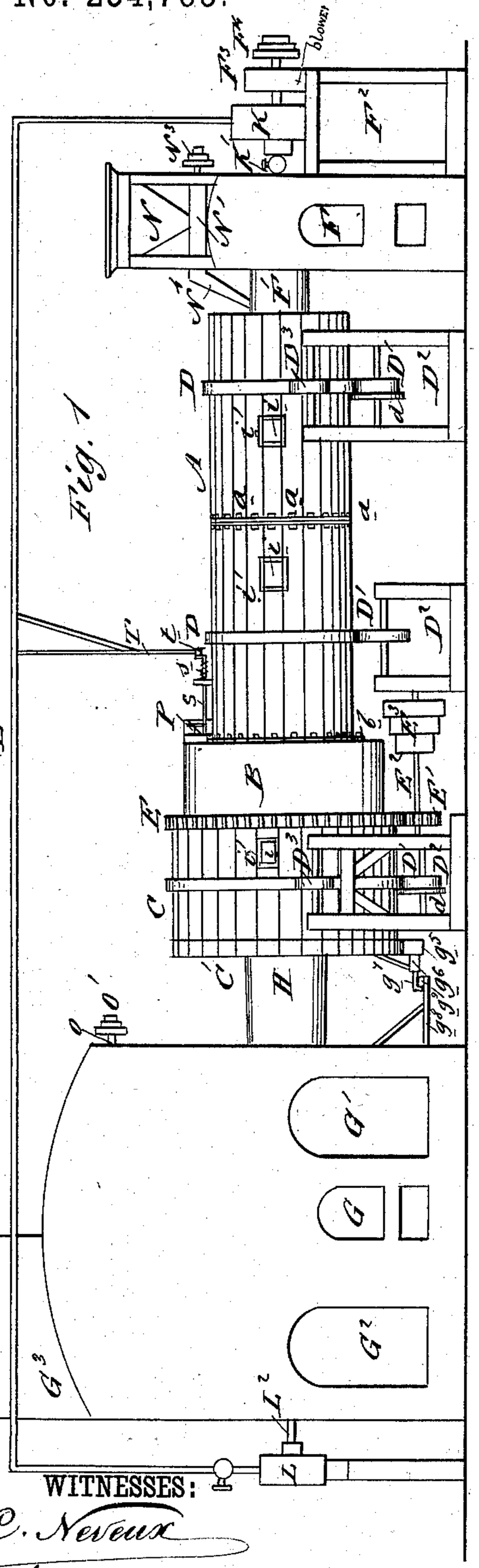
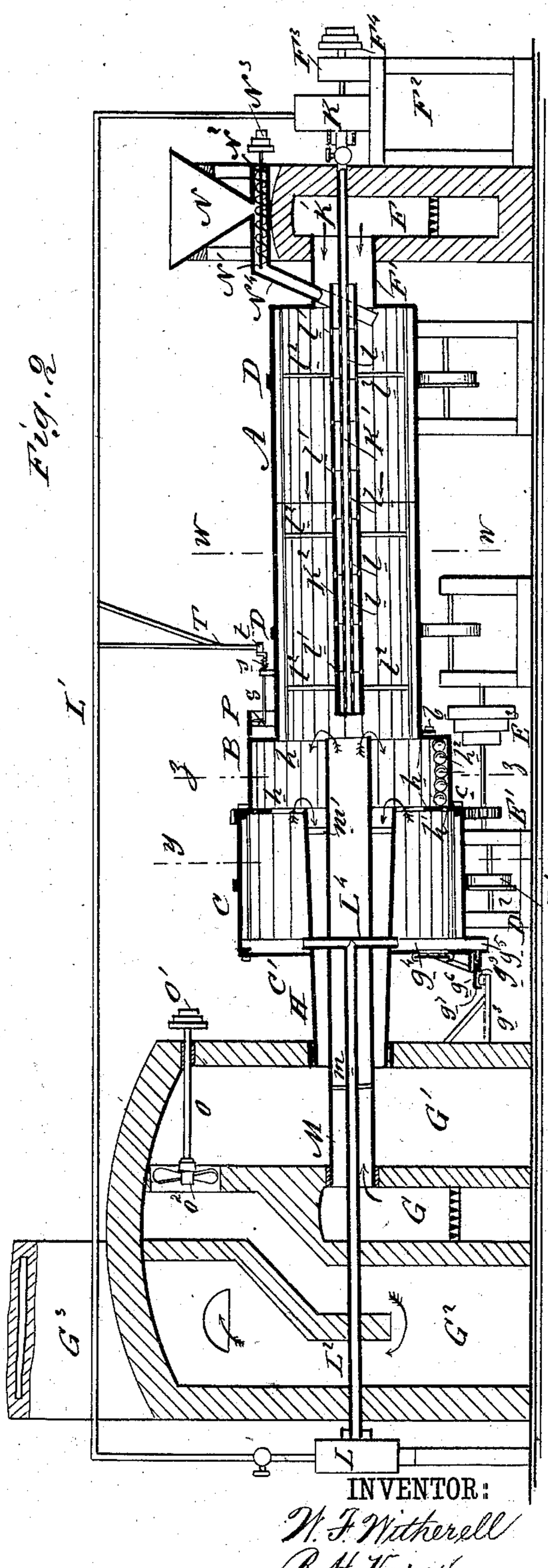
(No Model.) 2 Sheets—Sheet 1.

