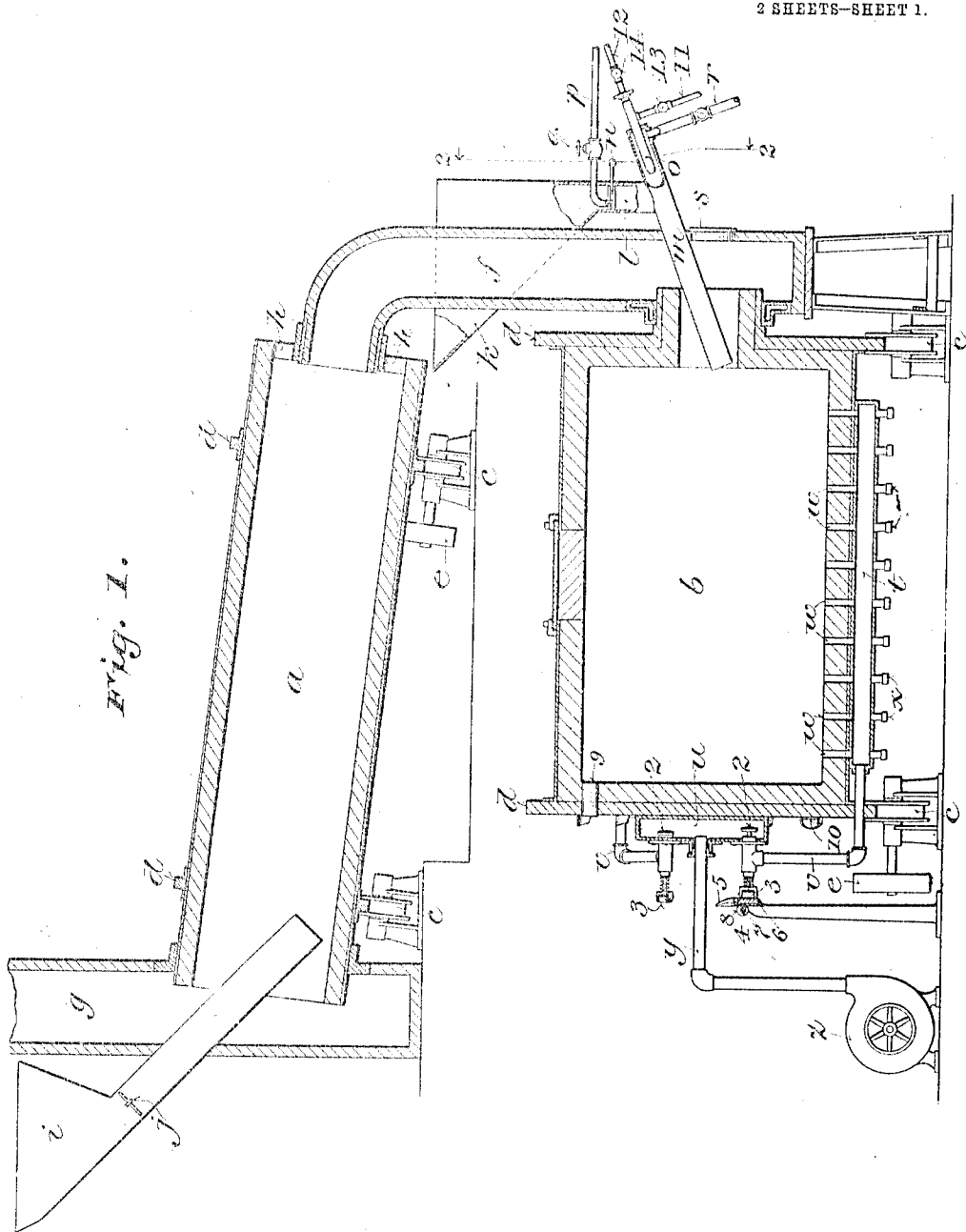


E. FINK.
ORE SMELTING AND REFINING APPARATUS.
APPLICATION FILED JAN. 5, 1910.

1,061,279.

