

No. 794,272.

PATENTED JULY 11, 1905.

R. BAGGALEY.

METHOD OF PRODUCING COPPER MATTES, WHITE METAL,
AND BLISTER COPPER IN A SINGLE FURNACE.

APPLICATION FILED APR. 13, 1904.

4 SHEETS—SHEET 1.

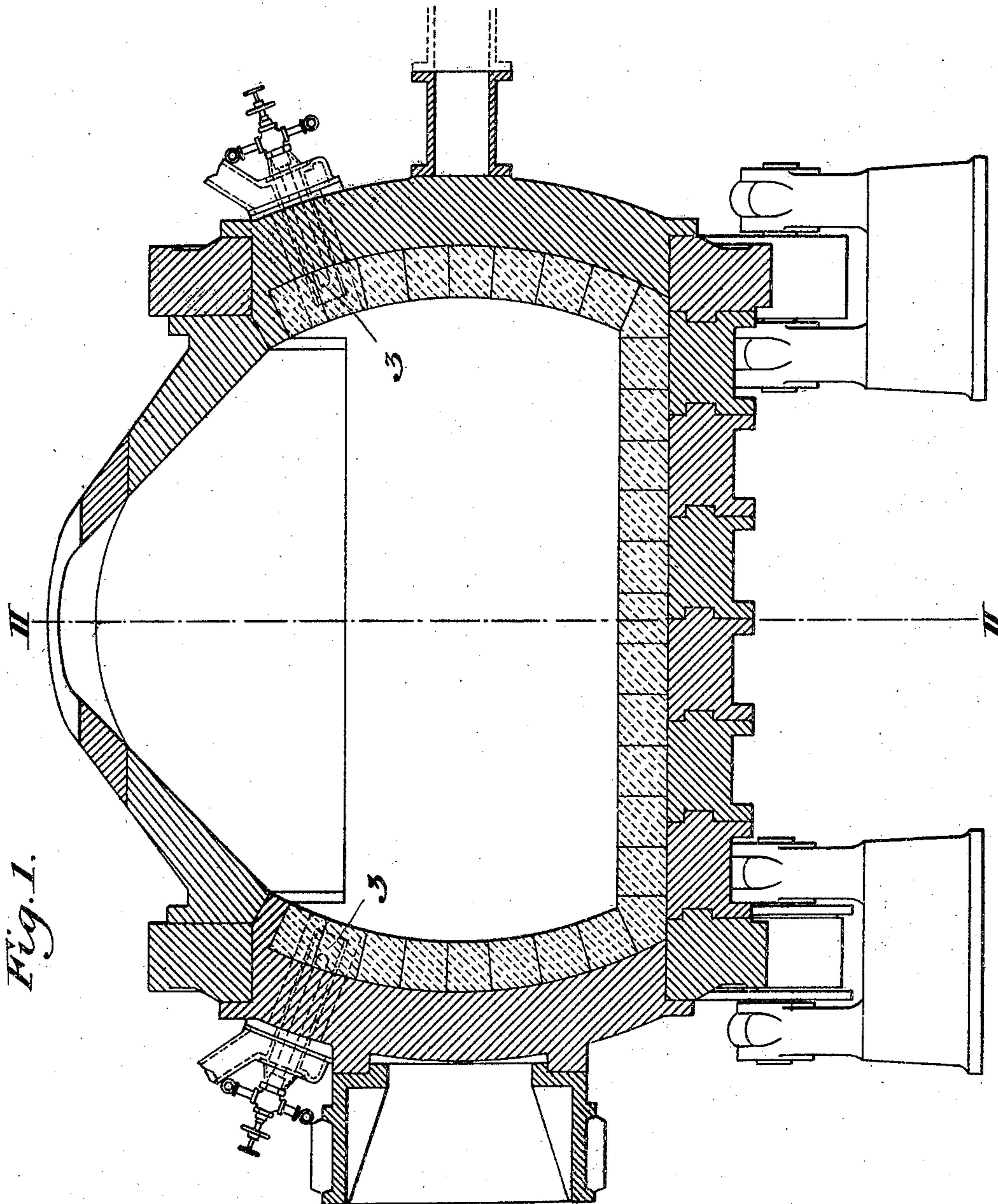


Fig. 1.

