No. 806,621. PATENTED DEC. 5, 1905.

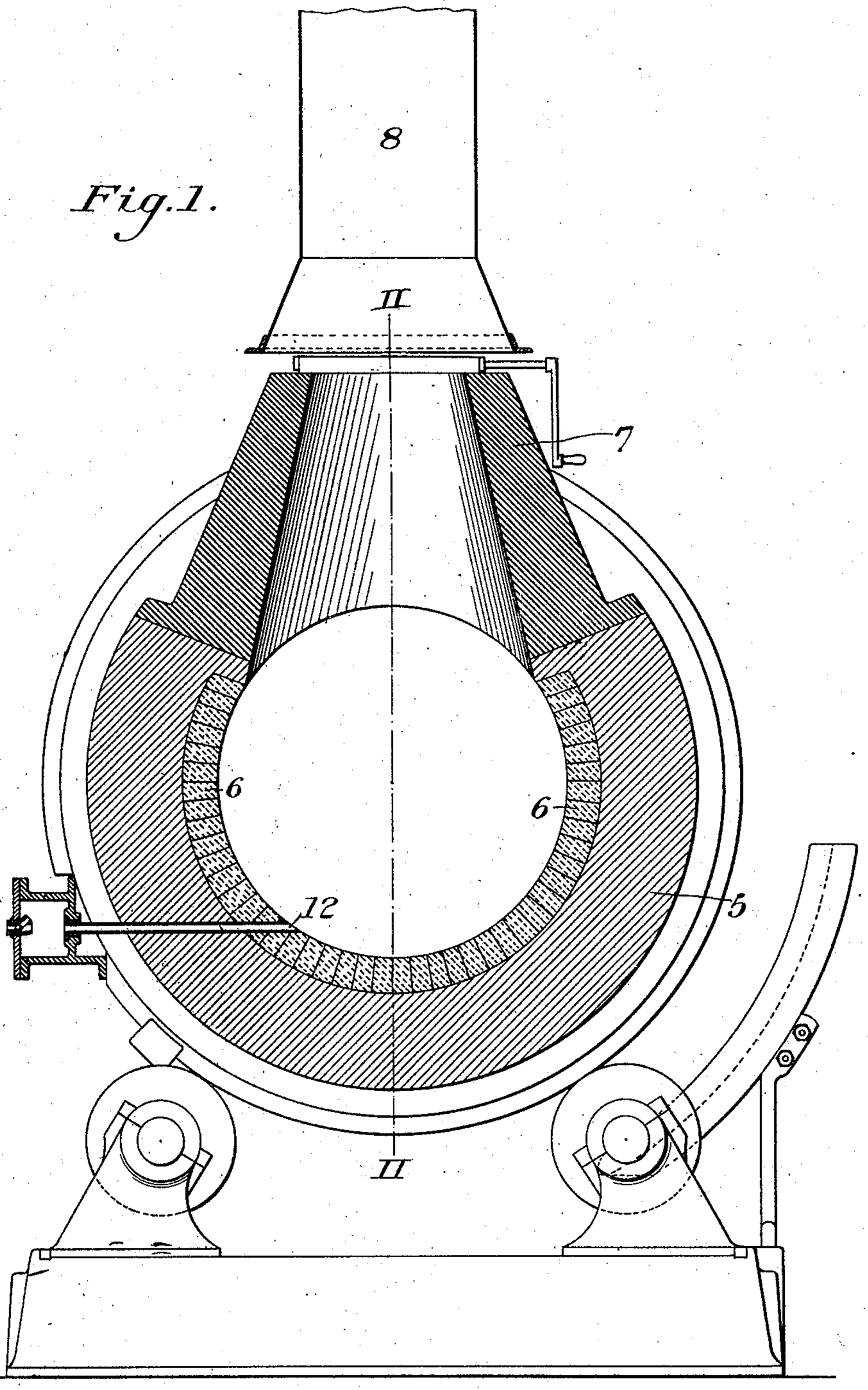
R. BAGGALEY.

COPPER REFINING FURNACE.

APPLICATION FILED MAY 1, 1905.

4 SHEETS—SHEET 1.

Fig. 1.



