J. J. BRADLEY.

METHOD OF PROTECTING IRON.

APPLICATION FILED FEB. 12, 1907. RENEWED MAR. 7, 1908.

900,656.

Patented Oct. 6, 1908.

2 SHEETS—SHEET 1.

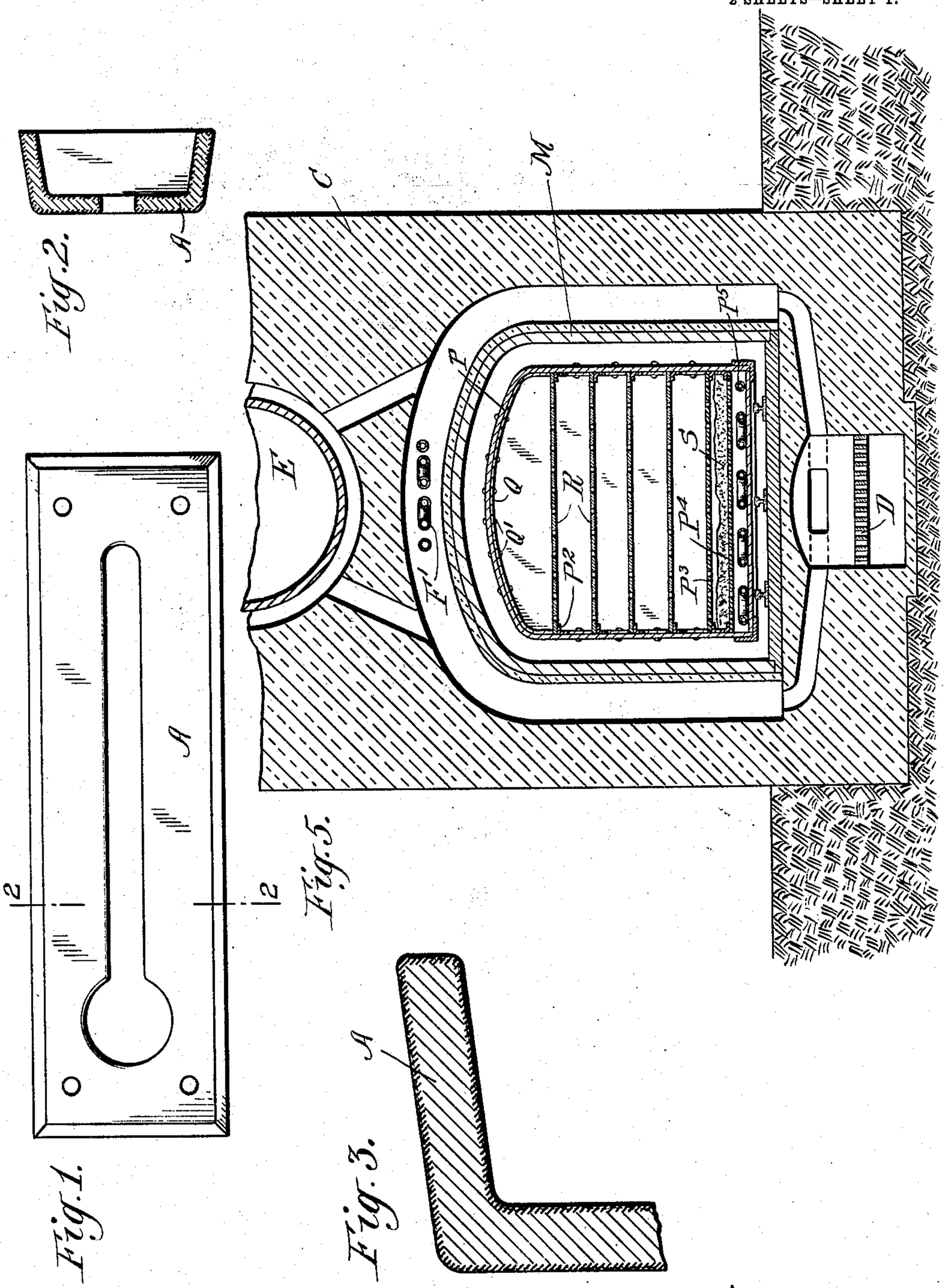

Fig. 2.

Fig. 5.

Fig. 1.

Fig. 3.

WITNESSES

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Fig. 4.