WITNESSES

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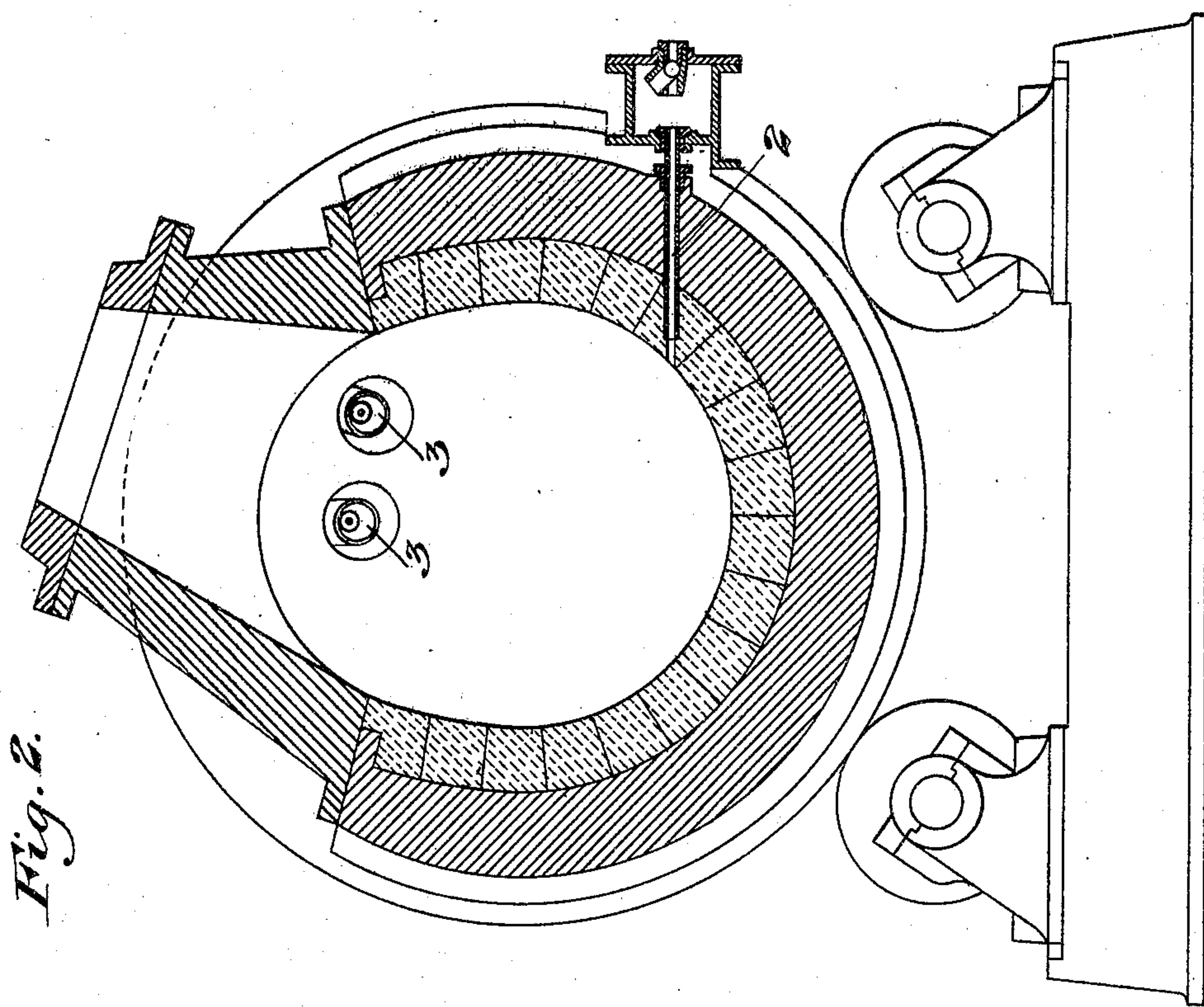
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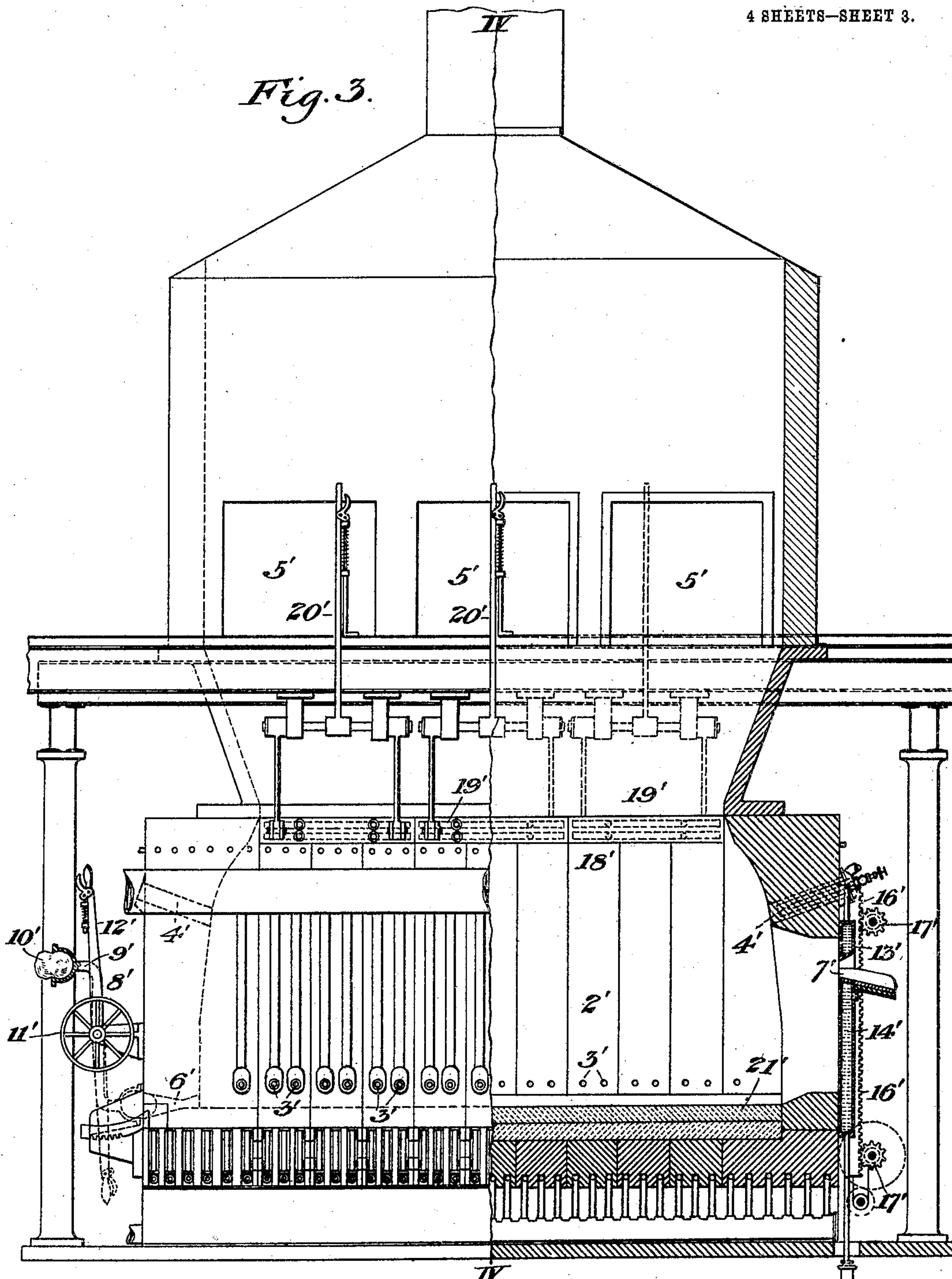
