No. 789,648. PATENTED MAY 9, 1905.

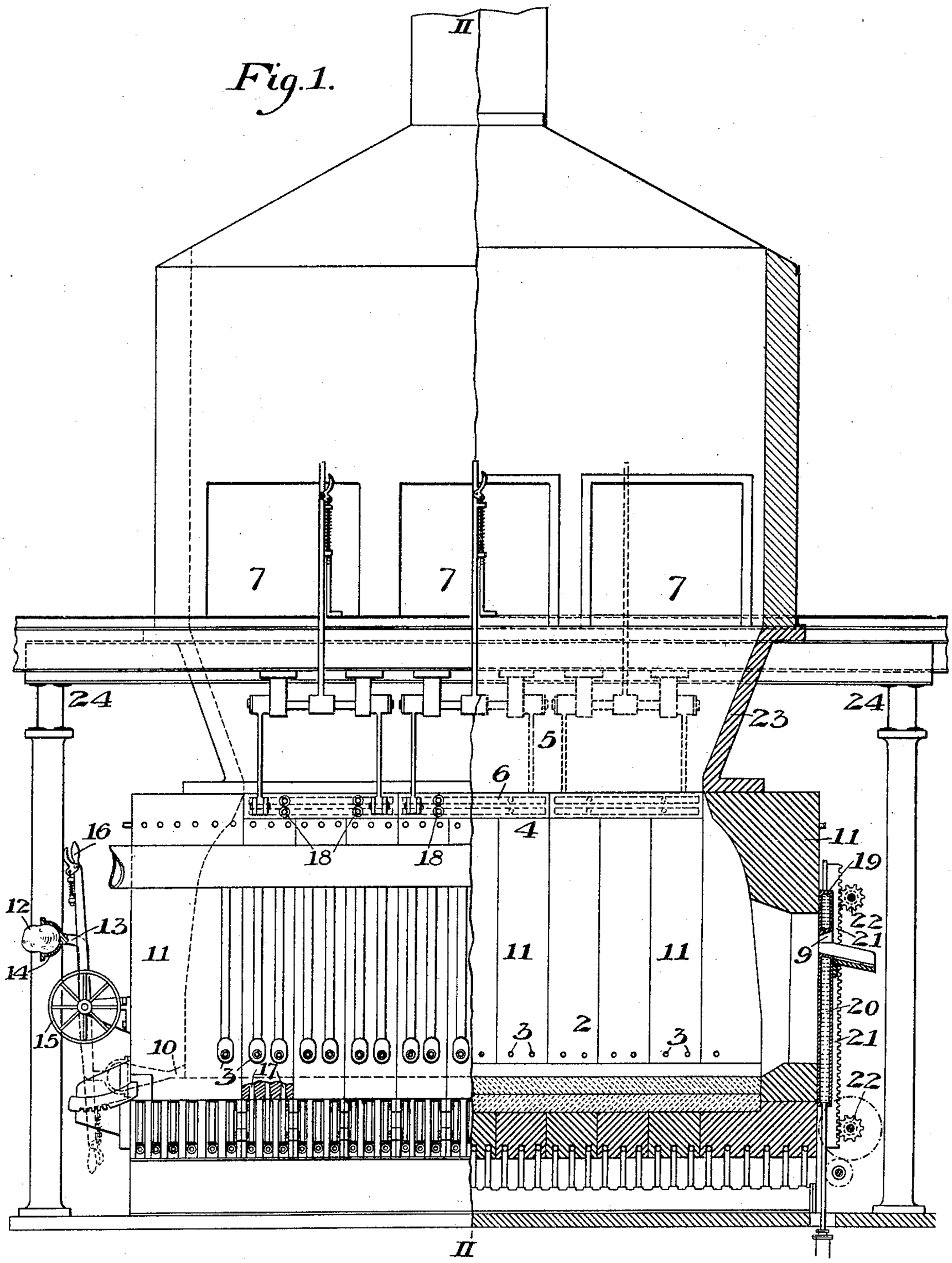
R. BAGGALEY.

