

(No Model.)

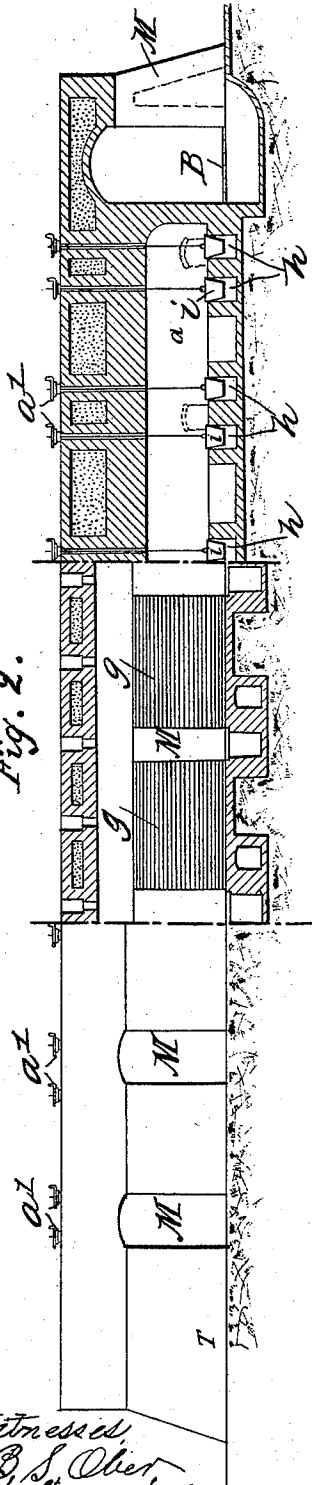
5 Sheets—Sheet 1.

C. D., A. D., L. D. & S. D. D'ENGHIEN.
KILN FOR BAKING OR FIRING EARTHENWARE.

No. 586,169.

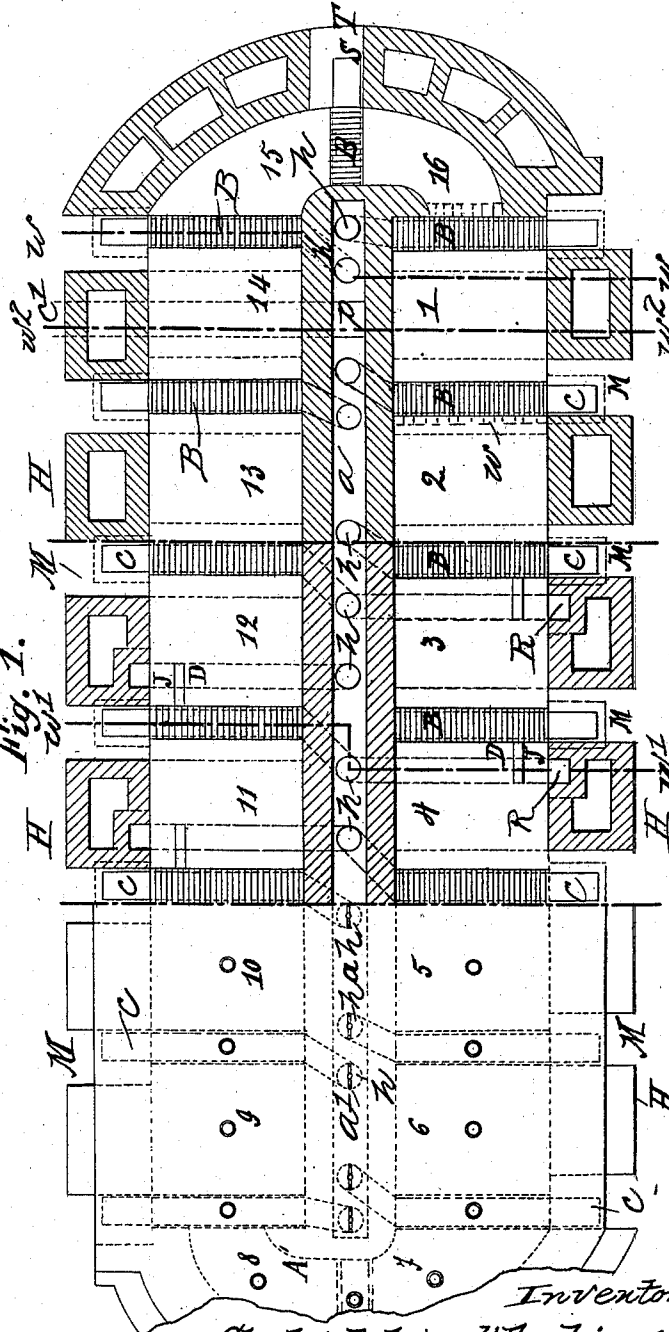
Patented July 13, 1897.

Fig. 2.



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Fig. 1.