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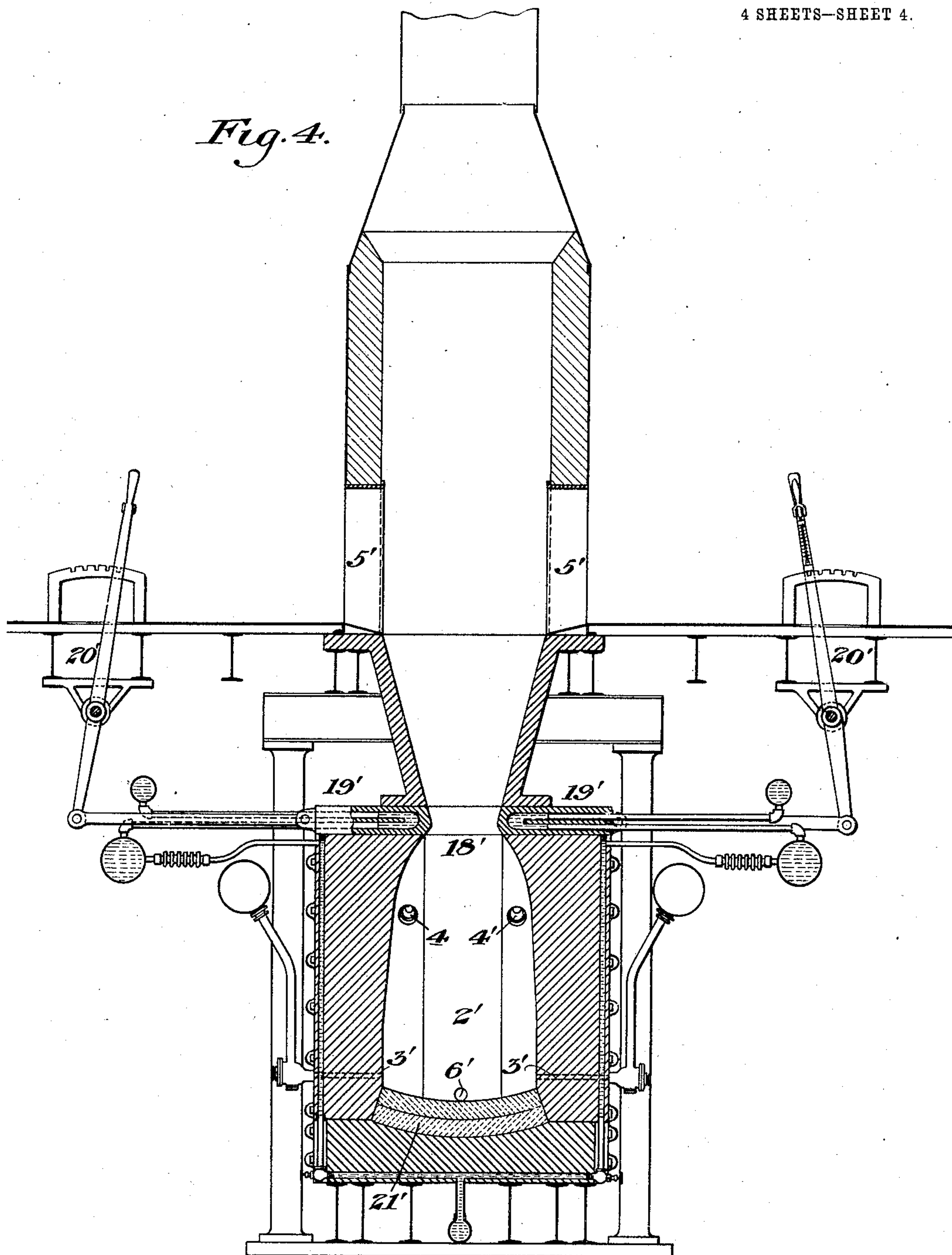
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4 SHEETS—SHEET 4.



