(No Model.). 7 Sheets—Sheet 1.

F. BROTHERHOOD.

MEANS FOR DRYING PHOSPHATE ROCK, &c.

No. 342,678. Patented May 25, 1886.

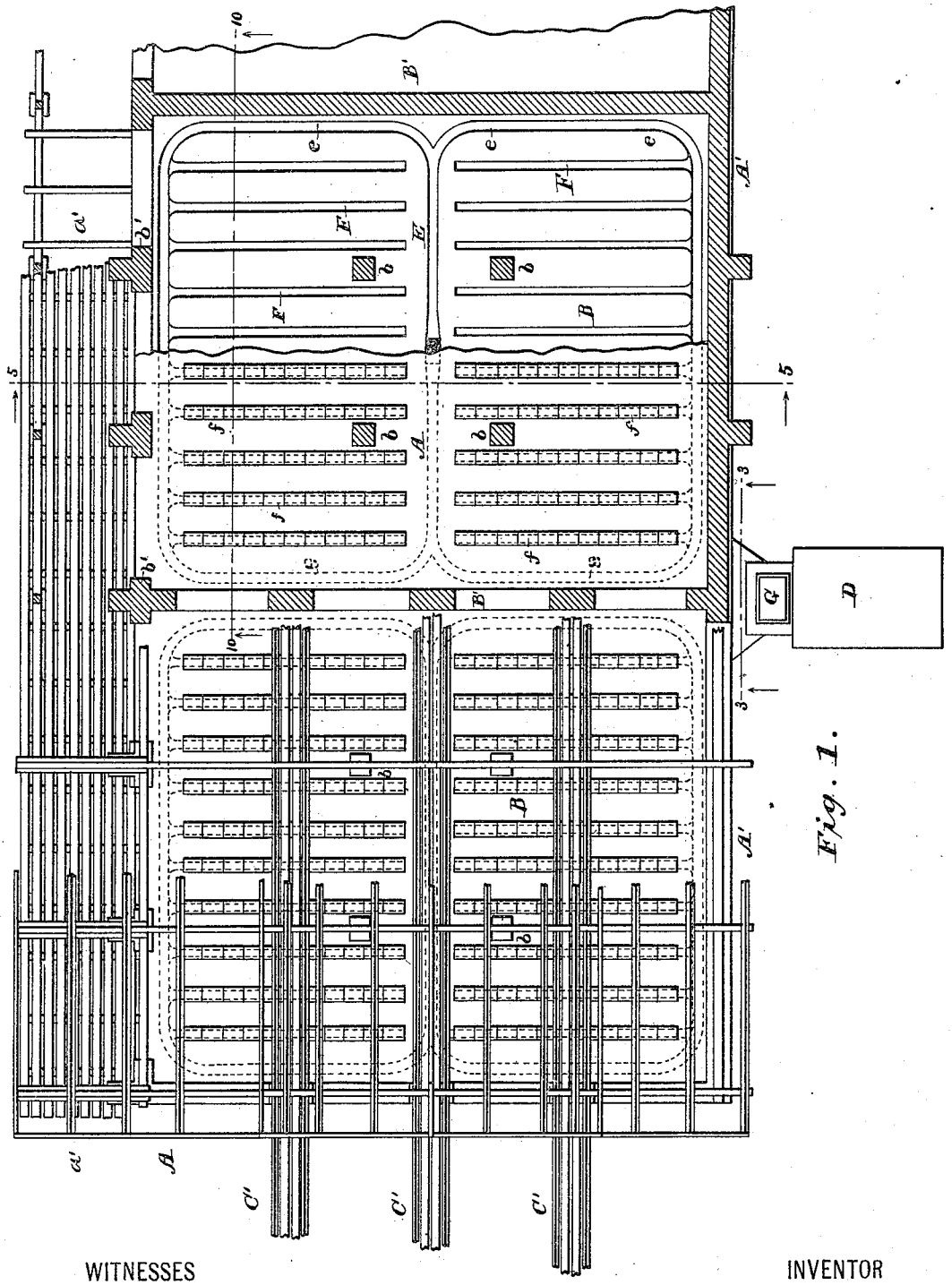

Fig. 1.

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Baldwin, Hopkins & Peyton.

