(No Model.)

# C. A. MARSHALL.

## IRON OR STEEL INGOT.

No. 377,316. Patented Jan. 31, 1888.

Fig. 2.

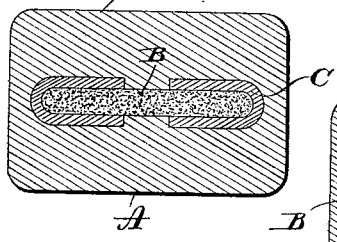



Fig. 1.

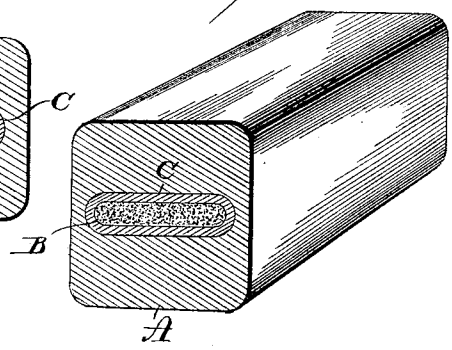



Fig. 3.

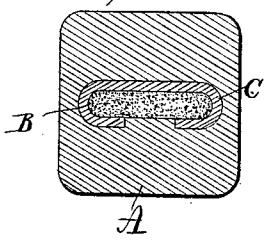



Fig. 4.

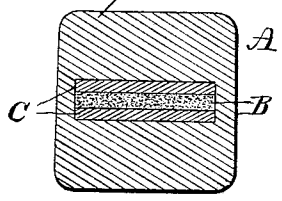



Fig. 6.

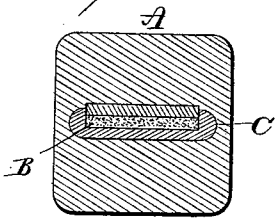



Fig. 5.

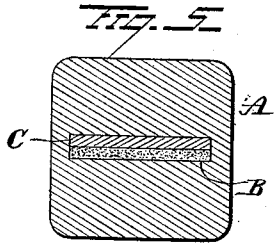



Fig. 7.

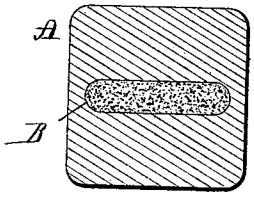



Fig. 8.

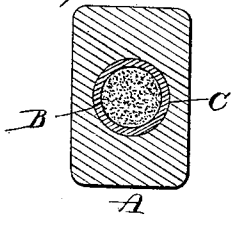



Fig. 9.

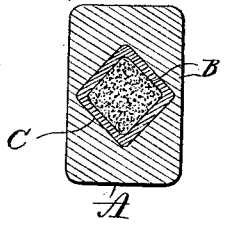
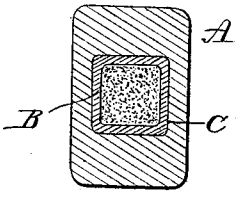



Fig. 10.




WITNESSES

E. A. Nottingham

M. E. Jones

INVENTOR

Chas. A. Marshall.

By H. A. Seymour.

Attorney.

N. PETERS, Photo-Lithographer, Washington, D. C.

# UNITED STATES PATENT OFFICE.

CHARLES A. MARSHALL, OF JOHNSTOWN, PENNSYLVANIA.

## IRON OR STEEL INGOT.

SPECIFICATION forming part of Letters Patent No. 377,316, dated January 31, 1888.

Application filed March 5, 1886. Serial No. 194,132. (No model.)

*To all whom it may concern:*

Be it known that I, CHARLES A. MARSHALL, of Johnstown, in the county of Cambria and State of Pennsylvania, have invented certain new and useful Improvements in Iron or Steel Ingots; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to an improvement in iron or steel ingots, and more particularly to iron or steel ingots adapted to be worked into tubes or tubular structures.

The object is to provide an ingot which shall be capable of being "edge" and "flat" rolled into a tube-blank without danger of welding.

A further object is to provide an ingot having a dense, smooth, and uniform interior surface not liable to lose its integrity and regularity when rolled into a blank.

With these ends in view my invention consists in certain features of construction and combinations of parts, as will be hereinafter described, and pointed out in the claims.

In the accompanying drawings, Figure 1 represents an ingot provided with a core of refractory material surrounded by a tube or lining of previously-worked metal. Figs. 2, 3, 4, and 5 are cross-sections of ingots provided with a core of refractory material partially surrounded by a lining of previously-worked metal. Fig. 6 represents a cross-section of an ingot provided with a core of refractory material surrounded by a sectional lining of previously-worked metal. Fig. 7 represents a cross-section of an ingot provided with a core of refractory material, the lining of previously-worked metal being omitted; and Figs. 8, 9, and 10 are cross-sections of an ingot provided, respectively, with round, square, and diamond-shaped cores of refractory material.

A represents the ingot provided with the core B of refractory material.