METHOD OF CONTINUOUSLY PRODUCING MATTE BY DISSOLVING ORES.

APPLICATION FILED APR. 13, 1904.

2 SHEETS—SHEET 1.

Fig. 1.



WITNESSES

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2 SHEETS—SHEET 2.

Fig. 2.

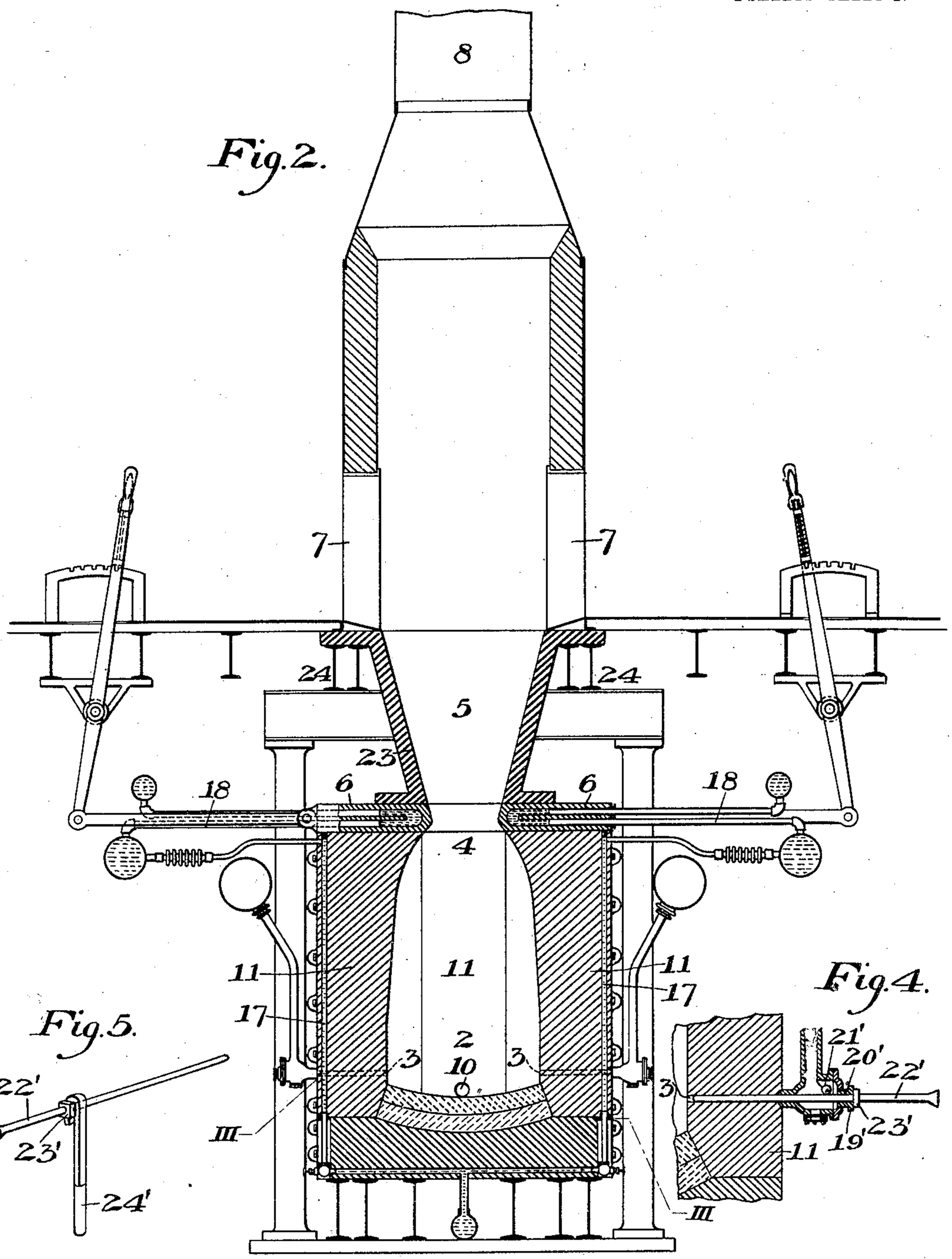
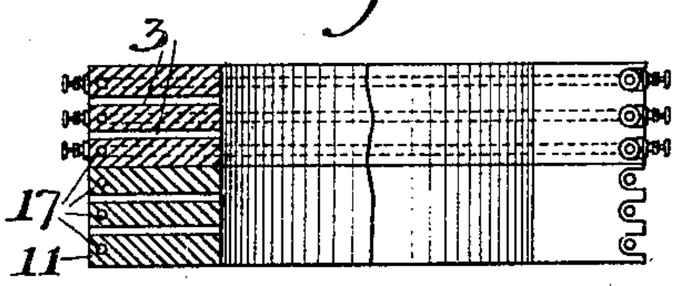