Patented May 13, 1913.

2 SHEETS-SHEET 1.



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Fig. 3.

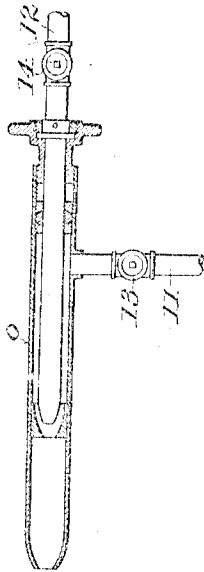


Fig. 3.

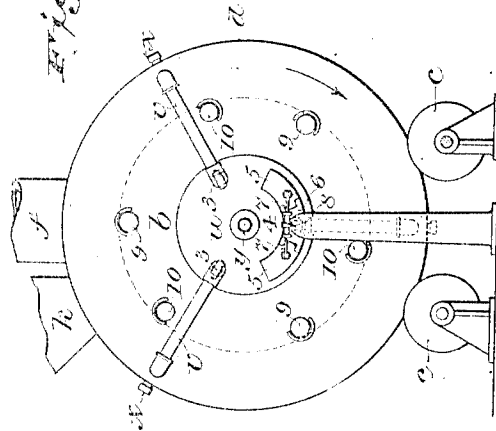


Fig. 4.

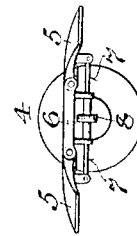
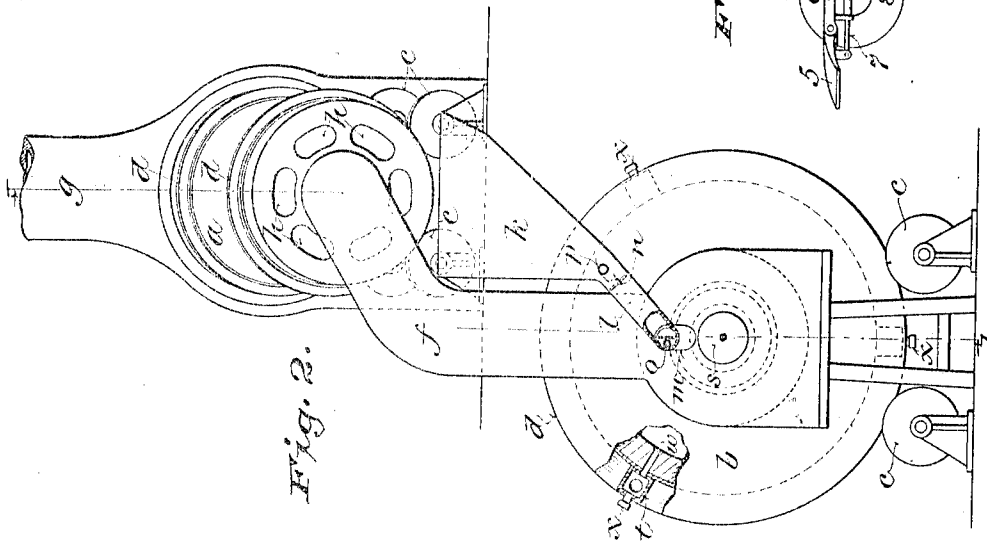


Fig. 2.



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UNITED STATES PATENT OFFICE.

EDWARD FINK, OF MILWAUKEE, WISCONSIN, ASSIGNOR TO FINK SMELTERS COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF SOUTH DAKOTA.

ORE SMELTING AND REFINING APPARATUS.

1,061,279.

Specification of Letters Patent.

Patented May 13, 1913.

Application filed January 5, 1910. Serial No. 536,453.

To all whom it may concern:

Be it known that I, EDWARD FINK, a citizen of the United States, residing at Milwaukee, in the county of Milwaukee and State of Wisconsin, have invented certain new and useful Improvements in Ore Smelting and Refining Apparatus, of which the following is a specification, reference being had to the accompanying drawing, forming a part thereof.

