

No. 644,000.

Patented Feb. 20, 1900.

A. E. BROWN.

CONTINUOUS KILN FOR BURNING BRICKS OR THE LIKE.

(Application filed Nov. 15, 1898.)

(No Model.)

4 Sheets—Sheet 1.

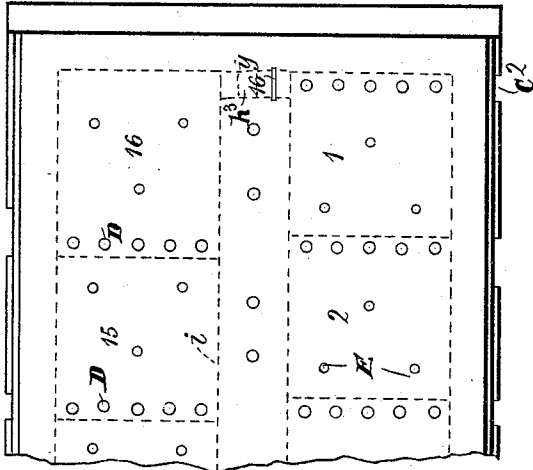
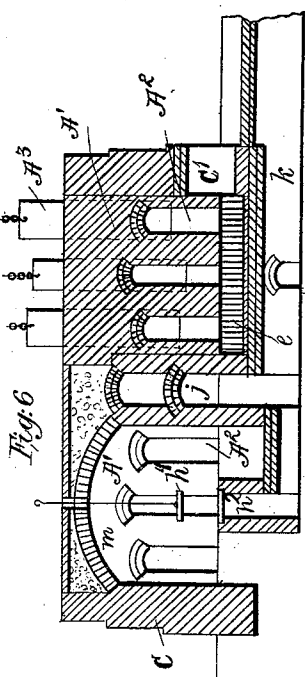
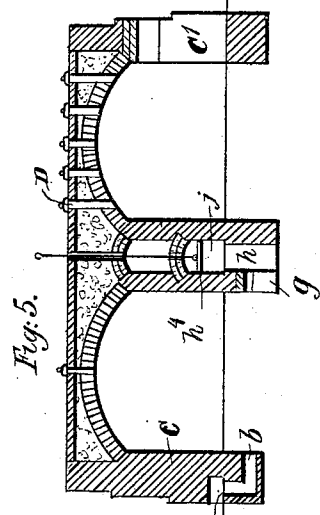
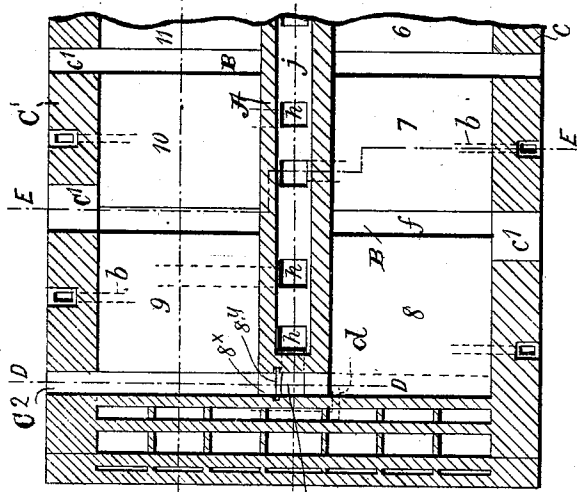
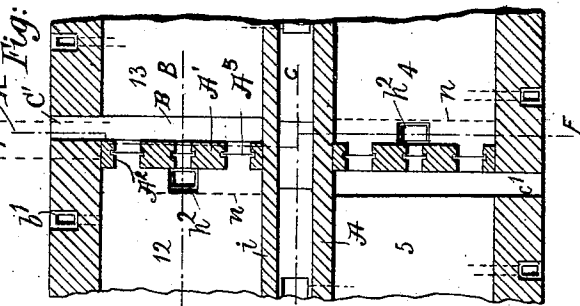


Fig. 1.



