3 Sheets—Sheet 1

J. M. THOMPSON.

Rotating Ore Furnace.

No. 236,648. Patented Jan. 11, 1881.

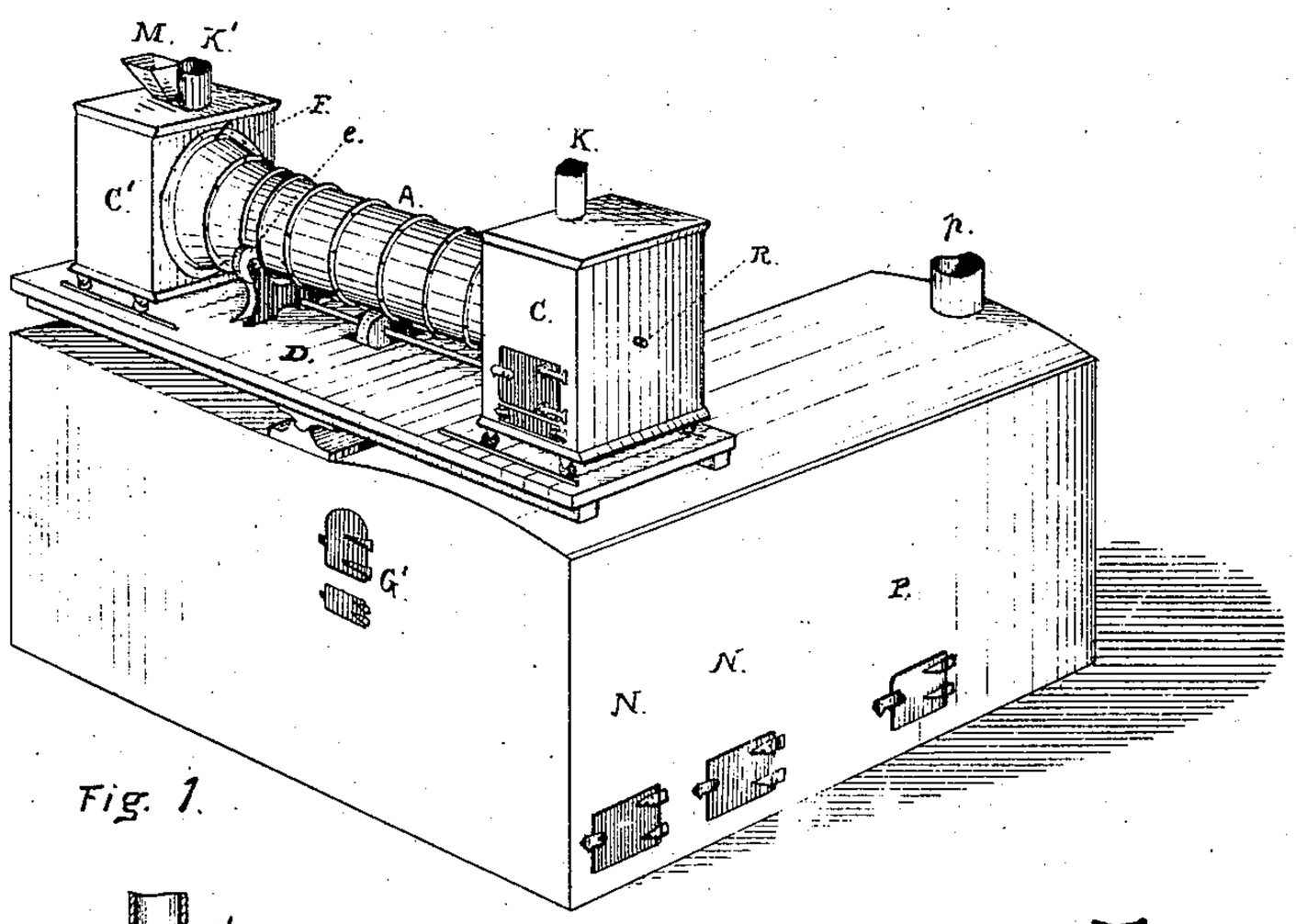

Fig. 1.

