No. 712,812. Patented Nov. 4, 1902.

# W. A. KÖNEMAN.

## ORE FURNACE.

(Application filed May 19, 1899. Renewed June 14, 1902.)

(No Model.) 4 Sheets—Sheet 1.

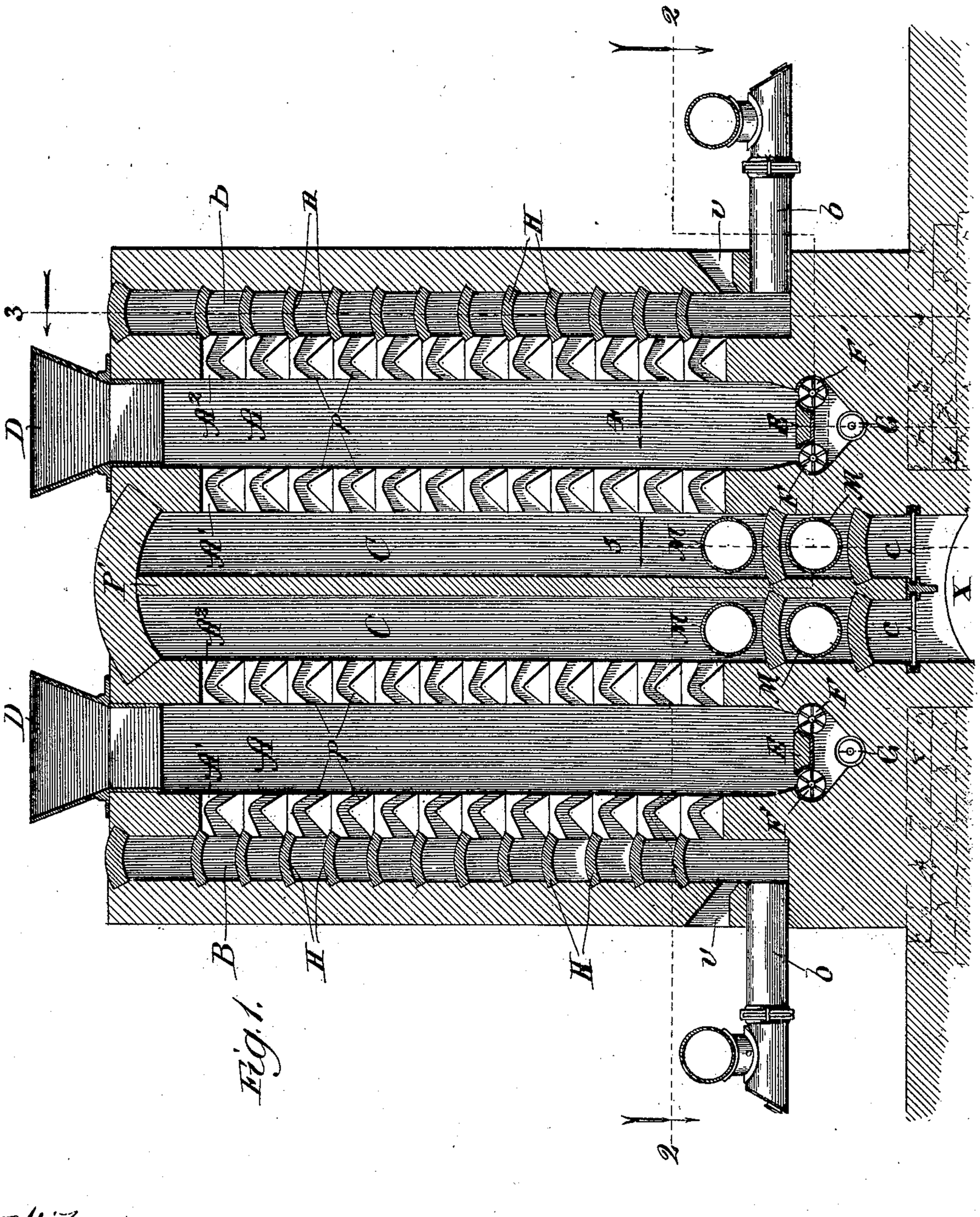


Fig. 1.

Witnesses:
Chas. E. Gaylord,
Lulu B. Peters.

Inventor:
William A. Köneman,
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Attys.

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## ORE FURNACE.

(Application filed May 19, 1899. Renewed June 14, 1902.)

