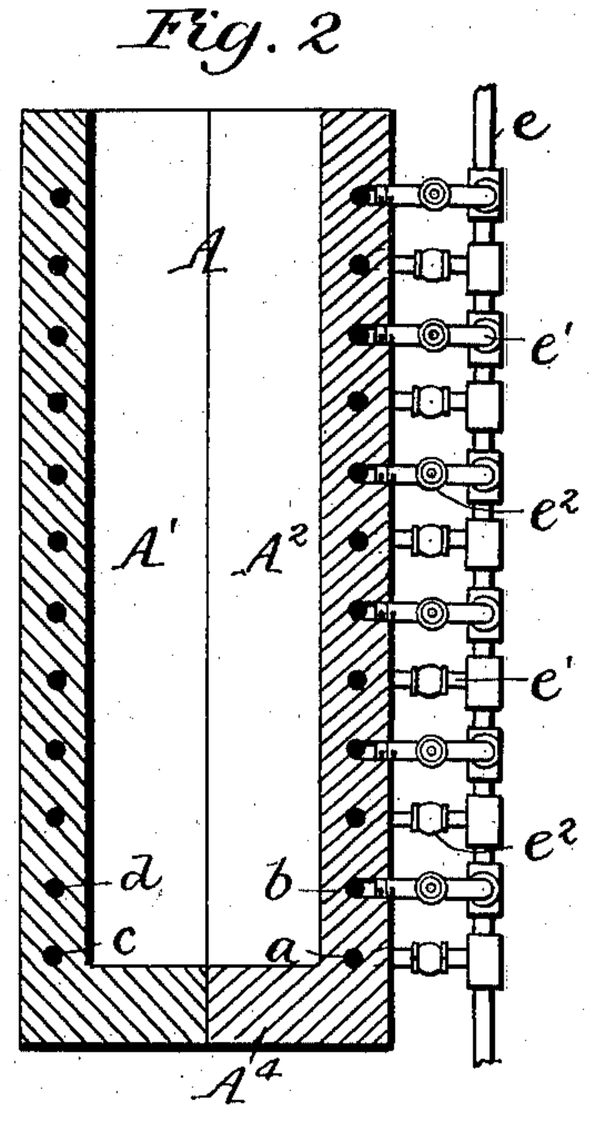


Fig. 3.

