(No Model.)

2 Sheets—Sheet 1.

# J. K. GRIFFIN.

## PROCESS OF AND FURNACE FOR SMELTING AND REDUCING ORES.

No. 299,637. Patented June 3, 1884.

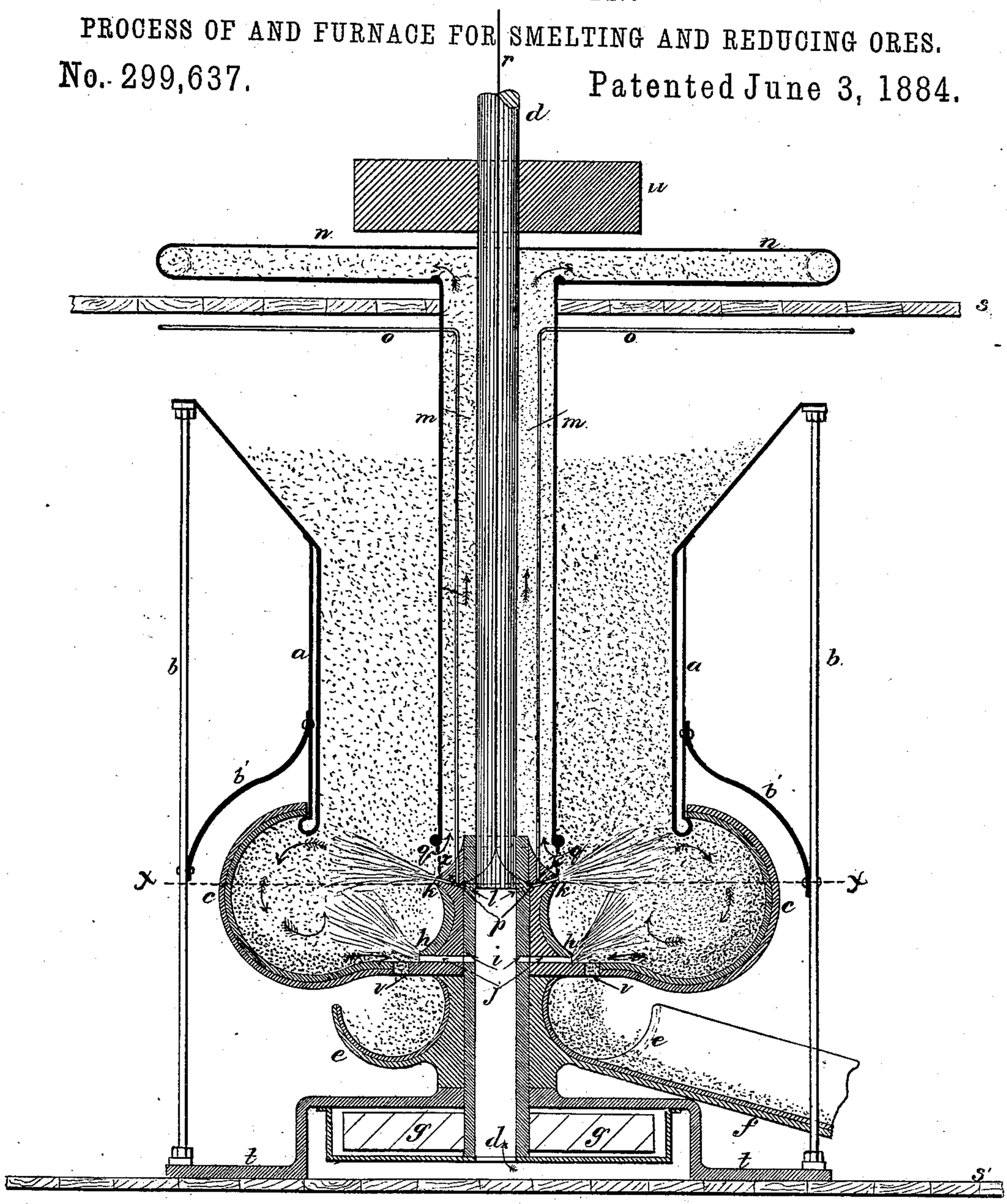


Fig. 1.

Witnesses

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(No Model.) 2 Sheets—Sheet 2.