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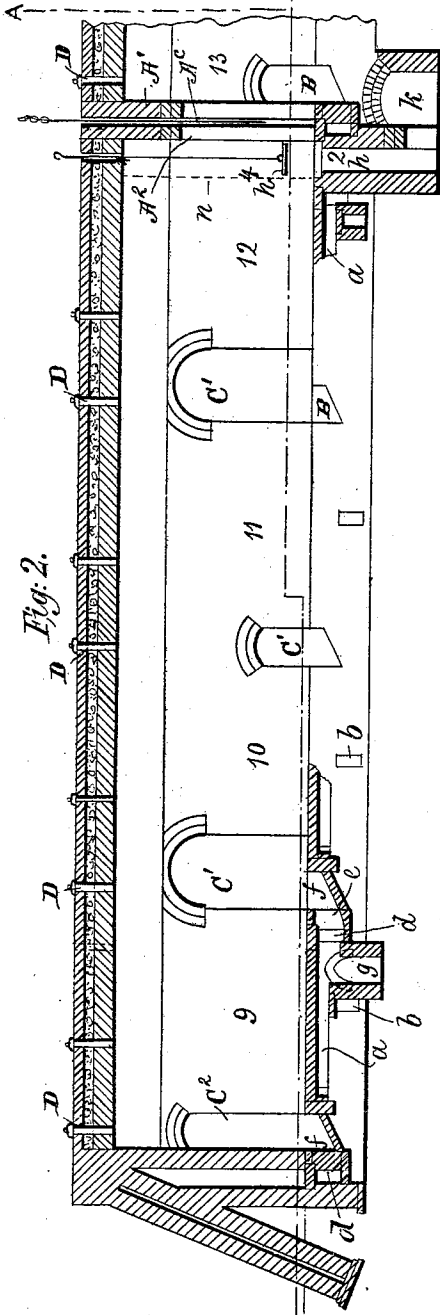
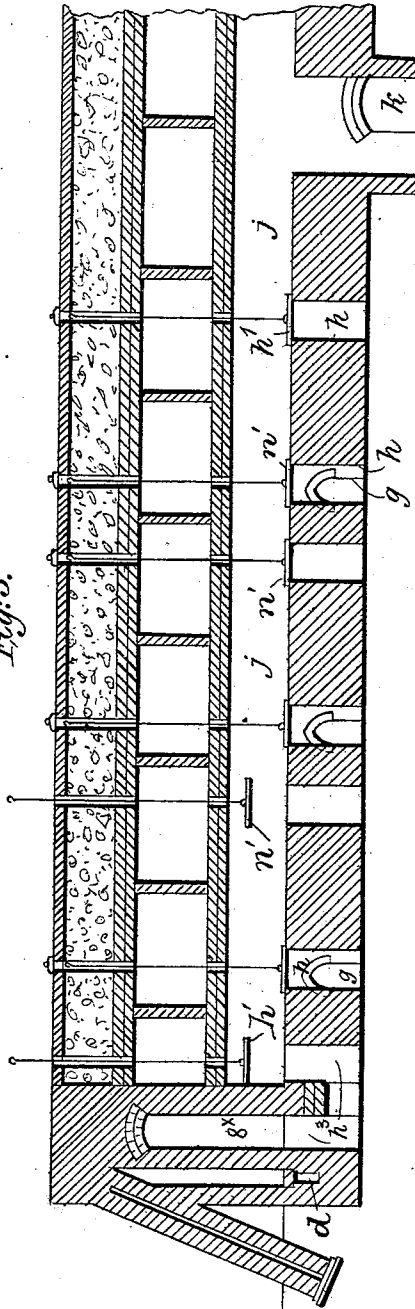


Fig. 2.

Fig. 3.



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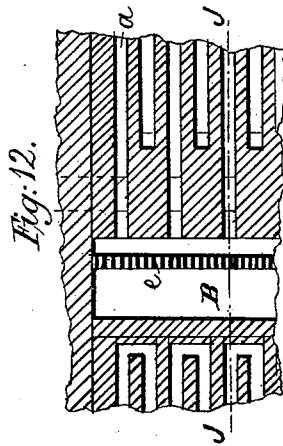
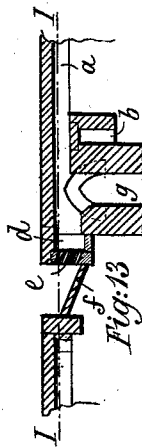
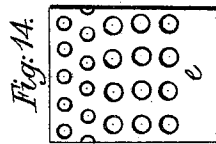
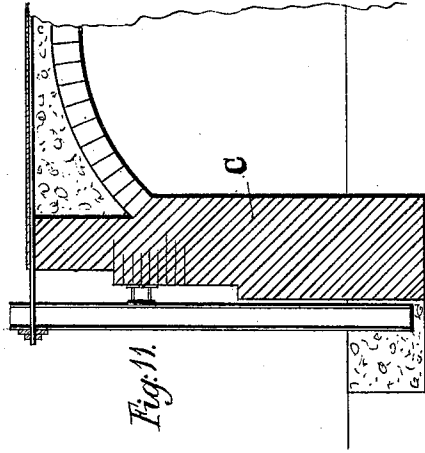
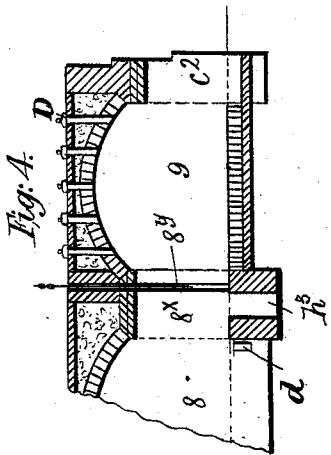
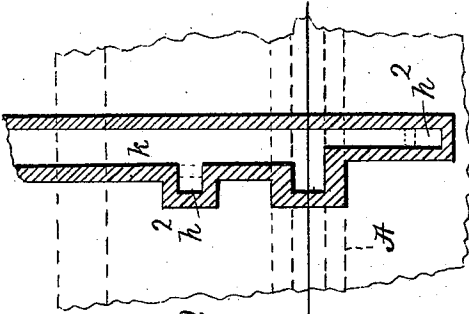
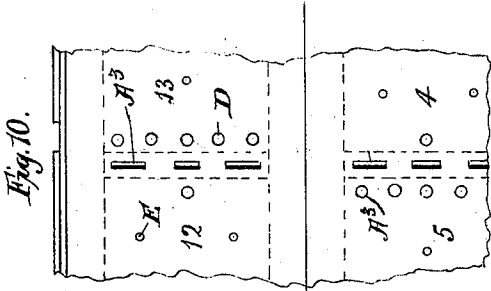
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(Application filed Nov. 15, 1898.)

