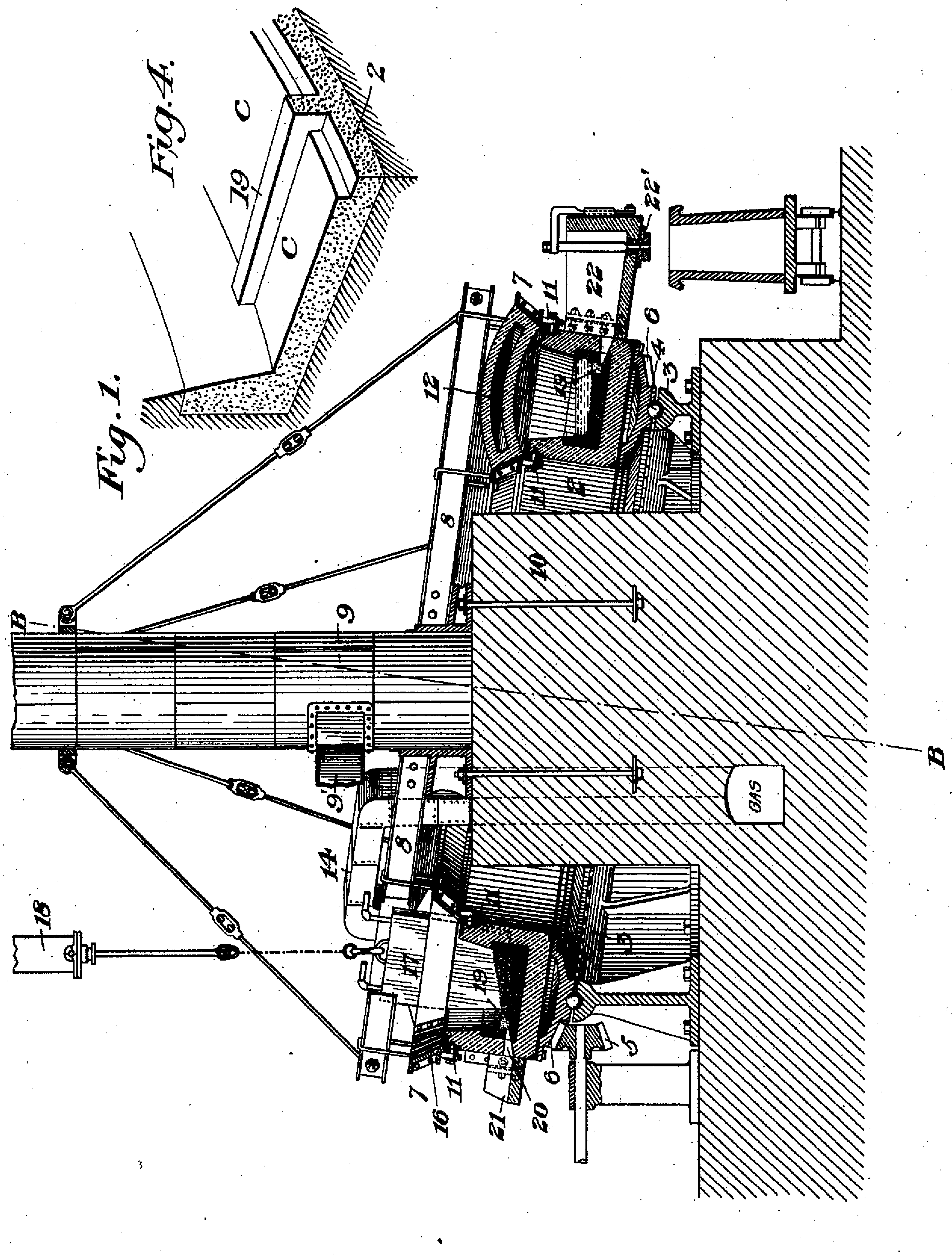
No. 693,313. Patented Feb. 11, 1902.

J. A. POTTER.

TREATING ORES OR SIMILAR MATERIALS.