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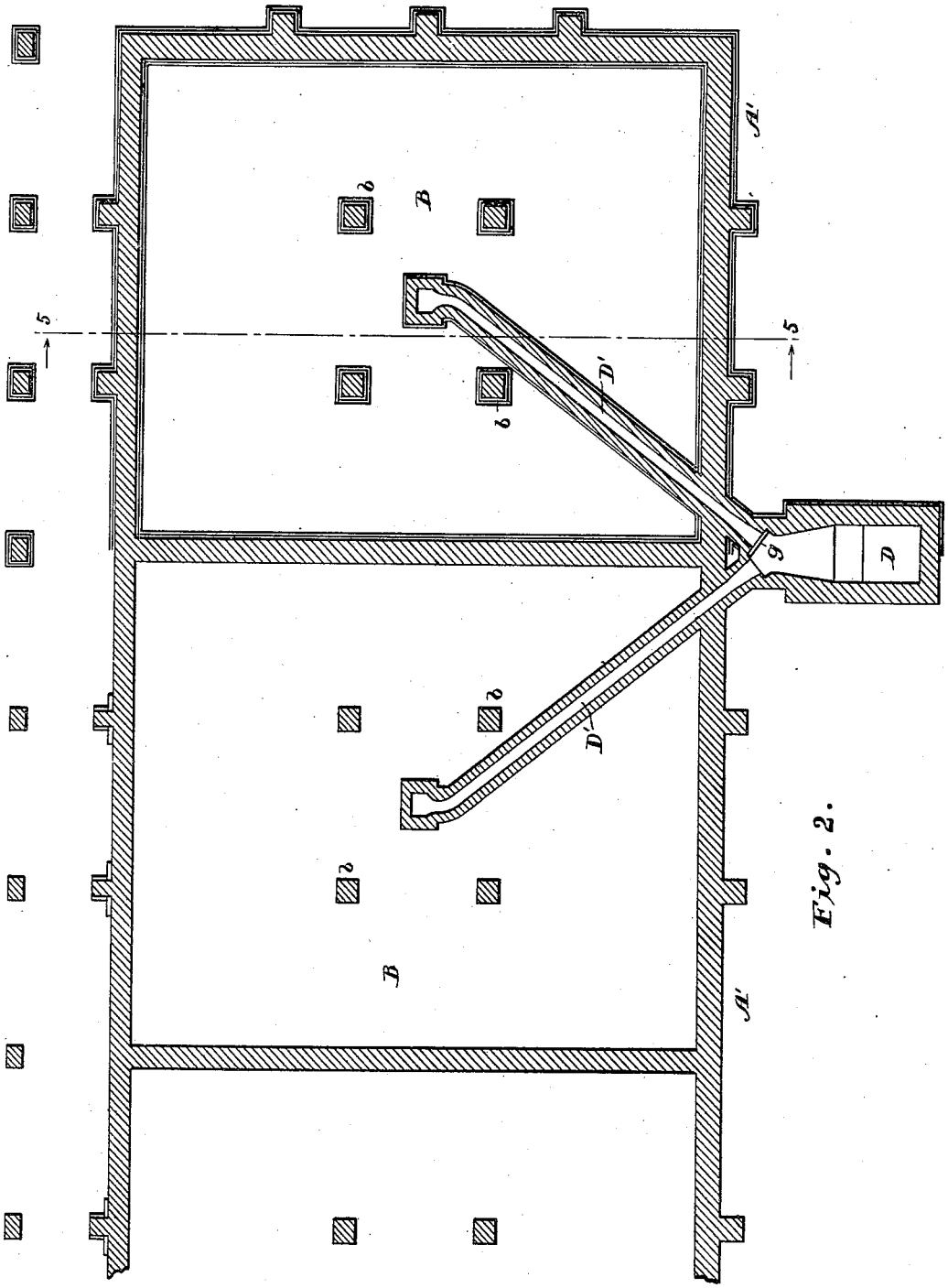

Fig. 2.

WITNESSES

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(No Model.) 7 Sheets—Sheet 3.

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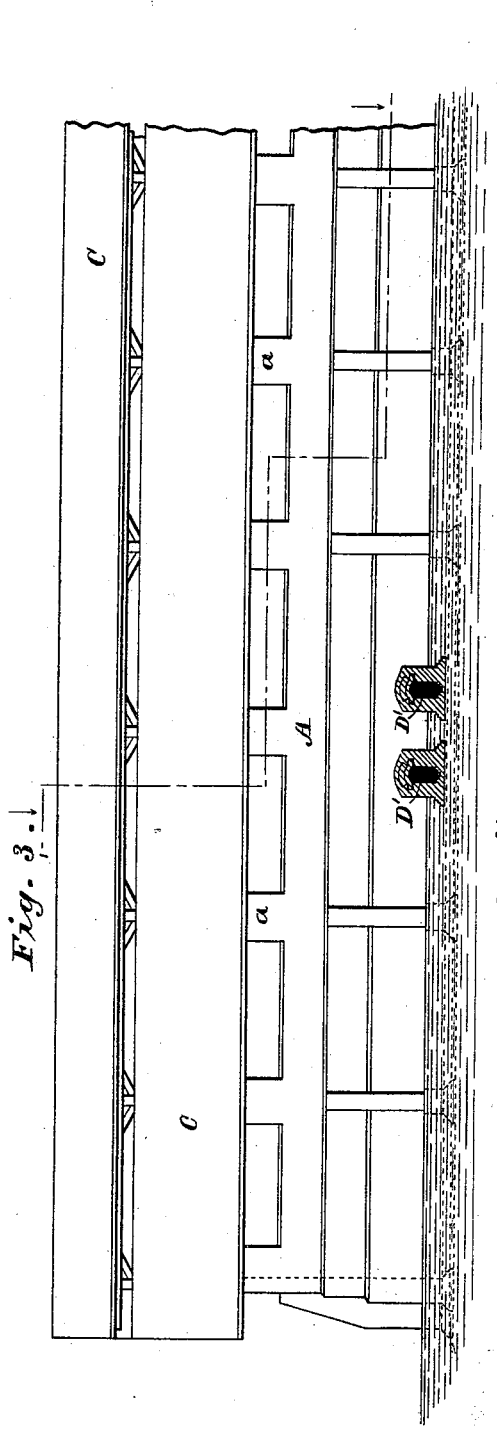

Fig. 3.