(No Model.)

4 Sheets—Sheet 3.



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4 Sheets—Sheet 4.

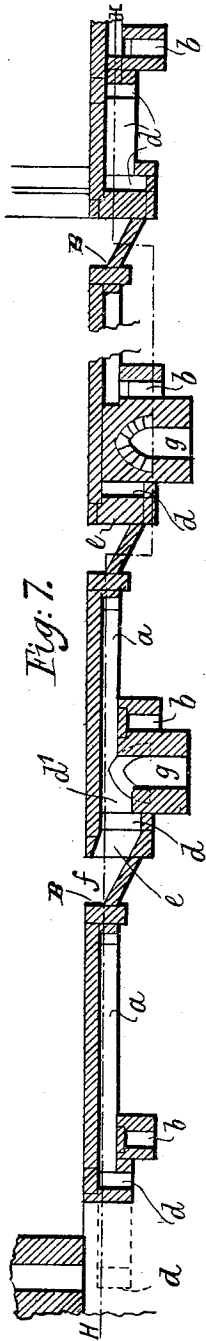


Fig. 7.

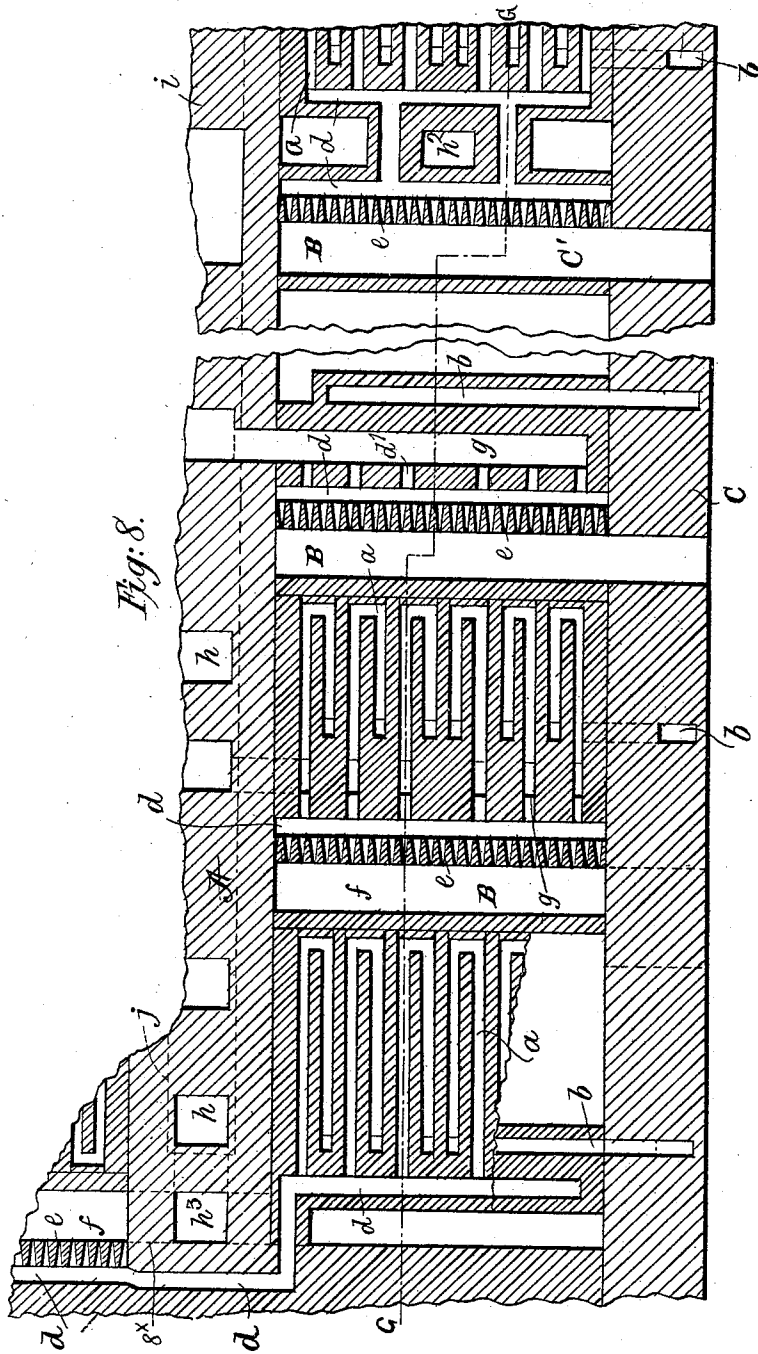


Fig. 8.