(Application filed May 16, 1899.)

(No Model.) 3 Sheets—Sheet 1.



WITNESSES

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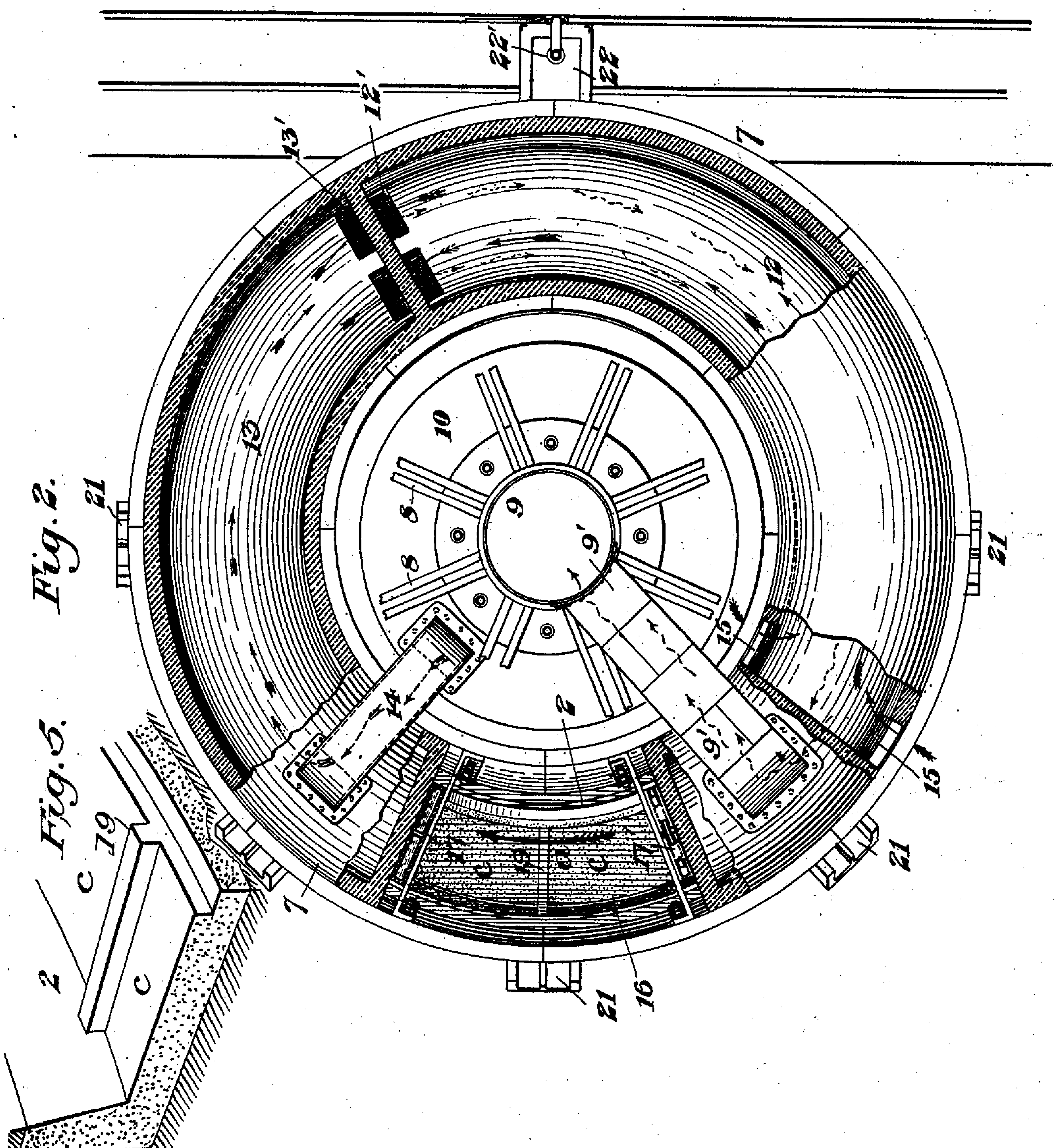

Fig. 2.