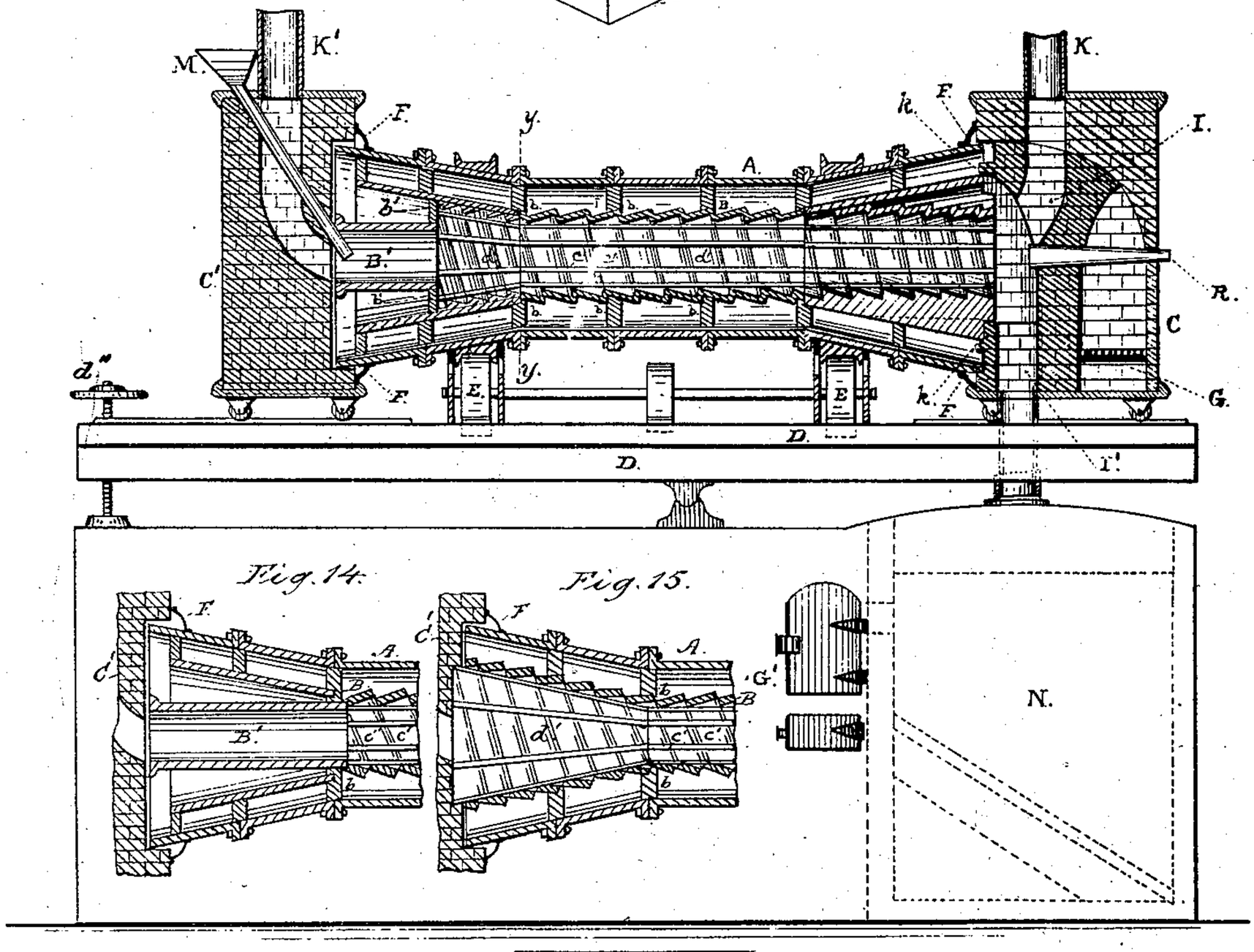

Fig. 14.

Fig. 15.

Fig. 2.

Witnesses:
C. W. M. Smith
Edward L. Osborn.

Inventor:
James M. Thompson

3 Sheets—Sheet 2.

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Fig. 3.

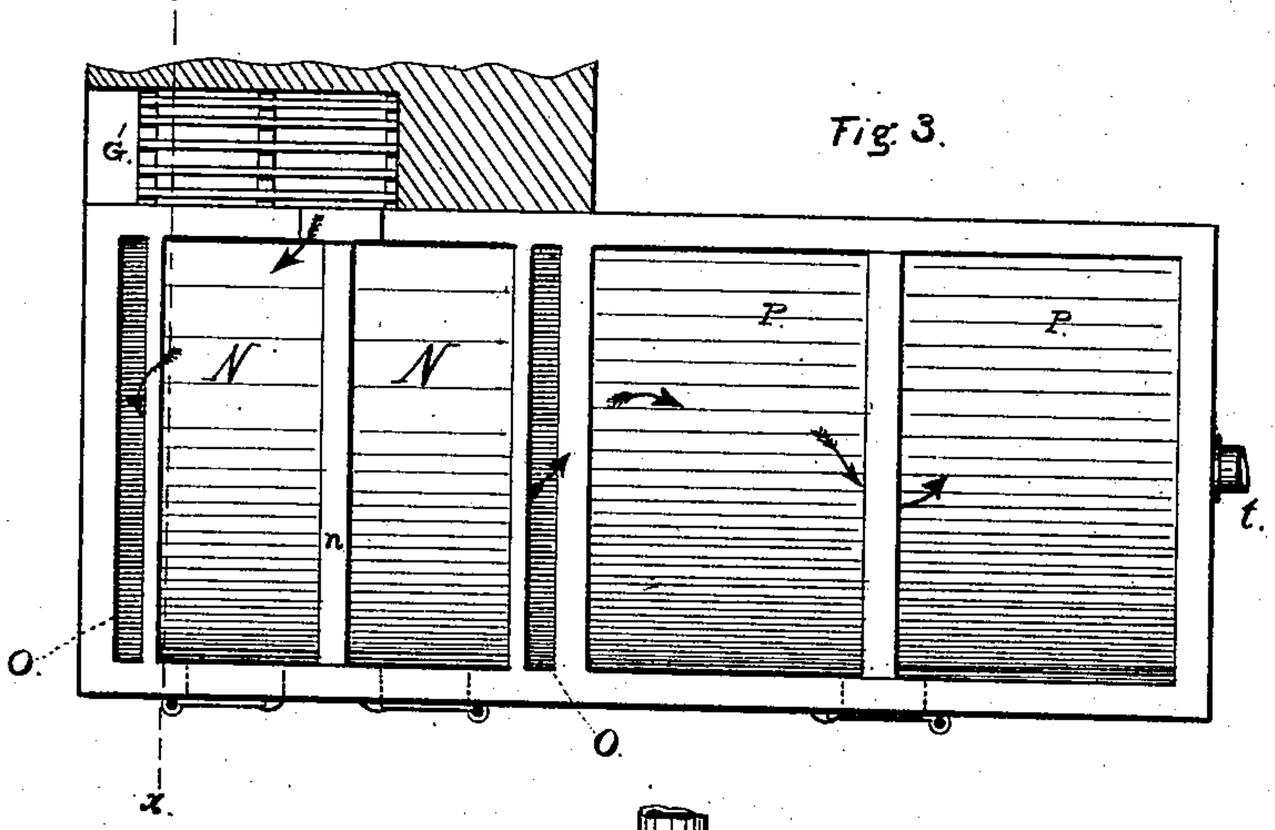


Fig. 4.