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UNITED STATES PATENT OFFICE.

RALPH BAGGALEY, OF PITTSBURG, PENNSYLVANIA.

METHOD OF PRODUCING COPPER MATTES, WHITE-METAL, AND BLISTER-COPPER IN A SINGLE FURNACE.

SPECIFICATION forming part of Letters Patent No. 794,272, dated July 11, 1905.

Application filed April 13, 1904. Serial No. 202,928.

To all whom it may concern:

Be it known that I, RALPH BAGGALEY, of Pittsburgh, in the county of Allegheny and State of Pennsylvania, have invented a

5 Method of Producing Copper Mattes, White-Metal, and Blister-Copper in a Single Furnace, of which the following is a specification, reference being had to the accompanying drawings, in which—

10 Figure 1 is a vertical longitudinal section of a converter suitable for the practice of my invention. Fig. 2 is a vertical cross-section on the line II II of Fig. 1. Fig. 3 is a side elevation, partly in vertical section, of a stationary furnace which may also be employed.

15 Fig. 4 is a vertical cross-section on the line IV IV of Fig. 3.

My invention provides means by which copper matte and, if desired, white-metal and blister-copper can be produced direct

20 from the ore in a single furnace, and thus make it possible to dispense with the expensive and wasteful practice which has obtained heretofore, in which when smelting

25 silicious ores the ores are water-concentrated to remove a large percentage of the silica, then calcined, smelted in a blast-furnace with coke to produce a matte, and the matte then blown in a converter. The losses involved in

30 every step of the former practice are very great, and the process has been expensive and unsatisfactory.

In the practice of my invention I use a combined melting and converting vessel,

35 which may be either the tipping converter shown in Figs. 1 and 2 or a stationary furnace, as in Figs. 3 and 4. The converter is provided with twyers 2 2 for introducing an air-blast and with burners 3 3, arranged on

40 opposite sides of the converter, to discharge flames downwardly and so located that the flames will impinge directly on the surface of the bath. In this manner I deliver heat to the desired points on the surface of the bath

45 accompanied with the requisite supply of oxygen to produce the greatest efficiency in the combustion. The converter should not have thin water-jackets exposed to the bath, since that would chill the bath, and I there-

50 fore prefer to employ a converter or convert-

ing-furnace with thick walls, preferably made of slabs or blocks of cast metal, which will resist the intense heats produced during the process without chilling the molten charge.