W. F. WITHERELL & B. H. VARY.

FURNACE FOR ROASTING, DESULPHURIZING AND CHLORIDIZING ORES.

No. 254,755. Patented Mar. 7, 1882.





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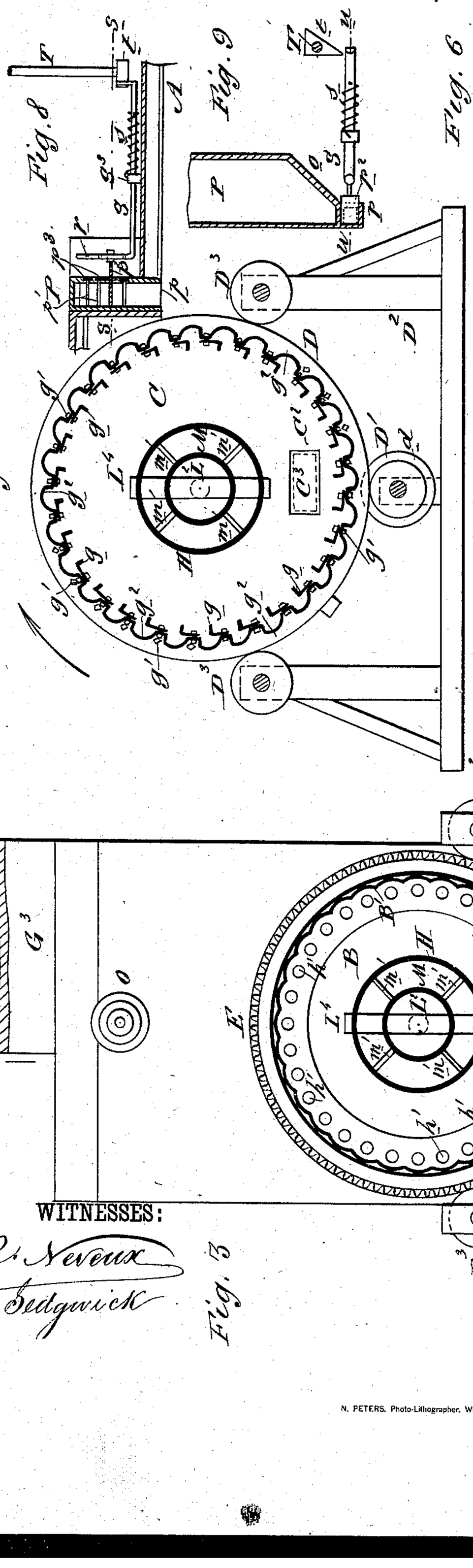