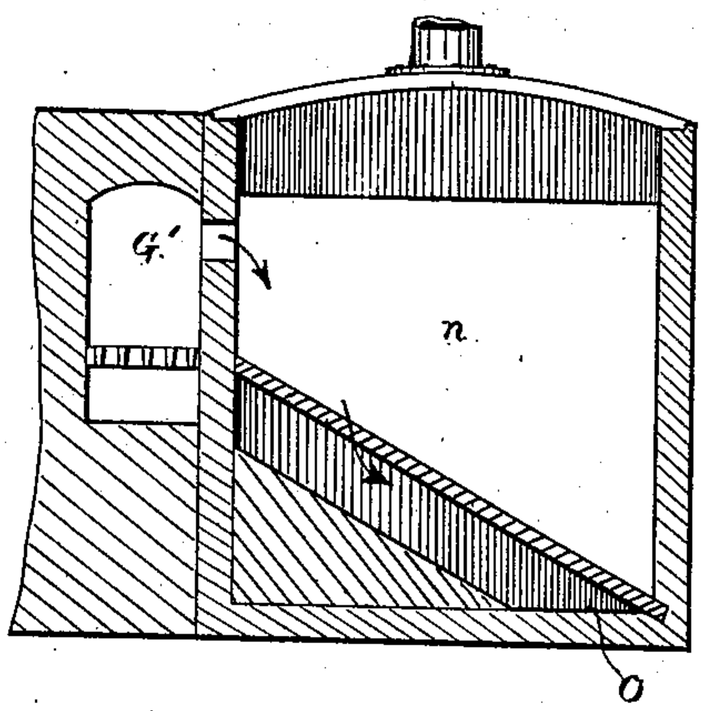


Fig. 5.

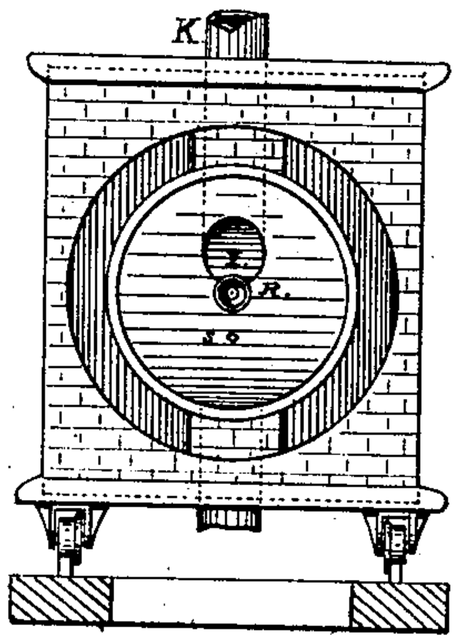


Fig. 6.

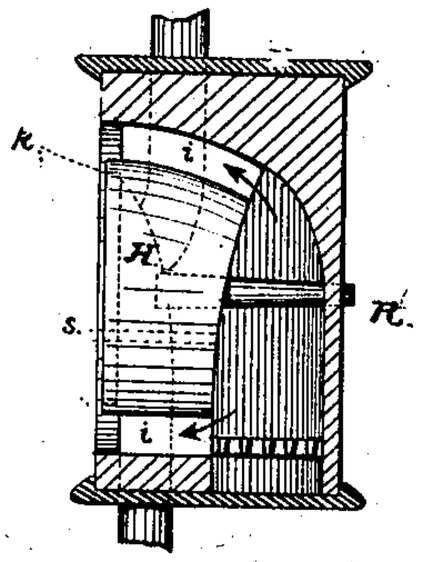
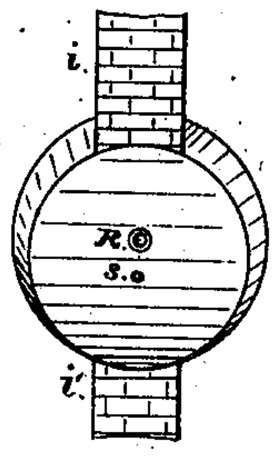


Fig. 7.



Witnesses:

C. M. Smith

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3 Sheets—Sheet 3.

J. M. THOMPSON.
Rotating Ore Furnace.

No. 236,648. **Patented Jan. 11, 1881.**

Fig. 8.

