No. 695,868. Patented Mar. 18, 1902.

F. NEVEGOLD.

REVERBERATORY SMELTING FURNACE.

(Application filed Apr. 20, 1900.)

(No Model.) 3 Sheets—Sheet 1.

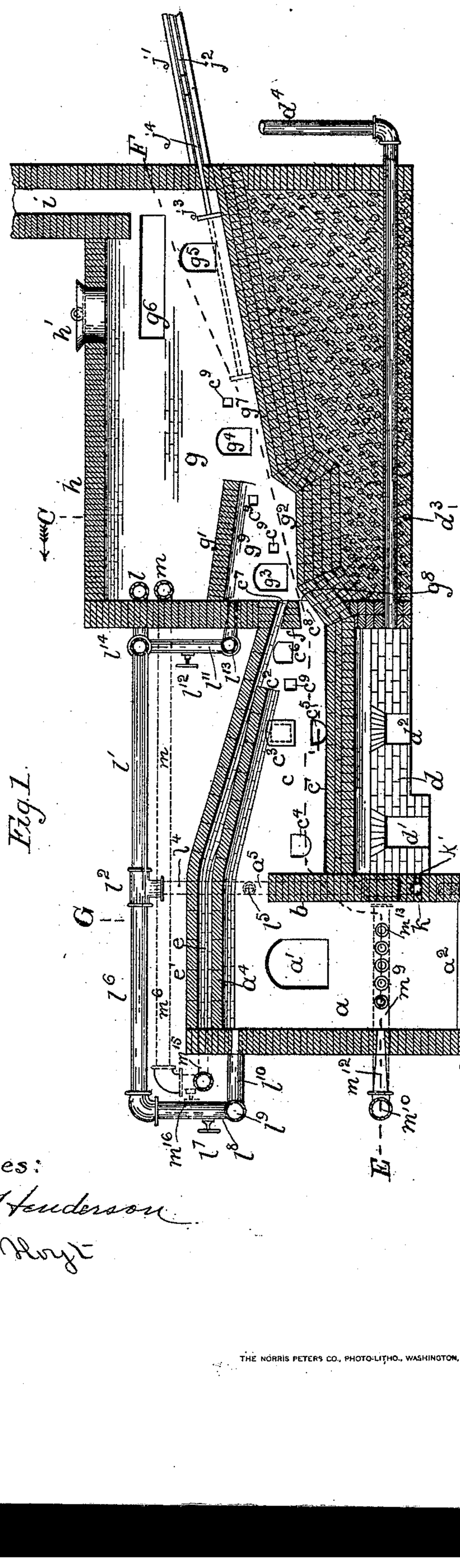

Fig. 1.

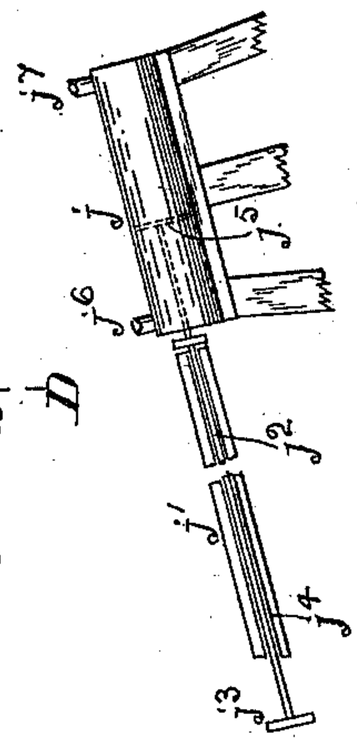

Fig. 8

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No. 695,868. Patented Mar. 18, 1902.

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REVERBERATORY SMELTING FURNACE.

(Application filed Apr. 20, 1900.)

(No Model.) 3 Sheets—Sheet 2.