(No Model.) 4 Sheets—Sheet 2.

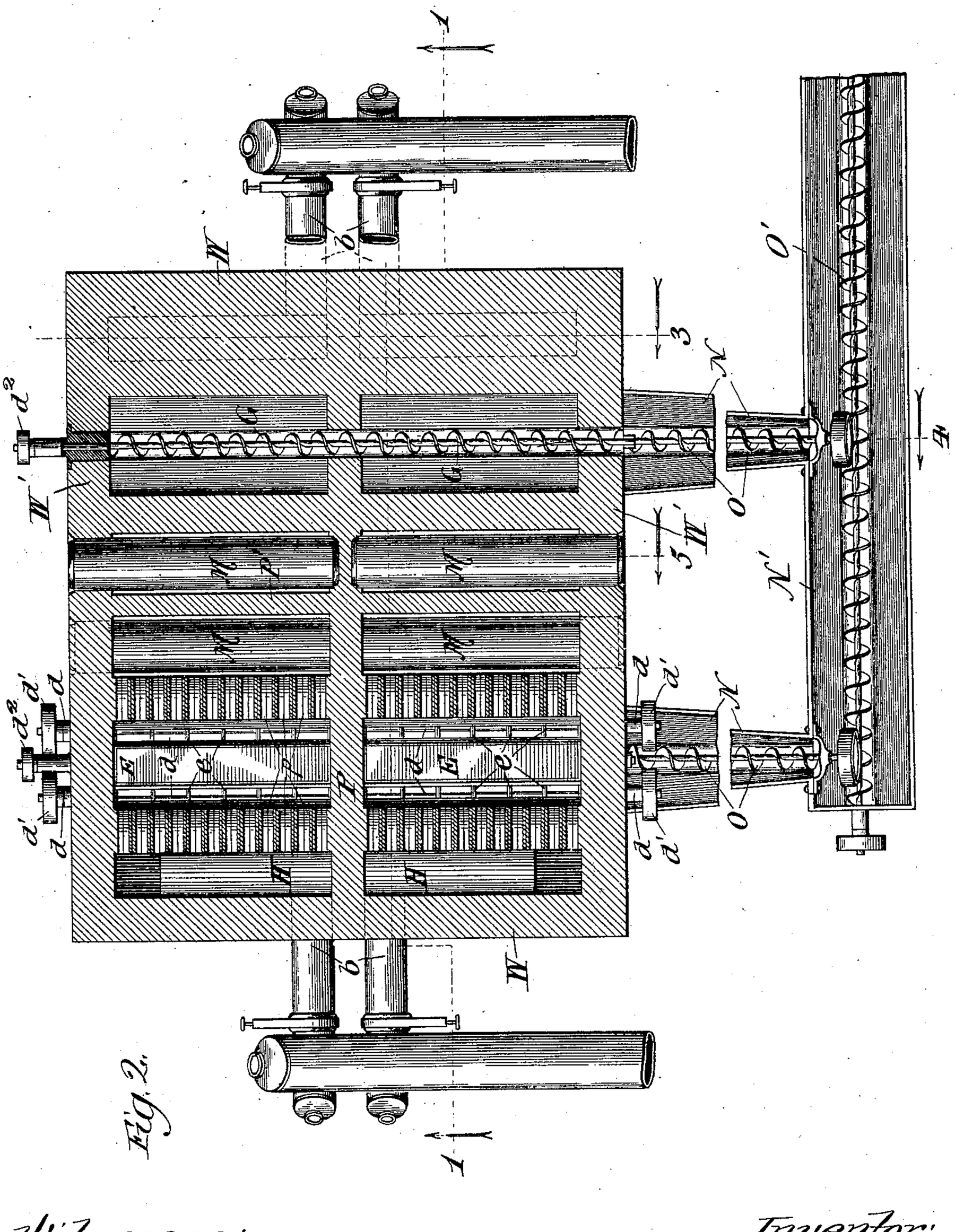


Fig. 2.

Witnesses:
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## ORE FURNACE.

(Application filed May 19, 1899. Renewed June 14, 1902.)

(No Model.) 4 Sheets—Sheet 3.