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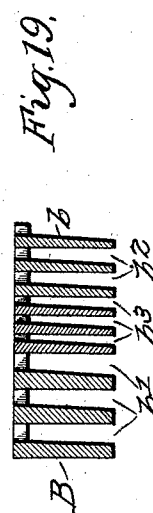
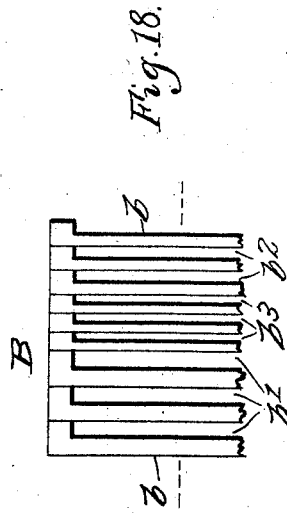
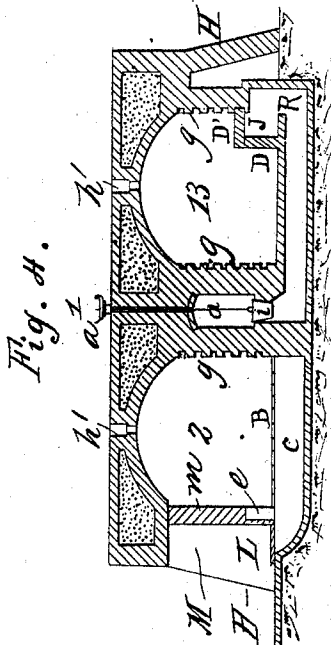
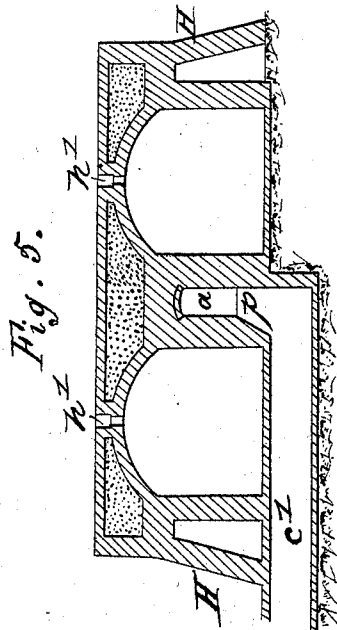
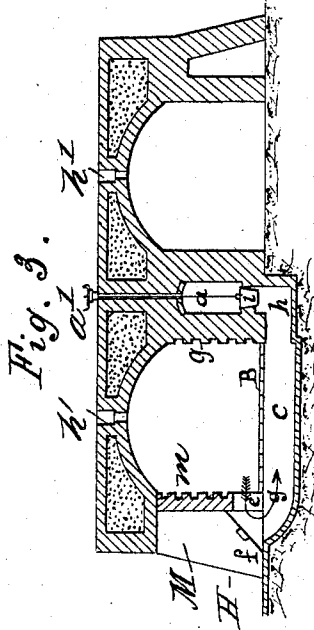
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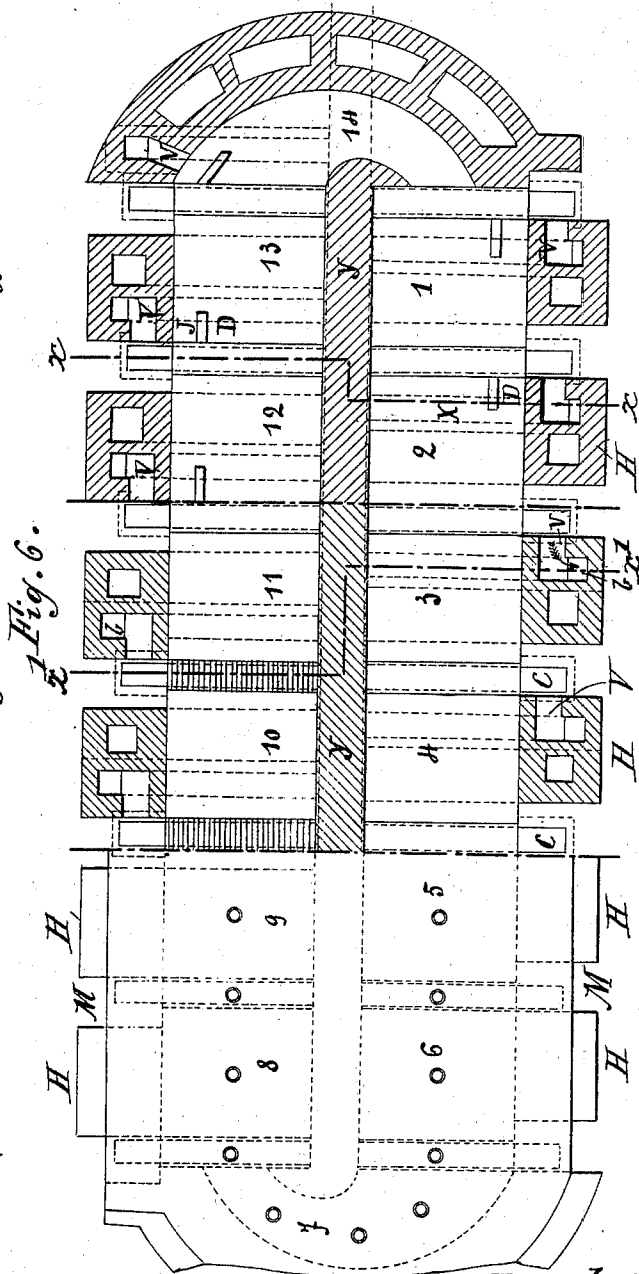
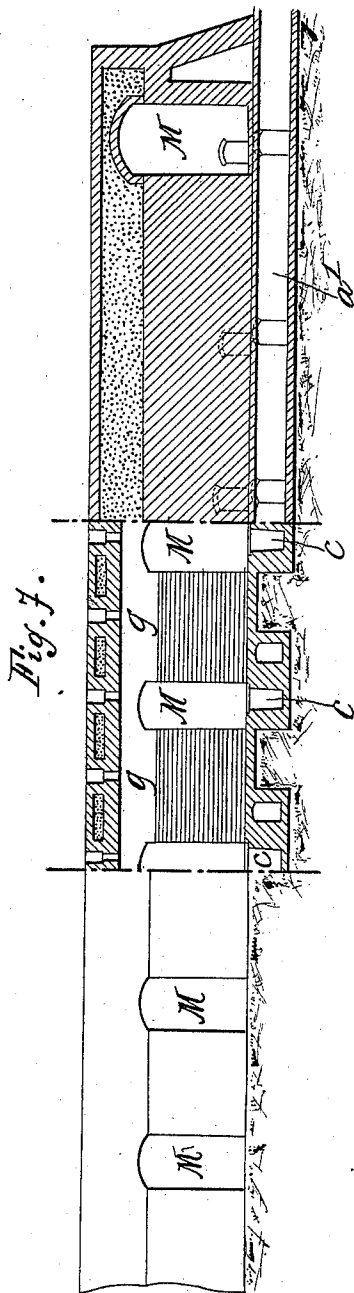
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5 Sheets—Sheet 4.