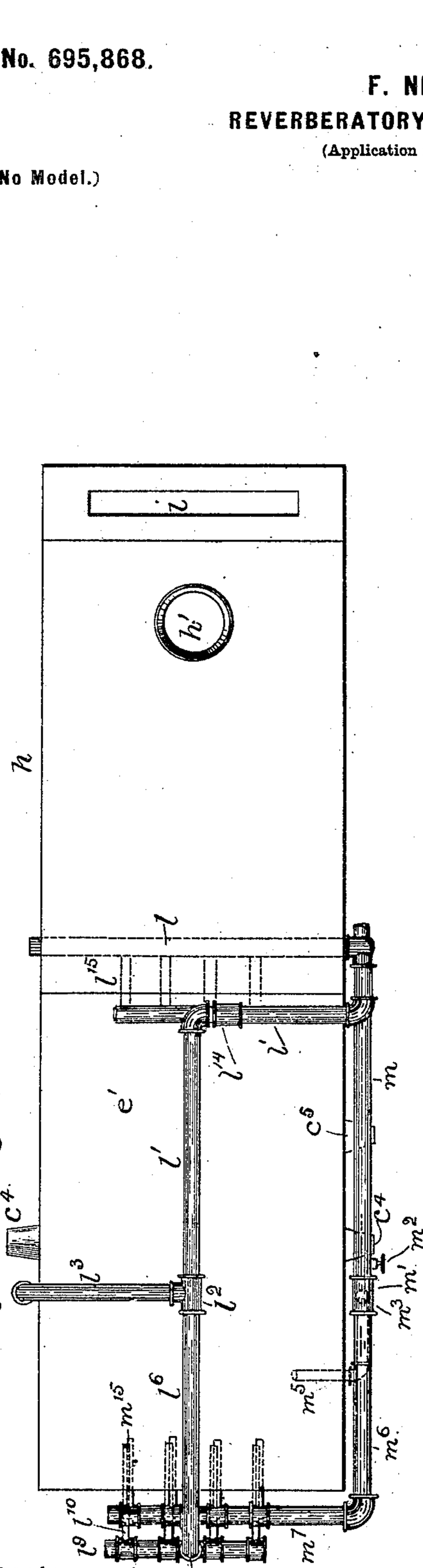

Fig. 4.

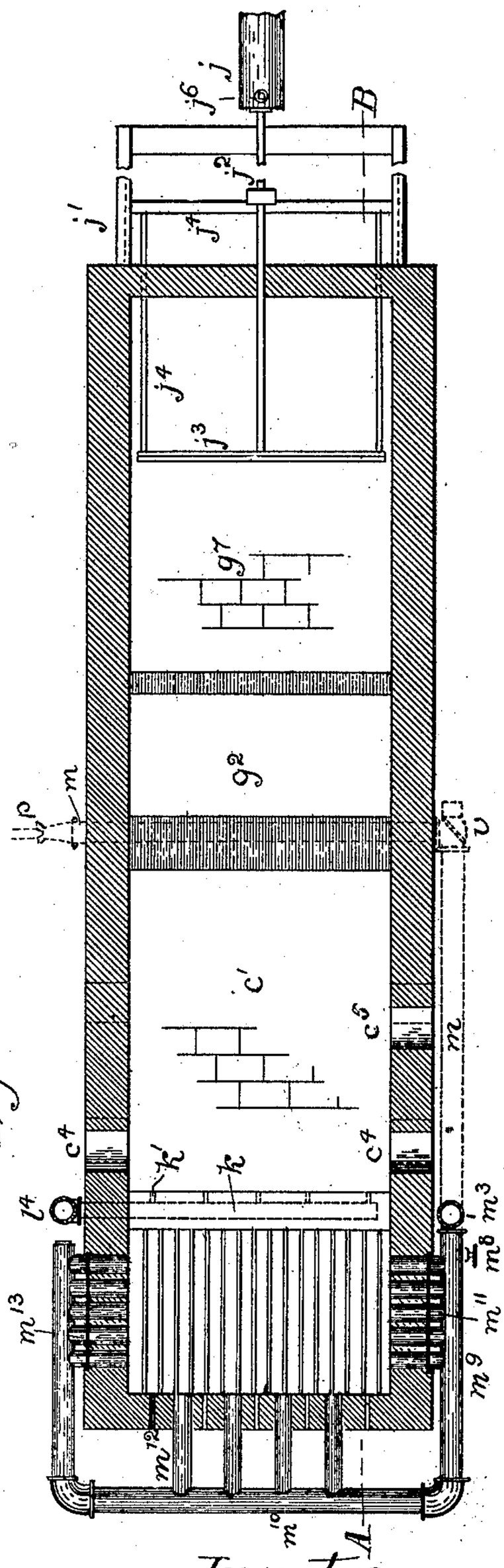

Fig. 2.

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REVERBERATORY SMELTING FURNACE.

(Application filed Apr. 20, 1900.)

(No Model.) 3 Sheets—Sheet 3

Fig. 3.

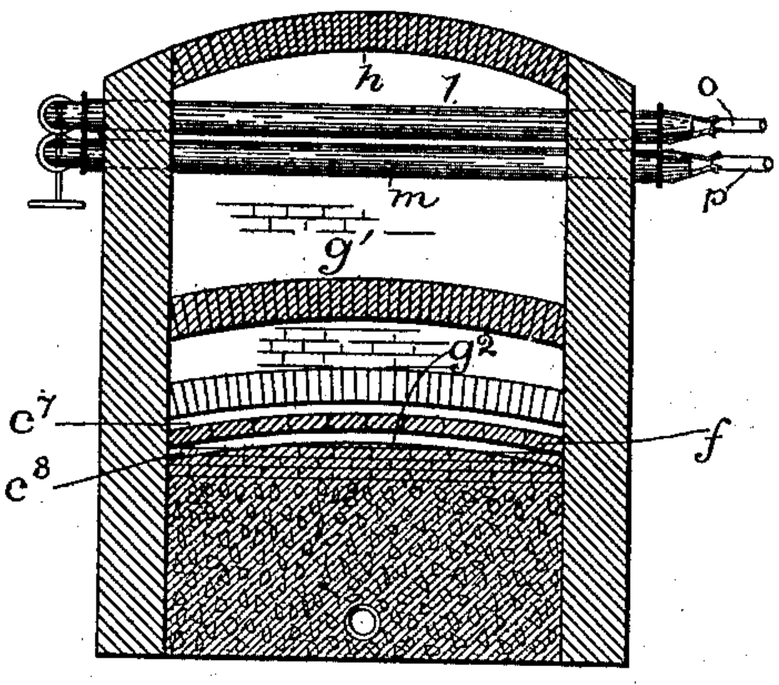


Fig. 6.