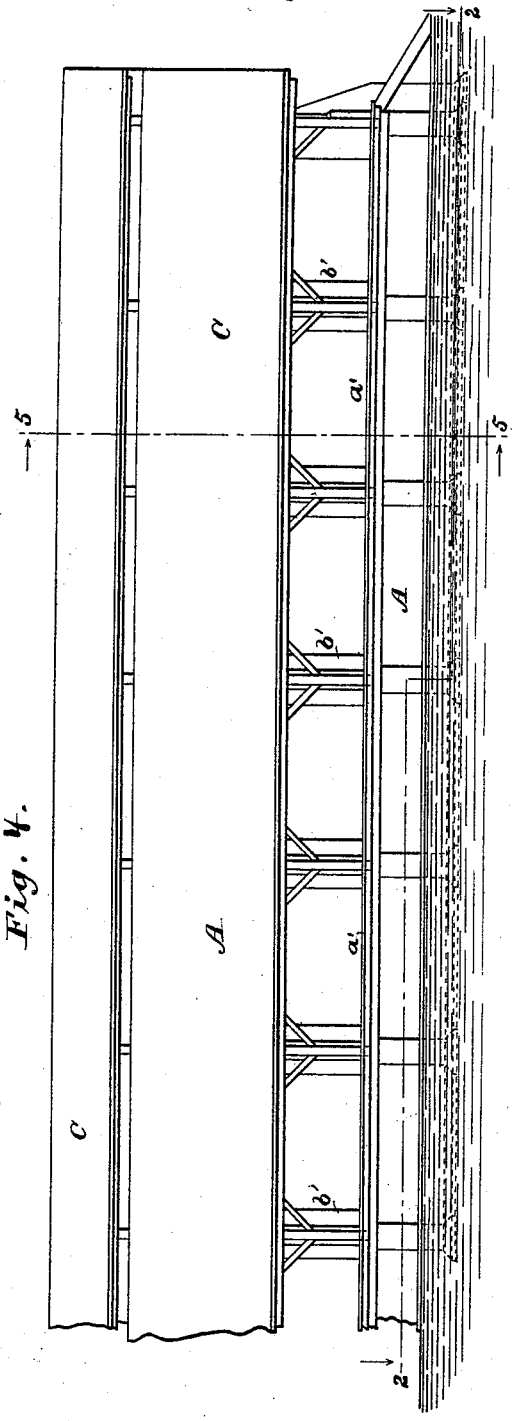

Fig. 4.

WITNESSES

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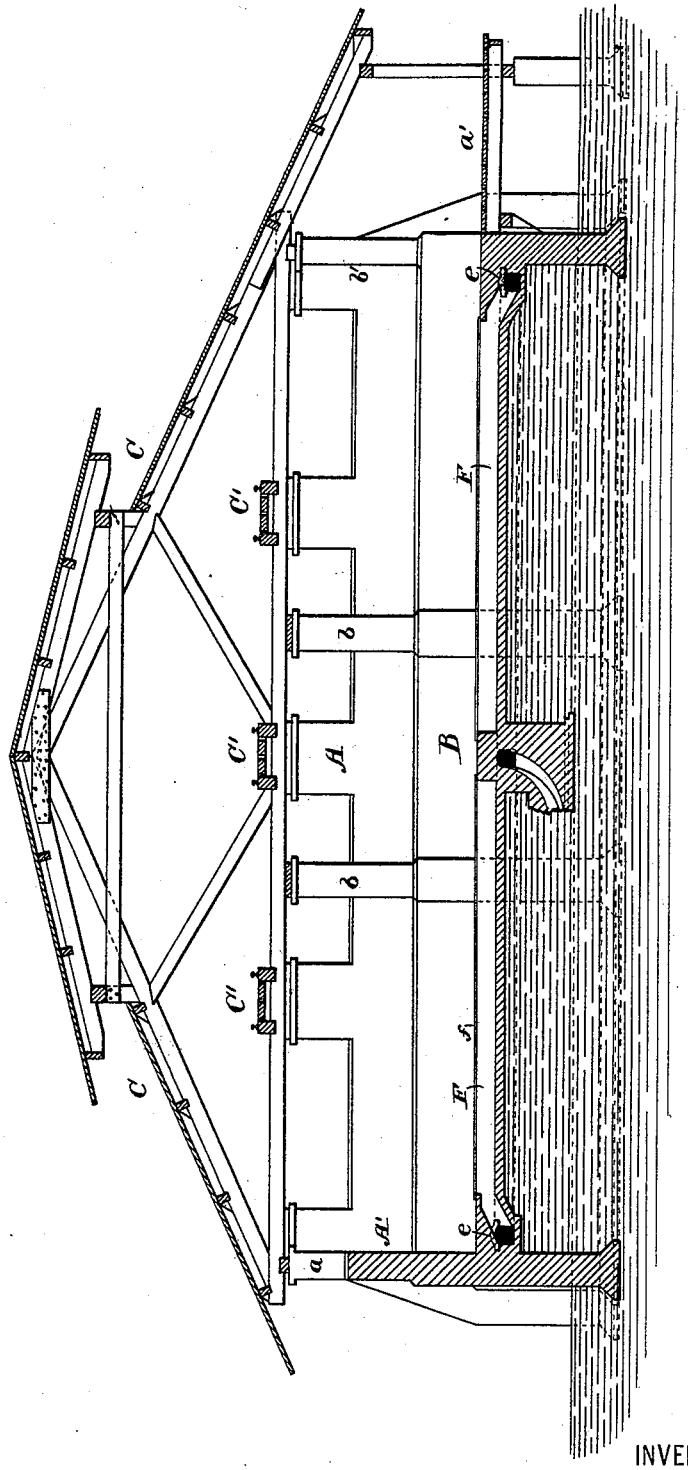

Fig. 5.

WITNESSES

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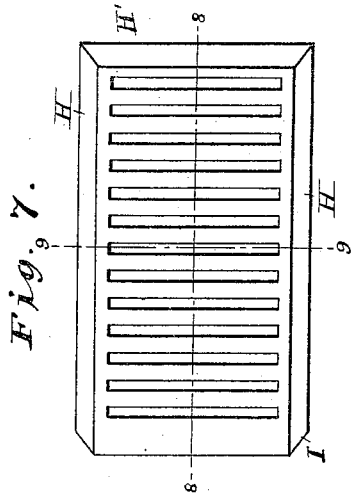

Fig. 7.

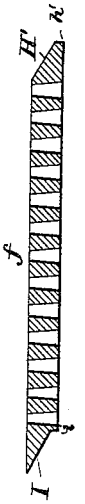

Fig. 8.

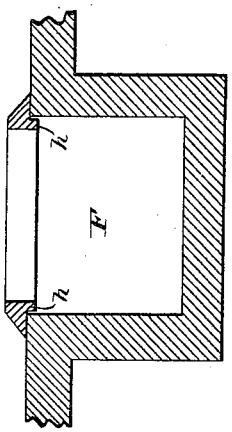

Fig. 9.