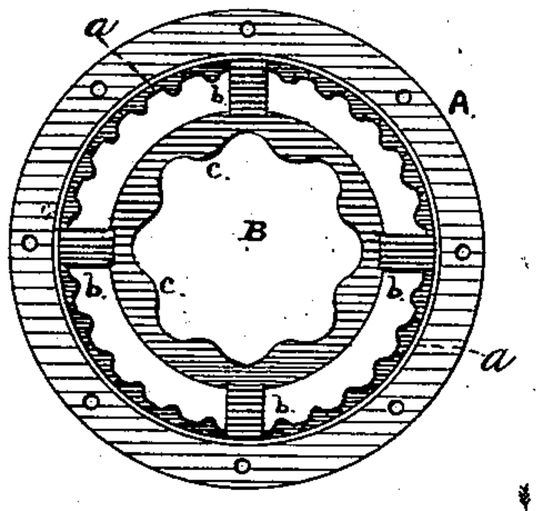


Fig. 9.

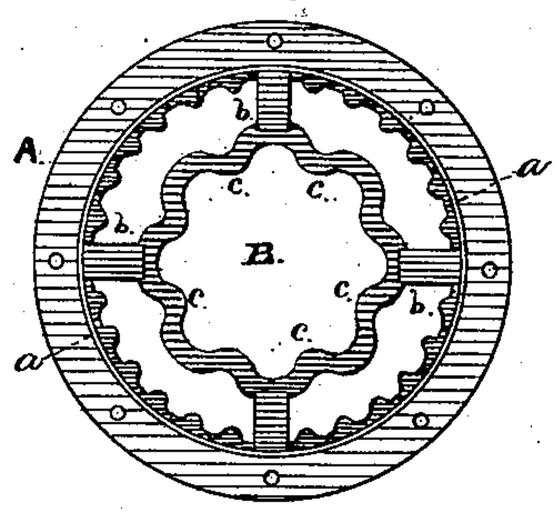


Fig. 10.

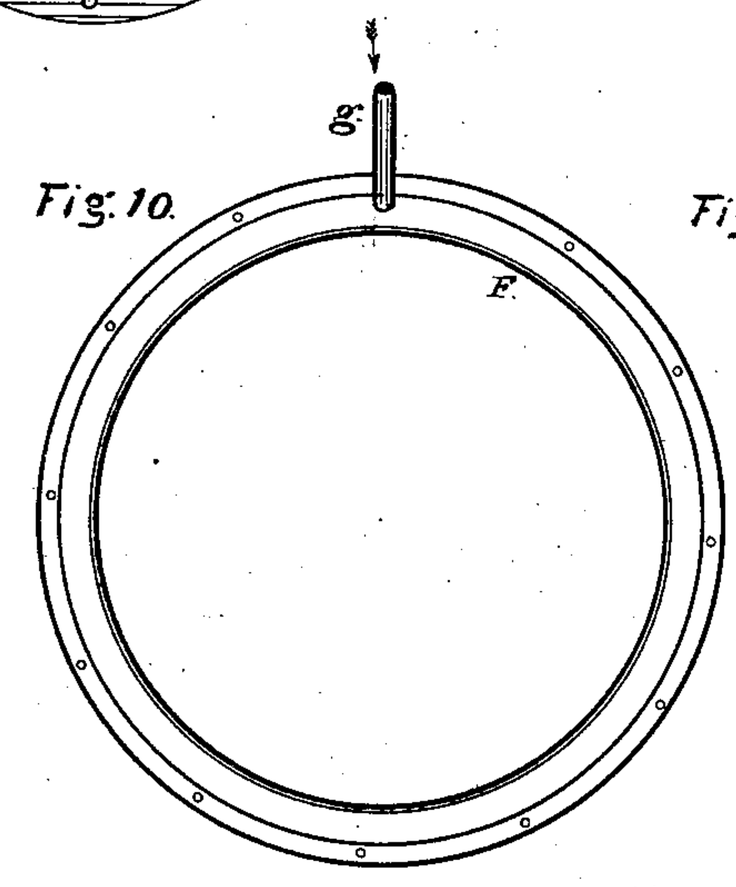


Fig. 11.

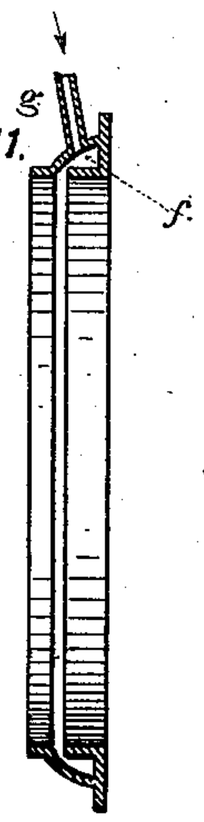


Fig. 13.