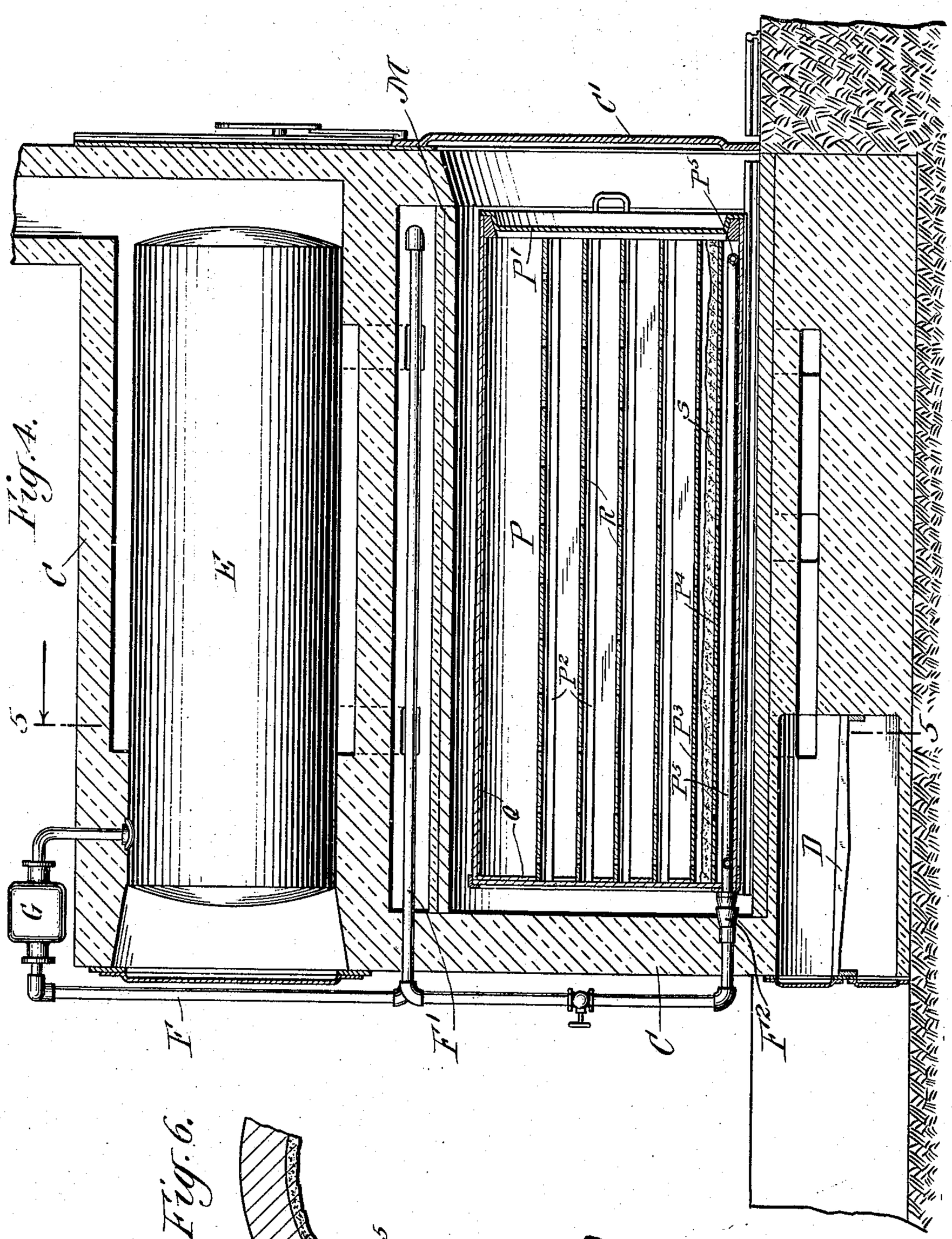
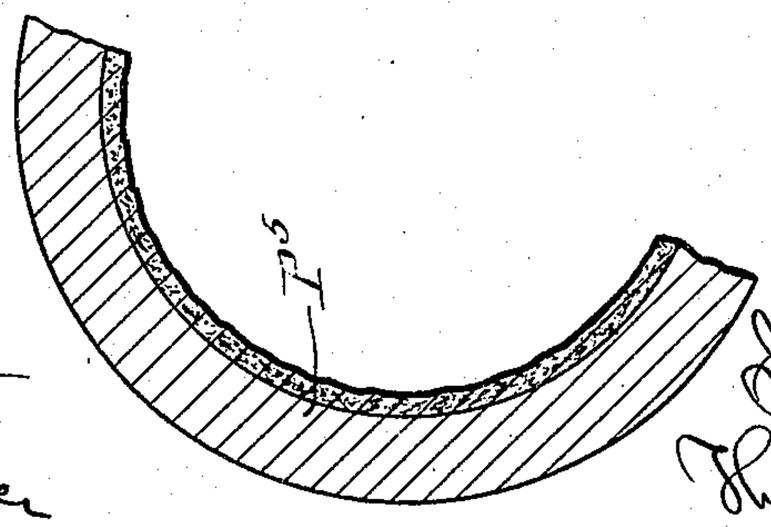