This invention relates more particularly to improvements upon apparatus of the class and for the general purposes of that shown and described in my application Serial No. 423,797 filed March 28, 1908.

The main objects of the improvements constituting the present invention are to provide for a continuous feed of ore into the apparatus as well as continuous preheating and smelting operations, particularly for the treatment of ores containing an excess or large percentage of sulfur, and generally to improve the construction and operation of apparatus of this class.

It consists in the construction, arrangement and combination of parts as hereinafter particularly described and then defined in the appended claims.

In the accompanying drawing like characters designate the same parts in the several figures.

Figure 1 is a vertical longitudinal section on the line 1 1, Fig. 2, of apparatus embodying the invention; Fig. 2 is an end elevation and a vertical cross section of the apparatus on the line 2 2, Fig. 1; Fig. 3 is an end elevation of the smelting barrel as seen from the left relative to Fig. 1; Fig. 4 is a plan view of the adjustable cam for operating the valves which control the supply of air to the tuyers, and Fig. 5 is an enlarged view in longitudinal section of a suitable form of burner with which the apparatus may be provided when liquid fuel such as oil is used.

The apparatus comprises a rotary roasting or heating barrel *a*, and a rotary smelting barrel *b*, which may be of cylindrical form and mounted one above the other as shown. These barrels may be formed of boiler plate or heavy sheet metal lined with fire brick, clay or suitable refractory material to protect the metal shells or casings.

They are each mounted upon supporting wheels or rollers *c* so as to be capable of rotation around their axes, the wheels or rollers being preferably flanged or grooved and the barrels provided with circular rails *d* fitting between the flanges or into the grooves of said wheels or rollers. One or more of the wheels or rollers associated with each barrel is provided with a pulley *e* or other means for rotating the barrel.

The barrel *b* is provided at one end with an outwardly flanged central opening which is connected by a flue *f* with the lower end of the barrel *a*, the latter being set at an inclination, as shown, to cause the ore fed into its upper open end to flow or travel gradually toward its lower end when the barrel is rotated.

The upper end of the barrel *a* communicates with a chimney or escape flue *g*, and around the central opening in its lower end, with which the flue *f* communicates, is provided with a circular series of openings *h* for the continuous discharge of ore on the under side and the admission of air, if desired, on the upper side. These openings may, if desirable, be closed or partially closed above and at the sides of the flue *f*.

Ore is fed into the barrel *a* from a hopper *i* having a spout passing through the chimney or escape flue *g* into the upper end of said barrel, and the feed is regulated by a valve *j*. The ore is discharged from said barrel *a* through the openings *h* below the flue *f* into a hopper *k* which is connected at the bottom by a spout or pipe *l* with the feed tube or pipe *m* which passes downwardly through the flue *f* into the central opening in the adjacent end of the smelting barrel *b*. The spout or pipe *l* is provided with a valve *n* which controls the supply of ore from the hopper *k* to the barrel *b*. The tube or pipe *m* may serve also as a fuel and air supply or burner pipe. For this purpose it is divided lengthwise by a partition as shown in Fig. 2, one side or passage being used for feeding ore and the other for fuel and air. When dry powdered fuel is used it is introduced into the smelting barrel *b* through one side or passage of the tube or pipe *m* with or by means of an air blast, no separate burner nozzle being required; but when oil or liquid fuel is used, a spraying

nozzle or burner *o*, such as shown in Fig. 5, is inserted in one side or passage of the feed tube or pipe *m*, as shown in Fig. 1.

An air supply pipe *p* provided with a valve *q*, leads into the spout or pipe *l* above the valve *n* and affords means for keeping the ore feed passage into the barrel *b* open. An air blast pipe *r* is connected with the fuel supply or burner side or passage of the tube or pipe *m*.

The flue *f* has an opening opposite the opening in the adjacent end of the barrel *b*, and this opening is provided with a removable closure *s* which has a "peep hole" for observing conditions in the interior of the barrel.

