No. 688,651. Patented Dec. 10, 1901.

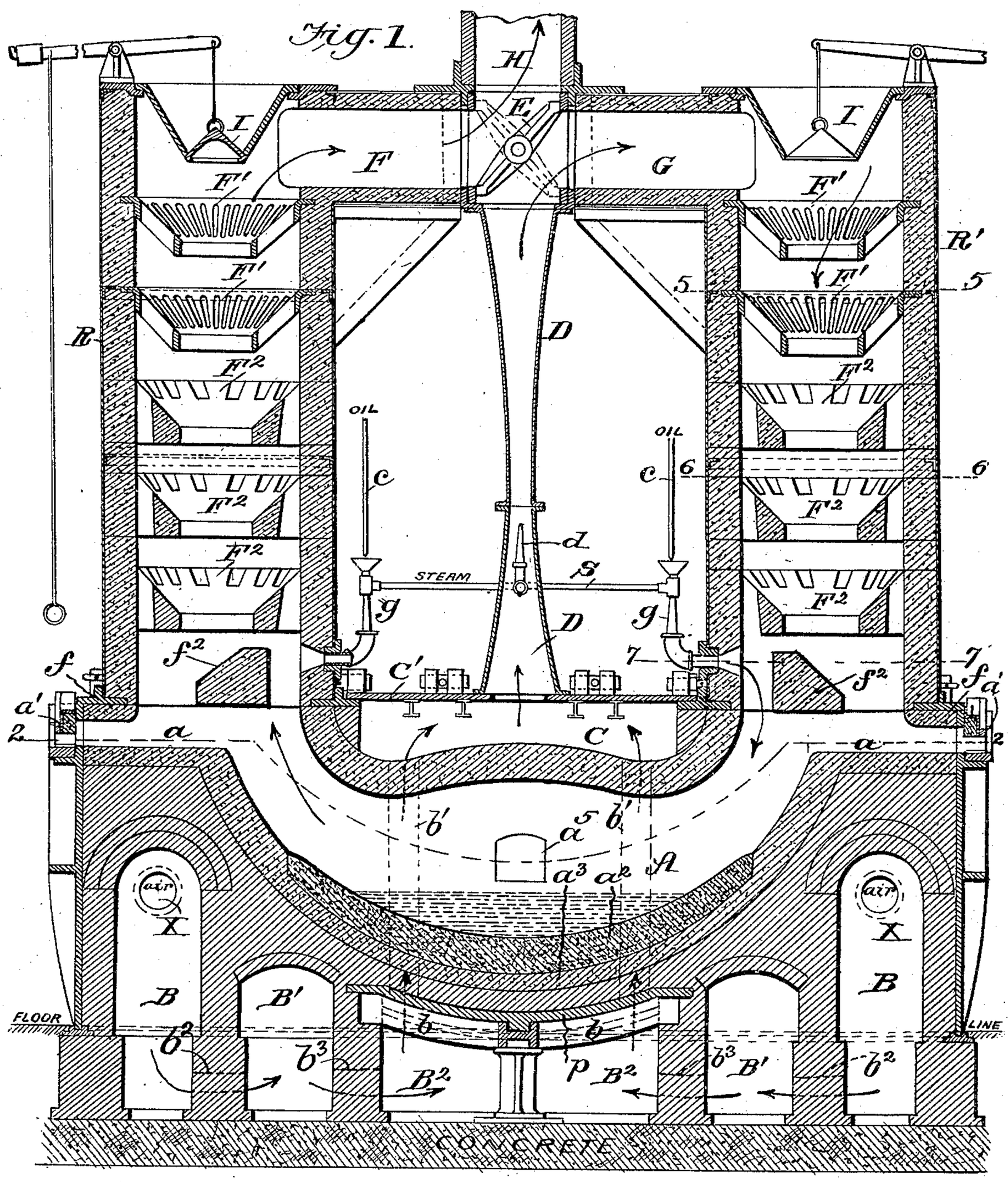
P. KIRK.

COMBINED ORE ROASTER AND SMELTER.

(Application filed Mar. 2, 1901.)

(No Model.) 4 Sheets—Sheet 1.

Fig. 1.



WITNESSES:
Jos. A. Ryan
Edw. W. Byrne.

INVENTOR
Peter Kirk.
BY Munn & Co.
ATTORNEYS

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(No Model.) 4 Sheets—Sheet 2.

Fig. 2.