Fig. 5.

Fig. 4.

Fig. 3.



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UNITED STATES PATENT OFFICE.

RALPH BAGGALEY, OF PITTSBURG, PENNSYLVANIA.

METHOD OF CONTINUOUSLY PRODUCING MATTE BY DISSOLVING ORES.

SPECIFICATION forming part of Letters Patent No. 789,648, dated May 9, 1905.

Application filed April 13, 1904. Serial No. 202,929.

To all whom it may concern:

Be it known that I, RALPH BAGGALEY, of Pittsburg, Allegheny county, Pennsylvania, have invented a new and useful Method of Continuously Producing Matte by Dissolving Ores, of which the following is a description, reference being had to the accompanying drawings, forming part of this specification, in which—

Figure 1 shows, partly in elevation and partly in vertical longitudinal section, a furnace suitable for the practice of my invention. Fig. 2 is a vertical section on the line II II of Fig. 1. Fig. 3 is a horizontal section on the line III III of Fig. 2. Figs. 4 and 5 are detail views.

My invention provides means for producing copper mattes without the need of water concentration and calcining and without the use of carbonaceous fuel or with only a small percentage of such fuel. The many attempts which have been made heretofore to accomplish this result have been unsuccessful because it has not been understood how to control the operation and to retain the heat or to prevent the furnace from choking up with accretions of slag, matte, iron ore, and coke, and many other difficulties have been encountered which my invention obviates. The desirability of such a process, although never heretofore realized in practice, is well understood. It avoids the need of water concentration, with the great expense and the loss of mineral values incident thereto. It also avoids the calcination of the ore previous to smelting, which is expensive and wasteful. It effects a great saving in fuel, and it prevents the losses due to volatilization and to the escape of flue-dust, which have been inseparable from prior processes. It also greatly reduces the investment of capital in a plant. In short, the prior practice produced a fifty-per-cent. copper matte by water concentration, calcining, and slow smelting with from ten to twenty per cent. of coke, while in my process the raw-ore tonnage without previous concentration can be quickly smelted, nine-tenths of it discharged as worthless slag, and the remainder converted into matte.

The present practice of smelting copper ores as practiced in the Butte district is briefly as follows: The ores before being taken to the smelter are enriched by water concentration, and owing to the scarcity of water at the mines they are generally transported long distances by rail to places where the water-supply is sufficient for a concentration plant. Thus in one instance the ore is transported for thirty miles, in another fifty-four miles, and in another one hundred and seventy-two miles, causing a great expense for the hauling of the ore to the concentrating plants and sometimes in returning the concentrates to the smelter.

It is not practicable to concentrate talcky ores, because they choke the water concentrating machinery and the sticky talc carries away with it from the concentrator the entire mineral values. Hence such talcky ores must be discarded and left in the mine-workings. Low-grade ores and ores high in iron have been similarly left in the mines because they could not be profitably treated. These ores can well be used in my process.

Nine-tenths of the total ore production of Butte is concentrated with a resultant loss in mineral values of at least twenty per cent., and this, added to the cost of the necessary plant and the cost of treatment and transportation, increases the charges very largely.