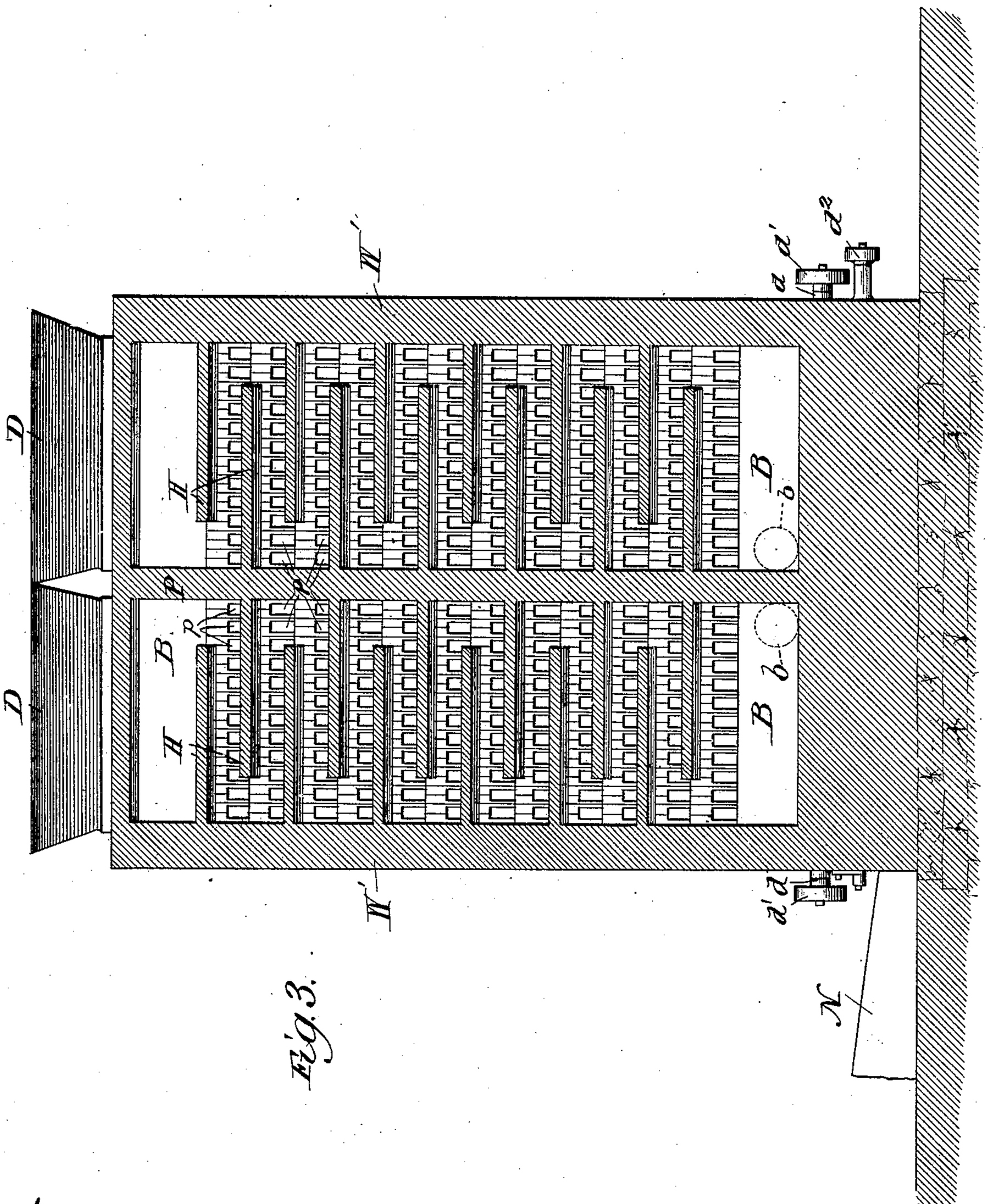


Fig. 3.

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# W. A. KÖNEMAN.

## ORE FURNACE.

(Application filed May 19, 1899. Renewed June 14, 1902.)