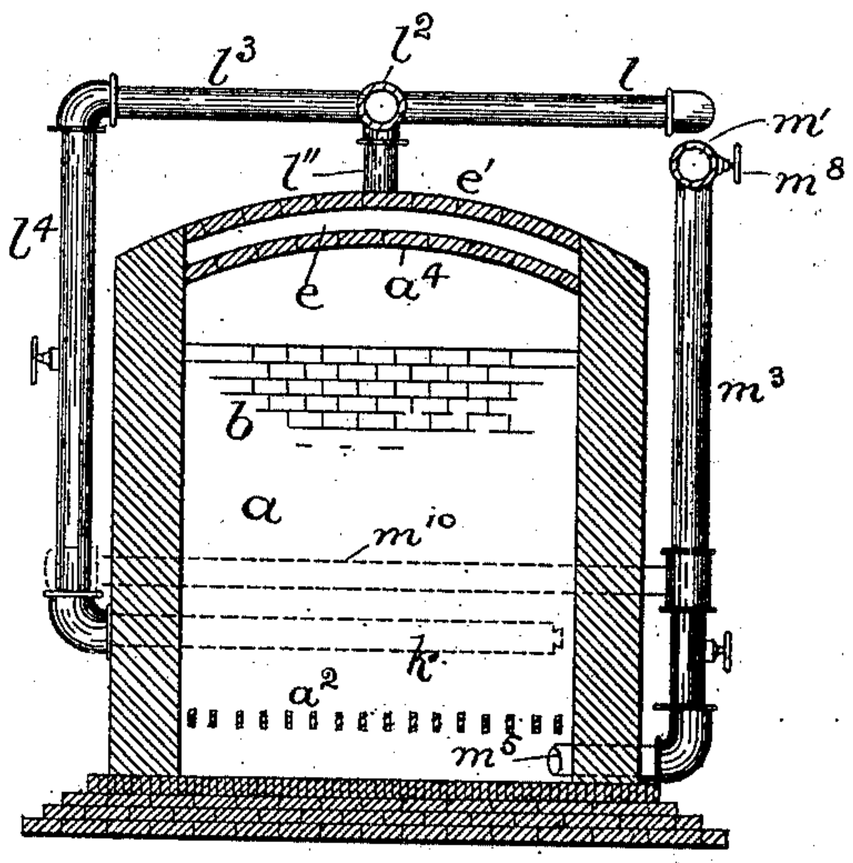


Fig. 5.

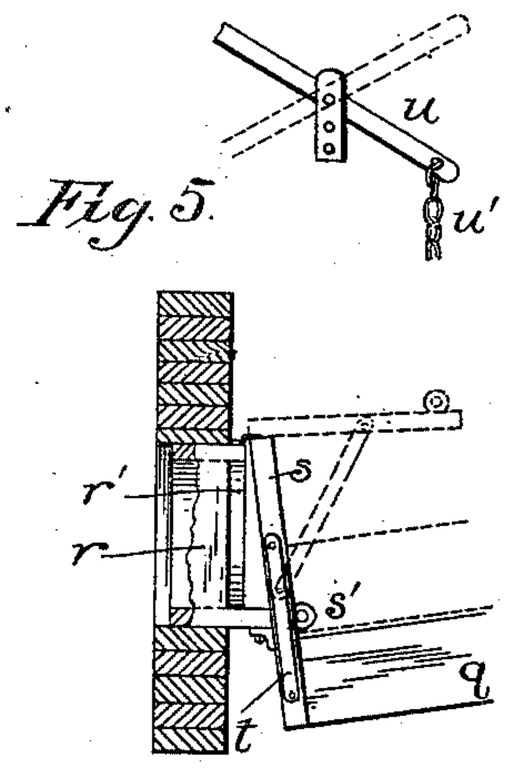
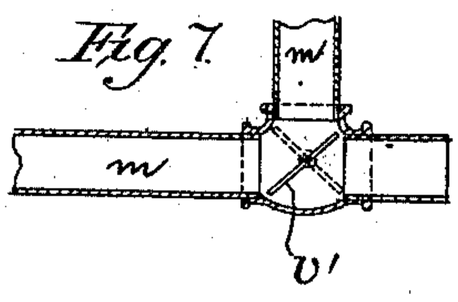


Fig. 7.



Witnesses:
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UNITED STATES PATENT OFFICE.

FREDERICK NEVEGOLD, OF PORTLAND, OREGON.

REVERBERATORY SMELTING-FURNACE.

SPECIFICATION forming part of Letters Patent No. 695,868, dated March 18, 1902.

Application filed April 20, 1900. Serial No. 13,652. (No model.)