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Fig. 12.

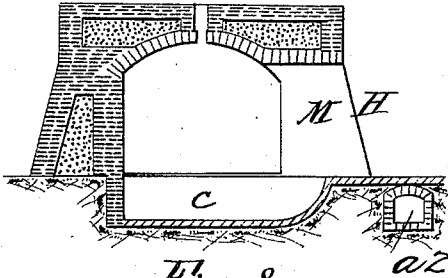


Fig. 13.

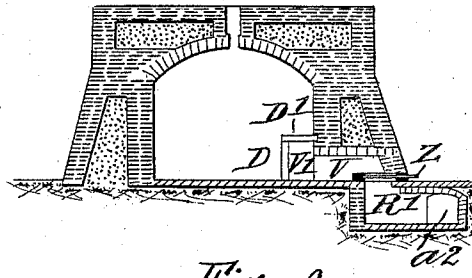


Fig. 8.

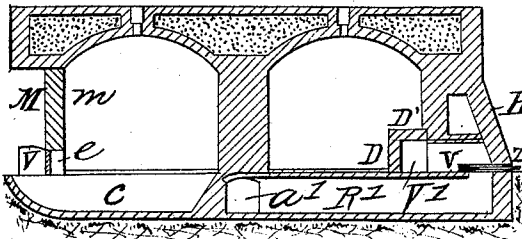


Fig. 9.

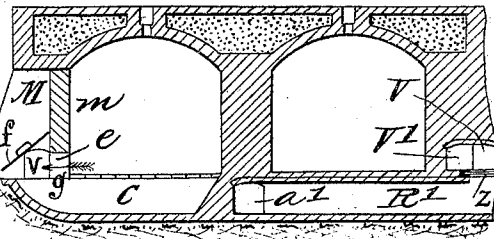


Fig. 15.

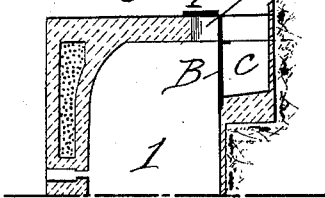


Fig. 14.

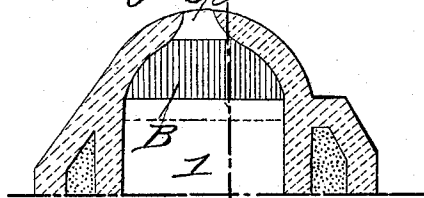


Fig. 16.

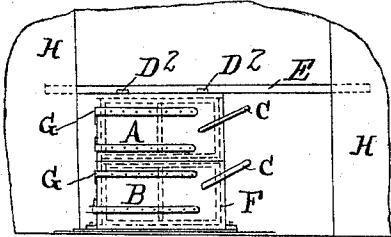
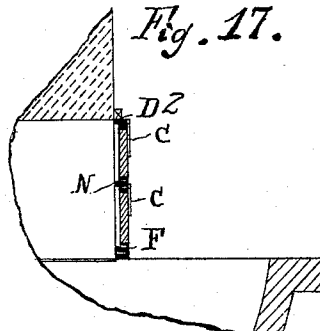


Fig. 17.