The smelting barrel is provided longitudinally at its periphery with one or more twyer boxes *t* and at one end with a wind box *u* which is connected by a pipe *v* with each twyer box. Twyer openings or passages *w* lead radially from each wind box *t* through the intervening shell and lining into the interior of the barrel *b* and opposite these openings or passages short pipes or openings which are normally closed by caps or plugs *x* are provided in the outer wall of each twyer box for the insertion of a rod to "punch" the twyers and keep them open. There are preferably a number of these twyer boxes and groups of twyers, in the present case three, so disposed around the barrel that the air blast through them into the charge will be practically continuous and that the barrel may be stopped in one or more positions in which all of the twyers will be above the level of the charge, thus permitting the melted charge to settle without agitation by the air blast.

The wind box *u* is connected by a pipe *y* with a blower *z* and the admission of air therefrom to the several twyer boxes is controlled by spring seated valves 2, the stems of which project outwardly from said wind box parallel with and equidistant from the axis of the barrel and are provided with rollers or heads 3 adapted by engagement with a stationary cam 4 to open said valves and hold them open while the twyers are passing below the charge, the barrel being rotated in the direction indicated by the arrow on Fig. 3.

The cam 4 is formed as shown in Figs. 1, 3 and 4, with outwardly beveled or inclined faces at the ends so as to gradually open the valves 2 and permit them to gradually close as the twyers are passing into and leaving the charge. It is also made adjustable so as to properly time the opening and closing of the valves according to the varying level of the charge. This may be accomplished as shown in Figs. 3 and 4, by hinging the beveled or inclined end sections 5 of the cam to the middle section 6 which is fixed, and connecting them by right and left screw-

threaded rods 7 and a correspondingly threaded sleeve nut 8, rotatably mounted and confined against endwise movement on the fixed middle section.

Midway between adjacent twyer boxes *t* one end of the barrel *b* is formed adjacent to its cylindrical wall as shown in Figs. 1 and 3, with one or more tap holes which are normally closed by plugs 9, for drawing metal or matte from the lower part of the charge. It is also formed adjacent to but a little in advance of one or more of the twyer boxes with one or more tap holes which are normally closed by plugs 10, for drawing off slag from the upper part of the charge while the twyers *w* are above the charge and are shut off from the air supply.

In the operation of the apparatus as hereinafore described, particularly in the treatment of ores containing an excess or large percentage of sulfur, the crude or raw ore fed from the hopper *i* into the upper end of the rotating barrel *a*, gradually travels downward through said barrel, in which it is subjected to the hot products of combustion escaping from the smelting barrel *b* through the flue *f* and thence through the barrel *a* into the chimney or escape flue *g*. The ore is thus heated and partially roasted preparatory to being smelted in the barrel *b*, and the moisture together with the sulfur fumes and products of combustion are carried off through the upper open end of the barrel *a* into the chimney or flue *g*. The heated and partially roasted ore is discharged through the openings *h* at the lower end of the barrel *a* into the hopper *k*, from which it is delivered through the spout or pipe *l* into the feed tube or pipe *m* and thence into the rotating barrel *b*. During the entire smelting operation a molten bath is maintained in the barrel *b* to receive the ore as it is continuously fed into the barrel through the tube or pipe *m*, and air is constantly introduced into the barrel through the supply pipe *r* and one side or passage of the tube or pipe *m*, and into the bath through the twyers *w*. The cam 4 is adjusted from time to time according to the level of the molten bath so that the valves 2 will be opened as the corresponding twyers are about to pass below the level of the bath and will be closed after said twyers leave the bath. Rapid desulfurization and smelting of the ore takes place throughout the entire operation of smelting and ore is continuously fed into the barrel *b* until the full capacity of the barrel has been reached. In the treatment of ores containing a large percentage of sulfur, but little fuel is required during the smelting operation, as the combustion of the sulfur and the slagging of the bases generates sufficient heat. For ores containing a smaller percentage of sulfur, more or less fuel is required, and this is sup-

