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W. A. KONEMAN.

PROCESS OF AND APPARATUS FOR ROASTING ORES.

No. 560,412. Patented May 19, 1896.

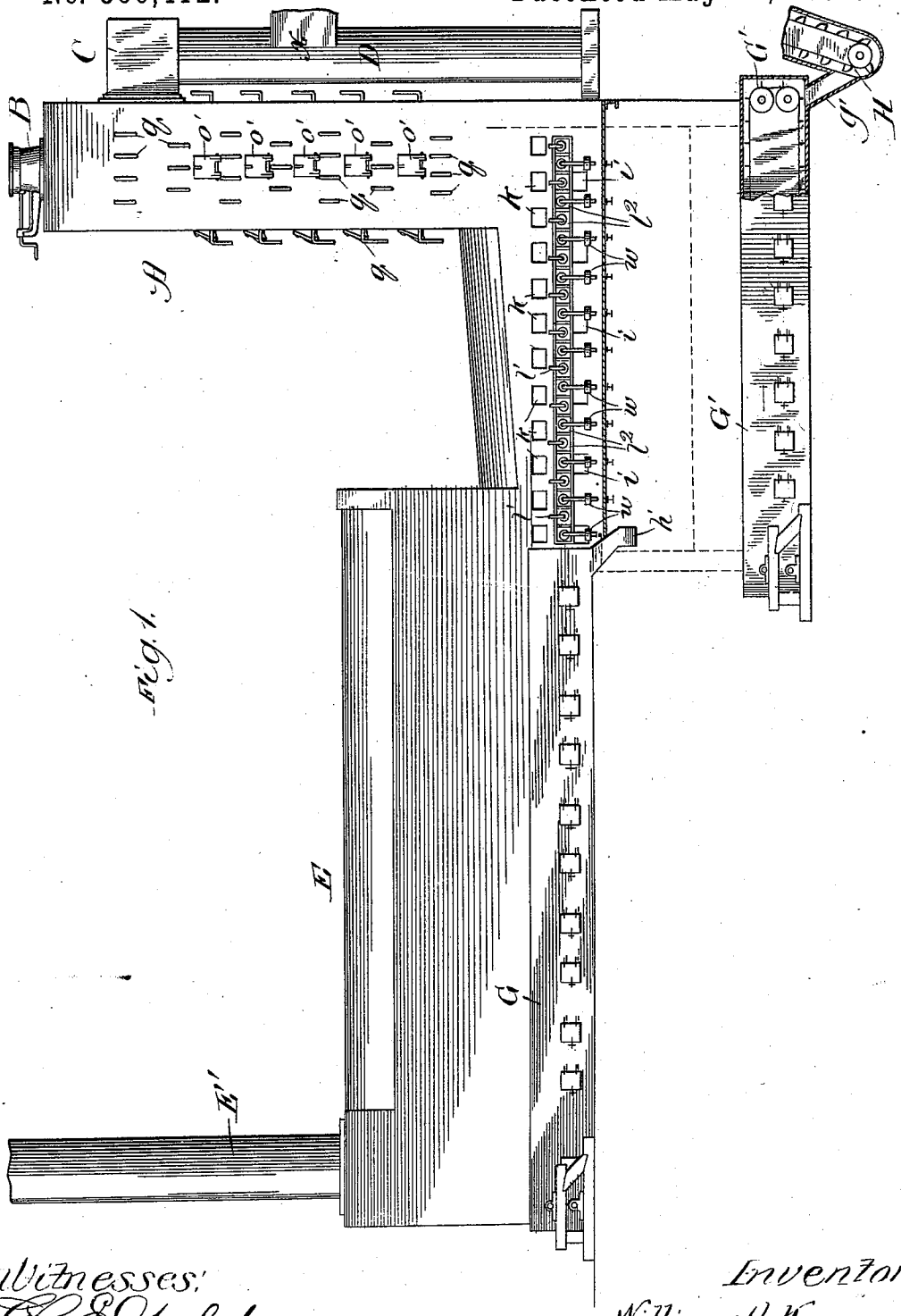

Fig. 1.