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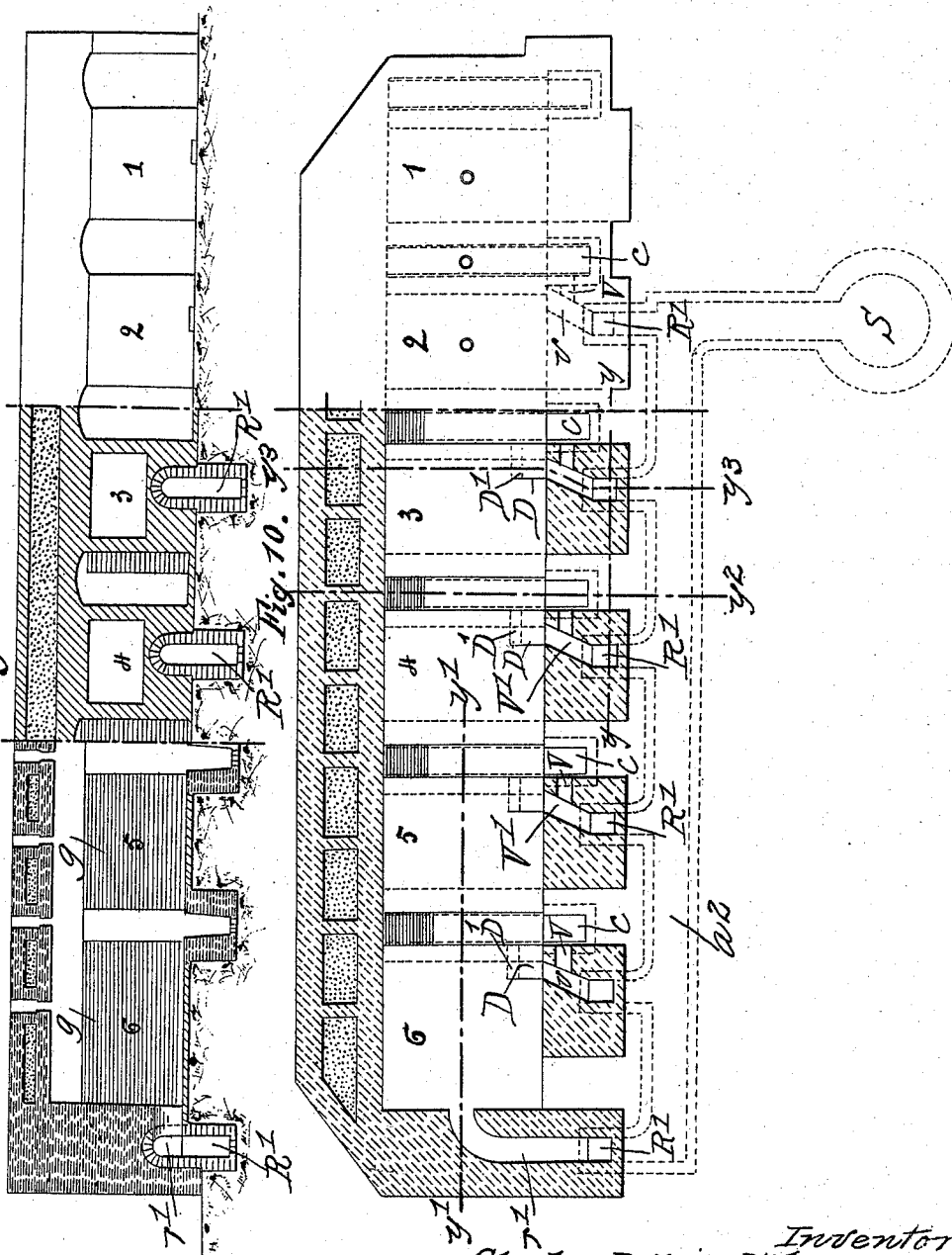
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C. D., A. D., L. D. & S. D. D'ENGHIEN.
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Fig. 11.



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UNITED STATES PATENT OFFICE.

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KILN FOR BAKING OR FIRING EARTHENWARE.

SPECIFICATION forming part of Letters Patent No. 586,169, dated July 13, 1897.

Application filed November 16, 1895. Serial No. 569,216. (No model.) Patented in Belgium November 7, 1894, No. 112,576, and February 25, 1895, No. 114,290; in England November 14, 1894, No. 22,008, and April 4, 1895, No. 7,914, and in France November 15, 1894, No. 217,063.

To all whom it may concern:

Be it known that we, CHARLES DUBOIS D'ENGHIEN, ALPHONSE DUBOIS D'ENGHIEN, LÉON DUBOIS D'ENGHIEN, and SILVAIN DUBOIS D'ENGHIEN, subjects of the King of Belgium, and residents of Hennyeres, in the Kingdom of Belgium, have invented certain new and useful Improvements in Kilns for Baking or Firing Earthenware, (for which patents have been obtained in Belgium, dated November 7, 1894, No. 112,576, and February 25, 1895, No. 114,290; in France, dated November 15, 1894, No. 217,063, and in England, dated November 14, 1894, No. 22,008, and April 4, 1895, No. 7,914;) and we do hereby declare the following to be a full, clear, and exact description of said invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to letters or figures of reference thereon, which form a part of this specification.

Our invention has relation to kilns for baking or firing earthenware of every description, and it has for its object certain improvements on the kiln shown and described in Letters Patent of the United States granted to us on the 9th of January, 1894, No. 512,284. These improvements consist, essentially, in the arrangement of the main draft-flue relatively to the kiln-gallery, so that a kiln of limited capacity and adapted for intermittent production can be built and said capacity gradually increased as may be required, and the intermittently-operating kiln finally converted into one for continuous operation.