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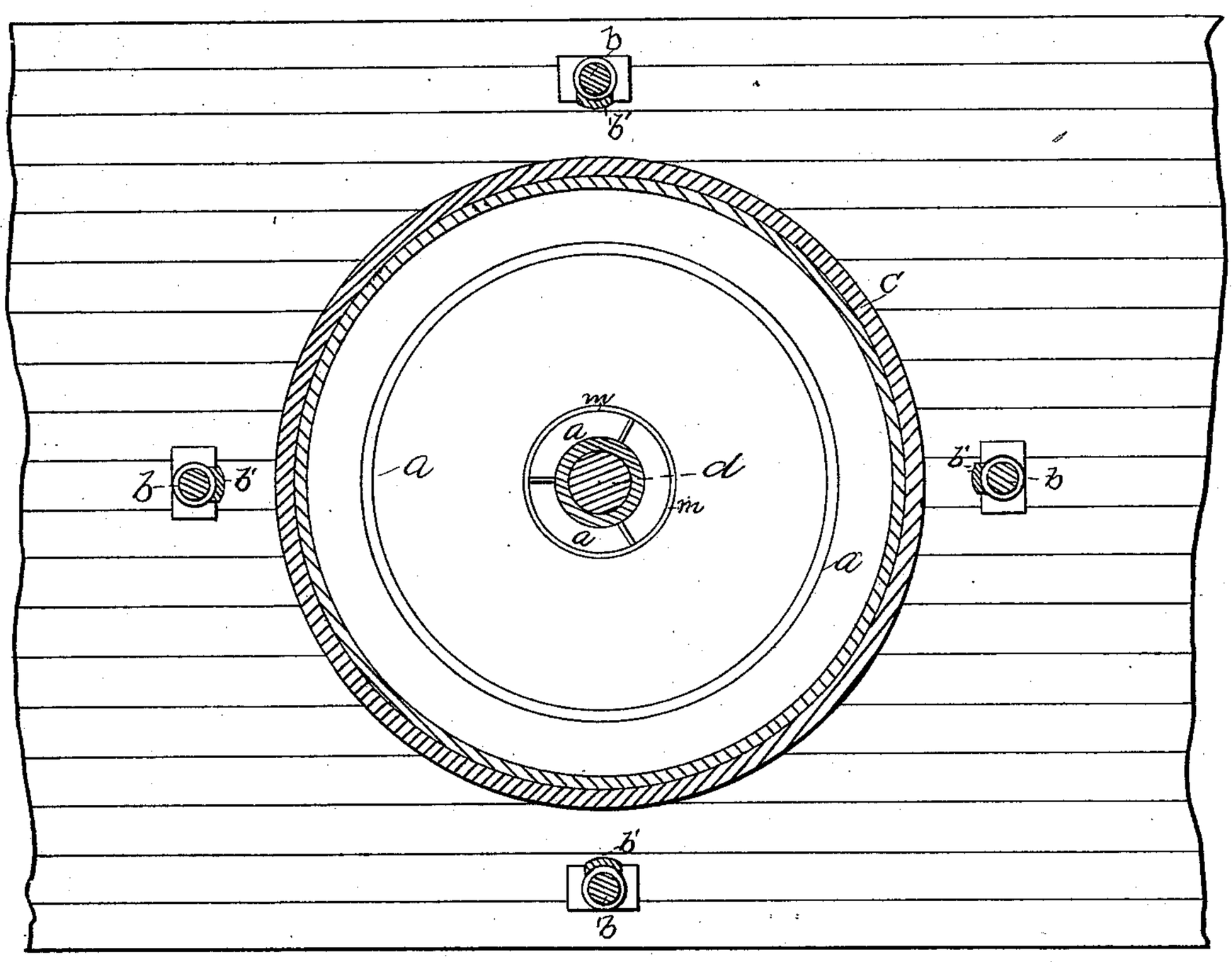
*Fig. 2.*




*WITNESSES*

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# UNITED STATES PATENT OFFICE.

JAMES K. GRIFFIN, OF BROOKLYN, NEW YORK.

## PROCESS OF AND FURNACE FOR SMELTING AND REDUCING ORES.

SPECIFICATION forming part of Letters Patent No. 299,637, dated June 3, 1884.

Application filed June 5, 1883. (No model.)

*To all whom it may concern:*

Be it known that I, JAMES K. GRIFFIN, a citizen of the Dominion of Canada, now residing in the city of Brooklyn, in the county of Kings and State of New York, have invented certain new and useful Improvements in Processes of and Furnaces for Smelting and Reducing Ores and other Substances, of which the following is a specification.

In the drawings herewith, Figure 1 shows a vertical section through the center of the furnace, and Fig. 2 a cross-section through the dotted line *x x* of Fig. 1.

The object of this invention is to provide a simple portable furnace in which the heat may be generated from gaseous, liquid, or solid fuels, at pleasure, and ores and other substances reduced, and the metals they contain extracted, smelted, and refined in one operation.