Fig. 5.

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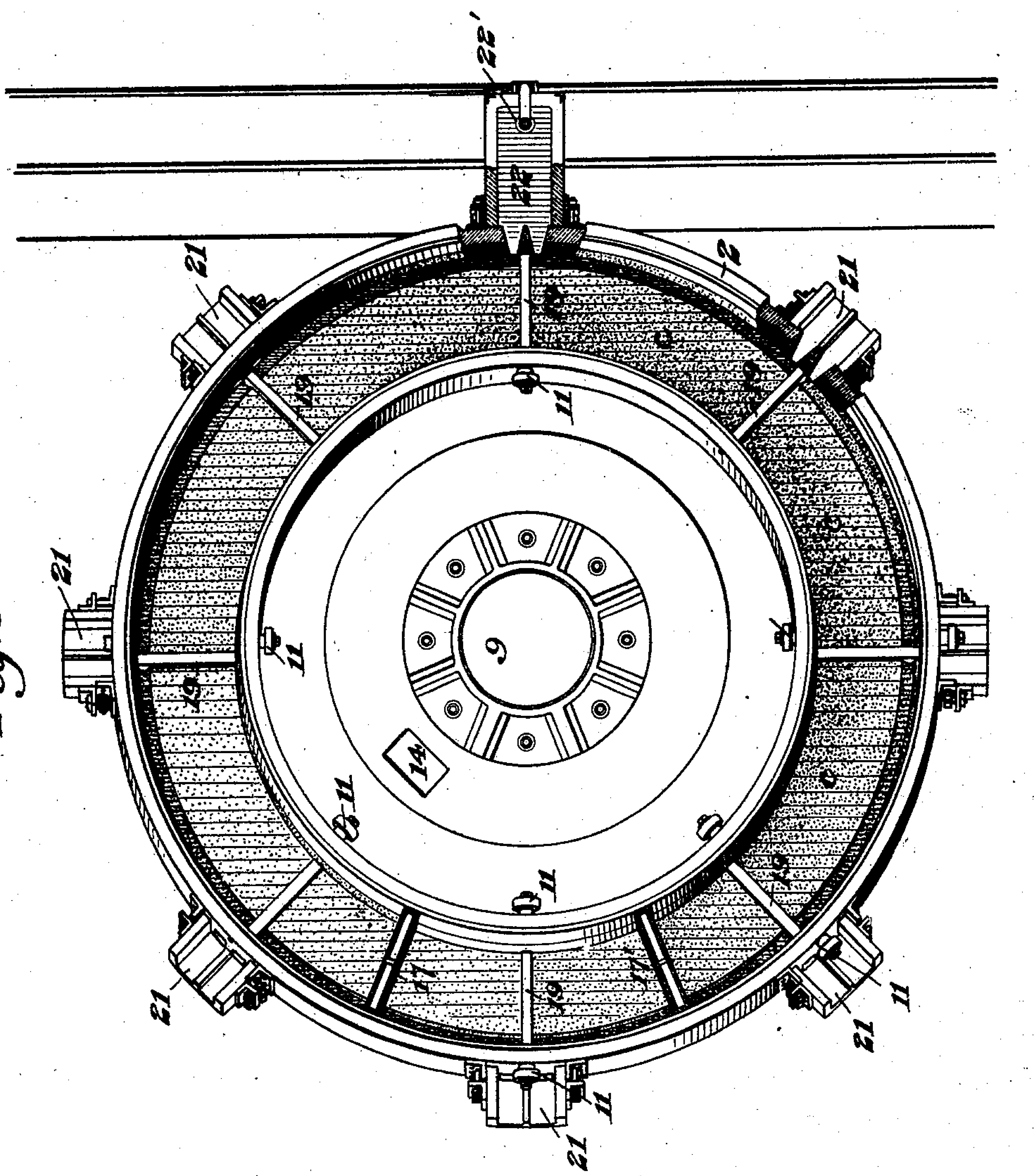
Fig. 3.