After the ores have been concentrated they must be roasted in calcining-furnaces, involving an additional expense for handling and a loss of values in flue-dust and volatilization. The calcining consumes a large part of the sulfur content of the ore, while in my process the sulfur is employed usefully as a fuel for generating the necessary heat. The concentrates must be briqueted after calcining if they are to be smelted in a blast-furnace; otherwise they must be smelted in a reverberatory or Swansea furnace, and either operation is expensive.

Coke, which has heretofore been used as fuel, is also costly, for it has equaled from fifteen to twenty-five per cent. of the total charge, and in addition to its cost it displaces about six times its weight of ore, and thus reduces the capacity of the furnace.

My invention substitutes concentration by

fusion for the water concentration, calcination, and briqueting heretofore employed; it produces matte from ores with little loss and with little or no carbonaceous fuel, and it makes possible the use of ores which heretofore have not been smelted successfully.

In practicing my invention I employ a furnace preferably of the general shape shown in the drawings, although it will be understood that its form and construction may be varied in many ways—for instance, by water-jacketing. The furnace has a lower dissolving and converting portion 2 and twyers 3, which enter near the bottom, preferably as near to the bottom as is practicable, so that they will always be below the level of the bath of liquid matte. The upper portion of the chamber 2 is contracted, as at 4, so as to form a comparatively narrow neck or passage connecting it with the upper charging portion 5. The walls of the chamber 2 preferably slope inwardly, and the chamber is much wider at the bottom portion than at the throat. In this way I retain the heat in the chamber and concentrate the splashing of the liquid matte or slag produced by the blast at a distance from the side walls, so that the matte and slag when so splashed will drop back and rejoin the molten bath without settling on and incrusting the walls. The throat 4 is preferably made variable in width by providing one or more inwardly and outwardly sliding sections 6, the appropriate adjustment of which will contribute to maintaining the heat of the furnace in the proper condition.

7 7 are the charging-doors. 8 is the usual stack, 9 the slag tap or overflow, and 10 the matte-tap with its safety-bot.

The walls of the chamber 2 should be made of material which will withstand the very high temperature generated during the process without abstracting heat so rapidly as to cause chilling and clogging of the furnace. For this purpose I may make them of thick blocks 11 of cast-iron, steel, or copper, provided, if desired, with small cooling-channels near their outside faces, through which water, air under pressure, or simple ventilating air-currents may be passed, the amount of water or air and the time of passing it through these channels being governed by the working of the furnace as observed by the operator. The heavy metal blocks retain the heat in the furnace, while the water or air-currents protect the blocks. My invention may also be successfully practiced in water-jacketed furnaces suitably constructed.

12 is the safety botting device for the matte tap-hole 10. It has an arm 13, provided with a cup 14, adapted to hold a plug of clay or like material which may be swung by a hand-wheel 15 to bring the plug against the tap-hole, where it is held by a locking-lever 16. "Dollies" may be used with which this matte tap-hole is plugged by hand; but I have found that with a deep body of fiery and corrosive matte constantly in the furnace, which produces a very heavy pressure, the furnace is liable to "run away," or, in other words, the matte either when tapped or before being tapped is apt to burst out and getting beyond the control of the operator to empty or partially empty the furnace, so that the converting-twyers may become uncovered. In such an event the furnace must either be immediately replenished with a fresh charge of molten matte to cover the converting-twyers as a means of restoring the internal heats through the oxidation of the combustible compounds and elements or else the furnace must be immediately emptied; otherwise the remaining matte now below the level of the converting-twyers will soon chill and solidify in a solid block, which would necessitate taking down the entire furnace to remove it and would involve much labor and expense even then to accomplish the result.