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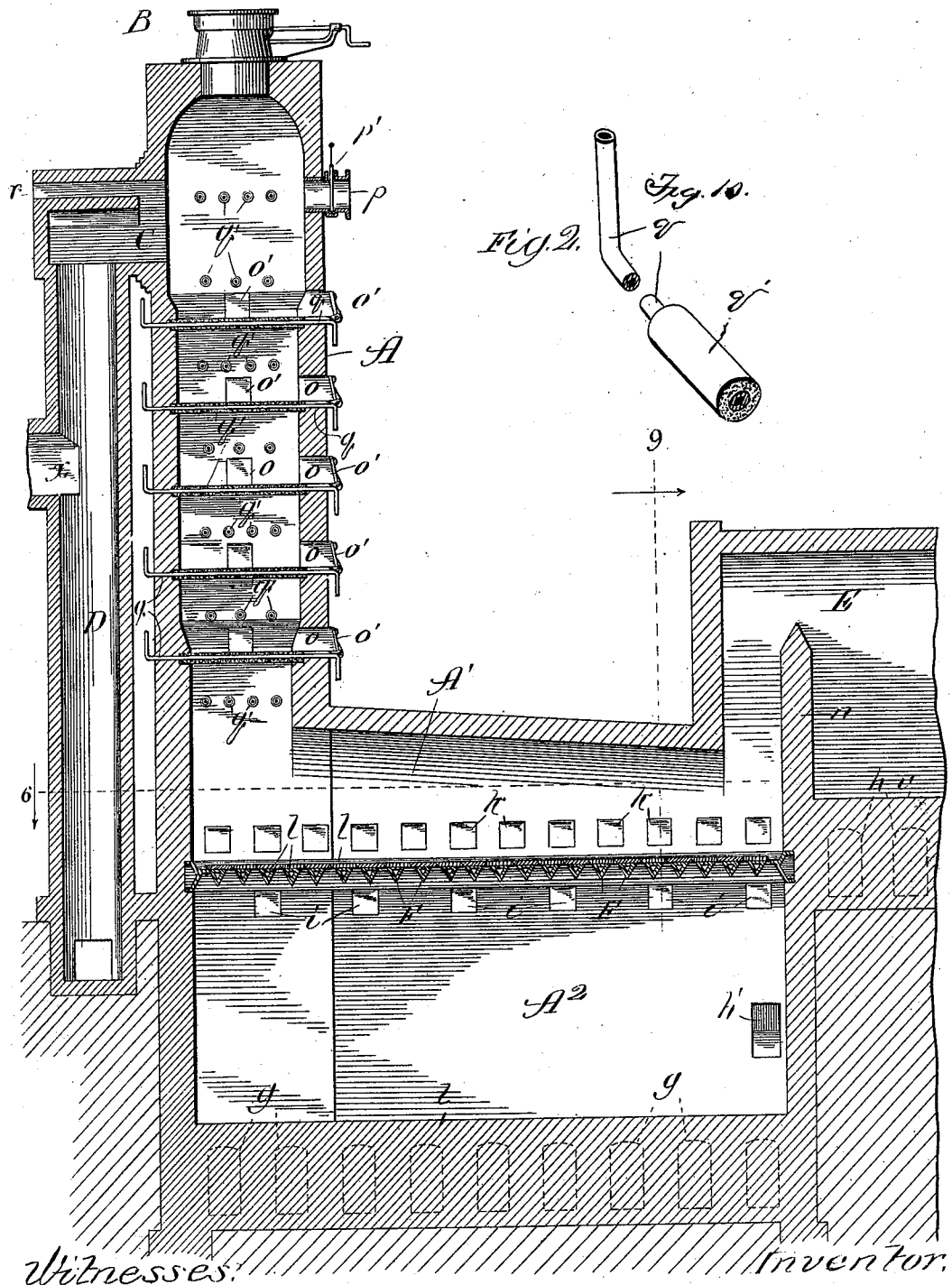

Fig. 2.