To all whom it may concern:

Be it known that I, FREDERICK NEVEGOLD, a citizen of the United States, and a resident of Portland, in the county of Multnomah and State of Oregon, have invented a new and useful Improvement in Reverberatory Smelting-Furnaces, of which the following is a specification, reference being had to the accompanying drawings as a part thereof.

My invention relates generally to the art of obtaining the metal in ores by the smelting process.

The object of my invention was to construct a furnace by which I could operate upon a large quantity of ore, continuing the work without interruption from the time of starting indefinitely. I desired also to so arrange the interior of my furnace that a large proportion of the heat in the fuel consumed will be utilized with a view to economy. To this end my smelter comprises a fire-chamber, a smelting-chamber, and an intermediate chamber, which I shall hereinafter term "concentrating-chamber" because of its functions, and I have also provided an auxiliary fire-chamber located under the concentrating-chamber to assist in the work of the latter. By the arrangement mentioned the smelting of the ore and the collecting or concentrating of the matte of the same is conducted in two separate chambers, which gives better results. The smelting-chamber is designed to first roast and then smelt the ore, and from the smelting-chamber the smelted material enters by a passage-way into the concentrating-chamber as slag and matte or metallic and non-metallic portions. The hearth of the smelting-chamber is covered with a vaulted roof or arch. On such hearth the blast of heated air, vapor, and gases is directed, and here the fiercest heat is developed, while the temperature of the intermediate concentrating-chamber is approximately held at that point which will keep the metal or matte in a fluid state and will facilitate its separation from the lighter slag. The fuel and combustible gases are provided with an ample supply of air and superheated vapor to aid and intensify their combustion. The fuel to be used is wood, oil, or gas. Coal is not suitable for my purposes. To enable me to control the temperature of the intermediate concentrating-chamber, I have introduced a particular disposition and control of the blasts.

When wood is used as fuel, a very strong blast blown into the fire-chamber would have a tendency to blow the fuel over the bridge-wall into the concentrating-chamber. To guard against this, I have balanced the blast through the fire-chamber by introducing a secondary blast, which enters the concentrating-chamber and thence the smelting-chamber through the same opening through which the gases collecting in the concentrating-chamber must pass to reach the chimney or flue, and as the two independent currents or volumes of gas cannot pass through a common opening or escape of limited size without interfering with the travel of each other it is a simple matter by providing suitable devices to cause a sufficient resistance to the blasts through the fire-chamber, and such resistance to such blast I term "balancing" the same. I have also introduced other features for furthering the smelting process and for protecting the smelting-furnace against unnecessary wear, all of which features, as well as those already referred to, are particularly explained and described, so as to enable all conversant with the art to which the specified improvements relate to practice my invention.

The general plan of construction of my smelting-furnace is shown in the drawings.

In such drawings, Figure 1 is a longitudinal vertical section on the line A B of Fig. 2. Fig. 2 is a plan section on the line E F of Fig. 1. Fig. 3 is a transverse vertical section on the line C D, Fig. 1, looking in the direction pointed by the arrow. Fig. 4 is a plan or top view of the roof of my invention. Fig. 5 is a detail illustrating the means devised by me for the purpose of obtaining a continuous feed of wood into the fire-chamber. Fig. 6 is a cross vertical section on line G H of Fig. 1. Fig. 7 is a partial plan section showing the arrangement of a valve v' in the pipe l at the point where it projects beyond the exterior of the furnace-walls, the object of said valve being to control the air-blast injected into said pipe, allowing said blast either to enter the branches of said pipe or else to escape through a blow-off or outlet v. A like valve is provided to control the pipe l in the same

manner. Fig. 8 is a detail of the mechanical ram for pushing the ore charges thrown on the roasting-hearth onto the smelting-hearth.

The letters designate the parts of my invention referred to in the description thereof hereinafter given.

The walls, floors or bottoms, and other parts and appurtenances of my smelting-furnace may all be constructed of such material as is known to be practical for such purposes.

