E. WHEELER.

Working Cast Malleable Metal.

No. 213,856. **Patented April 1, 1879.**

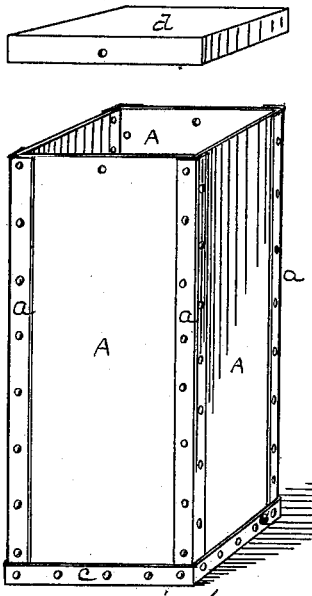

Fig. 1.

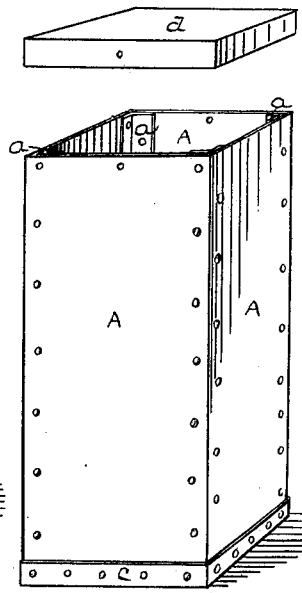

Fig. 2

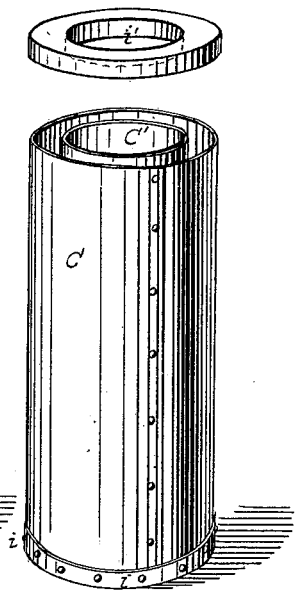

Fig. 7.

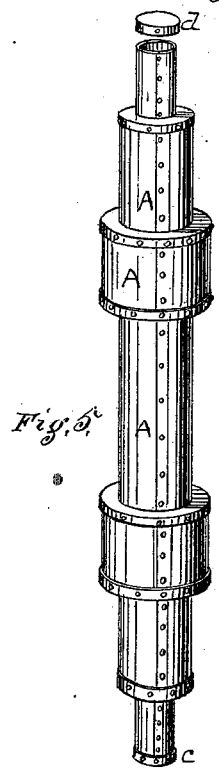

Fig. 5.

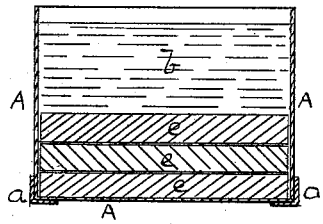

Fig. 3.

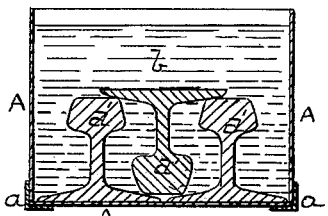

Fig. 4.

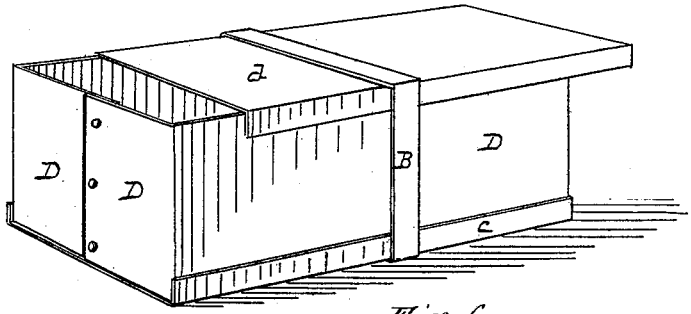

Fig. 6.