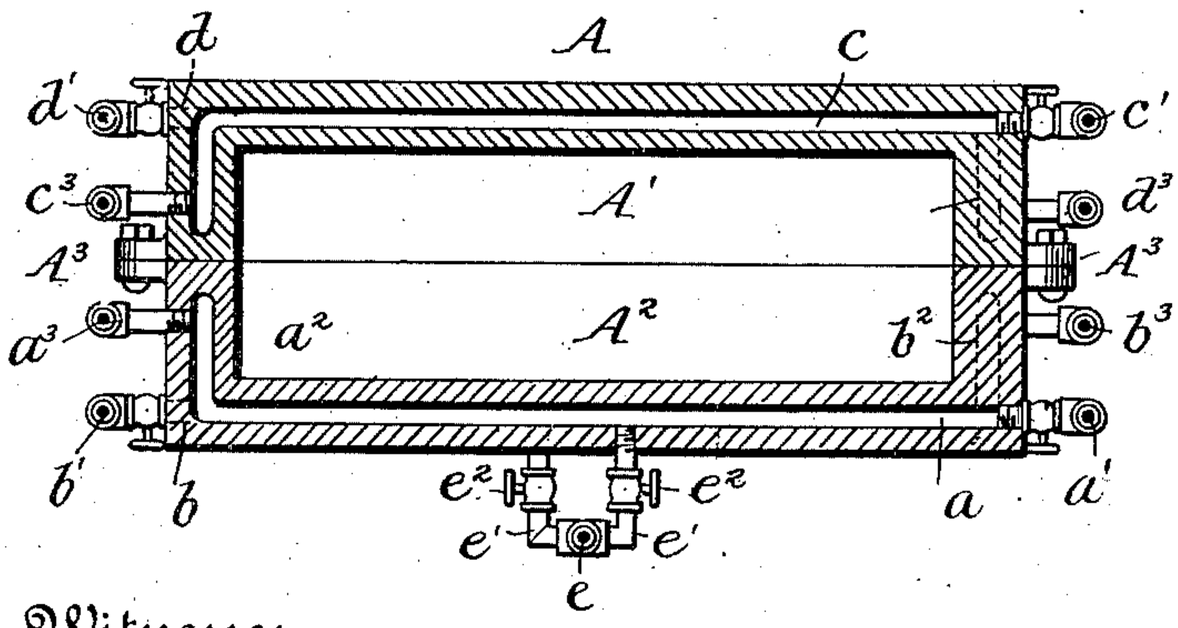
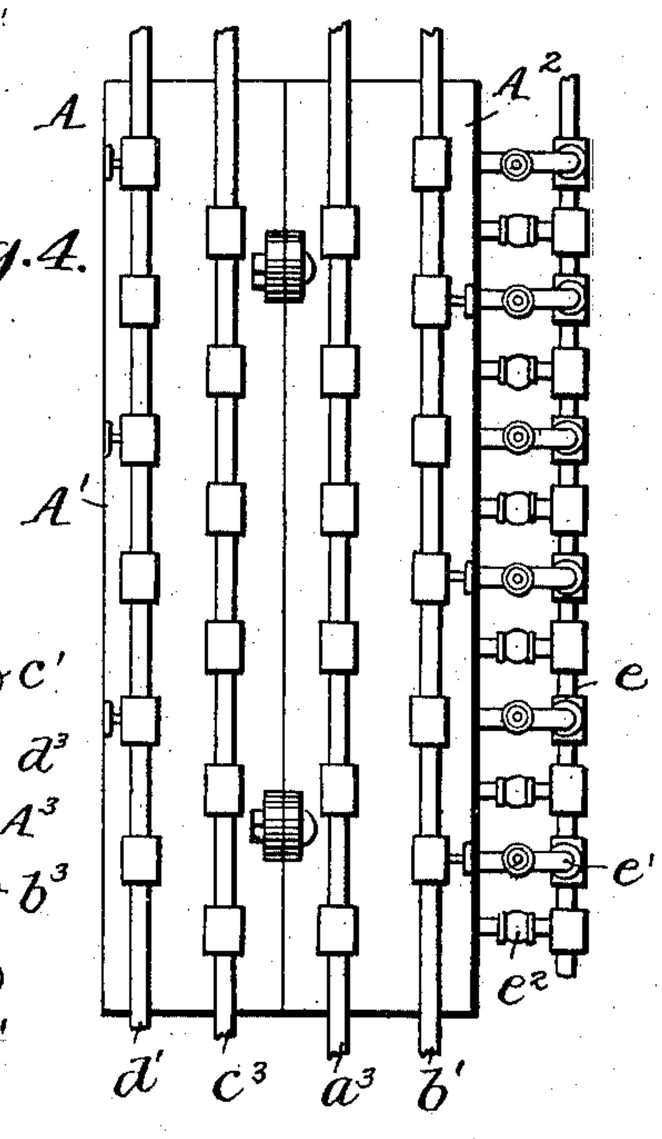


Fig. 4.



Witnesses
Jno. G. Hinkel
S. A. Fairgrieve

Inventor
James H. Carpenter
by Fowler Freeman
Attorneys

UNITED STATES PATENT OFFICE.

JAMES HENRY CARPENTER, OF READING, PENNSYLVANIA, ASSIGNOR TO THE CARPENTER STEEL COMPANY, OF NEW JERSEY.

APPARATUS FOR TREATING INGOTS OF STEEL.

SPECIFICATION forming part of Letters Patent No. 653,133, dated July 3, 1900.

Application filed March 14, 1895. Serial No. 541,739. (No model.)

To all whom it may concern:

Be it known that I, JAMES HENRY CARPENTER, a citizen of the United States, residing at Reading, in the county of Berks and State of Pennsylvania, have invented certain new and useful Improvements in Apparatus for Treating Ingots of Steel, of which the following is a specification.