In practicing the invention I introduce into the converter a first charge of material whose distinctive feature is freedom from compounds likely to produce light silica slags. I prefer to use for the first charge a

55 matte in congealed form, or in the absence of this pyrrhotite ores and certain sulfid ores may be successfully employed. These ores are high in fuel values—that is, high in sulfur, iron, and other elements whose oxidation

60 by the air-blast will produce a high temperature in the bath. Having introduced this charge into the converter, I direct the flame-jets from the burners upon it and melt it, thus forming a molten bath sufficient to

65 cover the twyers. In this operation I prefer to use no coke or charcoal, because when coke or charcoal is fed with the ores and fluxes in a solid heavy column it will have its foundation solidly planted over the entire

70 area of the furnace-bottom and will afford no space for an accumulation of molten matte except in the interstices of the mass, where it is not readily acted upon by the converting-blast. It also tends to become choked

75 with slag, which in that position is chilled by the air-blast, for although air blown into matte produces an intense heat air blown into slag, because of the absence of fuel values, produces a chilling effect, peculiarly

80 aggravated when the slag is mingled with ore. Moreover, even if the coke or charcoal is detached from the bottom through the agitation produced by the blast the lumps become enveloped in a coating of slag, which

85 seals them from contact with the air-blast, renders them incombustible, and in this condition they remain as an infusible obstruction floating on the molten bath that seriously interferes with the submerging of the

90 ore charge into the clean matte below. Therefore when solid fuel is used for the initial melting I discontinue it and remove it as soon as possible by tilting the converter or

95 if a stationary furnace is used by scraping

100

it out into the forehearth, thus providing a bath of clean matte in which to commence the dissolving of the ore.

After forming a molten body of clean low-
 5 grade matte by melting it in the converter in sufficient volume to cover the converting-twyers I shut the burners and start the converting-twyers into action, and thereafter feed ore to the bath preferably continuously
 10 and in small and regular quantities. By this I mean that each individual charge of cold raw ore thus fed shall constitute only a very small proportion relatively to the entire body of the molten matte contained in the
 15 converter. As soon as this process is started two distinct operations will be in progress at the same time—first, the existing body of molten low-grade matte will be rapidly oxidized and an intense white heat will be developed owing to the large volume of blast delivered through the converting-twyers; second,
 20 at the same time new supplies of fresh ore will be constantly dropping into the bath in small quantities at a time, and these will be subjected quickly to the following processes: Any contained moisture will be expelled, they will be fractured through the action of the excessive heat, their temperature will be raised to approximately that of the molten
 30 bath, they will be melted, and in the molten form they will join the remainder of the bath and will also be subjected to oxidation. During this process the slag is withdrawn from time to time by tipping the converter.
 35 The addition of new ore will increase the volume of the bath. At the same time the rapid oxidation will reduce its volume.

It will be desirable to take occasional test samples in order to determine the mineral
 40 contents of the matte and to stop the ore-feed from time to time in order to enrich the matte up to any desired degree, inasmuch as the continuous feeding of a comparatively low grade ore charge will have the effect of
 45 reducing the percentage of mineral contents. At this stage of the process the converter will be operating with a continuous feeding of ore, with twyers in full operation, without carbonaceous fuel, and with the auxiliary
 50 heat of the burners shut off. In other words, at this point in the process and thenceforth until the completion of one run I depend exclusively for the heats that enable me to perform a continuous melting process
 55 as long as I may desire to do so upon the combustion of iron, sulfur, arsenic, manganese, selenium, tellurium, and any other heat-producing elements or compounds usually found in ores. I am enabled by this
 60 means to eliminate with success objectionable impurities which cause so much trouble in other processes and to produce and continuously maintain a very high temperature.

If exceptionally refractory ores are under
 65 treatment, the heats of conversion may be

supplemented and augmented at will and to any desired extent through the addition of the auxiliary heat-flames. During the progress of the conversion the variety of ore fed to the converter should be determined by the
 70 condition of the bath, and it is important to keep the bath as free from floating slag as possible in order that the entering ore may be unobstructed in its union with the molten matter. Silicious ores of any description are
 75 added when flux is needed, and when fuel is needed ores rich in fuel values—such as the iron sulfid ores of the Butte district, which are usually low in mineral values—are utilized. Such low-value ores are at present in-
 80 capable of being used, and for this reason millions of tons thereof are now neglected in Butte and in Arizona copper-mines. In like manner pyrrhotite ores, which are invariably
 85 low in values, and all the low-grade sulfid as well as arsenic ores can be profitably used because of their great heat-producing properties. When silica flux is needed in order to separate the oxidized iron from the bath,
 90 all the quartz, gold, silver, and other ores associated with a quartz gangue that are now treated in stamp-mills or arastras, Chilean mills, and other processes of water concentration with high percentage of loss can be
 95 used, and the mineral contents can thus be recovered almost without loss. In like manner all the Butte ores, either those whose distinctive value is silver and whose gangue is usually tertiary granite, quartz, rhodocrosite, &c., as well as those Butte ores whose dis-
 100 tinctive value is copper and whose gangue is usually tertiary granite, porphyry, rhyolite, aplite, &c., may be thus used, inasmuch as the gangue of all of these is distinctly acid or silicious. My process is capable of recovering
 105 values from all ores of copper, gold, silver, nickel, and cobalt. Thus all the carbonates, oxids, cuprite, bornite, Lake Superior and Arizona virgin copper and scrap, also concentrates, mattes, &c., may be added to the
 110 bath at will and become dissolved and form a part of the molten bath with much greater economy in treatment costs and with much less mineral losses than when treated by any other known method. The best results are
 115 obtained by alternating the ore charges between ores rich in fuel and ores rich in flux and values.