Fig. 8

Fig. 9

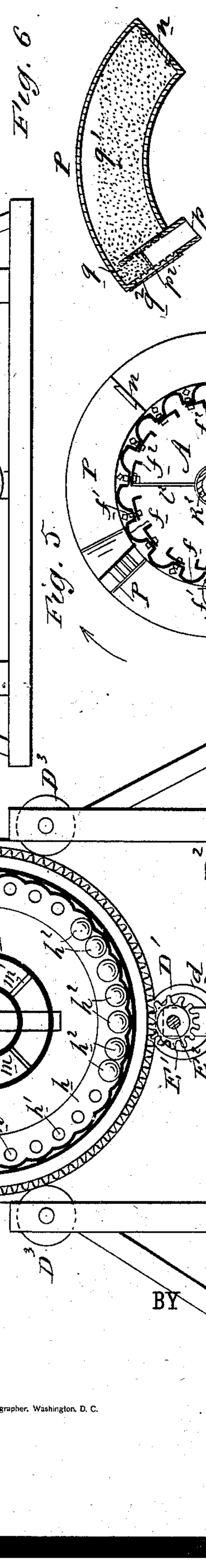

Fig. 6

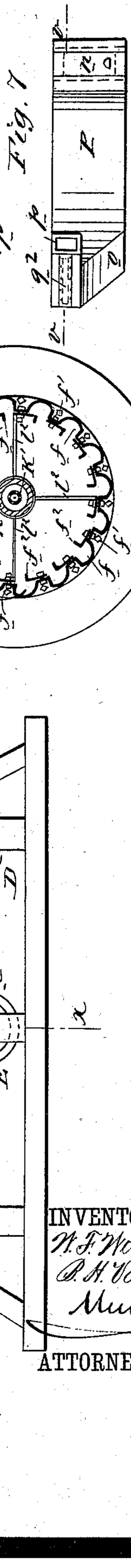

Fig. 7

Fig. 4

Fig. 5

Fig. 3

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UNITED STATES PATENT OFFICE.

WILLIAM F. WITHERELL, OF CHICAGO, ILLINOIS, AND BENNETT H. VARY, OF OGDENSBURG, NEW YORK.

FURNACE FOR ROASTING, DESULPHURIZING, AND CHLORIDIZING ORES.

SPECIFICATION forming part of Letters Patent No. 254,755, dated March 7, 1882.

Application filed September 8, 1881. (No model.)

To all whom it may concern:

Be it known that we, WILLIAM F. WITHERELL, of Chicago, in the county of Cook and State of Illinois, and BENNETT H. VARY, of Ogdensburg, in the county of St. Lawrence and State of New York, have invented certain useful Improvements in Furnaces for Roasting, Desulphurizing, and Chloridizing Ores, of which the following is a specification.

This invention relates to the class of revolving-cylinder ore roasting and chloridizing furnaces that are operated by two fires, and in which complete or partial desulphurization or oxidation of the ore is effected before the beginning of the chlorinating process.

The invention consists of a furnace composed of three revolving cylinders of different diameters and lengths, longitudinally connected and communicating with each other, having a fire-box at each end and suitable dust-chambers, and provided with novel internal stirring and ore-pulverizing devices, with novel internal air-supply pipes, and with external automatically-operating salt-box and ore-discharge pipe, all of which will be hereinafter set forth.

Figure 1 is a longitudinal elevation of the furnace. Fig. 2 is a longitudinal sectional elevation of the same on line *x x*, Fig. 3. Fig. 3 is an enlarged vertical sectional elevation on line *y y*, Fig. 2. Fig. 4 is an enlarged vertical sectional elevation on line *z z*, Fig. 2. Fig. 5 is an enlarged vertical sectional elevation on line *w w*, Fig. 2. Fig. 6 is an enlarged longitudinal section of the salt-box on line *v v*, Fig. 7. Fig. 7 is an enlarged reverse plan of the salt-box. Fig. 8 is an enlarged sectional end elevation of the salt-box and its attachments on line *u u*, Fig. 9. Fig. 9 is an enlarged sectional plan of the salt-box on line *s s*, Fig. 8.

Similar letters of reference indicate corresponding parts.