The improvements further consist in means whereby the draft in the kiln galleries or chambers may be varied in accordance with the nature of the ware to be baked or fired, in the means for facilitating the passage of the products of combustion along the walls of a kiln-chamber, in the means for graduating the combustion of the fuel at different points of the fuel-grates, in a novel construction

of kiln-chamber gates, and in details of construction and combinations of parts, as will now be fully described, reference being had to the accompanying drawings, in which—

Figure 1 is a partial plan and partial horizontal section of a kiln adapted for continuous or uninterrupted operation constructed in accordance with our invention. Fig. 2 is an illustration of said kiln by a partial side elevation and partial vertical section along the arch of a gallery and along a line intermediate of the two galleries, respectively. Figs. 3, 4, and 5 are vertical transverse sections taken respectively on lines $w w$, $w' w'$, and $w^2 w^2$ of Fig. 1. Figs. 6 and 7 are views similar to Figs. 1 and 2, respectively, illustrating a modified arrangement of the main and auxiliary draft-flues, whereby the dimensions of the end compartments are sufficiently reduced to avoid their subdivision. Figs. 8 and 9 are vertical transverse sections taken, respectively, on lines $x x$ and $x' x'$ of Fig. 6. Fig. 10 illustrates by a partial horizontal section and partial plan view, respectively, a kiln constructed for intermittent operation. Fig. 11 illustrates the same by a partial elevation and by sections taken, respectively, on lines $y y$ and $y' y'$ of Fig. 10. Figs. 12 and 13 are vertical transverse sections taken, respectively, on lines $y^2 y^2$ and $y^3 y^3$ of Fig. 10. Figs. 14 and 15 show by horizontal and vertical sections, respectively, the end compartment of the kiln, Figs. 10 to 13, the section Fig. 15 being taken on line $z z$ of Fig. 14. Figs. 16 and 17 show in elevation and vertical section an improved gate for closing the openings leading to the fuel-grates and kiln spaces or compartments; and Figs. 18 and 19 show in plan view and section the arrangement of said fuel-grates.

Referring to Figs. 1 to 5, in which we have shown a kiln with two connected galleries constructed for continuous operation, the main draft-flue a is located between the two galleries and communicates by a port or opening p with a flue c' below said main flue a ,

which flue *c'* (shown in dotted lines in Fig. 1 and in full lines in Fig. 5) is connected with a suitable stack. (Not shown.) The galleries are divided into twelve substantially equal spaces by fuel-grates B, said galleries being connected by an end compartment whose outer wall is of curvilinear form. Inasmuch as the main draft-flue *a* is located between the two galleries and preferably slightly above the floor or sole of said galleries, the area of the connecting end spaces is considerably increased, in fact to such an extent that it would be difficult to properly fire or bake earthenware placed therein. This we avoid by dividing the connecting end spaces into two and, if necessary, more spaces by means of a grate B or a number of such. Furthermore, if the inner curvilinear face of the outer wall of said connecting end spaces were a segment of a circle those wares placed along said wall farthest from the source of heat would not be subjected to the same degree of heat as those wares arranged in the more direct line of draft, hence would require a longer exposure to such heat or would result in the production of imperfectly baked or fired ware. This we avoid by gradually contracting said end spaces in the direction of the flow of the products of combustion from the source of heat, as fully described in our patent hereinbefore referred to. It is of course well understood that the flow of gases is always in a direction of least resistance, and in kilns of the kind under consideration those wares stacked along the side walls are exposed to less heat than the remaining wares, because the flow of the products of combustion is more or less obstructed by the resistance due to friction offered by smooth or plain surfaced walls to such products of combustion. To avoid this, we construct the side walls so as to form series of longitudinal parallel grooves *g*, as shown in Figs. 2, 4, 7, and 11, by laying alternate rows of bricks so as to project somewhat beyond the intermediate rows, thus forming a series of small parallel unobstructed flues or grooves through which the products of combustion can flow freely.

In order that all parts of the kiln-spaces may be uniformly heated, we construct the fuel-grates B in such a manner as to vary the degree of draft therethrough.

Those wares arranged along the walls of the kiln require, in all kilns as heretofore constructed, a longer time to bake than those wares placed centrally of the kiln-chambers. When the kiln is constructed as shown and described in reference to Figs. 1 to 5—namely, with two galleries and with the main draft-flue between them—the greater portion of the heat of the waste products of combustion is given up to the inner or dividing wall between the two galleries, so that the wares stacked along said dividing-wall will bake quicker than those arranged along the outer wall, yet

not as rapidly as the intermediate wares, and in the baking or firing of the finer grades of porcelain, in order to avoid the production of too great a percentage of second-class and imperfect wares, the uniform distribution of heat is an important factor. This we attain, as stated, by constructing the kiln with two galleries, by the provision of draft-passages in the lateral walls, and particularly by the construction of the grates as follows, reference being had to Figs. 18 and 19.

The grates B are constructed of preferably three sets of grate-bars *b*, that set arranged along the outer wall of the kiln having the greatest space between them, as shown at *b'*, the set of bars along the inner wall having a less space between them, preferably about two-thirds the space between the outer set of bars, as shown at *b''*, while the space between the intermediate set of bars is only about one-half as wide as the space between the bars of the outer set, as shown at *b'''*, so that the quantity of fuel consumed on the three sets of bars will be at the ratio of one, one-half, and two-thirds, respectively.