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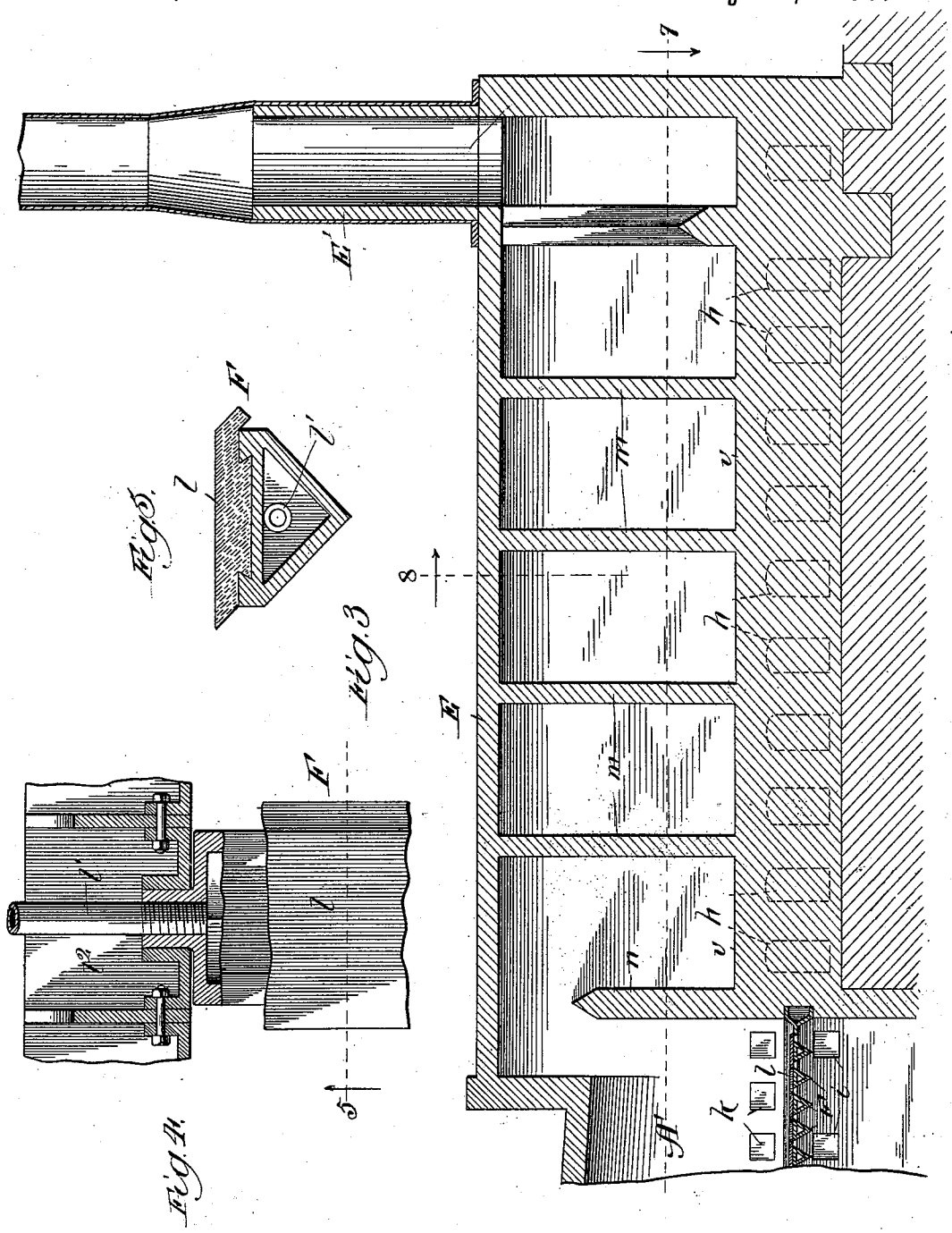

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(No Model.) 5 Sheets—Sheet 4.

W. A. KONEMAN.

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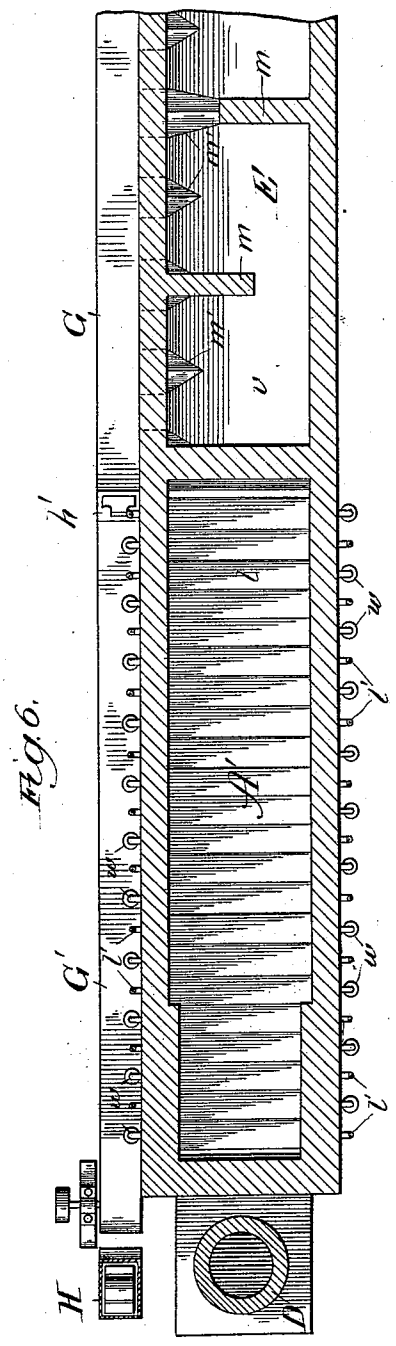