I prefer to cast the ingots with the core inclosed at the ends by ingot metal. When this is not done, the ends may be plugged with metal or forged together, or closed in any way that will prevent escape of the refractory material during the first few passes. By my method of flat and edge rolling the ingot or blank the tendency of the refractory material to escape at the ends is soon neutralized by the friction of the particles one with another and with the interior surface of blank.

When working with my preferred form of ingot, the matter of closing the ends is of minor importance, except in the case of the edge thickness being very small, when the solid ends aid to prevent splitting. Other forms of ingot I work so as to reduce the core to the form of a thin layer as soon as practicable.

The ingot is formed by supporting the core B in a mold and casting the ingot metal about it, and when so cast and the ends closed is ready to be operated upon by external pressure, either the hammer or the rolls, and more particularly is it adapted to be worked by what is commonly called "flat" and "edge" rolling.

The core of refractory material is preferably in a powdered or finely-granulated condition, or such as may be readily reduced to a powdered or finely-granulated condition by external pressure on the ingot. It may consist of powdered or finely-divided graphite mixed with dry finely-divided fire-brick; or, when the core B is used without its casing of previously-worked metal, it might consist of powdered or finely-divided graphite held in a coherent mass by damp fire-clay mixed sparingly therewith and subsequently baked to expel the moisture. This will form a core sufficiently rigid to retain its form in casting, but will readily disintegrate when external pressure is applied. A coherent surface formed on the core might also be sufficient; or a shell or casing of some material other than the core material might be employed to retain the core in shape, provided the casing be such that it would not become obstructive in the subsequent rolling of the metal or materially damage the interior surface of the metal while being worked.

In practice I find it preferable to incase the refractory material, either wholly or partially, by a thin layer of previously-worked metal, which may be referred to hereinafter as "superior metal." This is denoted in the several figures by the letter C. It preferably consists of wrought metal, iron, or steel, worked to give it a smooth surface and freed as far as

possible from "redshortness." Its outer surface, or that with which the ingot metal comes in contact, is made clear, and thus free to weld perfectly with the ingot metal when the latter is cast around it.

My preferred form of superior-metal lining or core-casing is that shown in Fig. 1. It consists of a primitive tube of superior metal of flat oval shape in cross-section, and is filled with a core of loose or powdered refractory material, B.

The flat oval or transversely-oblong shape of the core-cavity and the lesser thickness of the ingot metal at diametrically-opposite points of the cavity are matters of very great practical importance, since an ingot with the thickness of metal at the extremities of the longer transverse axis of the cavity, bearing a certain ratio of "lesser inequality" to the thickness of metal at the extremities of the shorter transverse axis of the cavity, may be reduced to the proper thickness to be opened into a cylindrical tube by flat rolling alone, or by flat rolling combined with a minimum amount of edge rolling to secure finished edges. Furthermore, the flattened upper and lower walls of the core-cavity receive the external pressure exerted by the rolls more directly, and the tendency to spread laterally, which occurs where the cavity is of a circular form, is in a great measure or entirely avoided. The ingot as thus constituted becomes an article of manufacture, and is particularly well adapted to flat and edge rolling into tube-blanks for the following reasons.

The loose or disintegrable refractory material forming the core will yield to the various pressures, disposing itself regularly throughout the lengthening cavity and allowing the metal to readily assume the desired shapes, and at the same time will effectually prevent the wall of the cavity from welding to itself, and, furthermore, may be removed with the least possible trouble.

When the powdered refractory material is inclosed in the casing of superior metal, the weld, which has been partially or completely effected in the casting, is completed or improved by the external pressure, and the interior of the primitive tube or casing having been previously worked to a smooth surface, furnishes a smooth interior for the tube-blank and completed tube, and serves to prevent the ingot from splitting while being worked.

The several modifications shown in the drawings are introduced to set forth some of the many forms in which the ingot-lining or core-casing of superior metal may be employed. Whether the complete primitive tube, the partial tube, the flat strip, or no metallic lining whatever should be used, naturally depends upon the purpose for which the completed tube is to be used and whether or not a smooth interior surface is required. In the tubular column, for example, the condition of the interior surface would be of comparatively little consequence; but in the finer qualities of steel tubing it would be a very great advantage to have a smooth and regular interior surface.

The process or method of making the herein-described ingot forms no part of my present invention, the same being the subject-matter of an application filed December 15, 1885, Serial No. 185,719, and now pending.

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

1. An ingot having a cavity filled with yielding refractory material, the ingot metal being thinner at two diametrically-opposite points of the cavity than at intermediate points, substantially as set forth.

2. An ingot having a cavity lined with superior metal, the ingot metal being thinner at two diametrically-opposite points of the cavity than at intermediate points, substantially as set forth.

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

CHAS. A. MARSHALL.

Witnesses:
E. C. SEWARD,
GEO. F. DOWNING.