Practice has demonstrated that the described arrangement of the grate will result in a uniform distribution of the heat throughout the width of the kiln. In Fig. 1 we have numbered the kiln-spaces formed by the grates B from 1 to 16, there being a manhole M at the outer end of each grate which is closed, as hereinafter described, when the kiln is in operation.

In our Letters Patent hereinbefore mentioned we have described and shown a single-panel gate for closing the manholes, so that access may be had to the grates for supplying the same with fuel and for stoking the fires. We have found that whenever these gates were opened for the purposes stated the indraft of cold air was such as to more or less chill the wares immediately in the path of the inflowing cold air.

One of the objects of our present invention is to avoid the inflow of large volumes of cold air into the kiln whenever a gate is opened. To this end the manholes M are temporarily built up when the kiln is in operation, leaving opposite the grate an opening *e* below the temporary wall *m*, Figs. 4 and 5, which opening is closed by a gate, Figs. 16 and 17, comprising a frame F, provided with lugs *D*², held in position by a bar E, removably seated in suitable recesses formed in the side walls or buttresses H of the opening M, and two gates A and B closing against a cross-bar N of the aforesaid frame, to which said gates are hinged, as shown at G, Fig. 16, each of said gates being provided with a handle C. The gate is, as usual, made of metal, and the swinging panels A B are hollow and filled with a suitable refractory material. As constructed, the gate-frame and gates, by re-

removal of the bar E, can be readily removed whenever this becomes necessary, while in supplying fuel to the grate the lower gate B is opened and for the purpose of stoking the fire the upper gate A is opened, so that in either operation but a comparatively small quantity of cold air will enter the kiln, not sufficient to act injuriously upon the wares.

According to the nature of the wares to be baked or fired we vary the direction of the products of combustion. Thus, for instance, in baking or firing the cheaper class of wares we direct the products of combustion to the main flue *a* as follows: Below each grate B is an ash-pit *c*, which extends beyond the outer end of the grates B and opens into the space between the walls or buttresses H, and according to the point at which the draft is to be established we place a baffle-plate *f* in front of the opening *e* below the temporary wall *m* and over the entrance to or open outer end of the ash-pit *c*, Fig. 3, the products of combustion flowing from grate B through opening *e* into ash-pit *c*, and thence through said ash-pit and opening *h* to the central main flue *a*, the flow of the products of combustion to said flue being controlled by a conical damper or valve *i*, seating in said opening *h* and adapted to be manipulated from the roof of the kiln in any suitable manner—as, for instance, by screw-rod and nut *a'*, Figs. 1 to 4, or by any other suitable means. From the main flue *a* the waste products flow through flue *c'* to a suitable stack, as hereinbefore stated.

We have shown the flue *c'* located near the right-hand end of the kiln. It will, however, be understood that it may be located at any other point, and instead of arranging it at right angles to the main flue *a* it may be parallel therewith or form substantially a continuation thereof. We prefer, however, to locate the said flue *c'* at or as near as practicable to that end of the kiln where the operation of baking or firing is commenced, in Figs. 1 and 2 at the right-hand end, in order to utilize to the utmost the heat of the waste products of combustion. In baking or firing the more delicate class of wares the more or less frequent removal of the temporary baffle-plate *f* affords access to the kiln of considerable quantities of cold air, which act injuriously thereon. This we avoid by giving the products of combustion a different direction from that last described. To this end we form a draft-opening J in the floor or sole of the kiln in front of the grates B and at the outer end thereof, said opening leading to a flue R in communication with the main flue *a*, Fig. 4. The opening J is open to the grate, but otherwise surrounded by a wall D and covered by a slab of refractory material D', thus forming a flue at the outer end of the grate B within the kiln, and when this connection is used we close the opening *e* below the tem-

porary wall *m* either by a full wall or by means of one of the gates A B above described. The products of combustion will now flow over the grate into the flue D D' through opening J and flue R through an opening *h* in the floor of said main flue, the draft being regulated by the valve *i* for said opening *h* above described. The openings J and flues R being constructed with the kiln, when the draft is not to be established therethrough the draft-opening J is covered by a slab of refractory material, and when it is desired to establish the draft through said connections the said slab is removed and the structure D D' is built around the opening, as described. In this manner the connections between some or all of the grates B and main flue *a* may be established in either manner described, which is of course a great advantage, as different kinds of wares can be baked or fired at the same time.

As shown in Fig. 1, the spaces 7 and 8 and 15 and 16 have no draft-flue connection with the main flue *a*, as this is not necessary when said end spaces are comparatively small; but when they are about the same capacity as the other spaces 1 2, &c., then we provide for said spaces 7 8 and 15 16 main-flue connections similar to those above described.

When no main-flue connections are provided for the chambers 7 8 and 15 16, the products of combustion of the fuel on the intermediate grates B flow to the ash-pit *c* or flue R, as the case may be, for spaces 9 and 1, respectively.

Of course the dimensions of the end connecting-spaces of the kiln will depend upon the distance between the two kiln-galleries, and when the main draft-flue *a* is located above the kiln-sole, between the two galleries, the distance between them is considerably increased, and in this case, as above stated, the said end spaces are not only divided into two or more spaces by grates B, but flue connections with the main draft-flue *a* are provided for said grates.