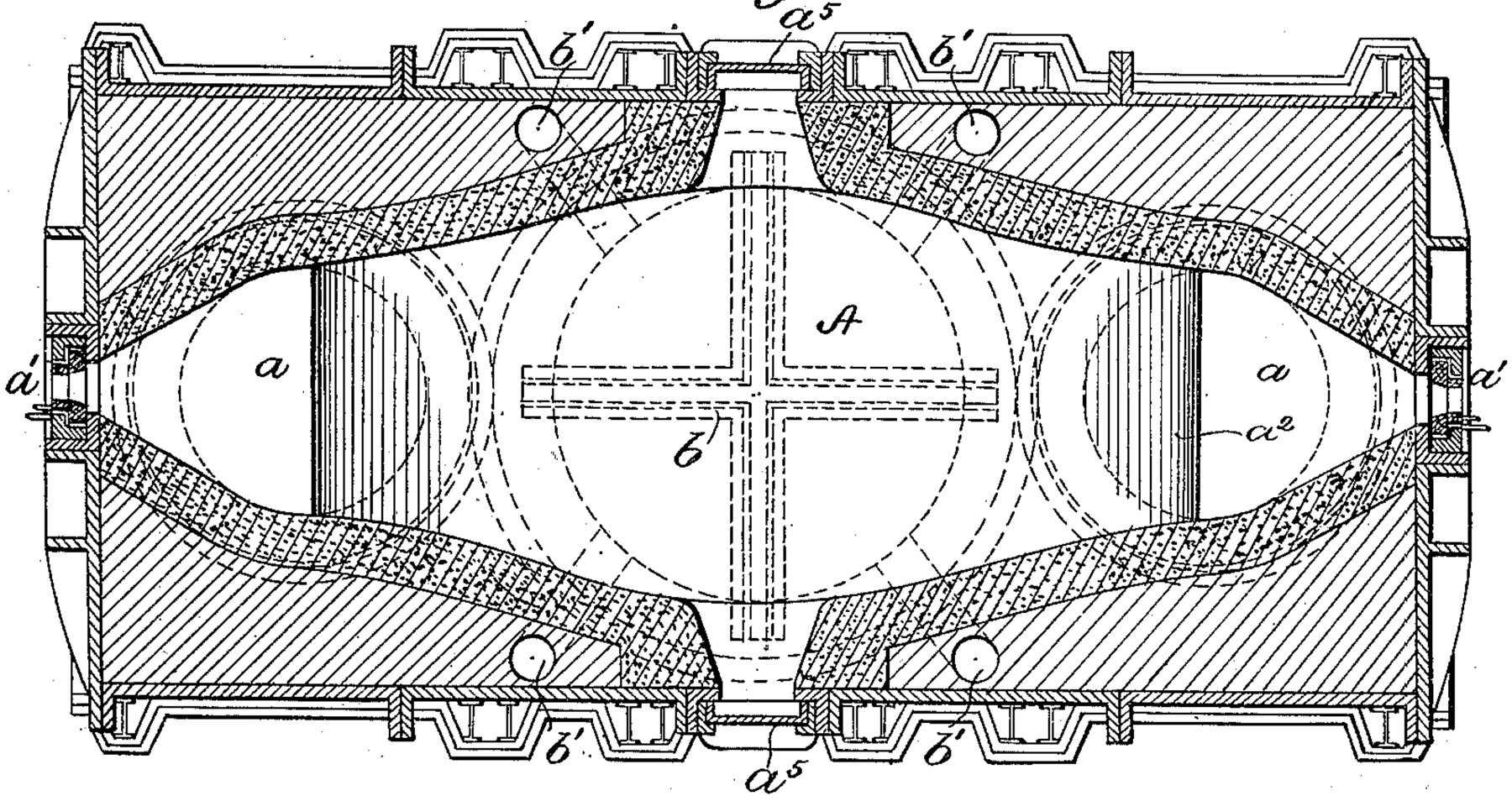
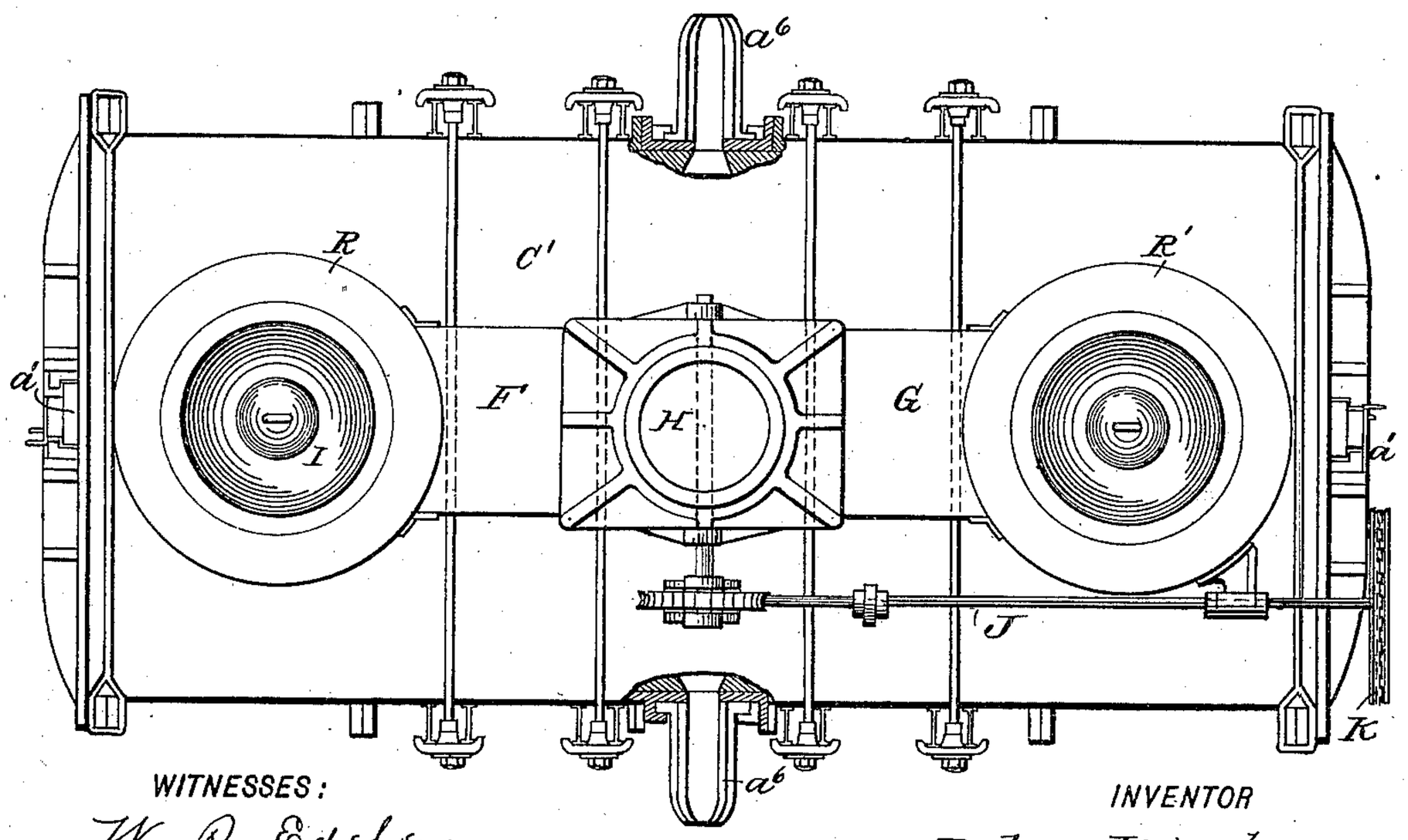