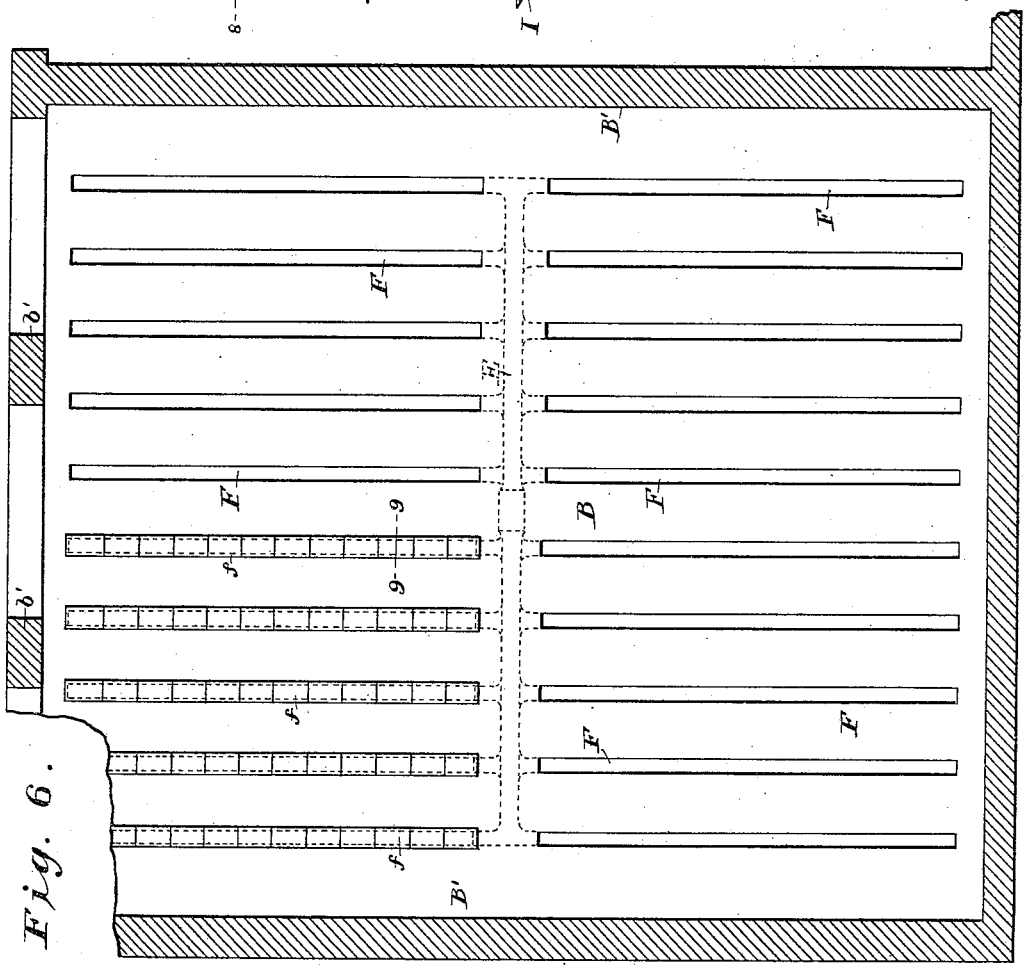

Fig. 6.

WITNESSES

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(No Model.) 7 Sheets—Sheet 6

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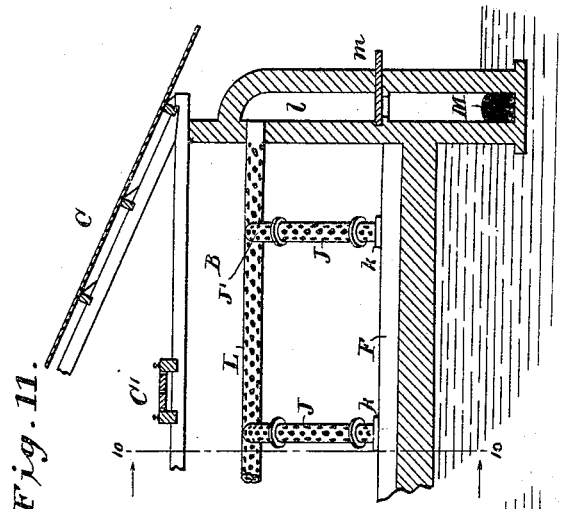

Fig. 11.

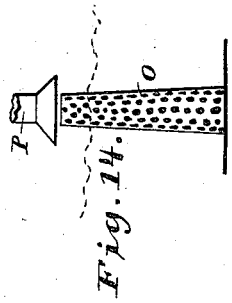

Fig. 14.

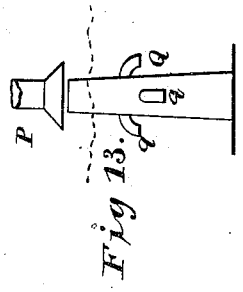

Fig. 13.