Fig. 6.

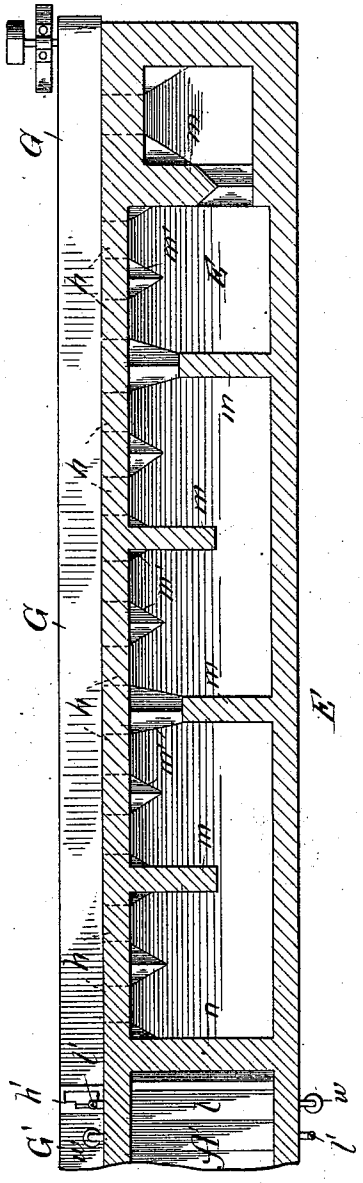

Fig. 7.

Witnesses:
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(No Model.) 5 Sheets—Sheet 5.

W. A. KONEMAN.

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Fig. 8.