Fig. 4.



WITNESSES:
W. R. Edelen.
Jas. A. Ryan

INVENTOR
Peter Kirk.
BY Munn & Co.
ATTORNEYS

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P. KIRK.

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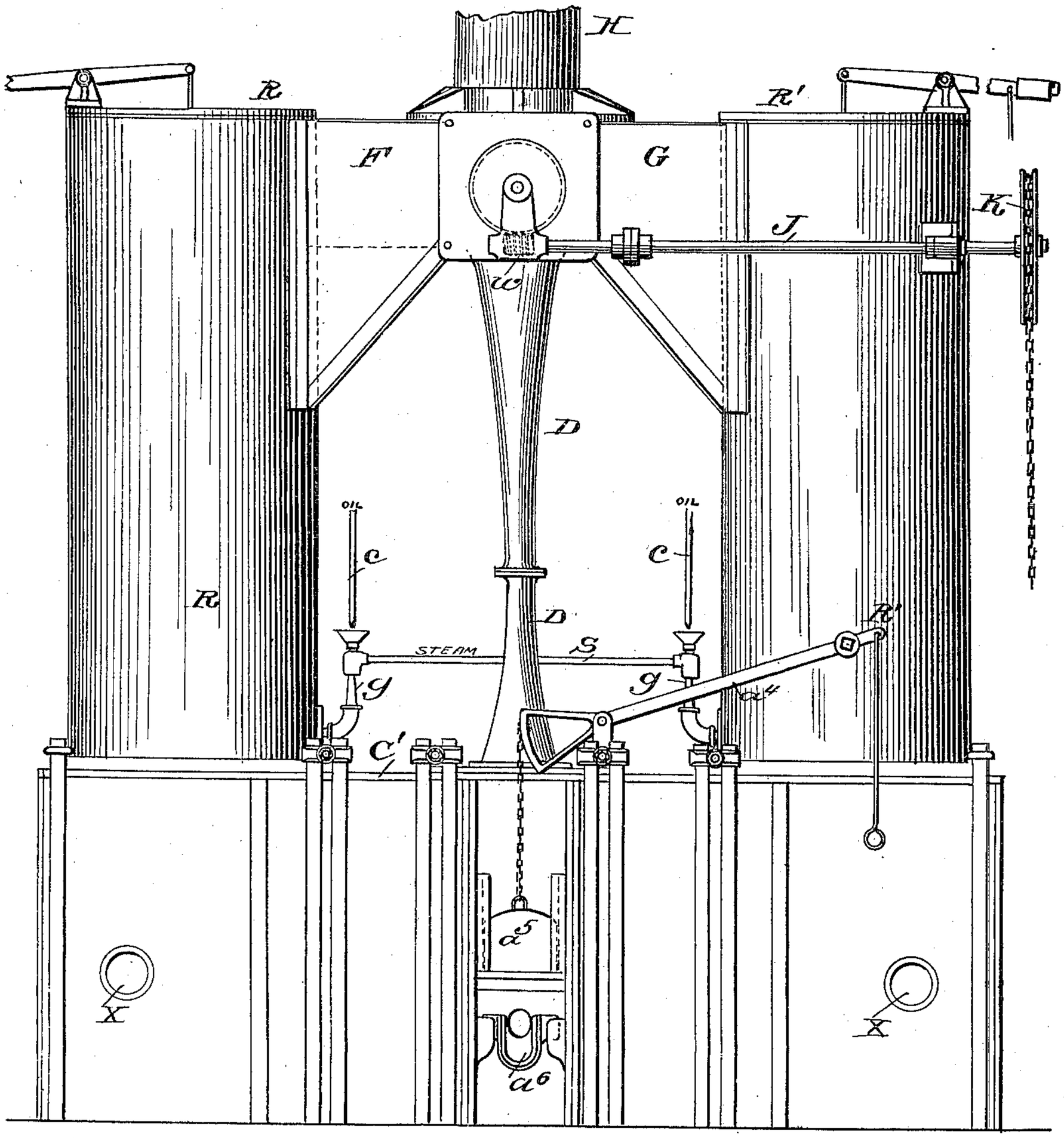
(Application filed Mar. 2, 1901.)

(No Model.) 4 Sheets—Sheet 3.

Fig. 3.



WITNESSES:
Jos. A. Ryan
Edw. W. Byrn.

INVENTOR.
Peter Kirk.
BY Munn & Co.
ATTORNEYS

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P. KIRK.

COMBINED ORE ROASTER AND SMELTER.

(Application filed Mar. 2, 1901.)

(No Model.) 4 Sheets—Sheet 4

Fig. 5.