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UNITED STATES PATENT OFFICE.

JOHN A. POTTER, OF CLEVELAND, OHIO.

TREATING ORES OR SIMILAR MATERIALS.

SPECIFICATION forming part of Letters Patent No. 693,313, dated February 11, 1902.

Application filed May 16, 1899. Serial No. 717,043. (No model.)

To all whom it may concern:

Be it known that I, JOHN A. POTTER, of Cleveland, in the county of Cuyahoga and State of Ohio, have invented a new and useful Improvement in Apparatus for Treating Ores or Similar Materials, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming part of this specification, in which—

Figure 1 shows in vertical central section a smelting-furnace constructed in accordance with my invention. Fig. 2 is a plan view of the furnace, partly broken away to show the construction. Fig. 3 is a plan view of the furnace-body. Fig. 4 is a detail view showing one of the dams, and Fig. 5 is a similar view showing a modified form.

In treating ores with my improved apparatus I introduce the ores to be smelted, together with an appropriate charge of reducing material and flux, into a furnace-chamber, which is moved through a progressively-increasing temperature, so that the metals of the ores are reduced successively and removed by liquation as they reach the proper zone of heat. In this way the reduction and separation of the metals are accomplished quickly and very efficiently.

While the apparatus may be modified in many ways within the scope of my invention as defined in the claims, yet I prefer to use certain apparatus which I have invented and which I will now describe.

In the drawings, 2 represents the body of the furnace, which is annular in form and is supported on an inclined annular track 3, preferably by interposed antifriction balls or rollers 4, on which it may be rotated, the axial line of rotation B B being inclined from the vertical. The furnace may be rotated by suitable mechanism, and I have illustrated for that purpose a driven pinion 5, meshing with an annular rack 6 on the under side of the furnace. The annular roof 7 of the furnace is stationary and covers the annular furnace body or hearth. I prefer to support it by beams 8, radiating from the base of a central stack 9, which is supported on a pier or other suitable foundation 10, and in order to enable the hearth to rotate freely I prefer to provide the hearth with a series of antifriction-rollers 11, which bear against suitable surfaces formed on the under side of the roof. The air and gas are supplied to the body of the furnace through suitable ports, and in order that they may be heated prior to their final delivery into the furnace I prefer to make the roof hollow, as indicated in Figs. 1 and 2, so as to afford air-passages 12 and gas-passages 13, which open downwardly into the hearth below at ports 12′ 13′. The gas-supply is introduced into the passage 13 by a pipe 14, while the air enters the passage 12 through a port 15. The ores to be reduced, together with the other portions of the charge, are introduced into the furnace through the charging-opening 16 and between partitions or diaphragms 17 17′, which extend downwardly through the roof and are water-cooled, being preferably provided also with lifting mechanism, which may consist of a hydraulic cylinder 18, enabling them to be lifted a short distance whenever the furnace is rotated. The direction of rotation of the furnace is shown by the arrow *a*, and the stack-flue is on the far side of the diaphragm 17′, leading through the roof into the central stack-flue 9 and communicating at the roof with the annular furnace-chamber. As the material passes under the depending diaphragm 17′ it is leveled off into thin layers by the lower edge of the diaphragm, which in this respect acts as a scraper.

The body of the furnace has a suitable refractory lining, the bottom of which is preferably composed of carbon bound with lime, and it is divided into compartments by refractory cross-dams 19, the furnace being subdivided thereby into compartments *c c*. These dams are desirable when the furnace is used for separating metals by reducing a metal and removing it from the oxids of other metals before the heat is sufficiently high to reduce the latter oxids; but where this method is not necessary, as where only one metal or an alloy of metals is to be obtained, the dams need not be employed. At each dam and on each side thereof I form a tap-hole 20, and I may apply to the furnace, adjacent to these tap-holes, suitable spouts 21 or a forehearth 22, the latter being applied where metal is to be removed from the furnace in large bulk.