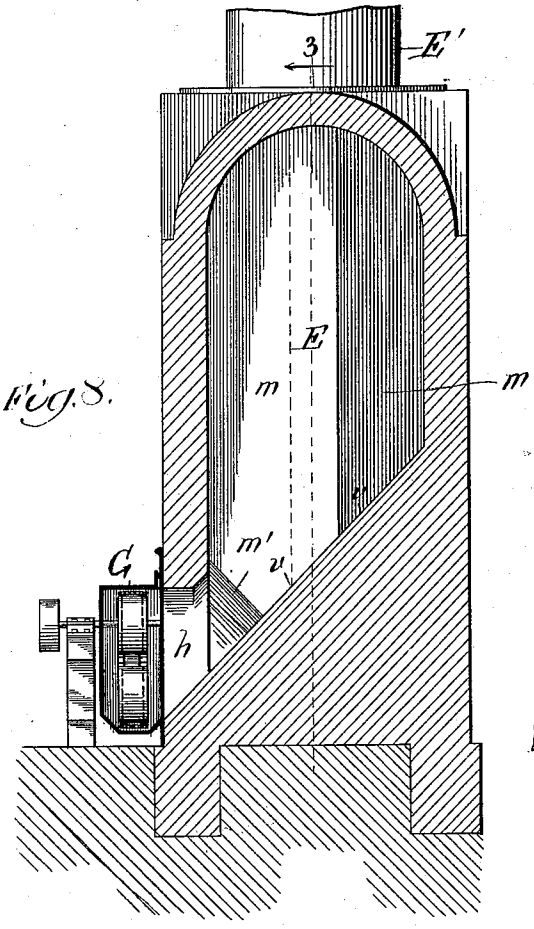
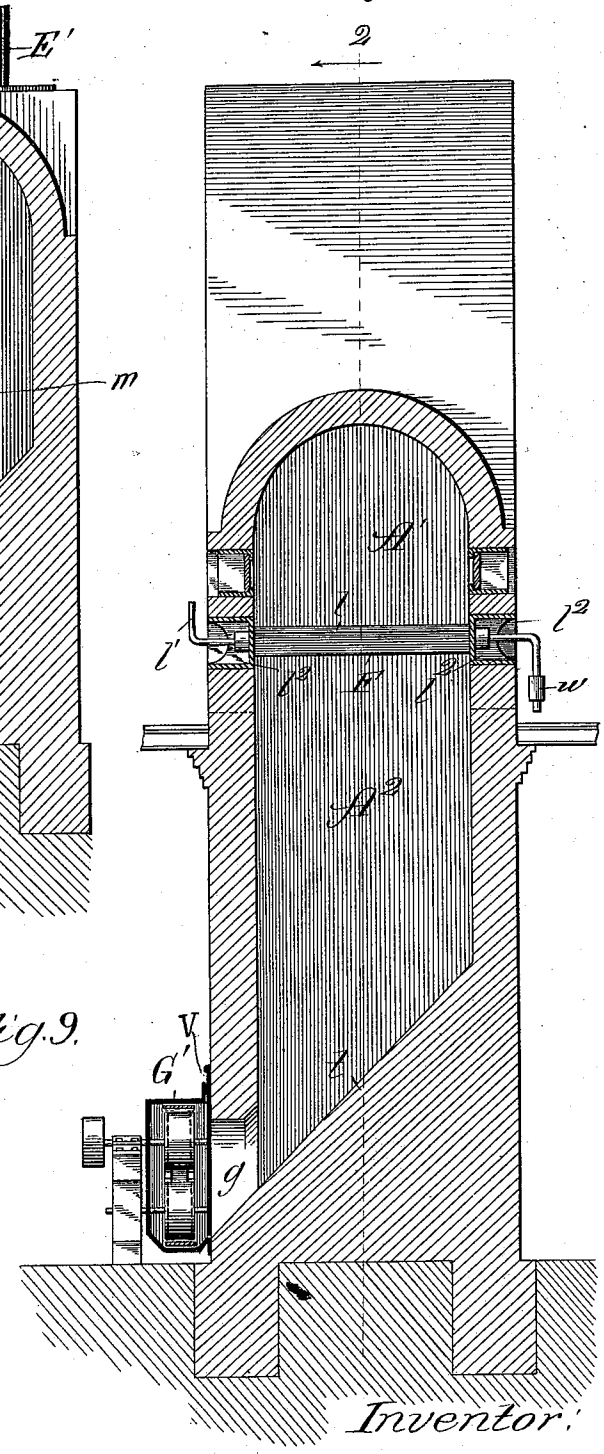


Fig. 9.



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UNITED STATES PATENT OFFICE.

WILLIAM A. KONEMAN, OF CHICAGO, ILLINOIS.

PROCESS OF AND APPARATUS FOR ROASTING ORES.

SPECIFICATION forming part of Letters Patent No. 560,412, dated May 19, 1896.

Application filed March 6, 1894. Renewed October 24, 1895. Serial No. 566,781. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM A. KONEMAN, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a new and useful Improvement in Ore-Roasting Processes and Apparatus, of which the following is a specification.

My invention relates to that step in the treatment of precious-metal-bearing ore known as "roasting" it when in a pulverized condition, and it is especially designed to afford an improvement in the ore-roasting procedure as carried on in a type of roasting-furnace known as the "Stetefeldt," which is designed more particularly for the treatment of what are commonly termed "dry" or "milling" ores, and wherein the pulverized ore is caused to feed downward in a shaft through flames rising in the latter, the current of which carries the lighter particles of the ore with them downward through an adjacent shaft to a deposit-chamber, leading to the outlet-flue for the products of combustion, and along which chamber these particles are deposited in hoppers. Among the objections to the Stetefeldt type of furnace which it is my object to overcome may be mentioned that the coarser ore, which drops through the uprising flame to the bottom of the initial shaft, is subjected to insufficient roasting by reason of falling past the fire and past the zone of heat before being thoroughly roasted, though the finer particles, carried over by the currents of the hot products of combustion, are thoroughly roasted, though only by subjection to supplemental heat, and what is considered a fair product of the treatment, in the sense of being adapted by it for extraction of the precious metals on a commercially-paying basis, is obtained by mixing together the insufficiently roasted coarse ore and the more thoroughly roasted fine ore. I overcome the objection referred to by maintaining all the pulverized ore throughout the roasting operation under subjection to the heat and by providing for obtaining the application of the greater heat to the coarser and heavier particles.