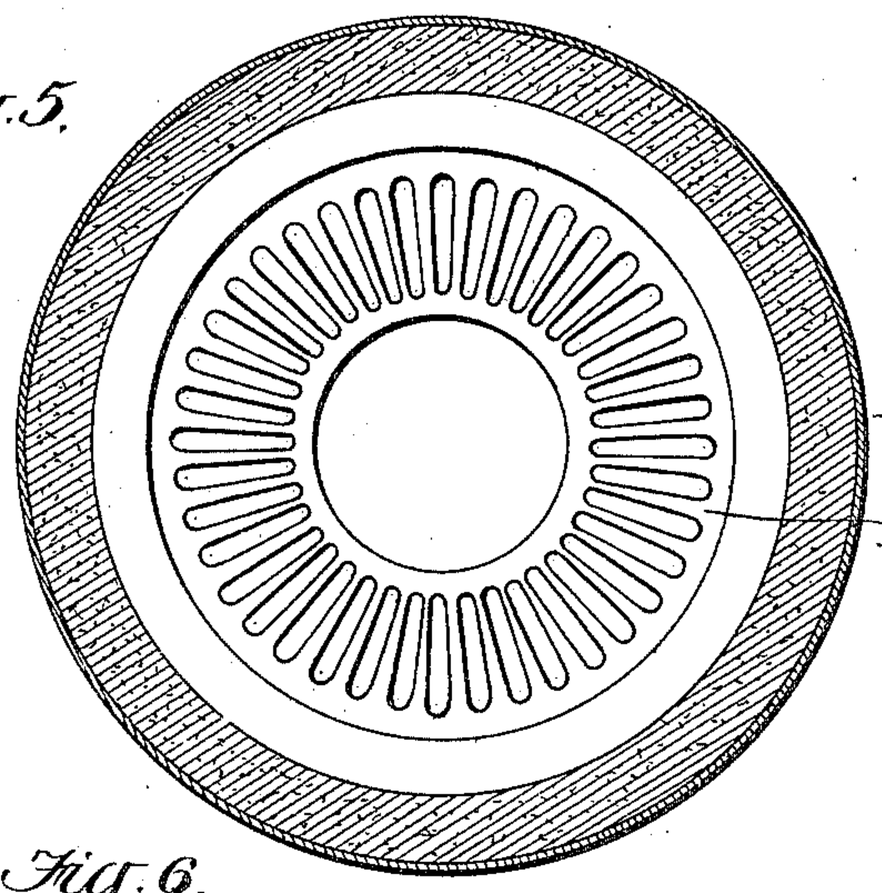


Fig. 6.