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UNITED STATES PATENT OFFICE.

ARTHUR EDWARD BROWN, OF LONDON, ENGLAND.

CONTINUOUS KILN FOR BURNING BRICKS OR THE LIKE.

SPECIFICATION forming part of Letters Patent No. 644,000, dated February 20, 1900.

Application filed November 15, 1898. Serial No. 696,575. (No model.)

To all whom it may concern:

Be it known that I, ARTHUR EDWARD BROWN, a subject of the Queen of Great Britain and Ireland, residing at Regent's Park, London, England, have invented Improvements in Continuous Kilns Suitable for Burning Bricks or the Like, of which the following is a specification.

My invention has reference to an improved construction of kilns of the continuous type adapted, *inter alia*, to be easily manipulated to enable high temperatures to be attained and bricks or other articles to be rapidly and evenly burned without excessive wear of the kiln and without damaging so large a proportion of the articles as is usual with kilns of known constructions, as also to admit of either large or small quantities of goods being advantageously dealt with at a time. For this purpose my improved kiln comprises two parallel rows of "burning-chambers," as hereinafter defined, so connected at their respective ends the one row to the other by tall narrow openings through the longitudinal division-wall as to constitute a continuous kiln without semicircular ends, such as obtain in some known forms of kilns of the kind referred to. The rows of burning-chambers above mentioned may each comprise either a series of chambers separated one from another by perforated transverse walls or partitions or, as I prefer, a long chamber with a central transverse partition having openings therethrough controlled by adjustable dampers, the series of chambers or the long chamber being provided at suitable intervals with special fire-boxes and flues and adapted to serve when worked as hereinafter described after the manner of a series of burning-chambers in a continuous kiln. Furthermore, according to my invention I provide the burning-chambers of continuous kilns with what I call "regenerative" fire-boxes, each comprising a hearth, with grating and regenerative air-passages, adapted to operate substantially as hereinafter described. The arrangement is such that the air-supply on its way to the hearth of each fire-box is heated by passing through passages beneath the floor of the kiln, which passages themselves receive heat from the hot bricks or other articles that are

on the floor of the corresponding and newly-burned chamber. Similar passages may also be constructed, if desired, in the side walls of the chambers, the passages in each case being connected at one end to an air-inlet passage. Thus the air can be raised to a high temperature by heat that would be otherwise lost by conduction into the earth or through the walls into the air. The heated air is conducted from the said passages (which should be as circuitous as possible) into an air-collecting space (hereinafter called the "hot-air chamber") extending across the width of but below the burning-chamber and common to all the said air-heating passages of the one chamber. From the hot-air chamber the heated air passes through the grating to the fire-box. The grating is constructed or composed of refractory material (the slits or openings being vertical or horizontal) and is arranged vertically, or approximately so, so as to divide the hot-air chamber from the hearth or fire-box. The arrangement is adapted to facilitate continuous efficient and smokeless combustion of fuel at the hearth. In some cases I may use a perforated screen instead of a grating. The hearth may be either horizontal or inclined; but I consider it advantageous to slope the hearth toward the bottom of the grating, so that fuel supplied to the hearth may more quickly fill up the space above it, and thus cover the tops of the slits and the more effectively utilize the heated air. Regenerative fire-boxes so constructed may be applied to existing continuous kilns.

Continuous kilns according to my invention may be built with any suitable number of burning-chambers, and a small number of such chambers may be arranged in a single row, forming a semicontinuous kiln. Such a kiln is herein included in the term "continuous kiln."

Although in this description I allude chiefly to the burning of bricks, it will be understood that pottery, terra-cotta, glazed ware, cement, lime, and various articles, even of very high quality, may be burned in such a kiln.