a is the fire-chamber, in the bottom of which are located the grate-bars a^2, on which grate-bars are piled boulders or rocks to a depth of two feet, and on these is placed the fuel. A blast of air is supplied under the grate-bars through the nozzle a^5, being an extension of the branch m^3. A clean-out a^3 is provided below the grate-bars. The fire-chamber is separated from the concentrating-chamber *c* by a bridge-wall *b*. The stoke-hole a' gives access to the fire-chamber, so as to be able to place and replenish the fuel therein from time to time. Such stoke-hole is placed pretty high up, so that a large charge of fuel may be inserted in the fire-chamber at one time, if desirable. In connection with the stoke-hole a' of the fire-chamber I use a device for obtaining a continuous feed of fuel, which I will describe later on. Adjoining the fire-chamber is the intermediate concentrating-chamber *c*, having a floor of graphite tiles c', and below the concentrating-chamber is an auxiliary heating-chamber *d*, the vaulted roof of which supports the bottom of the concentrating-chamber. In the walls of the concentrating-chamber is a matte tap-hole c^5 and two slag tap-holes c^4, all of which are provided with spouts. When starting up the furnace, such taps are respectively closed by fire-clay in the customary manner. The floor of the concentrating-chamber is sloped from both sides toward the portion c^{10} in line with the matte tap-hole, so as to provide a basin in which the matte or melted metal may be collected. The walls of both sides of the concentrating-chamber also have openings c^3, which are provided to enable one to watch the work going on within the concentrating-chamber, and such openings are closed by a wicket or sliding door. There are also a number of square peep-holes distributed in the wall of the concentrating-chamber and smelting-chamber and covered with mica or other suitable substance. The stoke-holes c^6 in each side of the walls of the concentrating-chamber, near the passage leading into the smelting-chamber, are provided to be able to throw in blocks of wood, which ignite and burn and keep ignited the combustible gases passing from the concentrating-chamber into the smelting-chamber. A false roof a^4 covers the fire-chamber and the concentrating-chamber for the greater part of its length, leaving only the opening c^2, at which point the superheating-chamber *e* communicates with the concentrating-chamber, and the gases and air blown through either have a common outlet through the passage e^7 into the smelting-chamber. At the point of communication between the concentrating-chamber and smelting-chamber is an arched wall *f*, having an opening or passage-way c^8 below it and the said passage-way c^7 above it. The roof proper, e', covering the fire-chamber and the concentrating-chamber, is above the false roof a^4 and provides an intermediate space or superheating-chamber *e*, through which is blown the secondary or balancing blast already mentioned. When the furnace is first started up, the fuel is filled in in front of the opening c^8, so as to block the same and obstruct the escape of the gases collecting in the said concentrating-chamber through such openings. When once the smelting process has fairly gotten started, said passage-way c^8, being only a few inches high, will fill with the matte and slag flowing in from the smelting-chamber. With the closure of the passage-way c^8 the gases collected within the concentrating-chamber have only the passage-way c^7 through which to escape into the smelting-chamber. The force with which the gases in the concentrating-chamber pass through the passage-way c^7 into the smelting-chamber is adjusted by regulating the blast issuing from the three sets of nozzles m^{11} m^{12} m^{13}, supplied by the pipe *m* and its branches m^3 m^9 m^{10}, subject to the resistance of the secondary blast blown through the pipe branches m^6 m^7 of pipe *m* out of nozzles m^{15} into the superheating-chamber, which secondary blast is also seeking to escape into the smelting-chamber through the passage-way c^7. Hence by means of the valve m^{16}, controlling the pipe from which issues the secondary blast, the force of such secondary blast may be relatively adjusted to the force of the blast through the fire-chamber to offset or balance the same, and thus overcome any disturbing consequences, notwithstanding a very powerful blast may be directed against the burning fuel in the fire-chamber, and the same means enable me to supply the combustible gases collected unconsumed in the concentrating-chamber with a sufficient volume of air, the resulting intermixture issuing as a fierce blast into the smelting-chamber. The smelting-chamber is provided in its sides with poke-holes g^4 and g^5.

i is the flue or chimney through which all the unconsumed gases in the furnace finally escape.

The charges of material to be smelted are introduced through a charge-hole h', which is provided with a suitable cover. The charges are thrown on the inclined floor portion or roasting-table g^7. Previous to the introduction of the material to be smelted a layer of sticks of wood is placed on said roasting-table and the charges of material to be smelted thrown upon this and thereupon the whole mass moved toward the hearth by means of a ram j^3. The wood required for constructing the layer or bed upon which is

to be thrown the material to be smelted is introduced through large rectangular openings g^6 for that purpose provided in the sides of the smelting-chamber. I also provide poke-holes g^5 below the openings g^6 to enable me to get at the said bed of wood for the purpose of arranging the same.

The first charge of ore is followed by others until the whole of the roasting-table g^7 is covered, and thereafter the charge operation is repeated as often as required to keep up a continuous feed to the hearth of the smelting-chamber. As has been stated, the smelting-chamber is devised to perform the two operations of roasting and smelting the ore. For the first operation I have provided the inclined floor portion or roasting-table g^7, which precipitously drops to the hearth g^2. The charges of ore thrown on the roasting-table in front of the ram-head are successively moved forward toward the hearth g^2 by the operation of the ram. Such charges of ore are thus exposed to a constantly-increasing temperature and finally to the intense heat issuing from the covered hearth of the smelting-chamber, and the ore is thus purified of its sulfur and other volatile substances before it is thrown on said hearth of the smelting-chamber and its smelting completed.