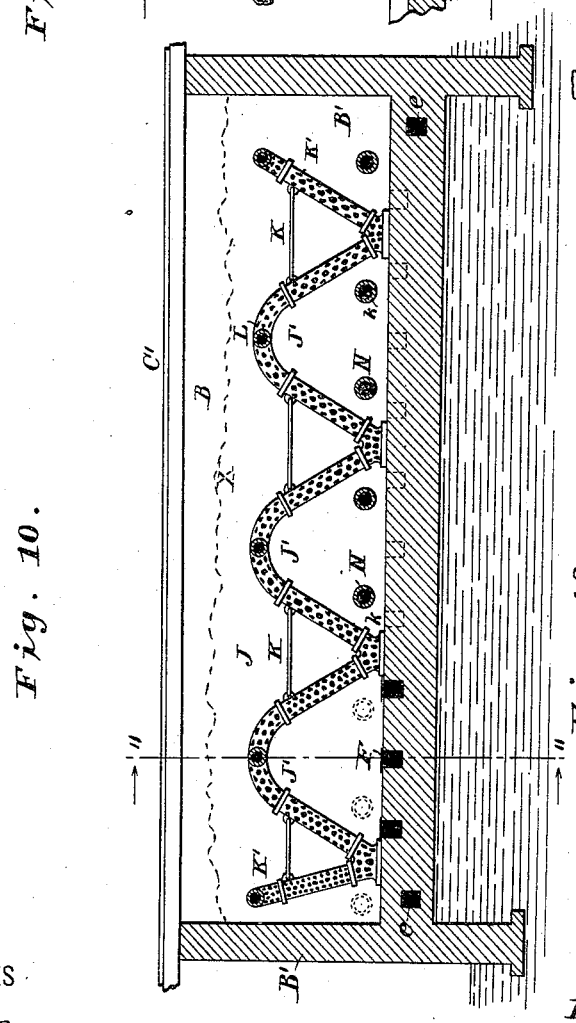

Fig. 10.

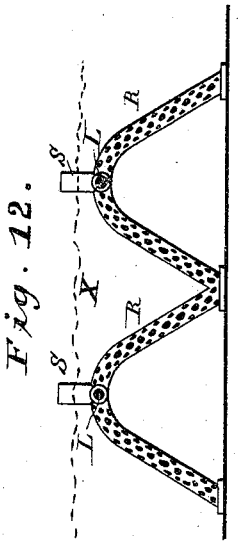

Fig. 12.

WITNESSES

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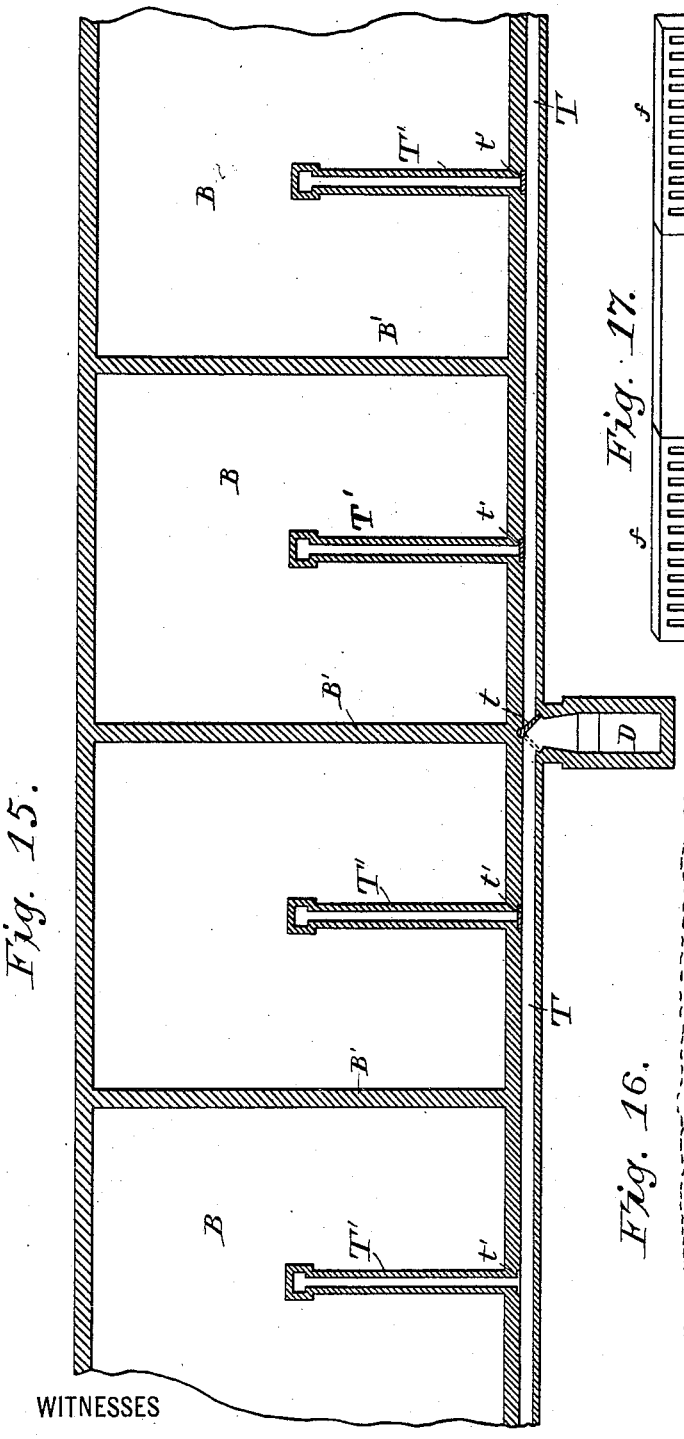

Fig. 15.

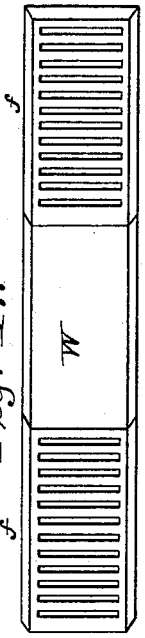

Fig. 17.

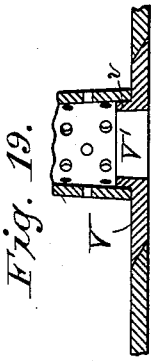

Fig. 19.

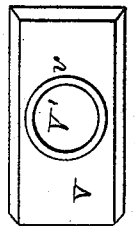

Fig 18.

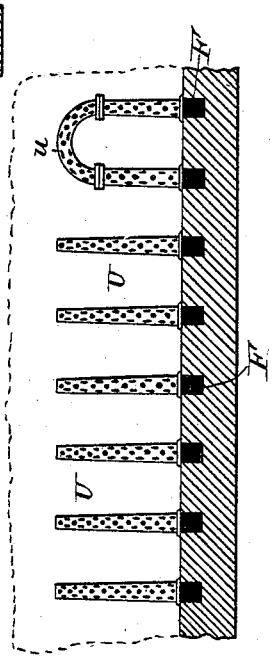

Fig. 16.