WITNESSES

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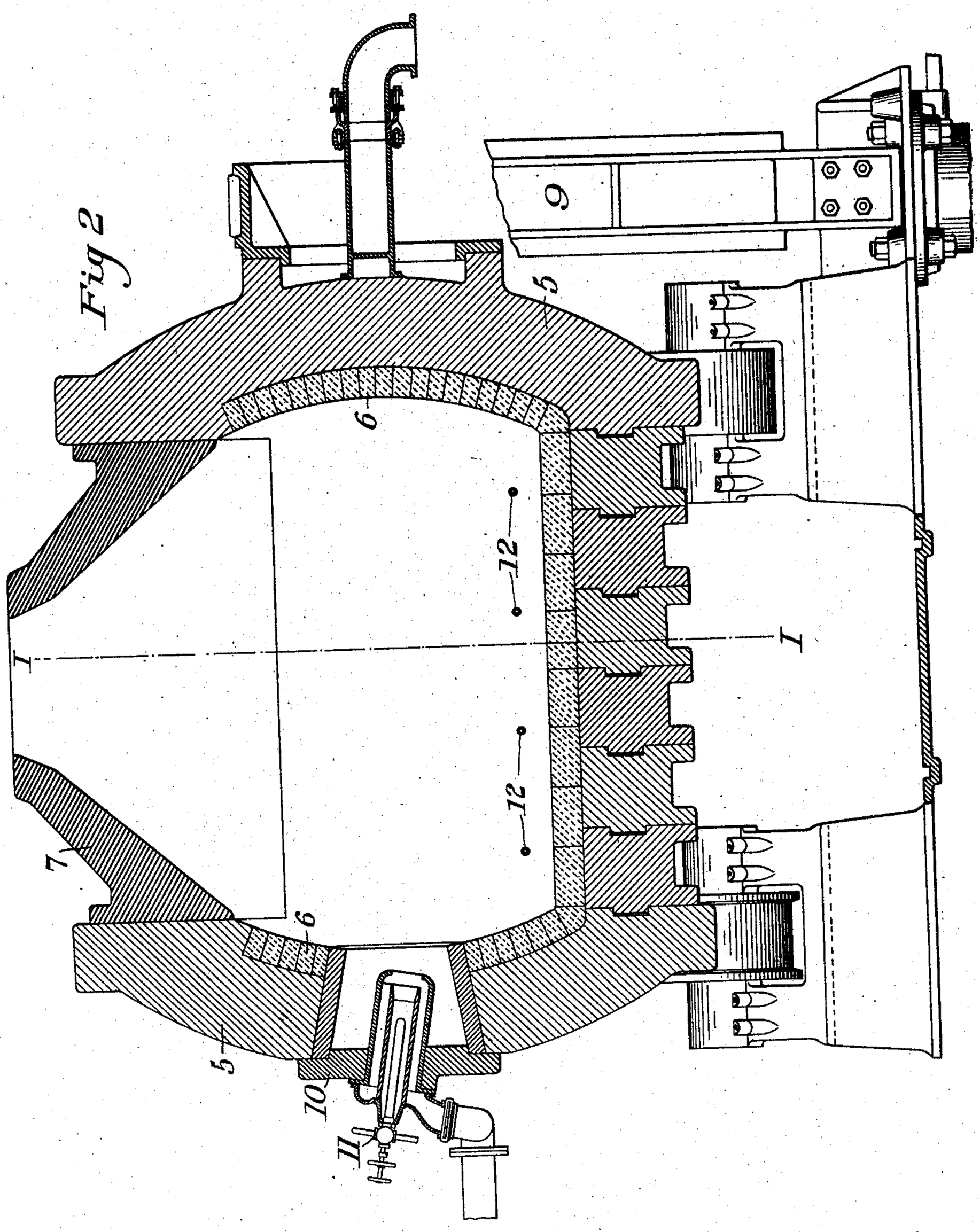
4 SHEETS—SHEET 2.