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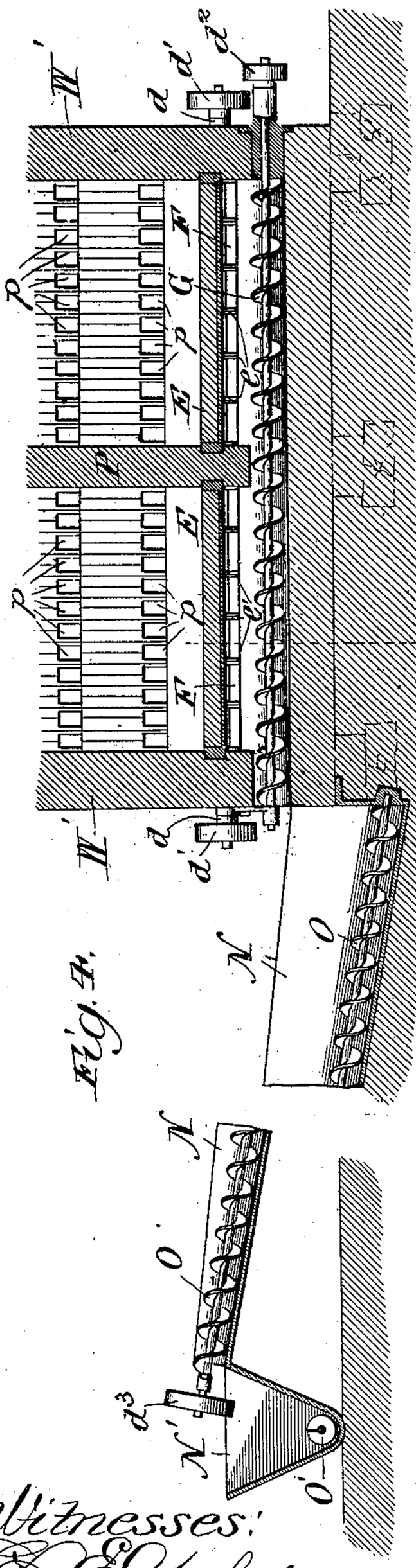


Fig. 4.

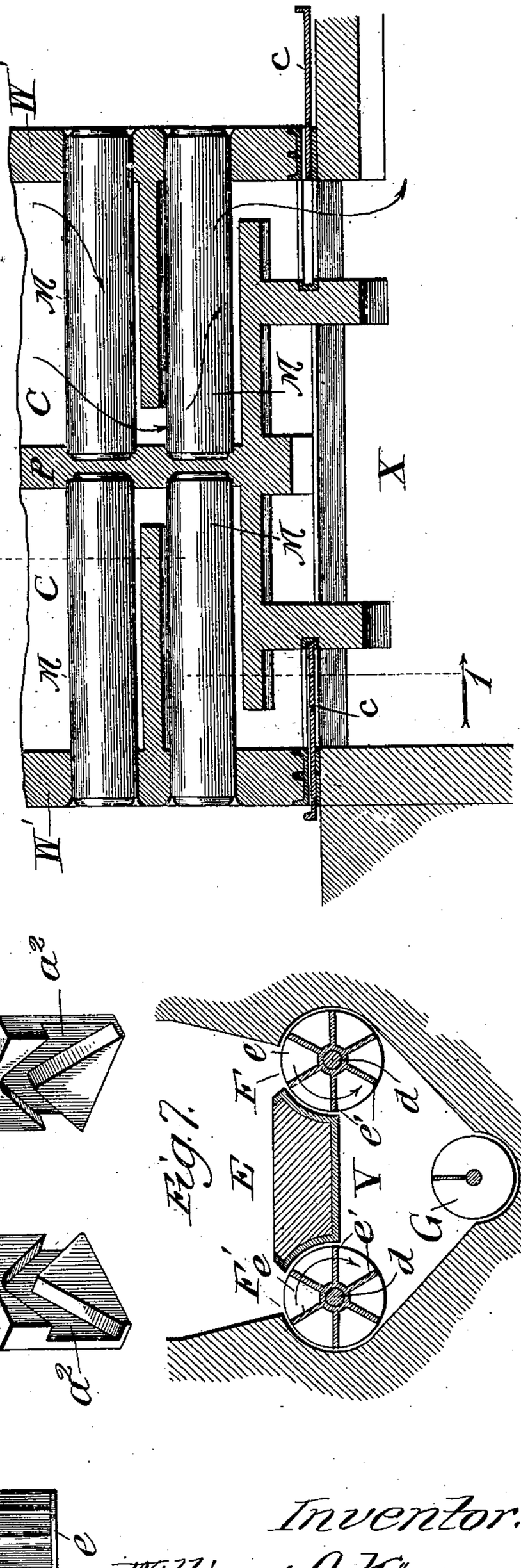


Fig. 5.




Fig. 6.




Fig. 7.




Fig. 8.

Witnesses:
Chas. E. Gaylord,
Lulie S. Alter.