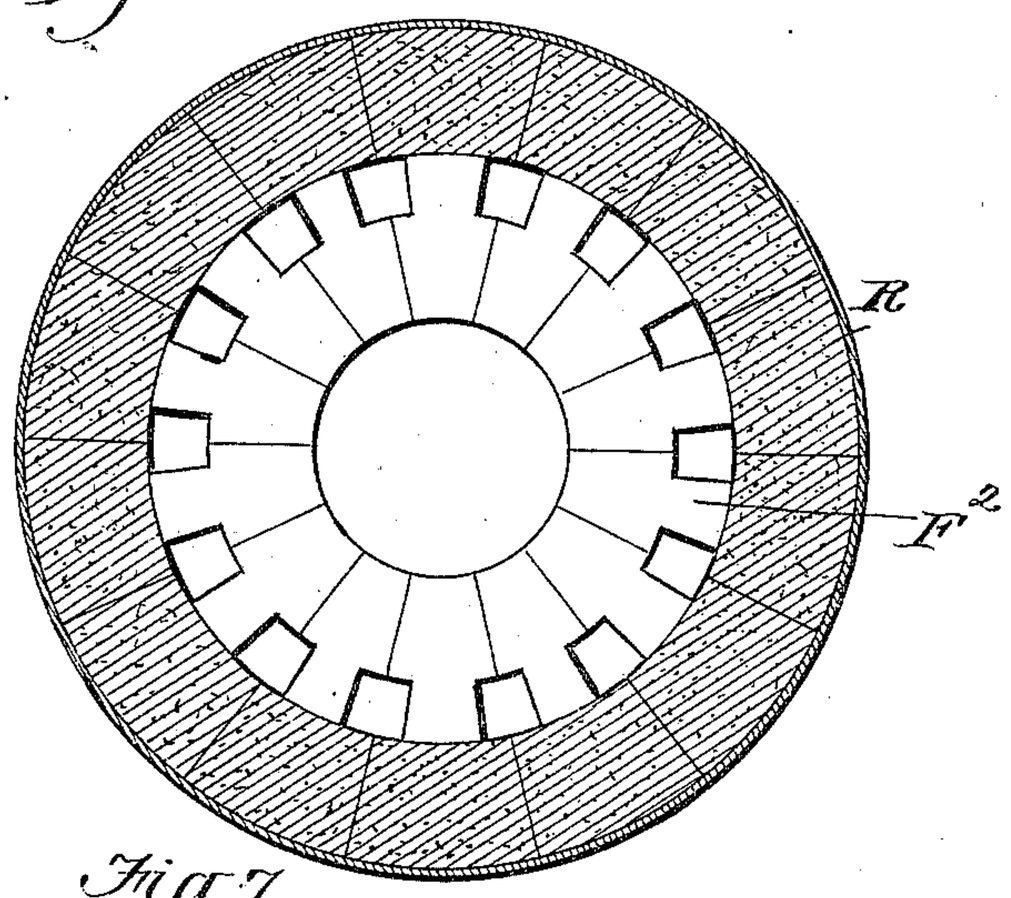
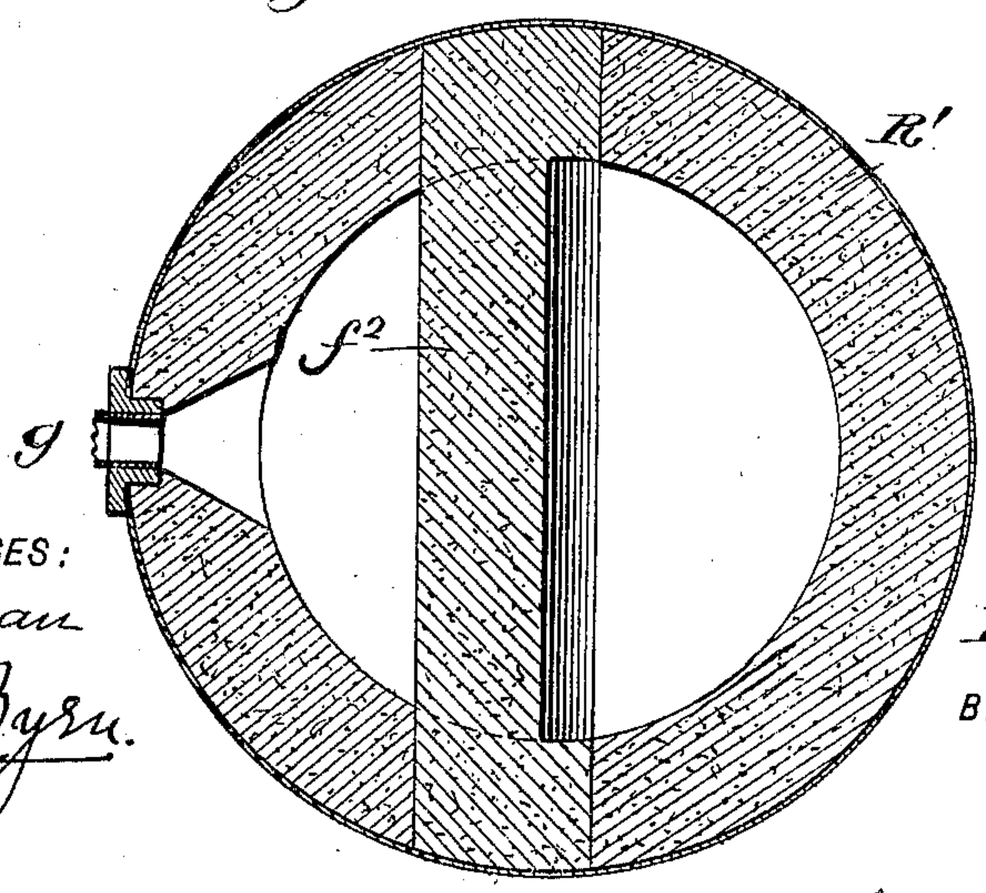