Fig 2



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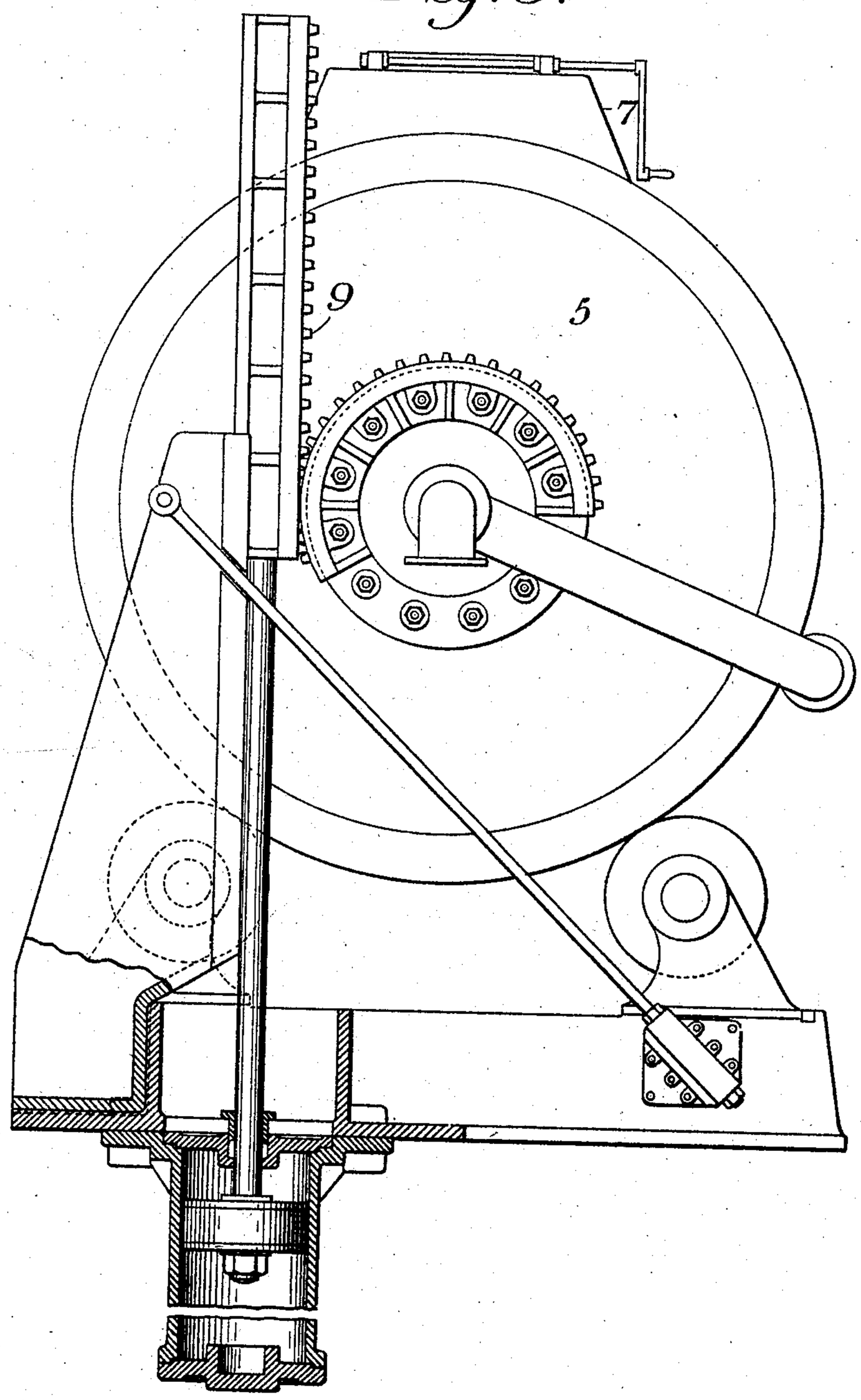
4 SHEETS—SHEET 3.

Fig. 3.



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4 SHEETS—SHEET 4.

Fig. 4.