The hearth g^2 of the smelting-chamber is covered by the arch g', such arch forming with the walls at the sides of the hearth an inclosure or inner chamber g^9 in which to confine and concentrate the heat of the blast of flame and gases issuing from the upper aperture in the wall f and impinged upon the hearth. The heat may be further intensified by burning sticks of wood thrown on the hearth through the stoke-holes g^3, and the blast of flame issuing from such inclosure of the hearth furnishes the means for heating the main portion of the smelting-chamber, the heat being intensified by the burning of the unconsumed combustible gases supplied with fresh oxygen from the blast through the pipe-nozzles m^{15}. The hearth g^2 of the smelting-chamber is inclined toward the passage-way from the smelting-chamber into the concentrating-chamber, so as to cause the smelted material to flow into said passage-way. Such passage-way has a low entrance g^8, which is situated considerably above the floor of the concentrating-chamber, and the slag tap-holes of the concentrating-chamber are situated on a level with such entrance, so that the smelted ore on the hearth of the smelting-chamber will be skimmed as it enters the passage-way c^8, and such portions as have not as yet been converted into a sufficiently liquid mass for entering the said passage-way will be held back on the hearth and further subjected to intense heat, and if such portions cannot be sufficiently melted they may then be raked out of the way through the stoke-holes g^3. The steep incline of the floor of the passage-way c^8 under the arched wall portion f, connecting the concentrating-chamber with the smelting-chamber, has also a special object in this that it facilitates the heavier matte or metallic portions in settling below the lighter slag.

The ram which I use for moving a charge of material to be smelted toward the hearth g^2 comprises a cylinder j, suitably supported, a piston j^5, having a rod j^2, attached to a sliding frame j^4, having a head j^3, the said frame operating in guides j'.

j^6 and j^7 represent pipes leading into the steam-chest of the cylinder and are supposed to be connected with the boiler. The burning of the sliding bed of wood upon which the charges of ore are thrown also considerably aids the smelting operation by helping to maintain the intensity of the heat in the smelting-chamber.

There are two blast-pipes l m, the courses of which are as follows: The pipe l has an extension l', a T l^{14}, from which extends downwardly a branch l^{11}, from the base of which a series of four nozzles l^{13} enter the smelting-chamber below the arch g'. The function of the nozzles l^{13} is to blow a rapid continuous stream or stratum of air and vapor under the arch g' and protect the latter against the intense heat developed under it. Without such protection the said arch could not last any length of time. The disposition of the pipes l m, both leading through the upper portion of the smelting-chamber, causes the air blown therethrough to become well heated before being ejected into the furnace. There would be no chilling, caused by such blasts of air, of the gas with which they come in contact in traveling through the furnace. From the T l^{14} an extension l' continues to the T l^2, and from this point one branch l^3 leads to a downwardly-extending branch l^4 into a horizontally-extending branch k, which is embedded in the base of the bridge-wall b, and which extension k has a series of perforations k', with which register openings in the base of the bridge-wall b, so that a blast may be introduced through such openings k' into the auxiliary heating-chamber d for the purpose of facilitating the combustion which it is found necessary to carry on in such chamber. The valve l^5 controls the branch l^4. The function of the auxiliary fire-chamber is to help regulate the temperature of the base of the concentrating-chamber c above it to prevent the matte from becoming chilled, and therefor not retaining its proper fluid condition. This auxiliary fire-chamber is indeed a convenient appurtenance to my furnace, as will be manifest to every one practiced in the art of smelting, although the use of the chamber for heating purposes may only be occasionally required. The pipe d^3 serves as the flue for the chamber d and is connected with an uptake d^4. From the T l^2 there is a branch l^6, leading to the front end of the smelting-furnace down a branch l^8 into a horizontally-extending branch l^9, from which project a series of nozzles l^{10} into the fire-cham-

ber beneath the false roof a^4, above which is the superheating-chamber *e*. The particular function of the nozzles l^{10} is to feed a blast of air under the false roof a^4, so as to protect the same against the intensity of the heat in the fire-chamber and concentrating-chamber. This branch of the pipe *l* also supplies fresh oxygen to the combustible gases in the concentrating-chamber, and besides furnishes the means for controlling the temperature of the concentrating-chamber, so as to regulate and maintain it at a suitable degree of heat. The pipe *m* leads to a T m', from which a branch m^3 extends downward and leads (through a portion a^5) into the fire-chamber below the grate-bars. The function of the pipe m^5 is to supply air up through the grate-bars and boulders to the burning fuel. From m' a branch m^6 leads to the front end of the smelting-furnace to the horizontal branch m^7, having a series of nozzles m^{15}, which enter the superheating-chamber *e*. The respective pipes and their branches are provided with suitably-disposed valves whereby to control the same. The air-blast entering through the nozzles m^{15} into the superheating-chamber is further heated by radiation through the false roof a^4, extending over the fire-chamber and, in part, the smelting-chamber. As the secondary blast entering through the superheating-chamber will commingle with the gases of the concentrating-chamber just before jointly entering the smelting-chamber through the common opening c^7, it is necessary that such blast be maintained at a sufficiently-high temperature to prevent it having any chilling effect. To accomplish this object the superheating-chamber is well adapted. By priming the concentrating-chamber—that is to say, introducing short sticks of wood through the stoke-holes c^6, so that such wood will ignite and burn immediately in front of the arched wall *f*—the intermixture of the gases at c^2 in the concentrating-chamber may be raised to a very high degree of heat just previous to their entering the inclosed hearth of the smelting-chamber. The branch pipe m^3 also has a branch m^9 m^{10}, which extends horizontally on three sides of the fire-chamber and is provided with four sets of nozzles m^{11} m^{12} m^{13}, blowing upon the fuel in the base of the fire-chamber. This blast must of course be kept in excess of that blown through the superheating-chamber, the two being balances, as already described.