*a a* is a stationary supplying-receptacle for ores or other substances, supported by the surrounding pillars *b b*, and stayed by the braces *b' b'*. A rotating crucible, *c c*, forms the bottom of the stationary supplying-receptacle *a a*, under which it revolves upon the vertical axle *d*. This axle is tubular for the passage of air through it from the blower *g*, at its base, to the burner *k k*, but is solid therefrom through the furnace upward to the pulley *u*, above the upper floor *s*, by which it is driven. The blower *g* forces the air upwardly through the vertical tubular axle *d*, the orifices *i*, and the tuyeres *h h*, into the rotating crucible *c c*. The blower likewise forces the air to the annular burner *k k* through the orifices *l*. *o o* are small feed-pipes for conveying oil, water, or other liquids or gases to the burner *k k*, which is formed of two annular disks—one above the other—with their faces together. The upper disk surrounds the solid axle *d*, which revolves through it. This disk is sustained by rods *x x* from it across the opening *q q* to the escape-pipe *m m*. The upper surface of that part of the crucible *c c* which surrounds the tubular axle between the orifices for air forms the lower annular disk of the burner *k k*. The contiguous surfaces of the said disks may be plain or corrugated, as shall best promote the intermixing of the elements passing between them.

*r r* is a conducting-wire, along the axle or elsewhere, from any proper electric apparatus to the burner *k k*, for the ignition of the fuel. The rotating crucible is secured to the tubular axle *d*, which is supported upon the trough *e e*, resting on the hollow base *t t*, which is secured to the floor *s'*. The crucible, trough, and ore-receptacle may be lined whenever practicable with refractory material, in such a manner as to allow a space for the circulation of some cooling agent.

The burner *k k*, in combination with the blower *g* for supplying air thereto, will be more fully described in separate application for patent. The receptacle *a a* and crucible *c c* being filled with ore, and the power applied to the driving-pulley *u*, it will be seen that the ore or other substance in the receptacle is stationary and does not revolve, while that within the crucible does revolve with it, thereby forming two strata of material in contact with and attrition against each other, the lower stratum in the crucible sustaining the weight of the upper stratum in the receptacle, by which the force of attrition is made effective. The oil from the burner *k k* being ignited, preferably by electricity, the combustion of the fuel, in combination with the centrifugal power in the rotating crucible, forces the heat and flame outwardly along the line of attrition between the said strata into the interstices between and among the particles of ore or other substance. When coal is used for fuel, alone, or in addition to oil or gas, it may be fed with the ore in the receptacle *a a* and pulverized at the time of combustion, as the line of attrition and combustion are the same. The necessary water may be supplied, if preferred, by wetting the ore and coal. The combustion of the incoming air, oil, water, or other fuel by the heat generated, explodes the air, water, and gases in the ore and other substances, which, with the friction between the strata thereof, reduces them to powder. The combined heat of combustion and friction, with the force of the blower *g* and the rotating exhaust-pipes *n n*, creates a powerful draft through the furnace, by which the products of combustion and the lighter powdered substances and waste material are carried from the furnace up the

central discharge-pipe, *m m*, through the rotating exhaust-pipes *n n*. These pipes are firmly attached to the axle *d* by the cover of the passage *m m*, and so curved backward at their outward extremities (not shown) as to discharge their contents in an opposite direction to that of their motion. If the furnace be covered to confine the internal pressure, it will, by its force upon the rotary exhaust-pipes *n n*, assist in or completely effect the revolution of the axle *d* and the crucible *c c* attached thereto. The pulverized waste passes off by the escape-pipe *m m* as fast as it has been sufficiently reduced to bring it within the lifting-power of the upward draft. At the same time the metal is separated therefrom by the explosion and attrition described, and projected outwardly by the centrifugal force in the rotating crucible against the sides thereof, when the gravity of the metal causes it to settle to the bottom to be met by the current of air from the tuyeres *h h*, for the removal and combustion of any impurities remaining in it. The centrifugal action while forcing the liquid metal against the sides of the crucible imparts a centripetal motion crosswise of the rotary motion, so that the metal is puddled by its action upon itself, whereby the extraneous matter, by reason of its lesser gravity, is pressed upwardly to the line of friction and heat for more complete reduction and expulsion, as aforesaid. As the mass of metal increases at the bottom of the crucible, it is discharged by the ports *c c*, immediately under the tuyeres *h h*, into the annular trough *e e*, to be carried off by the duct *f*. This discharge of the metal through the air coming from the tuyeres *h h* renders the escape of impurities impossible.

The running of the furnace may be continuous, as the crucible is self-discharging, in the manner described. The degree of heat used should be adapted to the work of reduction, separation, or smelting required to be done. By diminishing the heat in part or altogether a large portion, if not all, of the waste may be removed and the remaining ore or metal treated as described.