When the matte has been enriched to forty per cent. copper or over, I discontinue
 120 at that time the feeding of such ores as would lower the grade of the matte and continue to blow the charge in the same converter, using silica ores as a flux until it is brought to the grade of white-metal and thereafter to blister-
 125 copper, when it may be withdrawn and cast into pigs or slabs, or when it has reached the grade of white-metal I may transfer it to a finishing-converter and then transform it to blister-copper as a means of augmenting the
 130

producing capacity of the plant. The feeding of all kinds of ore must be stopped when the grade of white-metal has been reached.

In my process without previous concentration of any kind I melt the ores quickly into a low-grade matte and thereafter, through the medium of the converting-twyers, I enrich such low-grade matte into a high-grade matte of any degree desired.

In melting an ore charge that by assay averages four per cent. of copper it has been my experience that the melted matte will approximate eight per cent. An ore charge that averages five per cent of copper will thus yield usually a matte of nine per cent. An ore charge that will average ten per cent. of copper will usually yield a matte that will assay fourteen per cent. In other words, I have found that the mere melting of the ore has the effect of enriching it approximately four per cent. without much regard to its initial average mineral contents.

Where my invention is operated, say, for instance, with an ore charge that averages six per cent. of copper, the fusion of this ore will produce a resultant matte approximating ten per cent of copper. When the converting-twyers begin to act upon a matte like this, I thenceforth depend alone upon the heats derivable from the oxidation of the impurities in order to continue the smelting operations. I can readily do this, because at this point the matte will contain ninety per cent. of oxidizable impurities that are depended upon to supply heat, whereas the ordinary converting process as at present successfully conducted even at the commencement has but one-half this percentage of oxidizable impurities for a heat-supply, or it may have even less.

The heats utilized in this process, as before stated, are very great, and for this reason I can utilize a much larger proportion of silica and produce a much lighter and more fluid silicate of iron slag than is possible in present smelter practice, and hence the globules of matte can separate by gravity more readily from my slags than from others. I am enabled in this manner to discharge as slag ninety per cent. of the entire tonnage treated without the usual losses incident to water concentration, to calcining, and to slow smelting and with less than one-half the loss of metal in foul slags that are inseparable from present practice. After this worthless tonnage has thus been automatically discharged from my furnace and after my matte has been enriched through the action of the converting-twyers up to any point that I may desire, but preferably up to a point where the matte will correspond to that usually supplied to Bessemer converters, or, say, up to from forty-five to sixty per cent., I then feed the converter again with ores containing values, but exclusively on such ores as run very

high in silica—say, for instance, eighty per cent. or over. By this means I perform in the furnace with ores containing values which I separate and recover the work heretofore done in the first stage of the converting process through the destruction of the silica lining. When the requisite volume of mineral has been thus concentrated in the vessel and the iron has been separated from the bath through the addition of silicious ores and when this material has been withdrawn from the vessel in the form of silicate of iron slag, the feeding of ores of every nature and kind is stopped at the point where the bath consists of white-metal. It may then be transferred to a finishing-converter, as before stated, or it may be carried to blister-copper in the original vessel merely by continuing the action of the converting-twyers until the desired point has been reached. Should the action of the converting-blast have an undue chilling effect on the metals, particularly toward the final stage of the process, such chilling effect may be effectually counteracted and conquered by again starting the auxiliary heat-jets into operation.

Many unsuccessful attempts have been made in the past to add silica to the charge as a means of separating the iron otherwise than by the expensive mode of supplying it from the converter-lining. In one of these unsuccessful attempts, which is typical of all the others, it was sought to deliver the requisite quantity of silica into the converter in the form of finely-powdered quartz sand by blowing it with the blast through the twyers. The results may be briefly summed up as follows:

First. In order to satisfy the iron, about one-half as much quartz sand was required as the amount of copper contained in the matte. Hence for each ten tons of copper it would be necessary to deliver into the converter about five tons of quartz sand.