Inventor:
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Attys.

# UNITED STATES PATENT OFFICE.

WILLIAM ADOLPH KÖNEMAN, OF LONDON, ENGLAND, ASSIGNOR OF ONE-HALF TO AZEL F. HATCH, OF CHICAGO, ILLINOIS.

## ORE-FURNACE.

SPECIFICATION forming part of Letters Patent No. 712,812, dated November 4, 1902.

Application filed May 19, 1899. Renewed June 14, 1902. Serial No. 111,662. (No model.)

*To all whom it may concern:*

Be it known that I, WILLIAM ADOLPH KÖNEMAN, a citizen of the United States of America, residing at London, England, (whose post-office address is 23 Moorfields, London, England,) have invented certain new and useful Improvements in Ore-Furnaces, of which the following is a specification.

My invention relates to an improved construction of an ore drying, dehydrating, and roasting furnace of the class adapted for the oxidation of metalliferous ores by passing the heat transversely through a body of the ore in a confined column.

The primary object of my invention, which involves the principle referred to of transversely permeating the column of ore with the heat for drying and roasting it, is to provide a construction of furnace whereby its action on lump ore (ore crushed to a mesh of, say, one inch, more or less) shall be equal to that of other furnaces on ore which has been preparatorily pulverized, thereby avoiding the expense of drying the ore to prepare it for pulverization and the serious dust losses and damage to machinery and men from the dust that ensue from dry pulverization, and providing for pulverization a decrepitated roasted product materially reduced in weight by roasting instead of hard unroasted rock.

To these ends my invention consists in the general construction of my improved ore-furnace; and it also consists in details of construction and combinations of parts, all as hereinafter described and claimed.

Referring to the accompanying drawings, Figure 1 is a vertical transverse section of a multiple furnace containing my improvements, the section being taken at the line 1 1 on Fig. 2 and viewed in the direction of the arrows, or at the line 1 on Fig. 5 and viewed in the direction of the arrow; Fig. 2, a section taken at the irregular line 2 2 on Fig. 1 and viewed in the direction of the arrows, but showing the boilers in elevation; Fig. 3, a section taken at the line 3 on Fig. 1 and viewed in the direction of the arrow, or at the line 3 on Fig. 2 and viewed in the direction of the arrow; Fig. 4, a broken section taken at the line 4 on Fig. 1 and viewed in the direction of the arrow, or at the line 4 on Fig. 2 and viewed in the direction of the arrow; Fig. 5, a section taken at the line 5 on Fig. 1 and viewed in the direction of the arrow, but showing the boilers in elevation; Fig. 6, perspective views of the two halves of a port-containing brick detail; Fig. 7, a section taken at the line 7 on Fig. 4 viewed in the direction of the arrow and enlarged, and Fig. 8 a plan view of one section of a cutting or delivery device detail.

While it is within my invention to provide my improvements in a single ore-channel furnace for treating a small quantity of ore at a time, I prefer to construct it with a plurality of channels, in which construction each channel is that of a furnace independent of the others, so that the multiple construction merely involves so many independent furnaces bunched together for economy and convenience of operation. The present drawings are made from a quadruple furnace which I have erected for treating simultaneously the several products of ore preparatorily reduced by a crusher set to one-inch mesh, then passed over screens to produce several products of different degrees of fineness. When the finest is that which will pass through a one-sixteenth-inch-mesh screen, the medium all that passes through a three-eighths-inch-mesh screen, but rests upon a one-sixteenth-inch-mesh screen, and the coarser that which does not pass through a three-eighths-inch-mesh screen, I find in practice the coarser material may be best treated in a furnace-channel having a diameter of four feet, the medium in a furnace having a twenty-inch channel, and the fine in a furnace having a twelve-inch channel. It is therefore often advisable to construct the quadruple-section form of furnace having two channels each four feet wide, one channel twenty inches wide, and one channel twelve inches wide for treating the differential products of screening the crushed ore. The arrangement of width of the channels should, however, always be in accordance with the character and friability of the ore under treatment.

As each section of the furnace shown involves the same construction, the following description of one section will suffice for all, it being understood that the four sections are

included in a single structure, which may be composed throughout of fire-brick, the sections being divided from each other by a longitudinal central partition-wall P and a transverse central partition-wall P'.