Fig. 7.



WITNESSES:
Jos. A. Ryan
Edw. W. Byrn.

INVENTOR
Peter Kirk
BY Munn & Co.
ATTORNEYS

UNITED STATES PATENT OFFICE.

PETER KIRK, OF KIRKLAND, WASHINGTON.

COMBINED ORE ROASTER AND SMELTER.

SPECIFICATION forming part of Letters Patent No. 688,651, dated December 10, 1901.

Application filed March 2, 1901. Serial No. 49,589. (No model.)

To all whom it may concern:

Be it known that I, PETER KIRK, of Kirkland, in the county of King and State of Washington, have invented a new and useful Improvement in a Combined Ore Roaster and Smelter, of which the following is a specification.

My invention is in the nature of a combined ore roaster and smelter for smelting ores containing silver, lead, copper, gold, &c. A large proportion of these ores require to be roasted before smelting, since some of such ores contain too much sulfur, which should be and is reduced preliminarily by roasting to about seven per cent. Other ores, also, are too refractory and require to be partially deoxidized before smelting.

My invention consists in a novel form of apparatus for accomplishing the preliminary roasting and also the subsequent smelting of such ores in a practically continuous way with a great economy of heat and of labor. It is an improvement upon that form of combined roasting and smelting furnace in which two vertical roasting-chambers communicate at the bottom with the opposite ends of the hearth of a smelting-chamber and at the top with a stack by means of a damper, the said vertical roasting-chambers being arranged to operate alternately according to the Siemens regenerative principle.