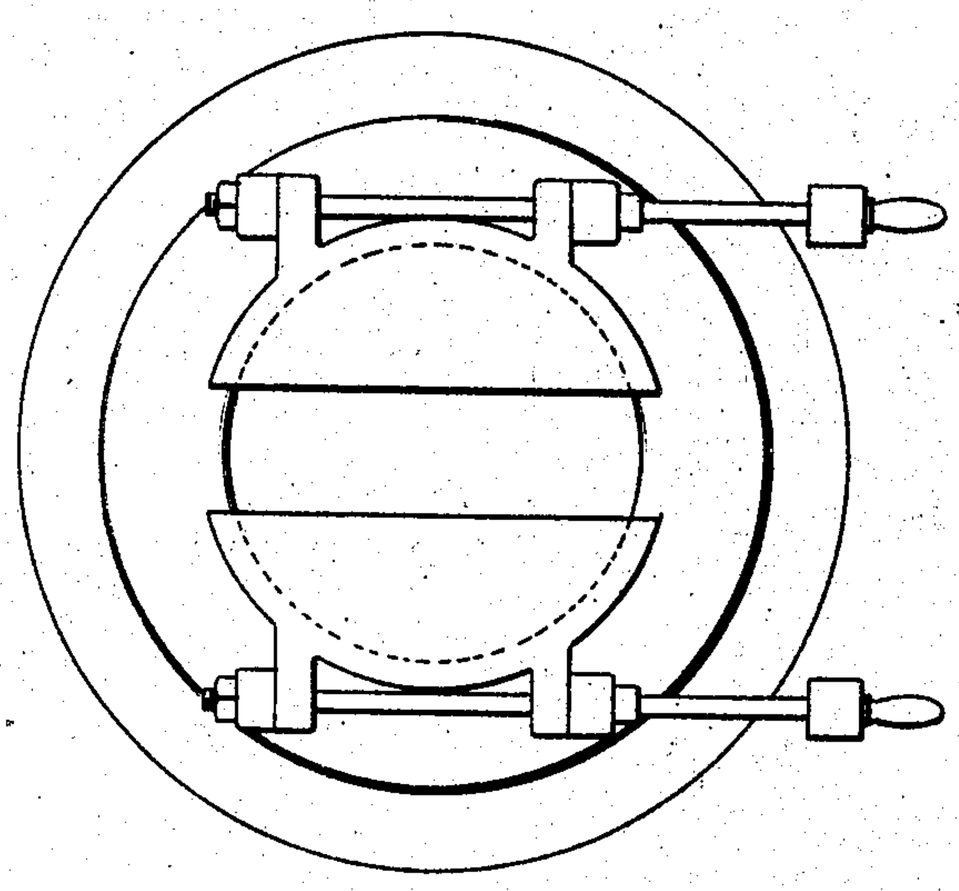
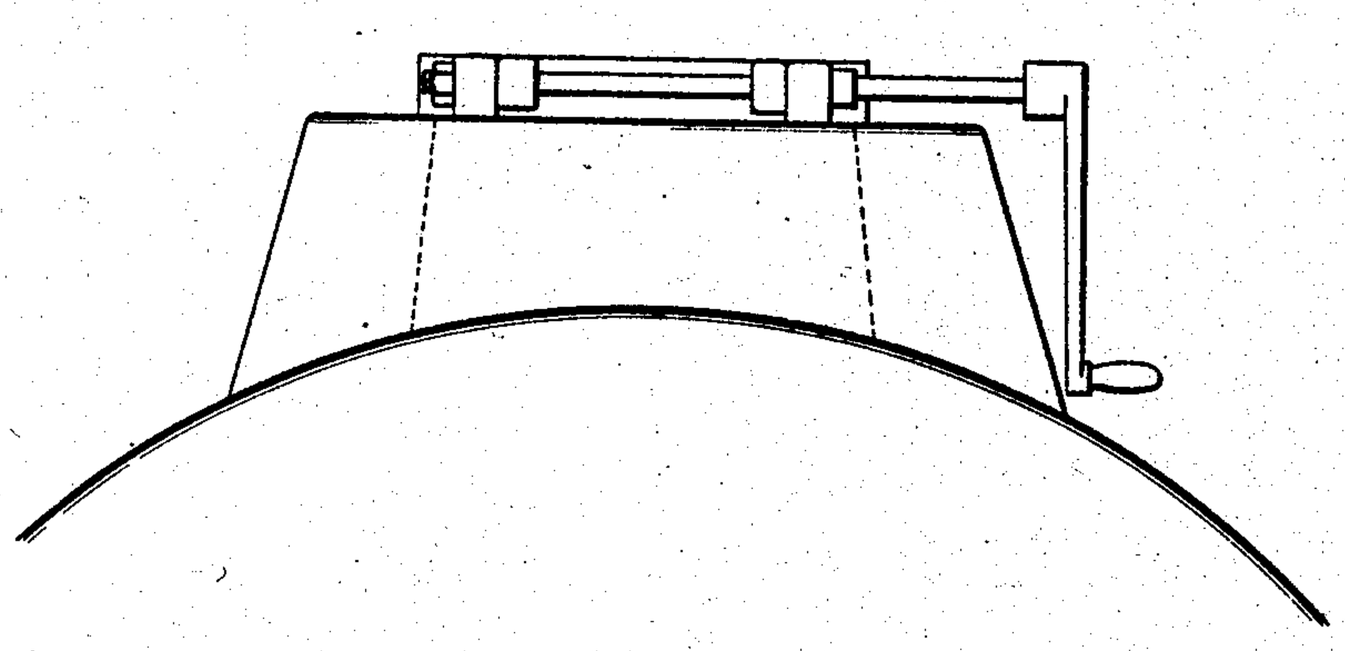


Fig. 5.