A is the ore-channel or ore-chamber for the column of ore to be treated, which is fed thereto through a hopper D at the upper end. This channel is formed between two walls $A' A^2$, composed of fire-brick, each brick comprising two rectangular sections $a\ a'$, placed face to face and provided on their meeting surfaces with corresponding and coinciding recesses $a^2$, preferably of the general V shape illustrated, affording ports $p$, inclining upward from their inlet ends and downward toward their outlet ends the better to hold the heat. The space between the wall A' and the outer side wall W of the structure forms a flame or combustion chamber B, having near its base an opening $v$, below which the fuel-supply enters the chamber through a pipe $b$ if the fuel employed is gas, as preferred, though it may be solid fuel. The chamber B contains two series of baffles (shown as arches H) supported along their sides in the walls W' and A and projected, respectively, from an end wall W' and the partition P, the members of each series extending short of the wall opposite that from which it projects to leave a space between its end and that wall and alternating with and lapping those of the other series to present a zigzag retarding course to the flame rising in the chamber.

The space between the wall $A^2$ and the partition P' affords an exhaust-chamber C, communicating with the combustion-chamber B through the ports $p$ in the walls $A' A^2$ and the ore chamber or channel A and communicating controllably at its base with an exhaust-flue X, (common to the chambers C of the entire set of furnaces,) the communication being controlled by a slide-valve $c$, suitably supported for its adjustment in the bottom of the exhaust-chamber. The exhaust through the flue X may be produced in a common manner either by a stack of suitable height or by an exhaust-fan, neither of which is shown, because it is too well known to require illustration.

The ore-chamber B is provided in its base with discharge mechanism comprising a longitudinal bed E, suitably supported in rigid position, coöperating with which at its opposite sides and let into them are rotatory cylindrical discharging cut-outs F and F'. Each of these discharging cut-outs comprises as its preferred construction a single shaft $d$, journaled in the opposite ends of the chamber and having secured upon it a number of abutting sections formed, like that shown at $F^2$ in Fig. 8, of two disk-shaped heads $e\ e$, connected by a number of radially-disposed blades $e'$, this sectional construction affording great strength to the blades by reason of their being reinforced at comparatively short intervals by connection with the heads. On the projecting end of each shaft $d$ is a pulley $d'$ for connecting it with a suitable driving power, (not shown,) and the connection is such as to rotate the shafts of the two devices F and F' in the contrary directions (toward the table E, indicated by the arrows on Fig. 7) to effect the discharge of the ore toward the longitudinal center of the ore-chamber beneath the table E, where the chamber is shown V-shaped in cross-section, with the discharging cut-outs let into offsets in the sides of the upper end of this V-shaped section, and a delivery worm conveyer G let into the apex and provided on its projecting end with a pulley $d^2$ for connection with a suitable driving power. (Not shown.) The receiving-trough V, afforded by the base of the chamber B below the table E, is open at one end to permit its contained conveyer to discharge the contents into an adjacent water-containing trough N, inclining upward from its receiving end nearest the furnace to a receptacle, shown as a trough N'. The trough N contains a correspondingly-inclined worm conveyer O, equipped with a pulley $d^3$ on its advance end, from which to connect it with a suitable driving power, (not shown,) and in the base of the receptacle N' is a similar conveyer O' for delivering the material from the trough N to a desired point.

The operation of the furnace as shown and with all the chambers in use is as follows: The furnace or system of furnaces is preparatorily brought to a reasonable working heat by preliminary firing, and the channels A are filled with material, such as oxidized ore or pure quartz, which requires no treatment and is only introduced as a bed for the ore to be treated to insure its passage through the entire length of ore-channel and its subjection accordingly to the full treatment. The flame from the burning fuel introduced at the bases of the chambers B ascends through the zigzag courses or passages formed therein by the arches H, the products of combustion traversing in succession all these passages and the whole horizontal length of each passage, and during the ascension the flame and heat are gradually drawn by the suction action upon the chambers C into the latter by way of the ports $p\ p$ transversely through the columns of ore in the channels A. Thus the more intense heat is absorbed in the lower section of the furnace, and inasmuch as a proportion of the heat units is abstracted between each set of arches the intensity of heat rising to the top gradually lessens, whereby a gently-heating temperature is obtained in the upper sections of the flame-chambers to subject the ore near its introduction into the chambers A only to a sufficient degree of heat to dry it. The increment of heat so imparted to and absorbed by the ore becomes reinforced during its downward passage, (while the furnace is in operation ore is constantly being