Generally stated, my improved apparatus involves an adequately high shaft through which the pulverized ore to be treated is caused to fall under retardation with the descending flame, which passes from the base of the shaft through a furnace-chamber having its floor or bottom formed as a continuous and unobstructed floor with a series of dumping-valves along which the particles of ore carried by the heat-currents are deposited, according to their specific gravity. In this chamber the ore is subjected to a reverberatory-furnace action from above. Below the dumping-valve floor of the furnace is a large storage-chamber into which the deposit on the valves may be dumped from time to time, and in this chamber the hot ore is confined for a comparatively long period of time—say twenty-four hours—under subjection to the addition of a suitable proportion of carbon, preferably in pulverized form, the consumption of which in the presence of the hot ore eliminates by volatilization from the latter, and more especially from the gold atoms it may contain, the deleterious volatile ingredients—such as sulfur, arsenic, tellurium, and antimony—which, when present in the subsequent amalgamating treatment to which the ore is subjected, tend to deteriorate the mercury and hinder amalgamation. Air which finds its way into the storage-chamber is highly heated therein, and when it enters the upper furnace-chamber through the dumping-floor, as when sections of the latter are dumped, it rises through and oxidizes the ore in the upper chamber. The subchamber may also be used for chloridizing silver-bearing ore, and the salt used may have pulverized carbon mixed with it. This prolonged carbon or chloridizing treatment is therefore properly a refining process, or it may be termed a "sweating process," and it constitutes the principal feature in my invention as a process in the treatment of the ore by roasting. Practically all these ores are associated with more or less positive metals in some form in the shape of sulfids, arsenides, &c. By first oxidizing these in the primary furnace they are introduced into the storage-chamber as oxids, so that by retaining them for a prolonged period in the storage-chamber in an incandescent condition with carbon they become reduced to a metallic or submetallic state, thus forming metallic iron, copper, &c., which readily combine with any sulfur, arsenic, and like impurities (owing to their affinity for the latter)

which may still be associated with the precious metal, thus setting the latter free. On the other hand, the volatile metal oxids, as antimony and tellurium oxids, &c., by contact with incandescent carbon, become reduced to the metallic state and volatilize while the temperature in the storage-chamber is maintained above the volatilization-point of the metal. It is this gradual reduction to the metallic state of all metals and volatilization of the volatile metals which I intend to signify by the term "sweating." If a fine particle of gold will not readily amalgamate with mercury, it may be made to amalgamate readily by heating it to incandescence and maintaining it in that condition for a time, because it is restored to its normal condition by this heating, which I intend to imply by the term "annealing."

Referring to the accompanying drawings, in which my improved apparatus is illustrated in all its details, Figure 1 shows my improved roasting-furnace by a view in side elevation and partly broken. Fig. 2 is a broken section of the same, taken at the line 2 on Fig. 9 and viewed in the direction of the arrow. Fig. 3 is a section taken at the line 3 on Fig. 8 and viewed in the direction of the arrow. Fig. 4 is a partly-sectional plan view of a broken section of one of the floor-valves presented on an enlarged scale. Fig. 5 is a section taken at the line 5 on Fig. 4 and viewed in the direction of the arrow. Fig. 6 is a section taken at the line 6 on Fig. 2 and viewed in the direction of the arrow. Figs. 7 and 8 are sections taken, respectively, at the lines 7 and 8 on Fig. 3 and viewed as indicated by arrows. Fig. 9 is a section taken at the line 9 on Fig. 2 and viewed in the direction of the arrow. Fig. 10 is a broken perspective view showing the hollow stagger-bar construction.

A is an upright shaft of considerable height, provided at its top with a feed B of any suitable construction for pulverized ore, and into the shaft leads a combustion-chamber C, supplied with air through an upper passage r and communicating with a flue D, which may lead from a fuel-gas source of supply, such as a producer, (not shown,) leading into its base and also, if desired, above its base with an inlet x for products of combustion from other suitable fuel to be used instead of the fuel-gas supply. At intervals down the shaft are provided series of stagger-bars q, the series extending alternately at right angles to each other. The bars q are tubular and rest near their opposite ends in the walls of the shaft, beyond which they are bent each to extend upward at one end and downward at the opposite end the better to produce through it a draft of air for its cooling effect, and within the shaft each bar is inclosed in an envelop q' of refractory material, such as fire-clay. Near the upper end of the shaft, at one side thereof, is shown a gas-draw-off opening p, containing a slide-valve p', and at intervals down the walls of the shaft are openings o, covered at their outer ends by doors o', hinged at their bases and slanting thence upward toward the shaft to remain closed by gravity, the openings affording means of access to or inspection of the interior of the shaft, though they are mainly provided as vents for the escape of the gases in case of overpressure or explosion produced in the shaft by their combustion, whereby the doors will readily open and thus injury to the shaft structure is avoided in such cases.