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UNITED STATES PATENT OFFICE.

RALPH BAGGALEY, OF PITTSBURG, PENNSYLVANIA.

COPPER-REFINING FURNACE.

No. 806,621. Specification of Letters Patent. Patented Dec. 5, 1905.

Application filed May 1, 1905. Serial No. 258,152.

To all whom it may concern:

Be it known that I, RALPH BAGGALEY, of Pittsburg, Allegheny county, Pennsylvania, have invented a new and useful Copper-Refining Furnace, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming part of this specification, in which—

Figure 1 is a vertical cross-section on the line I I of Fig. 2. Fig. 2 is a vertical longitudinal cross-section on the line II II of Fig. 1, and Fig. 3 is an end elevation showing the inlet for hydrocarbons and the power mechanism for tilting the furnace.

The main object of my invention is to provide suitable apparatus in which to practice the art disclosed in United States Patent No. 746,246, issued December 8, 1903, to make it possible to refine single small batches of molten copper direct from the converter and when occasion requires it through any derangement in the apparatus or through a temporary failure in the supply of hydrocarbon gases to refine the copper temporarily by hand-poling.

The apparatus invented by me is in many respects similar in form to a converter. It is preferably mounted on rollers in lieu of trunnions in order that each end of the vessel may be available for other things. Trunnions or other devices may, however, be used without departing from the spirit of my invention. The body of the vessel is preferably composed of narrow solid metal blocks or segments of circles—say eighteen inches thick. These may be thicker or thinner, if desired. These blocks may be composed of copper, cast or wrought steel, cast or wrought iron, or other metals. Steel castings of good quality are an excellent material for use in this work. The body of the furnace is preferably lined with a good quality of silica-brick—say, for instance, four and one-half inches in thickness. An acid lining may be inserted in plastic form, if preferred. It is the intention that the acid lining shall be less in thickness than the heavy metal blocks, for reasons that will hereinafter be explained. The top of the vessel is arranged so that it may be unbolted and removed in order to repair the lining or for any other purpose. I prefer for the sake of economy to make this top of solid metal without lining of any kind, for this will withstand the service, it will retain and conserve the internal heat, and it will last indefinitely without expense. A door or opening is provided at one end of the vessel, preferably at its axis. It may be used, if desired, in hand-poling; but its prime object is for supplying the auxiliary heat of a flame to the interior of the vessel and over the surface of the molten bath. To this end an oil or gas burner is provided, which may be hung from above or may be mounted on a hinged post at one side in such position that it may be quickly thrown into position. The burner is preferably supplemented with a metal-plate door, so that when it is in operation the opening will be closed practically air-tight.

In addition to the metal-plate door that constitutes a part of the burner apparatus I may also provide a supplementary door hinged to the side of this end of the vessel.

The refining-furnace is preferably equipped with four three-fourths-inch twyers on one side of the vessel. These twyers may be larger or smaller, if preferred, and their number may be increased or decreased to meet special conditions. I recommend that each twyer be lined with a seamless brass tube to prevent injury to the acid lining of the vessel when the twyers are punched. My object in using only four three-fourths-inch twyers is because in practicing the art disclosed in United States Patent No. 746,246, issued to me on December 8, 1903, the supply and quantity of hydrocarbon gas necessary to do the work will be comparatively limited. I may pump this gas either directly from gas-producers of the ordinary kind from Swedish charcoal-furnaces in series, as referred to in the patent stated, or preferably from one or more large storage-gasometers. This therefore becomes a very different proposition from using an oxidizing-blast, which is procured from the atmosphere and which is forced by means of large blowing-engines through a molten bath, in which a large percentage of impurities must be removed by oxidation. The method disclosed in the patent referred to contemplates the use only of a precreated reducing-gas, and a supply of this required in refining one charge of blister-copper is minute in comparison with the volume of oxidizing-blast that would be necessary in expelling all impurities from a matte charge by

means of an air-blast. For these reasons it is considered that four three-fourths-inch twyers will be sufficient, although more or less may be used, if preferred, without departing from the spirit of my invention.