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UNITED STATES PATENT OFFICE.

ELBRIDGE WHEELER, OF PHILADELPHIA, PENNSYLVANIA.

IMPROVEMENT IN WORKING CAST MALLEABLE METALS.

Specification forming part of Letters Patent No. **213,856**, dated April 1, 1879; application filed November 16, 1878.

To all whom it may concern:

Be it known that I, ELBRIDGE WHEELER, of Philadelphia, county of Philadelphia, State of Pennsylvania, have invented or discovered a new and useful Improvement in Working Cast Malleable Metals; and I do hereby declare the following to be a full, clear, concise, and exact description thereof, reference being had to the accompanying drawings, making a part of this specification, in which like letters indicate like parts.

My present invention relates to means and methods of working homogeneous iron and steel, or those grades of iron and steel which are reduced to a fluid condition during their course of treatment in being converted directly or indirectly from pig-iron—such for example, as crucible and Bessemer steel, Bessemer iron, or homogeneous iron or steel made by the "Siemens-Martin open-hearth process;" and my improvement contemplates the working or reducing of such materials either alone or in connection with wrought iron or steel which has been produced by any other process or processes, whereby a product is obtained which is either homogeneous throughout or a product known to the trade as "combination" iron or steel—that is, homogeneous in part and fibrous or of other character in part, or homogeneous throughout, but composed of different grades of metal, one part or portion of the product being high in carbon and another part being low in carbon; or these different grades of homogeneous metal may be treated or worked along with fibrous iron or steel, giving a product which, though one body, yet possesses in different parts some or all the characteristic features mentioned.

In working such metals in accordance with my invention, I provide a mold or casing of wrought-iron or other malleable metal suitable for the purpose, the form being adapted to the form of the product required. The thickness of materials of which the mold is made must be determined largely by the nature of the product, as will hereinafter appear. In any case the material must be strong enough, and the joints, angles, or corners of the mold must be tight enough, to retain the molten contents, not only when it is poured into the mold, but also during subsequent treatment or working.

Such a mold being provided it is filled as follows, one end or side being made removable for the purpose, or a gate or other suitable opening being made: If a product is required having substantially a uniform or common quality throughout its mass, the mold is filled with the desired material while molten or in a liquid condition by pouring or in other convenient way. It is not essential that the mold be filled at one pouring or while all the contents of the mold is liquid, as metal may be poured in from time to time, as convenience may suggest, until the desired quantity is obtained.

Again, if it is desired to mingle a certain proportion of scrap iron or steel, whether fibrous or cast along with homogeneous metal, such iron or steel may be first arranged in the mold as desired, and the molten metal afterward poured in, the molten metal filling the interstices between the solid materials, and further filling the mold to the desired extent; or it may be partially filled with homogeneous or molten metal of one grade as to carbon, and subsequently metal of another grade added, thus forming an ingot in which different grades of metal are arranged either miscellaneously or regularly in separate layers or divisions, the arrangement depending, of course, upon the character of the product required.

When thus filled the opening in the mold is closed by any suitable cap, cover, or stopper, which is made secure by riveting, welding, banding, or otherwise, so as to retain the contents during subsequent reworking. When thus closed the mold and contents are placed in a suitable reheating-furnace, and raised to such temperature that the homogeneous or cast portion of the contents shall be either in whole or in part in a state of fusion or semi-fusion. This may readily be done, and still preserve the integrity of the mold or casing, since the degree of heat at which wrought-iron fuses or becomes liquid is much higher than that at which homogeneous iron fuses, and still higher than that at which homogeneous or cast-steel fuses. In this operation the wrought or malleable iron mold or casing operates substantially as a crucible to retain

the contents and exclude air. It is not essential that the joints or meeting parts of the mold be made air-tight in the first instance, as it is sufficient if they be made tight enough to retain the molten metal as it is poured in; but in this subsequent reheating, as the mold approaches a welding-heat, such joints may be readily welded by the workman by the use of any suitable tool, especially such joints as are easy of access, and in view of the ease with which such welds may be made it is not essential that the cover for the pouring opening or gate be secured as tightly as would otherwise be necessary.