My improvements comprehend means for utilizing liquid fuel with steam in the heating and roasting operation and for heating and introducing air and working the charges, as will be hereinafter fully described with reference to the drawings, in which—

Figure 1 is a vertical central section through my combined roaster and smelter. Fig. 2 is a horizontal section on line 2 2 of Fig. 1. Fig. 3 is a front elevation of the apparatus. Fig. 4 is a plan view of the same. Fig. 5 is a section on line 5 5 of Fig. 1. Fig. 6 is a section on line 6 6, and Fig. 7 is a horizontal section on line 7 7 of Fig. 1.

In the drawings, Fig. 1, A represents the open-hearth furnace-chamber containing the bath. This hearth has a chrome-ore lining a^2. This makes a neutral bottom and is not fluxed by any of the fluxes used in the process. It is laid on a bed of silica fire-brick a^3 and a masonry substructure in which are formed a double series of air-chambers B B′ B^2, which communicate with each other through passage-ways b^2 b^3 and which are supplied with air from inlet-openings X. The lower or belly portion of the hearth is sustained by metal plates p and right-angularly arranged girders b, (shown in dotted lines in Fig. 2,) beneath which are the air-chambers B^2 B^2. From these air-chambers B^2 four vertical passage-ways b' lead to the space C above the hearth, said passage-ways being formed in the masonry, as seen in Fig. 2. The space above the hearth is decked over by plate C′, and in the chamber C beneath it the air reaches its highest temperature, said air coming in at X and passing successively through the chambers B B′ B^2 and then up passages b'. This hot air is taken up the induction-column D and into the furnace, as will be hereinafter described. These air-chambers B B′ B^2 C cool the walls of the furnace and avoid the damaging effect of excessive heat thereon and at the same time heat the air before its introduction into the furnace.

On opposite sides of the hearth and at each end of the furnace is formed the bench or table surface a, to which access is had through the doors a', and surmounting the furnace at these points are the two vertical masonry columns R and R′, which form both roasting and regenerator chambers, acting alternately in such capacity. To these chambers the ore is fed at the top through hoppers with cone-valves I of well-known construction. Within the chambers R and R′ are arranged a vertical series of hoppers at intervals of seven to eight inches apart. The two upper ones are made of iron or steel somewhat like a stove-grate, (see Fig. 5,) but with an opening through the center, and the three lower ones nearest the intense heat of the hearth are made of fire-brick, with a central opening and also a series of openings around their outer peripheries. Beneath the lower one of these hoppers there is a diametrical fire-brick cross-bar f^2, (see Fig. 7,) having an inclined side adapted to discharge the roasted ore from these hoppers onto the bench or table a, whence it is pushed into the hearth A by a suitable tool inserted through the doors a'.

The tops of the roasting and regenerator

chambers R R′ are connected by short horizontal flues F and G to the stack H, a swivel-damper E being located at the point of confluence on a horizontal axis, so that either flue F or G may be thrown into communication with the stack H and the other flue into communication with the inlet-column D for air and steam. This column, it will be remembered, communicates at its lower end with the hot-air space C below the deck-plate C′, and it is of small diameter in the middle and diverges toward both top and bottom. In its narrow throat portion an upwardly-turned steam-nozzle *d* takes steam from a steam-supply pipe S and creates a forced upward draft of hot air into the flue F or G and the chambers R and R′, according to the position of the damper E.

The fuel for the furnace is supplied in the form of liquid, preferably crude petroleum, which is introduced from pipes *c* into an injector and spray-nozzle *g*, to which an annular jet of steam is supplied from pipe S, the mixture of steam and oil entering the lower end of one of the chambers R or R′ alternately.

The flues F and G are incased between iron or steel girders, and these girders, with subjacent angle-brackets, carry the damper and the stack H, which latter is thirty inches in diameter and thirty feet high and at its lower end for a short distance is lined with fire-brick.

In Fig. 3 is shown the outside gears for working the damper, consisting of a worm-wheel on the damper-shaft meshing into a worm *w* on a shaft J, which at its outer end bears a wheel and endless chain K for operating the damper. In the same view also is seen one of the doors a^5 to the hearth and the lever a^4 for raising the same and also the inlet-openings X for the intake of air.