From one side of the base of the shaft A leads the horizontally-extending furnace-chamber A′, which opens at its outer end into an elongated dust-intercepting chamber E, leading to a stack E′, and the entrance to which is reduced and obstructed by a vertical wall n. The chamber A′ is constructed on the principle of a reverberatory furnace, the fundamental requirement in which is that the roof shall be at such a limited distance from the bottom that the heat radiating from the former may reverberate and act on the ore on the latter. At intervals along the chamber E are intercepting walls m, extending alternately from each side wall short of the opposite wall and between which and at their bases are the inwardly V-shaped projections m', tending the better to deflect the currents. The bottom portion of the chamber E slants downward, as shown at v in Fig. 8, from one side to the other, at which latter are the outlet-openings h in the chamber-wall (see Fig. 8) leading to an incased conveyer G of any suitable construction, which discharges into the chamber A′ through a spout h'. (See Fig. 1.)

The bottom or floor of the chamber A′ covers the carbonizing or chloridizing chamber A^2 and is formed with a series of dumping-valves F, affording a working floor and of peculiar construction, described as follows: Each valve F comprises a hollow metal body of triangular shape in cross-section and having a dovetailed seat in its upper flat side to hold a top l of fire-brick tile, the length of the valve adapting it to fit the transverse dimension of the chamber, pipes l', extending into the valve-body through its ends from beyond the opposite chamber-walls where those at one end are bent upward and those at the other end downward, the better to induce air-circulation through the hollow body of the valve, the depending pipe end carrying a weight w to maintain the valve in its normal position with the flat side uppermost, and the valve is journaled at its ends in bearings l^2, (see Figs. 4 and 9,) provided in openings in the opposite walls of the chamber A′.

In a wall of the chamber A′, just above the plane of the dumping-valve floor, is provided a series of openings k, through which to inspect and manipulate the material when necessary, and in the upper part of a wall of the chamber A^2 is provided a series of openings i, through which to introduce into the carbonizing-chamber the supply of pulverized

carbon or salt, or a mixture of both. The chamber A^2, like the chamber E, slants downward, as shown at *t* in Fig. 9, from one side to the other to outlet-openings *g* in the chamber-wall leading to an incased conveyer G', which may be like the conveyer G, and which discharges into a chute *g'*, Fig. 1, which may lead to an elevator H for conveying the material to the point of further treatment, as to a cooler. (Not shown.)

The operation is as follows: Pulverized ore is fed into the shaft A from its top with the hot products of combustion from the flue D and chamber C and drops through the shaft, wherein its fall and consequent subjection during suspension to the effect of the heat are prolonged by the bars *q*. Eventually the heavier particles of the ore deposit on the tile floor of the chamber A' at its end nearest the shaft, the lighter particles being carried with the current of heat along the chamber, on the dumping-floor of which they deposit according to their specific gravity. The very light particles are carried into the chamber E, in which they are more and more intercepted by the walls *m*, till the gases which escape into the stack are practically freed from ore, of which that withheld by the chamber E is directed to the elevator G and carried by the latter into the chamber A^2. From time to time the valves F are upset one at a time to dump the deposits of hot pulverized ore upon them into the chamber A^2, and into the latter are introduced from time to time, as required, through the openings *k* or *i*, pulverized carbon, which is ignited by the heat of the ore with which it is mixed and burned with the desired refining effect thereon, or salt, if the ore is of a nature requiring treatment by chloridizing, when pulverized carbon may advantageously be mixed with the salt. The operation of the conveyer G' should be such as to carry away during a certain period—say each hour and continuously—a proportionate quantity of the material in the chamber A^2, about equal to that introduced from the chamber A' during the same period, and as it is desired that the duration of time for the confinement of the ore in the chamber A^2 under subjection to the carbon or salt shall be about twenty-four hours, the quantity supplied and that withdrawn during each hour of the run should each be about one twenty-fourth of the capacity of the furnace, which I intend shall be about eighty to one hundred tons. The openings to the conveyer G' are shown to be controllable by vertically-adjustable valves V, to be closed for preventing discharge of the ore into the conveyer until it has been subjected to the treatment in chamber A^2 for a sufficiently long period. As will be seen, while the heat of the gases becomes expended in their course through the chamber A' to the stack, the reduction is more or less in accordance with the graduation in the size of the particles of the ore in the order of their deposit on the valve-floor F, whereby the coarser particles are subjected to the greater heat, and all of the ore is constantly presented during the period of its retention in the furnace-chamber A', to the roasting-heat. Moreover, as will be seen, the ore is subjected in the chamber A' to a reverberatory-furnace action from above (the roof of the chamber) and to the oxidizing action from below of hot air, which gains access to the furnace-chamber from the storage-chamber, and when the ore leaves the chamber A^2 it is uniformly roasted to the extent of so thoroughly refining it as to greatly enhance its amalgamating condition.