With a view to avoiding end connecting-chambers of great dimensions and yet derive the advantages resulting from a central main draft-flue we may arrange said flue below the kiln-sole and the partition-wall *y*, that divides the two galleries, as shown in Figs. 6 to 9, whereby the distance between the two galleries is reduced by almost three feet, and this arrangement of the main draft-flue is also of advantage where space for the kiln has to be taken into consideration. In said figures, *a'* indicates the main draft-flue. The flues for conducting the products of combustion from the grates to the main flue are in their essential features the same as those above described, differing only in arrangement necessitated by the change in the location of the main draft-flue *a'*. The products of combustion may be conducted to said main flue *a'* by

a flue V in the outer walls or buttresses H of the kiln, a baffle-plate *f*, Fig. 9, being so positioned as to lie in front of said flue V, the opening *e* below the temporary wall *m*, and over the mouth of the ash-pit *c*, so that the products of combustion will flow directly from the grate B to passage V into flue R' and thence to main flue *a*', the draft being here regulated by a sliding damper Z, interposed between the flues V and R' and adapted to be manipulated from the outside of the kiln. On the other hand, connection with the passage V may be made from within the kiln by a flue V' on a level with the grate B and leading into flue V, the mouth of said flue V' being extended along the grate by a vertical wall D, covered by a slab of refractory material D', as above described and as shown in Fig. 8, the draft being here also regulated by the sliding damper Z, adapted to be manipulated from the outside of the kiln. When the connections last described are used, the entrance to the flue V is temporarily bricked up or otherwise closed.

The described improvements are also applicable to kilns operating intermittently and having one or two galleries. The intermittently-operating kiln with two galleries is in fact but a portion of a continuously-operating twin-gallery kiln, so as to enable the manufacturer to increase the capacity of such intermittently-operating kiln in accordance with the increase in his business and finally convert such kiln into a continuously-operating kiln by connecting the two galleries at their ends by end chambers, as above described and as shown in Figs. 1 and 2. Thus, for instance, a kiln may be constructed having any desired even number of spaces—as, for instance, 1 2 3 12 13 14 15 16 of Fig. 1, the spaces 3 and 12 being closed by a solid wall. In all other respects the kiln will be constructed as described in reference to Figs. 1 to 5, and when it is desired to increase its capacity the end wall closing spaces 3 and 12 is taken down and any desired number of spaces added to the galleries until finally the end spaces are connected by spaces 7 and 8, when the kiln will be in condition for continuous operation.

Figs. 10 to 13 and Figs. 14 and 15 illustrate our improvements in their application to a single-gallery intermittently-operating kiln divided by means of grates B into any desired number of spaces, of which we have shown six, and the means for conducting the products of combustion to the main draft-flue described in reference to Figs. 6 to 9 are applicable to this type of kiln also.

As shown in Fig. 10, *a*² indicates the main draft-flue, leading to a stack S. The kiln-spaces are numbered 1 to 6, and the flues leading from said kiln-spaces to the main flue are indicated by the same letters of reference as the corresponding flues in said Figs.

6 to 9—namely, V is the passage leading from in front of the grates to the flue R', and V' the passage leading from one side of the grates at their outer end into said passage V.

D is the vertical wall, and D' the covering-slab, of refractory material, of the extension of the flue V' into the kiln, the flues R' communicating with the main draft-flue *a*². In this construction of kiln a connection between the grate for the end space 1 and the main draft-flue *a*² is also not required, as the products of combustion flow through said space to the flue connections with the grate B for space 2, while the products of combustion from the grate for the last compartment 6 are carried to the flue R' through a flue *r*', Fig. 10.

In order that the wares in space 1 may be more rapidly baked, we prefer to increase the area of the grate B therein, in which case we construct the end compartment as shown in Figs. 14 and 15, the grate B and fuel-opening O, leading thereto, being at the end of space 1, said opening being normally closed by a suitable gate or door, preferably by one of the double gates A B, hereinbefore described.

The starting of the continuously-operating kiln is effected as follows: the products of combustion in the kiln, constructed as described in reference to Figs. 1 to 5, flowing from right to left through the spaces 1 to 7 and in an opposite direction through the spaces 8 to 16. We first build a temporary wall W at the right-hand side or in rear of grate B for space 1, as shown in dotted lines in Fig. 1. The manhole M, opposite the said grate, is then built up so as to leave the space *e* below it, as above set forth, which opening is then closed by double gate A B, Figs. 16 and 17, after the grate has been supplied with combustibles ready to start a fire thereon. Space 1 is now filled with goods to be baked, which are introduced through the manhole M at the end of the grate for the space 2, after which this manhole is also closed like the one for space 1, except that the opening *e* may be temporarily bricked up and the entrance to the ash-pit *c* closed by a plate L, Fig. 4, or said opening *e* may be closed by a double gate A B, as in the case of the manhole for space 1, if the products of combustion are to flow to the main flue *a* by way of the opening J within the kiln-space. If, on the contrary, said products are to flow by way of the ash-pit, then the opening J is closed, and the baffle-plate *f*, Fig. 3, is used. Before introducing any goods into space 2 we build an open or checker work temporary brick wall *w*', as shown in dotted lines in Fig. 1, in front or left-hand side of grate B for space 2, thus practically converting space 1 into a kiln-chamber, and over this checker-work wall we secure paper to close the openings thereof and then introduce the goods into space 2 through manhole M, leading to the grate for space 3.