In the drawings, A represents the cylinder of least diameter and greatest length, designed to be about twelve feet long and about four feet in external diameter, said cylinder A being constructed in one or more flanged sections bolted together, as shown at *a*. B represents the shortest cylinder, designed to be about two feet long and of about six feet external diameter, bolted through its flanged end to the flanged end of cylinder A, as shown at *b;* and C represents the cylinder of greatest diameter, designed to be about four feet long and about eighty inches in external diameter, bolted by its flanged end to the opposite flanged end of the cylinder B, as shown at *c*. This furnace A B C is provided with suitable encircling rings or tires D, that bear on supporting anti-friction rolls D′, whose shafts are journaled in supporting-frames D^2, the rolls nearest the ends of said furnace A B C having annular flanges *d* to prevent longitudinal movement of said furnace, and each end guide or supporting-roll D^3 is supported in the supporting-frames D^2 to bear against the opposite sides of the cylinders A C and hold the furnace in place on the rolls D′. Encircling the cylinder B is a toothed gear, E, meshing with a small cog-wheel, E′, on a shaft, E^2, that is journaled in supporting-frames D^2, and has keyed upon it differential pulleys E^3, whereby power is transmitted to revolve said furnace A B C. This furnace A B C is designed to be set at about an inclination of one inch in six feet, inclining downward from the smaller to the larger end.

The cylinder A is longitudinally corrugated, as shown, whereby a series of parallel and alternate depressions and projections, *f f′*, are formed on the inside thereof, and along these projections *f′* are bolted angle-irons f^2, extending from one end to the other of said cylinder A, and forming, in combination with the depressions *f*, a series of buckets for lifting or stirring the ore as it passes through the furnace, said buckets f^2 lifting the ore and letting it fall through the flame or hot air passing through the furnace, and exposing it at the same time to the air admitted through the air-pipes, that will be hereinafter described. These depressions *f* are designed to be about four inches deep. The cylinder C is also longitudinally corrugated in the same manner as cylinder A, and has angle-irons *g* secured along its inward projections, *g′*, and extending partly over the depressions g^2, whereby buckets *g* g^2 are formed for lifting and letting fall the ore to expose it to the furnace reactions. Fire-brick or angle-irons *g* are used to project the falling ore into the body of the furnace, also covering the space between the buckets and protecting the shell of the furnace from the action of heat, and also to project the falling ore farther into the body of the furnace. In the case of the cylinder C, however, the

corrugations terminate a short distance from the head C′, thereby leaving the said cylinder C at that point of the diameter of the outside of the buckets *g g*², thus forming a gathering-trough, *g*⁴, for the ore, to an opening in which trough *g*⁴ is attached a peripheral discharge-pipe, *g*⁵, provided with a valve, *g*⁶, that is designed to be operated in the same manner as the salt-box valve *p*², as will hereinafter be described, a valve-rod, *g*⁷, and a fixed rod, *g*⁸, supporting a wedge-shaped block, *g*⁹, being arranged for this purpose.

The cylinder B is a plain cylinder, but is lined with a slightly-corrugated lining, B′, as shown in Fig. 3, and has annular flanges *h h* at each end, and through the flange *h* next to the cylinder C are orifices *h*′, that correspond in number and location with the buckets *g g*² in the cylinder C. In this cylinder B are a number of iron balls, *h*², whose function is, as the furnace revolves, to pulverize the agglutinated lumps of ore and mix the ore with the reagents fed from the salt-box P.

In the sides of the cylinders A C are inspection-ports *i i*, designed to be covered with mica, held in place by frames *i*′ *i*′, bolted to said cylinder, and a man-hole, C², is formed in the head of the cylinder C for the convenience of entering and cleaning or repairing the furnace A B C, and said man-hole C² is closed by a plate, C³, as shown.

At the higher end of the furnace A B C is a fire-box, F, from which a fixed cylindrical flue, F′, extends a short distance into the cylinder A, to convey therein the products of combustion from the fire in fire-box F, and at the opposite end of the said furnace A B C are the fire-box G and dust-collecting chambers G′ G², that communicate with the smoke-stack G³.

A conically-shaped flue, H, extends from the dust-chamber G′, through the furnace-head C′, to which it is fitted and firmly fastened, to a point corresponding with the line of junction between the cylinders B C, and its inner end is supported by a spider, *m*′, that encircles and radiates from the air-pipe M. This flue H revolves with the furnace A B C.