When the ingot is heated to the desired degree—that is, till the homogeneous or cast portion or portions are partially or wholly in a fluid or semi-fluid state—it is removed from the furnace and worked or reduced by hammering or by rolls to the desired form and size. During such reduction or working the mold or crucible still forms an air-tight cover for the contents, and they are reduced or drawn out together and to a proportionate degree.

If it is desired that the product should have a substantial coating or covering of iron, it may be secured by making the mold or casing of slabs or plates of proper thickness as compared with the capacity of the mold and the extent of reduction intended; or, on the other hand, the relative amounts of metal in the mold and its contents may be so proportioned that, when reduced, the iron covering or coating shall practically disappear, or become so thin or attenuated that it may be readily removed, if desired, by turning, planing, grinding, or otherwise.

The reaction which takes place within the mold during this reheating and reducing process is not fully determined, and, without committing myself to any particular theory, I would state that, as indicated by results thus far observed, there is a mechanical working out through the pores of the mold or casing of slag and other like impurities, and the oxygen which may be present, either combined with the metal or in other forms, seems to be eliminated in the same way, at least to such extent that I am unable to discover any undue amount in the product. And I have found this true when rusty files and rusty scrap of other kinds have been placed in the mold and the molten metal poured over them; and I have also taken metal from the Bessemer converter which was so high in oxygen that it would not cohere when worked alone, and successfully treated it as above described, and obtained a good and merchantable product, the excess of oxygen being apparently eliminated. And as to the chemical reaction, there is a tendency, especially in contiguous parts, to equalize the proportions of carbon which they contain, and this is carried to such extent, not only as between the different grades of metal in the contents of the mold, but also as between the mold or casing itself and the contents, that it is practically impossible to determine the line dividing one grade from another, as can generally be done in case one grade of metal is simply welded to another, and though the contents of the mold are not necessarily, and often, by preference, are not fused into one common homogeneous mass, yet there is fusion to a greater or less degree between the different grades of metal, both in the mold or casing and its contents, so as to make a union between them which may be termed one of unalloyed metallic contact, producing a gradual merging of one grade or kind of metal into another throughout the entire mass.

It has been found practically impossible, in the ordinary methods of working ingot iron and steel, to remove all porosity, although various attempts have been made, and such pores or flaws as are not wholly removed will, upon reduction of the ingot, be drawn out into seams and other imperfections. These pores are usually formed in the operation of casting the ingot; and since, in the old methods of reduction, these ingots are not again raised to that degree of heat at which such metal welds, these pores, seams, or imperfections cannot be removed. By my improved method of working, the ingot, while still inclosed within its mold, is again heated to the point of fusion at which homogeneous iron or steel can be united, and while so heated it is subjected to hammering or rolling, whereby all porosity, seams, and other like imperfections are effectually removed by a complete fusion of the entire mass into one body.

I have shown in the drawings different forms of molds adapted to some of the uses to which my improvement may be applied. These are, by preference, made of wrought-iron; but when certain grades of steel comparatively high in carbon are to be treated, the requisite mold may be cast of what is commonly known as "homogeneous iron or ingot-iron," and in such case the mold may be made without joints or seams except at the gate or pouring-opening. In preparing these molds I prefer to give them in many cases approximately the form desired in the finished article, especially where such form is irregular in outline. In such cases the subsequent reduction or working of the ingot is usually done by means of a hammer.