Figures 1 to 6, inclusive, of the accompanying drawings show a continuous kiln according to this invention, Fig. 1 being a sectional plan, the section being taken on the line A A

of Fig. 2, Figs. 2 and 3 part longitudinal sections taken, respectively, on the lines B B and C C of Fig. 1, and Figs. 4, 5, and 6 transverse sections of the kiln, taken, respectively, on the lines D D, E E, and F F of Fig. 1. Figs. 7 and 8 show in sectional elevation and sectional plan, respectively, regenerative fire-boxes according to this invention, Fig. 7 being taken on the line G G of Fig. 8 and Fig. 8 being taken on the line H H of Fig. 7. Fig. 9 is a detail sectional plan of the main flue. Fig. 10 is a part plan of the middle portion of the top of the kiln. Fig. 11 shows a form of bracing for small kilns. Fig. 12 is a part-sectional plan on the line I I of Fig. 13, and Fig. 13 is a part vertical section on the line J J of Fig. 12, illustrating the use of a perforated screen in place of the grating with vertical slits, shown in the previous figures. Figs. 14 and 15 show a part of the perforated screen separately. Fig. 16 is a sectional plan on the line K K of Fig. 18; Figs. 17 and 18, sections on the lines L L and M M, respectively, of Fig. 16; and Fig. 19, a section on the line N N of Fig. 17.

The kiln shown comprises two long parallel rectangular-shaped chambers separated by a central longitudinal wall A and each provided with a central transverse partition A' and with transverse fire-boxes B, arranged at intervals across the chamber below the floor thereof, the arrangement being such as to form sixteen burning-chambers, that are numbered, respectively, 1 2 3 4 to 16, and each of which is provided at its rear end with a fire-box, the central wall A being formed at its two ends with tall narrow openings 8^x and 16^x, that connect the adjacent end chambers 8 and 9 and 16 and 1 and are adapted to be controlled by dampers 8^y and 16^y, respectively, and the transverse partitions A' being formed with tall vertical openings A², adapted to be controlled by dampers A³. The outer side walls C of the rectangular-shaped kiln are provided with openings C' (hereinafter called "loops") opposite each fire-box B. These loops are or may be alternately large and small, as shown in Fig. 2, the larger ones serving for the introduction and withdrawal of the bricks to and from the burning-chambers on each side of a larger loop and the smaller loops serving for the withdrawal of ash and clinkers from the fire-boxes B opposite to them. In a kiln with very large chambers all the loops are made large. The arches of the kiln are covered with dry-rubbish filling, which is paved over in a usual manner and so as to form a flat roof. At one or at each end of the kiln there is provided a loop C², made sufficiently large to facilitate ignition of fuel at starting. Above each fire-box B there are formed in the roof fuel-charging holes D, provided with suitable covers. Charging-holes so placed have the advantage of not admitting cold air when the covers are removed; but the charging may be also ac-

complished by means of temporary doors in the loops C' C², the latter being bricked up when the kiln is in operation, as will be hereinafter described. Above the spaces intended to be occupied by blocks of bricks in the kiln peep-holes E are formed in the roof to enable the progress of the burning to be observed.

a shows circuitous air-passages arranged under the floor of each burning-chamber, so as to be heated by the hot goods thereon and supplied with air through an inlet-passage b, that leads from an opening formed in the outer wall C and is provided with an adjustable damper b', Fig. 5, to regulate the supply of air thereto or to close it entirely, according to requirement. The air-passages a communicate with a transverse hot-air chamber d, arranged below the floor of the corresponding burning-chamber and along one side of the corresponding fire-box B, which is formed with a vertical grating e of refractory material and a hearth f, that preferably slopes toward the grating, as and for the purpose hereinbefore explained. The hearth and grating of each regenerative fire-box thus formed extend from one side of the corresponding chamber to the other and constitute, as already indicated, the fire-box proper, into which the fuel is introduced through the charging-holes D, formed in the roof of the kiln. The space above each fire-box being unfilled by articles enables the hot gases of combustion to be diffused therein and mixed with the heated air, which passes through the cooling-chambers before being drawn forward by the draft induced by the chimney.

Figs. 16, 17, 18, and 19 show how the air-heating passages a are arranged vertically in the wall of the kiln and are connected, on the one hand, with the transverse air-chamber d through a passage a' and, on the other hand, with the inlet-passage b through a passage a², b' being the damper for controlling the supply of air. The hot air flows from the air-passages a into the hot-air chamber d and through the grating e on its way to the corresponding fire-box B, and the grating being composed of refractory material allows of the air being supplied at a very high temperature, which would be impossible with an iron grating. The hot-air chamber d also serves as an ash-pit to collect such ashes as may fall through the slits in the grating e. The hot air is conveyed from the hot-air chambers d of the end burning-chambers 8 and 16 to the fire-boxes B of the respective adjacent chambers 9 and 1 by means of hot-air passages, such as 8^z. Each hot-air chamber d may communicate by openings d' with a transverse smoke-flue g, one of which is provided for each burning-chamber, except the burning-chambers 4, 8, 12, and 16. Chambers 8 and 16 have openings h³ in the floors of the connecting-passages 8^x and 16^x, leading directly into the kiln-flue j, such openings be-