I also show in the drawings separately valve-controlled water-cooled passages 17 in the furnace-top, connected with water-pipes 18, which are connected with water-passages in the sliding sections 6. The slag tap or overflow is preferably made adjustable by opening two vertically-sliding water-cooled walls-sections 19 20, which are operated by racks 21 and pinions 22. The bottom section carries the slag-spout, and it may be lowered to the level of the furnace-bottom, if desired, while the top piece or cover may be raised twelve inches. By separating these sections a wide opening for the insertion of a rabbling-tool is afforded when necessary, and the spout may be lowered to any desired level to enable the slag to flow by gravity. The bosh 23 of the furnace above the converting-chamber is supported independently by beams and columns 24 to permit free motion of the sliding section 6, to distribute the great weight of the furnace, and to permit the ready removal of single blocks or jackets.

In practicing my invention in the best and preferred manner I separate the so-called "sulfid" ores from the more highly silicious ores and use them both in the manner described below. The sulfid ores include ores which are relatively low in silica and high in matte-making sulfids, such as pyrite, pyrrhotite, and the various sulfids and arsenids of copper. The highly-silicious ores referred to are relatively high in silica and low in matte-making materials. The so-called "highly-silicious" ores of Butte, whose gangue is usually tertiary granite, which heretofore have been concentrated with water for the removal of the silica, are examples of this class, while all the quartz gold, silver, and copper ores, whose gangue is quartz, are other examples. All such may be used in this process.

The low silica or sulfid ores above mentioned may be smelted in my process in a fur-

nace of any suitable type, and with or without the use of carbonaceous fuel, in order to produce a low-grade matte that is high in fuel values—that is to say, high in its content of sulfur, iron, and many other oxidizable elements or compounds. The matte and slag are preferably discharged from the smelting-furnace into the usual forehearth, where the slag is separated from the matte, and the clean matte is then drawn off when required for use in the furnace shown in the drawings. This furnace having been heated by a wood fire or by burning gas or oil is then charged with a sufficiently large bath of such molten matte to submerge the twyers 3 and preferably to extend above the same to a considerable distance—say up to the level of the slag-spout. This matte is preferably clean from slag, and it should contain a relatively large proportion of combustible compounds and elements, such as iron and sulfur. It constitutes a bath in which heat is generated by oxidation and which dissolves and liquefies the additions of ore made to it from time to time.

Relatively small charges of any of the above-described silicious or sulfid ores are added to the bath from time to time through the charging-openings 5, and carbonates, oxids, concentrates, mattes, or metal may also be added if available. The blast of air, introduced in great abundance through the twyers, oxidizes the combustible ingredients of the bath—namely, the sulfur and iron and many other elements and compounds—and produces an intense heat. The oxidized iron is fluxed by the silica of the added ore and forms a floating slag, while the metallic compounds of the ores, &c., are dissolved in and become part of the molten matte. As the body of matte is enriched by oxidation its exhausted combustible elements and compounds are replaced as required by additions of the sulfid ores in solid condition, which being relatively high in fuel values supply the elements necessary for combustion by the air-blast. The slag should be drawn off from time to time through the tap-hole or overflow 9, so that the surface of the bath may be kept as clean as possible and the ready dissolving of ore may be unimpeded. During the withdrawal of the slag the blast should be shut off temporarily by plugging the twyers, and for this purpose I provide the following mechanism: At their outer ends the twyers have heads 19′ formed with openings 20′ for the insertion of a bar and blast-plugs, the openings being normally closed by ball-valves 21′. The converting-twyers are provided with cardboard bottom gaskets, Fig. 4, so that should matte escape from any cause it will burn the cardboard and flow onto the ground in a stream until the twyer has been plugged instead of solidifying in the twyer-box.

As a means of regulating and of controlling the volume of blast delivered into the bath I use bars 22′, Fig. 4, preferably made of iron, which I insert into any or all of the twyers at which I wish to shut off the blast. The bars are made large enough in diameter to practically shut off the twyers and prevent the blast from entering the furnace. For instance, if the twyer be one inch in diameter I may use a round bar seven-eighths inch in diameter or even three-quarters inch. The length of the bar is such that the shoulder 23′ will engage or strike against the wind-box on the outside, and the twyer when in this position is long enough to reach within an inch or half-inch of the point at the inside limit of the twyer-orifice, where the blast enters the matte. By inserting such bar into the twyer-hole the blast will be shut off from this one twyer, and a small quantity of matte will chill against the bar at the inner end of the orifice. This small quantity of chilled matte—say one-half inch or one inch in thickness—will at once make an air-tight joint for the blast, a non-conducting protecting layer for the end of the bar, and a seal against the escape of matte. The shoulder 23′ on this bar is preferably made square, so that it may be turned with a wrench and so that the joint between the bar and the matte-plug may thus be ruptured and the bar removed. In this case the matte seal or plug may then be removed whenever it is desired to reopen the twyer by using the ordinary punching-bar.