plied to the burner *o* when oil is used, with a blast or jet of air or steam through the pipes 11 and 12, which are provided with regulating valves 13 and 14, or directly to the air supply side or passage of the feed tube or pipe *m* without a special burner, when dry powdered fuel such as charcoal is used. When the molten bath has reached the capacity of the smelting barrel *b* or the desired volume, the supply of ore thereto is stopped, the twyers *w* are all turned into positions above the level of the bath and the matte is allowed to settle. The heat is kept up by the operation of the burner or by the supply of fuel through the tube or pipe *m*, so that the slag becomes thoroughly liquid, thus permitting a clean separation of the matte therefrom. The slag is now drawn off through one of the tap holes provided with the plugs 10 by turning the barrel into the proper position therefor. Under ordinary conditions the matte is allowed to accumulate for twenty-four hours or more, so that but a single refining operation per day is necessary, but when the ore is rich in metal it may be desirable to refine oftener. The quality of matte produced during the smelting operation depends entirely upon the rate of supply of ore to the smelting barrel, the slower the feed the richer the matte, but it is desirable to regulate the feed so as to produce a matte containing about fifty per cent. of metal. During the refining operation air is supplied to the bath through the twyers *w*, but instead of rotating the barrel continuously in one direction as in the smelting operation, it is simply oscillated, the twyers being kept above the level of the metal to prevent chilling the same. If necessary to protect the lining of the smelting barrel, silica is supplied to the molten charge through the hopper *k* and feed tube or pipe *m*. In case the metal as it is formed by the refining operation shows a tendency to chill, this may be prevented by turning on the fuel supply. When the charge is in condition for drawing off the metal produced by the refining operation, one of the tap holes provided with the plugs 9 is turned into its lowermost position at the bottom of the barrel, thereby carrying all the twyers above the level of the charge, the plug is removed, and the metal drawn off. The slag from the refining operation, which is often rich in copper or metal, is retained in the smelting barrel and forms the basis for starting the next smelting operation.

The method and means of refining hereinbefore described does away with silicious linings and avoids the skimming operations which are essential with ordinary converters according to the usual practice.

The same apparatus and the same workmen or attendants serve both for the smelting and for the refining operations.

In certain cases the automatic spring seated valves 2 and the cam 4 may be dispensed with and the air supply connections from the wind box *u* to the twyer boxes *t* left constantly open.

Various changes and modifications in details of construction and arrangement of parts may be made without departing from the principle and scope of the invention.

By the term "rotary" as herein employed it is intended to include rotation alternately in opposite directions or a rocking or oscillatory movement, as well as continuous rotation in a single direction.

I claim:

1. In ore smelting and refining apparatus the combination of a rotary smelting barrel having an opening in one end, a rotary heating barrel, a flue connecting the end opening of the smelting barrel with one end of the heating barrel, an escape flue with which the other end of the heating barrel communicates, means for feeding ore into the end of the heating barrel adjacent to the escape flue, and means for conducting the ore independently of said flue from the other end of the heating barrel into the smelting barrel while said barrels are in motion.

2. In ore smelting and refining apparatus the combination of a rotary smelting barrel having a central opening in one end, a rotary heating barrel, a flue connecting the end opening of the smelting barrel with one end of the heating barrel, an escape flue with which the other end of the heating barrel communicates, an ore feed spout passing through the escape flue into the adjacent end of the heating barrel, and an ore conduit leading from the other end of the heating barrel through the connecting flue into the end opening of the smelting barrel.

3. In ore smelting and refining apparatus the combination of a rotary smelting barrel having an opening in one end, a rotary heating barrel, a flue connecting the end opening of the smelting barrel with one end of the heating barrel, an escape flue with which the other end of the heating barrel communicates, means for feeding ore into the end of the heating barrel adjacent to the escape flue, a longitudinally divided feed pipe passing through the connecting flue into the end opening of the smelting barrel, an ore conduit leading from the end of the heating barrel adjacent to the connecting flue into one passage of said feed pipe, and fuel and air supply pipes connected with the other passage of said feed pipe.