ing controlled by dampers h' . The chambers 4 and 12 are provided at the rear of the transverse partitions A' with openings h^2 , through which smoke is conducted from the spaces left between the stacks of bricks (indicated by the dotted lines at n in Fig. 1 and the partitions) to the main flue k , the said openings being controlled by dampers h^4 . At the proper stage of the operation smoke is directed from above one of the fire-boxes B through the grating e thereof and hot-air chamber d into the corresponding smoke-flue g , the flow of hot air through the hot-air passages a and chamber d being then stopped at that stage by the corresponding damper b' . This may take place with more than one burning-chamber at a time. The smoke passes through the smoke-flue into a damper-chamber h , which is capable of being opened or closed by a damper h' . These damper-chambers may be formed for convenience in the central longitudinal wall A of the kiln, and they communicate when the dampers h' are opened with a longitudinal kiln-flue j , common to all the said damper-chambers and situated above them. By placing the kiln-flue in the inner wall it is kept dry and warm, as well as being obtained of shorter length. At a suitable point in the length of the kiln-flue j , about the middle by preference, so as to equalize the draft, the smoke is conducted from the said kiln-flue into the main flue k , through which the smoke passes on its way to the chimney.

The transverse partitions A' , with openings A^2 and dampers A^3 , and the end connecting-passages 8^x 16^x , with dampers 8^y and 16^y , serve to enable the amount of cold air passing into the chambers in front of each partition or connecting-passage to be readily controlled to suit requirement or stopped entirely, the adjustment of the dampers being effected in rear of the burning-chambers that are in the process of cooling when the partition or the brickwork around the connecting-passage, as the case may be, is no longer at a sufficiently-high temperature to injure such dampers. The opening A^2 and passages 8^x and 16^x are made of ample height and width to admit of a practically-unobstructed passage of hot gases therethrough when opened. The connecting-passages 8^x and 16^x , with dampers 8^y and 16^y , and the transverse partitions A' , with openings A^2 and dampers A^3 , can also be used for the purpose of arresting the progress of the kiln for a time. It will be obvious that where-as either side of the kiln may be completely closed by means of the dampers 8^y 16^y in the end connecting-passages 8^x 16^x by means of the transverse partitions A' , closing may also be effected at the chambers adjacent to them. Should it be desired to arrest progress after having just finished burning those chambers in the middle of a row, the dampers of the end connecting-passages are closed down. On the other hand, should the chambers at one end of the double row be the last burned—

i. e., the last chambers of one row and the first in the next—then the openings in the middle partitions A' are closed, so as to arrest progress, the end connecting-passage being left open, the whole of the chambers from the middle of one row to the middle of the other being in various stages of heating, burning, or cooling.

When using two connected long chambers adapted each to serve as a series of burning-chambers, as hereinbefore described, the articles to be burned may be so piled as to constitute a series of blocks or stacks with intervening spaces. These spaces correspond in width and position with the fire-boxes and are placed at distances apart corresponding, or approximately so, to those at which the transverse walls would occur in a kiln where-in such were provided between the several burning-chambers of a row. Sometimes, as when a common class of goods is being burned, an increased output may be obtained by setting the articles in these spaces, leaving the latter only about three feet high instead of up to the crown and providing holes there-through for the passage of fuel.

When setting goods in the kiln, in the outer end of each end chamber a space is left between the outer end of the stack of goods and the end wall of the kiln, as indicated at n' in Fig. 1, corresponding in width, or approximately so, to the connecting-passage 8^x or 16^x in the longitudinal wall A , so as to provide a passage of considerable height extending across the full inside width of the two juxtaposed end chambers 8 and 9 or 16 and 1. To prevent the products of combustion from being drawn diagonally across the last chamber in the direction of the connecting-passage in the longitudinal wall and so leaving articles at the outer end corner insufficiently burned, the end articles of the block are so arranged or set in the chamber that the spaces between them near the connecting-passage are comparatively narrow and gradually increase in width toward the outer wall of the kiln. The requisite variation in the spacing may be easily ascertained in practice. The front block of bricks in the first chamber of the other row (the next chamber to be worked) need not be so arranged, as the impetus of the hot gases carries them along the space at the end of the kiln, so as to effect an equal distribution of heat.

In order to give a clear understanding of the operation of a continuous kiln constructed as hereinbefore described, I will assume that the burning operation is to be commenced at No. 1 chamber, in which case the connecting-passage 16^x , which connects it with No. 16 chamber, should be closed by a temporary brick partition. The chambers are set in succession as required and in the ordinary way. The articles can be dried in the kiln, if desired, the chambers for this purpose being set in advance. The two first chambers being set, a temporary partition is placed across