At the feed end of the furnace, in rear of the fire-box F, on a supporting-frame, F², is a blower, F³, operated by means of shaft and pulleys F⁴, and delivering air into an air-receptacle, K, from which an air-pipe, K′, is extended through the flue F′, and centrally through the cylinder A, nearly the whole length thereof. Said pipe K′ is plugged at its inner end, and is provided with many lateral openings, *l*, for the escape of air. This pipe K′ is surrounded by a fire-clay pipe or jacket, K², larger than the pipe K′, so that an annular space is left between the two pipes for heating the air; and said pipe or jacket K² is constructed in sections, with spaces *l*′ between their ends for the escape of air into the cylinder A; and said sections are held in place by spiders *l*², that radiate to the inner surface of the said cylinder A, and are there suitably fastened. The inner end of this pipe K² is also closed against the escape of air. Another air-pipe, L′, extends from the air-receptacle K to an air-receptacle, L, in rear of the dust-collecting chamber G², and from thence a pipe, L², extends horizontally through chamber G², fire-box G, and chamber G′, into the pipe M, which carries the products of combustion from the fire-box G, and which is surrounded for some distance by the flue H and cylinder C, and terminates in a cross-pipe, L⁴, that is open at both ends and projects in opposite directions through the pipe M and flue H, thereby discharging air into the cylinder C. Said air-pipe L² is held in place by an encircling spider or spiders, *m*, that radiate to the inclosing-pipe M, and are securely fastened thereto. The pipe or flue M is continued into the furnace to a point corresponding with the line of junction between the cylinders A B, and is securely fastened in place, so as to revolve with the said furnace A B C, by the cross-pipe L⁴, and by the spider *m*′, connecting it with the inner end of the flue H. The inner end of this pipe M is open, and is at a sufficient distance from the inner ends of the air-pipe K′ and its jacket K² to admit of a free passage of air through it, the said pipe M.

Over the fire-box F is a feed-hopper, N, from which the ore to be fed into the furnace A B C falls into a trough, N′, whence it is conveyed by a screw, N², operated by shaft and pulleys N³, into a conductor, N⁴, which directs it into the end of cylinder A, as indicated. Through the wall of the dust-collecting chamber G′, at the top thereof, is introduced a horizontal shaft, O, having on its outer end differential driving-pulleys O′, and on its inner end a propeller-fan, O², which is located above the fire-box G, where the chambers G′ G² communicate with each other. The function of this fan O² is to create a draft through the furnace A B C to the smoke-stack G³ in the directions of the arrows shown in Fig. 2.

P represents the salt and chemical box, by means of which suitable reagents are introduced into the furnace A B C. This box P is in the shape of a section of a circle, and is designed to be fitted with its inner curve upon the outside of the cylinder A against the end of the cylinder B, while the larger curve of the said box P corresponds with the circumference of the cylinder B. The one end of said box P is provided with a slide, *n*, to cover an opening through which it is filled, and the opposite end of said box P is sloped on one side, as shown at *o*, to facilitate the discharge of its contents, and a tube, *p*, extends from near the top of the box, on the inside thereof, through the bottom of said box P far enough to enter through the shell of the cylinder A. Through one side of this tube *p*, within the box P, are slots or openings *p*′, for the insertion of a slide-valve, *p*², and when the furnace is in operation all the slots *p*′, excepting that in which is the valve *p*², are covered with slides *p*³.

Within the box P an open space, *q*, is left at

the top of the tube p, so that when said box P is on the under side of the cylinder A, during the revolution of the latter, the contents of the said box P (represented at q', Fig. 6) will run into said tube p and fill the said tube p to the point where the valve p^2 is set.

A strip, q^2, of mica is fastened over an opening in the rear of the tube p, through which it may be seen if the valve p^2 works properly. This valve p^2 is opened by means of a rod, S, the ends of which are bent upward at right angles to the body thereof, as shown in Fig. 8, parallel with the tube p, said valve p^2 being secured to one end of said rod S, as shown, which rod end has formed in it perforations r, corresponding with the slots p' in said tube p, so that the valve p^2 can be adjusted to any desired elevation. This rod S is movably held in staples or eyebolts s^3, in which it works on the cylinder A, and has coiled about it a spiral spring, s, by means of which it is restored to its primary position, closing the valve p^2 after the latter has been opened.