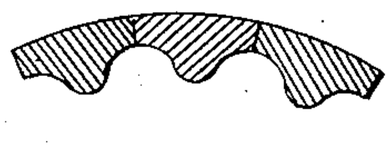
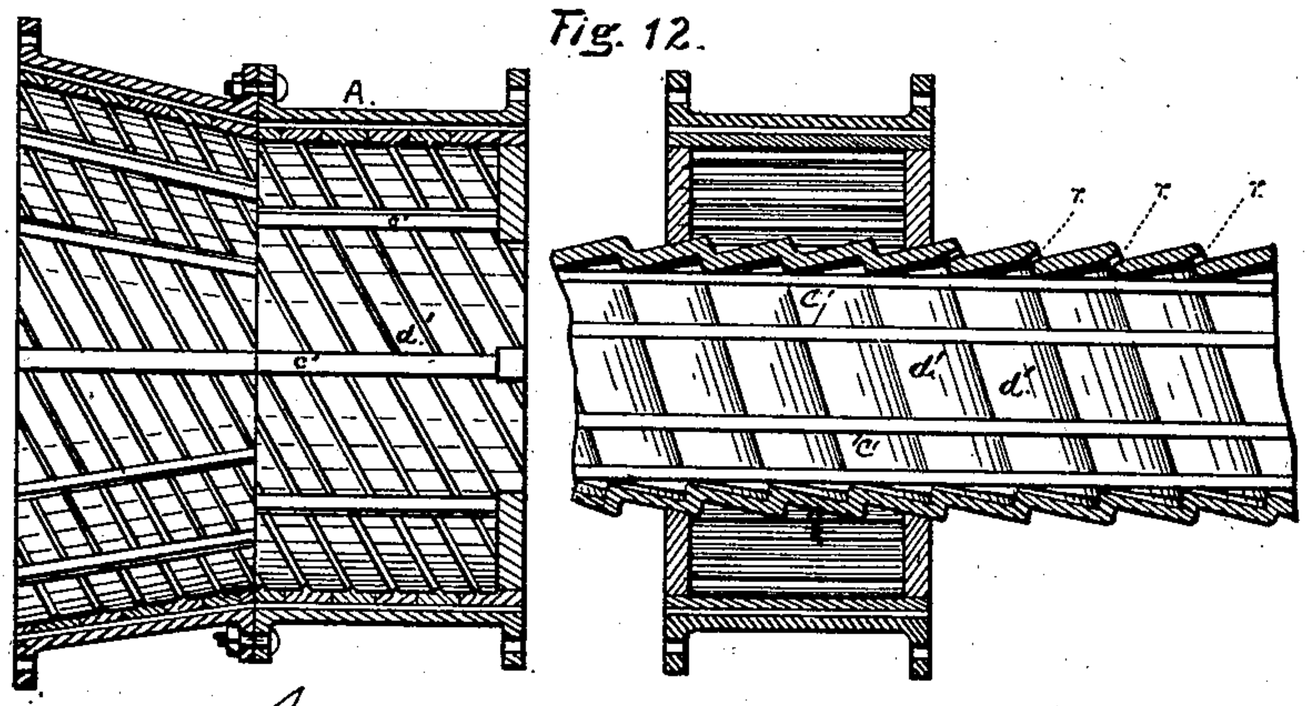


Fig. 12.



Witnesses:
C. M. Smith
Edward L. Osborn.

Inventor.
James M. Thompson

UNITED STATES PATENT OFFICE.

JAMES M. THOMPSON, OF SAN FRANCISCO, CALIFORNIA.

ROTATING ORE-FURNACE.

SPECIFICATION forming part of Letters Patent No. 236,648, dated January 11, 1881.

Application filed November 21, 1876.

To all whom it may concern:

Be it known that I, JAMES MONROE THOMPSON, of the city and county of San Francisco, State of California, have invented certain Improvements in Rotary Ore-Furnaces, of which the following is a specification.

My invention relates to rotating ore-furnaces for roasting and treating ores and like substances; and it consists, first, in the combination of the double revolving cylinder having a flue-space intermediate between its walls, with a fire-chamber and fire-back at one end of the cylinder provided with exit-flues and an ore-chamber at the opposite end of the cylinder having an ore-feeding chute, the whole being arranged on a tilting platform and forming a return-flue furnace having the capacity to progress the ore at any desired speed; second, in the combination, with the rotating ore-cylinder, of a hollow auxiliary cylinder secured to and within the receiving end of the said ore-cylinder, for preventing an excess of heat at the point where the ores are introduced into the ore-cylinder; third, in the peculiar construction of and manner of supporting the fire-back, in combination with the ore-cylinders and exit-flues; fourth, in the construction of the ore receiving and separating chambers at the discharge end of the double rotating ore-cylinder; fifth, in the combination, with the external joints of an ore-furnace, of a plate or sleeve covering the joint and having an air-channel connected to a pump or pressure-blower, by which a constant pressure of air, exceeding that within the furnace, is maintained within the air-channel, preventing escape of gases; in constructing the outer cylinder of a double rotating cylinder ore-furnace with a brick lining, and a layer of plaster-of-paris placed between such lining and the cylinder to better resist the action of the hot gases; in constructing the double cylinders with a gradually increased or diverging shape toward one end, to allow of the insertion of a muffle or short protecting-cylinder; and, further, in the combination of a longitudinally-tilting platform with end ore and fire chambers mounted thereon, the ore-cylinder connecting such chambers, and guide and bearing wheels for supporting and rotating the cylinder, all as fully hereinafter explained.

The following description of the construction and operation of my invention is sufficiently full and clear to enable any person skilled in the art to make and use or apply the same, reference being had to the accompanying drawings, and the figures and letters of reference thereon, making part of this specification.

Figure 1 of the drawings is an elevation, in perspective, of my improved rotating furnace mounted over the ore and dust chambers. Fig. 2 is a vertical longitudinal section through the center of the cylinder and the fire-chamber. Fig. 3 is a plan view of the ore and separating chambers with the tops removed. Fig. 4 is an end elevation, in section, of the ore and separating chambers, the section being taken through the line *x*-*x*, Fig. 3. Fig. 5 is a front view of the furnace end that contains the fire-box, the chimney-flue, and the chute for discharging the ores from the cylinder into the ore-chamber. Fig. 6 is a central section of the parts shown in Fig. 5. Fig. 7 is a back view of the fire-back removed from the fire-chamber. Figs. 8 and 9 are transverse sectional views taken through the line *y y*, Fig. 2, showing end views of the cylinders at this point. Figs. 10 and 11 are detail views of the annular packings employed at the ends of the outer cylinder. Fig. 12 is a longitudinal section through a portion of the inner and outer cylinders, showing the longitudinal projections and the inclines and diagonal projections to lift and drop the ores and cause them to progress through the furnace. Fig. 13 is a detail end view of the bricks which form the lining and projections within the cylinder.