The operation of the apparatus when used for the reduction and liquation of several ores is as follows: The mixture of ores to be reduced is introduced through the charging-door 16 into that one of the compartments *c* which is then between the partitions 17 17′. Then, these partitions being slightly raised above the bottom of the furnace-hearth, the hearth or body of the furnace is rotated in the direction of the arrow *a*, so as to carry the ore under the partition 17′ into the working portion of the structure at the stack, which is the coolest portion of the furnace-chamber. Meanwhile the air and gas are discharged into the furnace at the ports 12′ 13′, and the products of combustion travel thence to the stack-flue 9′, the hottest portion of the furnace stucture being near the inlet-ports 12′ 13′ and the temperature diminishing thence toward the stack-flue. As the furnace is rotated at intervals intermittently or slowly the layer of charge material contained in the compartment under consideration becomes hotter, and as the appropriate temperature for the reduction of each metal is reached that metal is reduced and becomes liquid and may be allowed to run off through the spout at the lowest point of the chamber against the dam, the inclination of the furnace causing the accumulation of the molten metal at the spout. After the more reducible oxids are reduced the spout is removed, and as the compartment reaches the hottest part of the furnace the forehearth 22 (shown in Fig. 3) may be attached, and the metal which has not been reduced at the previous lower temperature is finally tapped off. This last metal to be reduced is generally present in the greatest volume. I therefore employ the forehearth for its removal, and as it flows from the forehearth through the tap-hole 22′ it may be cast into an ingot.

In operating upon an ore containing iron, copper, and lead, and perhaps a little gold and silver, I mix a charge of such ore consisting of oxids of metal with a reducing agent, such as coke-dust. The mixed ore and the coke-dust are ground fine and the mixture is spread on the bottom of the furnace between the dams or partitions. When one compartment is filled, the furnace is moved to bring the next compartment into place, each filled compartment moving toward a hotter zone. The hot gases and flames travel from the low side of the furnace around it for about two-thirds of its diameter before entering the stack, and hence give different temperatures at different points. As the mass of ore in one compartment is thus moved step by step into hotter zones the oxid of lead will first be reduced at about 1,700° Fahrenheit, and the globules of metallic lead will pass down through the charge and collect in the lower part of the chamber at the lowest point, where the tap-hole is located. This tap-hole is open during this stage and allows the lead to run out into a receptacle, which may be hung on the furnace or may be moved along beneath the spout. As the furnace moves farther into more intense heat the oxid of copper begins to be reduced and runs off through the same tap-hole with any remaining lead into another receptacle provided for it. As the furnace moves into hotter zones more pure copper is separated from the oxids and allowed to pass off. When the copper has thus been separated and removed as far as possible, as the temperature is reached which will reduce oxid of iron the tap-hole is plugged up and this chamber is moved into the highest heat. The remaining material is thus formed into a liquid mass, which can be drawn off by attaching the forehearth or any other suitable way. This method of liquating the metals from the mixed oxids depends on subjecting the mass to successively-higher heats, and I have found by experiment that oxid of lead will be reduced at about 1,700° Fahrenheit, while it needs from 2,200° to 2,500° Fahrenheit to reduce oxid of copper and 2,800° to 3,000° Fahrenheit to reduce oxid of iron. A slag is not formed until the reduction of the oxid of iron has taken place. This is carried out by admitting lime into the furnace at the highest heat, while it will form a slag of less specific gravity than the metal, and when this is in a liquid state the slag and metals are tapped into the forehearth and arrange themselves therein according to their specific gravity.

If the dams or partitions are not used, the metals will form alloys at different stages of the reduction and accumulate at the lower part of the furnace, where they can be tapped off.