My invention relates to apparatus for treating ingots of steel; and it has for its main object to improve and simplify such apparatus; and it consists in the various features of invention, substantially as hereinafter more particularly pointed out.

In the accompanying drawings I have illustrated an apparatus for treating ingots of steel, and in which—

Figure 1 is a side view of a mold. Fig. 2 is a vertical transverse section of the same. Fig. 3 is a horizontal sectional view, and Fig. 4 is an end view thereof.

Among the particular objects of my invention is the production of plates of steel adapted to serve as armor-plates for war-vessels, forts, &c., or parts of machinery or other devices which must be of harder metal on one side than on the other, and while my invention is especially adapted for this purpose it can of course be used in whole or in part for other purposes; but I will describe it in this connection.

Referring to the drawings, A represents a mold of suitable size, shape, and construction for forming the ingot of steel, and in the present instance I have shown it as comprising two parts A' A^2, united together by flanges A^3 and suitable bolts or connections in a well-known manner, although, of course, the mold may be made in a single piece, depending upon the size and other considerations. Moreover, I have shown this mold as having a bottom A^4, although in some instances it is preferable to make them without bottoms, a piece of cast-iron plate or other material being used, so that the completed ingot may be dropped out from the mold at the bottom or the mold withdrawn from the ingot by suitable machinery. In other words, the particular form and shape of the mold will depend very largely upon the character of the ingot, and any of the usual and well-known forms may be used, and the ingot may be of any desired shape, either having straight or curved sides or otherwise, according to the ultimate form in which the article is to be made.

I am aware that heretofore it has been proposed to chill plates and other articles by providing passages for water or other fluids on one side, and I do not claim this feature broadly; but I provide means whereby one surface of the ingot can be thoroughly and evenly chilled throughout its extent and the other surface may be maintained relatively warm, so as not to take the chill and so as to prevent the setting of the metal too quickly, in order that the crystallization produced by the chill may extend to the greatest degree into the mass of the ingot. Thus the mold is provided with openings or with pipes embedded therein having suitable connections by means of which one face of the ingot may be chilled, while the other may be kept hot and prevented from chilling, and I have shown in the drawings a series of pipes a b alternately arranged in the mold, the pipes a being connected on one side, as by a pipe a', and at the other side preferably being carried or bent round the end of the mold, as at a^2, and being connected to a pipe a^3, while the pipes b are similarly connected at one end to a pipe b' and are carried or bent around the opposite end of the mold, as at b^2, and are connected to a pipe b^3. The other part of the mold A' is similarly provided with alternate rows of pipes c d, which may be similarly connected at their outer ends, as at c' c^3 and d' d^3.

The pipes a' b' may be suitably connected with a source of supply of fluid, so that the fluid shall enter the alternate pipes at one end and pass through and out the other end, thus permitting the cooling liquids to enter at both ends of the mold, so as to make the distribution of temperature even throughout the face of the ingot. As the cooling liquid, passing from one side to the other of the mold, will become more or less heated before it reaches its exit from the tube, I provide another pipe e, which is preferably arranged midway between the terminals of the pipes and which is provided with branches e', connecting with all of the pipes a b, and by this

means cooling liquids can be supplied along the central part of the ingot, accelerating the flow of fluids passing through the pipes and at the same time reducing their temperature, as they have become heated, and tending to more evenly and thoroughly cool or chill the whole surface of the plate, thus preventing the edges or any part of the ingot becoming chilled or cooled before the central portion is chilled, which might tend to warp or distort the plate or produce unevenness in the chill, which would tend to cause the surface to split or flake off or become cracked or otherwise defective.

The pipes *c' d'* may be connected with a source of heated fluid, such as hot water or oil, which may be passed through the pipes in opposite directions, so that this face of the ingot will be maintained in a molten condition for a longer time than usual, and thus the crystallization produced by the chill can extend deeper into the ingot and form a more perfect crystalline surface, and at the same time the rear surface of the ingot is left in a comparatively-soft condition. The fluid, as oil, may be passed through the pipes in a hot condition, or the pipes may be filled with oil or other heat-retaining substance, such as charcoal, and the objects of my invention be carried out to a greater or less extent, the essential feature being that while cooling or chilling fluids are applied uniformly to one surface of the ingot heat retaining or producing materials are provided for the other face of the ingot.