Fig. 6.



WITNESSES

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METHOD OF PROTECTING IRON.

No. 900,656. Specification of Letters Patent. Patented Oct. 6, 1908.

Application filed February 12, 1907, Serial No. 357,007. Renewed March 7, 1908. Serial No. 419,769.

To all whom it may concern:

Be it known that I, JOHN J. BRADLEY, a citizen of the United States, residing in the borough of Brooklyn, State of New York, have invented a certain new and useful Improvement in the Methods of Protecting Iron, of which the following is a specification.

I have discovered that it is practicable to change a continuous stratum at and just within the entire surface of an iron article to an alloy or to an analogous combination of iron and hydrogen and that the article will in consequence be well protected against what would otherwise be destructive chemical action. My experiments indicate that the result is still better for the presence of copper also in the alloy, and also for adding carbon at a late stage to penetrate to a very slight depth.

I have devised an apparatus and a method of operation for producing such alloy which is made the subject of the present patent.

I will make the new product the subject of a separate patent. It will be of service to show and describe such new product also in this patent for the means of production.

The accompanying drawing forms a part of this specification.

In the figures Figure 1 is a face view of a small iron casting which has been treated according to my invention. Fig. 2 is a cross-section on the line 2—2 in Fig. 1 and Fig. 3 is a cross-section of a portion of such article on a larger scale. In this latter figure the alloy or changed metal at or near the surface is indicated by section lines running in a different direction from the section lines which indicate the body or unchanged portion. The remaining figures show the apparatus. Fig. 4 is a longitudinal section. Fig. 5 is a vertical cross-section of the main portion on the line 5—5 in Fig. 4 and Fig. 6 is a cross-section of a portion on the same line on a larger scale.

Similar letters of reference indicate corresponding parts in all the figures where they appear.

A is the body of an iron casting preferably of a hard quality which requires very high heat to melt or appreciably soften.

The metal at and near the surface is changed by the presence therein of hydrogen and copper. These elements presented at high temperatures are absorbed in small proportions and induce a condition in the surface metal which I will refer to as "alloy". It is found that iron can absorb hydrogen until the portion near the surface contains an amount approximating eleven one-hundredths of one per cent. of that of the iron. The proportion of the copper, I believe to be considerably less. The copper disappears into the solution but I have never determined the precise rate. It is probably not essential to success that the copper shall have any specific proportion.

The effect is promoted by treating the whole surface or the portions thereof which are most important to be perfect, by a sand-blast or other convenient means for removing the scale. The proportion of hydrogen and copper becomes less and less from the exterior inward,—there is no dividing line. The adhesion of the alloy is as strong as any other part. The alloy maintains its original condition for an indefinite period. The alloy is less strong than iron and may be inferior to iron in other respects but it possesses the highly important quality of extraordinary resistance to oxidation or corrosion.

The following gives what I esteem a practicable form of apparatus and the best mode of operation.

C is the masonry of a furnace, C^1 a door thereof, and D a grate with proper facilities for supplying air and fuel, anthracite or coke will serve.

E is a steam boiler arranged to be heated by the hot gases discharged from the furnace.

F is a steam pipe having convolutions F^1 exposed to the hot gases. The pipe leads down further and delivers the super-heated steam through a trumpet-mouth F^2.

M is a shell within the furnace C which may be removed at each re-charging if desired but it is not usually necessary to do so.