The outside portion of the cylinder A is made of iron, and its interior is lined with fire-clay or other substance capable of resisting the action of the heat and gases of combustion. Between the shell and the lining is interposed a layer of plaster-of-paris or similar non-heat-conducting substance, to further protect the metal of which the cylinder is composed, and to more perfectly economize and retain the heat within it. This construction is shown at *a a*, Figs. 8 and 9.

Within the cylinder A is arranged a cylinder, B, of metal or some suitable refractory material, and composing the ore-cylinder, or

the one receiving and progressing the ores within it. It is supported within the outer cylinder, A, by the radial ribs or supports *b b*, Figs. 2, 8, and 9, so that a continuous fire-space is formed between the two cylinders. This space communicates at one end with the fire-chamber C, and at the other with the end of the inner cylinder, whereby the heat and gases from the fire, after passing between the two cylinders, are returned through the inner cylinder and brought into contact with the ores.

The flue K′, running to the chimney, opens out of the furnace at the opposite end from the fire-chamber, and is provided with a suitable damper. This flue connects, as shown, with the space between the cylinders, at the point where it joins the interior of the inner or ore cylinder, and any excess of the products of combustion not required to be passed into the ore-cylinder can be drawn off through this flue by opening or partly opening its damper. This inner cylinder, B, is made either plain or corrugated upon its inner and outer surfaces, for the purpose of increasing its strength and the better to withstand the expansive action of the heat, and its inner surface is provided with longitudinal projections or ribs *c c*, placed at a sufficient distance apart, with a series of diagonal or inclined grooves or depressions, *d′ d′*, within the spaces between the projections *c c*. The grooves are arranged on spiral or nearly spiral lines, by which the grooves in one space alternate with those in the next space, so that they form a regular series of inclines within the cylinder, running from one end to the other. These grooves or inclines operate to progress the ore when being raised and dropped by the projections *c c*, while the cylinder rotates, by constantly dropping it from the bottom of the inclines to the top of their opposite ones, and their inclination may be varied in degree, so as to progress the ores at different rates of speed through different portions of the cylinder.

The two cylinders, with their fire-spaces and projections and inclines, and the boxes or chambers C C′, are mounted upon the pivoted tilting table or platform D, which is provided with the friction-rollers and bearing-wheels E *e*, for supporting and rotating the cylinder or furnace. This platform has an elevating-screw, d^2, for inclining the furnace in either direction, so as to lessen or increase the steepness of the inclines *d′* and retard or accelerate the progress of the ores through the cylinder more or less, as desired; also, where it is desired to roast or treat the ore in charges, the furnace, after the ore has been received and distributed throughout its entire length, can then be inclined in the necessary direction sufficiently to entirely counteract the action of the inclines *d′* and retain the ore within it until roasted, and meanwhile the feeding of the ore into the furnace would be stopped, when, by restoring the furnace to its level position, or inclining it in the opposite direction, the ore will then be progressed through and discharged, when the furnace will be ready to receive and roast another charge.

The ends of the cylinder A that enter the fire boxes or chambers C C′ are surrounded by a metal plate or sleeve, F, secured to the face of the wall. This sleeve has a channel or air-space, *f*, provided with a pipe, *g*, through which air from a pump or condenser is forced under pressure, and the channel is kept filled with air having a greater pressure than the gases within the furnace. The cylinder end fits loosely within the sleeve F, so that it may revolve freely. The rim of the sleeve can also be provided with a gasket or packing of asbestus or other suitable material, which is kept closed around the cylinder by elastic metal flanges or springs. This sleeve F, with its air-space, constitutes the means for preventing the escape or leakage of gases and vapors from the inside of the rotating cylinder around the joints. The air forced into the pipe *g*, and constantly escaping around the edge of the plate, is at a greater pressure than the gases within, and thus forms an air-packing impervious to smoke and vapors. This device can also be employed to prevent the escape of smoke and gases from any other joints, as doors or draft-openings in furnaces where the pressure or density of the gases within at any time exceeds the atmospheric pressure.

I am aware that the moving joint of a revolving-cylinder ore-furnace has been covered by a hollow collar supported by the stationary part of the joint, and having its interior connected with the smoke-stack or uptake, so as to draw off the gases issuing from the joint; but with my device there is a current into the ore-furnace through the joint, and by the pressure upon the joint the gases are prevented wholly from passing through the same.

The fire box or chamber C, that contains the grate-surface G, is shown more particularly in Figs. 2, 5, and 6. In it the end of the ore-cylinder B is covered and protected by the wall or fire-back H, which arrests the passage of the heat and gases from the ore-cylinder, and deflects them into the discharging passages or conductors I I′, leading to the ore-chambers or to the chimney-flue. This wall is isolated from the side of the fire-chamber, except at the points where the supporting-walls *i i* (see Fig. 7) are placed, so that it is surrounded on the sides and back by the heat and gases from the furnace. It may or may not have a circular flange or rim, *k*, and is concaved on its face or side next the end of the ore-cylinder B. The passages I I′ are made through the supporting-walls, and communicate with the discharging passages and chutes connected with the ore-receiving chambers and the chimney. The chimney-flue or passage I may be provided with a suitable valve or damper, by closing which all the products of combustion can be diverted into the ore-chamber, if desired.