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

1. The process of roasting metalliferous ores, which consists in showering ore, in a pulverized condition, through a downward course together with a downdraft flame and retarding the acceleration of its motion in falling, diverting the fallen ore and flame into a lateral course and therein subjecting it simultaneously to a reverberatory-furnace action from above and to the oxidizing action of uprising air from below, removing the ore while in an incandescent state from said lateral course and storing and subjecting it for a prolonged period of time to the action of carbonaceous or other material by introducing pulverized carbon or such other material into contact with it, substantially as and for the purpose set forth.

2. In an ore-roasting furnace, the combination of a shaft having an inlet for pulverized ore at its upper end and communicating near its upper end with the medium of heat supply, a depositing-chamber for the ore, constructed on the principle of a reverberatory furnace, as described, and extending laterally from the base portion of the shaft and having a dumping-floor comprising a series of rotatably-supported valves, an ore-intercepting chamber leading from the depositing-chamber to the stack, and a storage-chamber below said floor, substantially as and for the purpose set forth.

3. In an ore-roasting furnace, the combination of a shaft having an inlet for pulverized ore at its upper end and communicating near its upper end with the medium of heat supply, a depositing-chamber for the ore extending laterally from the base portion of the shaft and having a dumping-floor, a chamber A^2 below said floor having outlets toward which the bottom of the chamber inclines, a conveyer into which said outlets open, an ore-intercepting chamber leading from the depositing-chamber to the stack and having outlet-openings toward which the bottom of the chamber inclines, and a conveyer into which said outlets open and leading to the chamber A^2, substantially as and for the purpose set forth.

4. In an ore-roasting furnace, the combination of a shaft having an inlet for pulverized ore at its upper end and communicating near

its upper end with the medium of heat supply, a depositing-chamber for the ore extending laterally from the base portion of the shaft and having a dumping-floor, a chamber A^2 under said floor having outlets toward which the bottom of the chamber inclines, a conveyer into which said outlets open, an ore-intercepting chamber leading from the depositing-chamber to the stack and having walls at intervals extending alternately from each side short of the opposite side and outlet-openings toward which the bottom of the chamber inclines, and a conveyer into which the intercepting-chamber outlets open and leading to the chamber A^2, substantially as and for the purpose set forth.

5. In an ore-roasting furnace, the combination of a shaft having an inlet for pulverized ore at its upper end and communicating with the medium of heat supply, a depositing-chamber for the ore extending laterally from the base portion of the chamber, a dumping-floor forming the bottom of the depositing-chamber and composed of a series of valves F each comprising a hollow triangular body journaled at its opposite ends in the chamber-walls and having a fire-clay top, and air-pipes leading from the interior of the body at its opposite ends beyond said walls and extending respectively upward and downward with a weight on the depending pipe, and a chamber A^2 below said floor, substantially as and for the purpose set forth.

6. In an ore-roasting furnace, the combination of a shaft A having an inlet for pulverized ore at its upper end and communicating near its upper end with the medium of heat supply, series of hollow bars *q* extending at intervals in the shaft across the same through its walls and bent upward and downward respectively at their opposite protruding ends, said bars being enveloped inside the shaft in coverings of refractory material, a depositing-chamber for the ore extending laterally from the base portion of the shaft and having a dumping-floor, and a chamber A^2 below said floor, substantially as and for the purpose set forth.

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In presence of—
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W. U. WILLIAMS.