P is an inclosed crucible of rectangular form and P^1 a removable head therefor. The whole or a large part of this vessel P is lined with copper Q secured by rivets Q^1. Similar copper surfacing may be applied to the shelves to be presently described. The copper should be of considerable thickness, say sheet copper $\frac{1}{8}$ inch thickness. It will be reduced in thickness as the furnace is used by the copper assuming a volatile condition and mingling with the hydrogen to permeate the iron. The interior of the crucible P is equipped with bearings P^2 at the sides, which support shelves R that can be easily drawn

out and replaced, and are adapted to receive and present to the hydrogen and to the fumes of copper mingled therewith the iron articles which are being treated. In the lower portion of the crucible are two horizontal perforated partitions P^3 and P^4, the space between which is filled or nearly filled with finely divided iron S, preferably iron turnings, which present great surface to the steam. In the bottom of the crucible P is a pipe P^5 formed with returns, the last return liberally perforated. The receiving end of this pipe extends outward through a proper aperture in the box and is engaged with the trumpet-mouthed end F^2 of the pipe F^1 The steam is led from the boiler through a proper reducing valve G so set that it will allow the steam to pass at only about one pound per square inch above atmosphere.

The steam in flowing through the convolutions F^1 becomes much but not sufficiently super-heated. The heat here is not sufficient to decompose the steam. The pipe P^5 matches in the trumpet-mouth F^2 and receives the steam and heats it more. I provide the pipe P^5 with a lining which reduces the tendency of the oxygen to combine with the iron or steel of this pipe. This lining may be effected at any previous period by first moderately heating and flowing melted borax (biborate of soda) through it and then while the entire inner surface of the pipe is viscous with the borax, blowing finely pulverized fire-clay through the pipe and allowing the particles to adhere. This pipe P^5 delivers the steam very hot into and causes it to pass upward through the mass of finely divided hot iron S above; there the oxygen is absorbed and only the hydrogen of the steam flows up and bathes the articles and is absorbed into all portion of the entire surface of each.

The depth to which the gases shall penetrate and consequently the thickness of the alloy in the articles being treated depends on several conditions, one of the most controllable of which is the temperature which should be a bright cherry red and another the duration,—a treatment several hours gives a much deeper penetration of the hydrogen and copper than half an hour. In due time the steam is temporarily shut off, the door C^1 is opened and the crucible P with its contents drawn out and removed to any suitable place to be slowly cooled and at length to be opened and emptied. Another crucible P previously prepared with a fresh lot of articles to be treated is introduced into the furnace C and the door C^1 closed and the work is again resumed. The fresh crucible and its contents thus introduced may be previously heated to shorten the time of treatment necessary.

I believe the invention is applicable by about the same mode of operation to cast-iron, drop-forgings, and other forgings, cut-iron, (as nails, screws and nuts), sheet-iron of all thicknesses, drawn iron, (as stamped work and wire), and all the grades of carbonized iron or steel.

When my improvement is applied to the manufacture of articles intended for decorative purposes, the shapes should be prepared and entirely completed before the sand-blasting and the other portions of my treatment.

Into each batch before the cooling has progressed far, I introduce naphtha or other convenient hydro-carbon. This may be done by connecting a hydro-carbon supply to the projecting end of the pipe P^5 and injecting the hydro-carbon in a vaporous form,—if it is not vaporous at first it becomes so, of course, before it has entered far into the hot crucible. One effect is to give a fine black to the surface.

Modifications may be made without departing from the principle or sacrificing the advantages of the invention. Parts can be used without the whole. The final treatment with hydro-carbon may be omitted.

I claim as my invention:

1. A method of treating iron articles by first shaping complete, second subjecting them at a high temperature to a bath comprising elemental hydrogen, and third slowly cooling, all substantially as herein specified.

2. A method of treating iron articles by first shaping complete, second subjecting them at a high temperature to a bath comprising elemental hydrogen and copper, and third slowly cooling, all substantially as herein specified.

3. The improvement in the art of protecting iron articles which consists in subjecting them at a high temperature to a bath comprising elemental hydrogen and afterwards to hydro-carbon and cooling slowly, all substantially as herein specified.

4. The improvement in the art of protecting iron articles which consists in subjecting them at a high temperature to a bath comprising elemental hydrogen and copper and afterwards to hydro-carbon and cooling slowly, all substantially as herein specified.

Signed at New York city this 30th day of January 1907.

JOHN J. BRADLEY.

Witnesses:
GEO. MCKITTRICK,
THOMAS DREW STETSON.