the back or left-hand end of chamber No. 2 and pugged up, so as to exclude air. Sometimes instead of a temporary partition, which is afterward removed, I apply a shield of suitable paper, such as wall-paper, which is afterward burned up by the hot products of combustion. The fire-box of No. 1 chamber is filled with coke up to the top of the slits in the grating thereof and the loops are bricked and pugged up, a small temporary fire-door being left in the loop of chamber No. 1. A small drying-fire is then kindled on the top of the coke in No. 1 fire-box, the No. 1 damper *h'*—viz., that controlling the exit of smoke from the No. 2 fire-box—being raised. Tanning or drying of the bricks in chamber No. 1 is thus commenced, and the fire is gradually extended across the chamber along the fire-box to increase the heat. When considered necessary, the air-inlet *b* under chamber No. 16 may be opened to admit cold air to the fire-box of No. 1 to aid the combustion. When chamber No. 1 is dry and ready for burning, the temporary partition is removed to the back of chamber No. 4, No. 1 damper is closed, No. 2 damper is opened full, and No. 3 damper is partly opened, thus enabling a moderate heat to be carried forward for the successive tanning of chambers Nos. 2 and 3. The temporary fire-door in No. 1 loop is then closed and coal dropped through the feed-holes *D* into No. 1 fire-box. The heat produced may be regulated by varying the amount of fuel supplied and the quantity of air admitted by the inlet *b*. When the bricks in chamber No. 1 are red-hot, coal is dropped through the feed-holes gradually into fire-box No. 2 and the temporary partition is moved behind a farther chamber. No. 2 damper *h'* is closed and Nos. 3, 4, and 5 are opened, as may be considered necessary. Gradually the temperature in chamber No. 1 will rise until the bricks are burned, and by that time the fire-box No. 2 will be full of incandescent coal. Then the air-inlet *b* to fire-box No. 2 is opened to admit air to the flues under chamber No. 1 to be heated and conducted to the fire-box No. 2 between chambers Nos. 1 and 2, thus causing the fire therein to burn intensely. The fire of chamber No. 1 is maintained to such extent as may be found desirable during the burning of chamber No. 2 and in a less degree during the burning of chamber No. 3. After that the air-inlet *b* to fire-box No. 1 is closed and the fire in such fire-box allowed to cool down. The fire-box of chamber No. 3 is gradually filled with coal while chamber No. 2 is burning, and at the proper moment hot air is admitted to it from the heated flues under No. 2. As the fire advances more unburned chambers are added in front, and the temporary partition is erected at each of the large loops in turn. Up to this time air has been admitted only through the air-passages under the chambers; but when the fire has reached and burned chamber No. 5, the fire of chamber No. 4 being still kept up and the

fire of No. 3 being out a small opening may be made in the loop of chamber No. 1 to admit cold air direct to that chamber. This air cools the burned bricks in chamber No. 1, and in a less degree those in chamber No. 2, and goes forward through hot chambers, gradually getting raised to a high temperature. The burning of the successive chambers then advances at a more rapid rate. When the burning of chamber No. 8 or chamber No. 9 is finished, the dampers *A*³ in the wall *A'* between chambers 4 and 5 may be lowered to the required extent and No. 2 loop may be taken down and the unloading of burned bricks and reloading with unburned bricks may be proceeded with. Supposing the first eleven chambers to be now in circuit, the smoke-dampers of chambers Nos. 9 and 10 are open at a time when no coal has been dropped into the fire-boxes Nos. 10 and 11, the corresponding air-inlets *b* are closed, and thus the corresponding fire-box-grating slits, hot-air chambers *d*, and smoke-flues *g* are free to act in the withdrawal of smoke from the circuit and at its farthest extremity. Also, though the fire-boxes Nos. 3, 4, 5, 6, and 7 are full of extinct or burning fuel, the smoke-flues *g* are not required to be in use and are closed by the corresponding dampers *h'*, and therefore the air-inlets *b* to those chambers can be used as desired without being interfered with by the smoke-flue.

In practice the filling of each fire-box with coal is done gradually in advance of the burning operation and before the corresponding air-inlet is opened. The hot gases from the burning-chamber in advancing toward the chimney ignite the coal in the fire-box, and by the time the necessity arises for obtaining full combustion the fire-box is full of incandescent coal, which bursts into intense combustion when air is admitted thereto.

In kilns where the fuel is thrown on horizontal fire-bars with an ash-pit under and cold air admitted direct to the fire-bars it is obvious that stoking of the fires is necessary to remove clinker and cause the dispersion of dust and small ash. With the fire-boxes herebefore described the dust and ash accumulate on the dead-hearth *f* and do not impede the entrance of fresh air to the fuel, and consequently no stoking is required.