A rod, T, made fast to some convenient point overhead, projects downward within reach of the free end of the rod S, and carries fixed on its end a wedge-shaped block, t. As the furnace A B C revolves the free end of the rod S is brought in contact with this wedge t, against the off or sloping side thereof, and thereby said rod S and its attached valve p^2 are drawn out, so that the contents of the tube p are discharged into the said furnace A B C. As soon as the rod S is free from the wedge t the spring s operates, as before said, to close said valve p^2. As the ore is fed into the furnace A B C it falls to the bottom, is caught in buckets $f f^2$, and is carried up. After passing the central line of the cylinder it begins to fall in thin sheets, and continues to fall regularly until each bucket $f f^2$ in turn becomes emptied. In falling the ore passes through the air and heat introduced into the cylinder A and strikes upon the bottom of the said cylinder A a little in advance of its starting-point, depending upon the inclination given to the said cylinder. The ore is then again carried up and falls, and this process is continued until it falls into the cylinder B. In its progress through cylinder A it becomes gradually heated, and the sulphur and other volatile or inflammable substances contained in it are either burned or volatilized and the ore oxidized. Near the end of the cylinder A the ore is met by an increased temperature from the cylinder B and fire-flue M, by which the sulphates still remaining in the ore are decomposed. The salt or other chemicals introduced from the box P here unite in regulated quantities with the ore at each revolution of the furnace A B C, and together they pass into the cylinder B, and are there thoroughly mixed and ground together by the action of the balls h^2, and any agglutinated lumps of ore are thereby pulverized, and any remaining excess of sulphur or other volatile substance escapes. The ore then escapes from the action of the balls h^2 through the orifices h' into the buckets g g^2 in the cylinder C, where, when chlorine gas is used, the ore is exposed to its action, and if chlorine gas is not used the ore is completely oxidized by the action of the air admitted through the pipe L^2. The ore is carried by the action of the buckets g g^2 of the cylinder C to the gathering-trough g^4, whence it escapes through the discharge-pipe g^5.

Having thus described our invention, we claim as new and desire to secure by Letters Patent—

1. An ore roasting, desulphurizing, and chloridizing furnace, constructed substantially as herein shown and described, consisting of the revolving cylinders, divided into sections A B C, longitudinally connected and communicating with each other, having a fire-box and flue at each end, provided with suitable dust-collecting chambers, and with interior air-distributing pipes, $K' L^2 L^4$, interior buckets, $f f^2$ and $g g^2$, corrugated lining B', and pulverizing-balls h^2, arranged as set forth.

2. In an ore-working furnace, the combination, with the longitudinally-corrugated cylinder A, of the longitudinal angle-irons f^2, substantially as herein shown and described, whereby ore-lifting buckets are formed in said cylinder, as set forth.

3. In an ore-working furnace, the combination, with the cylinder B, provided with perforated annular flanges h h and corrugated lining B', of the iron pulverizing-balls h^2, substantially as and for the purpose described.

4. In an ore-working furnace, the combination, with the revolving cylinder A, of the perforated air-distributing pipe K', and its perforated jacket K^2, held in place by spiders l^2, substantially as herein shown, and for the purpose described.

5. In an ore-working furnace, the combination, with the revolving cylinder A B C, fire-box G, and dust-collecting chambers $G' G^2$, of the revolving flues H M, air-distributing pipes $L^2 L^4$, and spiders m m', substantially as here in shown, and for the purpose described.

6. In an ore-working furnace, the salt-box P, provided with slide n, slotted tube p, slide-valve p^2, and slides p^3, substantially as herein shown and described.

7. In an ore-working furnace, the combination, with the salt-box P, provided with slide-valve p^2, of the rod S, spiral spring s, and rod T, provided with wedge-shaped block t, substantially as herein shown and described, whereby said box is automatically operated, as set forth.

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