WITNESSES

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UNITED STATES PATENT OFFICE.

FRED BROTHERHOOD, OF CHARLESTON, SOUTH CAROLINA.

MEANS FOR DRYING PHOSPHATE ROCK, &c.

SPECIFICATION forming part of Letters Patent No. 342,678, dated May 25, 1886.

Application filed January 20, 1886. Serial No. 189,201. (No model.)

To all whom it may concern:

Be it known that I, FRED BROTHERHOOD, of Charleston, South Carolina, have invented certain new and useful Improvements in Means for Drying Phosphate Rock, &c., of which the following is a specification.

My invention relates to improvements in driers of the class adapted to the treatment of large quantities of the material to be dried—such as ores, &c.

My object, chiefly, is to provide improved means of this class by which phosphate rock may be dried in large quantities thoroughly, expeditiously, and economically.

Some of the devices employed in connection with my present improvements are the same as or substantially similar to features of the invention set forth in Letters Patent No. 308,237 granted to me November 18, 1884.

The subject-matter deemed novel will hereinafter be particularly pointed out by the claims, after being first described by reference to the accompanying drawings, which, while not showing all details of a complete drying structure, represent those features illustration of which is deemed sufficient to convey a proper understanding of a suitable embodiment of my improvements and some modifications thereof.

Figure 1 is a view, partly in plan, with the roof omitted and various parts broken away, and partly in section in two horizontal planes, one above and the other beneath the floor-level, as indicated by the line 1 1 of Fig. 3. Fig. 2 is a view in section in two different horizontal planes, both beneath the floor-level, as indicated by the line 2 2 of Fig. 4. Fig. 3 is a view in rear elevation, partly in section, on the line 3 3 of Fig. 1. Fig. 4 is a front elevation. Fig. 5 is a view partly in end elevation and partly in section on the lines 5 5 of Figs. 1, 2, and 4. Fig. 6 is a view, partly in plan and partly in horizontal section above the floor-level, showing a modification, the covering-plates for some of the floor-flues being omitted. Fig. 7 is a plan view of one of the covering-plates for the floor-flues; Fig. 8, a section on the line 8 8 of Fig. 7, and Fig. 9 a section on the lines 9 9 of Figs. 6 and 7. Fig. 10 is a view, partly in elevation and partly in section on the lines 10 10 of Figs. 1 and 11, showing vapor-collecting and draw-off pipes, omitted from the preceding figures, as well as a modification; and Fig. 11, a view partly in elevation and partly in section on the line 11 11 of Fig. 10. Figs. 12 to 19, inclusive, show other modifications.

A large building or suitable structure, A, is divided into any desired number of heating-chambers, B. These chambers are preferably arranged in sets, as shown in Figs. 1 and 2, each set consisting of a pair of chambers, the chambers of a set being adjacent to each other, and each chamber being of proper dimension to contain a large amount of the material to be dried. The heating-chambers are separated by partition-walls B′, which are of solid construction to within a short distance of the open top of the structure, which is covered over by a ventilating-roof, C, so as to admit of the free escape of surplus heat, fumes, &c., as will further on become obvious. As will readily be understood, the roof-timbers are supported by the columns *b*, arranged centrally in the heating-chambers by the short columns *a* at the top of the back wall, A′, the partition-walls, and the end walls of the structure, and by the columns *b′* at the open front of the structure. An outside platform, *a′*, on the level of the floors of the heating-chambers, is provided at the front or open side of the structure, and extends the full length thereof.

The material to be dried is supplied to the heating-chambers by means of tracks C′ above them, along which cars are run and have their contents dumped into the chambers by way of their open tops.

As shown in Figs. 1 and 2, a single furnace, D, is provided for heating two adjacent chambers, there being one such furnace for every pair of heating-chambers; but, as further on to be explained, a single furnace may be employed to heat a large number of chambers in the desired order. A main flue, E, for each heating chamber, and located centrally beneath its floor, communicates about midway its length with the furnace by way of a conducting-flue, D′, and is divided into two branches, *e e*, passing from the central line of the chamber in opposite directions, or toward the front and the back of the structure, and extending around close to the walls of the heating-cham-

ber, as plainly shown in Fig. 1. Flues F beneath the floor, and covered by perforated or slotted metallic plates *f*, communicate with the main flue E. In some instances, as further on to be explained, these covering-plates are not all slotted. As shown, the floor-flues F are divided into two series, located at opposite sides of the heating-chamber, the floor-flues of one series communicating at their outer ends—their ends most remote from the center of the chamber—with that portion of one branch *e* of the main flue E which extends along next to the back of the chamber, and the floor-flues of the other series communicating at their outer ends with that portion of the other branch *e* of the main flue which extends along next the front of the chamber. By branching the main flue and extending it around close to the walls of the heating-chamber, and supplying heat to the floor-flues at points remote both from the center of the chamber and the place at which the conducting-flue D′ joins the main flue, a very uniform diffusion of the heat is provided for, and the proper heating of material next the walls of the chamber is insured, which might not be the case always were the floor-flues supplied with heat at their inner ends or next the center of the chamber instead of at their outer ends or next the walls of the chamber. The two conducting-flues D′ D′ of each furnace employed in connection with a pair of heating-chambers with which they respectively communicate diverge from each other from the furnace outward to points centrally beneath the floors of their respective heating-chambers where they connect with the main flues of the chambers, and in order that the hot air, &c., from the furnace may be directed to one heating-chamber and shut off from the other chamber of the pair while it is being emptied of dried material, or supplied with material to be dried, or out of use, for repairs, &c., a suitable damper or cut-off, *g*, is provided, which may be adjusted to prevent access of the hot air to either conducting-flue while allowing the full supply of heat to pass to the other conducting-flue. As shown, the cut-off *g* consists of a movable plate, which may be supported across the mouth of either conducting-flue against a suitable seat formed by a recess. A man-hole, provided with a removable cover, G, affords access to the cut-off. (See Figs. 1 and 2.) Obviously, provision may be made for cutting off the heat from both conducting-flues at the same time. Two cut-off plates or other well-known equivalent devices would answer the purpose. It will of course be understood that blowing apparatus is employed in connection with the furnaces, in well-known ways.