The above particular description of my invention presupposed the use of wood as fuel.

In Fig. 5 I illustrate the means devised by me for giving the fire-chamber a continuous supply or feed of wood fuel. The device shown represents a thimble *r*, conforming to the stoke-hole a', in which it is to be inserted, said thimble being provided with laterally-extending flanges r', which are seated snugly against the outside of the wall portions about said stoke-hole. Attached to the thimble *r* is a hinged cover *s*, having two bails *t*, pivoted on both sides and pivotally suspending a chute *q*. The cover is provided with an eye s', to which is attached a chain u', connected with a lever *u*, pivotally supported at some convenient place. By operating the lever *u* the door *s* may be lifted, and by so doing the chute hanging from the bails *t* would be brought in position so as to feed the wood directly into the fire-chamber.

The pipes *l m* have each an escape or blow-off and valves *v v'*, which valves are adapted to be so positioned as to close said escapes and let the blasts into the furnace or shut out the blasts and open the said escapes. The two valves are coupled together, so as to be operated simultaneously and that the blasts through the furnace will all either be turned on or off or otherwise suitably adjusted.

Whatever ore is being smelted it must always be seen to that the bottom of the concentrating-chamber contains a sufficient depth of smelted material to keep the passage-way c^8 from the concentrating-chamber into the smelting-chamber filled, so as to block that passage-way against the escape of gases therethrough. To assist in this requirement, the bases of the slag tap-holes c^4 have been placed on a level with said passage-way, as already described.

The blasts for my furnace may be produced by any of the known means. As represented in the drawings, Fig. 3, the pipes *o p* are steam-pipes forcing steam and air into the spread mouths of the pipes *l m*. The pipes *l m* are of sufficient diameter to allow for expansion of the mixture of air and vapor blown therethrough, especially the expansion due to heating such mixture.

The customary provision must be made for conveying the material to be smelted to the charge-hole. The detailed description of my furnace is in itself sufficient to enable any one skilled in the art to which it relates to make use thereof without recapitulating its operations.

By the arrangement of my furnace and the provision made for carrying on separately the several steps of the smelting process it is obvious that the work may be continued indefinitely and that an unlimited quantity of ore may be run into one matte. When operating on copper ore, as soon as the slag accumulating in the bottom of the concentrating-chamber rises to the top of the slag tap-holes the latter must be slightly open at the top to allow the slag to run out as fast as thereafter produced by the smelter and to enable the smelting to be continued until a sufficient amount of metal has been collected in the basin of the concentrating-chamber. After a considerable quantity of copper has been concentrated in the basin a portion may be drawn from the bottom, allowing an ample part of the upper portion of the metal under the slag to remain, however, to give such up-

per portion further time to become purified by separating from the slag by gravity during the continuance of the smelting work.

The procedure for running off the accumulating slag when smelting gold or silver ore is about the same as when smelting copper; but the matte is not drawn off until a large number of tons—say one hundred tons, for example—have been smelted. Then the blast is shut off and the matte allowed to settle for a while. The matte tap-hole is then opened and the whole matte run into a large ladle and thereupon treated in the usual way.

Now what I claim, and desire to secure by Letters Patent, is—

1. In a smelting-furnace, the combination of a fire-chamber, a smelting-chamber and an intermediate concentrating-chamber; a bridge-wall between the fire-chamber and the concentrating-chamber; a reverberating roof over both the last-mentioned chambers; a wall between the concentrating and smelting chambers having an upper passage-way, or flue, and a lower passage-way for the fluid smelted material; and an auxiliary fire-chamber under the concentrating-chamber, substantially as described.

2. In a smelting-furnace, the combination of a fire-chamber, a smelting-chamber and an intermediate concentrating-chamber; a bridge-wall between the fire-chamber and the concentrating-chamber; a reverberating roof over both of the last-mentioned chambers; a wall between the concentrating-chamber and smelting-chamber having an upper passage-way, or flue, and a lower passage-way for the fluid smelted material; an auxiliary fire-chamber under the concentrating-chamber; and means for causing a blast into the auxiliary fire-chamber, substantially as described.

3. In a smelting-furnace, the combination of a fire-chamber, a smelting-chamber and an intermediate concentrating-chamber; a bridge-wall between the concentrating-chamber and the fire-chamber; a reverberating roof over both the last-mentioned chambers; a false roof, extending over the fire-chamber and for the greater length of the concentrating-chamber, and providing an intermediate heating-chamber, discharging into the concentrating-chamber; means for producing a blast through the base of the fire-chamber, and a secondary blast through the said heating-chamber, means for regulating said blasts relatively to each other; a wall between the concentrating-chamber and smelting-chamber having an upper passage-way, or flue, and a lower passage-way for the fluid smelted material, substantially as described.