In present practice the refining of copper is a most intricate, uncertain, and expensive process. The refining-gases are produced in the molten copper itself and by its own heat solely by laborious and expensive hand-poling. This work cannot be done successfully with a bath of less than from eight to ten tons. Present practice tends in the direction of larger baths than that stated. Fifty and even one hundred and fifty tons of blister-copper are being handled in the refining-furnace at one time. It has been found that with a large bath the heat can be better retained than in small ones, for the reason that the proportion of chilling exterior surface is much less in the former than in the latter. Inasmuch as blister-copper is extremely sensitive to its surrounding conditions and because it always shows a great tendency to chill, the increased heat that thus becomes possible through handling a large bath at one time is of great importance. It will be apparent that such a large bath necessarily represents a large accumulation of product. Assuming that the ordinary product of a converter charge is four tons, a bath of one hundred tons in the refining-furnace will represent twenty-five such charges from a converter. Even a small bath in the refining-furnace—say of twelve tons—will represent three converter charges. The net result of these things is that in present practice it is impossible to transfer blister-copper in the molten form directly from the converter into the refining-furnace for treatment. In lieu of this desired practice it is necessary to store the converter product of many charges, to remelt them in the large refining-furnace with carbonaceous fuel at a heavy expense, and thereafter to hold this great molten bath over a period of many hours and sometimes over days, while the tedious and expensive hand-poling process is brought into requisition in order to subject the molten bath to the reducing influences of the hydrocarbon gases. This requires the services of several gangs of expert workmen, who command high wages and who work in shifts of eight hours each. Furnacemen are necessary in maintaining the fires. Copper-refiners who command very high wages are necessary in applying the green hardwood poles to the bath. Other workmen are required who are engaged in tapping and in casting the molten copper into plates, slabs, bars, cathodes, &c. During all of this time the great molten bath constantly absorbs oxygen on its surface from the atmosphere, and the sides and the bottom of the large furnace are absorbing by saturation vast quantities of copper, gold, and silver. A single furnace may thus absorb, through saturation, from fifteen to thirty thousand dollars worth of metal. A new furnace when started may thus absorb practically all of the metal contained in successive charges for a week or for even a longer period.

Ideal practice would be to receive the molten bath in small volume and in molten form directly from the converter immediately after each charge has been oxidized to the requisite extent, because in this way each separate converter charge of blister-copper can then be received into the refining-furnace and without the expense and the delay of remelting can be immediately refined and at once thereafter cast into cathodes or into plates, as may be desired, for shipment. The object of my invention is to make this ideal practice possible and, in short, to admit of the refining of copper in small batches in a smelter plant as quickly as made, continuously and without interruption, in like manner as the bessemerizing or oxidation of the mattes are now carried on. This method of refining is radically different from anything that at present exists.

Among the advantages of this invention may briefly be enumerated the following:

First. The ability to receive a single charge of molten copper directly from a bessemerizing-converter, to hold this charge indefinitely at any desired heat, to increase this heat, if necessary, and in this manner to refine a small bath.

Second. To accomplish thorough, complete, and exact refining in a fraction of the time at present required.

Third. To admit of carrying on the refining of copper in small baths and as a practically-continuous process in like manner as the converting of copper matte is now done.

Fourth. To materially reduce the present cost of refining.

Fifth. To accomplish the work practically throughout by means of machinery, thus eliminating the present high-priced skilled labor, that is sometimes paid as much as seven dollars per day of eight hours.

Sixth. To make it possible to subject a bath of molten blister-copper to the reducing influences of hydrocarbon gases up to a perfect pitch, or, in other words, to the exact point of refinement desired, then to instantly stop the reducing action, and thereafter to immediately pour the copper before it can have an opportunity of changing its pitch by the absorption of oxygen from the atmosphere, as is the case in present practice.

Seventh. To eliminate the present enormous metal losses from saturation in the end and side walls and in the bottoms of refining-furnaces. Even if partially recovered after the stoppage of a smelter plant the fact remains that so long as the furnaces operate an enor-

mous amount of money is thus continuously tied up.

Eighth. To make it possible to refine copper by means of precreated ligneous or hydrocarbon gases in lieu of the present practice of hand-poling. The difference between the two is that where copper is refined with a precreated gas any kind of cheap waste ligneous material may be utilized, such as sawdust, slabs, and all the waste material of the forest. Where the result is produced by hand-poling, only carefully-selected hardwood poles can be used, only a small portion of each pole can be actually consumed in performing effective work, and poles must be provided from the forest at frequent intervals and be used while yet filled with natural moisture; otherwise they become useless for the purpose.