In Figure 1 I have shown, in perspective, a rectangular mold made of plates or slabs of wrought or malleable metal. The sides A are cut to the desired dimensions, and united by angle-irons *a*, arranged on the outside corners and riveted, as shown, so as to make a joint or connection tight enough at least to retain molten metal. One end is closed by a flanged cap, *c*, which is riveted to the sides to make the end sufficiently tight. The other or pouring end may be closed after the mold is filled by a cover, *d*, which may be secured by pins, bands, rods, or in other convenient way. It is not so essential that this end be fastened tight, as the contents of the mold may become

more or less solidified before the top is closed, and the flanges of the cover may be welded to the sides A during the process of reheating, as before described.

Fig. 2 shows a mold similar to that shown in Fig. 1, the angle-irons along the edges being arranged inside the mold instead of outside.

Fig. 3 illustrates, by an end view, one method of arranging slabs or plates of solid iron or steel in the mold preparatory to pouring in the molten metal, A and *a* representing the mold or case, *e e e* the slabs or plates, and *b* the poured or homogeneous metal.

Fig. 4 illustrates in a similar way one method of arranging old rails *d'*, either iron or steel, within the mold A, preparatory to pouring in the molten metal *b*. In both this and the previous figure the mold is opened on one side instead of the end, in order to arrange the solid part of the contents more readily.

Fig. 5 is a perspective view of a cylindrical-shaped mold of varying diameter or size, adapted to form ingots for various kinds of shafting and other like purposes. Such a mold may be filled at one or more pourings, and either in whole or in part, with molten metal, the balance being some solid metal, which is first arranged as desired. The required reduction or working is done by means of a hammer.

Figure 6 illustrates another modification in the construction of the mold, the sides D being formed of one slab or sheet, and the bottom and top being made of flanged plates. The joints may be made tight enough to retain molten metal by the use of angle-irons arranged inside, and the whole may be bound together by a suitable number of bands, B.

Fig. 7 shows a mold adapted to form tubular ingots, the mold being filled in the manner before described. In this case the inner shell, C', and outer shell, C, are made sufficiently tight by riveting, leaving the desired space between them. This space is closed at one end by a cap or annular cover, *i*, which is riveted or otherwise secured to both rims C and C'. The other or pouring end may be closed after the mold is filled by a similar annular cover, *i'*. When properly reheated, this ingot may be reduced by rolls or hammer, either with or without a mandrel, to the desired hollow or tubular product.

Other forms of molds or cases may be made, but these I deem sufficient to enable the skilled workman to adapt my improved method of working metals to the requirements of each case, and also to illustrate what I now consider the best construction of molds for the purpose.

If desired, the joints or seams of the mold may be rendered tight enough to retain the molten metal by packing the same with sand or luting with clay, or other suitable material, and such modification in the construction of the mold I consider as coming within my invention.

I am aware that it is not new to pour molten steel into a thin sheet-metal case open at both ends, and then reheat and work the ingot so formed with the result of the burning off or wasting away of all or most of the metal case, as set forth in United States Patent No. 139,778, June 10, 1873, and in English Patent No. 932 of 1873.

My improvement contemplates the use of an ingot mold or case having closed ends as well as sides, and, by preference, a somewhat thicker body than that called for in the patents above referred to, so as to insure sufficient strength for subsequent working in the manner hereinbefore described.

I claim herein as my invention—

1. The method of working cast malleable metals by casting the same into a close malleable mold or casing, (either empty or partially filled with solid malleable metal,) and then reheating the close casing and contents until the latter is brought, wholly or in part, to a fluid or semi-fluid condition, and uniting and working down the case and contents under pressure, substantially as set forth.

2. A compound ingot composed of a mold or case of malleable metal, closed on all four sides and two ends, filled wholly or in part with other malleable metal poured in while in a state of fusion, substantially as described.

3. A wrought-metal ingot mold or casing made close or tight at all points except at the pouring opening or gate, in combination with a cover or cap adapted to be applied to and permanently close such opening or gate, substantially as set forth.

In testimony whereof I have hereunto set my hand.

ELBRIDGE WHEELER.

Witnesses:
J. I. McCORMICK,
CLAUDIUS L. PARKER.