It will be understood that the operation of the furnace is continuous, each compartment as it comes under the charging-door 16 receiving a charge of ore and reducing material, which is spread in a thin layer and is progressively reduced during the rotation of the furnace in the manner described above, being brought gradually from the low temperature to the required high temperature for final reduction. At the position of the forehearth shown in Fig. 3 the dam 19 separates two compartments, which owing to the inclination of the furnace slope in opposite directions, and I therefore employ two tap-holes, one on each side of the dam, for the removal of the metal from each of these chambers. Where metals are not to be separated by liquation, partitions need not be used, and the metal may be allowed to accumulate and be tapped off when desired, or where the partitions are present I may remove sections of them at their outer end, so as to put the adjacent compartments into communication, as shown in Fig. 5. The slag becomes liquid after the metal is reduced and floats on top of the molten metal, flowing off through the tap-holes after the metal is withdrawn.

The rotation of the furnace aids the reduction of the ores and accumulation of the reduced metals, not only by the agitation, but also by the flowing of the reduced liquid metal over the very hot reduced or partially-reduced but unmelted portion of the metal contained in the charge. The reduced unmelted metal is thus washed out or absorbed by the highly-heated melted body. This action of the liquid metal upon the material below greatly assists in completely reducing the metals from the ores, and thus saves loss which would otherwise result. As above stated, I prefer to make the bottom of the furnace of carbonaceous material, the effect of which is to assist in the reduction of the ore charged into the furnace.

It will be understood that within the scope of the following claims many changes may be made by the skilled metallurgist and mechanic without departure from my invention.

The invention is useful for the reduction of the precious metals mixed with lead, tin, or copper ores, but is not limited thereto, since it may be applied to the reduction of copper, iron, manganese, and other ores for the manufacture of steel and for other purposes in metallurgy.

I claim—

1. A rotary furnace having a body of annular form, and a roof covering at least a portion of said annular body, said roof being hollow and having inlets for gas and air, and downwardly-directed ports; substantially as described.

2. A rotary furnace having a body of annular form, provided with dams forming different chambers therein, and a stationary roof covering at least a portion of the annular body; substantially as described.

3. A rotary furnace having a body of annular form with radial dams, and a hollow roof over the furnace and having air and gas inlets and downwardly-directed ports; substantially as described.

4. A rotary furnace having a body of annular form arranged in inclined position, and a hollow roof covering at least a portion of said body, and having air and gas inlets, and downwardly-directed ports; substantially as described.

5. A furnace having an annular body, and stationary roof, means for rotating the body, a charging-opening leading into the body, and having partitions at both sides thereof, said furnace having an inlet for combustible fuel, and a stack-outlet; substantially as described.

6. A furnace having an annular body, and stationary roof, means for rotating the body, a charging-opening leading into the furnace, and having partitions at both sides thereof, said furnace having an inlet for combustible fuel, and a stack-outlet, said stack being in proximity to the charging-opening and the fuel-inlet being at a more remote point; substantially as described.

7. A furnace having a body of annular form, means for rotating the same, a stationary roof, dams dividing the chambers into compartments, and tap-holes in said compartments; substantially as described.

8. A furnace having a body of annular form, means for rotating the same, a stationary roof, and tap-holes at intervals around the body; substantially as described.

9. A furnace having a body of annular form, mechanism for rotating the same, and a relatively stationary roof, said roof being hollow and having downwardly-directed ports and said furnace having air-inlets; substantially as described.

10. A furnace having a body of annular form, means for rotating the same, a stationary roof, and tap-holes at intervals around the body, said furnace-body being inclined; substantially as described.

11. A furnace having an annular body, means for rotating the same, a stationary hollow roof having downwardly-directed ports, air-inlet ports and an outlet-flue leading through the roof to a stack; substantially as described.

12. A furnace having a body of annular form, mechanism for rotating the same, a relatively stationary roof having a hollow portion with downwardly-directed ports, air-inlet ports, a stack-flue leading through the roof, and a partition arranged to prevent short-circuiting from the ports to the stack-flue; substantially as described.

In testimony whereof I have hereunto set my hand.

JOHN A. POTTER.

Witnesses:
THOMAS W. BAKEWELL,
J. W. ATWOOD.