Ninth. To change what is now an extremely erratic, uncertain, hazardous, and expensive art into a simple, cheap, certain, and exact science.

Tenth. To make it possible to retain the copper in a thoroughly hot liquid condition until pored.

Eleventh. To make it possible to pour and to cast the copper into any desired form by machinery with a single workman in lieu of the gang of skilled workmen demanded in present practice.

Twelfth. To eliminate the troubles incident to present practice from the congealing of copper at or near the tap-hole of the furnace, which often solidifies to a thickness of eight or twelve inches, often necessitating the use of air-drills or hand-bars and sledges to open the tap-hole and to maintain a flow of the molten metal.

In the apparatus shown in the drawings the temperature of the molten bath may be maintained as long as desired and thoroughout the act of pouring to a point where the congealing of the bath is impossible. The pouring-lip of the apparatus is always open and free and hot. Consequently the bath cannot solidify upon it. During the act of pouring the vessel is tilted by machinery to any desired degree and until after the refined copper has been completely discharged from the vessel. For this reason solidification is impossible.

Many other advantages might be mentioned that need not here be enumerated.

As shown in the drawings, the furnace is made of heavy metal blocks or segments 5, preferably not less than eighteen inches in thickness, and has a lining 6, preferably made of silica bricks—say four and one-half inches in thickness. The object of this construction is to form a heavy wall that will absorb and conserve the internal heat practically without metal losses from saturation and that will not dissipate such heat, as may be the case where a water-jacket is used. Owing to the extreme tendency of molten copper to congeal, this feature is of importance and will commend itself to those skilled in the art. The intention is to make the silica lining relatively as small a proportion of the wall and the metal blocks as large a proportion of it as possible, to the end that the saturation of the internal lining with copper, gold, and silver will be very small when compared with the saturation that now prevails in all existing forms of refining-furnaces whose walls are composed of great masses of brick or plastic refractory material and whose bottoms are usually composed of crushed silica or of a refractory material of some kind. In this furnace, owing to the retarding influence of the heavy metal blocks that back up the silica lining on all sides, the travel of values from the molten bath will usually not exceed one and one-quarter inches into the interior substance of the silica brick. Sometimes it will be less. I have never known it to exceed one and one-half inches. A wall of this construction will not only retain the heats, but it will last almost indefinitely without repairs, because of the absence of iron in the bath, which alone seriously attacks the acid lining.

The slight saturation, as above described, of the interior surface of the silica wall seems to have the effect of prolonging the life of the lining almost indefinitely. Indeed this saturation accomplishes in a measure the automatic repair of the internal surface should this become fractured.

7 represents the cover or top of the refining-furnace, and it may be lined, if preferred, either with brick or with plastic material. I prefer to make it of heavy metal, as shown in the drawings, and to use it entirely without lining of any description. In this form it becomes practically indestructible, and I have found that the heavy mass of metal will absorb and conserve the internal heat and will not seriously dissipate it through radiation on the outside surface, providing it be made of sufficient thickness to insure this result.

8 represents an adjustable stack that may closely connect with this solid metal top and which is preferably arranged to cover or to recede from it. The top of the furnace or the stack may be provided with a damper (not shown) in order thus to regulate and to control the escape of the internal heat. In lieu of the adjustable stack the furnace may be provided with a hood the same in many respects as that of a converter. I, however, prefer the first-described device.

9 in Figs. 2 and 3 represents means for tipping the vessel similar to that often used on converters. The object in tipping the vessel is to throw the hydrocarbon-gas twyers 12 down under the molten bath when introducing reducing-gases and to regulate the depth of such twyers and their position under the bath at will. In like manner it may be util-

ized to raise the twyers above the level of the molten bath. The tipping of the furnace is also utilized in receiving the molten charge and at the completion of the refining process in pouring the bath into cathodes, plates, slabs, or whatever form may be desired. The same opening is preferably utilized in receiving the molten charge into the furnace that is used in pouring it after it has been refined. The bath may, however, be introduced at the end door 10, if desired, by swinging the oil or gas jet 11 away from it. Usually this opening should be kept closed in order to prevent the escape of heat while work is in progress.