The end of the ore-cylinder B is continued a proper distance beyond the end of the outer supporting-cylinder, A, and the outside corru-

gations, if any are used, are filled in or removed to form a circular rim of slightly less size than the space within the flange *k* of the fire-back, so that the space between the two cylinders and the interior space of the ore-cylinder are divided and separated from each other. An opening is made through the fire-back, and also through the outside wall of the fire-box, into which a conical tube or lookout-pipe, R, Figs. 2 and 6, is secured, and which passes across the fire-chamber, to enable the attendant to look within the interior of the ore-cylinder. The draft in the flues I I′ prevents any fumes from passing out of the pipe R, which is assisted by the conical form of the pipe, but creates a draft inwardly through such pipe. In practice, the end of the lookout-pipe is generally closed by a wooden plug, which can be easily removed when the attendant desires to look within the ore-cylinder. In this arrangement of my continuous or double cylinder the ores are fed into the end of the ore-cylinder, through the chute M of the chamber C′, and are progressed in a gradual manner, with the flames or heated air and gases, toward the hottest end of the cylinder and in the same direction with the draft.

Any part of the interior ore-cylinder, B, may be formed of materials having different heat-conducting powers, or it may be made gradually thinner toward its discharging end, so that the heat can be still further increased upon the ores as they are progressed through the furnace.

Another means of increasing the heat on the ores is shown in Figs. 12, 5, and 6, by the inclined openings *r r* in the cylinder B and the opening *s* in the fire-back H, by which any desired portion of the flames and heat can be admitted directly to the ores within the cylinder B.

In the treatment of some kinds of ores in my improved furnace it may be found desirable or necessary to still further protect the ores from too great heat at the point where they are first introduced into the ore-cylinder, and for this purpose I arrange and combine an auxiliary muffle or short cylinder, B′, within the end of the ore-cylinder, and supported in position by the radial ribs or posts *b′ b′* in such manner that the end of the muffle extends beyond the inner cylinder, B, and through to the side of the chamber C′, and a space all around it is formed for the passage of the flames as they return around the end of the interior cylinder, B, and into the space within it. Thus the ores, on being introduced into the cylinder, are not at first brought into direct contact with the products of combustion from the fire-chamber, but as they pass through the muffle B′ are gradually heated before being brought into contact with the flames and progressed into the hotter part of the ore-cylinder.

Should it be in any case necessary or desirable to protect the ores entirely from direct contact with the flames and products of combustion, this auxiliary muffle B′ can be extended to connect with the main interior cylinder, B; or, what is equivalent, the cylinder B can be extended beyond the exterior supporting-cylinder, A, and through to the side of the chamber C′, so as to prevent the passage of the products of combustion into it, and which will then pass around it into the chamber C′ and out through the flue K′. These modifications are clearly shown in Figs. 14 and 15, respectively, of the drawings.

The end of the exterior cylinder, A, within which the auxiliary muffle or cylinder B′ is contained and supported, is gradually enlarged in diameter, so as to afford sufficient space for the flames to circulate and pass around and return into the cylinder B; also, the end of the cylinder A next the fire-box C is similarly enlarged, as shown in Figs. 1 and 2, to admit the free passage of the flames and products of combustion into it and around the interior ore-cylinder, B.

The projections *a c* on the interior surface of the interior ore-cylinder, B, as well as of the auxiliary muffle or cylinder B′, can be formed of brick, of the shape shown in Figs. 8, 9, and 13 of the drawings—that is, with one projection and one half-groove on each side of it to one brick—by which the number of bricks required is reduced to one-half. The projections and the recesses or grooves are made circular in shape, to avoid the angles and corners around and in which the ore accumulates when in a soft or sticky condition; and the projections can be made more or less raking or inclined from a straight line toward the center of the cylinder, so that the ores will be dropped sooner or retained longer before being dropped, according to the direction in which the cylinder is rotated, and in the former case the cylinder can be rotated faster without carrying the ore around with it.

The ore-receiving chamber N N is situated below the discharging end of the furnace, or in proper position to take the roasted ores from the chute leading from the cylinder. It is divided into two halves or sections by the partition *n*, which is in line with the center of the discharge of the ores from the cylinder, so that the ores are separated and divided into two equal portions in the two chambers N N. This arrangement is for allowing a portion only of the charge to be withdrawn from the chamber at a time, (all of which has been retained for the length of time the opposite chamber has been filling up,) and for retaining all of the ores in a heated condition for a greater length of time after leaving the cylinder than could be done with a single ore-chamber, while the surfaces of both of the charges in the chamber N N are meanwhile constantly exposed to the direct contact and action of the heated air, gases, and flames passing from the furnace, and by which means a more perfect roasting and chloridizing of the ore is, in most cases, effected.

When necessary for the proper treatment or thorough reduction of some descriptions of ores

the ore-receiving chamber can be surrounded on its sides and bottom by the passages O O, communicating with the separating-chamber P or dust-chambers in such manner that the heated vapors and gases from the furnace, in passing into the receiving-chamber with the ores, will circulate around it in their passage through the flues or passages O O to the dust or separating chambers, and thus aid to keep the contents of the ore-receiving chamber in a properly-heated condition.