Second. The quartz sand quickly cut out and destroyed the twyers.

Third. The chilling effect of this large amount of cold solid material supplemented and greatly aggravated the chilling effects of the blast itself.

Fourth. Matte is of one specific gravity, silicate-of-iron slag is of another and lighter specific gravity, while pure silica is of another and of a very much lighter specific gravity. As a result just as soon as any slag was formed the contents of the converter separated into three distinct layers. The matte occupied the bottom portion of the converter, the silicate-of-iron slag floated on it, and the pure silica floated on the slag layer. The two elements, therefore—the iron in the matte and the pure silica—were hopelessly separated and the desired union was impossible.

Fifth. In making careful examination of

the mass that had thus chilled in the converter it was found that each separate particle of quartz sand that had been driven into the converter by the blast was enveloped in a
 5 protecting layer of chilled infusible silicate-of-iron slag and that it was thus protected by a non-conducting coating against possible attack by the iron, even had they been in actual contact, which they were not. All
 10 like attempts to introduce lumps of quartz into the bath have also resulted in failure.

The experience above recited will not be repeated in my process, and the silica, slag, and matte will not separate into distinct
 15 layers, for the following reasons: First, I use highly-silicious ore to supply the silica, and the specific gravity of the ore is greater than pure silica or silicate of iron; second, the heats produced in this furnace, aided when desired
 20 by the flames from the burners, are so great that the slag itself will overcome the chill of the silica to heat it, and finally to liquefy it so long as the feeding of ore is continued; third, when it is desired to add the silica ore
 25 I remove the top layer of low-grade slag, so that the silica ore will be instantly immersed in a clean bath of very hot molten matte, where it will be quickly heated, fused, and dissolved.

30 At the conclusion of the operation after the charge has been finally withdrawn the converter is again charged with ore and the process is repeated; but at this time the percentage of fuel required to melt the charge will be
 35 materially lessened because of the heated condition of the converter-walls.

In order to expedite the process and to save labor, which in mining districts is very costly, I prefer to provide charging mechanism, by which the ore can be delivered auto-
 40 matically to the converter or furnace.

Where the stationary furnace (shown in Figs. 3 and 4) is employed in practicing my invention, I proceed as above described, except that instead of discharging the slag and
 45 copper by tipping the apparatus I withdraw them through a slag-spout and through a metal tap-hole, respectively. In the drawings, 2' represents the melting and converting
 50 chamber of the furnace, built, preferably, of thick cast metal slabs or blocks, which will resist the high temperature and will retain the heat in the furnace without abstracting it, as a thin water-jacket would do. 3' 3' are the
 55 twyers. 4' 4' are the oil-burners; 5' 5', the charging-opening; 6', the outlet for metal or matte, and 7' the outlet for slag. 8' is a bottling device for the tap-hole 6'. It has an arm 9', provided with a cup 10', adapted to
 60 hold a plug of clay or like material, which may be swung by a hand-wheel 11' to bring the plug against the tap-hole, where it is held by a locking-lever 12'. The slag-tap is preferably made adjustable to any desired extent
 65 of opening by two vertically-sliding wa-

ter-cooled sections 13' 14', the lower one of which carries the slag-spout, and which are moved by powerful mechanism, consisting of racks 16' and pinions 17'. By separating
 70 them a large opening is afforded for insertion of a rabble when it becomes necessary to skim the slag, which is formed in great volume during the operation. The slag-spout may be lowered to any extent to suit the
 75 varying level of the bath, and thus to make possible the removal of the slag under all conditions of the furnace.

I utilize water-cooled pieces in the adjustable slag-spout, notwithstanding the chilling and therefore injurious effect that they exert
 80 on the contents of the furnace, because the pieces are small in proportion to the size of the bath and their chilling effect is not great, and by water-cooling them I prevent the internal skull or lining of chilled matte or slag
 85 from forming such a tough bond as would prevent its fracture when the powerful mechanism is utilized in opening the spout for the removal of slag.

When the slag and matte or copper are
 90 withdrawn, it is necessary to shut off the blast, and for this purpose I provide the twyers with suitable plugging devices.

The upper part of the chamber 2' is contracted, as at 18', so as to form a comparatively narrow throat or passage connecting
 95 it with the upper charging portion. The walls preferably slope inwardly, and the chamber is preferably made wide and much wider at the bottom than at the throat. The
 100 heat is thus retained to any desired extent, and the splashing of the liquid matte or slag by the blast at the middle of the bath takes place at a distance from the side walls, which are therefore not apt to be incrustated thereby.
 105 The throat may be rendered variable in width by providing one or more sliding sections 19', moved inwardly and held by levers 20'. The appropriate adjustment of these
 110 sections will make it easy to maintain the heat of the furnace at the proper degree.