The pipes *a' b'* are provided with suitable connections, and the pipe *e* and its connections may be so arranged that the cooling liquid may be caused to flow in any desired manner. Thus, for instance, in some cases it is desirable that the ingot should cool faster at the center than at the edges, and to accomplish this the cooling fluids may be passed directly through the pipe *e* at the center of the mold and flow outwardly therefrom toward the discharge-openings, and, if desired, the connections may be such that the fluid will flow both ways from the central connection *e'* through either or both of the pipes *a b*, so that both of the ends of said pipes will become discharge ends. Furthermore, it is desirable that one portion of the face shall be chilled more quickly than the other, and by providing suitable cocks or stops, as e^2, the fluid may flow from the center toward one end and not toward the other, and of course it will be understood that at the same time the fluid may be caused to flow through the pipes *a* alone or *b* alone, or alternately, or otherwise, according to the requirements of any particular case. In other words, by this arrangement I am enabled to produce a practically-uniform cooling of the entire surface of the ingot or may cool one portion faster than the other, or it can be cooled in lines or sections corresponding to any one or more of the pipes, and I have found by this construction that any desired effects on the surface of the plate can be produced.

With this apparatus I have found it practicable to produce a chill or crystallization of one surface of the plate to almost any desired depth, as the chilling process may be completely under the control of the operator, and I further find that plates thus treated show the highest physical tests as to elongation, hardness, and tensile strength of any with which I am familiar. When the ingot has thus been treated as desired, it can be forged, rolled, or otherwise put into its ultimate form or condition for use, and I have demonstrated the fact that this subsequent treatment does not interfere with the relative hardness and increased resistance of the plate gained by the chilling treatment to the ingot and that a plate thus obtained has a greater depth of crystallization and greater hardness than one hardened on the surface, as steel is now usually treated for this purpose, the forging of the steel ingot formed in my mold seeming to increase and intensify its desirable qualities, than otherwise. Moreover, by this process the ingots after being chilled can be rolled or forged into thin plates, preserving the increased resistance gained by the treatment, and it is well known that these thin plates cannot be effectually treated by the ordinary methods for hardening without buckling or bending out of the required shape. Moreover, I find that this is a special advantage in making large plates, too large to be effectually treated by the ordinary hardening process because of their bulk, as by the use of proper molds ingots can be treated in the manner desired and the ingots afterward rolled or shaped without interfering with the hardening process. Furthermore, this process largely reduces the expense of producing armor-plate, as the plates need no carbonizing treatment by cementation processes, which are expensive and difficult. Thus by treating or chilling one part or one side of the ingot of steel while it is being cast and retarding the cooling of the other side I am enabled to produce something more than the usual superficial chilling, as the chilling extends to a great depth, producing perfect crystallization extending directly into the softer portions of the ingot, and the chilled side is harder than that produced by the ordinary methods, while the soft side may be softer, and the subsequent rolling or forging in no way interferes with this condition.

What I claim is—

1. A mold for treating ingots of cast-steel, provided with two series of passages extending alternately from opposite sides of the mold, connections with a source of cooling liquid for each series, and a centrally-arranged supply-pipe having connections with the alternate passages, substantially as described.

2. A mold for treating ingots of cast-steel, provided with two series of passages extending alternately from opposite sides of the

mold across one face thereof and each series having passages extending partially across one end, and a supply and discharge pipe connected to each series of passages at opposite ends thereof, substantially as described.

3. A mold for treating ingots of cast-steel, provided with two series of passages extending alternately from opposite sides of the mold across one face thereof and each series having passages extending partially across one end, a supply and discharge pipe for each series at opposite ends thereof, and an intermediate supply-pipe connected to all the passages, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

JAMES HENRY CARPENTER.

Witnesses:
A. N. DOBSON,
W. CLARENCE DUVALL.