From the above description it will be seen that any desired number of pairs of heating-chambers may be provided, and that the contents of the chambers of each pair may be alternately heated by a common furnace, in order that as material is being dried in one chamber the contents of the other may be removed, and in this way loss of time be avoided and economy attained, both in construction (lessening the number of furnaces employed) and in consumption of fuel. Obviously, were a separate furnace built for each heating-chamber, the cost of the apparatus would be greatly increased, and there would be more or less waste of fuel when shutting off heat from the heating-chamber, and loss of time and labor in slowing down and starting up the fire.

The heating-chambers are emptied of their dried contents by laborers using wheelbarrows, by means of which the material is carried out at the front of the structure and by way of the platform *a′* to the desired place of deposit.

In order that the wheelbarrows may be moved about over the floors of the heating-chambers without unnecessary obstruction, and to admit of the expansion and contraction of the covering-plates of the floor-flues, these plates are constructed and arranged as follows: The opposite edges of the plates are beveled upon their upper surfaces, so that inclines H H, instead of abrupt shoulders, are provided at the side edges of the plates of each row, and the under surfaces of the plates are formed with shoulders *h h*, near their opposite side edges. The central thickened portion of each plate, extending from one side shoulder to the other, projects into the floor-flue with which it is used, but does not quite extend across the flue, thus providing for expansion, and the plates rest outside of the side shoulders upon the floor of the heating-chamber. Each of the covering-plates is beveled at one end upon its upper surface, but not for the entire thickness, this beveled end H′ terminating in a shoulder or upright edge, *h′*, of a thickness corresponding to that of the shoulders *h*, which project beneath the floor-level, and at its opposite end each plate, except the finishing end plates, presently to be described, is provided with an incline, I, formed by beveling its under surface from its edge inward to a shoulder, *i*, corresponding in thickness with the shoulders *h* and *h′*. It will thus be seen that ample provision is made for expansion and contraction when the plates are properly adjusted to the floor-flues in rows, beginning each row by placing a plate with its side having the beveled end H′ uppermost and at the end of a floor-flue, then placing the next plate with its beveled end H′ beneath the overlapping under beveled end, I, of the first plate with the end edge shoulder, *h′*, of the second plate not quite in contact with the shoulder *i* of the first plate, (thus providing for expansion and at the same time guarding against improper endwise movement,) and so on until a row is completed with the exception of the last or finishing end plate. These finishing end plates are precisely similar to the others, except that the under beveled end is omitted, and both ends are made with the top incline, H′, and end shoulder, *h′*. These finishing

end plates are made alike at both ends, as described, in order that there may be no obstruction at the ends of the rows of plates to the free movement of the wheelbarrows over the floors of the heating-chambers.

In Fig. 6 a heating-chamber is shown as having its floor-flues communicating at their inner ends with the main flue which is without the branches hereinbefore described, and the employment of which is deemed preferable. The main flue has communication midway its length with the furnace by a conducting-flue, as already explained, and the improved covering-plates *f* are employed.

To hasten the drying of the material, and at the same time provide for drying it with greater uniformity throughout the mass, I provide means for collecting and carrying off the steam or moist vapors passing upward through the material, which vapors as they ascend through the material become more or less cooled, especially during the earlier part of the operation, and materially retard the process of drying, as, unless carried off, they for a time add moisture to the upper portions of the mass by condensation at or near the top X thereof, and delay its drying for a much longer period than is required to dry the material at and near the bottom of the mass.

As shown in Figs. 10 and 11, there are provided perforated vapor-collecting pipes, arranged in rows J above the floor and extending from near one side of the heating-chamber to near the opposite side thereof, and from the bottom to near the surface X of the mass, each row being composed in sections and constituting a series of united perforated tubular arches, J′. The corresponding arches of the respective rows are in line with each other, and the rows extend parallel to each other and to the front of the structure. The spaces beneath the arches admit of the free passage to and from the front of the structure of the laborers with their wheelbarrows in emptying the heating-chambers. The sections of pipe composing a row of arches are securely connected together by tie-rods K, and the rows at their ends terminate in inclined sections K′, which may be of approximately half-arch shape instead of inclined, as shown. The pressure of the material against these end sections, K′, materially relieves the walls of the structure from strain, thus lessening the liability of their becoming bulged, as will be obvious. The flanges *k*, at the junctions of the arches of the respective rows, serve to support the rows upon the floor. Perforated draw-off pipes L connect the corresponding arches and end sections of the series of rows of vapor-collecting pipes, these connecting draw-off pipes communicating with the arches and end sections, so that the vapors entering to the pipes of the rows J can pass into the connecting-pipes L. Each connecting-pipe has communication at one end with a channel or upright wall-flue, *l*, and at its opposite end is closed. Each of the upright flues is provided with a cut-off, *m*, and communicates at its lower end with a horizontal end flue, M, which is connected with suitable exhaust apparatus. A suction-fan or a tall chimney would answer for the exhaust apparatus.

From the above description it will be seen that as the arches of the rows J of perforated pipe extend nearly to the top of the mass of material being treated, the moist vapors throughout the mass will be drawn off through the pipes L and flues *l* by suction when the exhaust apparatus is in action. The vapors pass readily into the arches by way of their perforations, and also into the connecting draw-off pipes by their perforations, and off by way of the draw-off pipes, the flues *l*, and the end flue, M. Any one or more of the flues *l* may be closed by its cut-off, to enable any particular portion of the mass of material to be subjected to the full action of the exhaust apparatus, as may be desired.