In addition to the air drawn into the fire-box through the air-passages air is also brought forward through several successive back chambers which have been burned, and in doing so it becomes highly heated, cooling down the burned chambers in its passage. Notwithstanding this heating it will be understood that it never attains the temperature of full combustion necessary to burn the unburned chambers. When, therefore, it arrives at a point where it meets with the intensely-hot gases of active combustion from a fire-box, it mingles with them and acts as a diluent thereto, thus preventing damage to the front face of bricks in the chamber being

burned and producing an equally-distributed heat, which can be regulated at will to suit the class of goods in the kiln. Owing to the rapidity of progress when in full work a large output can be obtained from a relatively-small kiln. Furthermore, owing to the facility and effectiveness of control the progress of burning can be delayed or arrested with very little loss of fuel and with prompt resumption of full activity when desired. A further advantage is adaptability to small output in that a small number of chambers can be filled and used with economical and good results. The contents of the chambers can be burned with practically-equal intensity from back to front, and thereby superior goods can be produced more uniform in quality than with some known constructions of kiln, while very few goods are liable to injury through excessive heating, notwithstanding that very high temperatures can be produced with an economical consumption of fuel.

A kiln constructed as described can be well adapted for use with forced draft, thereby producing very high temperatures and enabling the use of very hard coals or fuels of inferior quality. It can also be worked by an induced draft set up by a fan instead of a chimney.

What I claim is—

1. In a continuous kiln suitable for burning bricks and other articles, a fire-box arranged to extend transversely across and below the floor of each burning-chamber and comprising a solid hearth adapted to receive thereon a charge of fuel and an upwardly-extending grating of refractory material adapted to admit of the passage of air to the fuel on said hearth, substantially as described.

2. In a continuous kiln, a fuel-receptacle having a solid hearth arranged transversely across and below the floor of each burning-chamber and an upwardly-extending grating or perforated screen of refractory material arranged along one side of said hearth, means for supplying heated air through said grating or screen along the entire length thereof, substantially as described.

3. In a continuous kiln, a fire-box comprising a fuel-receptacle arranged transversely across and below the floor of said kiln and having a solid hearth and an upwardly-extending grating or perforated screen composed of refractory material, a transverse hot-air-supply chamber located at one side of said fuel-receptacle and in communication therewith through said grating or screen, means for supplying heated air to said chamber and fuel-charging apertures in the roof of said kiln above said fire-box, substantially as described for the purposes specified.

4. In a continuous kiln, a solid hearth arranged transversely across and below the floor of each burning-chamber, a transverse hot-air chamber located at one side of said hearth, an upwardly-extending grating or perforated screen of refractory material separating said hearth and hot-air chamber, and air-heating

passages opening into the hot-air chamber and arranged so as to be heated to a high temperature from a previously-burned chamber of the kiln, substantially as described.

5. In a continuous kiln, a fire-box extending transversely across and below the floor of each burning-chamber, a transverse hot-air chamber in proximity thereto, air-heating passages opening into said hot-air chamber and arranged to be heated to a high temperature by heat from the next adjacent previously-burned burning-chamber of the kiln, air-inlet passages each adapted to admit cold air to the air-heating passages of the corresponding chamber and means for independently controlling each air-inlet, substantially as described.

6. In a continuous kiln suitable for burning bricks and other articles, a fire-box arranged to extend transversely across and below the floor of each burning-chamber and comprising a solid hearth adapted to receive thereon a charge of fuel and an upwardly-extending grating of refractory material adapted to admit of the passage of air to the fuel on said hearth, in combination with a transverse hot-air chamber arranged in proximity to said grating, air-heating passages opening into said hot-air chamber and arranged to be heated to a high temperature by heat from the next adjacent previously-burned burning-chamber of the kiln, air-inlet passages each adapted to admit cold air to the air-heating passages of the corresponding chamber and means for independently controlling each air-inlet substantially as described.

7. In a continuous kiln suitable for burning bricks and other articles, a fire-box arranged to extend transversely across and below the floor of each burning-chamber and comprising a solid hearth adapted to receive thereon a charge of fuel and an upwardly-extending grating of refractory material adapted to admit of the passage of air to the fuel on said hearth, in combination with a transverse hot-air chamber arranged in proximity to said grating, air-heating passages opening into said hot-air chamber and arranged to be heated to a high temperature by heat from the next adjacent previously-burned burning-chamber of the kiln, air-inlet passages each adapted to admit cold air to the air-heating passages of the corresponding chamber, means for controlling each air-inlet separately, a smoke-flue, passages leading from the said hot-air chamber to said smoke-flue, and means adapted to open and close communication between each fire-box and said smoke-flue, substantially as described.

8. A continuous kiln comprising burning-chambers arranged in two parallel rows a longitudinal division-wall located between said rows of kilns and formed at each end with a tall narrow opening adapted to connect the said rows of chambers the one with the other, two transverse partitions each arranged centrally across one row of said burning-cham-

bers and also formed with tall narrow openings, dampers adapted to control the openings in said longitudinal wall and transverse partitions, a fire-box extending transversely across and below the floor of each burning-chamber, and means for supplying heated air to each of said fire-boxes, substantially as described.

Signed at 2 Pope's Head alley, Cornhill, London, England, this 4th day of November, 1898.

ARTHUR EDWARD BROWN.

Witnesses:

PERCY E. MATTOCKS,
II. MAYKELS.