discharged by the discharging apparatus E F F′, as hereinafter described,) the heat-reinforcement and consequent rise of temperature taking place very gradually, thus assuring the removal by gentle distillation of the volatile matter contained in the ore without danger of causing fusion in the early stages of the roasting period. Thus when the ore enters the furnace the milder heat at the top is imparted to it and removes its mechanical moisture. As the ore gradually descends it loses its water of hydration, and as it becomes more and more heated in its descent the sulfur and other volatile compounds are broken up, the first atoms of these compounds are gently distilled off, and oxidation takes place under gentle heat conditions, which prevent agglutination or sintering. The heat gradually increases from zone to zone downward in the ore-channel until a temperature is reached by the ore at which the remnant of volatile compounds is subject to oxidation, and the ore finally arrives at a point between the lower ports of heat communication, where it meets a degree of temperature sufficient to produce adequate oxidation for subsequent hydrometallurgical treatment. In ores containing a large percentage of gangue rock and not exceeding ten per cent. in sulfur a dead or sweet roast may be thus obtained.

In roasting, for example, sulfid ores there is, as is well known, danger of fusion or agglutination during the first period of the reaction, where the first atom of sulfur is being removed; but after the removal of the first atom of sulfur the ore can bear a higher temperature with much less danger of fusion or agglutination, and when the volatile ingredients have been practically all removed and the ore is in a fairly advanced condition of oxidation it is necessary with most ores to impart thereto a high temperature to attain the degree of purification and oxidation necessary for working them by any hydrometallurgical process. I have found in practice that these conditions of temperature are perfectly attained by the construction of combustion-chamber and the gradual application and absorption of heat afforded by my improvement, since without them the flame and heat quickly rise to the top of the combustion-chamber and eventually produce what may be termed a "regenerative" condition of heat in the top of the chamber, thereby causing the overheating of the top section of the ore, which it is most essential to avoid.

By keeping the hoppers D filled with ore and abstracting a certain quantity continuously at the bases of the channels A by the action of the discharging cut-outs F F′ and conveyers G the ore in the channels is kept in continual slight motion, thereby producing what may be termed an "automatic rabbling action," whereby practically each piece of the ore presents during its motion fresh surfaces to be acted on by the oxidizing medium. The abstraction of the finished ore may, however, be performed intermittently, and I find it desirable to cause the shafts *d* nearest the exhaust-chambers to rotate at a slower rate of speed than those nearest the combustion-chambers—say at the relative rates of four revolutions of the former to five or six of the latter, though depending on the character of the ore undergoing treatment, upon the amount of heat carried, and the amount of exhaust applied to the chambers C. The discharging device F E F′, moreover, affords a constant lock against the removal of ore when it is not desired to remove it.

It is important for the proper operation of the furnace that the exhaust shall be applied to the base of the chambers C, since when applied to the top an undue acceleration of the draft is caused at the upper ports *p* of the ore-chambers, and consequently an undue amount of suction on the upper arches H in the combustion-chambers, which induces unduly-rapid rise of the heat between the arches, while the suction applied to the bases of the chambers exerts the greatest effect on the lower ports, with the result that the greater amount of heat is drawn through them where it is most needed.

By dropping the hot ore from the trough-shaped sections V of the chambers A into the inclined receiving-troughs N, containing water, the ore is decrepitated, which facilitates its subsequent pulverization, and the water removes from the structural interstices of the ore whatever gaseous furnace products they may have absorbed, which act detrimentally in the subsequent treatment of the ore, especially if it involves the employment of cyanidation, owing to the lack in the ore itself of sufficient oxygen to enable the solution to act. The inclination of the trough N enhances the removal from the ore of these furnace products, (principally nitrogen and carbonic acid,) since the conveyer O gradually raises the ore from the water and allows it to drain in its outward passage, so that the ore is in a comparatively dry condition when it enters the receptacle N′.

Of course more or less waste heat escapes from the furnace through the chambers C and flue X. This may, however, be utilized to advantage, as where the production of distilled water is desirable, by interposing a series of short boilers (indicated at M in Fig. 1) in each exhaust-chamber in the path of the hot products of combustion to the flue.