If desired, the shoulder on the bar may be set one or two inches farther back, and a loop of the same width may be used inside the shoulder when the bar is inserted into the twyer. This loop 24′ (shown in Fig. 5) will admit of the bar being inserted into the twyer only the exact distance required, so that its end shall be one-half or one inch distant from the inner end of the orifice end, so that the matte-seal may be formed on the inside end of the twyer-hole. When it is therefore desired to reopen the twyer, this bar can be driven in with a hammer as a means of rupturing the seal and for the removal of the bar from the twyer.

When a sufficient body of matte of the desired content of values—say a matte of forty per cent.—has accumulated in the furnace, a portion of it is tapped off for further treatment through the matte tap-hole 10, and the bath and its heat-producing power are then restored by additions of sulfid ores. The operation is thus made a continuous one.

It is important that during the progress of the operation the enrichment of the matte should not proceed too rapidly or beyond certain limits. It should never be allowed to exceed sixty per cent. in values, and it should preferably not exceed forty per cent. thereof. If the bath should become too rich in copper and the proportion of its combustible ingredients—iron, sulfur, &c.—should become as a consequence proportionally too small, its ca-

pacity to generate heat by oxidation would be so enfeebled that it would lose its power to dissolve subsequent additions of ore, and the furnace would be apt to become incrusted and the molten bath to become chilled. Should the operator observe that this is taking place, he must at once add to the bath a supply of sulfid ores containing a relatively large proportion of sulfur and iron or like combustible elements or compounds, while if the furnace is working hot and the bath is low in values, as its temperature will surely indicate, he may add to the furnace ore having less fuel-power and richer in values. Thus by observing the condition of the heats in the furnace and in accordance therewith charging ore high in combustible ingredients at one time and ore high in silica or in mineral values at another the operator can keep the furnace under perfect control and can thus operate it successfully and continuously.

An essential feature of the invention consists in the formation and in the maintenance constantly of a bath into which a blast of air is discharged and which serves as a means of generating and maintaining heat which makes it possible to constantly add silica and to flux off the iron and to augment the mineral values as a means of enriching the matte.

Another feature of my invention consists in conducting the operation in a furnace or converter having a contracted throat by which the heat is conserved and the furnace prevented from choking. These principles may be carried out in apparatus of widely-different shapes and constructed of different materials. For example, it may be practiced in suitable converters.

I claim—

1. The continuous method herein described, of producing copper matte or copper, which consists in forming a bath of molten matte, blowing air thereinto, and adding thereto from time to time solid charges of ore rich in fuel value and low in silica and other solid charges of ore rich in silica; substantially as described.

2. The continuous method herein described of producing copper matte, or copper, which consists in forming a bath of molten matte, blowing air thereinto, dissolving in the molten bath alternately, charges of solid ore containing a relatively large fuel-supply in the form of oxidizable elements or compounds and other charges containing mineral values and high in silica; substantially as described.

3. The continuous method herein described of producing copper matte which consists in forming a bath of molten matte, blowing air thereinto, feeding to the bath charges containing a relatively large fuel-supply in the form of oxidizable elements or compounds, other charges containing mineral values and high in silica, and from time to time withdrawing portions of the enriched bath and replenishing the bath with fresh additions; substantially as described.

In testimony whereof I have hereunto set my hand.

RALPH BAGGALEY.

Witnesses:
J. H. REED,
THOMAS W. BAKEWELL.