4. In ore smelting and refining apparatus the combination of a rotary smelting barrel having an opening in one end, a rotary heating barrel, a flue connecting the end opening of the smelting barrel with one end of the heating barrel, a chimney with which the other end of the heating barrel communi-

cates, a feed spout passing through said chimney into the adjacent end of the heating barrel, and provided with a regulating valve, and an ore conduit leading from the other
 5 end of the heating barrel through the connecting flue into the end opening of the smelting barrel and provided with a regulating valve.

5. In ore smelting and refining apparatus
 10 the combination of a rotary smelting barrel having an opening in one end, a rotary heating barrel, a flue connecting the end opening of the smelting barrel with one end of the
 15 heating barrel, a chimney with which the other end of the heating barrel communicates, means for feeding ore into the end of the heating barrel adjacent to said chimney, an ore conduit leading from the other end
 20 of the heating barrel into the smelting barrel, and an air supply pipe directed into said conduit toward the smelting barrel.

6. In ore smelting and refining apparatus the combination of a rotary barrel having an
 end opening and twyers located at intervals
 25 around the barrel, a connection adapted to supply air under pressure to said twyers and means for supplying ore through said opening while the barrel is in motion.

7. In ore smelting and refining apparatus
 30 the combination of a rotary barrel having an end opening and twyers located at intervals around the barrel, a connection adapted to supply air under pressure to said twyers, and means for supplying ore and separate
 35 means for supplying fuel through said opening while the barrel is in motion.

8. In ore smelting and refining apparatus, the combination of a rotary barrel having
 40 an end opening and twyers located at intervals around the barrel, a connection adapted to supply air under pressure to said twyers and means for supplying ore and separate means for supplying fuel and air through
 45 said opening above the charge while the barrel is in motion.

9. In ore smelting and refining apparatus the combination of a rotary barrel provided
 at intervals around it with twyers, valve controlled air pressure supply connections
 50 leading to the several twyers, and adjustable means for opening and closing the valves in said connections at different predetermined positions of the twyers in their
 circuit as the barrel is turned.

55 10. In ore smelting and refining apparatus the combination of a rotary barrel having twyers arranged at intervals around it and a tap hole adjacent to its periphery mid-

way between adjacent twyers, and means of supplying air under pressure to the twyers
 60 while the barrel is in motion.

11. In ore smelting and refining apparatus the combination of a rotary barrel having twyers arranged at intervals around it
 and tap holes located one adjacent to the
 65 radial position of one of the twyers and another midway between adjacent twyers and adjacent to the periphery of the barrel, and means of supplying air under pressure to the twyers while the barrel is in motion.
 70

12. In ore smelting and refining apparatus the combination of a rotary cylindrical barrel provided at one end with a wind box
 and at intervals around its periphery with longitudinal twyer boxes each connected
 75 with the interior of the barrel by radial passages and with the wind box by a pipe, an air pressure supply pipe having a central slip connection with the wind box, self-closing valves controlling the supply of air from
 80 the wind box to the several twyer boxes and a stationary cam adapted to open said valves at predetermined points in the circuit of the twyers as the barrel is rotated.

13. In ore smelting and refining apparatus the combination of a rotary barrel having
 85 a wind box at one end and at intervals around its periphery twyer boxes which communicate with the interior of the barrel through radial passages and are connected
 90 with the wind box by pipes, an air pressure supply pipe connected with the wind box, valves controlling the supply of air from the wind box to the several twyer boxes, and a
 95 stationary cam having adjustable inclined ends and adapted to open and close said valves at different predetermined points in the circuit of the twyers when the barrel is rotated.

14. In ore smelting and refining apparatus the combination of a rotary barrel having
 100 twyers located at intervals around it and adapted to be all brought to rest above the level of the molten charge in the barrel and a tap hole located between adjacent sets
 105 of twyers in position to draw off the charge from the lower part of the barrel when all the twyers are thus brought to rest above the charge, and a connection adapted to supply air under pressure to said twyers.
 110

In witness whereof I hereto affix my signature in presence of two witnesses.

EDWARD FINK.

Witnesses:

CHAS. L. Goss,
 ALICE E. Goss.