The time of treatment required varies with the character of the ore; but I have found that ore containing seven per cent. sulfur, eight per cent. lime, and two and one-half per cent. each of potash and soda (all contained in a silicious gangue and the whole being a dioritic ore) may be brought to a dead or sweet roast condition in about thirty-six hours with an actual fuel consumption of

about one hundred and twenty-five pounds of coal to a long ton (two thousand two hundred and forty pounds) of the ore.

What I claim as new, and desire to secure by Letters Patent, is—

1. In an ore-furnace, the combination of a vertical combustion-chamber divided by horizontal baffles into passages, each opening into that immediately above it, whereby the products of combustion in rising through the chamber traverse in succession all the passages and the whole length of each passage, a vertical exhaust-chamber, walls spaced apart to form said combustion and exhaust chambers and containing numerous ports throughout their height, and an ore-chamber between said walls provided with a feed-inlet at its upper end and with a discharge-outlet at its base.

2. In an ore-furnace, the combination of a vertical combustion-chamber containing series of horizontal arches extending alternately from opposite walls to lap each other and form a series of horizontal parallel passages open at alternate ends to cause each passage to communicate with that immediately above it and the products of combustion in rising through said chamber to traverse all said passages in succession and the whole length of each passage, a vertical exhaust-chamber, walls spaced apart to form said combustion and exhaust chambers and containing numerous ports throughout their height, and an ore-chamber between said walls provided with a feed-inlet at its upper end and with a discharge-outlet at its base.

3. In an ore-furnace, the combination of a vertical combustion-chamber divided by horizontal baffles into passages each opening into that immediately above it, whereby the products of combustion in rising through the chamber traverse in succession all the passages and the whole length of each passage, a vertical exhaust-chamber, walls spaced apart to afford said combustion and exhaust chambers and formed with half-brick sections each provided on one side with a V-shaped recess, the recessed surfaces facing each other and forming ports *p*, and an ore-chamber between said walls provided with a feed-inlet at its upper end and with a discharge-outlet at its base.

4. In an ore-furnace, the combination of a vertical combustion-chamber divided by horizontal baffles into passages each opening into that immediately above it, whereby the products of combustion in rising through the chamber traverse in succession all the passages and the whole length of each passage, a vertical exhaust-chamber, walls spaced apart to form said combustion and exhaust chambers and containing numerous ports throughout their height, an ore-channel between said walls provided with a feed-inlet at its upper end, and a base in said ore-channel formed with ore-discharging mechanism.

5. In an ore-furnace, the combination with the vertical combustion-chamber and vertical exhaust-chamber having opposing walls containing ports through which said chambers communicate, of an ore-channel formed between said walls provided with a feed-inlet at its upper end and with a discharging-base comprising a flat table and rotary cylindrical cut-outs at opposite sides of the table, substantially as and for the purpose set forth.

6. In an ore-furnace, the combination with the vertical combustion-chamber and the vertical exhaust-chamber having opposing walls containing ports through which said chambers communicate, of an ore-channel formed between said walls provided with a feed-inlet at its upper end and with a discharging-base comprising a table and rotary cut-outs at opposite sides of the table, each formed of a shaft and cylindrical sections secured thereon, composed of heads and blades extending radially between them, substantially as and for the purpose set forth.

7. In an ore-furnace, the combination of a vertical combustion-chamber divided by horizontal baffles into passages each opening into that immediately above it, whereby the products of combustion in rising through the chamber traverse in succession all the passages and the whole length of each passage, a vertical exhaust-chamber, an exhaust-flue into which said exhaust-chamber opens at the base of said chamber, walls spaced apart to form said combustion and exhaust chambers and containing numerous ports throughout their height, and an ore-chamber between said walls provided with a feed-inlet at its upper end and with a discharge-outlet at its base.

8. An ore-furnace comprising, in combination, a plurality of vertical combustion-chambers each divided by horizontal baffles into passages each opening into that immediately above it, whereby the products of combustion in rising through the chamber traverse in succession all the passages and the whole length of each passage, a vertical exhaust-chamber for each combustion-chamber, separated therefrom by spaced walls containing numerous ports throughout their height and forming between them an ore-channel provided with a feed-inlet at its upper end, a discharging apparatus in the bottom of each ore-channel, and an exhaust-flue at the bases of and common to all said exhaust-chambers and having valve-controlled communication therewith.

In testimony whereof I have hereunto set my hand in the presence of the two subscribing witnesses.

WILLIAM ADOLPH KÖNEMAN.

Witnesses:
HAROLD WADE,
HARRY S. BRIDGES.