10 illustrates the metal plate-door in one end of the vessel, which may be swung aside with the burner when it is desired to practice hand-poling with hardwood poles. By simply tipping the refining-furnace to a point where the gas-twyers will be safely above the level of the molten bath hand-poling can be done. This feature may be useful in the event of any derangement in the hydrocarbon-gas plant in procuring a supply of ligneous material, &c.

11 illustrates a hydrocarbon-gas burner, which is preferably mounted on hinged pipes either above or at one side of the furnace. When the gas-burner is turned into position for operation, the pipe carries with it the plate-door 10, Fig. 2, at one end of the furnace in order to prevent the escape of gases and of the internal heat. When this gas-burner is not in use, the opening may be closed by a supplementary hinged door (not shown) or other means. The gas-burner may be utilized in heating the interior of the furnace to incandescence before the reception of the molten copper that is to be refined. The effect of this incandescence is to immediately increase the heat and the fluidity of the molten bath. Thereafter the oil or gas jet may be used in maintaining the heat of the bath to any desired extent and for any desired period. This heat may be increased at will to a silver-white incandescence and is sufficient to melt any ordinary metals or ores quickly.

In refining copper by the method disclosed in my United States Patent No. 746,246, issued December 8, 1903, or by the hand-poling process I preferably cover the molten bath with a layer of powdered charcoal or with carbon in some form in order to prevent the copper from absorbing suboxid from the atmosphere. My present invention may be utilized in practicing the art disclosed in Serial No. 263,393, filed June 5, 1905, for a method of refining copper, by Ralph Baggaley, Charles M. Allen, and Edward W. Lindquist, by the addition of suitable attachments to the wind-box. When so used, it will generally be unnecessary to provide this extraneous covering of carbon, because the process itself will automatically supply the same.

Doubtless many modifications will suggest themselves to those skilled in the art without departing from the spirit of my invention, since

What I claim is—

1. A refining-furnace whose walls are composed of metal and a refractory material, the latter being relatively less in thickness than the metal, said furnace having means for supplying heat above the furnace-hearth; substantially as described.

2. A refining-furnace whose walls are composed of a thin acid interior lining and a thick metal wall outside of the lining; substantially as described.

3. In a copper-refining furnace, the combination of a thick metal wall, a relatively thin refractory lining and means for supplying auxiliary heat above the level of the bath; substantially as described.

4. In a copper-refining furnace, the combination of a thick metal wall, a relatively thin refractory lining, means for supplying auxiliary heat above the level of the bath and means for introducing precreated hydrocarbon gas below the level of the bath; substantially as described.

5. In a copper-refining furnace, the combination of thick metal walls built up of comparatively narrow segments, a relatively thin refractory lining, means for supplying auxiliary heat above the level of the bath, and means for introducing precreated hydrocarbon gas below the level of the bath; substantially as described.

6. In a copper-refining furnace, the combination of thick metal walls built up of comparatively narrow segments, a relatively thin refractory lining, a solid removable metal top of sufficient thickness to withstand and to conserve the internal heat, means for supplying auxiliary heat above the level of the bath, and means for introducing precreated hydrocarbon gas below the level of the bath; substantially as described.

7. In a copper-refining furnace, the combination of thick metal walls built up of comparatively narrow segments, a relatively thin refractory lining, a solid removable metal top of sufficient thickness to withstand and to conserve the internal heat, means for supplying auxiliary heat above the level of the bath, means for introducing precreated hydrocarbon gas below the level of the bath, and means for regulating the escape of hot gases; substantially as described.

8. In a copper-refining furnace, the combination of thick metal walls built up of comparatively narrow segments, a relatively thin refractory lining, a solid removable metal top of sufficient thickness to withstand and to conserve the internal heat, means in one axis of the vessel for supplying auxiliary heat above the level of the bath, means for intro-

ducing precreated hydrocarbon gas below the level of the bath, and means for regulating the escape of hot gases; substantially as described.

9. In a copper-refining furnace, the combination of thick metal walls built up of comparatively narrow segments, a relatively thin refractory lining, a solid removable metal top of sufficient thickness to withstand and to conserve the internal heat, means for supplying auxiliary heat above the level of the bath, means for introducing precreated hydrocarbon gas below the level of the bath, means for regulating the escape of hot gases, and means for tipping the vessel either to receive or to pour the charge; substantially as described.

In testimony whereof I have hereunto set my hand.

RALPH BAGGALEY.

Witnesses:

LYNN W. SMITH,

AZELLE E. HOBART.