Instead of constructing a temporary checker-work wall, as described, and if the nature of the goods to be baked will admit, the said wall may be dispensed with and a simple paper partition interposed between the goods in spaces 1 and 2, and the brick wall or paper partition may be arranged either along the right or left hand side of the grate. The described operations will be continued for each of the successive kiln-spaces until all are supplied with goods to be baked. Fire may be started on the grate for space 1 as soon as space 2 has been stored with goods, the products of combustion flowing through ash-pit of grate for space 2 to valve-port *h*, main flue *a*, and stack, the valve or damper *i* for said port being previously opened, or said products of combustion may be caused to flow through *J R h a* to stack, as the case may be. After space 3 has been stored with goods the valve *i* for the draft-flue of space 2 is closed, and as the products of combustion find no issue the paper partition on the right or left of the grate for space 2 will be burned and the products of combustion will flow through space 2, and so on for the rest of the kiln-spaces until finally the temporary brick wall at *W* on the right of the grate for space 1 is removed, so that the products of combustion from the grate for space 1 will flow through the kiln from 1 to 16, thence by way of either of the systems of draft-flues to the main flue *a*.

When the goods in space 1 are baked, the fire on grate for said space is drawn, the gate for the introduction of fuel and the stoking of the fire on said grate is removed, the opening therefor bricked up, and the entrance to the ash-pit closed by a plate *L*, which latter is then covered with sand, so as to prevent all access of cold air to said space 1, fire being at the same time started on the grate for space 2, so that the goods in space 1 will gradually cool down, since none of the products of combustion pass through said space. A similar proceeding is resorted to for each successive kiln-space, the goods being removed therefrom as soon as they have cooled sufficiently for handling, and the process of charging the successively-emptied spaces is proceeded with as above described.

The removal of the goods of course takes place through the manholes *M*, and when these are opened the cold air entering the kiln is heated by the still-hot wares, the heated air mixing with the products of combustion of the fuel on the grate for the next succeeding kiln, so that the larger portion of the heat stored in the wares is also utilized.

The operation of a twin-gallery intermittently-operating kiln is substantially as above described, except that when the goods contained in the several kiln-spaces are baked the fire is drawn and the goods allowed to cool, and are then removed.

In the operation of a single-gallery inter-

mittently-operating kiln the kiln-spaces are filled with goods, the manholes *M* are closed, as described, and a fire on the grate for space 1, Fig. 10, is started. When the contents of space 1 are baked, fire is started on the grate for space 2, and so on until the contents of space 6 are baked, after which the fire for said space is drawn, the goods allowed to cool, and then removed.

In this type of kiln the products of combustion flow at the start from space 1 to 6, finding their way to the main draft-flue *a*² through flues *r'* and *R'* at the end of said space 6. When, however, the contents of space 1 are baked and fire is started on the grate for space 2, the products of combustion flow from 2 to 6, then from 3 to 6, and so on until the contents of said space 6 are baked, after which the fire on the grate for said space is drawn or allowed to die, and when the goods have cooled sufficiently to be handled they are removed.

As is usual, a peep-hole *h'* is provided in the arch of the kiln spaces or galleries for inspection of the goods therein, and should a paper partition not be burned by the heat and flame from a grate it can be ignited by means of a torch introduced through such peep-hole.

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

1. In a continuous-gallery kiln divided into spaces by fuel-grates, a main flue common to all said spaces, flues opening into said spaces in front of and above said grates at the outer end thereof, said flues connected with the main flue, and suitable dampers for controlling the flow of the products of combustion, substantially as and for the purposes set forth.

2. In a continuous-gallery kiln divided into spaces by fuel-grates, an ash-pit under such grates open to the atmosphere outside the kiln-walls, a main draft-flue, a flue connecting the ash-pit with said main flue and means for directing the products of combustion from above the grate into the open end of said ash-pit; of auxiliary flues opening at one end into the gallery-spaces in front of and at the outer end of the grates, said auxiliary flues in communication with the main flue, and suitable dampers for controlling the flow of said products of combustion to such main flue, substantially as and for the purpose set forth.

3. In a continuous-gallery kiln, a single partition-wall separating the galleries running lengthwise of the kiln and closing the inner side of the end connecting-spaces, fuel-grates dividing said galleries and end spaces into kiln-spaces, an ash-pit below each fuel-grate accessible respectively from the sides and ends of the kiln, and a main draft-flue formed in said partition-wall, in combination with flues connecting the ash-pits with said main flue, means for directing the products of com-

bustion from above the grate directly into the ash-pits at the outer end thereof, auxiliary flues for connecting the gallery-spaces directly with the main flue, and suitable dampers for controlling the flow of the products of combustion from the aforementioned flues to the main flue, substantially as and for the purpose set forth.

4. A continuous-gallery kiln divided into spaces by fuel-grates, and having parallel longitudinal channels formed in the side walls

of said spaces, substantially as and for the purpose set forth.

In testimony whereof we affix our signatures in presence of two witnesses.

CHARLES DUBOIS D'ENGHIEN.
ALPHONSE DUBOIS D'ENGHIEN.
LÉON DUBOIS D'ENGHIEN.
SILVAIN DUBOIS D'ENGHIEN.

Witnesses:

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