The furnace-bottom 21' is concave and is lined with a non-heat-conducting lining of magnesite brick or the like, which will not be
 115 destroyed by reaction with the iron oxid produced by oxidation of the matte. At the final stage of the process, when the matte has reached approximately the grade of seventy-six per cent. of copper, gold, and silver and
 120 twenty per cent. of sulfur, the charge being lessened in volume rests mainly or entirely within the concavity of the bottom, which, being a very poor conductor of heat, has the effect of holding it in liquid state during final
 125 treatment with the blast from the twyers, so that at the termination of the process it may be tapped. Should it become unduly chilled, its heat may be restored and maintained at any desired temperature by the auxiliary
 130 heat-flames.

My process of recovering values from various ores and in reducing them to actual metal may be practiced in districts far removed from transportation by providing a suitable furnace or converter, as herein described, means for providing a converting blast and a slag-boiler, as described in my patent application, Serial No. 203,486, filed April 16, 1904.

By the term "low-grade matte" used in this specification and claims I mean matte containing a less percentage of metal values and a higher percentage of fuel constituents—iron, sulfur, and the like—than is employed in present converter practice. Thus in a modern text-book it is stated that at the present time in America no copper material is regularly bessemerized, excepting matte containing over forty-five per cent. of metal values, and that a matte containing from forty-five to fifty per cent. is considered low grade when referring to the Bessemer process as usually carried out in America. As compared with this practice I provide a body of matte of lower grade than can be used in present converter practice without too rapid corrosion of the lining and employ it as a bath to which are made successive additions of value-bearing ore relatively high in silica for the purpose of enriching the bath with the contained values and fluxing the iron of the matte. The matte which I prefer to use for this purpose contains from six to twelve per cent. of metal values, since such matte can be produced readily and with economy by melting sulfid ores; but it may contain a considerably higher percentage of such values.

Within the scope of my invention the process and apparatus may be modified, since

What I claim is—

1. The method herein described of producing matte, white-metal or blister-copper in a single vessel or chamber, which consists in producing a bath by melting matte-making material in such vessel or chamber producing thereby a low-grade matte, removing slag and adding to the molten bath from time to time ore in small quantities at a time, namely in less quantities than the molten bath, blowing air through the bath and by the heat thereby developed fusing and fluxing such additions of ore; substantially as described.

2. The method herein described of producing matte, white-metal or blister-copper in a single vessel or chamber, which consists in producing a bath by melting matte-making material in such vessel or chamber with flame applied from above producing thereby a low-grade matte, adding to the molten bath from time to time ore in small quantities at a time, namely in less quantities than

the molten bath, blowing air through the bath, and by the heat thereby developed fusing and fluxing such additions of ore; substantially as described.

3. The method herein described of producing matte, white-metal or blister-copper, which consists in forming a bath of low-grade matte in a vessel or chamber, adding from time to time ore in small quantities at a time, namely in less quantities than the molten bath, blowing air through the bath, and by the heat thereby developed fusing such additions of ore, and collecting the enriched and concentrated matte or metal at the final stage of the process in a non-heat-conducting cavity in said chamber; substantially as described.

4. The method herein described which consists in forming a molten bath of low-grade matte, blowing air thereinto, adding ore relatively high in silica in small quantities at a time, namely in less quantities than the molten bath, and also adding charges of ore or matte high in fuel values in like manner, and applying the heat of a flame above the surface of the bath; substantially as described.

5. The method herein described of producing copper matte or copper, which consists in forming a bath of molten low-grade matte, blowing air thereinto, feeding to the bath ore in small quantities at a time, namely, in less quantities than the molten bath, and constricting the outlet of the resultant gases from the chamber; substantially as described.

6. The method herein described of producing copper matte or copper, which consists in forming a bath of molten low-grade matte, blowing air thereinto, feeding to the bath ore in small quantities at a time, namely, in less quantities than the molten bath, constricting the outlet of the resultant gases from the chamber, and varying the extent of constriction of the outlet conformably to the heat requirements of the bath; substantially as described.

7. The method herein described which consists in forming a molten bath of low-grade matte by melting a sulfid ore without otherwise materially increasing its percentage of metal values, blowing air thereinto, and adding silicious value-bearing ores to flux the iron of the matte and to add values thereto; substantially as described.

In testimony whereof I have hereunto set my hand.

RALPH BAGGALEY.

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