It is obvious that instead of the exhaust apparatus a furnace with blowing apparatus may be used in connection with the flues M and *l* and draw-off pipes, in which event the ends of the connecting draw-off pipes L, opposite those communicating with the flues *l*, would be open, and pass out of the heating-chamber. In this way the currents of heated air passing through the draw-off pipes would naturally seek escape in the most direct path—at the far ends of the connecting-pipes—and would draw off the vapors by suction, and also assist in drying the material, as will readily be understood.

If desired, the flues F beneath the floors may be dispensed with, and perforated floor-flues formed by the pipes N (see Fig. 10) above the floor, and having communication with the main flues E, be employed, or both the pipes N and the flues F beneath the floors be used in connection with the system of exhaust-pipes described.

Instead of the means above described for drawing off the moist vapors, a series of perforated upright pipes, O, Fig. 14, may be arranged in numerous places throughout the mass, so as to rest at their bottoms on the floor of the heating-chamber and project at their tops above the material, each tube terminating beneath the flaring lower end of a draw-off pipe, P, passing at its opposite end out at the roof of the structure. In this way a draft would be created which would carry off the vapors entering to the pipes O and lower end of the pipes P.

Instead of the perforated tubes O, tubes Q, Fig. 13, provided with short communicating curved tubes *q*, of any desired number, may be employed in connection with draw-off tubes P. Perforated arched tubes R, Fig. 12, may be arranged as shown in Figs. 10 and 11, and provided with connecting draw-off pipes, as in said figures, and in addition have short tubes S, communicating with the arches at top and projecting above the level of the material, so, as by means of pipes such as

those, P, above described, to draw off the vapors which may pass from the material into the arches.

Fig. 15 shows in horizontal section beneath the floor-level such features as are needed to illustrate a modification whereby any preferred number of heating-chambers B may be heated in turn, as desired, by a single furnace, D. The right and left main conducting-flues T, by way of which the furnace has communication with the different heating-chambers, are provided with a damper, *t*, by which to control the direction (to the right or left) in which the heat passes to the branch conducting-flues T'. There is one of the branch conducting-flues T' for each heating-chamber, and these flues communicate with the main flues E of the heating-chambers, in the manner and for the purposes before fully explained. Dampers *t'* provide for controlling the passage of heat from the flues T to the flues T'. It will be seen that by means of the dampers the chambers B may be heated as desired, and the heat be cut off from them at will.

Fig. 16 is a sectional elevation showing such parts as are required to represent a modification whereby perforated pipes are used in connection with the floor-flues F, instead of the perforated covering-plates *f*. In accordance with this modification perforated unconnected upright pipes U are arranged in rows, or upright perforated pipes of adjacent rows may be united by curved pipes *u*. These perforated pipes are closed at top and are employed in a system such in all respects as before described and represented in Figs. 1, 2, &c., except that in lieu of the perforated covering-plates, or some of them, covering-plates V, Figs. 18 and 19, are employed. These covering-plates V have each a central opening, V', surrounded on top by an annular flange, *v*, about which the base of a pipe, U, fits. If desired, both perforated covering-plates *f* and heat-distributing pipes U may be used. For instance, the floor-flues F may be covered alternately with the perforated plates *f* and the plates V, these plates V having the pipes U fitted to them. In some instances solid covering-plates W (see Fig. 17) may be employed at intervals. The plates V and W are inclined or beveled and shouldered, as before fully explained with reference to the perforated covering-plates.

I do not herein broadly claim either a drying structure divided into a number of heating-chambers independently heated or a drying structure having an open front to facilitate access to and the emptying of the heating-chambers thereof, or the combination, with a heating-chamber, of floor-flues, a main flue with which they communicate, a conducting-flue communicating with the main flue about midway its length, and a furnace with which the conducting-flue connects, or the combination of means for holding the material to be dried, means for supplying air to the material, and means for drawing off the air after its passage into or through the material, as, unqualifiedly considered, such features and combinations are older than my improvements herein described and claimed.

I claim as of my own invention—

1. The combination of the heating-chambers, their main flues, a single furnace for heating the chambers, its conducting-flues communicating with the different chambers and having independent communication with the respective main flues, the floor-flues communicating with the main flues, and means for cutting off the heat of the furnace from the main flues, substantially as and for the purpose hereinbefore set forth.

2. The combination of a heating-chamber, the main flue located centrally beneath its floor and provided with the branches passing around close to the walls of the heating-chamber, the two series of floor-flues communicating respectively at their outer ends with the opposite branches of the main flue, and the conducting-flue communicating with the main flue about midway its length, substantially as and for the purpose hereinbefore set forth.

3. The combination of a heating-chamber, its floor-flues having communication with a furnace, by which hot air is provided for drying the material in the heating-chamber, the perforated vapor-collecting pipes, about which the mass of material extends, and the draw-off pipes connected with the upper ends of the vapor-collecting pipes, substantially as and for the purpose hereinbefore set forth.

4. The combination of the heating-chamber, means for supplying hot air thereto at bottom, the rows of perforated tubular arches terminating in the inclined end sections, the tie-rods by which the arches and end sections are connected together, and the draw-off pipes, substantially as and for the purpose hereinbefore set forth.

5. The combination of a heating-chamber, means for supplying hot air to dry the material therein, the rows of perforated pipes, the draw-off pipes connected therewith, the flues *l*, with which the draw-off flues connect, and the end flue with which the draw-off flues communicate, substantially as and for the purpose hereinbefore set forth.

In testimony whereof I have hereunto subscribed my name.

FRED BROTHERHOOD.

Witnesses:

WM. H. LOCKWOOD,

WILLIE H. LOCKWOOD.