The operation of my combined smelter and roaster is as follows: The furnace is first heated up slowly, preferably by wood inserted in the hearth A through door a^5. The fire being started and the damper at the top of the stack being open, the damper E is adjusted, say, to the position shown in full lines in Fig. 1, so as to throw the air-currents down chamber R′ to the left across the hearth and up chamber R and out the stack. The current of air moves at first from the draft of the stack alone. In about thirty minutes the current is reversed by turning the damper to the position shown in dotted lines. The current is thus reversed every thirty minutes until the furnace is red hot. Then the steam-blower *d* is started, and when the furnace has come to a bright-red heat the oil is turned on and is fed through the injector *g* into the bottom of one of the chambers R R′, where it combines with the downcoming blast of air and steam and then passes across the hearth to produce an intense combustion. When the roasting-chambers have become fairly hot, one of the chambers R or R′ is filled with ore and the necessary flux, and the damper E is adjusted to cause the hot currents of combustion to pass upward through this ore until it has become hot and roasted, the gases from the top of said chamber passing out the stack. The current is now reversed and the hot ore (roasted) is pushed off the bench *a* into the hearth of the furnace. Meanwhile the other chamber has been filled with ore and flux previous to the reversal of the current. On the reversal this ore is then roasted while the hot roasted ore from the first chamber is being smelted. When the ore and fluxes are smelted, the slag-hole a^6 is opened and the slag is allowed to run off as made. When sufficient metal or bullion is produced to reach the slag-hole, the metal is tapped off and run into molds. This alternate operation of roasting in one or the other of the chambers R R′ and the passage of air and steam in reverse directions through the same goes on continuously without stopping the furnace as long as the furnace keeps in repair.

The advantages of my invention are as follows: The ore and flux enter the smelting-chamber while hot, thus making a great saving in fuel and reducing the labor in handling the ore. The superheated steam, combined with the oxygen of the air, has a great affinity for the sulfur and utilizes it as fuel. The process is rendered much shorter and all danger of "freezing-up" is avoided, as the zone of fusion is on the open hearth. If there is not sufficient flux to smelt the ore, more flux can be added through the doors into the bath. In the stack-smelter when a mistake is made in the quantity or proportion of flux there is risk of closing up the furnace, which cannot occur in my furnace. The economy in using oil is very great, which is an important factor when the transportation of fuel is expensive and difficult. I prefer to use coal-oil in crude form and find that one ton of the same gives as effective results as eight tons of coal.

In carrying out my invention I do not confine myself to the exact arrangement of parts shown and described, as various minor changes may be made without departing from the scope of my invention as claimed.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. In a combined smelting and roasting furnace, the combination with an open smelting-hearth and vertical roasting-chambers rising therefrom at each end and having ore-supporting devices in the same, the said roasting-chambers and smelting-hearth being in open communication as described; of two injectors for oil and steam arranged on the inner sides of each roaster, an air-heating chamber with steam-blower arranged between the injectors, and a pipe and damper for directing said hot-air blast into the top of either roasting-chamber substantially as described.

2. In a combined smelting and roasting furnace, the combination with an open smelting-

hearth and vertical roasting-chambers rising therefrom at each end and having ore-supporting devices in the same, the said roasting-chambers and smelting-hearth being in open communication as described; of air-chambers located below the smelting-hearth communicating with the outer air, an air-chamber formed above the smelter, vertical passage-ways connecting these upper and lower air-chambers, an air-pipe leading from the upper air-chamber to the top of the roasting-chambers and a steam-blower nozzle arranged in said air-pipe to energize the hot blast downwardly through the roasting-chambers substantially as described.

3. A combined smelting and roasting furnace, comprising an open smelting-hearth having at each end an elevated and horizontal bench-surface *a* with an externally-opening door at its outer end, two vertical roasting-chambers communicating with the top of the smelting-hearth having a series of tapered and open-slotted hoppers with central discharge, and an inclined face-bar f^2 placed beneath the lower hopper to discharge the roasted ore onto the bench substantially as described.

4. A combined smelting and roasting furnace, comprising an open smelting-hearth having at each end an elevated bench *a* with an external door at its outer end and a vertical roasting-chamber rising therefrom and in open communication therewith, a series of tapered and open-slotted hoppers arranged in the roasting-chamber, an inclined face-bar located below the lowest hopper to discharge onto the bench, and a steam and oil injector extending into the base of the roasting-chamber just above the smelter-hearth substantially as described.

5. A combined smelting and roasting furnace comprising an open smelting-hearth, vertical roasting-chambers communicating therewith at each end and having their upper ends connected to a common stack, inlet air-heating chambers formed above and below the open hearth, and a central vertical air-feed shaft with steam-blower connecting the air-heating chambers with the upper ends of the roasting-chambers substantially as and for the purpose described.

PETER KIRK.

Witnesses:
A. J. PIDGEON,
D. H. BEAN.