The heat in the ore-chamber may be still further increased, when found necessary, by the employment of the auxiliary fire-chamber G', communicating with the passages O O, and so combined with the ore-chamber and flues or passages O O and arranged as to supply a proper quantity or additional degree of heat to the surface of or around the ores.

The ore-receiving chamber N N is also made self-discharging, by having its bottom constructed to incline downward to its discharge-outlets, so that when the door of either chamber is opened the ores will discharge without any extra handling, and the chamber can also be made of any desired size or depth, so as to retain the ores or expose them for any length of time necessary for them to be sufficiently acted upon by the heat and heated air and gases and flames while they are passing toward their discharge.

An intermediate dust and "fume" or gas separating chamber, P, into which the vapors and gases from the furnace are discharged after passing from the ore-chamber, is provided, and which has two exit-passages, the upper one, *p*, being connected with the smoke-stack, and the lower one connecting with the dust or condensing chambers beyond, and it is also provided with an inclined bottom for collecting the finer particles of ores that may be carried over and out of the furnace by the draft, and a discharge-door is also provided, through which to discharge the same.

The ore is introduced into the furnace by the chute M and muffle B'. It passes from such muffle through the inner cylinder, B, progressing as the cylinder revolves, and is discharged at the opposite end of the cylinder into the passage I', which conveys it to the ore-chambers beneath. The products of combustion are generated upon the grate G in the furnace C, and first enter the space between the two cylinders. After traversing the length of such space they enter the end of the inner cylinder, where the ores are first received, and then pass through such inner cylinder in the same direction as the ores are moved, and finally pass out of the inner cylinder through the chimney-flue I or through the flue or passage I' into the ore-chambers.

Among the advantages of feeding and progressing the ores in the direction of the draft or in a direction not opposed to the draft from the fire-box, while they are at the same time subjected to increasing degrees of heat, which is accomplished in my improved furnace, are the following: All the ore passes into and through the cylinder and is subjected to the roasting process, thereby avoiding the necessity and expense of providing an auxiliary fire at the receiving end of the ore-cylinder to roast the finer particles, which is required in the case where the draft opposes the progress of the ores. The finer particles are progressed more rapidly, and at the same time are roasted as perfectly as the coarser particles, by which the roasting capacity of the furnace is very much increased. The ore is kept supplied in the first stages of the roasting process with purer air, and the gases of combustion, as well as the gases generated from the ores and other substances used for beneficiating the ores, are driven with the ores toward and out of the hotter end of the cylinder, and through them the ore is kept constantly falling or showering when it is in the proper condition and at the proper temperature to form combinations with the gases, as chlorides, &c., and thus a great saving of the quantity of salt or other substances introduced into the furnace for beneficiating the ores is effected.

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

1. In an ore-roasting furnace, the combination, with the interior ore-cylinder, B, and its exterior supporting brick-lined cylinder, A, having a flue-space between them for the passage of the draft and products of combustion, of the fire-chamber C, fire-back H, having flues I I', and chamber C', having ore-feed chute M and flue K, all constructed and arranged substantially as described, and for the purposes set forth.

2. In a rotating-cylinder ore roasting or reducing furnace, the combination, with the ore-cylinder, of the hollow auxiliary cylinder B', of uniform or varying thickness, secured to and within the receiving end of the ore-cylinder, for preventing an excess of heat at the point where the ores are introduced into the ore-cylinder, substantially as herein set forth.

3. In a rotating-cylinder ore-furnace, the combination, with the cylinders A B and fire-chamber C, of the fire-back H, having its face next the ore-cylinder B concaved and isolated from the side of the fire-chamber, except at the top and bottom, where it is supported by walls *i i'*, and the exit-flues I I', opening out of such fire-back, constructed and arranged substantially as subscribed, and for the purpose specified.

4. In an ore-furnace, the combination, with the ore-chamber N N, divided by a partition, of the ore chute or passage for delivering the roasted ore into said chamber, terminating centrally above the said partition, substantially as described and shown.

5. In an ore-furnace, the combination, with the ore-receiving chamber N N, of the flues or passages O O under its bottom or sides, to sup-

ply additional heat to the ore after being discharged from the furnace, constructed and arranged substantially as described and shown.

6. In an ore-furnace, the combination, with the ore-receiving chamber N N, of the auxiliary fire-chamber G′, adapted to supply additional heat to the surface of or around the ores while in such chamber, constructed and arranged substantially as described and shown.

7. In an ore-furnace, the combination, with the ore-chamber, of a separating-chamber, P, intermediate between said ore-chamber and the exit for the products of combustion, provided with two or more outlets at different elevations, constructed and arranged substantially as described and shown.

8. The method of preventing the escape of gases from the moving joints of furnaces consisting in maintaining externally at said joints an air-pressure exceeding the pressure of the gases within the furnace, substantially as described.

9. In a rotating-cylinder ore-furnace, the cylinder A, provided with a brick lining, and a layer, *a*, of plaster-of-paris placed between such lining and the cylinder, substantially as described and shown.

10. In a rotating-cylinder ore-furnace, the combination of the two concentric cylinders A B, gradually increased in cross-section toward one end, so as to allow a muffle to be inserted into the inner cylinder, substantially as described and shown.

In testimony that I claim the foregoing as my own I hereunto set my hand this 6th day of September, 1877.

JAMES M. THOMPSON.

Witnesses:
C. W. M. SMITH,
WILLIAM HARNEY