4. In a smelting-furnace, the combination of a fire-chamber, a smelting-chamber and an intermediate concentrating-chamber; a bridge-wall between the fire-chamber and concentrating-chamber; a reverberating roof over both the last-mentioned chambers; a false roof, extending over the fire-chamber and for the greater length of the concentrating-chamber, and providing an intermediate concentrating-chamber, discharging into the concentrating-chamber; means for producing a blast through the base of the fire-chamber, and a secondary blast through the said heating-chamber; means for regulating said blasts relatively to each other; means for throwing a continuous current of air or vapor under the false roof, to protect the same against the heat of the fire-chamber; and a wall between the concentrating-chamber and fire-chamber, having an upper passage-way, or flue, and a lower passage-way for the fluid smelted material, substantially as described.

5. The combination in a reverberatory furnace comprising communicating concentrating and smelting chambers, and a wall dividing the former from the latter with separate passage-ways for the products of combustion, and the melted material, respectively, of means for throwing a blast on the smelting-hearth immediately in front of said dividing-wall; and an arch projecting from such wall and extending from side to side of the smelting-chamber, over the smelting-hearth for the purpose of there concentrating and intensifying the heat, substantially as described.

6. The combination in a reverberatory furnace comprising communicating concentrating and smelting chambers, and a wall dividing the former from the latter with separate passage-ways for the products of combustion, and the melted material, respectively, of means for throwing a blast on the smelting-hearth immediately in front of said dividing-wall; an arch projecting from such wall and extending from side to side of the smelting-chamber, over the smelting-hearth for the purpose of there concentrating and intensifying the heat; and means for injecting a continuous current of air or vapor under said arch to protect the same, substantially as described.

7. The combination in a reverberatory furnace, of a fire-chamber, a smelting-chamber and an intermediate concentrating-chamber; a bridge-wall separating the fire-chamber from the concentrating-chamber; a wall dividing the smelting-chamber from the concentrating-chamber, with separate passage-ways for the heated products of combustion, and the melted material, respectively; a reverberatory roof over the fire-chamber and concentrating-chamber; the floor of the smelting-chamber comprising an inclined roasting-hearth and a smelting-hearth, on a lower level than the former, with a steep decline from the former to the latter, an arch, g' over the smelting-hearth for concentrating and intensifying the heat, the floor of the passage through the wall, f, for the melted material, declining precipitously to promote separation of the matte from the slag by gravity; blast-pipes adapted to inject air-blasts under said reverberatory roof and under the arch, g', and slag-taps in the walls of the concentrating-chamber on a level with the entrance of such passage-way, substantially as described.

8. The combination in a reverberatory furnace, of a fire-chamber, a smelting-chamber, and an intermediate concentrating-chamber; a bridge-wall separating the fire-chamber from the concentrating-chamber; a wall dividing the smelting-chamber from the concentrating-chamber, with separate passage-ways for the heated products of combustion, and the melted material, respectively; the roof of the passage-way for the melted material being low so as to skim the melted material passing through said passage-way and hold back insufficiently-melted matter; a reverberatory roof, over the fire-chamber and concentrating-chamber, suitably-disposed blasts, the floor of the smelting-chamber comprising an inclined roasting-hearth and a smelting-hearth, on a lower level than the former, with a steep decline from the former to the latter, an arch, g', over the smelting-hearth for concentrating and intensifying the heat; the floor of the passage through the wall, f, for the melted material, declining precipitously to promote separation of the matte from the slag by gravity; and slag-taps in the walls of the concentrating-chamber on a level with the entrance of such passage-way, substantially as described.

9. In a reverberatory furnace, the combination of a fire-chamber a smelting-chamber, and an intermediate concentrating-chamber, the smelting-chamber being on a higher plane than the concentrating-chamber, an inclined floor portion or roasting-hearth, g^7 in the smelting-chamber; a bridge-wall, b, separating fire-chamber from concentrating-chamber, a reverberating roof over the fire-chamber and concentrating-chamber, a false roof extending over the fire-chamber, and for the greater length of the concentrating-chamber, providing with the reberberating roof an intermediate heating-chamber, discharging into the forward end of the concentrating-chamber; means for producing a blast through the base of the fire-chamber, and a secondary blast through the said heating-chamber; means for regulating said blasts relatively to each other; means for throwing a continuous current of air or vapor under the false roof, to protect the same against the heat, a dividing-wall, f, between the concentrating and smelting chambers, having an upper passage-way, or flue, c^7, and a lower passage-way, c^8, for the fluid smelted material, said upper passage-way being adapted to direct the blast of volatile matter issuing out of the concentrating-chamber onto the smelting-hearth, and the roof of said lower passage-way being low so as to skim the melted material passing through said passage-way and hold back insufficiently-fused matter, the walls of the concentrating-chamber being provided with slag-taps arranged on a level with said lower passage-way; an arch, g', projecting from the wall f, over the smelting-hearth for the purpose of there concentrating the heat; suitably-disposed doors in the concentrating and smelting chambers for supplying fuel; means for injecting a continuous current of air or vapors under the arch, g' to protect the same; an auxiliary fire-chamber, d; and means for injecting a blast therein, substantially as described.

In testimony whereof I have hereunto affixed my signature, in the presence of two witnesses, this 24th day of March, 1900.

FREDERICK NEVEGOLD.

Witnesses:

GEO. W. HAZEN,

M. D. HOYT.