By ordinary processes the metal and slag are melted together in bulk and divided by their difference of gravity, the slag being drawn off above and the metal below. By my process the whole mass is first pulverized in the furnace by the heat and attrition, the waste and impurities being withdrawn upwardly while the metal is driven outwardly in the crucible, where it is smelted and purified in the manner described. By this method all the metallic elements are completely separated from the slag and other impurities and the quality of the metallic product greatly improved.

I do not claim, broadly, the rotating of a bowl, collecting-pot, sole, hearth, or crucible of any kind; but I do claim—

1. In a smelting and reducing furnace, the combination of a stationary supplying-receptacle, *a a*, with a crucible, *c c*, and means for rotating the same, the receptacle and crucible arranged in relation to each other, as shown and described, whereby one vessel is practically formed for containing the ore to be reduced, while a division-line of attrition is established between the stationary receptacle and the crucible, as and for the purpose set forth.

2. In a smelting-furnace, the stationary supplying-receptacle *a a* and rotating crucible *c c*, in combination with the discharge-pipe *m m*, substantially as described.

3. In a smelting-furnace, the stationary supplying-receptacle *a a* and rotating crucible *c c*, in combination with discharge-pipe *m m* and rotating exhaust-pipes *n n*, substantially as described.

4. In a smelting-furnace, the combination of stationary supplying-receptacle *a a*, rotating crucible *c c*, with blower *g*, vertical tubular axle *d*, tuyeres *h h*, and burner *k k*, substantially as described.

5. In a smelting-furnace, the combination of stationary supplying-receptacle *a a*, rotating crucible *c c*, with blower *g*, vertical tubular axle *d*, and tuyeres *h h*, substantially as described.

6. In a smelting-furnace, the combination of stationary supplying-receptacle *a a*, rotating crucible *c c*, with blower *g*, vertical tubular axle *d*, and burner *k k*, substantially as described.

7. In a smelting and reducing furnace such as described, the combination of the crucible *c* with the discharge-pipe *m m*, provided with the exhaust-pipes *n n*, substantially as set forth.

8. In a smelting and reducing furnace, the combination of the rotating crucible and stationary hopper with the central burner, *k k*, arranged to extend up within the crucible to a height approximating the line of attrition between the stationary receptacle and the crucible, substantially as and for the purpose set forth.

9. In a smelting and reducing furnace, the combination of the rotating crucible *c* and stationary receptacle with the central burner, *k k*, arranged to extend up within the crucible to a height approximating the line of attrition between the stationary receptacle and the crucible, the tubular axle *d*, and blower *g* for supplying air thereto, substantially as set forth.

10. In a smelting-furnace, the following elements in combination: stationary receptacle *a a*, discharge-pipe *m m*, rotating crucible *c c*, and burner *k k*, arranged and operated substantially as described.

11. The process of reducing and smelting ores which consists in rotating one mass or division thereof, while being held and smelted in the crucible *c c*, under the weight of and against another stationary mass or division thereof, held in the stationary supplying-re-

ceptacle *a a* while the said ores are under the influence of heat generated on the line of attrition between the stationary and rotating masses or divisions of ore, and forced between and among the particles thereof by the combustion of coal or other fuel, substantially as described.

12. The process of smelting and reducing ores which consists in rotating one mass or division thereof, while being held and smelted in the crucible *c c*, under the weight of and against another stationary mass or division thereof, held in the stationary supplying-receptacle *a a* while the said ores are under the influence of heat generated on the line of attrition between the said masses or divisions of ore, and forced between and among the particles thereof, by the combustion of coal or other fuel, and at the same time separating and carrying off the waste materials upwardly by the pneumatic force described while the metal is being separated and forced outwardly and downward within the crucible *c c* by centrifugal force, substantially as described.

13. The method herein described of separating the impurities from the molten metal, which consists in subjecting the molten mass at its point of exit from the crucible to a blast of air projected within the crucible and across the line of discharge, substantially as described.

14. The process of smelting and reducing ores which consists in rotating one mass or division thereof, while being held and smelted in the crucible *c c*, under the weight of and against another stationary mass or division thereof, held in the stationary supplying-receptacle *a a* while the said ores are under the influence of heat generated on the line of attrition between the said masses or divisions of ores, and forced between and among the particles thereof, by the combustion of coal or other fuel, and at the same time separating and carrying off the waste material upwardly by the pneumatic force developed in the furnace by combustion while the metal is being separated and forced outwardly and downward within the crucible *c c* by centrifugal force, when by its gravity it is pressed back to and through the discharge-ports *v v*, under and against a current of air from the tuyeres *h h*, over the said ports within the crucible *c c*, in the manner substantially as described.

In testimony that I claim the foregoing as my own I affix my signature in presence of two witnesses.

JAMES K. GRIFFIN.

Witnesses:
J. P. GRIFFIN,
A. HYDE.